

City of Arvada

City Council Agenda

DECEMBER 2, 2024
CITY COUNCIL CHAMBERS
Regular Business

Councilmembers:

Lauren Simpson, Mayor
Randy Moorman, Mayor Pro-Tem
Shawna Ambrose, District 2
Sharon Davis, At large
Bob Fifer, District 4
John Marriott, District 3
Vacant, At large

Staff Members Usually Present:

Linda Haley, Acting City Manager
Don Wick, Deputy City Manager
Rachel Morris, City Attorney
Jacqueline Rhoades, Director of Public Works
Sharon Israel, Director of Utilities
Jessica Garner, Director of Community & Econ. Dev.
Bryan Archer, Director of Finance
Gabriella Bommer, Director of Human Resources
Ryan Stevenson, Director of Vibrant Community & Neighborhoods
Rachael Kuroiwa, Director of Communications & Engagement
Ed Brady, Chief of Police
Kristen Rush, City Clerk

Info: 720-898-7550

CITY COUNCIL MEETING – CITY COUNCIL CHAMBERS 6:00 PM

1. Call to Order - 6:00 PM
2. Moment of Reflection and Pledge of Allegiance - Councilmember Fifer
3. Roll Call of Councilmembers
4. Approval of Minutes
 - A. November 18, 2024 City Council Meeting
5. Recognitions and Communications - None
6. Presentations - None
7. Public Comment on Issues not Scheduled on Agenda - Three Minute Limit
8. New Business
 - A. Consent Agenda
 1. R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63

2. R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66
3. R24-125, A Resolution Authorizing Amendment No. 2 to "An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements" for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00

B. Resolutions

1. R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada (Presenter: Jessica Garner, Director of CED)
2. R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities (Presenter: Jacqueline Rhoades, Director of Public Works)

C. Ordinances (First Reading)

1. CB24-020, An Ordinance Authorizing an Additional Appropriation for Fiscal Year 2024 (Public Hearing to be set for December 16, 2024 at 6:15 p.m.)

9. Other

10. Public Hearings - 6:15 PM - None

11. Public Comment - Five Minute Limit

12. Reports from City Council

A. Council Committee Reports

13. Reports from City Manager

A. Review of Future Workshops and Presentations

14. Reports from City Attorney

15. Adjournment



SUMMARY OF MINUTES OF THE MEETING OF THE ARVADA CITY COUNCIL HELD NOVEMBER 18, 2024

1. Executive Session – 5:00 p.m.
 - A. Legal Advice Pursuant to CRS 24-6-402(4)(b) and Instructions to Negotiators Pursuant to CRS 24-6- 402(4)(e) Relating to Mountain Shadows Metropolitan District Request for Consent to Impose Fees

Mayor Pro Tem Moorman moved to go into executive session for Legal Advice Pursuant to CRS 24-6-402(4)(b) and Instructions to Negotiators Pursuant to CRS 24-6- 402(4)(e) Relating to Mountain Shadows Metropolitan District Request for Consent to Impose Fees.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Fifer, Marriott

The Motion was Approved

1. Call to Order - 6:05 p.m.

This Arvada City Council meeting was a hybrid meeting using webinar technology. Mayor Simpson, Mayor Pro Tem Moorman, Councilmember Ambrose, Councilmember Davis, Councilmember Fifer and Councilmember Marriott were all present in chambers. Members of the public were given notice with instructions on how to participate with public comment.

2. Moment of Reflection and Pledge of Allegiance
3. Roll Call of Councilmembers

Those Present: Mayor Lauren Simpson, Mayor Pro Tem Randy Moorman, Councilmember Shawna Ambrose, Councilmember Sharon Davis, Councilmember Bob Fifer, Councilmember John Marriott

Also Present: Linda Haley, Interim Manager; Rachel Morris, City Attorney; Don Wick, Deputy City Manager; Bryan Archer, Director of Finance; Jessica Garner, Director of Community and Economic Development; Ryan Stevenson, Director of Vibrant Communities and Neighborhoods, Katie Patterson, Communications Manager, Infrastructure; and Kristen Rush, City Clerk.

4. Approval of Minutes – November 4, 2024

The minutes stand approved.

5. Recognition and Communication –
 - A. Proclamation for Small Business Saturday - Presented by Councilmember Marriott

Councilmember Marriott read the proclamation and said that City Council proclaims Saturday, November 30, 2024, as Small Business Saturday in Arvada. Liz Johnson, Manager of Communications &

Marketing, and Sarah Miley, Economic Development Specialist, along with representatives from the local small business community were present to accept the proclamation.

B. Proclamation for Colorado Crash Responder Safety Week - Presented by Councilmember Fifer

Councilmember Fifer read the proclamation and said that City Council proclaims the week of November 18-22 as Colorado Crash Responder Safety Week. Ed Brady, Police Chief, was present to accept the proclamation.

6. Presentations –

1. 3rd Quarter Financial Presentation

Bryan Archer, Finance Director, provided City Council with an un-audited financial report and a presentation of the Third Quarter 2024 financials. The presentation included revenue and expenditure highlights of the major funds including General Fund, Parks, Tax Increments, Capital Projects, Water, Wastewater, Storm Water, Golf, Solid Waste and the Internal Service Funds, an update on the current investment market and a status update on grants.

7. Public Comment –

1. Alma Carrillo, representing Representative Petersen's office, shared resource information
2. Lauren Rapp, Arvada resident, addressed council regarding a navigation center
3. Gary Enos, Arvada resident, addressed council regarding a navigation center
4. Tiffany Munoz, Arvada resident, addressed council regarding a navigation center
5. Alex Pray, Arvada resident, addressed council regarding a Climate Action Plan
6. Monique Lani, Arvada resident, addressed council regarding a navigation center
7. Sarah Kolb, representing the Arts and Culture Commission discussed the new mural under Garrison Street
8. Tracy Kent, Arvada resident, addressed council regarding a navigation center
9. Dave Cornell, Arvada resident, addressed council regarding a navigation center
10. Renee Cornell, Arvada resident, addressed council regarding a navigation center
11. Laura Sadousky, Arvada resident, addressed council regarding a navigation center
12. Dan Muller, Arvada resident, addressed council regarding a navigation center
13. Karen Duato, Arvada resident, addressed council regarding a navigation center
14. Lynn Clemens, Arvada resident, addressed council regarding the Heritage Canal Trail
15. Mike Rawluk, Arvada resident, addressed council regarding the Heritage Canal Trail

8. New Business

A. Consent Agenda –

1. R24-118 A Resolution Accepting an Annexation Petition Concerning Colorado Department of Transportation (CDOT) Coal Creek Maintenance Yard, a Parcel of Land Approximately Located on the South Side of State Highway 72 Between Canyon Pines Drive and Plainview Road, in the City of Arvada, County of Jefferson, State of Colorado, Finding said Petition Substantially Compliant with C.R.S. 31-12-107(1), and Setting a Public Hearing for January 6, 2025, 6:15 p.m. for City Council to Determine Whether the Area Meets the Requirements of C.R.S. 31-12-104 and 105, and is Considered Eligible for Annexation

2. R24-119 A Resolution Authorizing an Agreement Between the City of Arvada and WinnMarion Barber, LLC for Goods and Services Relating to Electric Vehicle Chargers Supply, Installation, Maintenance and Repair in an Amount not to Exceed \$838,948.06

Councilmember Marriott requested that R24-119 be removed from the consent agenda.

Councilmember Fifer asked to be recused from R24-118.

Mayor Pro Tem Moorman moved to recuse Councilmember Fifer from the vote.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Marriott

Those Abstaining: Fifer

The Motion was Approved

Councilmember Davis moved that R24-118, A Resolution Accepting an Annexation Petition Concerning Colorado Department of Transportation (CDOT) Coal Creek Maintenance Yard, a Parcel of Land Approximately Located on the South Side of State Highway 72 Between Canyon Pines Drive and Plainview Road, in the City of Arvada, County of Jefferson, State of Colorado, Finding said Petition Substantially Compliant with C.R.S. 31-12-107(1), and Setting a Public Hearing for January 6, 2025, 6:15 p.m. for City Council to Determine Whether the Area Meets the Requirements of C.R.S. 31-12-104 and 105, and is Considered Eligible for Annexation, be approved.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Marriott

Those Abstaining: Fifer

The Motion was Approved

2. R24-119 A Resolution Authorizing an Agreement Between the City of Arvada and WinnMarion Barber, LLC for Goods and Services Relating to Electric Vehicle Chargers Supply, Installation, Maintenance and Repair in an Amount not to Exceed \$838,948.06

Councilmember Fifer moved that R24-119, A Resolution Authorizing an Agreement Between the City of Arvada and WinnMarion Barber, LLC for Goods and Services Relating to Electric Vehicle Chargers Supply, Installation, Maintenance and Repair in an Amount not to Exceed \$838,948.06, be approved.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Fifer

Those voting No: Davis, Marriott

The Motion was Approved

B. Resolutions –

1. R24-120 A Resolution Authorizing a Loan Agreement Between the City of Arvada and the Arvada Urban Renewal Authority for Loans in the Amount of \$12,000,000.00 to Support Projects in the Ralston Fields Urban Renewal Area

Bryan Archer, Director of Finance, reviewed this resolution with council.

Councilmember Ambrose moved that R24-120, A Resolution Authorizing a Loan Agreement Between the City of Arvada and the Arvada Urban Renewal Authority for Loans in the Amount of \$12,000,000.00 to Support Projects in the Ralston Fields Urban Renewal Area, be approved.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Fifer, Marriott
The Motion was Approved

2. R24-121 A Resolution Authorizing an Intergovernmental Agreement between the City of Edgewater and the City of Arvada for the Secondment of an Arvada Employee to the Edgewater Police Department

Padraic Emerine, Assistant City Attorney, reviewed this resolution with council.

Councilmember Fifer moved that R24-121, A Resolution Authorizing an Intergovernmental Agreement between the City of Edgewater and the City of Arvada for the Secondment of an Arvada Employee to the Edgewater Police Department, be approved.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Fifer, Marriott
The Motion was Approved

3. R24-122 A Resolution Adopting Policy No. 100.3 - Council Vacancies Into the City Council Policy Manual

Rachel Morris, City Attorney, reviewed this resolution with council.

Councilmember Ambrose moved that R24-122, A Resolution Adopting Policy No. 100.3 - Council Vacancies Into the City Council Policy Manual, be approved.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Fifer
Those voting No: Marriott
The Motion was Approved

C. Ordinances (First Reading) –

1. CB24-018 An Ordinance Annexing Certain Land into the City of Arvada for Colorado Department of Transportation (CDOT) Coal Creek

- Maintenance Yard, a Parcel of Land Approximately Located on the Southside of State Highway 72 between Canyon Pines Drive and Plainview Road, in the City of Arvada, County of Jefferson and State of Colorado (Public Hearing to be set for January 6, 2025 at 6:15 p.m.)
2. CB24-019 An Ordinance Rezoning Certain Land within the City of Arvada from Jefferson County A-1 (Agriculture-One) to City of Arvada OS (Open Space) and Amending the Official Zoning Maps of the City of Arvada, Colorado for the Colorado Department of Transportation (CDOT) Coal Creek Maintenance Yard, Approximately Located on the Southside of State Highway 72 between Canyon Pines Drive and Plainview Road (Public Hearing to be set for January 6, 2025 at 6:15 p.m.)

Councilmember Fifer asked to be recused from the first readings.

Mayor Pro Tem Moorman moved to recuse Councilmember Fifer from the vote.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Marriott

Those Abstaining: Fifer

The Motion was Approved

Mayor Pro Tem Moorman moved that CB24-018, An Ordinance Annexing Certain Land into the City of Arvada for Colorado Department of Transportation (CDOT) Coal Creek Maintenance Yard, a Parcel of Land Approximately Located on the Southside of State Highway 72 between Canyon Pines Drive and Plainview Road, in the City of Arvada, County of Jefferson and State of Colorado (Public Hearing to be set for January 6, 2025 at 6:15 p.m.) and CB24-019, An Ordinance Rezoning Certain Land within the City of Arvada from Jefferson County A-1 (Agriculture-One) to City of Arvada OS (Open Space) and Amending the Official Zoning Maps of the City of Arvada, Colorado for the Colorado Department of Transportation (CDOT) Coal Creek Maintenance Yard, Approximately Located on the Southside of State Highway 72 between Canyon Pines Drive and Plainview Road (Public Hearing to be set for January 6, 2025 at 6:15 p.m.), be approved on first reading, ordered published in full and a Public Hearing be set for October 7, 2024, at 6:15 p.m.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Feret, Marriott

Those Abstaining: Fifer

The Motion was Approved

9. Other – None

10. Public Hearings –

- A. CB24-017 An Ordinance Authorizing a Withdrawal Agreement Between the City and County of Broomfield, the Board of County Commissioners of Jefferson County, Colorado, the City of Arvada, and the Jefferson Parkway Public Highway Authority (Ordinance No. 4883)

Mayor Simpson opened the public hearing on CB24-017.

Rachel Morris, City Attorney, reviewed this ordinance with council

No one wishing to speak for or against, the public hearing was closed.

Councilmember Ambrose moved that CB24-017, An Ordinance Authorizing a Withdrawal Agreement Between the City and County of Broomfield, the Board of County Commissioners of Jefferson County, Colorado, the City of Arvada, and the Jefferson Parkway Public Highway Authority, be approved on final reading, numbered 4883 and ordered published by title only.

The following votes were cast on the Motion:

Those voting Yes: Simpson, Moorman, Ambrose, Davis, Fifer, Marriott

The Motion was approved

12. Public Comment - Five Minute Limit –
13. City Council Reports –
 - A. Mayor Pro Tem Moorman invited everyone to his monthly coffee chat on November 22 from 2-4 p.m. at Sweet Bloom Coffee Roasters, 7745 Wadsworth Boulevard.
 - B. Councilmember Fifer thanked Mayor Pro Tem Moorman for the great speech he gave at the ribbon cutting at the Stanley Lake Trail Head.
 - D. Mayor Simpson discussed the legislative breakfast held this morning.
 - E. Mayor Simpson invited everyone to the grand opening of the Arvada Aquatics Center on Saturday from 2-5 p.m.
 - F. Mayor Simpson invited everyone to Olde Town on November 30 for the Tree Lighting from 2-8 p.m.
14. City Manager Reports –
 - A. Linda Haley, Acting City Manager, reviewed the upcoming Workshop Schedule.
15. City Attorney Reports – None
16. Adjournment at 8:20 p.m.

Lauren Simpson, Mayor

SEAL:

Kristen R. Rush, City Clerk



REPORT TO CITY COUNCIL

AGENDA ITEM
8.A.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: Consent Agenda

Report in Brief

1. R24-123, A Resolution Authorizing Amendment No. 3 to the "Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00" for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63
2. R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66
3. R24-125, A Resolution Authorizing Amendment No. 2 to "An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements" for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00

Suggested Motion: Moved by: _____ I move that the Consent Item(s),
Number(s) _____
be
(Removed from the Consent Agenda and Heard Upon Item _____) (Referred to a Workshop) (Postponed
Indefinitely).

YES _____ NO _____ ABSENT _____

That All/Remaining Consent Items be (Approved) (Rejected).

YES _____ NO _____ ABSENT _____

Prepared by:
Chris Koch, CCO Admin

Reviewed by:

Approved by:

Enclosure, exhibits & attachments required to support the report



REPORT TO CITY COUNCIL RESOLUTION

AGENDA ITEM
8.A.1.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63

Report in Brief

Amendment No. 3 to the Construction Management/General Contractor services contract between the City of Arvada and BT Construction, Inc. for the NTL10 - Tennyson and 58th project will increase the existing contract amount by \$13,258,966.50 to a new contract total of \$13,703,199.63.

The Arvada team recommends that the City Council approve R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63.

Financial Impact

CIP Project: 22-SR-11 NTL 10, 61st & Tennyson (Bond)

Financial Impact: \$13,703,199.63

This is a one-time request for Project Construction costs.

Funding Source: UT Wastewater Bond Projects (42)

CIP Account Number: 98551

Workday Account: PRJ23098551

Background

In 2022, the City of Arvada completed a Sanitary Sewer Master Plan that provided the hydraulic modeling results of the existing sanitary sewer infrastructure servicing northern Arvada. This report highlighted several areas of capacity concerns under existing and build-out conditions. NTL10 was identified as one of the four priority areas and the most time sensitive portion. The Arvada team contracted with BT Construction Inc. to provide construction management/general contractor services for the sewer improvements in Tennyson St between 61st Pl and Interstate 76.

Discussion

A Construction Management/General Contractor (CM/GC) alternative delivery method was selected for the project to mitigate construction risks due to the right-of-way having many underground utilities and the crossing of three railroads. BT Construction, Inc. was originally selected to be the project CM/GC in February 2023 following City procurement rules. BT

SUBJECT: R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63

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Construction was contracted for an amount of \$86,450.00 for pre-construction phase services. BT Construction has demonstrated their professionalism and construction knowledge throughout the pre-construction phase of this complicated project and has successfully negotiated a fair guaranteed maximum price for all work necessary to complete the project. Amendment 3 will increase the total contract value to \$13,703,199.63 and includes all construction time and materials costs for the project.

Original Contract: \$86,450.00

Amendment 1: \$266,350.00 for early procurement of electrical equipment

Amendment 2: \$91,433.13 for subsurface utility investigation

Amendment 3: \$13,258,966.50 for construction of the project

Public Contact

Posting of the City Council agenda.

Commission Recommendation

N/A

Strategic Alignment

The recommended action aligns with the Infrastructure Priority Area within the City Council Strategic Plan. Specifically, the recommended action is consistent with the following work system service included in the Infrastructure Priority Area:

Provides the community with a safe, reliable high quality water supply, drainage system, and wastewater disposal services for full city build-out, as defined in the Comprehensive Plan. This includes maintaining utility rates at the lowest practical levels with accurate billing that supports replacement of aging infrastructure in order to maintain robust utility systems.

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63.

Suggested Motion:

I move that R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63, be (approved) (rejected).

Prepared by:

SUBJECT: R24-123, A Resolution Authorizing Amendment No. 3 to the “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. for Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58TH Project in an Amount Not to Exceed \$86,450.00” for Purposes of Awarding Contractor Phase II with a Guaranteed Maximum Price of \$13,258,966.50, Thereby Increasing the Total Contract Amount to an Amount Not to Exceed \$13,703,199.63

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Chris Koch, CCO Admin

Reviewed by:

Approved by:

Mary Stahl, Senior Civil Engineer	10/16/2024
Chris Lisberg, Assistant City Engineer	10/16/2024
Jacqueline Rhoades, Public Works Director	11/5/2024
Tammy Hedlund, Legal Specialist	11/6/2024
Jessica Morales, Assistant City Attorney	11/8/2024
Bryan Archer, Director of Finance	11/13/2024
Rachel Morris, City Attorney	11/19/2024
Don Wick, Deputy City Manager	11/20/2024
Linda Haley, Acting City Manager	11/20/2024

Enclosure, exhibits & attachments required to support the report

RESOLUTION NO. R24-123

A RESOLUTION AUTHORIZING AMENDMENT NO. 3 TO THE “CONSTRUCTION MANAGEMENT/GENERAL CONTRACTOR AGREEMENT BETWEEN ARVADA AND BT CONSTRUCTION, INC. FOR PRE-CONSTRUCTION SERVICES FOR NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON & 58TH PROJECT IN AN AMOUNT NOT TO EXCEED \$86,450.00” FOR PURPOSES OF AWARDED CONTRACTOR PHASE II WITH A GUARANTEED MAXIMUM PRICE OF \$13,258,966.50, THEREBY INCREASING THE TOTAL CONTRACT AMOUNT TO AN AMOUNT NOT TO EXCEED \$13,703,199.63

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The Mayor or Mayor Pro Tem is authorized to sign and the City Clerk to attest, in form approved by the City Attorney, an Amendment to an Agreement that is in substantially the same form as that attached hereto.

Section 2. This resolution shall be effective upon its approval by the City Council.

APPROVED AND ADOPTED this 2nd day of December, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney:

BY: _____

AMENDMENT NO. 3
TO THE “CONSTRUCTION MANAGEMENT/GENERAL CONTRACTOR
AGREEMENT BETWEEN ARVADA AND BT CONSTRUCTION, INC. FOR PRE-
CONSTRUCTION SERVICES FOR NORTH TRUNK SEWER IMPROVEMENTS –
TENNYSON & 58TH PROJECT IN AN AMOUNT NOT TO EXCEED \$86,450.00” FOR
PURPOSES OF AWARDED CONTRACTOR PHASE II WITH A GUARANTEED
MAXIMUM PRICE OF \$13,258,966.50, THEREBY INCREASING THE TOTAL
CONTRACT AMOUNT TO AN AMOUNT NOT TO EXCEED \$13,703,199.63

1. **PARTIES.** The parties to this Amendment No. 3 are the City of Arvada, a Colorado home rule municipal corporation, whose mailing address is 8101 Ralston Road, Arvada, CO 80002 (“**Arvada**”) and BT Construction, Inc., a Colorado corporation whose place of business is located at 9885 Emporia St., Henderson, CO 80640 (“**Contractor**”), collectively referred to as the “**Parties**”.
2. **RECITALS AND PURPOSE.**
 - 2.1. Upon Contractor acceptance and City Approval, the Work and Contract Documents for the City of Arvada project entitled CMGC Selection for the North Trunk Sewer Improvements – Tennyson & 58th Project, RFP #23-UTS-010, shall be adjusted as provided herein.
 - 2.2. On or about March 27, 2023, the Parties entered into an agreement wherein Contractor would provide preconstruction phase (“**Phase I**”) Construction Management (“**CM**”) services, including but not limited to cost estimating, constructability reviews, value engineering, development of a Guaranteed Maximum Price, and risk management (the “**Original Agreement**”). Pursuant to the Original Agreement, the cost of Phase I would not exceed \$86,450.00.
 - 2.3. On or about September 29, 2023, the Parties executed Amendment No. 1 to the Original Agreement (“**Amendment No. 1**”). Amendment No. 1 established Guaranteed Maximum Price (“**GMP**”) No. 1 in an amount not to exceed \$266,350.00, to secure purchases and procurement/fabrication of electrical equipment related to the meter vault, as stated on Contractor’s Bid Number: 23-268-0905-KC. The cost of Amendment No. 1 was in addition to the cost of Phase I of the Original Agreement, increasing the total contract amount to \$352,800.00. Amendment No. 1 did not award Phase II Services to Contractor.
 - 2.4. On or about February 26, 2024, the Parties executed Amendment No. 2 to the Original Agreement (“**Amendment No. 2**”). Amendment No. 2 established GMP No. 2, in an amount not to exceed \$91,433.13, in order for Contractor to supply labor, equipment, materials, and supervision necessary to complete the site utilities for the Project. The cost of Amendment No. 2 was \$91,433.13, thereby increasing the total contract amount to an amount not to exceed \$444,233.13. Amendment No. 2 did not award Phase II Services to Contractor.

- 2.5. For the convenience of the Parties, (due to the voluminous nature of the Original Agreement, Amendment No. 1, and Amendment No. 2) the Original Agreement, Amendment No. 1, and Amendment No. 2 are not attached hereto but are incorporated herein by reference.
- 2.6. Pursuant to the Original Agreement, Contractor has the opportunity to be the General Contractor (“GC”) during the construction phase (“**Phase II**”); however, the construction phase contract is not guaranteed, and is dependent on successful GMP negotiations for all the Work necessary to complete the Project.
- 2.7. This Amendment No. 3 to the Original Agreement (“**Amendment No. 3**”) awards Contractor Phase II and establishes the GMP for Phase II in an amount not to exceed **\$13,258,966.50 (“GMP No. 3”)**. The addition of Phase II increases the total contract amount to an amount not to exceed **\$13,703,199.63**.
3. **CONTRACT DOCUMENTS AND EXHIBITS.** The Contract Documents shall consist of the Original Agreement, Amendment No. 1, Amendment No. 2, and this Amendment No. 3, together with the following:
- Exhibit 1: GMP No. 3 for Phase II Services;**
- Exhibit 2: NT10 Project Manual;**
- Exhibit 3: NT10 90% Measurement Payment; and**
- Exhibit 4: NT10 90% Construction Plans.**
- All exhibits referred to in this Amendment No. 3 are attached hereto and are, by reference, incorporated herein for all purposes. In the event any matter, term, provision, or condition that is the subject of the Original Agreement, Amendment No. 1, Amendment No. 2, or this Amendment No. 3 requires clarification or is in dispute, or is the subject of a difference of opinion, the purpose and intent of the agreement shall be first ascertained by reference to the Contract Documents in their entirety. In the event of any dispute or differences between the respective documents that constitute the Contract Documents, then Contractor shall secure the written instructions from Arvada before proceeding with the performance of the services affected by such conflicts, omissions, or discrepancies.
4. **ACCEPTANCE OF GMP PROPOSAL.** Pursuant to Sections 2.4.6, 2.4.8, and 7.1.1. of the Original Agreement, as amended by Amendment No. 1, Owner hereby accepts Contractor’s GMP No. 3 proposal and awards Contractor Phase II, as shown in **Exhibits 1, 2, 3, and 4**. GMP No. 3 shall not exceed **\$13,258,966.50**. The total contract amount following execution of this Amendment No. 3 shall not exceed **\$13,703,199.63**.
5. **FULL FORCE AND EFFECT.** All other terms and conditions shall be as set forth in the Original Agreement, Amendment No. 1, and in Amendment No. 2.

(Signature page follows)

DATED this _____ day of _____, 2024.

CITY OF ARVADA, a Colorado home
rule municipal corporation

Lauren Simpson
Mayor
8101 Ralston Road
Arvada, CO 80002
lsimpson@arvada.org

ATTEST/WITNESS:

City Clerk

APPROVED AS TO FORM:
For Rachel A. Morris, City Attorney

By: _____

BT CONSTRUCTION, INC., a Colorado
corporation

Josh Livermore
Vice President
9885 Emporia St.
Henderson, CO 80640
Josh.livermore@btconstruction.com

Exhibit 1

Amendment No. 3

To The “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. For Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58th Project in An Amount Not To Exceed \$86,450.00” For Purposes Of Awarding Contractor Phase II With A Guaranteed Maximum Price Of \$13,258,966.50, Thereby Increasing The Total Contract Amount To An Amount Not To Exceed \$13,703,199.63



**9885 EMPORIA ST
HENDERSON, COLORADO**

WWW.BTCONSTRUCTION.COM

To:	City of Arvada	Contact:	Kris Gardner
Address:	8101 Ralston Rd. Arvada, CO 80002	Phone:	421-2550
		Fax:	
Project Name:	Arvada - North Trunk Sewer	Bid Number:	23-123-0427-01
Project Location:		Bid Date:	

Item #	Item Description	Estimated Quantity	Unit	Unit Price	Total Price
1	Permits & General Conditions	1.00	LS	\$808,000.00	\$808,000.00
2	Pothole Existing Utilities	47.00	EACH	\$705.00	\$33,135.00
3	Mobilization	1.00	LS	\$78,800.00	\$78,800.00
4	Erosion Control / Stormwater Management	1.00	LS	\$109,500.00	\$109,500.00
5	Survey	1.00	LS	\$36,000.00	\$36,000.00
6	Traffic Control	1.00	LS	\$740,000.00	\$740,000.00
7	Dewatering (STA 1+00 To STA 7+00)	1.00	LS	\$860,000.00	\$860,000.00
8	Trench Stabilization Rock & Over Excavation	600.00	LF	\$115.00	\$69,000.00
9	Sanitary Bypass Pumping	1.00	LS	\$1,016,300.00	\$1,016,300.00
10	42" FRP Installation	3,096.00	LF	\$1,038.50	\$3,215,196.00
11	Connect To Existing Metro Trunk Line	1.00	LS	\$30,600.00	\$30,600.00
12	72" Diameter Manholes (Changed 96" Bid Item To 72") Bypass Manholes	4.00	EACH	\$29,970.00	\$119,880.00
13	84" Diameter Manholes	15.00	EACH	\$42,278.00	\$634,170.00
14	Manhole Lining	19.00	EACH	\$14,400.00	\$273,600.00
15	Diversion Vaults	2.00	EACH	\$159,560.00	\$319,120.00
16	CIPP Existing Sanitary Line	1.00	LS	\$152,920.00	\$152,920.00
17	Abandon Exist. Manholes (SSMH 4-7, SSMH4-8)	2.00	EACH	\$7,900.00	\$15,800.00
18	8" PVC - Sanitary Lateral & Existing Manhole Modification	35.00	LF	\$1,044.00	\$36,540.00
19	Sanitary Service Modification @ Existing MH 4-7	1.00	EACH	\$13,046.00	\$13,046.00
20	21" PVC - Sanitary Lateral & Existing Manhole Modification	26.00	LF	\$1,538.00	\$39,988.00
21	Storm Line Crossings	3.00	EACH	\$10,983.00	\$32,949.00
22	Cut-Off Walls	5.00	EACH	\$5,130.00	\$25,650.00
23	New Sanitary Meter Vault (Metro Standard)	1.00	EACH	\$655,720.00	\$655,720.00
24	Electrical For Meter Vault	1.00	LS	\$6,180.00	\$6,180.00
25	Demo / Abandon Existing Meter Vault	1.00	EACH	\$53,035.00	\$53,035.00
26	Remove Existing 30" Sanitary Line	2,465.00	LF	\$121.00	\$298,265.00
27	Trenchless Mobilization And General Conditions	1.00	LS	\$39,684.00	\$39,684.00
28	Shaft Construction And Backfill	1.00	LS	\$174,967.00	\$174,967.00
29	Engineering Services	1.00	LS	\$19,455.00	\$19,455.00
30	Geotechnical Instrumentation	1.00	LS	\$61,356.00	\$61,356.00
31	Railroad Cost	1.00	LS	\$374,868.00	\$374,868.00
32	GBM Auger Bore 30" Casing Under UPRR, RTD, BNSF	230.00	LF	\$1,531.50	\$352,245.00
33	Insituform 30" CIPP Lining In 30" Steel Casing	233.00	LF	\$750.00	\$174,750.00
34	8" C900 Waterline Relocation	695.00	LF	\$368.00	\$255,760.00
35	Waterline Service Reconnect	4.00	EACH	\$7,505.00	\$30,020.00
36	8" Lateral - Extend & Reconnect	2.00	EACH	\$8,950.00	\$17,900.00
37	8" Water Relocation @ Approx. STA 23+38.25	1.00	LS	\$32,330.00	\$32,330.00

Item #	Item Description	Estimated Quantity	Unit	Unit Price	Total Price
38	8" Gate Valve	5.00	EACH	\$3,685.00	\$18,425.00
39	8" - 45 Degree Bend	2.00	EACH	\$1,275.00	\$2,550.00
40	Asphalt Removal & Replacement	3,669.00	SY	\$171.00	\$627,399.00
41	Pavement Markings	1.00	LS	\$81,350.00	\$81,350.00
42	Temporary Asphalt (50% Of Total Trench Length)	3,640.00	SY	\$29.10	\$105,924.00
43	Staging Area Restoration	1.00	LS	\$17,100.00	\$17,100.00
44	Trench Maintenance & Citizen Notification	1.00	LS	\$77,160.00	\$77,160.00
45	Minor Contract Revisions	1.00	LS	\$600,000.00	\$600,000.00
46	Storm Channel	615.00	LF	\$187.00	\$115,005.00
	615' X 15' X 4'				
47	Waterline Lowerings	5.00	EACH	\$18,760.00	\$93,800.00
48	Sanitary Lowering Or Raising - STA 15+90	1.00	EACH	\$14,880.00	\$14,880.00
49	1.5" Force Main R&R	50.00	LF	\$280.00	\$14,000.00
50	2" Mill & Overlay (Adams County)	3,530.00	SY	\$28.00	\$98,840.00
51	Sidewalk Removal & Replacement	1,295.00	SF	\$22.50	\$29,137.50
52	Curb & Gutter Removal & Replacement	630.00	LF	\$95.00	\$59,850.00
53	ADA Ramp R&R	2.00	EACH	\$6,200.00	\$12,400.00
54	Concrete Pavement Replacement	168.00	SY	\$216.00	\$36,288.00
55	Concrete Cross Pan Replacement	14.00	SY	\$348.00	\$4,872.00
56	Gravel Surface Restoration - 3" Depth	287.00	SY	\$51.00	\$14,637.00
57	24" RCP Replacement	40.00	LF	\$433.00	\$17,320.00
58	Headwall Removal & Replacement	1.00	EACH	\$11,300.00	\$11,300.00
Total Bid Price:				<u>\$13,258,966.50</u>	

ACCEPTED: The above prices, specifications and conditions are satisfactory and hereby accepted. Buyer: _____ Signature: _____ Date of Acceptance: _____	CONFIRMED: BT Construction, Inc. Authorized Signature: _____ Estimator: _____
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Exhibit 2

Amendment No. 3

To The “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. For Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58th Project in An Amount Not To Exceed \$86,450.00” For Purposes Of Awarding Contractor Phase II With A Guaranteed Maximum Price Of \$13,258,966.50, Thereby Increasing The Total Contract Amount To An Amount Not To Exceed \$13,703,199.63

**SPECIFICATIONS PACKAGE
NORTH TRUNK SEWER IMPROVEMENTS PROJECT
NT10 TENNYSON AND 58TH**

**CITY OF ARVADA
COA PROJECT NO. 22-SR-11**

September 2024

Engineer of Record – Division 01, and Specifications 02050, 02070, 02072, 02080, 02085 02140, 02200, 02300, 02510, 02516, 02530, 02531, 02550, 02721, 02740, 02750, 02951	Engineer of Record – Specifications 02411, 02430, 02444, 02450, 02470
Engineer of Record – Divisions 03, 05, 06, and 08	Engineer of Record – Divisions 16 & 17

KENNEDY/JENKS CONSULTANTS, INC.
215 Union Boulevard, Suite 500, Lakewood, Colorado 80228
(303) 229-1750
JOB NO. 2246059*00

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PROJECT MANUAL

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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. The project generally consists of replacing approximately 3500 feet of existing 21" and 30" sanitary sewer piping with 42" sanitary sewer piping. This work includes but is not limited to earthwork, trenching, backfilling, pipe installation, pipe testing, and removal or abandonment of existing sanitary sewer piping. This project also involves installation of new water main piping, removal of existing water piping, relocation of service lines and other utilities as needed for construction, a wastewater flow metering vault with associated electrical and process improvements, trenchless piping installation, and site restoration as required for pipeline installation.
- B. Work hours for the project are 7:30 AM to 3:30 PM Monday through Friday, except on holidays that fall on a weekday. Work shall not be performed outside of these hours unless otherwise approved by the Owner. Work hours for the trenchless portion of the project can be outside of the 7:30 AM to 3:30 PM timeframe but shall be coordinated with and approved by the Owner with a minimum of two weeks advance notice.

1.02 WORK UNDER OTHER CONTRACTS – NOT USED

1.03 OWNER-FURNISHED CONTRACTOR INSTALLED ITEMS (O.F.C.I.) – NOT USED

- A. Certain items required for this project will be furnished by the Owner and installed by the Contractor. Such items are referred to as "Owner-Furnished Contractor Installed (O.F.C.I.)." O.F.C.I. items shall be picked up by the Contractor at the Owner's storage yard, transported to the project site and installed by the Contractor.
- B. Contractor's installation of O.F.C.I. items shall include attaching or anchoring items, connecting utilities and controls, lubricating and necessary adjustment, startup, testing, placing items in service. If items are new Contractor shall turn over operation and maintenance manuals and equipment warranties to Owner.

1.04 DOCUMENTING EXISTING

- A. Prior to commencing the Work, tour the site document photographically and in writing the condition of existing structures, roadways, equipment, improvements, and landscape planting on or adjacent to the site, see Section 01390. This record shall serve as a basis for determination of subsequent damage due to the Contractor's operations.

1.05 SHUTDOWN OF EXISTING UTILITIES, SERVICES OR OPERATIONS

- A. Obtain the Project Engineer's approval at least seven (7) days prior to the shutdown of any utility, service or operation of any existing facility. Give required

notice and make appropriate arrangements with utility owners and other affected parties prior to shutdown of any utility service.

- B. Schedule utility service or operations shutdowns for periods of minimum use and at the Owner's convenience. Have all required material, equipment and workers on site prior to beginning any work involving a possible shutdown. Perform work as required to reduce shutdown time to the minimum. In some cases, this may require increased numbers of workers and/or premium time night or weekend work.

1.06 REGULATORY REQUIREMENTS

- A. The codes and regulations together with local amendments when applicable adopted by the State and other governmental authorities having jurisdiction shall establish minimum requirements for this project. This project shall comply with the following:
 - 1. International Building Code (IBC) 2021 Edition
 - 2. International Fire Code (IFC) 2021 edition
 - 3. Uniform Plumbing Code (UPC) 2024 edition
 - 4. NFPA 70, National Electric Code (NEC) 2023 edition
 - 5. NFPA 820, National Electric Code (NEC) 2023 Edition
- B. The latest edition of the requirements in effect at the date of issuance of construction documents shall apply.
- C. It is the Contractor's responsibility to comply with laws and codes applicable to Means and Methods for performing the Work.
- D. It is the Contractor's responsibility to report code deficiencies in the design to the Engineer prior to proceeding with the Work.
- E. Paragraphs addressing Pre-Engineered Systems and Performance Specifications in other Sections cover the Contractor's responsibility to comply with code requirements when (1) performance specifications are used to describe all or portions of Work or items and (2) when pre-engineered (contractor designed) systems are specified.
- F. In cases where the Contract Documents are more restrictive than applicable codes, the Contractor shall comply with the Contract Documents.

1.07 REFERENCE STANDARDS

- A. When these specifications state that Work or tests shall conform to specific provisions in a referenced standard, specification, code, recommendation, or manual published by an association, organization, society, or agency the referenced provisions, as they apply to the Work of the Contractor only shall be considered a part of these specifications as fully as if included in total. When these specifications or applicable codes contain higher or more restrictive requirements than those contained in reference standards these specifications or applicable codes shall govern.
- B. The latest edition of a referenced standard published at the time of submission of bids shall apply unless a specific date for the referenced standard is cited in these specifications.

- C. General provisions in referenced standards, specifications, manuals, or codes shall not change the specific duties and responsibilities between any of the parties involved in this work from those described in the General Conditions. Provisions in referenced standards with regard to measurement and payment shall not apply to this Work unless specifically cited.

1.08 SPECIFICATION LANGUAGE AND STYLE

- A. Many parts of the Specifications as well as notes on the Drawings are written in the active voice and are addressed to the Contractor.
1. When words or phrases requiring an action or performance of a task are used, it means that the Contractor shall provide the action or perform the task. For example: provide, perform, install, furnish, erect, connect, test, operate, adjust or similar words mean that the Contractor shall perform the action or task referred to.
 2. When words or phrases requiring selection, acceptance, approval, review, direction, designation or similar actions are referred to, it means that such actions are the Owner's or the Engineer's prerogative and that the Contractor must obtain such action before proceeding.
- B. Requirements in the Specifications and Drawings apply to all work of a similar type, kind, or class even though the word "all" or "typical" may not be stated.

1.09 DEFINITIONS

- A. The following terms, when used in the Contract Documents, shall have the meanings listed:

ACCEPTABLE	"acceptable to the Engineer"
PERFORM	"perform all operations required to complete the work referred to in accordance with the intent of the Contract Documents"
PROVIDE	"furnish and install the work referred to including proper anchorage, connection to required utilities or other work, testing, adjustment and startup ready to put in service and perform the intended function"
REQUIRED	"required by the Contract Documents or required to complete the Work and produce the intended results"
SATISFACTORY	"acceptable to the Engineer"
SHOWN	"as indicated on the Drawings"
SITE	"geographical location of the Project and land within the work area shown on the contract drawings and within which the Work will be installed or built"
SPECIFIED	"as written in the Contract Documents including the Specifications and the Drawings"
SUBMIT	"submit to the Engineer"

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 SUBMITTAL PROCEDURES

- A. Accompany each submittal with a Submittal form which contains the following information:
 - 1. Contractor's name and the name of Subcontractor or supplier who prepared the submittal.
 - 2. The project name and identifying number.
 - 3. Description of the submittal and reference to the Contract requirement or technical specification section and paragraph number being addressed.
- B. Unless otherwise specified, provide submittals in electronic PDF searchable format.
- C. Submittals which include more than one (1) item or piece of equipment shall include a Table of Contents following the standard submittal form and cover sheets.
- D. Each submittal shall include a copy of the specification section and all referenced and applicable sections with addendum updates included. For each specification section, check-mark each paragraph to indicate specification compliance with the full paragraph as a whole or marked to indicate requested deviations from specification requirements. Each deviation from the specifications requested by the Contractor shall be underlined and referenced by a unique number in the margin to the right of the identified paragraph. The submittal shall include a detailed written explanation of the reasons for requesting the deviation that is clearly labeled to correspond with the unique number provided in the margin. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal on the basis that the submittal is incomplete and will be returned to the Contractor REJECTED – RESUBMIT with no further consideration.
- E. Where applicable, a copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- F. The Contractor shall allow 30 days for the Engineer's review of each submittal and 30 days for each resubmittal unless a different period is specified by the Engineer in writing. If the Engineer requests additional information or clarification of a submittal, the 30 days shall be measured from the date the additional information or clarification is received. If the Contractor requires more than two submittals to

obtain the Engineer's Favorable Review, the Contractor shall compensate the Owner for the cost of the Engineer's additional review time. The Contractor shall not perform work for which reviewed submittals are required without obtaining Favorable Review of submittals.

1.02 SCHEDULE OF SUBMITTALS

- A. Within fifteen (15) days after the Notice to Proceed, submit a Schedule of Submittals showing the date by which each submittal required for Product Review or Product Information will be made. Identify the items that will be included in each submittal by listing the item or group of items and the Specification Section and paragraph number under which they are specified. Indicate whether the submittal is required for Product Review of Proposed Equivalents, Shop Drawings, Product Data or Samples or required for Product Information only.

1.03 PLAN OF OPERATIONS

- A. Before beginning on site work, submit a plan showing Contractor's intended use of the site assigned to it. Show location of access points. Show location for Contractor's, Subcontractor's, and Engineer's field office (if applicable) and parking. Show location of Contractor's and Subcontractor's work areas and storage areas.

1.04 CONSTRUCTION SCHEDULE

- A. The form of Construction Schedule may be selected by the Contractor.
- B. Revise the Construction Schedule and resubmit within seven (7) days following any monthly meeting to review Contractor's Application for Payment when Contractor's work is fifteen (15) days or more behind schedule.
- C. Accelerated Work if Required to Meet Schedule: Give Engineer and Owner three (3) days prior notice of construction that will take place outside of normal work hours or work days. Compensate Owner for extra inspection cost caused by Accelerated Work required to meet Schedule.
- D. Give Engineer and Owner three (3) days prior notice of normal work days on which construction will not take place or of scheduled construction that will not take place. Compensate Owner for extra inspection cost resulting from failure to give notice.

1.05 SHOP DRAWING, PRODUCT DATA AND SAMPLES SUBMITTED FOR PRODUCT REVIEW

- A. This paragraph covers submittal of Shop Drawings, Product Data and Samples required for the Engineer's review referred to as Product Review submittals in the Technical Specifications (Divisions 2 through 17). Submittals required for information only are referred to as Product Information submittals in the Technical Specifications and are covered in paragraph 1.07. All shop drawings, product data and samples shall be considered as Product Review submittals unless specifically called out as a Product Information submittal in a technical specification.
- B. The Contractor shall make all Product Review submittals early enough to allow adequate time for the Engineer's review, for manufacture and for delivery at the construction site without causing delay to the Work. Submittals shall be made early enough to allow for unforeseen delays such as:

1. Failure to obtain Favorable Review because of inadequate or incomplete submittal or because the item submitted does not meet the requirements of the Contract Documents.
 2. Delays in manufacture.
 3. Delays in delivery.
- C. Content of Submittals:
1. Each submittal shall include all of the items and material required for a complete assembly, system or Specification Section.
 2. Submittals shall contain all of the physical, technical and performance data required by the specifications or necessary to demonstrate conclusively that the items comply with the requirements of the Contract Documents.
 3. Include information on characteristics of electrical or utility service required and verification that requirements have been coordinated with services provided by the Work and by other interconnected elements of the Work.
 4. Provide verification that the physical characteristics of items submitted, including size, configuration, clearances, mounting points, utility connection points and service access points, are suitable for the space provided and are compatible with other interrelated items that are existing or have or will be submitted.
 5. Label each Product Data Submittal, Shop Drawing, and Sample with the information required in paragraph 1.01A of this Section. Highlight or mark every page of every copy of all Product Data submittals to show the specific items being submitted and all options included or choices offered.
 6. Additional requirements for Product Review submittals are contained in the Technical Specification sections.
 7. Designation of work as "NIC" or "by others," shown on Shop Drawings, shall mean that the work will be the responsibility of the Contractor rather than the subcontractor or supplier who has prepared the Shop Drawings.
- D. Submittals that contain deviations from the requirements of the Contract Documents shall be accompanied by a separate letter explaining the deviations. The Contractor's letter shall:
1. Describe the deviation from the specifications requested and identify with a unique number and reference to the Specification Section paragraph or Drawing requirement. The letter shall include a detailed written explanation of the reasons for requesting the deviation that is clearly labeled to correspond with the unique number provided.
 2. Describe the proposed alternate material, item, or construction and explain its advantages and/or disadvantages to the Owner.
 3. State the reduction in Contract Price if any that is offered to the Owner.
- E. Engineer's Review Procedure and Meaning:
1. The Engineer will review each Product Review submittal prior to returning it to the Contractor. The submittal review form will indicate whether or not the review was favorable and what action is required of the Contractor. Review categories "No Exceptions Taken" and "Make Corrections Noted" both indicate Favorable Review.
 2. At a minimum, Favorable Review is contingent on:
 - a. The compatibility of items included in a submittal with other related or interdependent items included in previous or future submittals.

- b. Future submittal of items related to or required to be part of this submittal that were not included with this submittal.
- 3. Favorable Review of a submittal does not constitute approval or deletion of items required as part of the submittal but not included with the submittal. Favorable Review of items included in the submittal does not constitute deletion of specified features, options or accessories that were not included in the submittal.
- 4. The action required by the Contractor for each category of review is as follows:
 - a. **NO EXCEPTIONS TAKEN.** NO RESUBMITTAL REQUIRED.
 - b. **MAKE CORRECTIONS NOTED:**
 - 1) **NO RESUBMITTAL REQUIRED.** The Contractor shall make corrections noted prior to manufacture.
 - 2) **PARTIAL RESUBMITTALS REQUIRED.** The Contractor shall submit related accessory or optional items as noted which are required but were not included with the submittal and/or shall resubmit unsatisfactory portions or attributes of items as noted. The Contractor may proceed to manufacture those portions of the submittal that will be unaffected by required resubmittals.
 - c. **AMEND AND RESUBMIT.** The Contractor shall amend and resubmit the submittal as noted or required to comply with the Contract Documents.
 - d. **REJECTED - RESUBMIT.** The item submitted does not comply with the Contract Documents. Resubmit items that comply with the requirements of the Contract Documents.
 - e. **NOT REVIEWED.** The item submitted is incomplete or does not comply with the Contract Documents. The item has not been reviewed and is returned to the Contractor for correction.
 - f. **RECEIPT ACKNOWLEDGED.** Receipt of a submittal that is not subject to the Owner's review and approval is acknowledged; and, is being filed for information purposes only. Generally used in acknowledging receipt of Product Information. No further submittal activity is required by the Contractor.
- 5. The Product Review submittal review form may contain numbered notes. Marking a corresponding number on a Shop Drawing or Product Data submittal shall have the same effect as applying the entire note to the submittal.
- F. Re-submittals that contain changes that were not requested by the Engineer on the previous submittal shall be accompanied by a letter explaining the change.
- G. Favorable Review Required Prior to Proceeding: Do not proceed with manufacture, fabrication, delivery, or installation of items prior to obtaining the Engineers Favorable Review of Product Review submittals.
- H. Intent and Limitation on Engineer's Review:
 - 1. The Contractor has primary responsibility for submitting and providing work that complies with the requirements of the Contract Documents. That responsibility cannot be delegated in whole or in part to subcontractors or suppliers. Neither the Engineer's Favorable Review nor the Engineer's failure to notice or comment on deficiencies in the Contractor's submittals shall

relieve the Contractor from the duty to provide work, which complies with the requirements of the Contract Documents.

1.06 PROPOSED EQUIVALENTS (SUBSTITUTIONS)

- A. The term "first specified item" or "first named maker" refers to the first product identified in the Specifications by a model number or trade name and/or by a maker's name for a specified item. When the first specified item is followed by a second maker's name and "or equal," the Contractor may submit Proposed Equivalent (Substitution) items for the Engineer's review. Proposed Equivalent (Substitution) items that are in the Engineer's judgment equal to the first specified item in quality, utility, and appearance, will be Favorably Reviewed. Where a product description and first maker's name is followed by "or equal" with no second maker's name, it means the specifier knows of no equivalent product and the Contractor may submit Proposed Equivalent (Substitution) products by other makers for review. Where the term "or equal" is omitted, it means that the named item is required to meet the Owner's needs; no products or makers other than those specified will be considered.
- B. Time of Submittal:
 - 1. Submittal of Proposed Equivalents (Substitutions) shall be made within thirty-five (35) days of the Notice to Proceed. The Engineer may agree to a later submittal date if requested in writing within thirty-five (35) days of the Notice to Proceed. The request shall identify the item; give the Specification reference, and proposed manufacturer and model number of the item that will be submitted and the proposed submittal date.
 - 2. The Engineer's agreement to a later submittal date shall be in writing and shall not be construed as Favorable Review or acceptance of the manufacturer or item proposed.
- C. Content of submittals shall be the same as that required for Product Data, Shop Drawings, and Samples submitted for Product Review in another paragraph of this Section. In addition, the Contractor shall provide information on several recent similar installations of the item to verify its suitability. The information shall include the project name and location, the Owner's name, address, telephone number and name of a knowledgeable person to contact for information on performance of the product.
- D. If a non-equivalent substitute is submitted for review, it shall be accompanied by a proposed reduction in Contract Price which shall include the increased cost of Engineering service required to evaluate the proposed substitute (which shall be paid to the Owner whether or not the substitute is accepted) plus the greater of 1) the difference in price between the first specified item and the item submitted and 2) the difference in value to the Owner between the two items.

1.07 PRODUCT INFORMATION SUBMITTALS

- A. Submittal for Informational Purpose Only is an item required for the Owner's permanent records relating, in part, to future maintenance, repair, modification, replacement of work or as otherwise required. The Contractor shall clearly separate information for Product Review from information for Product Information in submittals that include both.

- B. Make Product Information submittals prior to delivering material, products, or items for which Product Information submittals are required.
- C. The Contractor has the sole and exclusive responsibility for furnishing products and work that meets the requirements of the Contract Documents.
- D. The Engineer reserves the right to comment on any submittal and to reject any product or work delivered, installed or otherwise at any time that the Engineer become aware that it is defective or does not meet the requirements of the Contract Documents.

1.08 OPERATION AND MAINTENANCE MANUALS AND PARTS LISTS

- A. Operation and maintenance (O&M) information shall be submitted in a format best suited for the type of manual to be provided to the Owner. Unless otherwise specified, provide information in electronic PDF searchable format.
- B. Provide operation and maintenance manuals and parts list for all equipment furnished under this Contract. Comply with the detailed requirements in Technical Specification sections. Include instructions for delivery, storage, assembly, installation, lubrication, adjusting, startup, operation and maintenance. Provide PDF bookmarks for all items listed in subparagraphs 1 through 5 below.
 - 1. For all equipment include:
 - a. Startup instructions
 - b. Normal operation instructions.
 - c. Trouble shooting instructions.
 - d. Lubrication instructions.
 - e. Maintenance and reinstallation instructions, and manufacturer's recommended preventative maintenance schedule.
 - f. Parts identification.
 - g. List of spare parts recommended to have on hand.
 - h. Operator safety instructions.
 - i. Cleaning instructions.
 - j. Theory of operation to discrete component level.
 - k. Schematic diagrams, flow diagrams, wiring diagrams, logic diagrams, etc. to discrete component level.
 - l. Parts list showing all discrete components with part number,
 - m. Manufacturers' service and maintenance technical manuals.
 - 2. For all Electrical Equipment, provide the following additional information:
 - a. Equipment ratings.
 - b. Calibration curves and rating tables if appropriate.
 - 3. For Complex Equipment provide in addition:
 - a. Alternate specified operating modes.
 - b. Emergency shutdown instructions.
 - c. Normal shutdown instructions.
 - d. Long-term shutdown instructions.
 - 4. Operation and maintenance manuals for systems composed of separate pieces of equipment shall include a system explanation of items 1, a, b, and c, and 3a through c, as well as the instructions for each separate piece of equipment.
- C. Submit not later than 60 days after Favorable Review of Product Review submittal.

- D. When standard manufacturer's literature is used highlight or mark all copies to shop specific items and options provided.

1.09 MANUFACTURER'S CERTIFICATES

- A. When specified in the Technical Specifications section, submit manufacturers' certificate to Engineer for review. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate. Certificates may be recent or previous test results on material or product but must be acceptable to the Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01390

PRE-CONSTRUCTION PHOTOS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Preconstruction Photos

1.02 DESCRIPTION

- A. Prior to commencing work, prepare a flash drive of pre-construction photographs capturing the existing project conditions including but not limited to site work locations, site access points, drainage areas, private drives, sidewalk, pedestrian ramps, landscaping, and public infrastructure expected to be affected as part of the new work. Include photographs of all access areas for the work.

1.03 QUALITY ASSURANCE

- A. Photographs shall not be made more than thirty (30) days prior to construction in any area. All records shall become property of the Owner.

1.04 SUBMITTALS

- A. Submit one (1) copy of the pre-construction photographs to the Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EQUIPMENT

- A. The Contractor shall furnish all equipment, accessories, materials and labor to perform this service.
- B. The photographs shall reproduce bright, sharp, clear pictures with accurate colors and shall be free from distortion or any other form of imperfection.

3.02 RECORD INFORMATION

- A. All photographs shall, by electronic means, display on the screen the time and date the photograph was taken.

3.03 LIGHTING

- A. All photographs shall be captured during time of good visibility.

END OF SECTION

SECTION 01400

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

- A. Perform all work in accordance with City of Arvada Engineering Codes and Specifications, except as otherwise noted in the Contract Documents.
- B. The Engineer may require that the manufacturer of individual products furnish a sworn statement that the inspection and all of the specified tests have been made, and the results thereof comply with the requirements of the applicable Standards specified.

1.02 CONSTRUCTION OBSERVATION

- A. General
 - 1. The Owner's Inspector shall decide any and all questions that may arise as to the quality and acceptability of the materials furnished, the work performed, the manner of performance and the rate of progress of the work. The Owner's Inspector shall decide all questions which may arise as to the interpretation of the Specifications and/or the acceptable fulfillment of the Contract and all disputes and mutual rights by the Contractors, if there be more than one contractor on the project. Kennedy/Jenks Consultants acting as the consulting engineer, is not a guarantor of the construction Contractor's obligations and performance of the Contract.
 - 2. Observation of work in progress and on-site visits are not to be construed as a guarantee by Kennedy/Jenks Consultants and the Owner of the Contractor's contractual commitment.
 - 3. Kennedy/Jenks Consultants and the Owner are not responsible for safety in, on, or about the project site, nor compliance by the appropriate party of any regulations relating thereto.
 - 4. Kennedy/Jenks Consultants and the Owner, exercise no control of the safety or adequacy of any equipment, building components, scaffolding, forms, or other work aids used in or about the project and do not supervise the Contractor or his or her forces.
- B. Overtime
 - 1. Any construction observation performed at times other than between the hours of 7:30 AM and 3:30 PM, Monday through Friday or on holidays that may fall on a weekday shall be done at the Contractor's expense. The minimum charge for weekend (Saturday or Sunday) or holiday observation shall be four (4) hours per day. The Owner shall review and approve whether or not overtime construction observation is necessary.

1.03 REPLACEMENT OF SURVEY STAKES

- A. The Contractor shall be responsible for protecting all stakes set for his or her use, and stakes which must be reset due to the negligence of the Contractor after the initial stakeout shall be replaced at the Contractor's expense.

1.04 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

1.05 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from the Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.06 FIELD SURVEY

- A. Field survey within the project alignment shall be performed by the Owner's survey crew except for the portion of field survey required for the trenchless crossing within the railroad corridor right-of-way. Contractor shall coordinate field surveying for this corridor with a third-party surveyor who is registered with each of the railroad companies to perform this service.

1.07 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

- B. Conform to reference standard by date of issue current on date of Contract Documents except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 TEMPORARY UTILITIES

- A. Sanitary Facilities: Provide and maintain self-contained portable sanitary facilities for the Contractor's, subcontractor's, Project Engineer's, and Owner's use. Facilities shall comply with applicable regulations and shall be serviced, cleaned and disinfected frequently.
- B. Temporary Water, Power and Telephone Service:
 - 1. Water: The Owner's Water Operations Division personnel shall be the sole operators of existing valves through which water for testing, disinfecting and flushing is obtained. The Contractor shall be responsible for metering and paying the Owner for water used for flushing, testing, and disinfection.
 - 2. Power: Connect to the existing electrical service with a service disconnect switch. Provide overcurrent and ground fault protection. Provide a meter and reimburse Owner for the cost of energy used.
- C. Temporary Heat: Provide temporary heat for enclosed spaces for the proper installation of finishes, such as floor coverings, wall coverings, woodwork and painting, and to protect all work and moisture sensitive electrical equipment against injury, dampness and cold. Fuel, equipment, and installation shall comply with all applicable codes and regulations. Salamander heaters or other space heaters using kerosene are not permitted.
- D. Temporary Ventilation: Provide equipment to ventilate enclosed areas to facilitate curing concrete, to dissipate humidity and to prevent accumulation of dust, fumes, or gases. Utilize ventilation equipment and supplement with temporary fans to maintain clean air and safe conditions for construction operations.
- E. Temporary Lighting: Provide and maintain lighting for construction operations to achieve a minimum lighting level of 20 foot-candles for rough work and 60 foot-candles for finish work.
- F. Temporary Fire Protection:
 - 1. Provide and maintain fire protection equipment, including extinguishers, fire hoses, and other equipment required by law or insurance carriers, or as necessary for proper fire protection during the course of the work.
 - 2. Use fire protection equipment only for fighting fires.
 - 3. Locate fire extinguishers in field offices, storage sheds, tool houses, temporary buildings, and throughout the construction site.

1.02 TEMPORARY CONSTRUCTION

- A. The Contractor is solely and exclusively responsible for the design, construction and maintenance of all temporary construction including forms, falsework, shoring, scaffolding, stairs, ladders and all other similar items.

- B. Construct adequate and safe forms and falsework to rigidly support partially completed structures. Provide temporary bridges to maintain vehicular and pedestrian access. Design and construct temporary forms, falsework, bridges and decking in accordance with applicable regulations and codes.

1.03 BARRICADES, FENCES AND ENCLOSURES

- A. Barricades: Provide temporary guardrails, ladders, stairs, guards, and barricades to protect persons in accordance with applicable regulations and OSHA requirements.
- B. Enclosures:
 - 1. Provide temporary watertight closures for openings in exterior surfaces as required to protect interiors from weather, moisture, humidity and extreme temperature.

1.04 PROTECTION OF INSTALLED WORK

- A. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.
- B. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is unavoidable, provide adequate protection to prevent damage to waterproof membranes and comply with recommendations for protection of the waterproofing or roofing material manufacturer.
- C. Provide heavy planking to protect curbs, gutters, culverts, paving and similar surfaces from damage by heavy equipment or vehicles.

1.05 SECURITY

- A. Provide security facilities to protect the Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.06 ACCESS ROADS AND PARKING AREAS

- A. Parking:
 - 1. Construct temporary gravel surfaced parking areas for construction personnel in Contractor staging and storage areas.
 - 2. Contractor must receive approval to access and utilize temporary storage and staging areas from the property owner(s) prior to mobilization.

1.07 TEMPORARY CONTROLS

- A. Cleaning:
 - 1. During Construction: Maintain the site and all work in a clean orderly fashion free of waste debris and rubbish. Store debris in covered containers. Pick up and remove debris daily if required, but not less frequently than weekly. Burning debris on site is not permitted. Clean mud from vehicles before leaving the site.
 - 2. If work under this Contract creates dusty, dirty or unsightly conditions in adjacent areas, the Contractor shall immediately cleanup the affected areas.
 - 3. Final cleanup is specified in Section 01700.

- B. Dust Control: Employ measures to prevent the creation of dust which may produce damage or nuisance to property or persons. Be responsible for all damage resulting from dust produced by construction operations. Periodically wet down unpaved areas where vehicles are operated. See Section 02300 for additional requirements.
- C. Erosion and Sediment Control: Employ measures to prevent erosion and trap any sediment created by construction operations before it leaves the site. Prevent sediment from entering streams or other water bodies. Contractor is responsible for obtaining the required erosion control and stormwater discharge permits for the project.
- D. Noise Control: Comply with regulations limiting construction noise levels. Use whisper quite air compressors. Use jack hammers with exhaust mufflers. Prevent noise disturbance to the public and adjacent property owners. Residential areas shall be under 50 dB of noise overnight per COA code 38-91. Decibel level to be measured at residential lot lines. Employ measures required to limit construction noise to 80 dBA at construction site boundaries during normal construction timeframes of 7:30 – 3:30 for collector streets.
- E. Water Control: Maintain excavations free of water. See Section 02140 for additional requirements.

PART 2 - PART 2 - PRODUCTS (NOT USED)

PART 3 - PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01550

TRAFFIC CONTROL

PART 1 - GENERAL

1.01 OBJECTIVES

- A. Provide for safe movement of vehicular, bicycle and pedestrian traffic through and around Contractor's construction operations. Traffic control requirements set forth herein are the minimum requirements imposed. The Contractor shall be solely responsible for providing all protective measures necessary.
- B. Proper traffic movement through the work area depends upon the driver controlling and directing his or her vehicle properly under unexpected situations and pedestrian attention to signs. The means of clarifying such conditions to the public include signs, flaggers, pavement markings, barricades, lights, cones, and delineators.
- C. No one standard sequence of signs or control devices will suit all conditions, which may result from construction operations. Even for the same work the conditions may vary from hour to hour, requiring adjustment and revision of the traffic control program in effect.
- D. The traffic control requirements specified herein are intended to establish general principles to be observed in the control and regulation of traffic through and around construction operations anticipated for this project. All pedestrian and vehicular detours are subject to review by the police chief, sheriff, or enforcement officer of the agencies having jurisdiction, and the Contractor shall revise the detours as ordered, at no additional cost.
- E. Cleanup site each day after completing work and remove all traffic hazards. Daily traffic control measures shall continue until cleanup activities have been satisfactorily completed and all of the Contractor's equipment has been removed from the traveled way area.

1.02 DESCRIPTION OF WORK

- A. Work Included:
 - 1. At all times, provide safe and adequate passage for vehicular and pedestrian traffic through, around, and adjacent to all construction operations by use of detours, bridging, backfilling, paving, traffic barriers or other favorably reviewed means.
 - 2. Establish and maintain detours and conduct construction operations in such a manner as to minimize hazard, inconvenience, and disruption to the public.
 - 3. Traffic control shall be directed equally to the regulation and protection of pedestrian traffic including pedestrians, bicyclists, joggers, skaters, skateboarders, etc.
 - 4. Provide for protection of pedestrians and separation of pedestrians from construction operations at all times.
 - 5. Direct, divert and detour traffic through, around, and adjacent to construction operations in accordance with the traffic control plans as specified herein or in accordance with favorably reviewed Traffic Control Plans. Revise the

- Traffic Control Plan, as necessary, only with the favorable review of the Project Engineer.
6. Contractor shall maintain at a minimum two lanes of traffic in the area of Work except for the portions of the Work that include:
 - a. The trenchless crossing of the railroad right-of-way
 - b. The installation of the meter vault and associated bypass piping on the south end of the area of Work. One lane of through traffic is required in this area with approved traffic control measures.

1.03 REFERENCES

- A. Manual on Uniform Traffic Control Devices (MUTCD)
- B. Model Traffic Code for Colorado, Revised 2020.

1.04 SUBMITTALS

- A. Traffic Control Plan:
 1. Submit a Traffic Control Plan (TCP) to the City Traffic Engineer in accordance with the procedures specified in Section 01300 under the Product Information category to clearly describe proposed traffic control measures. The plan shall be generally in accordance with the illustrations included in the Manual of Traffic Control and in the Work Area Traffic Control Handbook.
 2. Submittal shall consist of scaled drawings for each situation anticipated to be encountered, i.e., intersections, mid-block (each during working and non-working hours), etc.
 3. Scaled drawings shall show signs, traffic control devices and flaggers as required.
 4. Designate a Traffic Lead who will have responsibility for planning, preparing, contacting agencies, and implementing the TCP. Provide not less than 30 days written notice of transfer or termination of this individual to assure a smooth transition to a new Lead.
 5. No traffic control related work shall commence until a TCP is favorably reviewed by the Owner and Project Engineer.
 6. Revise and keep the TCP up to date as the project progresses. Consult with the Owner and Project Engineer on an ongoing basis to assure having a safe and workable plan in place.
- B. Haul Routes:
 1. Submit a plan of all delivery and haul routes to be used for the Project.
 2. Haul routes shall consist of collector and arterial streets whenever possible and minimize impacts to residential areas.

PART 2 - PRODUCTS

2.01 CONSTRUCTION SIGNS

- A. The term "Construction Area Signs" shall include all temporary signs required for the direction of public traffic through or around the work during construction. These signs are shown in or referred to in the current MUTCD. Construction area signs shall be installed per the TCP and at other locations as directed by the Owner or Engineer.

- B. All construction area signs shall conform to the dimensions, color and legend requirements of the MUTCD and these specifications. All sign panels shall be the product of a commercial sign manufacturer and shall be as specified in these specifications. The base material of construction area signs shall not be plywood or cardboard unless specifically identified in these specifications.
- C. Sign panels for all construction area signs shall be visible at 500 feet and legible at 300 feet, at noon on a cloudless day and at night under illumination of legal low beam headlights, by persons with vision of or corrected to 20/20, except that the nighttime requirement shall not apply to fabric sign panels for portable signs
- D. Temporary warning signs in construction areas shall have a black legend on an orange background. Color for other signs shall follow the standard for all highway signs.
- E. All signs used during hours of darkness shall be reflectorized or illuminated.
- F. Stationary Mounted Signs
 - 1. Stationary mounted signs shall be installed on wood posts for installation of roadside signs, except as follows.
 - 2. The height to the bottom of the sign panel above the edge of traveled way shall be at least 7 feet.
 - 3. Construction area sign posts may be installed on above ground temporary platform sign supports as favorably reviewed by the Engineer, or the signs may be installed on existing lighting standards or other supports as favorably reviewed by the Engineer. When construction area signs are installed on existing lighting standards, holes shall not be made in the standards to support the sign.
 - 4. The post embedment shall be 3 feet if post holes are backfilled around the posts with 3,000 PSI batch plant mix concrete.
 - 5. Sign panels for stationary mounted signs shall consist of Type II, Type III or Type IV retroreflective sheeting applied to an aluminum substrate.
 - 6. Sign panel fastening hardware shall be commercial quality.
- G. Portable Signs
 - 1. Each portable sign shall consist of a base, standard or framework and a sign panel. The units shall be capable of being delivered to the site of use and placed in immediate operation.
 - 2. Sign panels for portable signs shall be Type VI retroreflective sheeting, or shall be cotton drill fabric, flexible industrial nylon fabric or other approved fabric. Fabric signs shall not be used during the hours of darkness. Size, color, and legend requirements for portable signs shall be as described in the MUTCD. The height to the bottom of the sign panel above the edge of traveled way shall be at least 1 foot.

2.02 CONES AND PORTABLE DELINEATORS

- A. Cones:
 - 1. Traffic cones shall be fluorescent and of good commercial quality, flexible material suitable for the purpose intended. The outer section of the portion above the base of the cone shall be translucent and be of a highly pigmented fluorescent orange polyvinyl compound.
 - 2. The overall height of the cone shall be at least 28 inches and the bottom inside diameter shall be not less than 10.5 inches. The base shall be of

sufficient mass and size or shall be anchored in a manner that the traffic cone will remain in an upright position.

3. During the hours of darkness traffic cones shall be affixed with retroreflective cone sleeves. The retroreflective sheeting of sleeves on the traffic cones shall be visible at 1,000 feet at night under illumination of legal high beam headlights, by persons with vision of or corrected to 20/20.

B. Portable Delineators:

1. Portable delineators shall be orange in color.
2. The overall height of the channelizer shall not be less than 36 inches and the width shall not be less than 3 inches. The base shall be of sufficient mass and size or shall be anchored in a manner that the traffic cone will remain in an upright position.
3. Channelizers shall have affixed white retroreflective sheeting. The retroreflective sheeting shall be 3 inches x 12 inches in size. The retroreflective sheeting shall be visible at 1,000 feet at night under illumination of legal high beam headlights, by persons with vision of or corrected to 20/20.

2.03 BARRICADES

- A. Barricades shall be Type I, Type II or Type III barricades as set forth in the MUTCD.
- B. Barricades used during hours of darkness shall be equipped with flashers.
- C. Markings for barricade rails shall be alternate orange and white stripes. The entire area of orange and white stripes shall be Type I, engineering grade, or Type II, super engineering grade, retroreflective sheeting. The color of the orange retroreflective sheeting shall conform to PR No. 6, Highway Orange, of the Federal Highway Administration's Color Tolerance Chart. Retroreflective sheeting shall be placed on rail surfaces in such a manner that no air bubbles or voids are present between the rail surface and retroreflective sheeting. The predominate color for barricade components other than rails shall be white, except that unpainted galvanized metal or aluminum may be used. Sign owner identification shall not be imprinted on the reflectorized face of any rail but may be imprinted elsewhere.
- D. Ballasting shall be by means of sand-filled bags placed on the lower parts of the frame or stays but shall not be placed on top of the barricade nor over any reflectorized barricade rail face facing traffic.

2.04 TEMPORARY RAILING (TYPE K)

- A. Temporary railing shall consist of interconnected new or undamaged used precast concrete barrier units. Exposed surfaces of new and used units shall be freshly coated with white color paint prior to their first use on the project.
- B. Reinforcing steel bars to receive bolts at ends of concrete panels shall conform to the requirements in ASTM Designation: A36/A36M. The bolts shall conform to the requirements in ASTM Designation: A307.
- C. A round bar of the same diameter may be substituted for the end-connecting bolt. The bar shall conform to the requirements in ASTM Designation: A36/A36M, shall have a minimum length of 26 inches and shall have a 3-inch diameter by 3/8-inch-thick plate welded on the upper end with a 3/16-inch fillet weld.

- D. Temporary railing (Type K) shall be set on firm, stable foundation.
- E. Abutting ends of precast concrete units shall be placed and maintained in alignment without substantial offset to each other. The precast concrete units shall be positioned straight on tangent alignment and on a true arc on curved alignment.
- F. Each rail unit placed within 10 feet of a traffic lane shall have a reflector installed on top of the rail. Reflectors shall be as specified and adhesive shall conform to the reflector manufacturer's recommendations. A Type P marker panel shall also be installed at each end of railing installed adjacent to a two lane, two-way highway and at the end facing traffic of railing installed adjacent to a one-way roadbed. If the railing is placed on a skew, the marker shall be installed at the end of the skew nearest the traveled way.

2.05 FLASHING ARROW SIGNS

- A. Flashing arrow signs shall be finished with commercial quality flat black enamel and shall be equipped with yellow or amber lamps that form arrows or arrowheads as required. Each lamp shall be provided with a visor and the lamps shall be controlled by an electronic circuit that will provide between 30 and 45 complete operating cycles per minute in each of the displays and modes specified. The control shall include provisions for dimming the lamps by reducing the voltage to 50 percent, ± 5 percent, for nighttime use. Type I signs shall have both manual and automatic photoelectric dimming controls. Dimming in both modes shall be continuously variable over the entire dimming range.
- B. Flashing arrow signs shall conform to the MUTCD legibility requirements. The minimum legibility distance is the distance at which flashing arrow signs shall be legible at noon on a cloudless day and at night by persons with vision of or corrected to 20/20
- C. Flashing arrow signs shall be capable of being operated in four (4) different display modes as follows:
 - 1. Pass Left Display
 - 2. Pass Right Display
 - 3. Simultaneous Display - the lamps forming both right and left arrowheads and the lamps of the arrow shaft shall flash simultaneously.
 - 4. Caution Display - a combination of lamps not resembling any other display or mode shall flash.
- D. Flashing arrow signs shall also be capable of operating in one or both of the following modes, at the option of the Contractor:
 - 1. Flashing Arrow Mode - all lamps forming the arrowhead and shaft shall flash on and off simultaneously.
 - 2. Sequential Mode - either arrowheads or arrows shall flash sequentially in the direction indicated.
- E. Each flashing arrow sign shall be mounted on a truck or on a trailer and shall be capable of operating while the vehicle is moving and shall be capable of being placed and maintained in operation at locations as specified or as directed by the Owner or Engineer.
- F. Flashing arrow signs shall be mounted to provide a minimum of 7 feet between the bottom of the sign and the roadway.

- G. Electrical energy to operate the sign shall not be obtained from the vehicle on which the sign is mounted or from a generating plant mounted on the vehicle. Regardless of the source, the supply of electrical energy shall be capable of operating the sign in the manner specified.

2.06 PORTABLE TRAFFIC SIGNALS FOR ONE-LANE WORK ZONES

- A. Provide two (2) portable traffic signals for work zone traffic control during the construction that have the following features:
 - 1. Portable traffic signals with adjustable overhead lights that can clear H20 truck height clearance requirements. Provide two (2) lights per unit.
 - 2. Battery powered capable of running for 21 days without being recharged and include a solar panel to recharge the batteries.
 - 3. Motion activation to sense traffic build-up.
 - 4. Work zone light to allow workers to know which signal is red and which is green with a different flashing pattern or other means.
 - 5. Preemption system to allow emergency vehicle immediate pass through the signal work zone.
 - 6. Digital speed display to display vehicle speed through the work zone.
 - 7. Back plates to enhance visibility of the traffic lights.
 - 8. Manual operation of the signals through use of a hand controller module that lets a flagger control the signals. Provide a means to eliminate possible conflicting indications at each signal during manual controller use.
 - 9. The portable signals shall be linked and be able to communicate and assign only the proper right-of-way assignment at a time.
 - 10. Provide for wireless radio communication between the traffic signals that conforms to MUTCD guidelines.

PART 3 - EXECUTION

3.01 DIVERTING PEDESTRIAN TRAFFIC

- A. Whenever construction operations obstruct the flow of pedestrian traffic or present a hazard to pedestrians, take appropriate action to protect and separate pedestrians from the work area.
- B. Such action may include placement of barricades between pedestrians and work areas, placement of warning signs, and provision of personnel as required to protect pedestrians as conditions warrant.

3.02 DIVERTING VEHICULAR TRAFFIC

- A. Whenever construction operations obstruct the flow of vehicular traffic or present a hazard to vehicles operating in the vicinity of construction operations, take appropriate action to warn, detour and otherwise protect approaching drivers and vehicles.

3.03 MAINTAINING TRAFFIC CONTROL

- A. General:
 - 1. Traffic control devices shall be provided in sufficient quantities and types as required to provide safe and adequate traffic control. To properly provide for changing traffic conditions and damage caused by public traffic or otherwise,

the Contractor shall be prepared to furnish on short notice additional construction area sign panels, posts and mounting hardware or portable sign mounts. The Contractor shall maintain an inventory of the commonly required items at the jobsite or shall make arrangements with a supplier who is able, on a daily basis, to furnish the items on short notice.

2. During hours of darkness, approved lights and/or flares shall be included, in proper working order, to illuminate signs and hazards and alert approaching traffic.
3. Barricades shall be furnished and maintained along all open trenches in contact with traffic.
4. No work may begin on any day or at any time before traffic control devices have been placed and, if required, adjusted, and revised.
5. When leaving a work area and entering a roadway carrying public traffic, the Contractor's equipment, whether empty or loaded, shall yield to public traffic.

B. Traffic Control Placement:

1. All traffic control devices shall be placed in accordance with the MUTCD and the favorably reviewed Traffic Control Plan.
2. Locations of devices shall be adjusted to suit the conditions and circumstances of each detour situation. In all cases, signs shall be placed to most effectively convey their messages to approaching traffic.

C. Maintenance of Traffic Control Devices:

1. Maintain all traffic control devices, at proper locations and in proper working order, at all times during construction operations and whenever a hazard resulting from Contractor's operations exists.
2. Adjust and revise traffic control devices, placement, etc., to suit changing conditions around construction operations.
3. Clean all construction area sign panels at the time of installation. Used signs with the specified sheeting material will be considered satisfactory if they conform to the requirements for visibility and legibility and the colors conform to the requirements of the current MUTCD. A significant difference between day and nighttime retroreflective color will be grounds for rejecting signs.
4. Monitor all traffic control on a daily basis and replace or restore any traffic control devices that have been displaced or damaged.

D. Removal of Traffic Control Devices:

1. Traffic control devices shall remain in place at all times required to alert approaching traffic of upcoming hazards.
2. After hazard has been removed, all traffic control devices shall be removed. Signs shall be removed or their messages covered until removed.
3. Existing roadside signs conflicting with the construction area signs shall be removed and reset upon completion of work or securely covered.

3.04 FLAGGERS

- A. General: Flaggers shall perform their duties and shall be provided with the necessary equipment in conformance with the MUTCD.
- B. Employ flaggers:
1. As required for each specific detour in the Traffic Control Plan.
 2. For each individual railroad track crossing.

3. At all locations on a construction site where barricades and warning signs are insufficient to properly control traffic.
- C. Placement: Where flaggers are required, they shall be logically placed in relation to the equipment or operation so as to give adequate warning and shall be placed approximately 100 feet ahead of impact point unless otherwise specified by the authority having jurisdiction.
- D. Warning Signs:
 1. A warning sign shall be placed ahead of the flagger reading: "Flagger Ahead." The distance between the sign and the flagger should be based on the average traffic speed, allowing approximately 50 feet for each 10 miles per hour.
 2. During hours of darkness, flagger stations shall be illuminated such that the flagger will be clearly visible to approaching traffic. Lights for illuminating the flagger station shall receive favorable review by the Engineer before use.
- E. Equipment:
 1. Each flagger shall be provided with and wear a red or orange warning garment when flagging. Flaggers shall be provided with approved hand signs and two-way radios for communication.
 2. When flagging during hours of darkness, a flagger shall signal with a red light or flare and shall have a belt and suspender harness outside his/her garment fitted with reflectors or made from reflectorized cloth, unless the garment is well reflectorized in one of these ways.

3.05 NOTIFICATIONS

- A. Notify in writing all agencies having jurisdiction and service providers, and all affected residents and businesses at least 48 hours, excluding holidays and weekends, prior to instituting any lane closure or detour. At the end of each day's work, inform the ambulance services, police and fire departments, and affected community service providers of the status of all detours and/or lane or road closures.
- B. List of agencies and service providers to be notified:
 1. Fire Department
 2. Police Department

3.06 EMERGENCY VEHICLE ACCESS THROUGH DETOURS

- A. During all detours and/or street closures, provide for movement of emergency vehicles through the work area.
- B. It is essential that the Contractor's work and equipment does not impede egress from any fire or police station to other areas of their service area.

3.07 ACCESS TO PRIVATE PROPERTY

- A. General: Schedule and organize operations to minimize disruption of access to private property.
- B. Notification: Prior to blocking access to any private driveway or parking lot entrance, notify the resident or business owner or tenant of pending closure at least 72 hours in advance and allow resident to remove vehicles.

- C. Nights: During non-working hours no driveway, house, or parking lot shall be denied access to a public roadway.

3.08 NIGHT DETOURS

- A. General: The Contractor shall not be permitted to maintain any lane closure or road closure during non-working hours without first obtaining written approval of the Engineer.
- B. Restoration of Pavement:
 - 1. During non-working hours, restore travel lanes to their original alignment and configuration by means of backfilling and temporary pavement or bridging the trench with beams and steel plates designed to support HS-20 vehicles.
 - 2. Place "ROUGH ROAD" signs conforming to the MUTCD at uneven temporary pavement or bridging.

3.09 PARKING RESTRICTIONS

- A. General: Post approved "NO PARKING" signs at all locations necessary to establish work areas and detour traffic.
- B. Signs:
 - 1. Signs shall read: "NO PARKING CONSTRUCTION TOW-AWAY ZONE."
 - 2. Signs shall be mounted such that the wording "No Parking" is at an elevation at least 3 feet and not more than 7 feet above the adjacent flow line. Signs may be tied with string to trees and power poles, taped to existing sign poles, or mounted to stakes or barricades provided by the Contractor. The signs shall be placed as needed to control the parking of cars within the construction zone.
 - 3. Signs shall be placed at least 24 hours in advance of restriction. Upon completion of the work, all signs, stakes, and barricades shall be promptly and completely removed and disposed of by the Contractor. The Contractor shall promptly reset or replace all damaged or defective signs.
- C. Towing of Vehicles:
 - 1. The Contractor shall be fully responsible for the adequate removal of all parked cars. All vehicle removal shall be coordinated by the Contractor with the Police Department. The Contractor shall notify the Police Department upon posting of the parking restrictions for a particular street. For removal of parked vehicles, the Contractor shall notify the Police not less than two (2) hours prior to the needed removal with the address nearest the parked vehicle, make, model, color and license number. The Owner shall not be responsible for any delay or additional costs associated with the removal of parked cars that obstruct the construction operation.
 - 2. If a vehicle owner successfully contests a towing citation in court, and their citation is dismissed for causes related to the Contractor's failure to perform the requirements of this section, the Contractor shall reimburse the vehicle owner for the cost of any claims associated with the towing citation.

3.10 BRIDGING OVER TRENCHES AND EXCAVATIONS

- A. General:

1. For excavations not backfilled or permitted to remain open, bridging shall be placed across all trenches and excavations in existing streets and at driveways when work is not in progress.
- B. Design of Bridging:
 1. Bridging for vehicular traffic shall be of sufficient width to accommodate the required number of travel lanes.
 2. Bridging shall be designed to support HS-20 vehicular traffic.
 3. All bridging shall be set flush with travel surface or a satisfactory transition from travel surface to top of bridging shall be provided.
 - a. A satisfactory transition shall mean a change in elevation between the levels of not less than 12 inches horizontal to 1 inch vertical.
 - b. Transition may be accomplished by means of temporary pavement.

3.11 TEMPORARY TRAFFIC LANES

- A. Temporary traffic lanes shall be at least 10 feet wide, unless otherwise indicated on the Traffic Control Plan. Provide an additional 2 feet of clearance from curbs or other obstructions. The length of temporary lanes should be limited to the area under construction and the distance necessary to divert traffic.

3.12 TEMPORARY PAVEMENT MARKERS

- A. Wherever the Contractor's operations obliterate pavement delineation, including pavement markers and painted or thermoplastic lines for lane lines, stop bars, crosswalks, pavement legends, etc., such pavement delineation shall be replaced at the Contractor's expense by either permanent or temporary delineation before opening the traveled way to public traffic.
- B. Temporary delineation shall consist of reflective traffic line tape applied in pieces not less than 12 inches long and not less than 4 inches wide. The tape pieces shall be spaced no more than 12 feet apart on curves and no more than 24 feet apart on tangents.
- C. Install temporary stop bars, limit lines and crosswalks at any location where the construction operation obliterated the existing delineations. These temporary stop bars, limit lines and crosswalks shall consist of 6-inch-wide removable tape or approved equal.
- D. Reflective line tape or tabs shall be applied in accordance with the manufacturer's instructions. Temporary delineation shall be the same color as the permanent delineation.

3.13 STAGING AREAS

- A. The Contractor's equipment shall not be parked within any traffic lanes after working hours.
- B. The Contractor shall provide its own staging areas.

3.14 TRUCK TRAFFIC PLAN AND RESTRICTIONS

- A. Control the delivery and haul routes of all trucks having three or more axles used in conjunction with this work. This control shall extend to all such trucks owned by the Contractor, subcontractors, second and lower tier subcontractors, material suppliers, commercial haulers, and deliverers of equipment.

- B. To reduce tracking of dirt, tack coat, and other objectionable material onto various streets, the Contractor shall limit the number of truck haul routes.
- C. Arterial and collector streets shall be used for truck and equipment access.
- D. Trucks and equipment shall not be routed or parked on residential streets unless otherwise approved by the Owner.

3.15 MAINTAINING EXISTING AND TEMPORARY SIGNAL LIGHTING AND ELECTRICAL SYSTEMS

- A. Ensure effective operation of existing traffic signals and street lights within the construction area.
- B. When working within 100 feet of any signalized intersection, arrange with the signal owner to modify the controller timing as required to properly handle traffic during construction.
- C. Damage to Signal Lighting Electrical Systems:
 - 1. Ascertain the exact location and depth of all existing detectors, conduits, pull boxes, and other electrical facilities before using any tools or equipment that may damage those facilities or interfere with any electrical system.
 - 2. In the event that traffic signal or street light conductors are damaged, arrange for their repair within 24 hours. If a permanent repair is not possible or infeasible, make temporary repairs to ensure safe and efficient operation, until permanent repairs can be made. Both temporary and permanent repairs shall be made at the Contractor's expense and in coordination with the signal owner's requirements.
 - 3. In the event that in-pavement loop detectors are damaged, contact and coordinate with the signal owner to modify the controller timing as required to properly handle traffic during construction. Arrange for immediate replacement of loop detectors upon completion of construction work within the traffic lane where the damage occurred.

END OF SECTION

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SECTION 01600
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.02 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with product requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.03 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, damage, and theft.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.04 PRODUCT SUBSTITUTION PROCEDURES

- A. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 - 2. Will provide same warranty for Substitution as for specified product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 5. Will reimburse Owner for review or redesign services associated with re-approval by authorities having jurisdiction.
- D. Substitutions will not be considered when they are indicated or implied on Shop Drawing submittals, without separate written request, or when acceptance will require revision to Contract Documents.
- E. Substitution Submittal Procedure:
 - 1. Submit cover sheet for the request for Substitution for consideration.
 - 2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence.
 - 3. Project Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 FINAL CLEANUP

- A. Prior to Final Inspection, the Contractor shall clean the entire construction area and all other areas affected by the performance of work under this Contract. Perform cleaning using personnel specializing in and skilled in cleaning and maintenance work. Perform repair work using personnel skilled in executing the type of work being repaired. Perform all work to the highest trade standards applicable to that type of work.
 - 1. Remove all temporary construction, signs, tools, equipment, excess material and debris.
 - 2. Remove all lumps, splatters, spots and stains caused by paint, adhesive, asphalt, concrete, mortar, sealant or other foreign material from exposed or finished surfaces. Remove all temporary labels.
 - 3. Repair, patch or replace new or existing work including pavement, sidewalks, curbs, gutters, catch basins, gratings, manholes, covers, landscaping, plant materials and other items that have been damaged, broken, cracked or chipped as a result of performing this Work.
 - 4. Sweep clean and wash down all exterior pavement surfaces. Remove all hazardous material and material that may cause sediment in drainage systems prior to washdown. Remove all grease and oil stains on pavement caused by Contractor's equipment.

1.02 CONTRACTOR'S ACTION LIST OF ITEMS TO BE CORRECTED AND/OR COMPLETED

- A. During construction, the Contractor shall maintain an action list of items to be corrected and/or completed. Regularly add items and update the list as information becomes available or as requested by the Project Engineer.

1.03 SUBSTANTIAL COMPLETION

- A. When the Contractor considers the Work nearly complete, the Contractor shall review the Contract Documents, inspect the Work, and use the Contractor's action list to prepare a Contractor's Punch List of all deficient or uncompleted items. Complete or correct the items on the Punch List. When the Work is Substantially Complete, notify the Owner's Inspector that the Contractor has reviewed the Contract Documents, inspected the Work, and believes that the Work is Substantially Complete and ready for Semifinal Inspection.
- B. On receipt of the Contractor's Punch List and notice that the work is ready for Semifinal Inspection, the Owner's Inspector will inspect the Work. The Owner's Inspector may add additional items to the Contractor's Punch List, may find that the Work is not ready for inspection, may find that the Work is ready for inspection but not Substantially Complete or may find that the Work is Substantially Complete. When the Owner's Inspector finds the Work is Substantially Complete, he/she will prepare a Final Punch List and a notice of Substantial Complete, which will state

the date of Substantial Completion and the time agreed to by the Owner and the Contractor (not to exceed 30 calendar days) in which the Work shall be fully complete and ready for Final Inspection.

1.04 FINAL INSPECTION, FINAL COMPLETION AND FINAL PAYMENT

- A. When the Contractor has completed or corrected all the items on the Owner's Inspector's Final Punch List, the Contractor shall give the Owner's Inspector written notice that the Work is ready for Final Inspection. When the Owner's Inspector finds the Work acceptable and fully complete in accordance with the Contract Documents, and upon receipt of a final Application for Payment and all final submittals, the Owner's Inspector will recommend that the Owner issue a Notice of Final Completion, make Final Payment, and Accept the Work stating that to the best of the Owner's Inspector's knowledge, information and belief, and on the basis of the Owner's Inspector's observations and inspection, the Work has been fully completed in accordance with the terms and conditions of the Contract Documents.
- B. Final Submittals include:
 - 1. Operation and Maintenance Manuals and Parts Lists
 - 2. Record Drawings
 - 3. Insurance Certificate showing required continuation of coverage beyond Final Payment.
 - 4. Release of Liens.
 - 5. Waiver of Claims by Contractor.
 - 6. And any other submittals required by the Contract Documents and not previously received.

1.05 RECORD DRAWINGS

- A. The Contractor shall maintain on the jobsite, a complete set of Contract Documents and a complete file of all addenda, contract modifications and favorably reviewed submittals. The Contractor shall prepare a set of Record Drawings concurrently with the construction of the Work and in accordance with the following:
 - 1. The contractor shall utilize the Owner's survey department to survey final rim and invert elevations. Show the invert elevation of all gravity piping and the top of pipe, top of conduit or top of protective concrete encasement for other utilities. Elevations shall be related to a permanent visible elevation benchmark set at the site by the Contractor.
 - 2. Show the horizontal location of underground utilities measured from permanent visible physical features such as edge of asphalt or centerline of roadway. Northings and eastings of new structures is also acceptable.
 - 3. Comply with detailed requirements in technical specification sections describing the type of information required on Record Drawings. The Contractor's copy of Contract Documents, Contract modifications and Record Drawings shall be available to the Project Engineer for verification that the records are being currently updated.
- B. Submit Record Drawings and obtain acceptance prior to completion.

1.06 WARRANTY

- A. Contractor shall warranty the project Work for a total of two (2) years at the date of Final Completion and Acceptance of the Work.

1.07 FINAL ACCEPTANCE INSPECTION

- A. Three (3) months prior to the expiration of the two-year guarantee period the Contractor will send a final acceptance inspection request to all applicable City Divisions/Departments to inspect the project for final acceptance. At least sixty (60) days prior to the expiration of the warranty period, the Contractor will be notified in writing of all outstanding punch list items needed to be completed and will have thirty (30) days to complete the punch list items. See Section 231.00 of the City of Arvada Engineering Code for further detail.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide all demolition required to perform the work covered under this contract including without limitation:
 - 1. Remove existing construction shown to be removed.
 - 2. Remove and replace existing construction and/or finishes as required to provide access to perform other work included in this contract.
 - 3. Include removal of mechanical and electrical work that is to be abandoned, removed, or is located within the work area for construction whether or not the mechanical and electrical work is shown. Disconnect and cap off utilities in accordance with applicable codes and safety regulations.
 - 4. Where utilities that are not shown pass through construction that must be removed, and those utilities serve other areas, notify the Engineer and utility owner before disrupting service. If rerouting is required to maintain service, the Owner may issue a Change Order to accomplish the required work.
 - 5. Store and protect items intended for reuse.
 - 6. Assume ownership of debris and unwanted materials, remove from the site and dispose of legally.
 - a. Special requirements for waste management during deconstruction and construction operations.
 - 1) Protect the environment, both onsite and offsite, during deconstruction and construction operations.
 - 2) Prevent environmental pollution and damage.
 - 3) Maximize source reduction, reuse, and recycling of solid waste.
 - 7. Include the cost of removing and disposing of hazardous material including without limitation asbestos or asbestos-containing material, lead-containing paint, and PCBs.
 - 8. Comply with all State permit requirements for demolition. The Contractor shall perform a pre-demolition survey to determine whether hazardous material is present. If material is identified as hazardous, retain qualified and State-licensed Contractor to remove and dispose of the materials legally.
 - 9. If illegal electrical wiring is encountered such as "BX" or nonmetallic sheathed cable, notify the Engineer.
 - 10. Remove all loose items including rubbish, debris, furniture, etc.

1.02 NOISE AND DUST CONTROL

- A. Perform work in accordance with the requirements in Division 1. Particular attention is directed without limitation to paragraphs titled: Cleanup During Construction, Fire Protection During Construction, Dust Control, Erosion and Sediment Control, and Noise Control.
- B. Provide temporary controls to control dust and noise and exclude unauthorized persons.

- C. Perform work in a manner to cause least disturbance to the general public and least damage to work to remain.
- D. Maintain adequate means of safe, clear egress for all on-site personnel occupants.
- E. Employ all available techniques for construction noise abatement. Use remote, well-muffled air compressors and newest noise suppressed pneumatic and electric tools.

1.03 WARNING

- A. The Contractor is advised that work under this Section may be hazardous. The Contractor is to take all necessary precautions to ensure the safety of workers and property. Removal of and/or working in areas containing even minor amounts of hazardous material including without limitation, asbestos, lead-based paint, PCBs or other hazardous materials requires special precautions, knowledge, and procedures. If hazardous material is suspected, notify the Engineer or Owner.

1.04 QUALITY ASSURANCE

- A. Maximize use of source reduction and recycling procedures.

1.05 SUBMITTALS

- A. Information to be submitted in accordance with Section 01300.
- B. Submit copies of all executed permits.

1.06 PERMITS

- A. Contractor shall fill out, submit and pay for the following permits:
 - 1. Colorado Department of Public Health and Environment:
 - a. Demolition Notification Application Form (minimum 10 day lead time)
- B. Refer to CDPHE requirements and procedures for asbestos abatement and control of hazardous air pollutants.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 SOLID WASTE MANAGEMENT

- A. Develop and implement a waste management program in accordance with ASTM E1609 and as specified herein.
- B. Handling:
 - 1. Clean materials that are contaminated prior to placing in collection containers. Deliver materials in accordance with recycling, reuse, or waste facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process).
 - 2. Arrange for collection by or delivery to the appropriate recycling, reuse, or waste facility.

3. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

3.02 REMOVAL OF CONSTRUCTION IN AREAS TO RECEIVE NEW WORK

- A. Remove all unwanted mechanical and electrical work (whether shown or not) that is not wanted and is not needed to serve other areas that is in, on, or concealed behind work being removed. Cap off or terminate all mechanical or electrical work in accordance with the requirements of Divisions 15 and 16.
- B. Protect mechanical and electrical work that serves other areas. Relocate concealed mechanical and electrical work that is required to preserve service to other areas.
- C. Remove structural work designated for removal. Take precautions not to damage structural work intended to remain. Where temporary shoring is needed, submit a design prepared by an appropriately licensed engineer for review before proceeding.
- D. If structural elements are encountered that were not shown, protect them from damage and report their presence to the Engineer.

3.03 REMOVAL OF EXISTING CONSTRUCTION TO PROVIDE ACCESS TO PERFORM WORK

- A. Provide careful selective cutting and removal of existing construction where required to permit installation of new structural work.
- B. Treat existing mechanical, electrical, or structural work as described in other parts of this Section.
- C. Replace and/or patch removed construction and finishes in accordance with other parts of this Section.

3.04 PROTECTION OF WORK TO REMAIN

- A. Protect all work to remain. Repair damage with materials, workmanship, and finishes matching existing work when new.

3.05 CUTTING HOLES IN CONCRETE AND/OR CONCRETE MASONRY UNIT (CMU)

- A. The Contractor is cautioned that electrical conduits and reinforcing that are not shown on Drawings may be concealed in concrete CMU construction. Use electronic detection equipment to locate concealed items before cutting holes. Take all required precautions to avoid damage to existing conduits or reinforcing.

3.06 IF HAZARDOUS MATERIALS ARE ENCOUNTERED

- A. If hazardous materials are discovered, comply with paragraph 1.01 of this Section and all applicable laws.

3.07 REMOVAL AND DISPOSAL OF MATERIAL

- A. Store debris in suitable covered containers located where directed by the Owner and remove from site when full. Burning on the site is not permitted.

- B. Removed material (other than material to be reused) shall become the property of the Contractor who shall remove it from the site and dispose of it in a legal manner.

3.08 UTILITY LOCATES AND DEMOLITION

- A. Contractor is responsible for locating utilities during construction and coordinating the project work with said utility owners. Utility owners may require temporary support, temporary service, encasement, and/or relocation of utilities to facilitate the work.

END OF SECTION

SECTION 02070

WASTEWATER FLOW MANAGEMENT PLAN

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Planning and implementation of wastewater flow diversions.

1.02 SUBMITTALS

- A. Wastewater Flow Management Plan as specified herein.
- B. Public Notification Letter as specified herein.

1.03 GENERAL REQUIREMENTS

- A. Contractor shall provide labor, materials, and supervision to temporarily provide bypass pumping and flow control around the Contractor's work in accordance with the specific needs of the inspection, cleaning, or construction work.
- B. The means and methods of accomplishing and maintaining the bypass system shall be the sole responsibility of the Contractor.
- C. No interruption of sewage flow shall be permitted throughout the duration of the project.
- D. The Contractor is advised that the bypass plans must provide for accessibility to pedestrians and vehicular traffic in accordance with City, County, and property owner requirements.
- E. Bypass Operation will be required 24 hours per day during the period of Work. The bypass pumps and piping flow shall be continuously monitored by a competent operator.
- F. Contractor shall inspect upstream and downstream diversion structures and/or manholes prior to installation. Any modifications, excavations, or improvements required for the upstream and downstream structures/manholes to facilitate bypass pumping equipment should be included in the Wastewater Flow Management Plan submitted by the Contractor and shall be performed by the Contractor. The Contractor is responsible for providing pumps and temporary storage, if required, to handle the incoming flows.
- G. Bypass pumping shall be performed in a manner so as not to create a public nuisance or health hazard and shall conform to current Colorado Department of Public Health and Environment practices. The Contractor shall supply and operate equipment for pumping the listed flow rates with provisions for 100% backup pumping capacity onsite during pumping operation. Discharge line locations and street crossings shall be coordinated with the appropriate governing agency.
- H. Contractor shall coordinate with Metro Water Recovery (Metro) on the use of a bypass flow estimate for the project. Contractor shall be responsible for providing Metro with estimated bypassing flow rates based on agreed upon methods. Metering is not required on bypass piping.

- I. During construction of the tie in point with the Metro's interceptor it is expected that Metro's interceptor flows will need to be bypassed. Contractor shall coordinate with Metro on the appropriate bypass discharge location, flow rates, and pump/pipe staging to ensure that bypassed flow is accounted for during construction. Bypass flow for the Clear Creek interceptor shall be bypassed into the same interceptor system downstream of the tie in point, unless otherwise directed by Metro.
- J. Contractor shall submit the WFMP and Emergency Response Plan at a minimum 14 days in advance of proposed bypassing operations. Contractor shall receive approval of the WFMP and Emergency Response Plan from Metro prior to commencement of bypassing operations.

1.04 PUBLIC RELATIONS

- A. The Contractor is responsible for contacting property owners and businesses that are affected by the construction activities to inform them of the Work to be done and the estimated schedule and timing for the Work. Written notice shall be delivered to each home or business 2 weeks prior to construction. Notice shall include a local telephone number of the Contractor, and contact information for the Owner. Written notices must be reviewed by the Owner prior to distribution to the public.

1.05 WASTEWATER FLOW MANAGEMENT PLAN

- A. The Contractor shall submit to the Engineer a Wastewater Flow Management Plan (WFMP) at least fifteen (15) working days prior to implementation of flow diversion/bypass. The WFMP shall indicate the sequence of diversion operations, and all other operations the Contractor will establish to maintain wastewater service during the diversion/bypass period. The WFMP shall be reviewed and accepted by the Engineer before flow can be diverted/bypassed. No deviation from the approved WFMP will be allowed without prior approval from the Owner or Engineer.
- B. The WFMP shall include, but not be limited to, the following:
 - 1. Drawings indicating the scheme and location of pumps, suction piping, discharge piping, and temporary sewer plugs for each of the project sites.
 - 2. Capacities and sizes of pumps, standby equipment, and power requirements if applicable.
 - 3. Design calculations proving adequacy of the system and selected equipment, including static lift, friction losses, fitting losses, flow velocity, pump curves showing operating range, and pipe thickness calculations.
 - 4. The submittal shall include a start date, time, and duration of diversion.
 - 5. Sewer plugging method and type of plug.
 - 6. Method of noise control for each pump and generator.
 - 7. Thrust and restraint block sizes and locations where space is limited.
 - 8. Temporary pipe supports and anchoring where required.
 - 9. Staffing Plan.
- C. The WFMP shall include a Wastewater Discharge Emergency Response Plan indicating the procedures, personnel, equipment, and activities that will be implemented in the event of a wastewater discharge, spill or overflow to the environment, or diversion system failure. The Contractor shall be responsible for

implementation of the Wastewater Discharge Emergency Response Plan in accordance with Section 02072.

- D. The Contractor shall submit as part of the WFMP the monitoring procedure and frequency and shall continuously monitor the flow levels downstream and upstream of the flow diversion to detect any possible failure that may cause a wastewater discharge. The Contractor shall maintain a daily log of the monitoring and provide weekly copies to the Engineer in a manner acceptable to the Owner.
- E. The Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to wastewater discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing wastewater discharges, spills or overflows, containing the wastewater, recovery and legal disposal of wastewater, any fines, penalties, claims and liability arising from negligent or willful discharge of wastewater, and violation of any law, ordinance, code, order, or regulation as a result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Owner for such wastewater discharges, spills, or overflows, including any attorney fees and costs associated with defending any action against the Owner resulting from such discharges, spills, or overflows.

1.06 FLOW DATA

- A. The current average daily flow in the sewer pipe is 1,940 gallons per minute (gpm) and the current peak flow is 3,300 gpm. Contractor shall verify flows before bypass pumping commences. Contractor is responsible for designing the bypass system to accommodate peak flows at the time of construction.

PART 2 - PRODUCTS

2.01 TEMPORARY DIVERSION STRUCTURES

- A. Contractor, at his/her discretion, may construct additional diversion structure(s) at the bypass pump set-up location to accommodate the incoming wastewater flows for pumping. The Contractor is responsible for providing pumps and temporary storage, if required, to handle the incoming flows.

2.02 BYPASS PUMPING EQUIPMENT

- A. All bypass piping must be rigid pipe; flat piping (hose) is not acceptable.
- B. The Contractor shall only use equipment inspected and found to be fully functional. The Contractor shall use pressure-rated piping materials in good working condition. Where two or more pipes will be used, provide one redundant, additional pipe of greater or equal size.
- C. The Contractor shall provide a pumping system consisting of pumps, pipe, and generators capable of handling an estimated peak flow of 3,300 gpm. Extra pumps and generators with a total capacity equal to 100% of the design flows must also be provided. A minimum of two pumps and generators shall be on site with no single pump and generator having less than 100% capacity of the design flows. The Contractor shall utilize the flow bypass system to perform the necessary maintenance and repairs on the flow bypass system, and exercise and ensure the

operation of the backup pumps. The Contractor shall operate the backup pump(s) for a minimum of 25% of the total bypass time on a weekly basis. All pumps shall be fully installed, operational, and ready for immediate use.

- D. The influent flow rate into the bypass pumping diversion structure could be variable, and the flow rate could change from low flow to high flow over a short period of time. The bypass pumping system shall be capable of quickly adjusting to accommodate the variability in the influent flow rate.
- E. Pumps and generators shall be equipped with devices such as (but not limited to) mufflers and/or plywood/Styrofoam noise panels enclosing the engines to keep the noise level down to a minimum. A maximum noise level of 50 decibel (dBA) is permitted overnight as measured at residential lot lines. See requirements in Section 01500 for additional requirements.
- F. The Contractor is responsible for providing adequate freeze protection for the bypassing pumping equipment to allow the equipment to maintain pumping operations during the fall, winter and spring timeframe in Arvada, Colorado.

PART 3 - EXECUTION

3.01 BYPASS PUMPING EQUIPMENT

- A. The Contractor shall continuously monitor the flow levels downstream and upstream of the flow diversion to detect any possible failure that may cause a wastewater discharge. The Contractor shall maintain a daily log of the monitoring and provide weekly copies to the Owner in a manner acceptable to the Engineer.
- B. The Contractor shall provide one dedicated fuel tank for every single pump/generator, if fuel/generator driven pumps are used. The Contractor shall provide a fuel level indicator outside each fuel tank. The Contractor shall continuously (while in use) monitor the fuel level in the tanks and ensure the fuel level does not drop below a level equivalent of 2 hours of continuous flow diversion system operation. The Contractor shall take the necessary measures to ensure the fuel supply is protected against contamination. This could include, but is not limited to, fuel line water traps, fuel line filters, and protecting fuel stores from precipitation. The Contractor shall also monitor all piping and repair leaks immediately.
- C. The Contractor shall provide fuel leak containment around all generators.
- D. Drain residual wastewater from piping system to pipelines prior to disassembly, taking care to avoid wastewater spills.
- E. All pumps, generators and other equipment shall be placed on a plastic tarp to protect against spills of petroleum products used by the equipment.
- F. The Contractor can also utilize electric pumping options with provisions for backup power if preferred.

3.02 QUALITY CONTROL

- A. The Contractor must provide 24-hour supervision of the bypass pumping system during operation.
- B. The Contractor shall inspect manholes upstream of the proposed manhole used for pump suctions to verify if underdrains are present. If underdrains are present,

underdrains shall be extended past the expected hydraulic grade line during bypass pumping operations and underdrains shall be leak tight.

- C. The Contractor shall inspect the entire bypass pumping and piping system for leaks or spills on an hourly basis. The bypass system shall have trained and qualified attendants around the clock whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required. The attendants shall be qualified to both operate and repair any and all problems that may occur. The attendants shall have a cellular phone for communication between the Owner and the site in the event of emergencies. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted. In the event of any sewage spill, the Contractor shall be responsible for the prompt cleanup and disinfecting of the spill as outlined in Section 02072, Wastewater Discharge Emergency Response Plan. The Contractor shall compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.
- D. The Contractor shall inspect and maintain the bypass system daily, including the backup system. The Contractor shall maintain a log of all inspection, maintenance, and repair records, and provide copies to the Engineer upon request.
- E. The Contractor shall not damage existing public and private improvements, interrupt existing services and/or facility operations which may cause a wastewater discharge, spill, or overflow. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.
- F. The Contractor is prohibited from discharging any groundwater, stormwater, or hazardous waste to surrounding water bodies or wastewater/stormwater infrastructure unless previously approved by the authority having jurisdiction.

3.03 HYDROSTATIC PRESSURE TESTING

- A. The diversion system shall be hydrostatically pressure tested in the presence of the Owner or its representative using potable water prior to wastewater flow diversion. The Contractor shall demonstrate to the satisfaction of the Owner or its representative that both the primary and backup flow diversion systems are fully functional and adequate, and shall certify the same, in writing, to the Owner in a manner acceptable to the Engineer.
- B. Hydrostatic Pressure Test:
 - 1. Prior to operation, test each section of discharge piping.
 - 2. Test pressure shall be 50% greater than maximum operating pressures, or 10 psi above maximum operating pressures, whichever is greater.
 - 3. The test shall run for a period of 2 hours in the presence of the Owner or its representative.
 - 4. The Contractor shall fill the line with water.
 - 5. The line shall be sealed on the discharge end.
 - 6. The line may be put in service if after the 2-hour period the pressure has been maintained and there are no observable leaks.
 - 7. Notify Engineer 24 hours prior to testing.

3.04 CLEAN-UP

- A. The bypass pumping system shall be cleaned and drained prior to being dismantled and moved. The Contractor shall alternate pigging and purging of the system to remove all loose material. After the Contractor has cleaned the pipe, and prior to dismantling of the piping for removal from the Project site, the Contractor shall disinfect the pipe with 10% chlorine and water solution. Notify the appropriate governing agency of the downstream Wastewater Treatment Plant for chlorine added to sanitary sewer pipe larger than 24-inches in diameter.
- B. Disturbed Areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including, but not limited to, pavement restoration and landscaping, at least equal to that which existed prior to start of Work.

3.05 SCHEDULING

- A. The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Owner.

3.06 WASTEWATER DISCHARGE/DIVERSION SYSTEM FAILURE

- A. In the event of a wastewater discharge, spill or overflow, or diversion/bypass system failure, immediately implement the Wastewater Discharge Emergency Response Plan (Section 02072).
- B. The Contractor will be charged for all costs associated with the Owner's efforts if they are dispatched to the discharge, spill, or overflow.

END OF SECTION

SECTION 02072

WASTEWATER DISCHARGE EMERGENCY RESPONSE PLAN

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Development of a Wastewater Discharge Emergency Response Plan, to be implemented in the event of a wastewater discharge, spill, or overflow to the environment.

1.02 SUBMITTALS

- A. Emergency Response: Detailed implementation plan.

1.03 WASTEWATER DISCHARGE EMERGENCY RESPONSE PLAN DEVELOPMENT

- A. The Contractor shall develop and submit to the Owner at least fifteen (15) working days prior to the start of construction, a written Wastewater Discharge Emergency Response Plan (WDERP) in a form similar to the attached sample at the end of this section. The WDERP shall be developed to respond to any construction related wastewater discharge, spill, or overflow to the environment. The Contractor is prohibited from discharging any wastewater or hazardous waste encountered during the construction project into the environment.
- B. The WDERP shall include at minimum, the following:
 - 1. Identification of environmentally-sensitive areas that could be affected by a wastewater discharge, spill, or overflow, including but not limited to, waterways, channels, catch basins, and entrances to existing underground storm drains.
 - 2. Development of an emergency notification procedure that complies with State and Federal requirements including but not limited to, Section 25-8-601(2), C.R.S. The Contractor shall designate primary and secondary representatives, their respective office telephone numbers, mobile phone numbers, and e-mail addresses shall be provided. Owner contacts shall also be listed.
 - 3. Identification of personnel and equipment/tools that will be utilized in the event of a wastewater discharge, spill, or overflow to the environment. Include an emergency response team with arrangements for backup personnel and equipment. The emergency response team shall be able to dispatch to the site 24 hours a day 7 days a week including weekends and holidays to respond immediately to any wastewater discharge, spill, or overflow to the environment related to the Work.
 - 4. Identification of downstream public water systems.
 - 5. Identify owners of stormwater inlets in immediate vicinity.
 - 6. Step-by-step procedures to contain, control, and minimize wastewater discharges, spills, or overflows to the environment.
- C. At the pre-construction meeting, the Contractor will be provided with a list of Owner representatives to contact in case of a wastewater discharge, spill, or overflow to the environment. These contacts shall be added to the WDERP.

- D. Contractor cannot begin work until the Owner has accepted the WDERP in writing. The complete and final copy of the WDERP shall be available on the job site at all times.
- E. It shall be the Contractor's responsibility to assure that all employees, including subcontractors, know and obey all emergency procedures included in the WDERP.
- F. The emergency response plan shall comply with local regulations, including the City of Arvada, CDPHE, Adams County, and all other applicable regulations.

1.04 WASTEWATER DISCHARGE EVENT

- A. In the event of a wastewater discharge, spill, or overflow to the environment, the Contractor shall:
 - 1. Immediately implement the WDERP without direction from the Owner or the Engineer, to control and contain the discharge, spill, or overflow to the environment.
 - 2. Contact the Owner's personnel immediately. Information to provide shall include at minimum, the following:
 - a. Location of discharge, spill, or overflow to the environment
 - b. Estimated volume
 - c. Time discharge, spill, or overflow began
 - d. Duration if already terminated, or expected duration if in progress
 - e. Cause (if known)
 - f. Control measures implemented
 - g. Type of remedial and/or clean up measures taken
 - h. Description of affected or potentially affected sensitive areas such as waterways, channels, catch basins, and entrances to existing underground storm drains.Based on this information, personnel will determine whether the discharge, spill, or overflow is contained, and whether or not the Owner's maintenance contractor should be dispatched to the site. If dispatched, the Contractor shall be responsible for all costs incurred by the Owner's maintenance contractor as associated with the discharge, spill, or overflow.
 - 3. Contact owner of stormwater inlets if discharge, spill, or overflow enters stormwater system.
- B. The Contractor shall, within 2 working days of the wastewater discharge, spill, or overflow, submit to the Owner a written Wastewater Discharge Incident Report (Figure 1).
- C. The Owner's representative will evaluate the suggested procedural changes to avoid further discharges, spills, or overflows and will instruct the Contractor through the Owner on changes. The Owner may institute further corrective actions, as deemed necessary.
- D. The Contractor shall observe and comply with all federal, state, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to wastewater discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing wastewater discharges, spills, or overflows to the environment, containing the sewage, recovery and legal disposal of sewage, any fines, penalties, claims and liability arising from negligent or willful discharge of wastewater, and violation of any law, ordinance, code, order, or regulation as a

result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Owner for any such sewage discharge, spill, or overflow, including any attorney fees and costs associated with defending any action against the Owner resulting from such discharge, spill or overflow.

- E. The Contractor shall not damage existing public and private improvements or interrupt existing services and/or facility operations which may cause a wastewater discharge, spill, or overflow to the environment. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.
- F. Once the discharge, spill, or overflow has been contained and the situation causing the event has been stabilized, the Contractor shall restore the affected areas to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 02072-FIGURE 1
WASTEWATER DISCHARGE
INCIDENT REPORT

Project Title:

Report Date:

Incident Date:

Discharge Location:

Time & Duration of Discharge:

Estimated Lost Wastewater Volume:

**Notification to Owner/Engineer
Who/When Notified:**

Description of the Incident:

Cause (if known):

Control Measures Implemented:

Remedial and/or Cleanup Measures Taken:

Recommended Procedural Changes:

REPORTED BY:

[Contractor Representative]

Signature Date

RECEIVED BY:

[Owner Representative]

Signature Date

[Engineer Representative]

Signature Date

cc:

SECTION 02080

PRECAST CONCRETE SECTIONAL MANHOLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Precast reinforced concrete cylindrical sectional manholes, complete with openings, inserts, hardware, drains, covers, and frames.
2. Precast reinforced concrete manhole bases and tops.

1.02 REFERENCES

A. ASTM International (ASTM), Standard Specifications:

1. A36 Structural Steel
2. A48 Gray Iron Castings
3. A615 Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. A955 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
5. A1064 Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
6. C150 Portland Cement
7. C478 Precast Reinforced Concrete Manhole Sections
8. C1821 Installation of Underground Circular Precast Concrete Manhole Structures
9. C990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
10. C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
11. C913 Precast Concrete Water and Wastewater Structures

B. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Highway Bridges:

1. M198 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
2. M199 Standard Specification for Precast Reinforced Concrete Manhole Sections

C. American Iron and Steel Institute (AISI).

1.03 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Product Data:

1. Descriptive details of the manufacturer's proposed standard products, including:
 - a. Precast manhole sections.
 - b. Precast roof slab or cone section.

- c. Precast base slab.
 - d. Minimum concrete 28-day compressive strength.
 - e. Cement certification.
 - f. Manhole cover and frame.
 - g. Technical data sheets for protective coatings inclusive of MSDS, grade of materials, and design thickness
 - h. Coatings Work Plan inclusive of surface preparation, mixing instruction, application procedures, curing procedures and schedules, and all other pertinent items for the successful application of coatings per the manufacturer's recommendations.
2. Shop drawings, including:
- a. Layout:
 - 1) Plan:
 - a) Orientation of eccentric manhole with laterals shown
 - b) Indicate location of latter rungs
 - c) Inserts, attachments, and openings
 - 2) Section:
 - a) Finished grade of manhole lid/cover/grate
 - b) Elevations of bottom of manhole and pipe invert(s)
 - c) Inserts, attachments, and openings
 - d) Joint types and number of risers.
 - b. Reinforcing steel location and concrete cover.
 - c. Buoyancy calculations

1.04 QUALITY ASSURANCE

- A. Provide products of a manufacturer who has been regularly engaged in the design and manufacture of the product.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

- A. General: ASTM C478, and AASHTO M199 and also:
 - 1. Structure live load: HS-20
 - 2. Dead and operating loads from any attached equipment.
 - 3. Handling and installation loads.
 - 4. Backfill material: Structural backfill.
 - 5. Base material: Crushed rock meeting No. 67 coarse aggregate standard in section 703 of CDOT specifications
 - 6. Buoyancy: Design manhole for groundwater up to grade, showing resistance to buoyancy with factor of safety of at least 1.2.
- B. Permanent bypass manholes and manholes downstream of the meter vault shall be designed, constructed, and installed in accordance with Metro Water Recovery standard details and specifications.

2.02 PRECAST SECTIONS

- A. General:
 - 1. Manhole cone section: Eccentric; concentric not permitted

2. Cement: ASTM C150, Type II Portland cement, low alkali. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications.
 3. Roof slab opening: Size to support the manhole cover frame.
 4. Lifting eyes: Provide for each section.
 5. Manhole Bases and Base Beams
- B. Precast concrete risers (barrel sections) and tops shall comply with ASTM C478.
- C. Manufacturer: Jensen Precast, Reno, NV.; Oldcastle Infrastructure, Atlanta, GA; or equal.

2.03 JOINTS AND SEALANT

- A. Tongue and Groove Joint General: Joint shall conform to ASTM C990 and federal specification SS-S-210A.
- B. Sealant: Preformed, continuous rope gasket, protected by removable two-piece wrapper constructed from bitumen or butyl resins, blended with hydrocarbons and plasticizing compounds, and reinforced with inert mineral filler. Provide recommendation to Engineer, or Owner's Inspector, of cross-sectional dimensions that will produce an ASTM C990 compliant joint. Suggested products include Rub'r Nek LTM by Henry Co. or equal. No solvents, irritating fumes, or obnoxious odors.
- C. External Sealing Bands: Apply external sealant bands at joints for all concrete structures conforming to ASTM C877.
- D. Manufacturer: Henry® Co. or equal.

2.04 EXTERIOR COATING

- A. Provide a coating of coal tar epoxy applied at 16 mils to 20 DFT in one coat to the entire exterior surface of all concrete structures.
- B. Acceptable coatings are Tnemec 46H413, Koppers Bituplastic #33, or equal.
- C. If applied at the manufacturer's site, repair any damage to coating created during the maintenance hole installation in accordance with manufacturer's instructions. Abrasive blast exterior to SP 13, fill all bung and surface holes with Tnemec Series 218 Mortarclad, or equal prior to applying coal tar coating.

2.05 JOINT WRAP

- A. Joints shall be wrapped to prevent infiltration and exfiltration through the joints. Joint wraps shall conform to ASTM C877.
- B. Where joining two sections, or where two ends meet together, provide an overlap of approximately 2" and firmly press the overlapping strip onto the end of the underlying strip to seal the joint.
- C. Acceptable Manufacturers
1. Conwrap by ConSeal
 2. Rubr-Nek External Joint Wrap
 3. Or Approved Equal.

2.06 FRAMES AND COVERS

- A. Material: Cast iron; ASTM A48, Class 30B.

- B. Marking: In raised letters, as specified and as shown on the Drawings.
- C. Coating: Bituminous paint, black.
- D. Size: 24-inch diameter or 30-inch diameter as shown on the Drawings.
- E. Pick Hole: open, side, 1-inch diameter as shown on the Drawings.
- F. Manufacturers
 - 1. 24-inch: Neenah R-1706/1741, Deeter 1258, East Jordan Iron Works 2420/2405-C with 2420 Z1 ring
 - 2. 30-inch: Deeter #1197, Neenah R-1798, or East Jordan Iron Works 2500.
- G. See Section 522.08 of the City of Arvada Engineering Code of Standards and Specifications for additional requirements.

2.07 WATERTIGHT FRAMES AND COVERS

- A. Material: Cast iron; ASTM A48, Class 35B.
- B. Marking: In raised letters, as specified and as shown on the Drawings.
- C. Coating: Bituminous paint, black.
- D. Size: 24-inch diameter or 30-inch diameter as shown on the Drawings.
- E. Manufacturers
 - 1. See Section 2.06.
- F. Watertight: Shall include bolt and gasket design to prevent water infiltration. Cover shall be bolted with a minimum quantity of six (6) 1/2"-13 SS bolts and washers.
- G. Location: All maintenance hole rims and covers south of an including SSMH 4-8 shall be watertight.

2.08 LADDER RUNGS

- A. Cast-in Steps: Copolymer polypropylene plastic molded on ASTM A615 Grade 60 steel or ASTM A955 stainless steel reinforcing bar. Steps shall be one-half (1/2) inch diameter steel-reinforcing rods completely encapsulated in Copolymer Polypropylene. Rungs shall provide at least 12-inch-wide tread with non-slip surface. The minimum distance from the finished ground (street) surface to the first step shall be twenty-four (24) inches, and the maximum shall be thirty (30) inches. Refer to Section 522.04 City of Arvada Standard Details.
- B. Steps shall conform to OSHA requirements.
- C. Steps shall have a minimum tensile strength of 38,000 psi, minimum yield strength of 35,000 psi, and an elongation of not less than ten (10) percent in two (2) inches. Steps shall carry a load of 1,000 pounds when projected six (6) inches from the wall and 1,500 pounds when projected four (4) inches from the wall without permanent deformation.
- D. Manufacturer: M.A. Industries, or approved equal

2.09 MANHOLE BASES AND BASE BEAMS

- A. The minimum slab thickness shall be eight (8) inches. The minimum reinforcement shall be #4 reinforcing steel at twelve (12) inches on center, each direction or welded wire fabric, 4x4/W4xW4. The placing, fastening, splicing and supporting of

reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the Drawings, and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars." Splicing of the welded wire fabric shall be by lapping one space and securing the wire mesh together. All wire fabric shall conform to the requirements of the "Wire Reinforcement Institute, Inc."

- B. Manhole base beams shall be precast, reinforced concrete. The beams shall be twelve (12) inches wide by nine (9) inches deep by eight (8) feet long. Beams shall be set at a minimum of twelve (12) inches from the outside edge of the pipe.
- C. Cast-in-place concrete bases are acceptable and shall meet the standard details in the Contract Documents. See Section 03300 for additional requirements.
- D. Manhole benches shall be cast-in-place concrete or grouted in place. Precast benches are not allowed.

2.10 ACCESSORIES

- A. Boot connector:
 - 1. May be mechanically installed, cast-in or push-in.
 - 2. Shall provide a watertight connection meeting ASTM C923.
 - 3. Shall accommodate angular and lateral deflection with stress on the connector

2.11 SOURCE QUALITY CONTROL

- A. Precast Sections:
 - 1. Verify concrete compressive strength test results are satisfactory for the sections supplied.
 - 2. State the curing method. Identify the start and end dates for the sections supplied.
- B. Frames and Covers:
 - 1. Verify cast test bar tensile strengths are satisfactory.

2.12 INTERIOR PROTECTIVE COATINGS

- A. All precast manholes and vaults shall be field coated with an H₂S resistant coating. Coating shall be suitable for application onto concrete surfaces. Coating shall be applied to the interior of all manholes to provide a protective surface against corrosive gases expected from normal wastewater collection operations
- B. Contractor or manufacturer shall follow the coating manufacturer's preparation and application instructions for a proper application.
- C. City of Arvada Maintenance Holes:
 - 1. Type: Polymer
 - 2. Minimum Application Thickness: 500 mils or manufacturer's recommendation for a complete system installation
 - 3. Acceptable Manufacturers:
 - a. CCI Spectrum: Spectrashield
 - b. No approved equal

- D. Metro Water Recovery Maintenance Holes and Vaults:
1. Protective coatings shall meet the requirements of Metro Water Recovery's standard specification 09 96 01 – Concrete Coating/Lining 100% Solids High-Build Epoxy.
 2. Type: 100% solids high build epoxy
 3. Minimum Application Thickness: 125 mils
 4. Acceptable Manufacturers:
 - a. Environmental Coatings, Inc. – Sewer Sheild -100 (trowel), -101S (spray), 101A, or 150
 - b. Warren Environmental, Inc. – 301-14 (01-04) Epoxy
 - c. Sauereisen, Inc. – SewerGard 210XHB Epoxy
 - d. Vortex Companies – Quadex Structure Guard
 - e. No approved equal

PART 3 - EXECUTION

3.01 OPENINGS AND EMBEDMENTS

- A. The Contractor and manufacturer shall be responsible for the integration of embedded items in the quantity, materials, elevations, and locations required.
- B. Embedded pipes, conduits, sleeves, and other items intended to pass through walls and slabs shall be installed perpendicular to the surface unless noted otherwise.
- C. Openings in the structure shall be placed integrally at the time of casting. Unreinforced knockouts may be provided for post installed opening if approved by the Engineer. Openings shall not be placed by coring or cutting through reinforced concrete after the item has been cast.

3.02 INSTALLATION

- A. General: ASTM C1821 and also:
 1. Excavate and support excavations for manholes in accordance with Section 02300.
 2. Compact subgrade to a 12-inch minimum depth in accordance with Section 02300 or as otherwise shown on the Drawings.
 3. Provide a 12-inch stabilization rock layer under the base slab and compact in accordance with Section 02300. See City of Arvada Standard Detail 500-3 for additional requirements.
 4. Apply primer compatible with gasket to joint surfaces in accordance with manufacturer's instructions. Make all joints watertight with sealant gaskets.
 5. Concrete bases shall extend at least eight (8) inches below the bottom of the pipe and 2 inches above the top of pipe. The concrete manhole bench shall slope upward at least two (2) inches per foot from the top of the pipe. Refer to Section 523.06 City of Arvada Standard Details.
 6. Backfill around manholes with Structural Backfill material. Compact the backfill material in accordance with Section 02300 from the base up to final finish grade, over an area defined as being within a distance of 4 feet from the exterior walls.
 7. The top of the manhole structure shall be a minimum of twelve (12) inches and a maximum of eighteen (18) inches below the finished street or ground

surface elevation. Concrete extension risers or collars shall be used to bring the manhole ring and cover up to the finished street or ground surface elevation. Accurately locate and place the manhole or hatch frames to within 1/8 inch vertical elevation in paved areas and to 1/2 inch in other areas. Coordinate the activities of all trades so that this tolerance is achieved. Manholes five (5) feet deep or less shall be constructed as flat-top manholes. Refer to Section 522.04 of City of Arvada Standard Details.

8. Install the manhole cover in the frame. Machine the cover, if necessary, to obtain a solid fit, without rattling under load.
9. Locate eccentric manhole lids outside of the path of travel. Identify areas where this may not be achievable and coordinate with the Engineer prior to excavating for the manhole.

3.03 FIELD QUALITY CONTROL

- A. Verify all precast sections are continuously sealed with gaskets.
 1. Contractor shall receive favorable review of initial section and seals from the Engineer prior to placing subsequent sections.
- B. Verify all manhole covers fit quietly in the frames.

3.04 TEST FOR MANHOLES

- A. The Owner reserves the right to require a vacuum test on all new manholes installed, particularly in areas where the groundwater level is high or where there are questions regarding the integrity of the new barrel sections. All manholes shall be vacuum tested in accordance with ASTM C1244.
- B. All lift holes and any pipes entering the manhole shall be plugged prior to a vacuum being drawn and the drop over a specified time determined. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations. A vacuum of ten (10) inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to nine (9) inches of mercury. The manhole shall pass if the time for the vacuum reading to drop from ten (10) inches of mercury to nine (9) inches of mercury meets or exceeds the values indicated in the table provided in Section 524.02 of the City of Arvada Engineering Code of Standards and Specifications.

END OF SECTION

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SECTION 02085

PRECAST CONCRETE UTILITY VAULTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Precast reinforced concrete box structures for utility service, complete with openings, inserts, ladder rungs (where specifically called for), and hardware.

1.02 REFERENCES

A. ASTM International (ASTM), Standard Specifications:

1. A36 Carbon Structural Steel
2. A48 Gray Iron Castings
3. A615 Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. A955 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
5. A1064 Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
6. C150 Portland Cement
7. C478 Circular Precast Reinforced Concrete Manhole Sections
8. C857 Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
9. C858 Underground Precast Concrete Utility Structures
10. C891 Installation of Underground Precast Concrete Utility Structures
11. C877 External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
12. C913 Precast Concrete Water and Wastewater Structures
13. C990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Highway Bridges.

C. American Iron and Steel Institute (AISI).

1.03 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Product Data:

1. Acknowledgement that products submitted meet the requirements of standards referenced.
2. Manufacturer's installation instructions
3. Sizes, types, and manufacturer or bearing pads, if applicable.
4. Hardware to be utilized to support suspended appurtenances.
5. Descriptive details of the manufacturer's proposed standard products, including:
 - a. Precast sections.

- b. Concrete mix design.
 - c. Cement, aggregate, and reinforcing certifications.
 - d. Size, configuration, location, and quantity of reinforcing bars.
 - e. Size and location of openings verified by the Contractor.
 - f. Steps and/or ladder rungs.
 - g. Manhole rims and covers.
 - h. Manhole cones and risers, as applicable.
 - i. Grating and plate cover frames.
 - j. Any other prefabricated inserts and integrally cast hardware.
 - k. Technical data sheets for protective coatings inclusive of MSDS, grade of materials, and design thickness
 - l. Coatings Work Plan inclusive of surface preparation, mixing instruction, application procedures, curing procedures and schedules, and all other pertinent items for the successful application of coatings per the manufacturer's recommendations.
- 6. Shop drawings, including:
 - a. Design criteria.
 - b. Reinforcing steel location and concrete cover.
 - c. Location and type of joints.
 - d. Layout of all inserts, attachments, and openings.
 - 7. Signed sealed Structural Calculations by a PE registered in the State of Colorado demonstrating adequacy of structural design and buoyancy resistance.
 - 8. Submit test results showing that embedded connection items will adequately support the indicated loads.
 - a. Connection items to have an ultimate load capacity of at least two times the required indicated load.
 - 9. Fabricator's quality control documentation for special inspections as required by the building code, if applicable.
 - 10. Copies of source quality control tests.
 - 11. Certification of manufacturer's testing facility qualifications.

1.04 QUALITY ASSURANCE

- A. Provide products of a manufacturer who has been regularly engaged in the design and manufacture of the product for at least 5 years.
- B. Demonstrate to the satisfaction of the Engineer that the quality is equal to the product made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

- A. General: ASTM C857, ASTM C858, and C913, and also:
 - 1. Structure live load: The vault roof shall be designed to support the overhead fill, any surcharge, and a HS-20 traffic loading.
 - 2. Dead and operating loads from any attached equipment.
 - 3. Handling and installation loads.
 - 4. Backfill material: Structural backfill.

5. Base material: Crushed rock meeting No. 67 coarse aggregate standard in section 703 of CDOT specifications
6. Buoyancy: Design structure for groundwater up to grade, showing resistance to buoyancy with factor of safety of at least 1.1.

2.02 PRECAST SECTIONS

A. General:

1. Concrete:
 - a. Minimum 28-day compressive strength 5,000 psi.
 - b. W/C ratio: 0.42
 - c. ASTM C33 Size No.: 57
 - d. Air Content: 4.5-7.5%
 - e. Allowable shrinkage: None
2. Cement:
 - a. ASTM C150, Type V for vaults
 - b. Blended Cement ASTM C150, Type II for sulfate resistance for vaults, with expansion limits described in items e or f below for vaults.
 - c. Mass concrete: ASTM C150, Type II (HS).
 - d. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.
 - e. Less than 0.040 percent expansion at 14 days when tested according to ASTM C452 (CDOT S2 Mix)
 - f. Less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. (CDOT S3 Mix) .
3. Aggregate: ASTM C33
 - a. Provide aggregates approved for bridge construction by CDOT.
4. Reinforcing: Deformed bars conforming to ASTM A615 Grade 60. Wire mesh conforming to ASTM A1064.
5. Openings: Size as shown on the Drawings. Reinforce rectangular openings with additional diagonal reinforcing at the corners. Reinforce roof openings to support access hatches called for on the Drawings.
6. Lifting eyes: Provide for each section.

- B. Manufacturers: Jensen Precast, Reno, NV; Oldcastle Infrastructure, Atlanta, GA; or approved equal.

2.03 JOINTS AND SEALANTS

- A. See Section 02080.

2.04 EXTERIOR COATING

- A. See Section 02080.

2.05 JOINT WRAP

- A. See Section 02080.

2.06 WATERTIGHT FRAMES AND COVERS

- A. See Section 02080.

2.07 LADDER RUNGS

- A. See Section 02080.

2.08 ACCESSORIES

- A. Boot connector:
 - 1. May be mechanically installed, cast-in or push-in.
 - 2. Shall provide a watertight connection meeting ASTM C923.
 - 3. Shall accommodate angular and lateral deflection with stress on the connector

2.09 INTERIOR PROTECTIVE COATINGS

- 1. See Section 02080.

2.10 SOURCE QUALITY CONTROL

- A. Precast Sections:
 - 1. Verify concrete compressive strength test results are satisfactory for the sections supplied.
 - 2. State the curing method. Identify the start and end dates for the sections supplied.
- B. Frames and Covers:
 - 1. Verify cast test bar tensile strengths are satisfactory.

PART 3 - EXECUTION

3.01 OPENINGS AND EMBEDMENTS

- A. The contractor and manufacturer shall be responsible for the integration of embedded items in the quantity, materials, elevations, and locations required.
- B. Embedded pipes, conduits, sleeves, and other items intended to pass through walls and slabs shall be installed perpendicular to the surface unless noted otherwise.
- C. Embedded plates, grates, hatches, angle frames, and other items intended to provide a working surface shall be installed flush to the surface unless noted otherwise.
- D. Aluminum items embedded in concrete shall be treated with an asphaltic coating.
- E. Openings in the structure shall be placed integrally at the time of casting. Unreinforced knockouts may be provided for post installed opening if approved by the Engineer. Openings shall not be placed by coring or cutting through reinforced concrete after the item has been cast.

3.02 INSTALLATION

- A. General: ASTM C891 and also:
 - 1. Excavate and support excavations for vaults in accordance with Section 02300.

2. Provide a 12-inch crushed rock layer under the base slab and compact in accordance with Section 02300.
3. Apply primer compatible with gasket to joint surfaces in accordance with manufacturer's instructions. Make all joints watertight with sealant gaskets.
4. Backfill around the vault with Structural Backfill material. Compact the backfill material in accordance with Section 02300 from the base up to final finish grade, over an area defined as being within a distance of 4 feet from the exterior walls of the vault.
5. Accurately locate conduits, pipes, spools, and knock-outs for mechanical connections through the vault.

3.03 FIELD QUALITY CONTROL

- A. Verify all precast sections are continuously sealed with gaskets.
- B. Causes for rejection of units include, but are not necessarily limited to the following:
 1. Cracked units.
 2. Chipped, broken, or spalled edges.
 3. Units not within allowable casting tolerances.
 4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
 5. Non-uniform finish or appearance.
 6. Low concrete strength.
 7. Improperly placed embedded items and/or openings.
 8. Exposed wire mesh, reinforcing or prestressing strands.

END OF SECTION

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SECTION 02140

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall perform site dewatering necessary to lower and control groundwater levels and hydrostatic pressures to allow excavation and construction to be performed properly under dry conditions. This Section includes materials, installation, maintenance, operation, and removal of temporary dewatering systems.
- B. The Contractor shall perform all treatment necessary for the legal disposal of all groundwater encountered. The cost of treatment shall be borne by the Contractor and no additional compensation will be made for inadequate treatment facilities. Based on available groundwater quality analyses, it is anticipated that a short-term remediation permit will likely be required from CDPHE to discharge water into local receiving bodies. Other options for dewatering activity discharge may be pursued at the Contractor's discretion.
- C. Dewatering operations shall be adequate to ensure the integrity of the finished project. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The Contractor shall obtain and comply with the applicable discharge requirements of the agency that will receive project dewatering. This may include but is not limited to:
 - 1. Colorado Department of Public Health and Environment (CDPHE) – General Permit COG80000 – Discharges for Short-term (< 2 year) Construction Dewatering Activities

1.03 CONTRACTOR SUBMITTALS

- A. The following shall be submitted in compliance with Section 01300:
 - 1. Before starting excavation, the Contractor shall submit Shop Drawings including a detailed plan, schedule, and description of the dewatering of excavations. The Shop Drawings shall include:
 - a) The proposed type of dewatering system
 - b) The arrangement, location, and depths of system components
 - c) A complete description of the equipment and instrumentation to be used, with installation, operation, and maintenance procedures
 - d) A description of the Contractor's means and methods for measuring groundwater levels and piezometric water levels
 - e) Documentation of proposed treatment methods including treatment equipment cutsheets and verification from equipment vendors that the proposed equipment can perform treatment of groundwater to meet the requirements of legal disposal
 - f) Methods for disposal of dewatering effluent

2. Before starting excavation, the Contractor shall submit copies of well installation permits, if required.
 3. Before starting excavation, the Contractor shall obtain and submit copies of the dewatering discharge permit obtained for the project Work.
 4. The Contractor shall submit copies of well destruction permits, if applicable.
 5. The Contractor shall be solely responsible for obtaining groundwater discharge permits. The Contractor must submit copies of these permits to the Owner.
- B. Contractor shall submit a daily report that includes the following information:
1. Groundwater levels and piezometric water levels in observation wells (if any).
 2. Changes in elevation of reference points to detect settlement in adjacent structures.
 3. The average dewatering flow rate.
 4. Water quality testing results as required by the approved groundwater discharge permit.

1.04 QUALITY ASSURANCE

- A. The Contractor shall conduct a demonstration of its proposed system and shall provide verification that adequate personnel, materials, and equipment are available.
- B. The Contractor shall maintain adequate control to ensure that the stability of excavated and constructed slopes is not adversely affected by water, that erosion is controlled, and that flooding of excavations or damage to structures does not occur.
- C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, the Contractor shall establish reference points and shall observe the reference points at frequent intervals to detect any settlement which may occur. Frequency of intervals of detection testing shall be determined based on recommendations of the geotechnical engineer and the nature of the critical structure or facility and distance from the excavation, except that the minimum frequency shall be twice per working day (once at the beginning of the workday and once at the conclusion of the workday).

1.05 DEWATERING EXPECTATIONS

- A. The Contractor shall assume that groundwater may be present in all excavations throughout the length of the project. The Contractor shall be prepared for dewatering activities and legally dispose of groundwater in compliance with all Federal, State, and Local regulations and the requirements of the permits relating to groundwater discharge.

1.06 WATER QUALITY

- A. Water quality analytical results are provided as an appendix to these specifications. These are for reference only and not intended to reflect actual water quality at the time of dewatering. Contractor shall obtain additional samples and perform water quality testing as required by the groundwater discharge permit.

PART 2 - MATERIALS

2.01 MATERIALS AND EQUIPMENT

- A. Dewatering includes well points, sump pumps, treatment facilities, temporary pipelines for water disposal, rock or gravel placement, observation wells, and other means including standby pumping equipment maintained on the jobsite continuously.
- B. The Contractor shall provide piezometers for monitoring groundwater levels or other instruments and measuring devices, as required.
- C. The Contractor shall be prepared to collect water samples and coordinate water quality testing with a certified laboratory as required by the groundwater discharge permit.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The Contractor is responsible for compliance with the approved dewatering discharge permit, City of Arvada, and CDPHE requirements for any discharge of groundwater to the environment. Before starting dewatering operations, the Contractor shall obtain the required permits and authorization, as required, for the disposal of groundwater. The Contractor shall comply with all applicable sampling, testing, monitoring, and reporting requirements.
- B. The Contractor shall maintain an adequate system to lower and control the groundwater to permit excavation, construction of structures, and placement of fill materials to be performed under dry conditions.
- C. Sufficient dewatering equipment shall be installed to pre-drain the water-bearing strata below the bottom of foundations, drains, water lines, sewer lines, and all other excavations.
- D. The hydrostatic head in water-bearing strata below pipelines, appurtenances, foundations, and all other excavations shall be reduced to ensure that the water level is a minimum of two (2) feet below the excavation surface at all times.
- E. The system shall be placed into operation before excavation below groundwater level is started. The system shall be operated continuously 24 hours per day, 7 days a week until pipelines, appurtenances, and structures have been constructed, fill materials have been placed, and dewatering is no longer required.
- F. The site shall be graded to facilitate drainage, and runoff shall be diverted from the excavation. Surface runoff shall be directed to local stormwater collection or collected in shallow ditches around the perimeter of the excavation, drained to sumps, and pumped or drained by gravity away from the excavation.
- G. Dewatering shall at all times be conducted to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- H. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock at no additional cost to the Owner.
- I. Flotation of structures and facilities shall be prevented by maintaining a positive and continuous removal of water.

- J. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means shall be used to prevent pumping of fine sands or silts from the subsurface. A continuous check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- K. Water and debris shall be disposed of in a legal and suitable manner in compliance with dewatering discharge permit requirements and Section 02050, without damage to adjacent property. No water shall be drained into work built or under construction. Before disposal, water shall be treated in accordance with permit requirements. Before disposal, water shall be filtered to remove sand and fine- sized soil particles.
- L. The release of groundwater to its original level shall be performed in a manner that avoids disturbance of natural foundation soils, prevents disturbance of compacted backfill, and prevents flotation or movement of structures.

END OF SECTION

SECTION 02200

SITE PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Site preparation shall consist of all clearing, grubbing, and related work necessary to prepare the project site for construction operations.
 - 2. No open burning of debris, lumber, or other scrap will be permitted.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DEMOLITION

- A. Demolish and remove any fences, posts, poles, or other structures from within the project site, areas to be cut or areas to receive fill, and pipeline alignments.

3.02 CLEARING

- A. Clearing shall consist of the removal of shrubs, grasses, debris, and rubble from the project site which will obstruct or otherwise impede construction operations.
- B. Clear the following areas:
 - 1. Trenching and excavating extents within the area of Work.
 - 2. Construction staging areas
 - 3. Material and equipment storage areas if not included in the construction staging areas

3.03 GRUBBING

- A. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the construction area. This material, together with logs and other organic debris, shall be excavated and removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated as construction areas under this Contract, such as areas for structures, pavement, fills. Depressions made by grubbing shall be filled with structural backfill material and compacted to make the surface conforms with the original adjacent surface of the ground unless further excavation is required. Grub borrow areas to the extent necessary to obtain material free of stumps and roots.

3.04 DISPOSAL

- A. Dispose of remaining vegetation and debris in accordance with Section 02050.

END OF SECTION

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SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Perform all excavation, trenching, shoring, dewatering, backfilling, compaction, grading, and disposal of excess material necessary or required for the construction of the work as covered by these Specifications and indicated on the Drawings. The excavation shall include, without classification, the removal and disposal of all materials of whatever nature encountered, including water and all other obstructions that would interfere with the proper construction and completion of the required work.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 300.
- B. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO T99 Standard Method of Test for Moisture-Density Relations of Soils
 - 2. AASTO T193 Standard Method of Test for The California Bearing Ratio
- C. ASTM International (ASTM)
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates
 - 2. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - 3. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 4. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction
 - 5. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³).
 - 6. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 7. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³).
 - 8. ASTM D1883 - Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
 - 9. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 10. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
 - 11. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

12. ASTM D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils
 13. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 14. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 15. ASTM 3744 - Standard Test Method for Aggregate Durability Index
 16. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 17. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 18. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 19. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
 20. ASTM D7928 - Standard Test Method of Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
- D. Colorado Department of Health and Environment (CDPHE) Design Criteria for Domestic Wastewater Treatment Works
 - E. Municipal Government Pavement Engineers Council (MGPEC)
 - F. Colorado Department of Transportation (CDOT) Standard Specifications (CDOT Standard Specifications)
 - G. Standards listed below apply when no other more stringent standard is referenced. The order of precedence is as follows:
 1. City of Arvada Engineering Code of Standards and Specifications
 2. Adams County Development Standards and Regulations
 3. CDPHE Design Criteria for Domestic Wastewater Treatment Works
 4. CDOT Standard Specifications

1.03 DEFINITIONS

- A. Site: Area of Work as depicted in the Drawings.
- B. Fill: Earth used to fill holes, pits, or depressions necessary to bring the final grade up to the specified elevation or contours.
- C. Pipe Bedding: Zone of material that extends from six (6) inches below the pipe to 12 inches above the crown of the pipe.
- D. Trench Zone: Zone of material that extends from the top of the pipe bedding to the bottom of the pavement subgrade in pavement areas or to the top of the trench in earth areas.
- E. Subgrade: Zone of material that is improved to create a stable, suitable platform for subsequent layers.
 1. Finished Subgrade: Finished subgrade indicates the top of the subgrade section in a cut scenario.
- F. Over excavation: Excavation beyond the limits shown in the Drawings.

- G. Relative Compaction: In-place dry density divided by the maximum dry density laboratory compaction expressed as percentage.
- H. Rock Excavation:
 - 1. Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or with the use of rippers and all boulders or other detached stones each having a volume of one cubic yard or more, as determined by physical or visual measurements. Unless specified in the Contract, rock excavation is material that meets one of the field test criteria outlined in Section 360 of the Arvada Engineering Code of Standards and Specifications to be conducted by the Contractor.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Contractor shall not excavate, construct embankments, or fill until all the required submittals have been reviewed and approved.
- C. Submittals for Informational Purposes:
 - 1. Excavation Protection Plan: Identify location, extent, and type of excavation protection. Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations for cuts 20 feet, or greater, to support plan. Structural calculations for cuts 20 feet, or greater, shall be done under the supervision of a Professional Engineer experienced in the design of this Work and licensed in the State of Colorado.
 - 2. Dewatering Plan: submit dewatering plan in accordance with Section 02140.
- D. Product Data:
 - 1. Potholing Report.
 - 2. Gradation report(s) for bedding material and import backfill materials.
 - 3. Test results on bedding and import material indicating Sand Equivalent, R-value, Durability Index, Liquid Limit, Plastic Limit and Plasticity Index.
 - 4. Compaction Reports indicating results from quality control testing.
 - 5. Flow-fill and flashfill: Mix design and laboratory testing data verifying compliance with air content, slump, strength and removability (RE) requirements.
 - 6. Geotextile fabric indicating fabric and installation procedure
 - 7. Pipe manufacturer's data regarding bedding methods of installation and general recommendations.
- E. Samples and Test Results:
 - 1. Furnish, without additional cost to the Owner, such quantities of bedding material and Import materials, listed herein, as may be necessary for testing. All testing and retesting to meet requirements and specifications shall be at the Contractor's expense.
 - 2. Test bedding and import materials proposed for use demonstrating that the materials conform to the specified requirements. Materials testing shall be performed by a qualified Geotechnical Engineer working under the direction of a Colorado Registered Professional Engineer. Perform tests no more than 60 Calendar Days prior to submission. Submit results to the Project Engineer at least ten (10) days prior to delivery.

3. Submit certifications for each source of all imported/borrow materials indicating the location where the imported/borrow material will be obtained, including the street address, town, lot and block, county and state, and a brief history of the site which is the source of the material.
 - a. Owner may request a copy of the material delivery ticket at delivery of each load each day.
 4. Notify the Project Engineer a minimum of 48 hours before obtaining samples. The Project Engineer may choose to be present while samples are obtained.
- F. Testing Agency Qualifications
1. The Testing Agencies' submittal shall include, at a minimum, the inspection certificate of the Testing Agency, within the last two (2) years, by a third party such as the American Association for Laboratory Accreditation, the National Voluntary Laboratory Accreditation Program or the Cement and Concrete Reference Laboratory, as appropriate; and a copy of the Testing Agencies Quality Assurance Program as outlined in Section 1.05.F.

1.05 QUALITY ASSURANCE / QUALITY CONTROL

- A. All material furnished and all work performed shall be subject to rigid inspection. No material shall be delivered to the site until it has been favorably reviewed by the Project Engineer and sample test results provided. All material furnished and all work performed shall be subject to inspection, and no material shall be delivered to the site until it has been favorably reviewed by the Project Engineer.
- B. Source Quality Control: Furnish all bedding material from a single source throughout the work unless otherwise approved.
- C. Field Quality Control:
1. All testing shall meet minimum testing requirements as outlined in Section 322.00 of the Arvada Engineering Code of Standards and Specifications.
 2. The Contractor shall hire an independent soil testing laboratory approved by the Owner to perform the following tasks for flatwork, pipeline installation, non-structural fill or items not requiring special inspection as outlined under Special Inspections:
 - a. Perform a Particle-Size Distribution (Gradation) Analysis every 5,000 cubic yards of materials delivered.
 - b. Test Pipe Bedding and Trench Zone material for quality and in-place density requirements specified herein. Contractor shall test every 200 feet of trench.
 - c. Where Special Inspections are not required, test fill materials to verify conformance with material quality every 5,000 cubic yard of materials delivered.
 3. The Person responsible for and is in direct supervision of all the Quality Control testing shall be a Registered Professional Engineer in the State of Colorado and practicing in the field. If any materials furnished or the work performed by the Contractor fails to meet the Specifications, such deficiencies shall be reported to the Owner's Inspector immediately. Preliminary written field reports and/or test results shall be given to the Owner's Inspector immediately after they are performed. Final reports shall be forwarded to the Owner's Inspector no later than one week following the testing.

4. Results of all tests, including failing tests, shall be reported. When the work fails to pass tests or meet specifications, additional tests shall be taken as directed by the Project Engineer. All testing and retesting services shall be at the expense of the Contractor except for City projects where the cost of testing will be covered by the Owner unless otherwise noted in the Special Conditions for the project. Testing agency personnel are not authorized to stop work or to alter, relax or release any requirements of these Specifications, or to approve, accept or reject any portion of the Work.
 5. Material that does not meet the gradation, quality or compaction requirements shall be removed and replaced with material that does comply at no additional cost to the Owner.
- D. Field Quality Assurance
1. The Project Engineer will:
 - a. Review materials, not covered under Special Inspections.
 - b. Review results of the Contractor's independent testing laboratory tests and request additional testing at the Project Engineer's discretion.
 2. The Contractor shall provide access as required throughout the earthwork process for observation and testing purposes. The Contractor shall not proceed with work until the certified materials Testing Agency is on site for observation and testing, unless approved by the Owner or Project Engineer. Refer to Section 320.00 of the Arvada Engineering Code of Standards and Specifications for further requirements.
 3. Preliminary written field reports and/or test results shall be given to the Owner's Inspector immediately after they are performed. Final reports shall be forwarded to the Owner's Inspector no later than one week following the testing.
- E. Special Inspections:
1. The Contractor shall be responsible for special inspections in accordance with the building code IBC Chapter 17 Section 1705.6. Special inspection is required for work related to constructing buildings, structures, structural work, and roadways, and includes but is not limited to:
 - a. Verifying materials below foundations are adequate to achieve the design bearing capacity requirements.
 - b. Verifying excavations are to the depth identified in the Drawings and the bottom of excavations are suitable materials.
 - c. Perform classification and testing of compacted fill materials.
 - d. Verifying materials meet quality, lift thickness, and in-place density requirements specified herein.
 - e. Prior to placement of compacted fill, inspect subgrade and verify the site has been prepared properly.
 2. Testing shall be performed at the frequency listed below or as otherwise established by Section 322.00 of the Arvada Engineering Code of Standards and Specifications, whichever is more stringent.
 - a. Project Engineered Fill: Test every 500 square feet for each 2 feet of fill.
 - b. Subgrade: Test every 200 square feet where in-place materials have been disturbed and recompacted or as recommended by the Project Engineer.
 - c. Structural Backfill:

- a) Test every 200 square feet of building footprint, with no less than two tests per structure.
- b) Test every 200 cubic yards of material placed within 10 feet around the building.

F. Testing Methods:

- 1. Testing shall conform to the requirements of the Arvada Engineering Code of Standards and Specifications Section 321.00.
- 2. Agencies testing soil and rock shall meet the requirements of ASTM D 3740. All testing agencies shall meet the requirements of ASTM E 329.
- 3. Conduct sampling and testing in general accordance with the FHWA Report No. FHWA NHI-01-031 (Mayne and others, 2002) and the AASHTO (1988) Manual on Subsurface Investigations.
- 4. In-situ testing per Tables 3-2 and 3-3 of the CDOT Geotechnical Design Manual.
- 5. Classify rock core samples in accordance with the International Society of Rock Mechanics (ISRM) publication, Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses (ISRM, 1981).
- 6. Follow applicable testing procedures outlined in the current AASHTO and ASTM Standards specified in the CDOT Laboratory Manual of Test Procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Earthwork materials shall be stored in a location approved by the jurisdiction where the storage area is located and by the Owner.
- B. Stockpile material so that it's not contaminated, does not cause damage, does not become saturated, and is identifiable.
- C. Storage of Excavated Materials:
 - 1. Neatly place excavated materials far enough from the excavation to prevent stability problems. Keep the materials shaped to cause the least possible interference with drainage.
 - 2. Excavated materials unsuitable for backfill shall be disposed of immediately.

1.07 SUBSURFACE INVESTIGATIONS

- A. Geotechnical investigations for design purposes for this project were completed by Lithos Engineering in a report dated MM DD, YYYY. A copy of this report is included in the Appendix of these specifications.
- B. Contractor shall meet the requirements and recommendations within the Geotechnical Baseline Report, Geotechnical Data Report, and these specifications, whichever is more stringent.

1.08 ADDITIONAL SAFETY RESPONSIBILITIES

- A. The Contractor shall select, install, and maintain shoring, sheeting, bracing, and sloping as necessary to maintain safe excavations. The Contractor shall be responsible for ensuring such measures: (1) comply fully with 29 CFR Part 1926 OSHA Subpart P Excavations and Trenches requirements, (2) provide necessary support to the sides of excavations, (3) provide safe access to the Geotechnical Engineer's sampling and testing within the excavation, (4) provide safe access for

backfill, compaction, and compaction testing, and (5) otherwise maintain excavations in a safe manner that shall not endanger property, life, health, or the project schedule. All earthwork shall be performed in strict accordance with applicable law, including local ordinances, and applicable OSHA requirements.

- B. The Contractor shall be responsible for the safety of his/her workers and shall comply with safety and health standards of authorities having jurisdiction and any other appropriate safety and health codes.

PART 2 - PRODUCTS

2.01 MATERIAL DEFINITIONS

- A. Engineered Fill: Engineered fill may be Imported Soil or Native Soil that has been processed to meet the below requirements.
1. Native Soil: Native soil shall have organic material less than 3 percent by weight. It shall not contain rocks or lumps larger than 3 inches in greatest dimension or more than 15 percent of the material larger than 1 ½ inches and be free of organics, debris, and other deleterious materials. Wet, soft, or frozen material, organic matter, asphalt chunks, or other deleterious substances shall not be used as backfill. Refer to section 360.01 of the Arvada Engineering Code of Standards and Specifications.
 2. Imported Soil: Imported soil shall meet the general gradation of "Class 1 Structure Backfill Material" as specified in Section 703.09 of the CDOT Standard Specifications for Road and Bridge Construction.
 - a. This material shall have a liquid limit not exceeding 35 and a plasticity index of not over six when determined in conformity with AASHTO T 89 and T 90 respectively.

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inch	100
No. 4	30 to 100
No. 50	10 to 60
No. 200	5 to 20

- B. Sand:
1. Sand gradation shall have 90 percent passing No. 4 sieve and less than 3 percent passing a No. 200 sieve with a minimum sand equivalent (SE) of twenty (20). Well-graded sand or squeegee sand must comply with Section 367.00 of the Arvada Engineering Code of Standards and Specifications.
 2. Well-graded sand:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	70 to 100
No. 8	36 to 93
No. 16	20 to 80
No. 30	8 to 65
No. 50	2 to 30
No. 100	1 to 10

No. 200

0 to 3

3. Squeegee Sand:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 200	0 to 5

C. Flow-Fill:

1. Flow-fill shall consist of a controlled low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregates, water, chemical admixtures and/or cellular foam for air-entrainment.
 - a. Air Content, ASTM C231: 6% minimum
 - b. Compressive Strength, ASTM D4832: 50psi-150psi at 28 days
 - c. Slump, ASTM C143: 7" - 10"
 - d. Removability Modulus, RE (as defined in MGPEC Section 19.2C): 1.5 maximum
2. When flow-fill is used for backfilling abandoned structures, the compressive strength shall not exceed 200 psi at 28 days.

D. Flashfill:

1. Flashfill shall consist of a controlled low-strength, self-leveling cementitious material composed of various combinations of fly ash, water, chemical admixtures and/or cellular foam for air-entrainment. No aggregate or sand is usually needed. It shall have a minimum specified air content to provide suitable resistance to frost heaves. Flashfill may generally be placed without lift thickness limits.
 - a. Air Content, ASTM C231: 15% Minimum
 - b. Compressive Strength, ASTM D4832: 100psi - 300psi at 28 days
 - c. Slump, ASTM C143 (one lift, no rodding): 8"-11"
 - d. Spread, ASTM D6103: 8"-12" or greater
 - e. Removability Modulus, RE (as defined in MGPEC Section 19.2C): 1.5 maximum
2. When flashfill is used for backfilling abandoned structures, the compressive strength shall not exceed 200 psi at 28 days.

E. Crushed Rock:

1. Crushed rock can be used as an alternative bedding material in the presence of groundwater and/or unstable soil conditions if approved by the project Geotechnical Engineer. Crushed Rock shall be $\frac{3}{4}$ " maximum conforming to the following gradation and rock quality requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	90 to 100
1/2 inch	30 to 60
3/8 inch	0 to 20
No. 4	0 to 5
No. 8	0

100 Revolutions	15 maximum
500 Revolutions	52 maximum

F. Fine Aggregate:

Material that complies with the gradation of "Fine Aggregate" as specified in Section 703.01 of CDOT Standard Specifications for Road and Bridge Construction.

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

G. Stabilization Rock:

1. Material which shall be placed in over-excavation areas, areas with unsuitable in situ material, or areas with a high water table in order to stabilize the existing material. Gradation of stabilization material shall be determined on a case by case basis and shall be approved by the project Geotechnical Engineer and shall be used in areas of unstable subgrade and as coordinated with the Project Engineer.
2. Uniformly graded rock ranging from ¾ inch to 1-½ inch.

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inches	100
¾ inch	0 to 10

H. Geotextile Fabric:

1. Non-woven, non-biodegradable, needle punched geotextile comprised of polypropylene fibers. Install with a minimum 12-inch overlap, unless otherwise shown in the Drawings.

Apparent Opening Size	70	U.S. Sieve
Permittivity	1.7	sec ⁻¹
Flow Rate	135	gal/min/ft ²
Grab Tensile Strength	120	lbs
Tensile Elongation	50	%
UV Resistance @ 500 hrs	70	%

2. Acceptable Manufacturers:
 - a. TC Mirafi; Model 140N; or Equal.

2.02 TRENCH BACKFILL

- A. Trench Backfill may be native soil or imported soil meeting the above requirements and conforming to Section 368 of Arvada Engineering Code of Standards and Specifications. For trenches beneath pavements and flatwork, backfill from a

minimum of 1 foot below grade to grade shall consist of material meeting the requirements for AASHTO class A-1 or A-2 material.

- B. The following special trench backfill requirements shall apply for utilities located in existing or planned road right-of-ways.
 - 1. Constrained Areas - Areas in which proper backfill compaction cannot be achieved such as utility crossing, under curb and gutter, or any area identified by the Certified Materials Tester or Construction Inspector, shall be backfilled with Controlled Low Strength Material (CLSM) "flow-fill" as defined above.
- C. Materials used above the subgrade level shall comply with the requirements for sub-base and base course materials as defined Section 02721.
- D. Bracing installed to prevent cave-ins shall be withdrawn in a manner that shall maintain the desired support during the backfill operations. Driven sheet pilings shall be cut off at or above the top of pipe, and the portion below the cut-off line shall be left in the ground.
- E. Adams County Trench Backfill Requirements
 - 1. The following requirements shall be met when backfilling trenches within Adams County right-of-way.
 - 2. Adams County generally follows the "PIPE In TRENCH" detail in CDOT M-206-1, Excavation and Backfill for Structures, with the following clarifications and additional requirements under pavement.
 - a. Lower trench backfill material from bottom of trench (top of bedding) up to 1 foot above top of pipe shall be CDOT Structural Backfill (Class 1).
 - b. Upper trench backfill material from 1 foot above top of pipe up to top of subgrade shall be predominantly granular soils by classification (A-1, A-2-4, A-2-5, A-2-6, A-2-7, and A-3) and meet the following additional requirements:
 - 1) A maximum of 35 percent of material by dry weight passing the No. 200 sieve.
 - 2) Maximum Liquid Limit of 60
 - 3) Maximum Plastic Index of 25
 - 4) The upper 2 feet of backfill material below the subgrade elevation shall have a resistance value of at least 40 when tested by the Hveem Stabilometer or the equivalent resilient modulus.
 - 5) The material shall be tested and compacted in accordance with the requirements for CDOT Structural Backfill (Class 2).
 - c. The native soil excavated from the trench may be used for backfilling if it meets all requirements and is of acceptable quality.
 - d. CDOT Structural Backfill (Class 1) may be used to backfill the full height of the trench.
 - e. Flow-Fill may be used to backfill any part of the trench height.
 - f. Trenching for sanitary sewer removal may be backfilled with material that meets the requirements of Part 3 above, CDOT Structure Backfill (Class 1), Flow-Fill, or some combination thereof.
- F. For sections of pipe owned by Metro Water Recovery (Metro), Contractor shall use acceptable trench backfill (embedment) materials as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 2.1.B of this specification for additional requirements.

2.03 PIPE BEDDING

- A. Bedding material for all FRP, PVC, HDPE, CUP, and DIP ("flexible pipe") shall be fine aggregate, well-graded sand, or squeegee sand as defined above.
- B. Bedding material for all RCP shall consist of materials that meet the gradation of "No. 67 Coarse Aggregate" as specified in Section 703.00 of the CDOT Standard Specifications for Road and Bridge Construction unless otherwise recommended by the Geotechnical Project Engineer and approved by the Owner. RCP shall be bedded to springline at a minimum.
- C. Crushed rock can be used as an alternative bedding in the presence of groundwater. Crushed Rock shall be $\frac{3}{4}$ " maximum conforming to the gradation and rock quality requirements described above.
- D. Excavated native soil, meeting the above requirements, is not suitable to be used as pipe bedding material.
- E. All pipe shall be installed with sufficient bedding material to provide a minimum of six (6) inches of separation between the subsoil and the barrel of the pipe. Bedding material shall be placed to a minimum depth of twelve (12) inches above the barrel section of all flexible pipes. Bedding material shall be worked under pipe to provide uniform haunch support.
- F. For sections of pipe owned by Metro, Contractor shall use acceptable trench bedding materials as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Sections 2.1.A and 2.1.C of this specification for additional requirements.

2.04 STRUCTURAL BACKFILL

- A. Structural backfill is earthen material that is installed around and over any structure shown on the approved plans. Structural backfill may be imported soil, flow-fill, or flashfill as specified in the material definitions above.

2.05 WATER

- A. The water used shall be reasonably free of objectionable quantities of silt, oil, organic matter, alkali, salts, and other impurities.

2.06 TRACER WIRE

- A. Per Colorado Senate Bill 18-167, all new underground facilities, including laterals and services up to the structure or building being served, require tracer wire.
- B. Tracer wire shall be #12 AWG Copper Clad Steel insulated by high molecular weight high density polyethylene (HMWPE) and shall be installed on all pipe, including at least one carrier pipe inside a casing pipe. If tracer wire is not attached to a carrier pipe, it may be cad-welded to both ends of a casing pipe and terminated in test stations within ten (10) horizontal feet from ends of the casing pipe. Attach wire with 2-inch-wide tape, taped at 12-inch intervals. Property ground tracer wire at all dead ends and stubs. Tracer wire shall follow the uniform color

code per American Public Works Association (APWA). Refer to Section 400.20 Arvada Engineering Code of Standards and Specifications.

1. Provide: Copper Clad Steel Tracer Wire by KrisTech, or Solid Tracer Wire by T. Christy's; or equal.
 2. Manufacturers: KrisTech West Coast; T. Christy Enterprises, Inc.; or equal.
 3. Splice Kit: '3M' Type DBY-6 Low Voltage Direct Bury Splice
 4. Copper Split connector: Burndy KS17 copper or equal
 5. Test Stations: CP Test Services, Glenn Series Glenn-4 with locking lid, 2 7/8" X 4 1/2" OR approved equal.
- C. For sanitary sewer mains, tracer wire shall meet the requirements above and be taped to the carrier pipe before installation of carrier pipe supports and installed in the steel casing along with the carrier pipe. A test station shall be installed for the tracer wire in the Arvada ROW near each end of the steel casing pipe. A separate, electrically isolated, tracer wire shall be welded to each end of the casing.
- D. A qualified tester shall verify continuity of tracer wire and a report shall be submitted to the Owner and Project Engineer with other record drawings. Uninterrupted continuity shall be tested in accordance with the requirements of Section 420.20 - Tracer Wire and Warning Tape and Marker Posts of Arvada Engineering Code of Standards and Specifications and is a requirement for construction acceptance into warranty.
- E. For sanitary infrastructure owned by Metro, Contractor shall provide tracer wire meeting the following requirements:
1. Materials:
 - a. Wire:
 - 1) HDPE Insulation suitable for direct bury
 - 2) 12 GA AWG
 - 3) Solid Core
 - b. Test Station:
 - 1) Copperhead Industries Snakepit Test Station or approved equal
 - 2) Green Lid
 - c. Wire nuts: Waterproof type
 - d. Split Bolts: Brass
 - e. Splice Kit: '3M' Tyle DBY-6 Low Voltage Direct Bury Splice or Equal

2.07 WARNING TAPE

- A. All domestic water lines shall have a 2-inch-wide, inert, fade-resistant plastic film resistant to acids, alkalis, and other components likely to be encountered in soil. Warning Tape colors shall follow the uniform color code per American Public Works Association (APWA) and shall not be placed more than 24 inches above top of pipe.
1. Provide: Terra Tape® Standard; T. Christy Enterprises, Inc. T A.ND.3-COLOR-CODE; or equal.
 2. Acceptable Manufacturers: Reef Industries, Inc.; T. Christy Enterprises, Inc.; or equal.
 3. Color code per American Public Works Association (APWA).
- B. All sanitary pipelines shall have a six (6) inch wide, detectable, magnetic warning tape installed twelve (12) to eighteen (18) inches above all pipe, on top of the

bedding, for the purpose of warning of location of buried pipeline. For sanitary sewers, the marker tape shall be green in color with black lettering in a continuously repeating pattern with the words "Caution Sanitary Line Below".

- C. For sanitary infrastructure owned by Metro, Contractor shall provide tracer wire meeting the following requirements:
 - 1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
 - 2. Replace or install tape for existing utilities within the excavation area.
 - 3. Fabrication:
 - a. Legend: Preprinted and permanently imbedded
 - b. Message continuous printed
 - c. Tensile strength: 1750 psi
 - d. Minimum thickness: 4 mils
 - e. Width: 6 inches
 - 4. Manufacturers:
 - a. Reef Industries, Terra Tape
 - b. Allen, Markline
 - 5. Sanitary Pipelines Marking Schedule:
 - a. Minimum letter height: 1 ¼ inch
 - b. Color: Green with black letters
 - c. Legend:
 - 1) First line: "CAUTION CAUTION CAUTION"
 - 2) Second line: "BURIED SEWER LINE BELOW"

2.08 MARKER POST

- A. All sanitary structures that are not located in a hard paved surface, asphalt or concrete, shall have a triview marker post. Marker posts for wastewater shall be green. Refer to Section 522.12 of the Arvada Engineering Code of Standards and Specifications.
- B. Marker posts shall include on all three sides, a decal with City of Arvada's logo, Utilities phone number 303-898-7780 and the universal "Call Before You Dig" symbol.
 - 1. Acceptable Manufacturers: Rhino Industries Decal - Rhino SD-6308K-R or equal.
- C. For domestic water lines, marker posts shall be blue. Refer to Section 420.20 of the Arvada Engineering Code of Standards and Specifications.
- D. For sanitary structures owned by Metro, Contractor shall use Brady-Stake, Carsonite, or equal for marker posts. Marker posts shall be set in an 8 inch diameter by 18 inch deep concrete foundation.

PART 3 - EXECUTION

3.01 GENERAL CONSTRUCTION REQUIREMENTS

- A. Barriers: Barriers shall be placed at each end of all excavations and at such places along excavations as may be necessary to warn all pedestrian and vehicular traffic of such excavations.

- B. Access: Free access must be maintained to all fire hydrants, water valves and meters, and private driveways.
- C. Temporary Pavement: Place temporary pavement or first lift of permanent pavement on trenches in existing streets within 24 hours after the trench has been backfilled. Refer to Section 02740 for paving requirements. Maintain temporary pavement until permanent pavement is to be placed.
- D. Preparation: Identify required lines, levels, contours, and datum locations. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic. Maintain and protect above and below grade utilities indicated to remain. Provide traffic control and detours as necessary per Sections 01500 and 01550.

3.02 CONTROL OF WATER

- A. Prepare and submit a Dewatering Plan in accordance with Section 02140.

3.03 EXISTING UTILITIES

- A. General: The known existing utilities and pipelines are shown on the Drawings in their approximate location. The Contractor shall exercise care in avoiding damage to all utilities as he or she will be held responsible for their repair if damaged. There is no guarantee that all utilities or obstructions are shown, or that locations indicated are accurate. Utilities are piping, conduits, wire, cable, ducts, manholes, pull boxes, and the like, located at the project site.
- B. Potholing:
 - 1. Contact all affected utility owners and request them to locate their respective utilities prior to the start of "potholing" procedures. The utility owner shall be given 7 days written notice prior to commencing potholing. If a utility owner is not equipped to locate its utility, the Contractor shall locate it.
 - 2. Clearly paint the location of all affected utility underground pipes, conduits, and other utilities on the pavement or identify the location with suitable markers if not on pavement. In addition to the location of metallic pipes and conduits, non-metallic pipe, ducts, and conduits shall also be similarly located using surface indicators and detection tape if present and shall then be similarly marked.
 - 3. After the utility survey is completed, commence "potholing" to determine the actual location and elevation of all utilities where crossings, interferences, or connections to new pipelines or other facilities are shown on the Drawings, marked by the utility companies, or indicated by surface signs. Prior to the preparation of piping shop drawings, or the excavating for any new pipelines or structures, the Contractor shall locate and uncover these existing utilities including services and laterals to a point 1 foot below the utility. Submit a report identifying each underground utility and its depth and location. Any variation in the actual elevations and the indicated elevations shall be brought to the Project Engineer's attention.
 - 4. Excavations around underground electrical ducts and conduits shall be performed using extreme caution to prevent injury to workmen or damage to electrical ducts or conduits. Similar precautions shall be exercised around gas lines, telephone, and television cables.

5. Excavations shall have a surface dimension of no more than 18-inch by 18-inch. Air spades and vacuum excavators shall be used to limit the size of the excavation and damage to adjacent facilities. Backfill after completing potholing.
 6. Repair potholes in accordance with Section 900 – Asphalt Mix Design and Construction of the Arvada Engineering Code of Standards and Specifications.
- C. Interferences:
1. If interferences occur at locations other than shown on the Drawings, the Contractor shall notify the Project Engineer, and a method for correcting said interferences shall be coordinated with the Project Engineer. If the Contractor does not expose all required utilities prior to shop drawing preparation, he or she shall not be entitled to additional compensation for work necessary to avoid interferences, nor for repair to damaged utilities.
 2. Any necessary relocations of utilities, whether shown on the Drawings or not, shall be coordinated with the affected utility. The Contractor shall perform the relocation only if instructed to do so in writing from the utility and the Project Engineer.
- D. Shutdowns: If the Contractor requires a utility to be shutdown for a period of time to commence construction, the Contractor shall notify the utility owner and receive approval of the shutdown, including the shutdown schedule, prior to proceeding with the work.
- E. Overhead Facilities: There are existing overhead electric and telephone transmission lines at the site. Extreme caution shall be used when working in the vicinity of overhead utilities to prevent injury to workmen or damage to the utilities. The Contractor shall be required to comply with the applicable provisions of OSHA when working anywhere on this project.
- F. Existing gas, water, sewer, and telephone house laterals exist along the pipeline alignments. Protect all service laterals from damage due to construction operations. If any laterals are damaged, notify the Project Engineer and the affected utility immediately. The cost of repair shall be borne by the Contractor.

3.04 TRENCH EXCAVATION

- A. This section is exclusive of the railroad corridor from the manhole just south of the corridor (SSMH 4-8) to the manhole just north of the corridor (SSMH 4-9). Refer to the 02400 series of the project specifications for specialized requirements related to this work.
- B. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line and removed from the jobsite prior to starting the trench excavation. If the vertical edges of a trench in a roadway ravel during construction, they shall be trued to a vertical plane to a point twelve (12) inches outside the limits of excavation prior to milling and placing the resurfacing material. This material shall not be used in any fill or backfill.
- C. Excavation for pipe and other utilities shall be in open cut. The trench shall be as wide as necessary for sheeting and bracing and the proper performance of the work up to the maximum width permitted as shown on the Drawings. The sides of the trenches shall be vertical in paved areas. The bottom of the trench shall be

constructed to the grades and shapes indicated on the Drawings. Favorable review by the Project Engineer is required prior to use of alternative methods of construction.

- D. Remove lumped subsoil and rock up to one cubic yard, measured by volume. Remove larger material as specified in Paragraph 3.15 Rock Excavation.
- E. Do not advance open trench more than 200 feet ahead of installed pipe.
- F. Accurately grade the bottom of the trenches to provide uniform bearing and support for each section of the pipe or conduit at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Dig bell holes and depressions for joints after the trench bottom has been graded. For the pipe to rest on the bedding for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth, and width as required for properly making the joint. Remove stones as necessary to avoid point bearing.
- G. The trench shall not be backfilled until the Owner's Inspector favorably reviews the pipe and bedding installation.
- H. If unsatisfactory material is encountered at the bottom of excavation, coordinate with the Project Engineer steps to remove and replace with material approved by the Project Engineer.
- I. Backfill and compact excavations with material approved by the Project Engineer.
- J. For all piping or conduits to be placed in any excavated and backfilled area, such as at manholes or for building connections, the structural backfill shall be first compacted to a level at least 3 feet from the top of the piping or conduit elevation and then retrenched to pipe grade.
- K. Provide secured ladders for access to the trench by construction and inspection personnel. Additional secured ladders shall be provided to any structure or pipe that must be inspected and tested. Failure to provide safe inspection access shall void initial inspection and follow up inspection shall not be performed until proper safe access is provided to the items to be inspected.
- L. If the bottom of the excavation is soft or unstable, and in the opinion of the Project Engineer, cannot satisfactorily support the pipe, the soft or unstable material shall be removed and replaced a minimum of 12-inches below grade with Stabilization Rock or as otherwise specified by the Project Engineer.
- M. All trenching shall be performed in accordance with all Occupational Safety and Health Administration (OSHA) requirements. Refer to Section 364 Arvada Engineering Code of Standards and Specifications.
- N. For sections of pipe owned by Metro, Contractor perform trench excavation as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 3.2 of this specification for additional requirements.
 - 1. Trench size:
 - a. Maximum trench width at top of pipe may not exceed outside diameter of utility service by more than the following dimensions:
 - 1) Overall diameter of utility service is 33 inches or less: 18 inches

- 2) Overall diameter of utility service is more than 33 inches: 24 inches
- b. Cut trench walls vertically from bottom of trench to 1 foot above top of pipe.
 - c. Keep trenches free of surface water runoff.
2. Follow Section 3.2.E for electrical conduit trenching requirements.

3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms, and the protection of the work.
- B. Inspection of Excavation: Notify the Owner's Inspector when excavation for the structure is complete. No forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation has been inspected and approved by the Owner's Inspector.

3.06 SURPLUS EXCAVATION MATERIAL

- A. All surplus excavation shall be removed from the jobsite and disposed of properly. If the surplus excavation is disposed of on private property, written permission shall be obtained from the property owner and a copy given to the Project Engineer.
- B. The Contractor shall investigate and determine if excavated soils are hazardous in nature and require specialized disposal. It is the Contractor's responsibility to legally dispose of surplus excavated material.

3.07 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations in accordance with OSHA regulations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. Support trenches excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- C. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.
- D. Remove sheeting, shoring and/or bracing without damage to the pipe, the alignment of the pipe, or the pipe bedding.

3.08 SUBGRADE PREPARATION

- A. Finished Subgrade: Finished subgrade material may be native soil or import material and prepared to be non-yielding when proof-rolled by passing over all areas to receive fill or as required by the Project Engineer with a minimum 10-ton roller, front-end loader with loaded bucket, or other heavy rubber-tired vehicle with high tire pressure (e.g., loaded tandem dump truck), in the presence of the Owner's Inspector.
- B. Once suitable soil conditions are achieved, the subgrade should be scarified and compacted prior to fill placement. The suitable exposed soil materials should be scarified and moistened or dried, as necessary, to a minimum depth of 12 inches below the proposed construction.

- C. If subgrade is unstable, wet, or soft and air-drying is not an option, Contractor shall coordinate with the Project Engineer for corrective methods prior to placing subsequent lifts.
- D. Unstable Soils
 - 1. If the bottom of the excavation is soft or unstable, and in the opinion of the Project Engineer, cannot satisfactorily support the pipe, the soft or unstable material shall be removed and replaced a minimum of 12-inches below grade with Stabilization Rock or as otherwise specified by the Project Engineer.
- E. For sections of pipe owned by Metro, Contractor notify Metro when unstable materials are encountered. If Metro determines that the subgrade cannot be made stable, Contractor will be directed to over excavate and stabilize with crushed rock and geotextile fabric.
 - 1. Over excavate to a depth of 12 inches or as directed by the Geotechnical Engineer.
 - 2. Place crushed rock directly on the geotextile.
 - 3. Crushed rock shall be fully encapsulated in geotextile and edges shall lap at least 12 inches.
 - 4. Crushed rock shall be placed up to the design subgrade elevation.

3.09 SUPPORT OF EXCAVATIONS

- A. Adequately support excavation for trenches and structures to meet all applicable requirements in the current rules, orders, and regulations. Excavation shall be adequately shored, braced, and sheeted so that the earth will not slide or settle and so that all existing structures and all new pipe and structures will be fully protected from damage. Keep vehicles, equipment, and materials far enough from the excavation to prevent instability.
- B. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting, and bracing shall be carefully removed so that there shall be no voids created and no caving, lateral movement, or flowing of the subsoils.

3.10 TRENCH BACKFILL

- A. Backfill shall comply with Section 368.00 of the Arvada Engineering Code of Standards and Specifications.
- B. Backfill materials shall be compacted by vibrating, tamping, or a combination thereof.
- C. Trench Backfill:
 - 1. Place trench materials true to the lines, grades, and details indicated on the Drawings.
 - 2. Place trench materials in uniform, level layers, not exceeding 8 inches thick measured before compaction. The difference in level on either side of a pipe shall not to exceed 4 inches.
 - 3. Backfill material shall not be placed over the pipe or conduit until after the joints have been completed and inspected by the Owner's Inspector.
 - 4. Protect the pipe or conduit from damage during the construction period. It shall be the Contractor's responsibility to repair broken or damaged pipe at no extra cost to the Owner. Once repair is inspected and approved by the

Owner's Inspector, contractor shall retest the line. Carefully place backfill around and over the pipe. Tamping of backfill over the pipe shall be done with tampers, vibratory rollers, and other machines that will not injure or disturb the pipe.

5. Do not allow construction traffic over the pipe trench until the trench has been backfilled to be even with the existing adjacent grade, temporary AC pavement has been placed over the backfilled trench and/or a traffic rated metal plate has been placed over the trench.
- D. Import Backfill: The removal and replacement limits and quantity of import backfill material shall be coordinated and accepted by the Project Engineer and Owner prior to proceeding with the installation.
- E. Flow-Fill: Generally, the Contractor may place Flow-Fill in approximate 3 feet thick layers, allow bleed water to rise and divert away from placement before another layer may be added. Refer to MGPEC Section 19.4E for more information.
- F. Flashfill: flashfill may generally be placed without thickness limits.
- G. Excavated material: Excavated material can be reused as backfill provided all organic material is removed unless more stringent requirements are provided in the geotechnical report. For trenches beneath pavements and flatwork, backfill from a minimum of 1 foot below grade to grade shall consist of material meeting the requirements for AASHTO class A-1 or A-2 material. All excavated material which meets the requirements for backfill materials shall be stockpiled in a manner which shall not contaminate the excavated material and shall be located a sufficient distance from the trench to avoid overloading, to avoid obstructing sidewalks, driveways, or streets, and to provide the least possible interference with traffic.
- H. Backfill of service lines in streets: Service lines trenches cut through surfaced streets or adjacent to existing curbs, gutters, and sidewalks in public ROW shall be bedded using squeegee and backfilled using an approved backfill material.
- I. For sections of pipe owned by Metro, Contractor perform trench excavation as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 3.4 of this specification for additional requirements.
 1. Furnish backfill to a minimum of 24 inches above top of pipe.
 - a. Place backfill in lifts not exceeding 8 inches loose thickness
 - b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
 - c. Observe specific manufacturer's recommendations regarding backfill and compaction.
 - d. Compact each lift to specified requirements.
 2. Water flushing for consolidation is not permitted.
 3. Follow Section 3.4.E for electrical conduit backfilling requirements.

3.11 BACKFILL UNDER STRUCTURES

- A. Crushed Rock shall be placed in uniform, level layers, not exceeding 6 inches thick measured before compaction under manhole structures and vaults.

- B. Backfill Adjacent to Structures
 - 1. Do not place backfill against structures until the concrete has been patched and cured.
 - 2. Do not place backfill against structures until at least 28 days after the concrete was placed, or until the concrete has achieved a strength of at least 80% of the required design strength, whichever is earlier. Concrete strength shall be demonstrated by field cured cylinders tested at the Contractor's cost, prepared and tested in accordance with ASTM C31 and ASTM C39.
 - 3. Place Structural Backfill within 2 feet of a structure.
 - 4. Place structural backfill in uniform, level layers, not exceeding 6 inches thick measured before compaction. Bring backfill up uniformly on all sides of the structure, and on both sides of buried walls.
 - 5. The Contractor shall uniformly process, maintain proper moisture in, and properly compact each lift throughout the backfilling process.
- C. Backfill for Walls Below Grade
 - 1. Backfill should be placed in horizontal lifts not exceeding 6 inches in loose thickness. Only light, hand-operated compaction equipment (e.g., jumping jack, walk-behind vibratory plate compactor) shall be used within 10 feet of walls below grade.
 - 2. All sheeting and bracing used for structure excavation shall be removed by the Contractor prior to backfilling.
- D. Rock Subgrade Under Structures
 - 1. Unless shown specifically otherwise in the Drawings, do not use rock as backfill above the elevation of the highest base slab of the structure.
 - 2. 3/4-inch Crushed Rock shall be used in areas subject to expansive soils as recommended by the Geotechnical Engineer.
- E. In constrained areas where proper compaction of backfill cannot be achieved around structures, CLSM "flowable fill" shall be used as defined in Section 360.01 of the Arvada Engineering Code of Standards and Specifications.

3.12 BEDDING

- A. All pipe shall be installed with sufficient bedding material. The bedding material shall be tamped under the haunches for the full length of the pipe barrel to ensure support for the entire length of pipe. The pipe barrel shall be uniformly supported along the entire lengths of the pipe.
- B. Standard Bedding: Limits of bedding material shall be from 6-inches below the bottom of the pipe to 12-inches above the top of the pipe.
- C. Bedding shall be compacted by vibrating, tamping, or a combination thereof, to 70% relative density for well-graded sand or squeegee material as determined by ASTM D4253 and D4254.
- D. Geotextile Fabric shall be installed with Class B Bedding per the bedding detail on the Drawings.

3.13 COMPACTION

- A. Trench backfill shall be placed in lifts of eight (8) inches or less in loose thickness when heavy, self-propelled compaction equipment is used or six (6) inches or less in loose thickness when hand-guided equipment (i.e. jumping jack, plate

compactor) is used, processed and moisture-conditioned, and each lift thoroughly consolidated by tamping, vibrating, or a combination thereof, until the moisture content and the relative compaction complies with the values shown in the table below.

- B. For new landscape areas, compaction shall be between ninety (90) percent or greater of the maximum Standard Proctor dry density in the top two (2) feet of soils below finished grade. Where sidewalk or concrete trail will be constructed, soils shall be scarified for a minimum depth of twelve (12) inches, moisture treated, and recompacted two (2) feet wider than the footprint of the sidewalk or trail until the moisture content and the relative compaction complies with the values shown in the table below.
- C. The Geotechnical Engineer shall determine whether backfill material exhibits a suitable Standard Proctor compaction curve and can be tested in accordance with ASTM D698. If the material does not exhibit a Standard Proctor compaction curve, material shall be compacted to a minimum relative density of 65% (ASTM D4253 and ASTM D4254).

Soil Classification AASHTO M145	Relative Compaction By <u>Standard Proctor</u> ASSHTO T99 with CP23 (ASTM D698) (percent compaction)	Relative Compaction By <u>Modified Proctor</u> ASSHTO T180 with CP23 (ASTM D1557) (percent compaction)	Moisture Content Range (with respect to Optimum Moisture Content)
A-1 through A-5	-	95	-2 to +2 (based on AASHTO T180)
A-6 and A-7	95	-	0 to +2 (based on AASHTO T99)

- D. Add water to the backfill material or dry the material as necessary to obtain moisture content within 2 percent of optimum. Employ such means as may be necessary to secure a uniform moisture content throughout the material of each layer being compacted.
 - 1. Contractor shall use air-drying to reduce moisture content and/or achieve compaction before other methods may be considered. Or, where applicable, Contractor shall demonstrate air-drying is not possible before other methods may be considered.
- E. When densities of compacted materials do not meet the requirements, remove and/or recompact the material until the requirements are met. The Contractor is responsible for the cost of retesting all failing tests, including the initial retest.
- F. After the material has been moisture conditioned, compact it with compaction equipment appropriate for the use to achieve specified compaction.
- G. If the backfill material becomes saturated through negligence or otherwise, remove the faulty material and replace it with suitable material compacted to the specified density at no additional cost to the Owner.

- H. Compaction within Adam's County ROW shall be in accordance with ASTM D1557 (Modified Proctor) or ASTM D698 (Standard Proctor) as depicted in the table above unless otherwise specified.
- I. Compaction for Metro pipelines shall meet 95 percent maximum dry density as measured by ASTM D698.
- J. Compaction of embankment and backfill materials by flooding, ponding, or jetting is not permitted.

3.14 SITE GRADING

- A. Swales: Reconstruct stormwater swales as required to match existing conditions. Take care not to excavate into swales and cause destabilization of the swale structure so that stormwater cannot be adequately conveyed in quantities previously experienced. Provide temporary stabilization as needed to maintain the shape and cross sectional area of storm swales along the project alignment.
- B. Gravel Areas: Place gravel material onsite to finished grade elevations as shown on the Drawings, unless otherwise noted.
- C. Where filter fabric is installed within an earthen or rock-lined drainage swale or channel, overlap filter fabric a minimum 12" with upstream fabric placed over downstream fabric. Join seams per manufacturer recommendations.

3.15 ROCK EXCAVATION

- A. Rock excavation shall begin when a CAT 325 to 336 (or equal) excavator is no longer able to dig on a single pass with tiger teeth and is scraping at the trench due to refusal.
- B. Sedimentary bedrock is defined as Rock Excavation if it does not satisfy the Ripping Test criteria as described in Section 203 of CDOT's Standard Specifications for Road and Bridge Construction, 2017.
- C. Excavate and remove rock by mechanical method using single tooth ripper, hydraulic chiseling or drilling.
- D. Cut away rock at bottom of excavation to form level bearing.
- E. Remove shaled layers to provide sound and unshattered base for manhole bases and pipe bedding.
- F. In utility trenches, excavate to 9-inches below invert elevation of pipe and a maximum of 24-inches wider than pipe diameter or as indicated on the typical trench detail.
- G. Remove excavated materials from site.

3.16 EMBANKMENT CONSTRUCTION

- A. Embankment construction shall comply with Section 361 of Arvada Engineering Code of Standards and Specifications.
- B. Embankment construction shall include placement, processing, and compaction of all embankment material, and all related work required to ensure proper bond of materials with previously placed embankment material. All embankment construction should be conducted in accordance with specifications and

procedures provided and under the direct supervision of the project Geotechnical Engineer.

- C. No excavation shall be performed in any area until the proposed work has been staked by the Contractor, cross-sections of existing ground are determined and plotted, and all survey elevations and cross-sections shown on the approved plans are reviewed and approved by the Project Engineer. Excavation shall be performed to the lines and grades shown on the approved plans. Prior to placement of subgrade, utilities shall be installed, utility service lines shall be stubbed to the edge of the ROW, and all trenches shall be backfilled and properly compacted.
- D. Earthmoving equipment, watering equipment, processing equipment, and compaction equipment are the responsibility of the Contractor. Equipment shall be suitable for performing excavation and embankment work in accordance with Specifications set forth in Section 300 Arvada Engineering Code of Standards and Specifications.
- E. Embankment material shall be a homogenous mixture of Suitable Material as defined below. The full depth of each layer shall be processed to ensure a satisfactory bonding surface for the next layer of embankment material. If more than 24 hours have lapsed between the time of compaction testing and placement of the next layer of roadway embankment, the area shall be retested.
 - 1. Suitable Material is defined as earthen material that consists of non-organic sands, gravels, clays, silts, and mixtures thereof. Rock with a maximum size of six (6) inches is allowable for embankment. Claystone fragments exceeding three (3) inches in particle size are not to be incorporated in embankment material unless specifically approved by the project Geotechnical Engineer and the Project Engineer. Bedrock that breaks down to specific soil types and sizes during excavation, hauling and placement may be considered as suitable material if they are excavated and moisture conditioned and aged for a period of time to achieve a uniform, homogeneous material.
- F. Following clearing and grubbing, scarify remaining native material below embankments to a minimum depth of 6 inches. Moisture condition the scarified surface to within 2 percent of optimum water content and compact native material in accordance with the requirements of these specifications unless otherwise specified or shown on the Drawings.

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SECTION 2411

BORE AND JACK

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section presents requirements for guided tunnel excavation and the installation of the Initial Support associated with the work, including furnishing all labor, equipment, and materials for tunnels in the Contract.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.
- C. Section 1.06 herein specifies allowable tunnel construction methods for the tunnel.

1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 02470 – Geotechnical Instrumentation and Monitoring
 - 2. 02444 – Construction Shafts
 - 3. 02550 – Cured-In-Place-Pipe Lining
 - 4. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 5. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. CASING PIPE: Pipe installed along the designed tunnel alignment that also serves as the Initial Support.
- B. CUTTERHEAD: The leading face of a rotary tunnel excavation system that is responsible for excavation of the ground.
- C. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- D. GUIDANCE SYSTEM: A system that is utilized to guide the tunnel excavation along the design line and grade within specified tolerances.
- E. GUIDED AUGER BORING: The trenchless installation of a Casing Pipe by Jacking and rotary excavation using a Cutterhead and attached auger string. Line and grade are maintained through the use of a Guidance System. Capable of accurate steering in both line and grade directions unless used in conjunction with a Pilot Tube.
- F. INITIAL SUPPORT: Temporary ground support installed concurrent with tunnel excavation to maintain tunnel stability. Includes Erected Support and Casing Pipe.
- G. LAUNCH SEAL: A seal that is fitted on the shaft wall and through which the boring machine and casing pipe passes to reduce inflow of groundwater and ground into the tunnel shaft.

- H. OBSTRUCTION: Objects or portions of objects located within the cross-sectional area of the tunnel excavation face. An Obstruction shall be defined as:
 - 1. Makes further advancement of the tunnel impossible using techniques typically used for the current tunnel excavation method; and
 - 2. Has an unconfined compressive strength greater than 15,000 psi, or consists of steel, concrete, brick, timber, rock, rubble, or other artificial material.
- I. ONE-PASS TUNNELING SYSTEM: A method of tunneling in which Initial Support is the Final Support and no secondary Carrier Pipe is required.
- J. OVERCUT: The difference between the radius of the excavation created by the boring machine or cutting shoe as appropriate, and the outside radius of the Initial Support.
- K. OVERCUT BAND: A thin band attached to the front of the first Casing Pipe segment or cutting head used to create an Overcut and lessen skin friction and decrease required installation forces.
- L. PILOT TUBE: A Guidance System consisting of a small diameter, double-wall pipe jacked into the ground ahead of the Casing Pipe or Intermediate Casing with directional control. The Pilot Tube creates the physical alignment along which the Casing Pipe is installed.
- M. TUNNEL SHIELD: A steel cylinder that provides ground support at the tunnel face and the leading edge of the Initial Support and is advanced through the ground with the Casing Pipe. Capable of accurate steering in both line and grade directions.
- N. TWO-PASS TUNNELING SYSTEM: A method of tunneling in which Initial Support is installed prior to installation of the Carrier Pipe.

1.04 REFERENCE STANDARDS

- A. ANSI/AWS D1.1 Structural Welding Code
- B. ASTM A36 / A36M-19 – Standard Specification for Carbon Structural Steel
- C. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- D. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- E. ASTM A1097 – Standard Specification for Steel Casing Pipe, Electric-Fusion (Arc)-Welded (Outside Diameter of 10 in. and Larger)
- F. AREMA – 2020 Manual for Railway Engineering, Chapter 1
- G. BNSF 2023 Utility Accommodation Policy, Part 3 – Utilities Perpendicular to Railroad Property
- H. UPRR 2023 Pipeline Installation Engineering Specifications

1.05 GENERAL REQUIREMENTS

- A. Be responsible for design and construction of Initial Support, and performance of the tunnel excavation.

- B. Minimum design requirements are presented herein. Be responsible for developing and implementing the design to fulfill the specified design requirements provided by the Engineer which are necessary for completion of the work.
- C. Perform tunnel excavation in accordance with all Governing Agencies, applicable permits and requirements, and all applicable laws and regulations.
- D. Construct and install tunnel Initial Support concurrently with the tunnel excavation. Exposed, unsupported ground will not be allowed.
- E. Provide means to control the face of the tunnel in the case of loss of ground integrity. Face control can include but is not limited to: slurry, the cutterhead, competent soil plugs, ground improvement, sand bags, breasting boards/plates, shotcrete, or other means subject to approval of the Engineer.
- F. The Contractor will select Initial Support while adhering to requirements specified herein.
 - 1. Safely withstand all installation and long-term loads, and specifically: rail, ground, roadway, construction and machine loads including non-uniform loading, and stress concentrations.
 - 2. Include all loads and stresses caused by fabrication, transportation, and construction operations including handling, erecting, and grouting pressures.
 - 3. Minimum Casing Pipe thickness is specified herein. Increase Casing Pipe thickness as necessary to correspond with Contractor equipment, safely resist applied loads, and to control ground movement.

1.06 ALLOWABLE TUNNELING METHODS

- A. Use of guided auger boring is the only allowable method. Allowable methods have been selected based on anticipated ground conditions and ground behavior as described in the GBR and in conjunction with the dimensions of the tunnel. The Contractor may propose to use an alternative system for tunnel excavation and support. Any alternative methods are subject to approval by the Owner, Engineer, and Governing Agencies. Note that approval of specified methods has been obtained by the Governing Agencies prior to bid and approval of alternative methods may result in substantial time delays and will be the sole responsibility of the Contractor.

1.07 GROUND CONDITIONS

- A. Information regarding the ground conditions to be anticipated can be found in the GBR and GDR.

1.08 QUALIFICATIONS

- A. Prequalified tunnel contractors will substantially perform all tunnel construction work. Subcontracting of the Work detailed in this specification will not be allowed. Ancillary work may be subcontracted with approval from the Owner and Engineer; for example, trucking and grout supply/mixing.
- B. The Contractor directly engaged in tunnel excavation and support work will have completed at least four (4) tunnel projects during the past two (2) years using similar methods as allowed and selected for use under Section 1.06 and similar scope as proposed for this project. This experience will cover the full range of the

Work detailed in this specification, including but not limited to the excavation of the tunnel, disposal of muck, and control of the encountered conditions.

- C. The onsite foreman for tunnel construction shall have:
 - 1. At least five (5) years of construction experience with excavation and support of tunnels
 - 2. Successfully completed at least two (2) similar jobs within the last three (3) years using excavation and support methods similar to those proposed by the Contractor.
- D. All personnel employed by the Contractor in the work will be experienced and competent in their respective tasks and will work only under the direct control of a suitably experienced foreman or superintendent.
- E. Design of engineered structures as defined herein will be signed and sealed by a Registered Professional Engineer in the State of Colorado who has completed a minimum of two (2) tunnel projects of similar scope in the past five (5) years.

1.09 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. Each number submittal below is to be submitted as a single package, i.e. submit all portions of the 2. Tunnel Work Plan as a single submittal package.
 - 1. Submit qualifications as stated in 1.08.
 - 2. Tunnel Work Plan. Submit a detailed work plan of all proposed tunnel construction operations and Initial Support provisions. Include a description and drawings of proposed methods and procedures for:
 - a. Working drawings including the launch and retrieval shaft layouts, ancillary equipment, thrust block and/or rail system configuration, and limits of construction during tunneling;
 - b. Tunnel excavation equipment to be used including manufacturer literature, drawings, as-built and modified dimensions, anticipated overcut, and capacities;
 - c. Guidance System selection and line and grade control methods;
 - d. Line and grade surveying methods during installation;
 - e. Excavating the tunnel including description of activities involved in a single cycle of excavation and Initial Support Installation;
 - f. Addressing and handling excavating the tunnel in mixed face conditions where shown in the GBR
 - g. Procedures for measuring excavated muck quantities versus the installed length or progress during tunneling operations;
 - h. Lubrication system and lubricants;
 - i. As necessary, Casing Pipe coupling methods to maintain pipe segment alignment during installation;
 - j. Hauling and disposal of excavated muck, including disposal site details;
 - k. Adhering to noise ordinances stipulated for the project. This may include but not be limited to noise barriers and restrictions on working hours;
 - l. Detailed contingency plans for the following:
 - 1) Obstructions (as defined herein) encountered during tunnel construction;
 - 2) Settlement and/or heave;

- 3) Loss of line and grade during tunnel construction.
3. Submit a plan to maintain stability of the face and prevent ground loss at the beginning of the drive. This may include but is not limited to: ground modification outside the shaft and machine design.
4. If Initial Support selected by the Contractor differs from as provided in Part 2, Initial Support design calculations including loads, methods, assumptions, results, and safety factors.
 - a. Include as a minimum, evaluation of axial, flexural and shear of the Initial Support in uniform and non-uniform loading and support conditions as dictated by the proposed installation techniques and long-term loading. A safety factor appropriate for the level of uncertainty and the nature of the construction shall be applied.
 - b. Calculations shall be signed and stamped by a Professional Engineer Registered in the State of Colorado with minimum qualifications as stated in Section 8.
5. The Contractor will submit dewatering plans in accordance with Section 02411 – Dewatering for approval in locations where Shaft or Tunnel excavations extend beneath baselined groundwater elevations as indicated in the GBR. The Contractor shall develop and submit groundwater related contingency plans including:
 - a. Contingency plan to handle excess water encountered in the tunnel.
 - b. Contingency plan to address unstable ground encountered in the tunnel due to incomplete dewatering.
6. Schedule. A critical path schedule of tunneling-related activities and activities for project components interfacing with the tunnel. The schedule will include at a minimum:
 - a. Duration for launch and receiving shaft or pit excavation;
 - b. Launch pit set up; and
 - c. Anticipated daily production rate for tunnel excavation and initial support installation;
 - d. CIPP Liner installation
 - e. Submit Manufacturer's written certifications that Initial Support materials meet or exceed the specified requirements as stated herein.
7. Contractor's safety plan for personnel conducting tunneling operations including, but not necessarily limited to, provisions for ventilation, temperature control, lighting, electrical safeguards, safety of the public, monitoring, and warning systems, submittal will be for information only and not approved or disapproved by Engineer;
8. Certifications of qualified welders where welding is required.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 1. Provide Written Daily Logs including: a summary of encountered ground conditions and ground behavior; the length of excavated and supported tunnel; an estimate of estimated muck quantity; and a general summary of daily tunneling activities. Written Daily Logs are to be recorded by the Contractor's onsite personnel and signed by the Contractor's Tunneling Superintendent for each shift and will be submitted to the Engineer within two working days of the date of the log.
 2. Instrumentation monitoring results as required herein and in Section 02470 – Geotechnical Instrumentation and Monitoring.

- C. Provide copies of reports as detailed in this specification and as required by public authorities to the Engineer within two working days hours following preparation and submittal to third party authority. These reports are for record purposes only.
- D. Postconstruction Submittals:
 - 1. Record Drawings as detailed in Section 3.12.

PART 2 - EQUIPMENT, PRODUCTS AND MATERIALS

2.01 EQUIPMENT

- A. The Contractor will determine and provide the equipment necessary for excavation and Initial Support of the tunnel and to complete all work associated with this Section within the ground conditions stated in the GBR, without impacts to overlying infrastructure, and without showing evidence of undue stress or failure. Backup equipment shall be required in the event of an equipment breakdown and where the condition of the equipment to be used indicates that routine component replacement or repair will likely be necessary during the work.
- B. Tunnel excavation equipment will have the following minimum attributes:
 - 1. Be capable of controlling the ground during excavation and shutdown.
 - 2. If applicable, have a system to minimize roll of the boring machine and Initial Support during installation and/or allow for rotation to correct roll.
 - 3. Be capable of being operated in a manner that will prevent loss of ground during excavation and be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified.
 - 4. Utilize a Guidance System capable of accurately measuring and controlling the excavation equipment and Initial Support position during installation such that the Carrier Pipe can be installed to the line and grade tolerances specified in this Section.
 - 5. The excavation and installation equipment will be capable of handling and removing all anticipated material documented in the GBR.
 - 6. Have the minimum thrust capacity required to install the Casing Pipe.

2.02 PRODUCTS AND MATERIALS

- A. Minimum Initial Support diameters are listed on the Drawings. The Contractor may, at its discretion use a larger Initial Support diameter subject to approval by the Engineer.
- B. Casing Pipe:
 - 1. A Casing Pipe will be used for the RR crossings.
 - 2. The minimum casing pipe thickness 0.469 inch(es) as required by the Governing Agency granting the utility permit; whichever results in a greater thickness. Casing Pipe thickness may be increased by the Contractor at its discretion.
 - 3. At a minimum the Casing Pipe will conform to ASTM A1097 and be manufactured specifically for jacking.
 - 4. The pipe will be utilized in accordance with the pipe manufacturer's specifications, guidelines for tunnel installation, and recommendations of the equipment manufacturer.
 - 5. The contractor will adhere to pipe manufacturer's installation guidelines for:

- a. Handling;
 - b. Launch shaft preparations;
 - c. End preparations, mating procedures; and
 - d. Installation.
- 6. The Casing Pipe will be round. Casing Pipe are required to have a roundness tolerance so that the difference between the major and minor outside diameters are not exceed to lesser of 1% of the specified nominal outside diameter or 0.25-inches.
- 7. Steel pipe shall be in conformance with ASTM A1097 and of leakproof construction, such as butt welded or interlocking joints which are capable of withstanding railroad loading. Pipe shall have a specified minimum yield strength of at least 35,000 psi.
- 8. All metallic casing pipes are to be designed for effective corrosion control, long service life, and relatively free from routine servicing and maintenance. Corrosion control measures for metallic casing pipe must include cathodic protection which can be an active induced current, or a passive system that could be sacrificial anodes and/or protective coating rated for cathodic protection such as fusion bonded epoxy with an abrasion resistance overcoating.
- C. Pipe Joints:
 - 1. Jacked Casing – Either of:
 - a. Welded with a full penetration butt weld in accordance with ANSI/AWS D1.1.
 - b. T5 as manufactured by Permalok, Tri-Loc as manufactured by Trinity Products, or equivalent.
 - 2. The joints are to be in accordance with the pipe manufacturer's specifications and guidelines for jacked or rammed pipe.
- D. Lubricant:
 - 1. Lubricant used to reduce friction shall consist of a mixture of bentonite, water, and additives, and is the responsibility of the Contractor.
 - 2. Lubricant will be non-toxic, and not release environmental contaminants into the groundwater either directly or from degradation and shall comply with NSF/ANSI Standard 060

PART 3 - EXECUTION

3.01 TUNNEL REQUIREMENTS – GENERAL

- A. Do not begin tunneling until:
 - 1. Required preconstruction submittals have been made and the Engineer has reviewed and accepted submittals in writing.
 - 2. All required permits are in place and the Governing Agency has been satisfactorily notified of the schedule and work.
 - 3. Shaft excavations, stabilization and shoring have been satisfactorily completed in accordance with Section 02444 – Construction Shafts.
 - 4. The locations of all monitoring and instrumentation points have been established and initial baseline measurements have been obtained in accordance with Section 02470 – Geotechnical Instrumentation and Monitoring.

5. A pre-job activity and safety meeting has been conducted with the Contractor and Engineer. Arrange this conference and inform the Engineer of the time and place of the conference at least seven (7) days in advance of tunneling.
 6. Existing utilities near the proposed alignment have been identified both horizontally and vertically.
- B. Perform tunneling operations in a manner that will minimize loss of ground and minimize settlement or heave of the ground surface, structures, utilities and other facilities above and adjacent to the tunnel.
 - C. Maintain clean working conditions at all times inside and around the tunnel and shafts. All excavated muck, and any other material not required for tunneling are to be removed from the excavation in a timely manner.
 - D. Design, install and operate tunneling support utilities as necessary for support of construction and the safety of workers in accordance with project requirements and all Federal, State, and local laws, regulations, and codes. Utilities including but not be limited to electrical, lighting, water, and ventilation.

3.02 TUNNEL EXCAVATION - GENERAL

- A. Maximum radial Overcut is to be compatible with the subsurface conditions, stiffness characteristics of selected pipe, and joint system, tunnel diameter, and excavation method at the designed maximum installation loads. Overcut may not exceed 0.75-inches unless approved otherwise by the Engineer.
- B. Monitor and control the volume of muck removed. Compare theoretical and actual volumes of spoil removed as excavation progresses. Investigate potential voids created by over excavation and fill them with grout to avoid surface settlement or structure damage.
- C. During shutdowns and other interruptions in tunnel excavation work, provide means to maintain the integrity of the ground at the face of the tunnel.
- D. Avoid damage to pipe sections, joints, and overall Initial Support during tunnel construction. In the event of damage to a pipe section or pipe joint during Tunneling, the Contractor must notify the Engineer within the day of observation of the damage.
 1. If a damaged Casing Pipe cannot be repaired, jack all damaged pipe sections completely through the tunnel following completion of tunnel excavation.
- E. Limit the jacking force to stay at or below safe working limit of the Initial Support.
- F. Continuously monitor and record the jacking loads at the jacking frame or boring machine as applicable.

3.03 GUIDED AUGER BORING

- A. Requirements presented in Sections 3.01 and 3.02 of this Specification apply to this Section unless specifically noted herein.
- B. Guided Auger Boring shall utilize a Guidance System to install the Casing Pipe. The Guidance System will consist of:
 1. A pre-installed Pilot Tube; or
 2. An On-Target Steering System as manufactured by McLaughlin or approved equivalent.

- C. Intermediate Casings
 - 1. If the Contractor elects to use a Pilot Tube Guidance System, install Intermediate Casings as follows:
 - a. Minimum one Intermediate Casing 12 to 18-inch diameter installed the full length of the crossing prior to advancing the final Casing Pipe.
- D. In Running or Raveling ground, maintain a minimum Soil Plug to reduce inflow of material.
- E. Control the advance, volume of material excavated, and size of the Soil Plug to result in stable ground at the leading edge of the pipe and to prevent the loss of ground and heave.
- F. Prevent the soil within the plug from running or flowing and exposing the ground at the leading edge of the pipe.
- G. Record, at a minimum, the following data which will be made available to the Engineer:
 - 1. Maximum jacking load encountered during each Casing Pipe segment advance;
 - 2. Cutter head torque;
 - 3. Steering pressures utilized to maintain or return to design line and grade;
 - 4. Cutter head RPM; and
 - 5. Line and grade.

3.04 LUBRICATION OF CASING PIPE

- A. For Initial Support methods using Casing Pipe, provide the means to inject lubrication into the overcut annulus as the Contractor deems necessary.
- B. Provide adequate protection for the lubrication system to withstand all anticipated ground conditions as described in the GBR.
 - 1. Breakage or failure of the lubrication system shall not relieve the Contractor of its responsibility to install the Casing Pipe as required or for excessive settlement of the ground surface or other underground structures.

3.05 OBSTRUCTION DURING TUNNELING

- A. Remove, clear, or otherwise make it possible for the tunneling equipment and Initial Support to progress past, or through an Obstruction in accordance with the Contractor's submitted contingency plan.
- B. Additional payment for Obstruction removal will be made if the object is found to meet the definition of an Obstruction and subject to the following requirements:
 - 1. Notify the Owner in writing on the same calendar day as encountering the Obstruction.
 - 2. Notify and obtain approval from affected Governing Agencies of the intent to excavate to remove the Obstruction if excavation is necessary within the right-of-way limits of affected Governing Agencies.
 - 3. Submit a complete plan for removal of the Obstruction including estimated time and costs to the Owner prior to starting Work to remove the Obstruction.
 - 4. Upon written authorization by the Owner, proceed with removal of the Obstruction by means of the approved removal procedure.
 - 5. No excavation to remove the Obstruction will be allowed without the Owner being present.

- C. If the Obstruction is such that the tunnel is at risk of endangering life and/or property, the Contractor is directed to work 24-hours/7-days per week as necessary to create a stable and safe condition. Requirements in Section 3.05.B apply thereafter.

3.06 QUALITY CONTROL

- A. Perform all Tunnel Excavation and Initial Support work in the presence of the Engineer, unless the Engineer has granted prior approval in writing to perform such work in their absence.
- B. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the most restrictive applicable requirements.

3.07 TUNNEL LINE AND GRADE TOLERANCES

- A. At a minimum, the tunnel is to be within 1 inches of the design line and 1 inches of the design grade, or sufficiently true and accurate to the design alignment and profile to allow for accurate placement of the Carrier Pipe, whichever is more stringent. Installed Initial Support not meeting the tolerances indicated will be reconstructed or replaced at the Contractor's cost.
- B. Changes in Initial Support alignment and grade during installation are to be made gradually such that joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- C. If the Initial Support is off line and/or grade by more than the specified tolerances, make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- D. If the tunnel is sufficiently far off line and/or grade to require redesign of structures, acquisition of easements, or backfilling and re-excavation, the Contractor shall be responsible for doing all necessary additional work as determined by the Engineer and all associated costs. If the Initial Support is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor is responsible for all redesign costs.
- E. The Contractor is responsible for setting control points and controlling the line and grade of the tunnel as necessary to achieve the specified line, grade and tolerances for the Initial Support.

3.08 SAFETY REQUIREMENTS

- A. Designate a site or project Safety Officer. The Safety Officer will administer an accident prevention program and prepare a code of safe practices and an emergency plan. Provide the Engineer with a copy of each prior to starting tunnel excavation. Hold safety meetings and provide safety instruction for new employees and site visitors.
- B. Lighting Work Areas: Provide all work areas with sufficient lighting to facilitate proper performance and inspection of work, provide safe passage between the installation Shaft and Tunnel heading, and be in accordance with applicable federal, state and local laws, safety codes, regulations, and ordinances.

3.09 TUNNEL ACCESS

- A. Provide safe access for the Owner and Engineer during active tunnel work. Access will be for, but not be limited to, the following: to inspect and observe the work; to perform independent line and grade surveys; for geologic mapping, for monitoring of instrumentation; and for installation of additional instrumentation.

3.10 EXCAVATED MATERIAL

- A. Transport and dispose of all excess excavated materials and muck properly away from the construction site in such a fashion that trucks and other vehicles do not create a dirt nuisance on roads and pathways.
- B. Secure the required permits and promptly remove and dispose of any spillage and excess muck as required.

3.11 CLEANUP AND RESTORATION

- A. Remove all equipment, unused materials, and debris from the site once the required work has been completed. Restoration will follow construction as the work progresses and be completed as soon as possible. Restore and repair any damage resulting from surface settlement or heave caused by the work immediately. Any property or improvements damaged or destroyed, will be restored to a condition equal to or better than existing prior to construction at no additional cost to the Owner. Restoration will be completed immediately, if a third party or the Owner are inconvenienced by the damage, and in no case later than thirty (30) days after the damage is discovered. This provision for restoration includes all property which was affected by the construction operations.

3.12 CONSTRUCTION RECORDS

- A. Maintain Written Daily Logs for all components and phases of tunnel construction. Submit Daily Logs to the Owner or Engineer within two working days. The Daily Logs are to be signed by the site Superintendent or shift foreman and contain the following:
 - 1. Subcontractors onsite with their personnel and equipment, and the work performed. The reports are to be broken down into work time and down/standby time for each Subcontractor;
 - 2. Work crews and equipment onsite, and the work performed. The reports are to be broken down into work time and down/standby time for each crew and piece of equipment;
 - 3. Progress made for each construction stage;
 - 4. Survey results – line and grade;
 - 5. Problems or unusual conditions encountered and actions taken to address these situations;
 - 6. Record of safety meetings conducted; and,
 - 7. List of visitors to construction site.
- B. Maintain records of all surveys.
- C. Maintain records of the tunnel excavation including but not limited to the following:
 - 1. The station of the face of the excavation and advance distance;
 - 2. The position of the tunneling face or machine in relation to the design line and grade;

3. The maximum jacking load encountered during each Initial Support segment advancement.
 4. The date, starting time, and finish time;
 5. Any unusual conditions, breakdowns, and delays; and
 6. Excavated muck quantity.
- D. Maintain records of all monitoring of the during construction including but not limited to the following:
1. Description and position of complete and partially complete Initial Support installed;
 2. Description of ground type and conditions, and ground behavior; and
 3. Inconsistencies such as unusual spacings, deformations, and unusual performance.
- E. Construction Record Drawings. Keep and maintain at the construction site a complete set of final design drawings for recording as-built conditions. It will have been marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings will be kept up-to-date during construction. The record drawings will be updated at least once every week to current conditions. The record drawings will contain the following as a minimum:
1. Locations (line and grade) of the installed Initial Support as required herein.
- F. As-built drawings shall be submitted and accepted by the Engineer prior to recommending final payment.

3.13 PROGRESS MEETINGS.

- A. Contractor's onsite foreman to attend the periodic hour-long (weekly or bi-weekly) construction meetings in person during a time frame of two weeks before the active tunneling operations to two weeks after the active tunneling operations for each tunnel.

END OF SECTION

SECTION 02430

CONTACT GROUT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Section includes requirements for conducting Contact Grouting of overcut and voids outside the Initial Support.
- B. Requirements in this Section apply to all tunnels on the project. Submittals must be provided for each tunnel separately.

1.02 RELATED WORK:

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 02065 – Concrete
 - 2. 02470 – Geotechnical Instrumentation and Monitoring
 - 3. 02411 – Tunnel Excavation and Initial Support
 - 4. 02450 – Carrier Pipe Installation and Backfill
 - 5. 02444 – Construction Shafts
 - 6. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 7. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. CONTACT GROUT: An approved mixture of Portland cement and water used to fill the annular overcut space created during tunneling.
- B. CONTACT GROUTING: The filling of the overcut and voids in the ground or between the ground and Initial Support.
- C. GROUT PORTS: Location along the tunnel Initial Support where grout is injected in the overcut and void space.
- D. See Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS:

- A. ASTM C150 – Standard Specification for Portland Cement.
- B. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
- C. ASTM C942 – Test Method for Compressive Strength of Grout for Pre-placed Aggregate Concrete in the Laboratory.

1.05 GENERAL REQUIREMENTS

- A. The Contractor is responsible for construction and performance of the Contact Grouting on this project.
- B. The Contractor is responsible for developing and implementing Contact Grouting to fulfill the specified requirements necessary for completion of the work.
- C. The Contractor will provide testing of materials and verification of material properties.
- D. The Contractor will provide the Engineer with a schedule of Contact Grouting activities at least two (2) weeks before beginning grouting, and update weekly. Notify the Engineer at least one working day in advance of schedule changes.

1.06 QUALIFICATIONS:

- A. The Contractor will be experienced in grouting tunnels and underground projects using methods, materials, and equipment comparable to this project. Demonstrate successful completion of at least three (3) grouting jobs in the last five (5) years with similar scope to the proposed Contact Grouting plan.

1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. The preconstruction submittals below shall be submitted as a single package.
 - 1. Contractor Contact Grouting qualifications.
 - 2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for grouting. Include at a minimum the method(s) of transporting/delivery, sequence and stages of Contact Grouting, injection locations, and verification of grouting.
 - 3. Provide the maximum anticipated Contact Grout pressure, calculated by an engineer registered in the State of Colorado. This pressure is to be verified in the field and will not be exceeded without prior approval from the Engineer. The maximum anticipated Contract Grout Pressure is not to cause heave or distress the ground surrounding the Casing Pipe and will not damage the Casing Pipe.
 - 4. Mix design for the grout including proportions of all constituents, properties of the test results of the wet mix, and test results of the cured backfill.
 - a. Submittal will fulfill all the QA/QC requirements specified herein.
 - b. Submit test results from samples made using the same materials, including water and cement that will be used on the Project. Use of potable water will exclude submitting test results with the same water.
 - 5. Description of equipment and methods proposed to mix Contact Grout including mixing equipment, quantity controls and instrumentation.
 - a. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of grout.
 - 6. Injection methods for grout including pumping equipment, mixer, agitator, hoses, boosters, pumping distances, return flow lines, flow rates, and pressures.

- a. Include methods and description of instrumentation to monitor and control placement of the grout, and procedures to be used to verify complete placement and check for voids.
- 7. Drawings and description of grout ports, plugs and valves for the ports, and materials used to plug and permanently seal the grout ports following Contact Grouting.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 - 1. Test results. Include results of all Contact Grout tests specified herein for the grout including but not limited to field tests and laboratory tests.
 - 2. Instrumentation and monitoring collected data during contact grouting as specified in Section 02470 – Geotechnical Instrumentation and Monitoring.
 - 3. Daily Logs as specified herein. Submit logs daily for the previous day's work within 1 day.

PART 2 EQUIPMENT, PRODUCTS, AND MATERIALS

2.01 GROUTING EQUIPMENT

- A. If Contact Grout is batched onsite, the Contractor's grouting equipment is to consist, at a minimum, of:
 - 1. Water meter in gallons;
 - 2. High speed shear mixer;
 - 3. Paddle type agitator;
 - 4. Grout pump; and
 - 5. Grouting header assembly.
- B. Provide grouting equipment with the ability to grout to the maximum grout pressure, controllable to within 0.5 pounds per square inch (psi), and controllable to within 0.5 gallons per minute (gpm).
- C. Provide controls on the proportioning and mixing of the grout sufficient to assure the designed mix is achieved.
- D. Provide a pressure gauge at the injection point with a range suitable for the expected pressures and reading to an accuracy of 0.1 psi or better.
- E. Provide a flow meter with a range suitable for the expected grout flows and measuring the rate of flow to an accuracy of 0.2 gpm or better.
- F. Provide a total flow indicator capable of measuring the grout injected at each port to an accuracy of 1 gallon or better.
- G. Provide piping with a spigot and valve at the injection point for collecting grout samples.

2.02 COMMUNICATIONS EQUIPMENT

- A. Provide equipment to communicate between workers in the tunnel at the grout injection points with workers outside the tunnel.

2.03 MATERIALS

- A. Cement: per Division 02065, Concrete.
- B. Contact Grout.
 - 1. A mixture of Portland cement and water.
 - a. Maximum water/cement ratio of 1:1 by volume.
 - b. 28-day strength of at least 500 psi.
 - c. No shrinkage when tested per ASTM C827.
 - 2. Sand may be added only with approval of the Engineer.
 - 3. Tested for compressive strength per ASTM C942.
 - 4. Use only potable water. Alternative water sources may be utilized with the approval of the Engineer.
- C. Ports and Port Patches in Initial Support.
 - 1. Ports and Port Patches in the Initial Support as shown on the Contract Drawings. The holes or ports are to be compatible with a minimum 1-inch diameter pipe nipple.
 - 2. Ports are to be pre-fabricated in Casing Pipe.

PART 3 EXECUTION

3.01 CONTACT GROUTING

- A. Contact Grout using methods and procedures that track the movement of grout and verify presence of grout throughout the tunnel by injecting grout at one port and using nearby ports to detect the presence of grout. Sequentially close off and move injection points to ensure full grout coverage of voids outside of the casing pipe.
- B. The grout pressure is to be sufficient for the grout to fill voids and displace fluids surrounding the pipe. Maximum allowable grouting pressure is to be maintained from the start of grout injection of each hole to refusal of the hole.
- C. The maximum grout pressure at all locations is to be less than the pressure that would cause ground surface heave and/or cause hydraulic fracturing and/or cause damage to the Initial Support.
- D. Maximum Contact Grout injection port spacing as shown on the Contract Drawings. Contact Grout through any injection port will be considered complete when the grout take is $\frac{1}{4}$ of a cubic foot of grout or less for a minimum of 5 minutes at maximum grout injection pressure, or when grout delivery causes rapid increases in the grout injection pressure beyond the maximum grout injection pressure.
- E. After completion of Contact Grout, replace plug, and fill or patch in accordance with Initial Support manufacturers' specifications and recommendations.

3.02 RIBS AND LAGGING INITIAL SUPPORT

- A. If ribs and lagging are used and stable ground exists as determined by the Engineer, Contact Grouting may be performed concurrently with Backfill Grouting through grout transmission holes cut in the Initial Support. The maximum size of a single grout transmission hole is to be one rib board spanning between two members of steel ribs.
- B. If unstable ground exists as determined by the Engineer, perform Contact Grouting through ports drilled or cut in the lagging. Follow all other requirements specified herein.
- C. Regardless of ground type, space ports as shown on the Contract Drawings similar to other Initial Support types.

3.03 QUALITY CONTROL

- A. Monitor and record as a minimum all data necessary to complete the required Submittals.
- B. Pressure gauges of appropriate diameters and ranges for monitoring the Contact Grout injection pressures are to be located as close as possible to the point of injection in the line transporting the Contact Grout. Contact Grouting is not permitted without pressure gauges in good working condition.
- C. The volume of grout injected is to be measured, recorded, and compared with the anticipated volume per foot of grout expected. The advance of the grout will be monitored using grout injection ports.
- D. Perform all monitoring and testing as specified and as necessary to complete all submittals.
- E. Ground Movement
 - 1. The Contractor is solely responsible for damage caused by grouting operations. The Contractor is to determine the amount of movement allowed and control movements within those limits. The Contractor at his expense, will be required to repair any damage caused by grouting.
 - 2. Surface survey points as designated in Section 31 09 13 – Tunnel Instrumentation and Monitoring are to be monitored and measured during Contact Grout pumping. If surface heave is measured during Contact Grouting, grouting at that specific Port will be immediately ceased and the Contactor will move on to the next port in series.

3.04 TESTING

- A. Test the Contact Grout. Obtain samples of Contact Grout at the point of discharge or alternatively at a simulated point of discharge through the same or greater pumping distance.

- B. Compression and Shrinkage Testing of Grout: A minimum of one set of five 3-inch diameter by 6-inch high cylinders shall be made for each 200 LF of contiguous tunnel. At least one set of test samples shall be made from each 75 cubic feet, or major fraction thereof, of Contact Grout placed in any one day. Test grout compressive strength at 7 days and 28 days.
- C. Testing results are to be provided to the Engineer as they become available from the Contractor-employed testing agency.

3.05 DAILY LOGS

- A. Maintain Daily Logs of the work. As a minimum, the Daily Logs will contain the following:
 - 1. Work hours, equipment and crews in use with persons and craft designations;
 - 2. Stations of grouting;
 - 3. Volume and pressures injected at each location and grout sequence with take at each port and observations of return from nearby holes;
 - 4. Record of holes grouted with locations, quantities, pressures, injection times, and verifications used; and
 - 5. Problems or unusual conditions encountered, and actions taken to address these situations.

END OF SECTION

SECTION 02444

CONSTRUCTION SHAFTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Section includes Requirements for construction of shafts, pits, portals and all excavations to access tunnel work including requirements for excavation, ground support, and abandonment.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 02470 – Geotechnical Instrumentation and Monitoring
 - 2. 02411 – Bore and Jack
 - 3. 02550 – Cast in Place Pipe Liner
 - 4. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 5. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. SHAFTS: The launch or retrieval locations of the tunnel installation, typically situated adjacent to the excavation, the Initial Support is installed under or at tie-in locations to the larger pipe system(s). In shallow tunneling scenarios, can also be pits or portals, excavated in a sloped manner up and away from tunneling equipment.
- B. SHAFT SUPPORT SYSTEM: Temporary erected support within the excavated Shafts to create a safe location for launch and retrieval of the tunnel installation. Shaft Support Systems commonly include but are not limited to trench boxes, slide rails, sheet piles, ring beams and liner plate, or soldier pile and lagging.
- C. See Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS

- A. Occupational Safety and Health Administration (OSHA) Regulation 1926 Subpart P, Excavations.

1.05 GENERAL

- A. Be fully responsible for the construction pits, shafts, or shaft support systems.

1.06 REQUIREMENTS

- A. The Contractor will determine the shaft footprint size, methods of excavation, ground control, ground support type, and allowable excavation slopes needed to

perform the work and provide access for tunnel construction subject to the limitations specified herein and elsewhere in the Contract Documents.

- B. Ground support for shafts and excavations shall stay within established easements unless the Contractor obtains additional easements, permits and approvals from affected property owners.
- C. Where excavations are undertaken near any structure or facility including but not limited to buildings, highways, streets, or utilities; do not alter, damage, impair, or interfere with the operation of the structure or facility.

1.07 GROUND CONDITIONS:

- A. Information regarding the ground conditions can be found in the GDR and GBR.

1.08 QUALIFICATIONS

- A. The onsite Foreman or Superintendent for shaft construction shall have successfully completed at least two (2) similar jobs within the last five (5) years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- B. The Shaft Support Designer shall have successfully designed at least two (2) similar jobs within the last five (5) years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- C. All personnel employed by the Contractor in the work shall be experienced and competent in their respective tasks and shall work only under the direct control of a suitably experienced supervisor.
- D. Shaft Support Designer shall be a Registered Colorado Professional Engineer with qualifications as listed under Section 1.08.

1.09 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity.
 - 1. Shaft Work Plan including:
 - a. Description and shop drawings of the shafts, components of the shaft, and shaft excavation.
 - b. Details of proposed methods and procedures for excavating shafts.
 - c. Proposed shaft size and shape.
 - d. Layout and proposed location(s) of shaft and tunnel support equipment.
 - 2. Shaft Support including:
 - a. Descriptions and shop drawings describing and illustrating the type of Shaft Support System proposed, methods of installation, and equipment proposed to install the support.
 - 3. For Shafts greater than 20 feet in depth, provide Shaft support design calculations including loads, methods, assumptions, results, and safety factors. Shaft support shall consider support around the openings where the tunnel will exit the launch shaft and enter the receiving shaft. Calculations shall be signed and stamped by the Shaft Support Designer.

4. As necessary, Thrust Block design as part of the shaft to withstand applied Casing Pipe installation loads. The design shall include loads, methods, assumptions, results, and safety factors.
 - a. Thrust Block designer shall be a Registered Colorado Professional Engineer with at least five years of experience with the design of tunnels and shafts.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 1. Written Daily Logs. The Daily Logs shall have field logs submitted to the Engineer. As a minimum, the logs shall include:
 - a. The depth of excavation at each shaft.
 - b. The number of people on the crew.
 - c. Method of excavation.
 - d. Shaft support installed.
 - e. Description of the soils encountered, position of different soils layers, estimated groundwater inflow rates and depths, and description of ground behavior.
 - f. Any unusual conditions, breakdowns, and delays.
- C. Postconstruction Submittals:
 1. Record of what shaft support elements remain in the ground with location and top elevation.
 2. Written Daily Logs shall be provided for Shafts prior to initiating tunnel construction.

PART 2 - EQUIPMENT, PRODUCTS, AND MATERIALS

2.01 EQUIPMENT

- A. Excavation Equipment. The Contractor will determine the equipment used to excavate the shafts.
- B. Ancillary Equipment. The Contractor will determine the equipment used for all ancillary work including but not limited to spoil removal, materials transfer, and tunneling utilities.

2.02 MATERIALS

- A. Contractor will determine the type and design the shaft temporary support.

PART 3 - EXECUTION

3.01 GENERAL EXECUTION

- A. The Contractor will determine the shaft and excavation sizes and shapes subject to easement, utility, and property limitations.
- B. Perform excavations in a manner that will limit loss of ground and limit settlement of the ground surface, structures, and utilities above and adjacent to the shafts.
- C. Designate an OSHA Competent Person and identify and adhere to all relevant OSHA regulations.

3.02 EXCAVATION SUPPORT SYSTEMS

- A. Design and construct shafts to withstand all imposed loads, including at a minimum, ground conditions identified in the GBR, dynamic loads from equipment, applicable live loading conditions, and surcharge loads from materials.
- B. Grade ground surface in the vicinity of shafts to prevent surface water from entering the excavation.

3.03 RESTORATION

- A. All structures and utilities modified or moved shall be restored to the original condition or as determined by the Engineer.

3.04 ABANDONMENT

- A. Backfill around pipes and manholes inside shafts to the spring line of the pipe with flowable fill and pipe bedding in accordance with the Construction Drawings. Backfill shafts above spring line in lifts with approved materials in accordance with 02300 Earthwork.
- B. Backfill shafts and excavations with specified and approved materials and methods in accordance with Project Specifications.
- C. Remove all structural elements within five feet of the ground surface that are used for support of shafts and excavations. Any materials left in the ground shall be approved by the Engineer and surveyed and documented on the Record Drawings.

END OF SECTION

SECTION 02450

CARRIER PIPE INSTALLATION AND BACKFILL

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers requirements for installation of the Carrier Pipe in the tunnel and backfilling the annulus between the Carrier Pipe and Initial Support with Backfill Grout.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

1.02 RELATED WORK

- A. Related Documents and Specification Sections include but are not necessarily limited to:
 - 1. 02411 – Tunnel Excavation and Initial Support
 - 2. 02430 – Contact Grout
 - 3. 02444 – Construction Shafts
 - 4. 02470 – Geotechnical Instrumentation and Monitoring
 - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 6. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. **BULKHEAD:** Material placed between the Carrier Pipe and the Initial Support used to contain the Backfill Grout during placement. Bulkheads are typically required at both ends of a tunnel and may also be located at intermediate locations within a tunnel to contain the Backfill Grout in the annular space between the Carrier Pipe and Initial Support.
- B. **BACKFILL:** Filling of the annular space between the Carrier Pipe and Initial Support.
- C. **BACKFILL GROUT:** Flowable material to be used in the Backfill operations; can be Cellular Grout or Flyash Grout.
- D. **CELLULAR GROUT:** A low density, lightweight, cementitious material that contains stable air or gas cells as preformed foam uniformly distributed throughout the mixture.
- E. **CONTACT GROUTING:** As defined in Section 02430 – Contact Grout.

- F. FLYASH GROUT: A self-leveling and self-compacting, cementitious material using pozzolanic flyash as the primary cementitious material.
- G. See Section 02411– Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS

- A. ASTM C495 – Standard Test Method for compressive strength of lightweight insulating concrete.
- B. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- C. ASTM C796 – Standard Test Method for foaming agents for use in producing Cellular Grout using preformed foam.
- D. ASTM C869 – Standard Specification for foaming agents used in making preformed foam for Cellular Grout.
- E. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
- F. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders
- G. ASTM D5971 – Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
- H. ASTM D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material
- I. ASTM D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material

1.05 GENERAL REQUIREMENTS

- A. Contractor shall be responsible for design, construction, and execution of the carrier pipe installation and pipe backfill.
- B. Minimum design requirements are presented herein. It is the Contractor's responsibility to develop and implement the design to fulfill the specified design requirements determined by the Contractor which are necessary for completion of the work.
- C. Requirements
 - 1. Install Carrier Pipe without damage and to the grades shown and specified.
 - 2. Restrain Carrier Pipe from movement due to buoyant and other forces during Backfill Grouting.
 - 3. Backfill annulus outside Carrier Pipe fully with Backfill Grout.

4. Introduce Backfill Grout into the annulus outside the Carrier Pipe using grout lines (slick lines) secured to the Carrier Pipe or Initial Support or directly from the shafts. Grout ports through the Carrier Pipe are not allowed.
 5. Introduce Backfill Grout in tunnels at a spacing of not greater than 1/3 the total tunnel length through the use of slicklines, or other approved method(s).
 6. Provide testing of materials and verification of material properties as required herein.
 7. Notification.
 - a. Provide the Owner's Representative with a schedule of Carrier Pipe installation and Backfill Grouting activities at least three (3) weeks before beginning pipe installation, and update weekly.
 - b. Notify the Owner's Representative at least one working day in advance of schedule changes.
- D. Pipe Installation Methods
1. Install Carrier Pipe in the tunnel either incrementally or by jacking or pulling a pre-assembled pipe string as determined by the Contractor.
 2. Utilize casing spacers or other approved blocking method on the Carrier Pipe to prevent pipe movement.
 3. Utilize the manufactures (Hobas) recommended joint restraint methods or devices to prevent pull-out or over-assembling of Carrier Pipe joints.

1.06 QUALIFICATIONS

- A. The Contractor will be experienced in the installation of pipe in tunnels and backfilling annular spaces using methods, materials, and equipment comparable to this project.
- B. Designate Installation and Backfill Grouting Experts. The Installation and Backfill Grouting Experts may be the same person. The Experts will have the a minimum of the following experienced:
1. Be thoroughly knowledgeable about the transportation, placement, and securement of prefabricated pipe in tunnels.
 2. Successfully have completed at least two (2) similar projects in which the pipe was placed in the Initial Support using the same methods as proposed for this project.
 3. Successfully have completed at least two (2) similar projects in which the pipe annulus in a tunnel was backfilled with Flyash Grout or Cellular Grout as applicable.
 4. Be thoroughly knowledgeable about mixing, pumping and placement of Backfill Grout, including Flyash Grout or Cellular Grout as applicable, in tunnels.

1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. Preconstruction submittals detailed below shall be submitted for approval as a single package.
1. Qualifications of pipe Installation and Backfill Grouting Experts (may be the same person).
 2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for installation of the Carrier Pipe in the tunnel. The submittal will address, as a minimum, pipe:
 - a. Transportation,
 - b. Section joining,
 - c. Line and grade surveying, and
 - d. Line and grade control.
 3. Methods, procedures, and equipment for monitoring, controlling, and adjusting the alignment of the Carrier Pipe in the tunnel prior to Backfill Grouting.
 4. Descriptions, Shop Drawings, and calculations for securing the pipe during Backfill Grouting. Submit calculations which evaluate:
 - a. Theoretical annulus volume for actual Initial Support ID and Carrier Pipe OD with adjustments for bells and spacers.
 - b. Buoyant force(s) generated during backfilling of each stage.
 - c. Loads and deflection of tiedowns, bracing, and spacers.
 - d. Bearing stresses on the pipe and the tunnel walls from the tiedowns or braces.
 - e. Bending stresses on the pipe between tiedowns or braces.
 - f. Maximum allowable backfill injection and head pressure (if a pump is used)
 - g. The calculations shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
 5. Description of equipment and methods proposed to mix Backfill Grout including:
 - a. Mix design and results of preconstruction tests for the Backfill Grout. Results of tests on trial batches conducted as part of grout mix design and pre-grouting verification testing.
 - b. Mixing equipment
 - c. Quantity controls
 - d. Instrumentation
 - e. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of Backfill Grout in the tunnel.
 6. Description of injection methods for Backfill Grout including:
 - a. Pumping equipment
 - b. Delivery equipment (hoses, valves)
 - c. Pumping distances and delivery points
 - d. Flow rates
 - e. Pressures
 - f. Bulkhead details
 - g. Proposed orientation of all grout and ventilation pipes.

- h. Methods and description of instrumentation to monitor and control placement of the backfill, and procedures to be used to verify backfill volumes.
 - i. Method and procedures to handle excessive flowing water if criteria in Section 3.07.L herein, are met.
 - 7. Pipe manufacturer certification letter stating that the proposed backfill materials and methods are acceptable for the carrier pipe type.
 - 8. Trial batch results demonstrating the same mix design that includes:
 - a. Date of mix performed and reported
 - b. Mix number
 - c. Materials
 - d. Sources
 - e. Physical properties
 - f. Compressive strength results
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 - 1. Survey results. Surveys will be conducted and submitted as specified herein.
 - 2. Daily Field Reports.
 - 3. Field installation logs having as a minimum, stations and length of Carrier Pipe installed and volume of Backfill Grout delivered; Submit logs daily. Provide copies of reports as required by public authorities to the Engineer within 24 hours following preparation and submittal to third party authority. These reports are for record purposes only.
- C. Postconstruction Submittals:
 - 1. Survey of the line and grade of the Carrier Pipe in the tunnel.
 - 2. Compressive strength results of Backfill Grout.

PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

2.01 MATERIALS

- A. Carrier Pipe: as shown on the Contract Drawings and as specified in the Contract Documents.
- B. Backfill Grout will have the following properties:
 - 1. Flowable through delivery lines and in tunnel annulus
 - 2. Have a heat of hydration that will not weaken or otherwise harm pipe materials.
 - 3. Viscosity is to be low enough to allow grout to completely fill all voids in the annulus between the Carrier Pipe and the Casing Pipe.
 - a. Efflux time through a Flow Cone per ASTM C 939 will be no greater than 22 seconds.

4. Minimum 28-day compressive strength of 300 psi. Test in accordance with ASTM C 495.
 5. Minimum wet density of 45 pcf unless water is present in the tunnel at which point a minimum wet density of 65 pcf is required, or per the direction of the Engineer.
 6. Additives may be used only with review per approval of the Engineer.
 7. Non-shrink mix.
 8. Grout will be a mix of potable water and cement and/or flyash or foamed Cellular Grout. No aggregates are allowed.
 - a. Cellular Grout:
 - 1) Cement: Portland Type I/II.
 - 2) Foaming agent for Cellular Grout: in accordance with ASTM C 869.
 - a) Test in accordance with ASTM C 796.
 - b. Flyash Grout:
 - 1) Flyash Grout is to composed of:
 - a) Type C Flyash, water, and a set retarder, or
 - b) Type F Flyash, cement, water, and a set retarder. Cement to Flyash ratio is not be greater than 0.25:1 by weight.
- C. Pipe Securement: secure pipe using prefabricated spacers or other approved bracing.
1. Spacers:
 - a. Specifically designed for placing Carrier Pipe in tunnels and as skids for the pipe to ride on during installation.
 - b. Variable in size or adjustable to place the position of the Carrier Pipe taking into account variations of the tunnel and Initial Support.
 - c. Design to have sufficient contact points with the Carrier Pipe and the tunnel Initial Support to resist damage/deformation to carrier from buoyancy caused by Backfill Grouting.
 2. Bracing: wood, steel, or other system that is rigid under the imposed loads and does not damage the Carrier Pipe.
- D. Bulkhead Closure:
1. Provide Bulkheads at the ends of the pipe to prevent spillout of the Backfill Grout and not damage or degrade the Initial Support or Carrier Pipe during installation or over the life of the structure.
 2. Provide venting at the crown of the annulus between Carrier Pipe and Initial Support at the highest elevation to ensure the tunnel is fully evacuated of water/air and filled with grout.
 3. Brick and mortar, concrete, or Engineer approved equivalent will be used for the Bulkhead.

PART 3 EXECUTION

3.01 GENERAL

- A. The Carrier Pipe is to be internal braced, if necessary, to protect the pipe and control deflections including out-of-round distortions during transportation, handling, and installation.
- B. Pipe installation and Backfill Grouting is to be conducted under the direct supervision of the Installation and Backfill Grouting Expert(s).

3.02 PREPARATION

- A. Do not commence with pipe installation until the tunnel is prepared for pipe installation in accordance with the following requirements:
 - 1. The tunnel excavation has been stabilized and Contact Grouting has been completed outside the Initial Support as specified in Section 02430 – Contact Grout.
 - 2. The alignment of the tunnel has been surveyed and has been verified to allow for installation of the Carrier Pipe to the specified tolerances and clearances.
 - 3. The tunnel has been cleaned as specified herein.

3.03 SURVEYS

- A. Surveys are to be at intervals not exceeding 20 ft and will be for both line and grade to an accuracy of 0.01 ft or better.
- B. Conduct the following surveys:
 - 1. Completed tunnel Initial Support prior to installation of the Carrier Pipe.
 - 2. Carrier Pipe invert prior to Backfill Grouting.
 - 3. Carrier Pipe invert after Backfill Grouting.

3.04 QUALITY CONTROL

- A. Test methods are to be in accordance with ASTM C 495.
 - 1. Cast the specimens into cylinders at least 3 inches in diameter and 6 inches tall.
 - 2. Separate and remove the specimens for testing by cutting and trimming the forming material surrounding the cylinders.
- B. Backfill Grout Mix Design:
 - 1. Two sets of compression test specimens will be made.
 - 2. Test one set of specimens at an age of 7 days and the other set at an age of 28 days.
 - 3. Test mix for unit weight at the time of cylinder casting.

- C. Index Testing of Backfill Grout:
 - 1. Conduct set of index tests from the first batch of Backfill Grout mixed each day, after a change in mix design, and from each batch of Backfill Grout from which compression test specimens are made.
 - 2. Conduct index tests a maximum of every two hours from each batch to verify the grout properties.
 - 3. Include as a minimum the following index tests at the time of placement:
 - a. Wet unit weight (wet density)
 - b. Ambient temperature
 - c. Grout temperature
 - d. Efflux time through Flow Cone
- D. Compression Testing of Backfill Grout:
 - 1. Make a minimum of one set of 5 specimens each day when up to 25 cubic yards of Backfill Grout is placed.
 - 2. Make at least one additional set of specimens from each additional 50 cubic yards, or major fraction thereof, placed in any one day, but no more than three sets of specimens for each day.
 - 3. Test two specimens of each set at an age of 7 days and 2 specimens at an age of 28 days.
 - a. Hold one specimen in storage.

3.05 TOLERANCES AND CLEARANCES

- A. The Carrier Pipe is to be installed to the line and grade specified in the Technical Specifications and Drawings.
- B. The Carrier Pipe will have a clearance of at least 3 inches between the outside of the pipe and the closest point of the Initial Support system in all directions.
- C. Changes in Carrier Pipe alignment and grade will be made gradually such that pipe joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. Reverse grades will not be allowed.
- E. If the Carrier Pipe is off line and/or grade by more than the specified tolerances, the Contractor will make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- F. If the Carrier Pipe is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor will be responsible for all redesign costs.

3.06 INSTALLATION METHODS

- A. Install the pipe into the tunnels by sliding an assembled pipe string into the tunnels by jacking or pulling, or both. Alternatively, individual sections of pipe may be carried into the tunnel and mated in place.
- B. Complete each joint by mating per the manufacturer's requirements and the Contract Documents.
- C. Adjust the position of the Carrier Pipe within the spacers as necessary to achieve proper line and grade when the pipe is at the final position.
- D. Securing: Ensure that the pipe and each pipe segment is firmly secured to prevent flotation, settlement, lateral and axial movement, and pipe deflection during Backfill Grouting.

3.07 BACKFILLING METHODS

- A. Before placement of Backfill Grout in the tunnel, demonstrate, using trial mixes of the same design as those proposed for use and the same equipment proposed for placement, the ability to produce Backfill Grout of the required density and strength. Demonstrate the ability to pump the Backfill Grout mix the distances proposed without loss of Backfill Grout quality; may be based on previous projects.
- B. Completely backfill the annulus between the Carrier Pipe and the Casing Pipe with Backfill Grout. Placement methods will facilitate complete filling of the spaces below the Carrier Pipe and around the Carrier Pipe support system components.
- C. Place Backfill Grout in multiple lifts to prevent pipe flotation unless stiffeners or pipe supports, and closely spaced blocking of sufficient structural rigidity are provided to prevent pipe flotation, movement, or damage to the pipe. Lift thickness required to prevent flotation and damage to the pipe will be determined by the Contractor as represented in the required submittal calculations.
- D. Do not subject the Backfill grout to free fall greater than 10 feet.
- E. The pressure of the backfill against the Carrier Pipe must not exceed manufacturer limitations at any time and at any location.
- F. If the grout is to be pumped, create a pressure break between the pump and the injection point to prevent grout being pumped directly into the liquid grout pool inside the tunnel annulus.
- G. The Contractor may elect to inject Backfill Grout into the tunnel at the shaft(s) or from within the tunnel depending on the pipe installation method. Spacing of discharge points is specified in Section 1.05 to assure continuity between discharge points.
- H. Backfill grout is to be injected from the top of the shafts or pumped from the base of the shaft.
 - 1. Vertical drop holes along the tunnel length will not allowed.

- I. If the complete filling of the annulus and voids is not verified during backfilling, conduct a secondary grouting program to fill the remaining annulus and voids.
- J. Maintain a supply of swabs and compressed air at the tunnel at the location of the backfilling operations or the bulkhead as appropriate to facilitate cleaning of injection lines or outlets as necessary.
- K. To prevent contamination of the Backfill Grout, do not introduce water into the tunnel through injection lines.
- L. Flowing Water
 - 1. If water is inflowing from the ground into the tunnel at a rate greater than one gallon per minute at any location, it must be directed to the invert and controlled in a manner that prevents backfill grout washout.
 - 2. Develop a plan to direct water using panning, drain pipes, drain rock, etc. prior to grouting.
 - 3. Fill drain pipes, drain rock, etc with grout once the primary annulus backfill grouting is complete.

3.08 CONSTRUCTION RECORDS

- A. The Contractor shall maintain Daily Field Reports for pipe installation and annular sealing. The Field Reports shall be signed by the site superintendent or shift foreman and shall contain the following:
 - 1. Crews and subcontractors onsite with their personnel and equipment, and the work performed. The reports shall be broken down into work time and down/standby time for each crew and subcontractor;
 - 2. Record of pipe installed;
 - 3. Pipe joining reports;
 - 4. Record of annular sealing materials, and configuration of the seals;
 - 5. Quantity of Backfill installed;
 - 6. Materials testing agency including index testing and specimens;
 - 7. Problems or unusual conditions encountered and actions taken to address these situations.

END OF SECTION

SECTION 02470

GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section presents requirements for installation, monitoring, and removal of instrumentation for monitoring of ground movements before, during, and after tunnel construction.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

1.02 RELATED WORK

- A. Related Specification Sections include but are not limited to:
 - 1. 02411 – Bore and Jack
 - 2. 02444 – Construction Shafts
 - 3. 02550 – Cast-In-Place-Pipe Liner
 - 4. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 5. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- B. INSTRUMENT SPECIALIST: Party responsible for the installation, maintenance, and monitoring instrumentation.
- C. INSTRUMENTATION SURVEYOR: Party responsible for performing survey and establishing baseline readings for surface survey points, monitoring point arrays, and utility monitoring points.
- D. MONITORING POINT: General terminology referencing a Surface Survey Point and/or Utility Monitoring Point.
- E. MONITORING POINT ARRAY: A series of Surface Survey Points arranged in a row to monitor surface movement.
- F. RESPONSE VALUES: Recorded differential movement at which point a necessary change to the construction means and methods needs to be implemented to prevent damage to overlying or adjacent existing road surfaces or utilities.
- G. SURFACE SURVEY POINT: Monitoring locations at which the roadway and or rail lines will be monitored for horizontal and vertical movement during tunnel and shaft construction.
- H. PAVEMENT OR SIDEWALK SURVEY POINT: Monitoring locations at which the roadway will be monitored for horizontal and vertical movement during tunnel and shaft construction. Referred to as Surface Survey Point throughout.

- I. UTILITY MONITORING POINT: Location at which utilities will be monitored for vertical movement during tunnel and shaft construction.
- J. See Related Specification Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

1.04 GENERAL

- A. The Contractor shall monitor, at a minimum, all locations noted on the Geotechnical Instrumentation and Monitoring sheets of the Contract Drawings for movement during and after tunnel construction.
- B. Minimum requirements are presented herein. It is the Contractor's responsibility to implement the monitoring plan as specified herein or as necessary to ensure the safe completion of the work and prevent damage to existing infrastructure.

1.05 REQUIREMENTS

- A. Minimum instrumentation and monitoring requirements are presented herein.
- B. Designate an Instrumentation Specialist to oversee installation and monitoring of instrumentation. The Instrumentation Specialist will develop the instrumentation plan then supervise and be responsible for the instrument installation, maintenance, and monitoring. As built and baseline surveys associated with the instrumentation shall be under the direction of and reviewed by the Instrumentation Surveyor.
- C. Positively identify all utilities within the project location.
- D. Obtain applicable permits from Governing Agencies and utility owners to perform instrumentation and monitoring work.
- E. Remove or abandon in place all instrumentation in accordance with applicable laws, regulations, and guidelines following completion of construction.
- F. As a minimum install all instrumentation as shown in the Contract Drawings and in accordance with this specification.

1.06 QUALIFICATIONS

- A. Instrumentation Specialist: The Instrumentation Specialist shall have experience working on tunneling projects where installation, maintenance and monitoring of geotechnical instrumentation similar to those specified herein are required. The Instrumentation Specialist will have had direct involvement in directing or installing instrumentation and monitoring and working with the Instrumentation Surveyor to monitor and collect survey data. The Instrumentation Specialist shall have served in a similar capacity on a minimum of two (2) tunnel projects in the previous five (5) years.
- B. Instrumentation Surveyor: The Instrumentation Surveyor shall be a licensed Professional Surveyor in the State of Colorado and shall have served in a similar capacity on a minimum of two (2) tunnel projects in the previous five (5) years

1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity:
 - 1. Qualification Documentation. Submit Instrumentation Specialist and Instrumentation Surveyor as stated in Section 1.06 Qualifications.
 - 2. Geotechnical instrumentation and monitoring work plan:
 - a. Description of methods and materials for installing and protecting instruments and monitoring points.
 - b. Submit all applicable Manufacturer literature describing operation and maintenance of survey and monitoring equipment. Provide Manufacturer brochures, product descriptions and drawings of all equipment. Manufacturer literature should indicate the equipment to be used can perform to the specified accuracy and observation frequency stated in Sections 3.05 and 3.06 specified herein. A certificate issued by the instruments Manufacturer stating that the Manufacturer has inspected, calibrated, and tested each instrument before it leaves the factory is to be included.
 - c. For all instruments installed in boreholes and potholes:
 - 1) Detailed step by step procedures for installation.
 - 2) Post installation acceptance test.
 - 3) Sample installation record sheet.
 - 3. Location of any monitoring points and instruments to be installed, highlighting any points and instruments that are not included in the contract drawings.
 - 4. Permits. List permits, third party approvals including but not limited to roadway, traffic control plans if within roadways, and approval contract submittals required to perform the work.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 - 1. Installation Records. Within five days of installation of each instrument and prior to the start of tunnel construction, submit documentation including:
 - a. The installed instrument location, instrument identification number, instrument type, installation date, initial baseline elevations and coordinates, and offset and stationing to alignment.
 - b. Furnish details of installed instruments showing all dimensions and materials used, a separate statement describing installation procedures for each instrument, and as-built drawings of each instrument including lengths, elevations, and dimensions.
 - 2. Data. Provide results of initial baseline readings within 2 days of measurement. Provide initial monitoring results to the Engineer verbally immediately following measurement. Monitoring measurements shall then be provided to the Engineer in writing within 1 day of measurement.

PART 2 - EQUIPMENT, PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Surface Survey and Utility Monitoring Points shall be flush or countersunk with the ground or roadway surface in areas where the instrument may be damaged or be an impediment to other activities.

- B. On-Rail Optical Survey Targets shall be mounted by the Instrumentation Specialist to either the railroad ties or rails in accordance with the Governing Agency of the railroad. These targets are to be mounted in a way such as to provide for accurate reading while not interfering with Railroad operations.

2.02 PRODUCTS

- A. Surface Survey Points: Surface survey points indicated on the drawings installed in pavement are to consist of one PK nail. Each Surface Survey Point is to be tagged or marked to indicate the identification number, tunnel station and offset from centerline.
 - 1. PK nails installed in pavement are to be nails that are driven or drilled and grouted into the pavement.
- B. Utility Monitoring Points: Each utility monitoring point shall consist of a pipe casing that exposes the utility and retains the ground to allow for multiple readings throughout the work
 - 1. Utility Monitoring Points may be a Geo Instruments Utility Monitoring Point or approved equivalent and installed as shown on the contract drawings and per Manufacturer's recommendations.
 - 2. Utility Monitoring Points may be monitored using an AMTS or a displacement sensor that automatically transmits measurements to a gateway via wireless logger.
 - 3. Utility Monitoring Points can consist of a survey rod placed on the utility for each reading or approved equivalent and installed as shown on the contract drawings and per Manufacturer's recommendations
- C. Survey Equipment: The selected survey equipment shall have an accuracy of 0.01 feet.

PART 3 - EXECUTION

3.01 GENERAL

- A. Installation. Instrumentation shall be installed at the locations shown on the Contract Drawings or as directed or approved by the Engineer. All instrumentation shall be installed, and the initial readings recorded a minimum of 2 weeks prior to the start of tunnel construction, as described in section 3.05.
- B. Access. Provide and facilitate safe access to the instrumentation for the Instrumentation Surveyor and Engineer.
- C. Existing Conditions. Locate conduits and underground utilities in all areas where utility monitoring points are to be installed.
- D. Identification. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public.
- E. Instrument Designation. A unique instrument identification number shall be assigned to each survey point. The instrument identification number shall be clearly marked on each instrument.
- F. Surveying. Following installation, the location of the top of all survey points shall be surveyed to provide baseline horizontal and vertical coordinates. Data shall be

provided to the Engineer. Re-surveying from control points shall be required monthly or more frequently to address potential disturbance or resolve conflicting data as directed by the Engineer.

3.02 QUALITY CONTROL

- A. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the strictest or most restrictive applicable requirements.
- B. Installation:
 - 1. Written notice shall be provided to the Engineer at least 24 hours before installing monitoring instrumentation.
 - 2. Should actual field conditions prevent installation of instruments at the location and elevations shown on the Contract Drawings or specified herein, obtain prior acceptance from the Engineer for new instrument location and elevation.

3.03 SAFETY REQUIREMENTS

- A. Methods of installing the instrumentation are to be such as to ensure the safety of the work, project participants, the public, third parties, and adjacent property, whether public or private.
- B. Safe access to instrumentation is to be maintained for the Instrumentation Surveyor and Engineer at all times as necessary to satisfy the monitoring requirements specified herein.

3.04 INSTALLATION

- A. Surface Survey Points: Install surface Survey Points at locations as shown on the Contract Drawings or as approved or directed by the Engineer. Monitor surface survey points for movement in the x, y, and z directions for each reading.
- B. Utility Monitoring Points:
 - 1. Utility Monitoring Points shall be installed per manufacture recommendation or as shown on the Contract Drawings.
 - 2. The Instrument Specialist shall be responsible for any damage to the utility during installation of the Utility Monitoring Points and shall replace or repair as necessary to facilitate monitoring.
 - 3. Use one of two options to measure the elevation of each utility
 - a. A rod shall be lowered into the hole until it rests on the utility. Place centralizers around the rod to prevent it from moving in the hole. Take survey readings from the top of the rod.
 - b. Temporarily lower a survey rod down the pipe casing until it rests on the utility. Take survey readings from the rod.
 - 4. Monitor utility monitoring points for movement in the z direction only for each reading.
- C. After completion of installation, as-built location of all instruments and monitoring points shall be determined and provided to the Engineer. Horizontal positions shall be determined to an accuracy of ± 0.01 ft and the elevations to an accuracy of ± 0.01 ft.

3.05 MONITORING

- A. Initial Readings: The Contractor shall take initial readings of all instruments to establish a baseline and provide the Engineer with this data a minimum of 2 weeks prior to the start of tunnel construction.
- B. Frequency:
1. The Contractor shall provide the Engineer with these data within 1 working day of data collection.
 2. At a minimum, the Contractor shall maintain the following reading schedule:

Instrument Type	Instrument Reading Schedule		After Tunneling Completion ^(b)
	During Shaft Construction	During Tunneling ^(a)	
Surface Monitoring Points	Twice Weekly	Once Daily	Weekly
Utility Monitoring Points	Twice Weekly	Once Daily	Weekly

Notes:

- (a) Daily readings must be taken around the same time each day and no more than 4 hours apart, i.e. between 8 am and 12 pm for each reading.
 - (b) Weekly measurements shall occur until movement between successive measurements is negligible as determined by the Engineer and monthly thereafter until the Tunnel Contractor demobilizes from the site. A minimum of two weekly readings shall be recorded after tunneling completion.
3. Perform additional monitoring as necessary to control construction and to ensure safe work completion. Closer interval readings shall be taken during periods of high precipitation or as instructed by the Engineer.
- C. Reporting: Provide final data from readings of all monitoring locations to the Engineer within 1 working day of the recorded measurements. When available, copies of field instrumentation data shall be provided verbally to the Engineer immediately after the data are collected in the field. The data shall include, but are not limited to, the following:
1. A copy of the data sheets containing a cumulative history of readings and proximity of tunnel excavation to the instrument location at the time of each reading.
 2. A copy of the plot of measured values versus time, including a time history of construction activity likely to influence such readings if readings begin to approach Response Values, as determined by the Engineer.
- D. Interpretation: The Contractor shall provide interpretations of monitoring data and submit them to the Engineer along with the data. Data or interpretations shall not be published or disclosed to other parties without advance written permission of the Owner or Engineer. The Engineer may make his/her interpretations of the data available to the Contractor.

3.06 RESPONSE VALUES:

A. Abide by the following response values:

Instrument Type	Response Values	
	Threshold Value	Shutdown Value
Surface Monitoring Points	0.01 feet in Z 0.2 feet in any of X or Y	0.02 feet in Z 0.4 feet in any of X or Y
Utility Monitoring Points	0.04 feet in Z	0.08 feet in Z

B. When a given response value is reached, respond in accordance with the following:

1. Threshold Value: Notify the Engineer immediately. Meet with the Engineer and Owner to: 1) review interpretation of the data and results, 2) review the construction means and methods, and 3) determine what changes, if any, shall be made to better control movement.
2. Shutdown Value: Notify the Engineer immediately. Safely secure the tunnel taking all measures to prevent further settlement, completely close all openings at the excavation face, and stop all work inside the tunnel immediately upon closing the face and meet with the Engineer and Owner and notify affected parties including Governing Agencies and other property Owner(s) to develop a plan of action before work is resumed. Work inside the tunnel can continue if a plan of action is agreed upon by all affected parties and if substantial risk to monitored facilities is determined to not increase with further construction activity.

3.07 MAINTENANCE

- A. Damaged Instruments: Protect the instruments from damage. Damaged installations shall be replaced or repaired by the Instrument Specialist and approved by the Engineer prior to continuing construction at the Instrument Specialist expense. Provide new baseline readings if instruments are substantially damaged by as determined by the Engineer.
- B. Maintenance: Maintain survey monitoring locations by ensuring survey point identification tags or nomenclature is legible.

3.08 FINAL DISPOSITION

- A. Surface Survey Points. Remove all Surface Survey Points in accordance with applicable laws, regulations, and guidelines.
- B. Utility Monitoring Points. Remove all Utility Monitoring Point materials. Utility Monitoring Point locations shall match the previous conditions prior to Utility Monitoring Point installation.

END OF SECTION

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SECTION 02510

WATER SYSTEM PIPING AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Furnish and install all piping, including fittings, valves, and accessories as shown on the Drawings, described in the Specifications and as required to completely interconnect all piping for a complete and operable systems.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. American Association of State Highway and Transportation Officials (AASHTO)
- C. American National Standards Institute (ANSI)
- D. American Society of Mechanical Engineers (ASME)
- E. ASTM International (ASTM)
- F. American Water Works Association (AWWA)
- G. NSF/ANSI Standard 61 Drinking Water System Components (NSF 61)
- H. NSF/ANSI Standard 600 Drinking Water System Components (NSF 600)

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
 - 1. Layouts and schematics: Submit detailed installation drawings of all piping and connected equipment. The drawings shall include each pipe, all fittings, valves, and other appurtenances.
 - 2. Submit data to show that the following items conform to the Specification requirements:
 - a. Pipe, fittings, and accessories.
 - b. Restrained joints.
 - c. Valves.
 - d. Linings and coatings, as applicable
 - 3. All items that are submitted for use on potable water or reclaimed water pipelines including, but not limited to, piping and valve linings, solvent cements, welding materials, gaskets and gasket lubricants, and additives in concrete or cement mortar shall be NSF certified for use in water systems. Submit proof of NSF certification for each item submitted including updated NSF 600 requirements, as applicable, effective as of January 1st, 2023.
- C. Manuals: The Contractor shall furnish manufacturer's installation and operation manuals, bulletins, and spare parts lists for the following items:
 - 1. All valves over 4-inch size.
- D. Affidavits: Submit affidavits from the manufacturer of the following valves:
 - 1. Gate valves.

- E. Certified testing results for pipeline pressure and bacteriological tests, see Section 02516.
- F. The preceding submittals shall be in the Product Information Category except where noted.

1.04 QUALITY ASSURANCE

- A. All materials and equipment furnished under this Section shall: (1) be of a manufacturer who has been regularly engaged in the design and manufacture of the materials and equipment for at least 5 years; and (2) be demonstrated to the satisfaction of the Engineer that the quality is equal to the materials and equipment made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.
- B. Factory Quality Control: The Contractor shall test all products as noted herein and by the reference specifications.

1.05 POTHOLING

- A. Do not prepare any shop drawings for, or make final order for, or design any pipe materials for any particular section of pipeline until all utilities in that section of pipeline have been exposed, as specified in Section 02300 and until such time as no interferences are found between said existing utilities and the proposed pipeline alignment. If interferences are found in any particular section of pipeline, notify the Engineer so that a solution for avoiding the conflict can be identified prior to the ordering of materials.

1.06 CONSTRUCTION SCHEDULING/SEQUENCING

- A. Construction under this Contract involves modification of the existing potable water system which must continue to provide water service during construction.
- B. Connections and utilities changes must be programmed to provide the least possible interruptions of service. Prior to any shutdown, all materials, fittings, supports, equipment, and tools shall be on the site and all necessary labor scheduled prior to starting any connection work. The Contractor shall notify the water service customers at least 48 hours in advance of any required shutdowns. All temporary piping shall be disinfected in accordance with Section 02516 before being put into service.
- C. All work under this Contract shall be conducted in a manner which will minimize shutdowns, open roadways, or traffic obstructions caused by the construction. Shutdowns causing damage to adjacent public and private property shall not be permitted, and any damage resulting shall be the sole responsibility of the Contractor.
- D. Planned utility service shutdowns shall be accomplished during periods of minimum use. The Contractor shall program his or her work so that service will be restored in the minimum possible time and shall cooperate with the Owner in reducing shutdowns of the utility system to a minimum.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials provided for a complete potable water system shall meet the requirements of these specifications and Section 400 of the Arvada Code of Engineering Standards and Specifications, whichever is more stringent.
- B. Pipe and valve sizes are nominal inside diameter unless otherwise noted.
- C. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.
- D. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and leakage and bacteriological tests as specified in Section 02516.
- E. Bolts: Unless specified otherwise herein, flange bolts and nuts, coupling bolts and nuts, and other hardware shall be as follows:
 - 1. Buried: Type 304 stainless steel, minimum tensile strength: 60,000 psi.
 - 2. Apply an anti-gauling compound to the threads of stainless steel bolts.

2.02 PIPING MATERIALS

- A. See the Pipe Schedule on the Drawings for general piping requirements and material designations.
- B. Pipe Systems: Each designation identifies not only the pipe itself, but the entire system as well as including the associated fittings, appurtenances, and installation and test procedures.
- C. Copper Pipe:
 - 1. Pipe: Copper, ASTM B88
 - a. Buried: Type K (soft drawn).
 - 2. Service Line Transition Fittings
 - a. Manufacturer: Mueller Flared fitting, Ford flared fitting, Mueller #110 compression fitting, Ford Quick Joint or equal
- D. Polyvinyl Chloride Pipe:
 - 1. Pipe: Polyvinyl chloride pressure pipe, cast-iron pipe outside dimensions. Pipe shall be UL listed or Factory Mutual Approved.
 - a. 4-inch through 12-inch: AWWA C909
 - 2. Minimum Pressure Class: 235 psi
 - 3. Fittings:
 - a. Distribution and transmission line fittings for PVC shall be ductile iron and in accordance with AWWA C153 and AWWA C110. Fittings shall have a three-hundred fifty (350) psi pressure rating. Fittings shall be coated both internally and externally with fusion bonded epoxy in accordance with AWWA C116. The fittings shall be furnished with mechanical joint ends in accordance with AWWA C111 and, in addition, the tee-head bolts and hexagon nuts shall conform to ASTM F3125, Grade A325 Type 3 and be fabricated from "Cor-Blue", a high strength, low alloy steel. 4" through 12" diameter fittings may also be ductile iron One-Bolt type with integral restrained joints as manufactured by One-

- Bolt, Inc. All metallic fittings shall be encased in polyethylene wrap per AWWA C105, regardless of soil conditions.
- b. T-Head Bolts and Nuts manufacturers shall be TriPac 2000, CoreBlue by NSS Industries, or Blue Bolt by Birmingham Fasteners, no equal.
 - a. All metallic fittings shall be coated per AWWA C116 and be encased in polyethylene wrap per AWWA C105, regardless of soil conditions.
4. Joints:
- a. Unrestrained joints: Bell and spigot, gasketed; or twin gasket coupling.
 - b. Restrained joints: Bell and spigot (push-on) gasketed, or mechanical joints; both using ductile-iron clamp-on restraining devices.
 - 1) Restrained joints are required at all valve, bends, and fittings with mechanical connections and dead ends at a minimum.
 - 2) Contractor shall identify all areas where restrained joints are required in the field and include as part of the product submittal package.
 - 3) Restraining devices: Ductile-iron with ductile-iron or cor-ten rods and bolts. Pressure rating a minimum of 150 psi. Series 2000PV by EBBA Iron; Uni-Flange Series 1500; or Star Pipe Product Stargrip Series 4000.
 - 4) Protection for buried restraining devices: Double-wrap with polyethylene encasement, AWWA C105 and tape the edges of the encasement with PVC tape. The polyethylene seams and overlaps shall be wrapped and held in place by means of two (2) inch wide plastic-backed adhesive tape. The tape shall have adhesive that shall bond securely to both metal surfaces and polyethylene film. Manufacturer shall be Polyken #900, Scotchrap #50, or approved equal.
5. Gaskets: SBR rubber.
- E. Corrosion Protection
- 1. When soil resistivity is less than 10,000 ohm-centimeters (OHM-CM), metallic pipe and fittings shall be protected against corrosion in accordance with Section 420.19 of the Arvada Code of Engineering Standards and Specifications.
 - a. Mechanical Joint Tees, Bends, Caps, Plugs and all other fittings shall be furnished from the manufacturer with cement mortar lining and coating system to match adjacent piping. T-head bolts and nuts shall be corrosion resistant. Any bare fittings or components shall be wrapped with a non-firming, wax based anti-corrosion wrap system. The wax wrap system shall be Trenton anti-corrosion materials or approved equal.
 - b. Mechanical Joint Restraint (Wedge action, self-actuating, such as Megalugs) for ductile iron pipe shall be furnished from the manufacturer with a bituminous or epoxy coating. Mechanical joint restraint for PVC pipe shall be furnished from the manufacturer with red primer coat. T-head bolts and nuts shall be corrosion resistant. Mechanical joint restraint shall be wrapped with a non-firming, wax based anti-corrosion wrap system. The wax wrap system shall be Trenton anti-corrosion materials or approved equal.
 - 2. The cathodic protection system shall be designed by a Colorado Licensed Professional Engineer, accredited by the National Association of Corrosion Engineers (NACE) as a Cathodic Protection Specialist (CP4). See Section

420.19 of the Arvada Code of Engineering Standards and Specifications for further detail.

3. Polyethylene encasement:
 - a. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C105/A21.5.
 - b. Polyethylene encasement shall be the V-Bio Enhanced Polywrap consisting of three layers of co-extruded linear, low-density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the fitting exterior shall be infused with a blend of antimicrobial compound to mitigate microbiologically infused corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
 - c. The raw materials used to manufacture polyethylene film shall be Type I, Class A, Grade E 1 in accordance with ASTM D1250.
- F. Mechanical Couplings:
 1. Mechanical couplings shall meet the requirements as outlined in Section 420.04 of the Arvada Code of Engineering Standards and Specifications.
 2. Sleeve: Cast-iron or fabricated steel.
 3. Followers: Cast-iron, ductile-iron, or steel.
 4. Sleeve bolts: Type 304 stainless steel
 5. Coating: Fusion epoxy line and coat sleeve and followers.
 6. Pressure rating: The test pressure of the applicable service or 150 psi, whichever is greater.
 7. Performance: Longitudinal movement and angular deflection capabilities shall meet AWWA C-219.
 8. Manufacturers:
 - a. Romac XR501
 - b. Viking Johnson MaxiFit
 - c. Viking Johnson MaxiStep
 - d. Powerseal PowerMax
 - e. Or approved equal
 9. Gaskets: SBR rubber.
 10. Joint restraint: Provide joint harnesses (attachment plate assemblies) across couplings. Design restraint in accordance with AWWA M-11 for 150 psi.
 11. Protection for buried connectors and adaptors: Polyethylene wrap encasement. See Section 2.02.E for requirements.

2.03 VALVES AND ACCESSORIES

- A. General Requirements for Valves:
 1. All valves of each type shall be the product of one manufacturer.
 2. All valves shall be furnished with control assembly, operators, and suitable type wrench including handles as specified herein or as shown on the Drawings.
 3. All threaded stem valves shall open by turning the valve stem counter-clockwise.
- B. Valves and Accessories:
 1. Gate Valves:
 - a. All gate valves shall open left (counter-clockwise). Gate valves in sizes four (4) inches to twelve (12) inches shall be of the ductile iron body, non-rising stem, open left, resilient seated type with an AWWA standard two (2) inch square operating nut, manufactured in accordance with

- AWWA C509 or AWWA C515. Class designation shall be compatible with the pipe class designated for the project. Valves shall comply with the requirements of NSF 61.
- b. Rating: 200 psi water
 - c. Type: Resilient seated, non-rising stem, AWWA C509 or AWWA C515, as modified herein
 - d. Gate: The valve gate shall be ductile iron, fully encapsulated with EDPM rubber, and shall be capable of a drip-tight shutoff with flow in either direction. The EDPM shall be permanently vulcanized to the gate.
 - e. Connection: Mechanical Joint
 - f. Bolts: all bolting shall be stainless steel AISI grade 304. If nuts are used on the bolts the nuts shall be 304 stainless steel and the bolt threads shall be coated with an anti-gauling compound. Coat bolts and nuts with an epoxy coating.
 - g. Stem: Valve stems shall be made of stainless steel or bronze with a minimum yield strength of 40,000 psi. Stems shall be provided with separate or integral bronze thrust collars. Bronze valve stems shall contain no more than five percent (5%) zinc, no more than two percent (2%) aluminum, and no more than one percent (1%) lead. Stainless steel stems shall contain a minimum of sixteen percent (16%) chrome.
 - h. Stem seal and Gaskets: Valve stem seals shall be an o-ring type, with not less than one (1) o-ring below the thrust collars and two (2) o-rings above the thrust collars. If an o-ring groove is cut into the stem, the diameter of the groove shall not be less than the root diameter of the stem threads. O-rings and gaskets shall be made of an NBR rubber to help prevent the effects of permeation. Bonnet gaskets shall be an o-ring type that completely encircles each individual bonnet bolt so that the bolts are isolated from internal or external water sources.
 - i. Interior/Exterior Coating: Fusion epoxy in accordance with AWWA C550
 - j. Manufacturers:
 - 1) American AVK with stainless steel stem
 - 2) American Flow Control
 - 3) Clow
 - 4) Kennedy
 - 5) Mueller
 - 6) J&S Valve
 - 7) Or approved equal
 - k. Valves shall comply with the requirements of ANSI/NSF 61.
2. Valve boxes, adjustable screw type:
- a. Materials: gray cast iron, ASTM A48 Class 35B, three (3) piece adjustable screw boxes with a round or oval base and a five and one-fourth (5¼) inch screw-type shaft suitable for depth of cover as required. Castings shall be heavy duty Class 35B. See City of Arvada standard detail 400-6 for additional requirements.
 - b. All valves set at greater than normal depth shall have an extension stem provided and installed with the valve box so that the valve may be operated with a standard seven (7) foot valve key. A valve operating nut at six (6) feet or greater below final grade shall have an extension stem provided to bring the operating nut to a depth of four (4) feet below final grade. Coatings shall comply with AWWA C116 and polyethylene wrap per AWWA C105, regardless of soil conditions. Valves set greater than

eight (8) feet below final grade may require a manhole over the valve operator as determined by the Engineer or Owner.

- c. Manufacturers: Star brand VB002 CL 35 and Castings, Inc. Series 6850 or approved equal

2.04 SERVICE CONNECTIONS

- A. General: All corporation stops, service clamps or saddles, and service connection accessories shall be the product of one (1) manufacturer.
- B. Corporation Stops:
 - 1. Rating shall be 100 psi water for normal pressure service line. If pressure greater than 100 psi is expected, a high-pressure corporation stop rated at 150 psi shall be utilized.
 - 2. Type: Thread inlet; compression connection outlet; complies with ANSI/ASME B1.20.1
 - a. Two spiral wraps of three (3) mil PTFE (Teflon) tape shall be wrapped clockwise around the inlet threads on the closed corporation stops.
 - 3. Manufacturer: Mueller Co. Model H-10003
 - 4. Provide insulation for corporation stops as necessary.
 - a. Manufacturer: Ford Service Insulators
- C. Water Service Saddles
 - 1. Water service saddles shall be required for all AWWA C909 PVC water lines for water service taps. Service saddles shall be brass or bronze and shall comply with AWWA C800.
- D. Tapping Saddles (Non-Service Type)
 - 1. Tapping Saddles for Wet Taps of Distribution and/or Transmission Mainlines shall be manufactured by ROMAC or approved equal. Tapping Saddles shall conform to all the requirements set forth in Section 420.27 City of Arvada Standards.
 - 2. Tapping Valves: Tapping valves shall conform to all the requirements set forth in Section 420.27 City of Arvada Standards.
 - 3. Tapping Sleeves: All tapping sleeves for use on PVC water mains shall be designed for an operating pressure of one-hundred fifty (150) psi and shall be fabricated using Type 304 (18-8) Stainless Steel.

2.05 APPURTENANCES

- A. Provide all necessary assembly bolts, washers and nuts, thrust blocks, supports, gaskets, flanges, and all other appurtenant items shown on the Drawings, specified or required for the proper installation and operation of the piping, and devices included in or on the piping, equipment, and piping accessories.
- B. End Seals for Casing Pipe: A one-eighth ($\frac{1}{8}$) inch thick synthetic rubber wrap around end seals with stainless steel bands shall be installed on the casing pipe after carrier pipe insertion. End seals shall be Model W wrap around end seal or Link Seal. End seals shall be watertight. Link seals may be used and shall be manufactured by GPT Industries S-316.
- C. Gasket Pipe Lubricant: Whitlam Plumb-Pro Blue Lube or approved equal.

2.06 CORROSION PROTECTION SYSTEMS

- A. When soil resistivity is less than 10,000 ohm-centimeters (OHM-CM), metallic pipe and fittings shall be protected against corrosion. See City of Arvada Standard Engineering Code and Specifications Section 420.19 for details.

2.07 AIR VALVES FOR CLEAN WATER SERVICE

- A. For temporary dead end water lines, a temporary blow-off valve may be permitted. The blow-off assembly shall be installed perpendicular to and on the downhill side of the waterline and shall drain to the nearest street gutter line or drainage channel. The blow-off assembly standpipe shall have a threaded end to accept a fire hose coupling. The top of the standpipe shall be between four (4) and six (6) inches below grade.
- B. Standard: AWWA C512, except as modified herein.
- C. Air and Vacuum Valves (AVVs):
 - 1. Function: Exhausts large volumes of air during pipeline filling and allows air back in when pipeline pressure drops below atmospheric pressure.
 - 2. Provide slow closing Surge Check below air valve consisting of a globe style, sliding disc spring return valve.
 - 3. Materials: Cast or ductile iron body; stainless steel float.
 - 4. Pressure Rating: 150 psi.
 - 5. Manufacturers: Apco Series 140 or 150; equivalent by Valmatic; or equal.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. General Handling and Placing:
 - 1. Exercise great care to prevent injury to or scoring of the pipe lining and coating, as applicable, during handling, transportation, or storage. Pipe shall not be stored on rough ground and rolling of the pipe on the coating will not be permitted. Repair any damaged pipe sections, specials, or fittings or replace at the direction of the Engineer.
 - 2. Inspect each pipe, fitting, valve, and accessory carefully before installation. Inspect the interior and exterior protective coatings and patch all damaged areas in the field or replaced at the direction of the Engineer.
 - 3. Place or erect all piping to accurate line and grade and backfill, support, hang, or brace against movement as specified or shown on the Drawings, or as required for proper installation. Remove all dirt and foreign matter from the pipe interior prior to installation and thoroughly clean all joints before joining.
 - 4. Connections between ferrous and non-ferrous piping and accessories shall be made using a dielectric coupling, union, or flange.
 - 5. Pipe installation shall comply with Section 421 of the City of Arvada Standard Engineering Code and Specifications.
- B. General Buried Piping Installation:
 - 1. Trenching, bedding, and backfill for buried piping shall be as shown on the Drawings and as specified in Section 02300.
 - 2. Where no grade elevations are shown on the Drawings, buried piping shall have at least 4 feet of cover. Where pipe grade elevations are shown on the

Drawings, install the pipe with straight grades between the indicated elevations.

3. Provide each pipe with a firm, uniform bearing for its full length in the trench except at field joints. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work.
4. Protect buried piping against thrust by use of restrained pipe joints. Securely brace all exposed free pipe ends. Cap or plug pipe ends that are left for future connections as shown on the Drawings and in a manner favorably reviewed by the Engineer.
5. Do not pull bell and spigot, gasketed joints more than 75% of the maximum deflection permitted by the pipe manufacturer.
6. Where piping leaves concrete encasement, provide a joint capable of angular deflection within 12 inches of the encasement.
7. Snake buried PVC pressure pipe from side to side in the trench in long sweeps.
8. Wrap metallic appurtenances with polyethylene encasement and tape the encasement tightly closed to the pipe.

C. Water Service Lines:

1. Connection of copper to all metallic water mains shall be electrically insulated by means of an approved insulator fitting installed on the corporation stop. After installation, the fitting shall be cleaned and wrapped with a double layer of eight (8) mil polyethylene before backfilling. An insulator fitting shall also be installed on the outlet side of the meter setter.
2. A water service line crossing over a foreign line (storm sewers, water transmission lines, etc.) shall be insulated through areas and at points where its bury is less than four (4) feet. Butt joints between sections and side slits in insulation shall be duct or mole taped upon placement around the service line.
3. Service line trenches cut through surfaced streets or adjacent to existing curbs, gutters, and sidewalks in public ROW shall be bedded and backfilled in accordance with Section 02300.

D. Water Main Installation:

1. The Contractor is advised that precautions taken to keep the pipeline clean during construction will facilitate achieving the disinfection requirements of this project with a minimum of effort and expense. Compliance with these suggested minimum procedures will not relieve the Contractor of the disinfection requirements.
2. Prior to installation, thoroughly clean the interior of each length of pipe and each fitting or valve and inspect to ensure that no foreign material remains. Cover both ends with plastic and do not uncover them until just prior to completing the joint.
3. Whenever pipe laying is discontinued for short periods, or whenever work is stopped at the end of the day, close the open ends of the pipe with watertight plugs or bulkheads.
4. Provide adequate trench pumping to ensure against groundwater contacting the inside of the pipeline at any time. Do not lower any pipe or fitting into a trench where groundwater is present and may enter the pipe. When necessary, pump the water from trenches and keep the trench dry until the joints have been completed and the open ends of the pipe have been closed with a watertight plug. Do not remove the plug until the trench has again been pumped dry.

5. Keep new pipe sections clean and dry.
6. When making the connection between a new pipeline and an existing pipeline, or when repairing a damaged pipe, take the following extra precautions:
 - a. Clean the exterior of the existing pipeline of all dirt and debris, and spray or swab with a standard 5.25% or stronger chlorine solution (as specified) in the immediate vicinity of the work. Clean equipment and materials, including new pipe and fittings, to be used in making these connections of all dirt and debris and disinfect them. Allow at least 30 minutes contact time for disinfection before the chlorine solution is diluted or rinsed off. Provide sufficient trench pumps to prevent flooding of the trench.
 - b. When an old line is opened, either by accident or by design, the excavation may be wet or badly contaminated from groundwater. Apply liberal quantities of standard chlorine solution or tablets to the open trench areas to lessen the danger from such pollution. Tablets are recommended because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation. Scatter liberally around and locate the tablets so that flow entering the work site will contact the disinfecting agent. Trench application should be done very carefully to avoid contact by skin and clothing with chlorine solution. Minimally, safety dictates wearing safety goggles and rain gear.
 - c. When excavating a leaking or broken pipeline, "valve-off" the system gradually to less than watertightness. This is to prevent causing areas of zero pressure which would allow entry of foreign material. A flow should be maintained which is slightly less than trench pump capability. Once the break is exposed and cleaned to disallow site contamination, the valving can then be made watertight.

E. Service Taps

1. All service taps shall be wet taps. Shutting down any portion of the water system shall only be allowed when uncontrolled circumstances do not permit a wet tap. Any shut down of the water System must be approved in writing by the Owner.
2. Tapping of PVC pipe shall be made with a Tapping Saddle.
3. Arvada's Water Utility Department, unless otherwise approved by the Owner, shall complete tapping of all water lines up to and including two (2) inch diameter taps. Notification shall be given to the Water Utility Department two (2) working days (forty-eight [48] hours) in advance of the tap in order to provide ample time to schedule the work. In those instances where Arvada crews are not available to complete taps in a timely manner or when the tap is over two (2) inches in diameter, the tap may be installed by a contractor or plumber licensed by Arvada who specializes in the installation of water taps.
4. Service saddles and corporation stops meeting the standards shall be supplied and installed by the contractor.

F. Tracer Wire

1. Per Colorado Senate Bill 18-167, all new underground facilities, including mains and laterals up to the structure or building being served, require tracer wire.
2. Tracer wire to be installed in accordance with Section 02300.

G. Installation Specifics

1. Copper Pipe:
 - a. Bends shall be made in a manner that does not crimp or flatten pipe.
 - b. Pipe shall have joints squarely cut clean, properly fluxed and heated before solder is placed in the joint. Joints must be driven up tight before solder is added. Compression and flared joints shall be made up in accordance with the manufacturer's instructions. Brazing shall be in accordance with ANSI B31.1.
2. Polyvinyl Chloride Pipe: Installation shall conform to AWWA M23, Chapters 6 and 7, as modified herein.

3.02 COUPLING INSTALLATION

- A. Flexible Couplings: Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible coupling gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolt on opposite sides a little at a time until all bolts have a uniform tightness. Workers tightening bolts shall be equipped with torque-limiting wrenches or other favorably reviewed type.
- B. Tie Rods: Except where double-nutting is required, install the nuts snug. Tighten the nuts gradually and equally at opposite sides of the pipe until snug to prevent misalignment and to ensure that all rods carry equal loads. If double-nutting is required, double-nut each end of each tie rod. The space between the pairs of nuts shall be $\frac{1}{2}$ -inch greater than the distance between the lugs. Provide double-nutting at buried locations and where otherwise required on the Drawings.

3.03 INSTALLATION OF VALVES AND ACCESSORIES

- A. Buried installations:
 1. Install in the closed position.
 2. Support valve in trench to prevent settling and excessive strain on the connection to the pipe.
 3. Install polyethylene encasement in accordance with AWWA C105.
 4. Place valve boxes directly over valves with top of box being brought to surface of finished grade or as indicated on the Drawings.
 5. After installation, carefully backfill and compact on each side of box.
 6. Valve Boxes not located within a pavement section shall be provided with an 18-inch square by 8-inch deep concrete collar.

3.04 FIELD QUALITY CONTROL

- A. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.
- B. The Contractor shall:
 1. Perform leakage tests.
 2. Perform bacteriological tests.
 3. Be responsible for the costs of additional inspection and retesting resulting from non-compliance.

3.05 INTERRUPTION OF WATER SERVICE

- A. The Contractor must, in writing, advise affected users forty-eight (48) hours prior to performing work on a service, distribution or transmission line which will interrupt a customer's supply of water. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.
- B. In addition, the Contractor must contact Arvada's Engineering Inspection Department through the City's permit system and as directed by the assigned inspector to schedule the closing of valves necessary to isolate the line or lines on which work is to be performed. Only City personnel are to operate existing system valves or new valves if they are connected to the City system. Also, it is the Contractor's responsibility to advise the governing fire district as to time and interval the system will be down and also the location of all fire hydrants that will be out of service.
- C. A normal outage shall be a maximum of four (4) hours and between the hours of 8:30 a.m. and 3:00 p.m. If the outage will be greater than four (4) hours, the work shall be done in a manner to minimize the inconvenience to users, such as working at night in a continuous operation until service is restored. A connection which will require an outage longer than four (4) hours shall be subject to review by the Owner as to the appropriate time for the connection. If in the process of installing a connection there exists a customer, industry, or building in the area that cannot be out of water such as a hospital, school, etc., the Contractor shall take appropriate means to provide and convey potable water to them at all times during the performance of the work.
- D. Whenever a fire line serving a fire protection system is out of service, the respective fire protection district shall be notified a minimum of forty-eight (48) hours before the shut down.

3.06 ABANDONMENT OF WATER MAIN AND WATER VALVES

- A. Water mains to be abandoned shall be removed and properly disposed of off site.
- B. Water valves to be abandoned shall be removed in their entirety with a blind flange installed at the tee. Water valves that would connect to abandoned water main or no water main shall not be left in place.

END OF SECTION

SECTION 02516

DISINFECTION AND TESTING OF WATER LINES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes disinfection and testing of potable water distribution systems.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. American Water Works Association:
 - 1. AWWA B300 - Hypochlorites
 - 2. AWWA B301 - Liquid Chlorine
 - 3. AWWA B303 - Sodium Chlorite
 - 4. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
 - 5. AWWA C651 - Disinfecting Water Mains.

1.03 QUALIFICATIONS

- A. Testing Laboratory: Independent testing laboratory specializing in testing potable water systems, approved by the local health authority.
- B. Submit bacteriologist's signature and authority associated with testing.

1.04 QUALITY ASSURANCE

- A. Notify the Owner's Inspector a minimum of 24 hours in advance of testing. All testing shall be made in the presence of the Owner's Inspector.
- B. Disinfection shall be accomplished under the supervision of the Contractor by a person skilled and experienced in the operation of water systems.

1.05 SUBMITTALS

- A. Testing Schedule, including proposed plans and locations for water conveyance and discharge, submitted in writing to the Engineer for approval a minimum of 14 Calendar Days before testing is to start. Testing shall be coordinated with the Owner's Inspector.

PART 2 - PRODUCTS

2.01 DISINFECTION CHEMICALS

- A. Chemicals
 - 1. AWWA B300: Hypochlorite
 - 2. AWWA B301: Liquid Chlorine
 - 3. AWWA B303: Sodium Chlorite

- B. Hypochlorite Tablet Adhesive
 - 1. Certified to NSF Standard 61
 - 2. Permatex RTV Clear or approved equal.

2.02 HYDROSTATIC TESTING MATERIALS

- A. All test equipment, temporary valves, temporary blow-offs, temporary bulkheads and blind flanges, temporary manual air release valves, or other water control equipment and materials shall be determined and furnished by the Contractor. No materials shall be used which would be injurious to the pipeline or its future function. The Contractor shall be held solely responsible for ensuring that a sufficient water source is available for all operations.
- B. Temporary manual air-release valves shall be provided as necessary for pipeline test. The pipe outlet shall be constructed in the same manner as for a permanent air valve and after use, sealed with a blind flange, pipe cap, or plug.
- C. Air-release and water drainage connections shall be included.

PART 3 - EXECUTION

3.01 SEQUENCE

- A. Disinfection / Chlorination
- B. Hydrostatic Testing
- C. Flush Line, Dechlorinate Discharged Water, Refill
- D. Clearwater / Bacteriological Testing

3.02 DISINFECTION / CHLORINATION

- A. All potable waterlines shall be chlorinated in accordance with the requirements of the Colorado Department of Public Health and Environment and shall comply with AWWA C651.
- B. The chlorination of the finished pipeline shall be done prior to the hydrostatic testing.
- C. Before filling the pipe with water, the pipe shall be clean and free of debris to the satisfaction of the Engineer.
- D. Chlorine tablets may be used for disinfection in 16-inch and smaller pipe when the line cannot be flushed prior to chlorination. Tablets shall be attached to the inside top of the pipe with an acceptable, food grade approved, adhesive prior to the pipe installation in the trench. Continuous Feed Method shall be used when it is necessary to flush the line prior to chlorination or for rechlorination.
- E. The tablet method shall not be used when trench water or foreign materials have entered the water line during installation or the ambient temperature is below forty-one (41) degrees Fahrenheit. The tablets shall be secured to the crown of each pipe section, as it is installed in the trench, with "red" PERMATEX or other approved adhesive. Under normal conditions to obtain the twenty-five (25) MG/L residual chlorine concentration, after twenty-four (24) hour solution time, will

require the use of the number of tablets called for under pipe diameter and opposite pipe joint length as listed below.

Pipe Diameter Inches	Tablets Required for 20 ft.	CL Residual in 20 ft. Pipe mg/L
3	1	116.97
4	2	131.59
6	3	87.73
8	6	98.69
12	12	87.73
14	17	91.31

- F. Chlorinated water shall be held in contact with the pipe for 24 hours.
- G. Perform chlorination testing: Upon completion of the 24-hour retention period required for disinfection, the water in the pipeline shall be tested and have a residual chlorine content of not less than 50 mg/l at all hydrants and blow-offs. If the test is unsatisfactory, disinfection shall be repeated until a 50 mg/l free chlorine residual is obtained.
- H. Obtain one (1) test sample for every 1,000 linear feet of pipe.
- I. For continuous feed method, slug method, or cut and repair method, see Arvada Engineering Code of Standards and Specifications Section 421.13.

3.03 HYDROSTATIC TESTING

- A. Conduct hydrostatic testing accordance with AWWA C600.
Hydrostatic testing shall be completed after chlorination testing and prior to the clearwater / bacteriological testing and final connection to the existing system. Hydrostatic testing shall only be performed after the line has been cleaned of debris, concrete anchor blacks have cured, and all backfill is in place. Water Operations Division personnel shall be the sole operators of existing valves through which water for testing, disinfecting, and flushing is obtained. The Contractor shall be responsible for metering and paying the Owner for water used for testing, disinfecting, and flushing.
- B. Before applying test pressure, completely expel air from section of piping under test without causing surges or damage to the line and its appurtenances. Provide temporary blow-off(s) or use fire hydrant(s) as necessary so air can be expelled as pipeline is filled with water. All air within the pipe shall be purged therefrom, and 24 hours lapsed time allowed for water adsorption into the pipe lining, before pressure testing.
- C. Test Pressure: The hydrostatic test pressure shall be one-hundred fifty (150) psig at the lowest point in the line of the section under test or working pressure plus 50 psi, whichever is greater. Fire lines shall be tested at two-hundred (200) psig. When directed by the Project Engineer, a higher test pressure may be required.
- D. Slowly bring piping to test pressure and allow system to stabilize. Do not open or close valves at differential pressures above rated pressure.
- E. Conduct hydrostatic test for at least a 2-hour duration.

- F. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damaged or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
- G. Leakage Allowance:
 - 1. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valves section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled and/or displace with water. No pipe installation will be accepted if the leakage in U.S. gallons per hour is greater than set forth herein below in accordance with AWWA C600, C604, C605 and M11: Allowable leakage for steel pipe is for o-ring rubber gasket joints only. The allowance shall be zero (0) on all welded or mechanically couple steel pipe and for all fire lines.

DIP or PVC Pipe Diameter (Inches)	Nominal Allowable Leakage US Gallons per Hour per 1,000 feet per 24 hours
4	0.33
6	0.50
8	0.66
12	0.99
14	1.16

- H. The Owner reserves the right to substitute its own calibrated meter and/or pump for the Contractor's meter or pump for testing.
- I. When leakage exceeds specified acceptable rate, locate source and make necessary repairs. Repeat test until specified leakage requirements are met.

3.04 CLEARWATER / BACTERIOLOGICAL TESTING

- A. Upon completion of passing chlorination and hydrostatic tests, the pipeline shall be thoroughly flushed through all hydrants and blow-offs until the water runs clear with no chlorine residual in excess of that carried in the existing system. As a minimum, the total volume of the water line being tested shall be flushed. The Contractor shall be responsible for metering and paying the Owner for water used for flushing.
- B. The Owner's Inspector shall be present and operate all valves during flushing and dechlorination of lines.
- C. The contractor shall take all necessary precautions to prevent the flow of strong chlorine solution into existing water facilities and shall be responsible for damaged done by heavily chlorinated water. Sodium thiosulfate shall be used when flushing water on the ground and to waterways that do not contain fish. Vita-D-Chlor Neutral, or approved equal, shall be used when flushing to waterways with fish. Flushing to the sanitary sewer shall only be allowed if it meets the requirements as set by Metro Water Recovery in the dewatering discharge permit, if applicable.
- D. The line shall be visually inspected for turbidity. If the inspection is unsatisfactory, the line shall be flushed again. If the turbidity test fails a second time, the line shall be re-chlorinated and then re-flushed.

- E. Refill water line. Before the new water main is finally connected to the distribution system for use, conduct clearwater / bacteriological testing.
- F. Prior to placing any new water main in service, a bacteriological analysis of the water in the new main shall be performed by the Owner. A minimum of sixteen (16) hours after the new main is flushed of the high chlorine residual a bacteriological sample shall be obtained. Results of the bacteriological analysis shall be available twenty-four (24) hours after the sample was obtained. If the bacteriological analysis turns up positive a second test shall be taken. If the second test turns up positive the main shall be re-flushed and the process started over until a negative bacteriological analysis is obtained. Only after a negative bacteriological analysis is obtained can a new water main be placed in service and water is transferred to the new main.

3.05 TEST RESULTS

- A. Chlorination Testing Report
 - 1. Type and form of disinfectant used
 - 2. Date and times of disinfectant injection
 - 3. Test locations
 - 4. Name of person collecting samples
 - 5. Initial and 24 hour disinfectant residuals in treated water in mg/l for each outlet tested
 - 6. Date and times of flushing
 - 7. Disinfectant residual after flushing in mg/l for each outlet tested
- B. Hydrostatic Testing Report
 - 1. Length of pipe tested
 - 2. Test Pressure
 - 3. Duration of the test
 - 4. Amount of make-up water
 - 5. Owner's Inspector and the Contractor shall sign report
- C. Clearwater / Bacteriological Testing Report
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.
 - 5. Initial and 24 hour disinfectant residuals in mg/l for each outlet tested.
 - 6. Coliform bacteria test results for each outlet tested.
 - 7. Certify water conforms, or fails to conform, to absence of coliform bacteria.

3.06 PLACING LINE IN SERVICE

- A. Connection to the water distribution system shall be in a neat and workmanlike manner. An Owner's Inspector shall be present at all times during the construction of the connection. Under no circumstances shall a non-disinfected main, which cannot be isolated, be connected to an existing disinfected main. Disinfection of the line shall meet the requirements of the Colorado Health Department.
- B. The Owner is not responsible for water tightness of its valves and existing facilities. If existing valves leak, the Owner will assist in reducing the influx of water, but the

contractor must use methods at his or her own disposal to work with the resulting leakage.

- C. When connecting lines to the water distribution system, it may be necessary to operate new and existing valves. Valves on or connected to the system must be operated by the Owner's personnel only. The Contractor shall give the Owner's Inspector forty-eight (48) hours notice to arrange for operating the valves. Both the Contractor and the Owner's Inspector shall be present when the valves are being operated.
- D. Super chlorinated water in the line must be fully dechlorinated prior to release to streets or into storm sewers, ditches, streams and/or their tributaries. Contractors' proposed method of dechlorination must be approved by the Project Engineer and be performed within the limits set forth in the NPDES permit, as issued to the City by the Colorado Department of Health. Sodium Thiosulfate Pentahydrate XTL can be used as a dechlorinator, available from Van Waters & Rogers, Inc. If the super chlorinated water is released to a dirt area that will not run to a receiving water then the requirement to dechlorinate may be waived by a representative of the City's Water Quality department.
- E. Placing Line in Service: A line will only be accepted for tapping and/or placing in service after all of the following conditions have been met
 1. The main has been installed to the satisfaction of the Owner's Inspector and all pertinent notes and measurements have been made.
 2. The main has been successfully filled, chlorinated, dechlorinated and pressure tested to the requirements of the City of Arvada.
 3. A bacteriological sample has been collected and results indicate that no E. Coli or total coliform bacteria are present

END OF SECTION

SECTION 02530

SANITARY GRAVITY PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Furnish and install all piping as shown on the Drawings, described in the Specifications, and as required for a complete and operable system. The work includes replacement of existing sanitary sewer mains.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 500.
- B. American Society for Testing and Materials (ASTM):
 - 1. C923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
 - 2. D3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - 3. D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
 - 4. D3262 Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
 - 5. D4161 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
 - 6. D3681 Standard Test Method for Chemical Resistance of "Fiber glass" Pipe in a Deflected Condition
 - 7. F679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
 - 8. F77 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Submit the following for review:
 - 1. Potholing Report: Verify by excavation, inspection, and measurement all installation conditions, including existing utilities and structures, for buried pipe before preparation of Shop Drawings. Submit field measurements, elevations, station locations, and photos. See Section 02300 for additional requirements.
 - 2. Shop Drawings: Submit data to show that the products specified in this Section conform to the Specification requirements.
 - 3. Design calculations:
 - a. Pipe loading calculations
 - b. Buoyancy calculations assuming water elevation is at grade
 - 4. CCTV footage of the installed sanitary pipeline, see Section 02951.
 - 5. Leakage Testing Plan
 - 6. Test Results: As required herein.

1.04 QUALITY ASSURANCE

- A. All materials and equipment furnished under this Section shall be of manufacturers who have been regularly engaged in the design and manufacture of the materials and equipment for a period of at least 5 years.
- B. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.
- C. Field Quality Control:
 - 1. The Contractor shall:
 - a. Perform jet cleaning on 100% of the new system
 - b. Perform CCTV on 100% of the new system
 - c. Perform leakage tests on 100% of the new system
 - d. Perform mandrel tests, if required by Owner
 - e. Be responsible for the costs of additional inspection and retesting by the Owner resulting from non-compliance or concerns with pipe installation.

1.05 POTHOLING

- A. Do not prepare any shop drawings for, or make final order for, or design any pipe materials for any particular section of pipeline until all utilities in that section of pipeline have been exposed, as specified in Section 02300, and until such time as no interferences are found between said existing utilities and the proposed pipeline alignment. If interferences are found in any particular section of pipeline, notify the Engineer so that a solution for avoiding the conflict can be identified prior to the ordering of materials.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Pipe sizes are nominal inside diameter unless otherwise noted.
- B. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.
- C. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and leakage tests as specified hereinafter.
- D. See the Pipe Schedule on the Drawings for general piping requirements and material designations.

2.02 FIBERGLASS REINFORCED PIPE (FRP)

- A. Pipe:
 - 1. All pipes shall be designed and furnished under the requirements of ASTM D3262 by centrifugally casting (CCFRPM) or TopFibra Enhanced Filament Winding (EFW) process and using premium composite components resulting in a dense, nonporous, corrosion-resistant, consistent composite sandwich structure. The interior surface of the pipes (liner) shall be manufactured using a nominal 40-mil (0.040") premium made flexible polyester resin and capable of handling flow velocities of 18 ft/sec for flow without solids present. The

interior surface shall provide corrosion, crack, and abrasion resistance membrane. The exterior surface of the pipes shall be comprised of 10-mil (0.010") compressed smooth sand and or resin-glass layer which provides short-term UV, impact, and abrasion protection to the exterior. The exterior layer thickness is not to be used for calculations towards pipe strength and pipe stiffness.

2. Inside Diameter: See Drawings. The nominal ID and tolerances for open-cut pipes shall be per dimensions as published in Table 1 of ASTM D3262 in US customary units.
 3. Nominal Stiffness (SN): 46 for 25' or less earth cover and 72 for all others.
 4. Minimum Pressure Class (PN): 50 psi
 5. The pipe and fittings shall be free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe and fittings shall also be as uniform as commercially practical in color opacity, density, and other physical properties.
 6. The manufacturer shall provide written confirmation to the Engineer that the pipe and fittings supplied under the terms of this specification meet or exceed these specifications herein.
- B. Joints: Elastomeric gasket joints, ASTM F477.
1. Unless otherwise specified, the coupling shall be a structural filament wound coupling (FWC) or U-Reka sleeve with machined grooves to house the EPDM gasket. The joints must meet the pressure performance requirements of ASTM D4161. The coupling shall have the same corrosion rating as the FRPM pipe or higher.
 2. Fittings, Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of FRP or steel pipe.
 3. Lengths: Pipe shall be supplied in nominal lengths of 20, 40, and 48 feet. Actual laying length shall be nominal ± 2 inches.
 4. Inside Diameter: See Contract Drawings
 5. Stiffness: Joints to match the appropriate pipe stiffness specified
 6. Roundness: Pipe shall be round within 0.2% of the outside diameter.
 7. Wall Thickness: The minimum wall thickness shall be the stated design thickness.
 8. End Squareness: Pipe ends shall be square to the pipe axis within $\pm 1/8"$.
- C. Factory Testing:
1. Pipe shall be manufactured and tested in accordance with ASTM D3262.
 2. Joint shall meet the requirements of ASTM D4161.
 3. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be SN36 psi minimum or if over 25 feet deep, SN72 psi shall be used. The inner liner and outer UV shell thickness are excluded from stiffness as required by AWWA M45 load calculation parameters.
 4. Gasket Tests: Test 3 gaskets of each size for all properties noted in Section 7 of ASTM F477.
- D. Approved Manufacturers
1. HOBAS Pipe

2.03 POLYVINYL CHLORIDE PIPE (PVC)

- A. Pipe and Fittings: Polyvinyl chloride sewer pipe.
 - 1. Four-inch through 12-inch nominal size: ASTM D3034, SDR 35.
- B. Joints: Elastomeric gasket joints, ASTM D3212.
 - 1. Joints shall provide a watertight seal.
- C. Gaskets: Nitrile, ASTM F477.

2.04 APPURTENANCES

- A. Furnish and install all necessary guides, inserts, anchors, and assembly bolts; washers and nuts, hangers, supports, gaskets, and flanges; all other appurtenant items shown on the Drawings, specified or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.
- B. Link seals may be used to connect pipeline to structures as necessary and shall be manufactured by GPT Industries S-316.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. General
 - 1. Proper equipment, tools and facilities shall be provided and used by the Contractor for safe and efficient performance of the work. All pipe and sanitary sewer appurtenances shall be carefully lowered into the trench in such a manner as to prevent damage to pipe materials and to protect coatings and linings. Under no circumstances shall pipe or fittings be dropped or dumped into the trench. Any pipe or fittings that are dropped or dumped shall be removed from the work site and shall not be used.
 - 2. When buried, all ductile iron pipe fittings and appurtenances shall be protected with polyethylene wrap.
 - 3. The Owner's Inspector shall be notified at least one working day (twenty-four [24] hours) in advance of when pipe is to be installed in any trench. No pipe shall be covered until the Owner's Inspector has inspected the installation.
- B. Storage and Handling:
 - 1. Great care shall be exercised to prevent damage to the pipe during handling, transportation, and storage. Pipe shall not be stored on rough ground and rolling of the pipe on the coating will not be permitted. Any damaged pipe sections shall be repaired or replaced at the expense of the Contractor as satisfactory to the Engineer.
 - 2. All pipe handling and storage shall be strictly in accordance with the pipe manufacturer's recommendations.
 - 3. Each pipe section shall be carefully inspected before installation, and all damaged areas patched in the field or replaced as satisfactory to the Engineer.
 - 4. For pipe handling, use textile slings, forklift, or other suitable materials. The use of chains or cables is prohibited.

C. Piping Installation:

1. Trenching, bedding, and backfill for buried piping shall be as shown on the Drawings and as specified in Section 02300.
2. The profile drawings show invert elevations at certain structures and may show pipe slopes. In case of any conflicts the invert elevations shall govern over slopes. Install pipe with straight grades between indicated invert elevations.
 - a. Installation tolerances of pipe slopes for all gravity sanitary piping must fall within 0.0002 ft/ft of the design slopes shown on the Drawings. If final installation slopes exceed the design slopes shown on the drawings, this shall be reviewed on a case-by-case basis.
 - b. For installation tolerances of pipe inverts for the carrier piping crossing the railroad right-of-way see Section 02411.
3. The Owner's Inspector shall be notified at least one working day (twenty-four hours) in advance of when pipe is to be installed in any trench. No pipe shall be covered until an Owner's Inspector has inspected the installation.
4. Manhole locations are identified on the plan drawings by coordinates and by station. In case of any conflicts the coordinates shall govern over the stations.
 - a. Jointing:
 - 1) Clean ends of pipe and joint components.
 - 2) Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
 - 3) Use suitable equipment and end protection to push or pull the pipes together.
 - 4) Install gravity pipe from lowest profile elevation to highest profile elevation, with bells facing upstream.
 - 5) Do not exceed forces recommended by the manufacturer for joining or pushing pipe.
 - 6) Provide dewatering system to draw down groundwater level below bottom of the pipe trench. See Section 02140.
 - 7) Any pipe damage during handling and storage or by transport shall be repaired according to the manufacturer's recommendation or removed from the site and replaced at the Owner's Inspector's option, at no additional cost to the Owner. The Inspector's decision regarding rejection shall be final. Rejected pipe shall be clearly and indelibly marked to prevent confusion with pipe in subsequent shipments.
 - 8) If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until they are used in the Work. In certain cases, the repair of pipes is allowed onsite under the supervision of a factory trained technician.
 - 9) Precautions shall be taken to prevent floatation of the pipe in the trench. Remove and relay any pipe which has floated. Contractor is responsible to prevent the floatation of the pipe during construction. The contractor to submit installation plan to Engineer for review prior to commencement of construction.
 - 10) All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.

D. Tracer Wire:

1. Per Colorado Senate Bill 18-167, all new underground facilities, including mains and laterals up to the structure or building being served, require tracer wire.
2. Tracer wire to be installed in accordance with Section 02300.

3.02 CLEANING

- A. Prior to testing, the inside of each main sewer shall be thoroughly cleaned of all dirt, loose scale, sand, and other foreign material. Cleaning shall be by flushing with water or balling as appropriate for the size and type of the pipe.
- B. Contractor shall capture dirt and debris, remove from sewer system, and dispose of properly.

3.03 PERMANENT PLUGS

- A. Clean interior contact surfaces of all pipes to be cut off or abandoned. Construct a concrete plug in the end of all pipe 18 inches or less in diameter. Minimum length of concrete plugs shall be 8 inches. For pipe 21 inches and larger, the plugs may be constructed of common brick or concrete block. The exposed face of block or brick shall be plastered with mortar. All plugs shall be watertight and capable of withstanding all internal and external pressures without leakage.

3.04 LEAKAGE TESTS

- A. General:
 1. Leakage tests may be required by the Owner for pipelines installed in this project. It is at the discretion of the Owner if leakage tests shall be performed upon completion of CCTV and/or mandrel testing of the sanitary pipelines.
 2. Furnish all equipment, materials, personnel, and supplies to perform the tests.
 3. Pressure gauges and metering devices shall be of a type, accuracy, and calibration acceptable to the Engineer. The Engineer may require certification of the gauges and meters by an independent testing firm at the Contractor's expense.
 4. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Engineer.
- B. The leakage test shall be made after all pipe is installed and backfilled, but prior to placing permanent resurfacing. The Contractor may conduct preliminary tests prior to backfill. If the Contractor elects to conduct preliminary tests, he or she shall provide any necessary temporary thrust restraint and shall retest as set forth herein prior to surfacing placement.
- C. Test Procedure: Leakage tests shall be air pressure tests conducted as follows:
 1. Furnish all materials, equipment and labor for making an air test. Air test equipment shall be favorably reviewed by the Engineer.
 2. The Contractor may conduct an initial air test of the sewer mainline after densification of the backfill but prior to installation of the house connection sewers, if applicable. Such tests will be considered to be for the Contractor's information and need not be performed in the presence of the Engineer.
 3. Each section of sewer shall be tested between successive manholes, or in sections if favorably reviewed by the Engineer, by plugging and bracing all openings in the sewer mainline and the upper ends of all building connection

sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again. The Contractor has the option of wetting the interior of the pipe prior to the test.

4. The final leakage test of the sewer mainline shall be conducted in the presence of the Engineer and shall meet the requirements listed in the City of Arvada Engineering Code and Specifications Section 524.01 Air Testing Pipeline.
- D. Correction of Defects: If leakage or infiltration exceeds the allowable, the installation shall be repaired or replaced, and leakage tests shall be repeated as necessary until conformance test requirements specified herein have been fulfilled. All detectable leaks shall be repaired, regardless of the test results.
- E. Reports: Keep records of each piping test, including:
 1. Description and identification of piping tested.
 2. Description of test procedure.
 3. Date of test.
 4. Witnessing by Contractor and Engineer.
 5. Test evaluation.
 6. Remarks, to include such items as:
 - a. Leaks (type, location).
 - b. Repairs made on leaks.
 7. Test reports shall be submitted to the Engineer.

3.05 INTERRUPTION OF SANITARY SERVICE

- A. The Contractor must, in writing, advise affected users forty-eight (48) hours prior to performing work on a service or collector line which will interrupt a customer's wastewater line. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.
- B. In addition, the Contractor must notify Arvada's Wastewater Division (720-898-7770) of the schedule for plugging and bypassing manholes necessary to isolate the line on which work is to be performed.
- C. The Contractor shall provide all labor, materials and equipment to properly handle and divert all sewage flow when required for construction. See City of Arvada Code 523 for further detail.

3.06 SANITARY SEWER MAIN ABANDONMENT

- A. Sanitary sewer mains within the Adams County public right of way shall be removed.
- B. When approved by the Project Engineer, sanitary sewer mains within City of Arvada public right of way may be abandoned in place by filling with concrete or flow fill. Where a pipe is abandoned at a manhole, the pipe shall be plugged at the manhole and removed for a minimum of two (2) feet. Any manholes on abandoned sanitary sewer mains shall have the top cone removed and the remaining manhole hole void space shall be filled with flowable fill with compressible strength of less than 200 psi so that it can be excavated in the future as needed.

- C. Sanitary service connections to City mains that are to be abandoned shall be removed at the main and repaired using a repair clamp. Service lines in the right of way shall be removed. The service may be abandoned in place on private property, with the approval of the property owner, with a minimum of two feet of pipe filled with concrete or flow fill.
- D. Prior to filling with concrete or flow fill any pipe to be abandoned in place shall be flushed with clean water to remove debris. The flushing water shall be properly captured and treated and not released to the storm water system or a natural channel. Flushing water and debris shall not be discharged to downstream sanitary sewer piping.

END OF SECTION

SECTION 02531

SANITARY PRESSURE PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes: Poly Vinyl Chloride (PVC) pressure piping sizes 1.5 inches to 4 inches in diameter. Provide all piping, fittings, and accessories as shown on the Drawings, as specified herein, and as required to completely interconnect all piping and equipment for a complete and operable system.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. ASTM International (ASTM):
 - 1. ASTM D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - 2. ASTM D2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - 3. ASTM D2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
 - 4. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
 - 5. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- C. Uni-Bell PVC Pipe Association:
 - 1. UNI-PUB-9 Installation Guide for Gasketed-Joint PVC Pressure Pipe
- D. American Water Works Association (AWWA):
 - 1. AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
 - 2. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100 mm through 1500 mm), for Water Transmission and Distribution
 - 3. AWWA M23 PVC Pipe – Design and Installation

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
 - 1. Pipe Layouts:
 - a. Shop drawings indicating layout of piping, fittings, valves, and other appurtenances necessary for a completed pipeline.
 - 2. Calculations: Calculations showing compliance under this section.

- C. Product Data:
 - 1. Submit data on the following items showing compliance under this section:
 - a. Pipe, fittings, and accessories
 - b. Gaskets
 - c. Connections to existing pipelines, laterals, and structures
 - d. Flexible couplings and flanged coupling adapters
 - e. Restrained joints
 - 2. Certifications:
 - a. Certified affidavit of compliance with ASTM D2241.
 - b. Certified field test reports specified herein.

1.04 QUALITY ASSURANCE

- A. The Pipe Manufacturer shall be a member of the Uni-Bell PVC Pipe Association.

PART 2 - PRODUCTS

2.01 PVC PIPE

- A. Sizes: 1.5 to 4 inches in diameter.
 - 1. PVC pipes shall be manufactured and supplied in accordance with AWWA C900 and/or ASTM D2241.
- B. Minimum working pressure:
 - 1. Pressure Class 200 psi, SDR 21
 - 2. Provide wall thicknesses matching the specified pressure class.
- C. Lay length: Pipe furnished shall have normal laying length of 20 feet to 22 feet.
- D. The pipe shall be made of PVC compound having a cell classification of 12454 or 12364 in accordance with ASTM D1784.
- E. Pipe shall be homogenous throughout, free of voids, cracks, inclusions, and other defects.
- F. Pipe for potable water use shall be blue or white in color. Pipe for recycled or reclaimed water use shall be purple in color. Pipe for other non-potable water uses shall be green or white in color.
- G. Pipe outside diameters shall be equal to those of cast iron (cast iron pipe sizes, CIPS) unless otherwise specified by the Owner.
- H. Pipe Identification:
 - 1. Buried pipe markings shall conform to AWWA C900:
 - a. Pipe shall have markings at the ends of each pipe stick
 - 1) Manufacturer's name or trademark and lot code
 - 2) Nominal pipe size and OD (e.g., CIOD or IPS)
 - 3) Legend (e.g., PVC AWWA C900)
 - 4) Dimension ratio
 - 5) Pressure class in psi
 - 6) Hydrostatic integrity test pressure
- I. Acceptable Pipe Manufacturers:
 - 1. Charlotte Pipe and Foundry Company
 - 2. Diamond Plastics Corps.

3. Westlake Chemical Corporation
4. JM Eagle
5. or equal

2.02 FITTINGS

- A. Ductile iron fittings shall be manufactured and supplied in accordance with AWWA C110 and/or C153.
 1. External Coating:
 - a. Buried pipe coating shall be an asphaltic coating approximately 1 mil thick in accordance with AWWA C151.
 2. Internal Lining:
 - a. Fittings furnished shall have an Amine Cured Novalac Ceramic Epoxy Lining: Protecto 401, or equal.
 - b. Thickness test linings per SSPC PA 2 using a magnetic film thickness gauge. Test interiors for pinholes with nondestructive 2,500 volt test. Correct all defects before shipment.
 3. Polyethylene encasement:
 - a. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C105/A21.5.
 - b. Polyethylene encasement shall be the V-Bio Enhanced Polywrap consisting of three layers of co-extruded linear, low-density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the fitting exterior shall be infused with a blend of antimicrobial compound to mitigate microbiologically infused corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
 - c. The raw materials used to manufacture polyethylene film shall be Type I, Class A, Grade E 1 in accordance with ASTM D1250.
 - d. See Section 02510 for additional corrosion protection requirements.
- B. PVC fittings shall be manufactured and supplied in accordance with AWWA C900.
 1. Fittings shall be made of PVC compound having a cell classification of 12454 or 13343 in accordance with ASTM D1784.
 2. Pipe used in fabricated fittings shall have a wall thickness equal to or greater than the wall thickness of the pipes to which the fitting will be joined.
 3. Acceptable PVC fitting manufacturers shall be the same as identified for pipes.
- C. Fitting Identification
 1. Each fitting shall be clearly labeled. Identify:
 - a. Size
 - b. Pressure class
 - c. Angle deflection, if applicable

2.03 JOINTS

- A. Joints: Joints shall be gasket, bell and spigot and push-on type conforming to ASTM D3139.
- B. The bell and coupling shall be the same, or greater, thickness as the pipe barrel.
- C. Deflection at the joint shall not exceed 1 degree or the maximum deflection recommended by the manufacturer, whichever is smaller.

- D. Gaskets: Gasket material shall be NBR (Nitrile or Buna-N) in accordance with ASTM F477.
 - 1. If gaskets are supplied separately from pipe, it is the Contractor's responsibility to ensure that the gaskets supplied are designed for the pipe in use.
- E. Joint lubricant shall be approved by the pipe manufacturer and shall have no detrimental effect on the gasket or pipe.

2.04 JOINT RESTRAINT

- A. Contractor shall provide joint restraints in accordance with ASTM D2774, AWWA C605, and the Pipe Manufacturer's recommendations.

2.05 TRACER WIRE

- A. Per Colorado Senate Bill 18-167, all new underground facilities, including laterals up to the structure or building being served, require tracer wire.
- B. Tracer wire to be installed in accordance with Section 02300.

2.06 BEDDING AND BACKFILL MATERIALS

- A. Bedding: Pipe Bedding shall be as specified in Section 02300, except as indicated on the drawings.
- B. Backfill: As specified in Section 02300.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Excavate pipe trench in accordance with Section 02300.
- B. Install mechanical restraint per Manufacturer recommendations.
- C. Install polyethylene encasement for fittings in accordance with AWWA C105.
- D. Install tracer wire and test stations per Section 02300.
- E. Minimum depth of cover over the pipe measured from final grade to the top of the pipe shall be 4.0 feet, unless otherwise noted on the Drawings. Deviations from said depth of cover over the pipe shall be approved by the Owner.
- F. Maintain all water and/or force main lines a minimum of 10 feet horizontal from other utilities, unless otherwise indicated on the plans.
- G. Maintain all water and/or force main lines a minimum of 18 inches vertical from other utilities, unless otherwise indicated on the plans.
- H. Contractor shall install pipe to lines and grades as indicated on the plans. Contractor shall notify the engineer of any deviations for review and acceptance.
- I. Install pipe to allow for expansion and contraction without stressing pipe or joints. Maximum deflection of joints shall not exceed AWWA C600 requirements as listed below:

Pipe Size	Maximum Deflection	Radius of Curvature	
		L=18'	L=20'
4" - 12"	5°	205'	230'

- J. Install restrained joints per manufacturers recommendations. Restrained joints shall be placed at all tees, bends, caps, and reducers.

3.02 FLUSHING

- A. Refer to Section 02516 for flushing requirements.

3.03 PRESSURE TESTING

- A. Refer to Section 02516 for hydrostatic testing requirements.

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SECTION 02550

CURED-IN-PLACE PIPE (CIPP) LINING

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers the rehabilitation of fully deteriorated gravity sanitary sewers through the installation of cured-in-place pipe liners, inclusive of the following:
 - 1. Cleaning and flushing existing sanitary sewer pipelines.
 - 2. Closed circuit televising (CCTV) of existing sewer pipelines.
 - 3. Public relation requirements.
 - 4. Cured-In-Place-Pipe (CIPP) liner design and installation.
 - 5. Sampling and testing requirements.

1.02 REFERENCE STANDARDS

- A. Supply all products and perform all work in accordance with the latest applicable ASTM International (ASTM) standards.
- B. The following ASTM Standards are being made part of the Specifications for the various approved processes and will be used as a minimum. Latest revisions of all standards are applicable.
 - 1. ASTM C581 Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures Intended for Liquid Service.
 - 2. ASTM D543 Standard Test method for Resistance of Plastics to Chemical Reagents.
 - 3. ASTM D578 Specification for Glass Fiber Strands.
 - 4. ASTM D638 Standard Test Method for Tensile Properties of Plastics.
 - 5. ASTM D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 6. ASTM D2990 Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
 - 7. ASTM D5035 Test Method for Breaking and Elongation of Textile Fabrics (Strip Method).
 - 8. ASTM D5199 Standard Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
 - 9. ASTM D5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe.
 - 10. ASTM E1251 Standard Practice for General Techniques for Qualitative Infrared Analysis.
 - 11. ASTM F1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
 - 12. ASTM F1743 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).

- 13. ASTM F2019 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).
- 14. ASTM F2561 Rehabilitation of a Sewer Service Lateral and its Connection to the Main Using a One Piece Main and Lateral Cured-in-Place Liner.

1.03 SUBMITTALS

- A. Product Data:
 - 1. CIPP Liners: Submit manufacturer's information on resin, resin enhancer, tube material, curing chemicals, sealant/caulking material, end seals, and lubricants.
 - 2. Submit manufacturers' certificates certifying products meet or exceed specified requirements. Certification shall state that all CIPP materials have been manufactured in accordance with all applicable ASTM standards, and the CIPP method is suitable for the installed environment.
- B. Shop Drawings:
 - 1. For all liners, indicate liner dimensional information for each pipe size to be relined. Include field measurements of each host pipe section with liner design.
- C. Manufacturer's Storage and Installation Instructions:
 - 1. Submit manufacturer's requirements for receiving, handling, and storage of materials.
 - 2. CIPP Liner: Submit detailed description of liner placement and curing procedures for piping. Submit manufacturer's recommended installation pressures and cure times, minimum and maximum, for each reach. Include description of procedures for sealing liner material at manholes and re-establishing service connections.
- D. Contractor Qualifications:
 - 1. Submit documentation of lining installer's experience.
 - 2. Submit certification of Contractor's and Superintendent's licensure to install the provided lining method.
 - 3. Submit documentation from the manufacturer that there is an established and ongoing quality control and quality assurance program for the product at the manufacturer's production facility. This should include proof that the manufacturer has the necessary equipment and trained personnel to properly implement the program.
- E. Design Data: Liner thickness design calculations, in conformance with the specified design requirement, shall be submitted. Design shall be signed and sealed by a Professional Engineer registered in the State of Colorado.
- F. Field Measurements: Contractor to verify pipe materials and measure the actual diameter of each pipe section to be lined. Measurements shall be provided to Engineer. For CIPP lining, each liner section shall be manufactured per actual diameter of pipe section. Provide actual measurements and liner dimensions for each pipe section with liner design.

- G. CIPP Resin Curing Schedule: Submit resin curing schedule indicating the time and temperature for each pipe reach per the manufacturer's requirements.
- H. CIPP Sample Test Results: When requested by the Owner, the Contractor shall submit test results from prior CIPP field installations to verify that the physical properties specified have been achieved in previous field applications. Testing submittal shall include an affidavit from a third-party testing laboratory of installation samples.
- I. CCTV Inspection Records and Reports: CCTV inspections shall be provided for each installation for the full proposed lining extents of the project.
 - 1. Submit CCTV after cleaning and prior to lining, showing the condition of existing pipe and pipe joints.
- J. Public Notification Letter: Submit public notification letter/flyer to Engineer for review and acceptance prior to distribution to public.
- K. Traffic Control Plan per Section 01550.
- L. Liner Extents Plan: Contractor shall provide a plan for lining through existing manholes to the extents as shown on the drawings. Plan shall include a schematic, proposed curing method, plan for maintaining liner integrity, and method of liner integrity verification.
- M. Closeout Submittals
 - 1. Submit post lining CCTV within 3 days after liner installation is complete, showing entire finished liner and re-established service connections. Line shall be dry and clean during the video inspection and CCTV shall include both ends of liner.
 - 2. CIPP Resin Curing logs shall be submitted after the liner installation.
 - 3. Record Drawings per Section 01700.

1.04 DESIGN REQUIREMENTS

- A. GENERAL
 - 1. Design lining material for a fully deteriorated host pipe in accordance with ASTM F1216 or ASTM F1743. Rehabilitated pipe shall have sufficient structural strength to support dead loads, live loads, and groundwater loads imposed.
 - 2. Design liner to least possible thickness to minimize decreasing the inside pipe diameter.
 - 3. Design liner material to provide joint less and continuous structurally sound construction.
 - 4. The liner extent for the existing 30" VCP/RCP pipe includes three manholes along the alignment. The liner should be manufactured to line through each of these structures so that no deformation or wrinkling of the liner will be formed during or after curing.
 - 5. The liner shall be cut open in the manhole trough for existing SSMH 4-7 to allow for the existing sanitary service connection within the manhole to discharge into the newly lined pipeline.
 - 6. The liner extent for the new 30" steel casing pipe is as shown on the Drawings.
 - 7. The design requirements for individual pipe segments are listed in the table below. This design criteria are based on field investigations and existing

records. Contractor should verify field conditions match those shown below and report any differences to the Owner.

Reach	Pipe Size (inches)	Pipe Deterioration	Depth of Bury	Dry Soil Density (lbs./ft ³)	Live Loading	Water Table	Ovality	Factor of Safety
(E) VCP/RCP	30	Fully Deteriorated	Indicated on Drawings	Between 87 and 159 pcf,	Cooper E-80	Between 12 and 19 feet below ground surface	2%	2.0
(N) Steel	30	Fully Deteriorated ^(a)	Indicated on Drawings	Between 87 and 159 pcf	Cooper E-80	Between 12 and 19 feet below ground surface	2%	2.0

Note:

^(a) Fully deteriorated is selected for the new installation to provide additional rigidity to the structural liner design in this location.

- B. Cured-in-Place Pipe, Resin Impregnated Felt Design Requirements: The liner shall be designed in accordance with ASTM F1216, Appendix X1. The design shall assume no bonding to the original pipe wall. All material properties used in design calculations shall be long-term (time-corrected) values. The cured-in-place liner minimum design thickness shall be calculated based on the following physical conditions of the existing pipe.
1. The liner shall be structurally designed for a minimum service life of 50 years.
 2. The safety factor shall be 2.0.
 3. Long-term modulus and strength shall be set to 50% of the initial values given in paragraph 2.01B, above.
 4. Design lining material for a fully deteriorated host pipe.
 5. Live loading shall be considered to be HS-20 except for railroad crossings in which case use Cooper E-80.
 6. All pipes shall be considered to have a minimum of two percent (2%) ovality in the circumference.
 7. Allowable liner deflection of 5%.
 8. The pipeline depth, diameter, and length shown on the Drawings are based on field investigation and existing records. The Contractor shall use field measurements of the pipeline length and diameter for the liner design. Any discrepancies between the Drawings and the field measurements shall be reported to the Engineer.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 3 years of documented experience.
- B. Installer: Company specializing in performing work of this section and who is licensed and approved by the manufacturer. Company shall have a minimum of 3 years of documented experience with projects of similar size and complexity as this project; and with the installation of liner materials specified herein. Project Superintendent shall have a minimum of 3 years of experience as Superintendent on similar Projects.

- C. Design liner under the direct supervision of Professional Engineer experienced in design of this work and licensed in the State of Colorado.

1.06 MATERIAL DELIVERY, STORAGE AND HANDLING

- A. Materials shall be transported to, and stored at, the site in such a manner that they will not be damaged, exposed to direct sunlight, or result in any public safety hazard, and per manufacturers' recommendations.

1.07 COORDINATION

- A. Notify property owners and businesses in advance of expected disruption of sanitary service. Notification shall be provided to each affected property owner in a written format. Submit the public notification letter/flyer to Engineer for review and acceptance prior to distribution to the public.
- B. Limit disruption of service to individual properties to one-time occurrence for maximum 8 hours.
- C. Do not disrupt customer service between the hours of 5:00 p.m. and 8:00 a.m.
- D. Contractor must coordinate service disruptions with City Arvada Utilities Department.

PART 2 - PRODUCTS

2.01 CURED-IN-PLACE PIPE, RESIN IMPREGNATED FELT

- A. Materials
 - 1. Tube: Fabricated from one or more layers of absorbent non-woven felt fabric meeting the requirements of ASTM F1216 or ASTM F1743.
 - a. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. The Contractor shall make allowances in determining the felt tube length and circumference for stretch during installation and shrinkage during curing and aging. The minimum design length shall be that which continuously spans the distance from the center of the inlet manhole to the center of the outlet manhole.
 - b. The tube shall have a uniform thickness equal to the designed nominal tube thickness when compressed at installation pressures.
 - c. The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife.
 - d. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated layers.
 - e. The outside layer of the tube (before installation) shall be plastic coated with a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall not be subject to delamination after curing of the CIPP.
 - 2. Resin: Shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that when properly cured within the tube composite meets the requirements of ASTM F1216 and ASTM F1743. Maximum amount of resin enhancer shall be 30 pounds per 100 pounds of resin.

- B. Structural Requirements: The physical properties of the cured CIPP shall have minimum initial test values as defined in Table 1 of ASTM F1216 and supplemented below for polyester resin. Properties for the polyester or any other enhanced resins shall be substantiated with third party test data.

Property	Test Method	Cured Composite (per ASTM F1216)
Modulus of Elasticity	ASTM D790	400,000 psi minimum
Flexural Stress	ASTM D790	4,500 psi

- C. The tube thickness shall meet approved design calculations based on structural requirements listed herein. The nominal CIPP thickness shall be at least the calculated design thickness, per ASTM F1216, except where fabric layers overlap, in which case it may be in excess of this value. The wall thickness of the felt tube shall be ordered to the next standard 1.5 mm incremental thickness above the minimum calculated design thickness.
- D. Chemical Resistance: The CIPP shall meet the chemical resistance requirements of ASTM F1743, Section 7.
- E. Manufacturers:
1. Tube manufacturers:
 - a. Aegion (Insituform Technologies), Inc.
 - b. Liner Products, LLC
 - c. Applied Felt
 - d. National Liner
 - e. Or Approved Equal
 2. Resin manufacturers:
 - a. AOC
 - b. Richold
 - c. Interplastic
 - d. Substitutions: Not Permitted

2.02 END SEALS

- A. End seals shall create a water tight seal between the liner and the host pipe and meet the requirements of ASTM F1216 and ASTM F1743.
- B. Acceptable manufacturers:
1. LMK
 2. Or Approved Equal

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Contractor shall verify existing conditions before starting work in accordance with Division 1 and other applicable specifications.

- B. Site verification of conditions:
 - 1. Verify field measurements of pipe inside diameters and lengths between manholes prior to design, fabrication, and delivering of liner material.
 - 2. Verify existing pipe material changes from previous repairs.
 - 3. CIPP Liners: Contractor to measure actual diameter of each pipe section to be lined. Measurements shall be provided to Engineer and each liner section shall be manufactured per actual diameter of pipe section. Provide actual measurements and liner dimensions for each host pipe section with liner design.

3.02 CLEANING, FLUSHING, AND LINE OBSTRUCTIONS

- A. It is the responsibility of the Contractor to clear the line of obstructions such as roots, debris, sedimentation, grease, and mineral deposits that will prevent or hinder the insertion of the liner prior to liner installation. Presence of obstructions in the pipeline are considered incidental to the work and are not reason for a change order. Costs for the cleaning and disposal shall be borne by the Contractor.
- B. Clear obstructions, service piping protrusions more than ¼ inch and other materials from entire circumference of existing pipe to ensure inserted pipe liner contacts only existing pipe wall.
- C. If the cleaning work is not satisfactory to the Owner, the Contractor shall perform additional cleaning, at the Contractor's sole cost, so that the installation of the liner pipe is not hindered.
- D. All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting for the cleaning operation shall be removed from the sewer system and properly disposed of by the Contractor, at the Contractor's sole cost.
- E. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public and/or private property being serviced by the sewer line. The Contractor shall bear full costs associated with any flooding or damage to basements of structure.
- F. If the pre-lining video inspection reveals an obstruction such as a protruding service connection, offset joint, or a collapse that will prevent the CIPP insertion process, and it cannot be removed by conventional sewer cleaning equipment, the Contractor shall uncover and remove the obstruction through a point repair. Such excavation must be approved in writing by the Owner prior to the commencement of work. If the obstruction was not shown on the Drawings or revealed by the Contractor at the time of the bid, the work will be considered as a separate pay item by Change Order.

3.03 INITIAL VIDEO INSPECTION

- A. Conduct closed-circuit video inspection in accordance with Section 02951 after cleaning and removal of line obstructions.
- B. Pipeline shall be dry during the pre-lining inspection.
- C. Notify the Engineer and Owner's Inspector if any of the following defects are observed:
 - 1. Major offset of joints
 - 2. Crushed walls

3. Other obstructions.
- D. If flow is resumed in the pipe prior to lining, and after the pre-lining video inspection, the Contractor is required to re-inspect the pipeline immediately before lining to ensure no debris has been introduced into the pipe.
- E. Submit the initial video inspections via thumb drive or file sharing link to the Engineer and Owner's Inspector for review. DO NOT start trenchless rehabilitation until the Engineer and Owner's Inspector has reviewed and accepted the initial video inspections. The Owner may require additional videotaping to ensure that all obstructions have been removed prior to lining.
- F. Submit the video "logs" to the Engineer and Owner's Inspector for review. Each service connection or tap must be documented and the following information provided, if applicable:
 1. Whether the service is active or "capped". Contractor shall determine by dye test, running water, or visual inspection whether connections of active or abandoned.
 2. Linear distance from starting manhole.
 3. Circumferential position on pipe (2 o'clock, 10 o'clock, etc.).
- G. Owner's Inspector and Contractor shall agree prior to liner installation which services are to be re-established, if applicable.

3.04 PUBLIC RELATIONS

- A. The Contractor is responsible for contacting property owners and businesses that are affected by the construction activities to inform them of the Work to be done and the estimated schedule and timing for the Work. Written notice shall be delivered to each home or business 2 weeks prior to installation of the liner. Notice shall include a local telephone number of the Contractor, and contract information for the Owner or Engineer. Written notices must be reviewed by the Engineer prior to distribution to the public.
- B. Two (2) days prior to the liner installation, a follow-up notice shall be delivered to each home or business that has a service connection on the sewer pipeline that is scheduled to be lined. The notice shall instruct occupants to minimize water usage on the day of the liner installation and to fill floor drain traps with water to prevent potential odors.

3.05 INFILTRATION

- A. Minor infiltration (drips or wet, blotchy areas) is a normal condition and is not to be considered a change in conditions by the Contractor. For CIPP liners, if, in the opinion of the Contractor and Engineer, infiltration is significant enough to adversely affect the curing process, the Contractor shall install chemical grout or perform other remedies to address the infiltration, as approved by the Engineer. Chemical grouting or other infiltration remedies will be considered additional work and will be paid for through a Change Order.

3.06 BYPASS SEWAGE

- A. The Contractor is responsible for setting up the bypassing pump system per Section 02070 - Wastewater Flow Management Plan, and Section 02072 - Wastewater Emergency Response Plan to isolate each section of piping for lining.

- B. Maintain bypass pumping until lining is totally formed and fully cured and service connections are re-instated, if applicable.
- C. Coordinate with other work prior to removal of bypass pumping.
- D. All traffic control issues resulting from the bypass pumping, including interruption of traffic flow due to laying bypass pipe across intersections, are the responsibility of the Contractor and shall be coordinated with the appropriate jurisdictions and governing agencies. Contractor is also responsible for coordination with local businesses and residences that may be affected by the bypass pumping operations. Driveway access shall be maintained to homeowners and business at all times.
- E. Bypass design flows are listed in Section 02070. Flows listed are approximated based on flow metering data and should be verified by the Contractor prior to start of work.

3.07 INSTALLATION, CURED-IN-PLACE PIPE - RESIN IMPREGNATED FELT

- A. Cured-In-Place Pipe installation shall be in accordance with ASTM F1216, or ASTM F1743, with the exception that resin impregnation shall only take place at a permanent facility. Field wet-outs will be allowed with Engineer's approval.
- B. Pre-qualified Installers:
 - 1. Aegion (Insituform Technologies) (National)
 - 2. Inland Pipe Rehabilitation (previously Granite) (National)
- C. The Contractor shall verify the lengths between manholes in the field before the liner tube is cut and impregnated. Individual installation runs may include one or more manhole-to-manhole sections as authorized by the Engineer.
- D. Resin Impregnation: The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. To ensure thorough resin saturation throughout the length of the felt tube, the point of vacuum shall be located to create adequate withdrawal of air so that the tube is fully wet out and no dry spots are visible at the exterior coating.
- E. Unless otherwise specified to provide for excess resin migration, the gap thickness of the wetting out equipment shall be sized to allow an excess of 5 to 10 percent resin to pass during impregnation.
- F. The leading edge of the resin slug shall be as near to perpendicular as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the Installer uses an alternate method of resin impregnation, the method must produce the same results.
- G. Tube Insertion: The wet-out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.

- H. Temperature gauges shall be placed inside the tube at the invert level of each end to monitor the temperatures during the cure cycle. Curing logs are to be kept and submitted to Engineer.
- I. Curing shall be accomplished by utilizing hot water under hydrostatic pressure or low temperature steam pressure in conjunction with low pressure air for inversion in accordance with the manufacturer's recommended cure schedule. Once the liner installation has started, installation pressures shall be maintained between the minimum and maximum pressures as required by the manufacturer until the operation has been completed. Should the pressures deviate from within the acceptable operating range, the installed liner will be rejected and the Contractor must remove and dispose of the tube at no cost to the Owner. Cure schedules must be strictly adhered to with no exceptions.
- J. "Dimples" shall be visible where service openings are present so it is absolutely clear where the service openings are located. If dimples are not present, Contractor to use infrared device to locate sanitary sewer service connections.
- K. The Contractor shall apply an annular space, hydrophilic sealant at the manhole or CIPP termination point. The seal shall be of a material compatible with the CIPP material and shall be approved by the Owner or Engineer.
- L. If the Contractor lines through an active manhole or structure (i.e. not identified as abandoned on the Drawings), the top half of the CIPP liner shall be neatly cut off, not broken or sheared off. The opening shall be smoothed so that no tears or burrs are present. The channel section through the manhole shall be smooth. Void space between the liner and the channel wall shall be filled with non-shrink grout and sealed with the annular space sealant. All manholes shall be individually inspected. Liners installed through structures that have deflection angles greater than 45 degrees, shall be cut off at the pipes and the liners shall be removed from inside the structure. If access to a manhole is not available, this shall be discussed during the lining extent plan submittal.
- M. Liner shall be trimmed at the inside edge of the manhole or vault. The trimmed liner shall be smoothed so that no tears or burrs are present.

3.08 INSTALLATION - END SEALS AT MANHOLES OR VAULTS

- A. End seals will create a water tight seal between the host pipe and the liner. Seals will be installed per manufacturer recommendations and meet all applicable ASTM standards.
- B. Where voids are present, a sealant may be used in addition to end seals. Sealant shall be a quick-set epoxy or high viscosity epoxy with good adhesion to the liner and concrete. Contractor will apply sealant to create a watertight and flexible seal between the liner and the host pipe.
- C. The channel in the manhole or vault shall be a smooth continuation of the pipe(s) and shall be merged with other lines or channels. Void space between the liner and channel wall shall be filled with non-shrink grout and sealed with sealant.
- D. All sealants and grouts coming into contact with the CIPP material will be approved for use with the CIPP product by the CIPP manufacturer.

- E. All manholes or vaults shall be individually inspected for liner cut-offs and end sealing works. Liner shall be cut off at pipes and all liner removed within intermediate manholes with deflection angles greater than 45 degrees.

3.09 FIELD QUALITY CONTROL

- A. Construction Observation will be performed in accordance with Division 1 and applicable specifications. Additional observation may be required by Engineer.
- B. Manhole structures shall be protected from damage.
- C. When liner fails to form, remove failed liner and install new liner.
- D. No infiltration of groundwater is permitted after installation of liner.
- E. Confirm service connections are complete and are unobstructed.
- F. Wrinkles or lifts shall not exceed 2% of the host pipe diameter, or ¼ inch, whichever is greater. Contractor shall repair or replace that section of the pipe at no additional cost to the Owner. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for approval.
- G. Defects such as foreign inclusions, dry spots, pinholes, delamination, and wrinkling beyond the specification allowances, as determined by the Engineer as affecting the integrity or strength of the liner, or as adversely affecting the hydraulic capacity of the pipe, shall be repaired or replaced. Contractor shall repair or replace that section of the pipe at no additional cost to the Owner. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for approval.
- H. Excavate for point repairs or service connections only on an emergency basis and as permitted by the Owner or Engineer.
- I. Where field wetouts are used, a manufacturer's representative, with a minimum of 2 years' experience with in-line mixing, will be present on site for the first 24 hours of production and available by phone for 24-hours coverage thereafter.

3.10 FIELD SAMPLES

- A. This section applies to Cured-In-Place Pipe for Resin Impregnated Felt.
- B. Field Samples for CIPP:
 - 1. Contractor shall submit samples as required herein. Contractor shall provide all labor and materials necessary to produce samples for laboratory and/or field testing. Contractor to contract directly with third party certified laboratory for testing as required.
 - 2. The wall thickness will be measured in accordance with the applicable ASTM Standards. Test method to be determined by testing laboratory. Any liner having a measured wall thickness of less than 80% of the required thickness shall be removed and replaced with a liner meeting the minimum thickness requirements.
 - 3. The flexural strength and flexural modulus of elasticity shall be determined in accordance with ASTM D-790. Any liner having test results with flexural strength or flexural modulus of elasticity of less than 80% of the specified flexural strength and flexural modulus shall be removed and replaced with a liner meeting the strength requirements.
 - 4. Method for obtaining sample for 18 inch-diameter pipe or larger:

- a. Provide a flat plate sample using the method described in ASTM F1216. An affidavit shall be provided by the wetout facility for each flat plate sample. The affidavit shall state that the flat plate sample is the same as the liner it represents.
 - b. Label the manhole number and date of installation and submit the sample pipe to the laboratory for testing.
- 5. Sample frequency:
 - a. One (1) sample per wet-out batch.

3.11 POST-LINING VIDEO INSPECTION

- A. Conduct closed-circuit video inspection in accordance with the specifications of this project regarding Video Inspection of Pipelines after cleaning and removal of line obstructions.
- B. Pipeline shall be dry during the post-lining inspection.
- C. Submit the post video inspections on a thumb drive or file sharing link to the Engineer and Owner's Inspector for review.

3.12 CLEANING AND SITE RESTORATION

- A. Remove debris resulting from work and unused materials from site and legally dispose.
- B. Areas damaged or modified by the Work shall be repaired or restored to a condition equal to or better than the original condition. Site restoration is incidental to the Work and shall not be regarded as a reason for change orders.
- C. Care shall be taken to avoid damage to private property (i.e. sprinkler systems, lawn areas, etc.). If damage occurs, repairs shall be completed as soon as possible. Costs associated with the repairs shall be the responsibility of the Contractor.

END OF SECTION

SECTION 02721

AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Aggregate base course.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 300.
- B. CDOT Standard Specifications for Road and Bridge Construction
- C. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb Rammer and an 18-in. Drop.
- D. American Society for Testing and Materials:
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³).
 - 3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, newest version.

1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Materials testing shall be performed in accordance with Minimum Materials Testing Frequencies found in Section 322 of the City of Arvada Engineering Code of Standards and Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials and construction shall be in accordance with the requirements of Section 304 of the CDOT Standard Specifications for Road and Bridge Construction
- B. Aggregate Base Course: Base course material gradation shall meet the requirements of Class 5 (1½" maximum) or Class 6 (1" maximum), in accordance with Table 703.03 of CDOT Standard Specifications for Road and Bridge Construction.

Sieve Size	Max % Passing
50 mm (2")	100
25 mm (1")	85-100
19 mm (3/4")	75-100
12.5 mm (1/2")	55-90
9.5 mm (3/8")	45-80
4.75 mm (#4)	25-55
1.18 mm (#16)	5-25
75 µm (#200)	0-5

- C. Herbicides
 - 1. As specified in Section 217 Herbicide Treatment, Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.
 - 2. Labels shall be registered with the Colorado Department of Agriculture and the U.S. Environmental Protection Agency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.
- C. Excessively dry surfaces shall have water applied to them and shall be reprocessed.

3.03 AGGREGATE PLACEMENT

- A. Aggregate base course placement shall comply with Section 300 – Soils and Earthwork of City of Arvada Engineering Code of Standards and Specifications.

- B. Placing and spreading shall be done by means of a spreader machine, moving vehicle, motor grader, or by other approved equipment methods. The material shall be placed without segregation. Any segregated areas shall be removed and replaced with uniformly graded material at the Contractor's expense.
- C. The thickness of each base course layer shall not exceed six (6) inches before compaction. If uniform density cannot be obtained by six (6) inch lifts, the maximum lift thickness shall not exceed four (4) inches. Each lift must be compacted with vibratory equipment.
- D. Compact to 95% of the maximum density determined in accordance with AASHTO T180 as modified by CP 23. If uniform density cannot be obtained by 6-inch layers, the maximum thickness shall not exceed 4 inches. The moisture content shall be $\pm$ 2 percent of optimum moisture content.
- E. The prepared base course surface shall be smooth and free of ruts and irregularities and shall be level and contour surfaces to elevations and gradients indicated. The base course shall be maintained in this condition by watering, drying, rolling, and/or blading until the asphalt or concrete flatwork is placed. The surface tolerance of the base course shall be in accordance with Section 304.06 of the CDOT Standard Specifications for Road and Bridge Construction.
- F. Maintain optimum moisture content of fill materials to attain required compaction density.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation
- B. Compaction testing shall be performed in accordance with Section 304 of the CDOT Standard Specification for Road and Bridge Construction. After passing all compaction tests, the base course shall be proof-rolled.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
- D. Frequency of Tests: As specified in Section 322 of the City of Arvada Engineering Code of Standards and Specifications.

END OF SECTION

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SECTION 02740
FLEXIBLE PAVEMENT (ASPHALT)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Asphaltic concrete paving, wearing, binder, and base course.
 - 2. Surface sealer.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 900.
- B. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, latest edition.
- C. Municipal Government Pavement Engineers Council (MGPEC), Pavement Design Standards and Construction Specification Manual, latest edition.

1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Product Data: Submit product information and mix design.
- C. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Section 01600 - Product Requirements: Environmental conditions affecting products on site.
- B. Hot mix asphalt shall be placed only on properly constructed subgrade and interim lifts that are free from water, snow, ice, and frozen subgrade. The asphalt shall be placed only when weather conditions permit the pavement to be properly placed and finished as determined by the Owner's Inspector. The hot mix asphalt shall be placed only when both the air and surface temperatures equal or exceed the temperatures specified in table below.
 - 1. Air temperature shall be taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.
 - 2. The Project Engineer may waive minimum temperature requirements for placing prime coats and layers of asphalt below the top layer of the pavement section.

Compacted Layer Thickness (inches)	Minimum Air and Surface Temperature (°F and rising)	
	Top Layer	Layer Below Top Lift
2 to < 3	50	40
3 or more	45	35

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate Base Course: In accordance with Section 02721 Aggregate Base Course and the City or County standards having jurisdiction.
- B. The gradation of the mineral aggregate shall be grading SG (1 inch nominal), S (3/4 inch nominal) or SX (1/2 inch nominal). In no case shall grading SG be used for a permanent final lift of asphalt; however, the Project Engineer may require the use of grading SG in a pavement section. Grading SX (1/2 Inch Nominal) shall be used for the permanent final lift or overlay of all asphalt, unless approved by the Project Engineer.
- C. All asphalt pavement mix designs shall be based off of City and County of Denver Standard Drawing 12.7 -Typical Asphalt Mix Details by Traffic Use or Lift Position.
- D. Aggregate for Hot Bituminous Pavement:
 1. Grading S: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.

<u>Sieve Size</u>	<u>Percent Passing</u>
1-inch	100
3/4 -inch	90 to 100
No. 8	23 to 49
No. 200	2 to 8

2. Grading SX: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 -inch	100
1/2 -inch	90 to 100
No. 8	28 to 58
No. 200	2 to 10

3. Grading SG: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 ½ -inch	100
1 -inch	90 to 100
No. 8	19 to 45
No. 200	1 to 7

E. Tack Coat: In accordance with MGPEC Item 20.5 Tack Coat.

F. Seal Coat: In accordance with CDOT Section 409 Chip Seal.

2.02 ASPHALT PAVING MIX

- A. Materials shall comply with Section 900 – Asphalt Mix Design and Construction of City of Arvada Standards and Specifications.
- B. Asphalt mixes shall be from the City and County of Denver Approved Hot Mix Asphalt Designs List and shall be submitted to the Project Engineer for approval fourteen (14) days prior to placement.

2.03 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Testing, inspection, and analysis requirements.
- B. Submit proposed mix design for review prior to beginning of Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subbase is dry and ready to support paving and imposed loads.
- B. Verify grades and elevations of base are correct.
- C. Verify that manhole frames, valves etc. are installed in correct position and elevation.

3.02 ASPHALT CUTS

- A. All cuts to be squared off with a saw-cut or blade-cut prior to restoration.
- B. Maximum width of asphalt cut shall be 12-inches from edge of concrete gutter.
- C. Cuts shall be made so that the asphalt patch extends past the trench wall 24-inches minimum on each side or per City/County requirements.
- D. The Contractor shall place a temporary, cold mix, asphalt patch in all street cuts immediately after completing backfill and compaction if a permanent hot mix asphalt patch cannot be installed. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.

- E. When pavement cuts are required, the following conditions shall be met to avoid interference with traffic:
1. Pavement cuts in streets shall be open only between 9:00 a.m. and 3:30 p.m.
 2. Two-way traffic shall be maintained at all times around the construction area. A Traffic Control Plan (TCP) shall be prepared in accordance with Section 01550.

3.03 BASE COURSE

- A. Aggregate Base Course: Install as required by the City/County having jurisdiction or per the approved pavement design, and as specified in Section 02721 Aggregate Base Course.

3.04 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with MPGEC Item 20.5 Tack Coat.
- B. Apply tack coat to contact surfaces of curbs and gutters.

3.05 PLACING ASPHALT PAVEMENT

- A. Place asphalt pavement in accordance with City/County standards. City of Arvada requires asphalt and placement compaction shall comply with MGPEC Item 20, latest edition.
- B. Place asphalt within 24 hours of applying tack coat.
- C. Unless otherwise required by the City/County or indicated on the Drawings, place asphalt to a total compacted minimum thickness of 6.5 inches.
1. Place Hot Bituminous Pavement Grading S to 4.5 inches compacted thickness.
 2. Place Hot Bituminous Pavement Grading SX to 2 inches compacted thickness.
- D. The minimum allowable compacted lift thickness shall be two (2) inches. The generally accepted standard for compacted lift thickness is three times (3X) the nominal maximum particle size (NMPS). In no case shall the compacted asphalt layer thickness be greater than four times (4X) the NMPS.

Gradation	Minimum Lift Thickness	Maximum Thickness
SG	3"	4"
S	2.5"	3"
SX	2"	3"

- E. Compact each course by rolling to specified density. Densities shall be between ninety-two (92) percent and ninety-six (96) percent of the Rice unit weight (theoretical maximum density) as determined by an independent asphalt testing laboratory. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment. See Section 900 - Asphalt Mix Design and Construction of City of Arvada Standards and Specifications for additional compaction requirements.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without

roller marks.

- G. Contractor to repair/replace all traffic signal wires damaged during paving operations.
- H. Contractor to restore all pavement markings per City/County standards.
- I. Contractor shall place asphalt in a T-patch in accordance with Arvada Engineering Code of Standards and Specifications Detail 900-1.

3.06 MANHOLE RIM AND VALVE/SURVEY RANGE BOX ADJUSTMENTS

- A. Manholes, valve boxes and survey range boxes shall be adjusted to within one-quarter inch ($\frac{1}{4}$ ") below finish grade before the final surface course of pavement is placed. The Contractor shall remove all foreign matter found or introduced into them in the performance of this work, and it shall be their responsibility to ensure proper compaction around them after they have been adjusted. Manholes, valve boxes, and range boxes should be set to final grade just prior to the final lift of asphalt being placed on newly constructed or newly re-constructed streets.
- B. If manholes are not set to grade prior to the final lift of HBP being placed, the Contractor shall vertically and uniformly cut the existing asphalt mat full depth three (3) feet square around the center of the manhole with sides parallel and perpendicular to street centerline. Manholes shall be raised to proper grade using concrete riser rings. If more than twelve inches (12") of concrete riser rings are required to raise the manhole lid to final grade, then a new manhole barrel section must be installed to allow the lid to be set to grade with less than twelve (12") of concrete riser rings. If range boxes and valve boxes are not set to grade prior to the final lift of asphalt being placed, the asphalt mat shall be core drilled full depth twelve (12") diameter centered on the valve box or range box. Auger drilling shall not be allowed. Range boxes shall then be set on compacted subgrade at the proper elevation to match final grade. Adjustable range boxes shall be screw adjusted to within one-quarter inch ($\frac{1}{4}$ ") below existing grade. Valve boxes shall also be screw adjusted to within one-quarter inch ($\frac{1}{4}$ ") below final grade. Drop in type valve box risers shall not be allowed on newly constructed or newly re-constructed streets. New hot mix asphalt (Grading SX, $\frac{1}{2}$ " mix) shall be placed and properly compacted in the excavated area. The entire area in the vicinity of the raised manhole, valve box or range box shall then be infrared repaired to blend the Patch with the existing asphalt and to eliminate any vertical joints in the final lift of asphalt.
- C. On streets that are being sealed, the Contractor shall cover the manholes, valve boxes and survey range boxes with roofing paper or other suitable material prior to sealing. The covering shall be left in place for a minimum of forty-eight (48) hours after which it shall be removed and disposed of. All covers shall be clean when work is complete.
- D. In the case of manhole rings, the Contractor shall vertically and uniformly cut the existing asphalt mat eight (8) inches from the ring and remove the mat and base to a depth of six (6) inches below finish grade. Rings shall then be removed, and the existing riser rings adjusted and pointed to provide the required subgrade for resetting the set rings, free of pressure points. Once the ring is reset to finish grade the collar eight (8) inch x six (6) inch void between the mat and the ring shall be

filled with asphaltic concrete and compacted.

3.07 ADAMS COUNTY ASPHALT REQUIREMENTS

- A. Existing asphalt pavement shall be removed to straight edges made by full-depth vertical saw cuts. A "T" patch with additional width for the top course of asphalt will not be required since the County expects to modify or reconstruct the pavement with the future Tennyson Street Improvements project.
- B. The edges of pavement removal/patching must be located 1 foot or more outside of the top edges of the trench excavation, i.e., the patch width shall be 2 feet or more wider than the top width of trench.
- C. The sawcut edges of existing pavement must receive a tack coat of diluted emulsified asphalt before the patch material is placed.
- D. Patch material shall be Hot Mix Asphalt SX (75) (PG 64-22) placed and compacted in lifts with typical thickness of 2 inches and maximum thickness of 3 inches. A substitute asphalt mix may be submitted to Adams County for consideration.

3.08 TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Scheduled Compacted Thickness: Within $\frac{1}{4}$ -inch.
- C. Variation from Indicated Elevation: Within $\frac{1}{2}$ -inch.
- D. Or as required by the City/County having jurisdiction.

3.09 POTHOLE REPAIR

- A. Exploratory potholing voids are to be backfilled and the core patched with a temporary patching material immediately after initial potholing is complete.
- B. All material disturbed and/or removed during the exploratory operation shall be replaced with an approved flow-fill mix.
- C. Squeegee shall not be allowed as backfill material except for use as pipe bedding with a twelve inch (12") maximum depth over the pipe.
- D. Within seven (7) days of initial drilling, or within a reasonable and practical amount of time after completion of the projected work, potholes will be permanently patched.
- E. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.
- F. Any exploratory pothole and/or patch that are deemed dangerous shall be repaired immediately.
- G. All permanent repairs shall be made to look symmetrical and/or uniform. No jagged, uneven patches will be allowed.
- H. All edges and patch areas shall be dried, cleaned and tacked. All newly placed asphalt shall be maximum one-half inch ($\frac{1}{2}$ ") mix (SX) and shall be compacted properly in two (2) inch lifts.

3.10 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Materials testing shall be performed by a qualified geotechnical engineer working under the direction of a Colorado Registered Professional Engineer. Testing shall be included in the Contractor's overall cost for the project. In cases where testing indicates that construction does not meet the project specification requirements, costs for additional testing shall be borne by the Contractor.
- C. See the asphalt testing table in the Arvada Engineering Code of Standards and Specifications section 922.00 for additional requirements related to asphalt testing, reference standards, and minimum test frequencies.

END OF SECTION

SECTION 02750
RIGID PAVEMENT (CONCRETE)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Concrete sidewalks.
 - 2. Concrete curbs, gutters, curb ramps, and crosspans.
 - 3. Miscellaneous concrete slabs.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 800.
- B. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, current version.

1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Product Data: Submit product information and mix design for each proposed mix to be used.
- C. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Aggregate Base Course: In accordance with Section 02721 Aggregate Base Course and City/County standards.
- B. Concrete materials shall meet the requirements specified in the appropriate subsections listed in CDOT Section 601 *Structural Concrete* and the appropriate City/County standards.
- C. Roadways, Crosspans, Curb Cuts, Curb Ramps, Driveways, Sidewalks, Curb, and Gutter:
 - 1. Class P Concrete, in accordance with CDOT Section 601 *Structural Concrete*.
 - 2. Minimum 28-day compressive strength: 4,500 psi.

2.02 REINFORCING STEEL

- A. Reinforcing Steel in accordance with CDOT Section 602 *Reinforcing Steel*.

2.03 FORM MATERIALS

- A. Forms shall be of wood, metal, or other suitable material, and shall extend from the full depth of the concrete.
- B. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing.
- C. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. It is the responsibility of the Contractor to contact the Owner's Inspector a minimum of one (1) full working day (twenty-four [24] hours) in advance of the required inspections. Concrete shall not be placed until all forms and reinforcement have been observed by the Owner's Inspector. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications for inspection requirements.

3.02 BASE COURSE

- A. Aggregate Base Course: Install as required by the City/County and as specified in Section 02721 Aggregate Base Course.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement, as applicable.
- C. Notify Owner's Inspector and Project Engineer a minimum 24 hours prior to commencement of concreting operations.
- D. All edges of the existing flatwork to remain shall be saw cut. Flatwork repairs and replacement shall be as directed by the Owner's Inspector and at the Contractor's expense.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with City/County standards and in accordance with CDOT Section 601.12 *Placing Concrete*.

- B. Concrete thickness shall match existing concrete thickness unless otherwise noted.
 - 1. Detached sidewalks along local residential streets shall be a minimum of four (4) inches thick and all other sidewalks shall be a minimum of six (6) inches thick. Areas of sidewalk or concrete trails crossed by driveways or in parks, open spaces or greenbelts shall be constructed with a minimum of six (6) inch thick concrete.
 - 2. Curb cuts in six (6) inch vertical curbs shall be constructed at all driveway locations.
- C. Curb ramps shall be installed at locations designated by the Project Engineer and as shown on the Drawings. Directional curb ramps, rather than diagonal or corner curb ramps, shall be installed unless site conditions or constraints prohibit their placement; or their placement creates an unsafe or undesirable condition for pedestrians or wheelchair travel along the sidewalk. The curb ramps shall be constructed with slopes, landings, and detectable warnings (truncated domes) as shown in the latest revision of the Colorado Department of Transportation M&S Standards. Truncated domes shall be from the CDOT approved products list, and the Contractor shall follow specific installation details per the manufacturer. Replaceable cast-in-place (wet set) truncated dome panels shall be easily removed and replaced, made of fiber reinforced fiberglass/composite material, and color shall contrast the surface applied to. Panels shall have a beveled edge for wheelchair egress. No truncated dome pavers shall be used within City right-of-way. Panel size shall have a depth of two (2) feet.
- D. Fresh concrete shall be adequately protected from weather damage and mechanical injury during curing periods. Should damage occur, the concrete shall be removed and replaced at no cost to the Owner. The selected curing process shall be started as soon as it can be performed without injury to the concrete surface. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications for additional placing requirements.

3.05 TESTING

- A. A representative of the concrete testing agency shall inspect, sample, and test material and production of concrete as required by the Project Engineer. Minimum testing frequency shall be as specified in Section 825.00 of the Arvada Engineering Code of Standards and Specifications.
- B. Any test failures shall trigger testing for the next three (3) loads. The concrete testing agency shall report all test and inspection results to the Project Engineer and Contractor immediately after they are performed. All test reports shall include the exact location of the work at which the batch represented by a test was deposited. The report of the strength test shall include detailed information on storage and curing of specimen prior to testing, the project number, and the location of the concrete (curb, manhole, inlet, sidewalk, paving, etc.).
- C. The concrete testing agency or its representative is not authorized to revoke, alter, relax, expand or release any requirements of these Standards and Specifications, nor to approve or accept any portion of the work. When it appears that any material furnished or work performed by the Contractor fails to fulfill

specification requirements, the testing agency shall report such deficiencies to the Project Engineer and the Contractor.

D. See Section 03330 for additional requirements.

3.06 FINISHING

- A. Sidewalks and Bikeways: Light broom and trowel joint edges.
- B. Curbs and Gutters: Light broom.
- C. Parking Area Pavement: Light broom.

3.07 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation.

END OF SECTION

SECTION 02951

VIDEO INSPECTION OF PIPELINES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipeline flushing and cleaning.
 - 2. Video inspection of sewer pipelines
 - a. All new gravity sewer lines
 - 3. Audio-video taping of pipeline interior.

1.02 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Submit completed USB drives, identified by project name, street name, and manhole numbers. USB drives become property of Owner.
- C. Submit cleaning and television inspection logs for each section of sewer line to be inspected.

1.03 QUALIFICATIONS

- A. Video inspection of pipelines to be completed by a Company specializing in performing work of this section with minimum 5 years documented experience.
- B. Video inspections must be in NASSCO version 7, or latest edition.

PART 2 PRODUCTS

2.01 MEDIA

- A. NASSCO Version 7 Compatible, or latest edition.
- B. Windows Real Player, Windows Media Player, or Flexireader formatted USB drives.
 - 1. Videos shall be delivered in Mpeg4 format.
- C. Audio track containing simultaneously recorded narrative commentary describing in detail condition of pipeline interior.

2.02 CONTENTS OF VIDEO INSPECTION

- A. The following information, to the extent it can be reasonably determined, is to be recorded visually on the USB drives, and video logs. NASSCO Version 7, or latest edition, shall be followed.

- B. Date: The date on which the videotaping was performed at the beginning of each segment.
- C. Manhole to Manhole: The manhole identification number for both the upstream and downstream manholes at either end of the taped segment.
- D. Direction of Video: Relative to flow direction, indication whether the camera is facing upstream or downstream.
- E. Continuous Digital Counter: A digital counter to designate the distance from the "upstream" manhole.
- F. Street Name: The street name which contains the video segment and/or the nearest cross street.
- G. Service Identification: Identification of all taps by size, type, and pipe entrance location. A clock reference is also preferred.
- H. Cracks: Identification of all cracks (spiral, lateral, beam) by type, severity, location and footage.
- I. Broken Pipe: Identification of all broken pipe other than cracks by location, cause if known (i.e., improper installation of service, encroachment of other utility, etc.), severity, and footage.
- J. Sags: Identification of all sags greater than one inch (1") by beginning/start, best estimate of depth of sag (greatest point), and ending footage. If the segment has a number of sags or one long continuous sag, view the apparent length and depth of the sag. Once convinced as to the extent of the sag, suck the sag down by the use of the jet cleaning unit so the condition of the pipe wall can be viewed. Also identify any apparent high spots.
- K. Infiltration: Identification of all forms of infiltration (or exfiltration) by estimation of flow volume (GPM), possible source, visible calcium deposits, and footage.
- L. Vertical/Horizontal Offset Joints: Identification of all joints which appear to be offset from original alignment, severity, location, and footage.
- M. Wide Joints: Identification of all joints which appear to have a wider separation of bell and spigot than normal, by width and footage.
- N. Oval/Deformed Pipe: If PVC or other flexible pipe material exists which may deflect and not sustain noticeable failure, identification of shape of pipe (i.e., egg shaped, non-circular, etc.), footage, and location.
- O. Percent Deterioration: Identify severity of deterioration.
- P. Lens Height: Indication whether the camera has been lowered, and the reason. Otherwise, the camera should be set as close to the center of the pipe as possible.
- Q. Size and Type (Material): List inside pipe diameter and type of material for each pipe segment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify location of sewer pipelines to be inspected.

3.02 PREPARATION

- A. Flush and clean pipeline interiors to remove sludge, dirt, sand, stone, grease, and other materials from pipe to ensure clear view of interior conditions.
- B. Intercept flushed debris at next downstream manhole by use of weir or screening device, remove, and dispose of debris from system off site.

3.03 APPLICATION

- A. Closed-circuit TV Camera System:
 - 1. Utilize cameras specifically designed and constructed for closed-circuit sewer line inspection. Utilize camera equipment with pan and tilt capability to view each lateral connection at multiple angles.
 - 2. Utilize camera capable of moving both upstream and downstream; minimum 1,000 feet horizontal distance with one setup; direct reading cable position meter.

3.04 PROCEDURES

- A. Color Video: Since color provides better contrast and detail, no black and white video will be accepted.
- B. Video (Travel) Speed: To the extent practicable, the speed range at which all segments will be videotaped will be a maximum of 1 Ft/Sec, and a minimum of ½ Ft/Sec. Should variance from these parameters occur, it must be noted on the audio, and the reason for the variance. It is recognized that variance from the minimum speed according to the condition of the pipe is not a serious problem, but that exceeding the maximum velocity can reduce the viewability of the video and may be grounds for request of re-videotaping the specified segment.
- C. Counter Variance:
 - 1. Variance of counter/as-built distance shall not exceed the following:

As-Built Distance	Variance
0 - 100 feet	2%
101 - 200 feet	2%
201 - 300 feet	3%
301 - 400+ feet	3%

- 2. If the as-built distance and counter distance have a greater difference than specified by the variance, the Contractor shall either verify recorded as-built distance or re-video the entire segment.
 - D. Lens Obstruction: If the lens is obstructed by a foreign object or by fog (e.g., water spray, mist, etc.), attempt to clear the lens of the obstruction. If attempts fail and

additional videotaping would produce the same results, continue to videotape the extent of the segment; otherwise, re-video all or the portion which had not been viewed.

- E. Lighting: Ensure that the illumination level inside the pipe is high enough to identify clearly the condition of the interior circumference. If segments are not already visible, a request will be made to re-video the segment. If there are outside contributing factors which make the pipe impossible to illuminate, identify such on video log.
- F. Skips in Video: If a portion of the video segment is not recorded on the CD USB drive (such as through malfunction of equipment), the segment must either be entirely re-videotaped from the beginning of the skip to the end, or the entire segment must be re-videotaped. Such corrective action will be at the Contractor's expense.
- G. Video Footage: Properly identify footage from "upstream" manhole (i.e., as-built footage is from center of manhole to center of manhole). State location of beginning of video segment and correlate counter to this footage (i.e., beginning of pipe segment would be 2 feet, center of manhole would be 0 feet).

3.05 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation.

END OF SECTION

SECTION 03100

FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formwork requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03330 - Concrete Testing and Inspection.
 - 4. Section 03350 - Concrete Mixing, Placing, Jointing, and Curing.
 - 5. Section 03351 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 347R, Guide to Formwork for Concrete.
- B. Qualifications:
 - 1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
 - a. Above qualifications apply to slabs and beams not cast on the ground.
- C. Miscellaneous:
 - 1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
 - 2. Design requirements:
 - a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
 - 1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
 - b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
 - 3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores and installation of reshores and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
 - a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the

loads placed thereon. Calculations shall be performed by a licensed professional engineer.

- b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
 - 1) The structural system that exists.
 - 2) Effects of all loads during construction.
 - 3) Strength of concrete.
 - 4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
 - 5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
 - 6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Div 01 for the requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Manufacturer and type of proposed form ties.
- B. Calculations:
 - 1. Calculations signed and sealed by a professional engineer for shoring systems of elevated slabs.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms for Surfaces Exposed to View:
 - 1. Wood forms:
 - a. 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
 - b. Built-in-place or prefabricated type panel.
 - 2. Metal forms:
 - a. Metal forms may be used except for aluminum in contact with concrete.
 - b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.
- B. Forms for Surfaces Not Exposed to View:
 - 1. Wood or metal sufficiently tight to prevent leakage.
 - 2. Do not use aluminum forms.

2.2 ACCESSORIES

- A. Form Ties:
 - 1. Commercially fabricated for use in form construction.
 - a. Field fabricated ties are unacceptable.
 - 2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
 - 3. Embedded portion of ties to be not less than from face of concrete after ends have been removed.
 - 4. Cone size:
 - a. 3/4 IN minimum diameter cones on both ends.
 - b. Depth of cone not to exceed the concrete reinforcing cover.
 - 5. Provide ties with built-in waterstops in all walls that will be in contact with liquid and/or below grade soil.
 - 6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with process liquid during plant operation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Form Surface Treatment:
 - 1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
 - a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
 - 2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.
- B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
 - 1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.
- C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

- A. Install products in accordance with manufacturer's instructions.
- B. Tolerances:
 - 1. Conform to ACI 117.
 - 2. Variation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in risers.
 - 1) Maximum in any 10 FT of height: 1/4 IN.
 - 2) Maximum for entire height: 1/2 IN.
 - b. For exposed corner columns, control-joint grooves, and other exposed to view

- lines:
 - 1) Maximum in any 20 FT length: 1/4 IN.
 - 2) Maximum for entire length: 1/2 IN.
 - 3. Variation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
 - 1) Maximum in any 10 FT of length: 1/4 IN.
 - 2) Maximum in any bay or in any 20 FT length: 3/8 IN.
 - 3) Maximum for entire length: 3/4 IN.
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
 - 1) Maximum in any bay or in 20 FT length: 1/4 IN.
 - 2) Maximum for entire length: 1/2 IN.
 - 4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
 - a. Maximum in any bay: 1/2 IN.
 - b. Maximum in any 20 FT of length: 1/2 IN.
 - c. Maximum for entire length: 1 IN.
 - 5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
 - 6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.
 - 7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.
 - 8. Footings and foundations:
 - a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
 - b. Misplacement or eccentricity:
 - 1) 2 PCT of footing width in direction of misplacement but not more than 2 IN.
 - c. Thickness:
 - 1) Decrease in specified thickness: 5 PCT.
 - 2) Increase in specified thickness: No limit except that which may interfere with other construction.
 - 9. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
 - 10. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
 - 11. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.
- C. Make forms sufficiently tight to prevent loss of mortar from concrete.
- D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.
- E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.

1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
 2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.
- F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.
1. Brace and tie formwork to maintain correct position and shape of members.
- G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.
- H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.
- I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.
- J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
1. Securely brace forms against lateral deflection.
 2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.
- C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.
- D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.
- E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
1. For walls of water containing structures, leave forms in place for a minimum of 48 HRS.
- F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28 day compressive strength.
1. Where a reshoring procedure is planned, supporting formwork may be

removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

- G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.
- C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.
- D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.
- E. Tighten reshores to carry their required loads without overstressing.
- F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

3.5 FIELD QUALITY CONTROL

- A. Special Inspection and Testing:
 - 1. See Structural Drawings.
 - 2. See Section 03330.

END OF SECTION

SECTION 03150

ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing adhesive anchorage, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
 - a. Structural members and accessories.
 - b. Metal, wood, and plastic fabrications.
 - c. Mechanical and electrical equipment and components.
 - d. Plumbing, piping, and HVAC work.
 - e. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03330 - Concrete Testing and Inspection.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete and Commentary.
 - b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
 - a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
3. American Institute of Steel Construction (AISC):
 - a. 303, Code of Standard Practice for Steel Buildings and Bridges.
4. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

- i. F436, Standard Specification for Hardened Steel Washers.
 - j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - k. F594, Standard Specification for Stainless Steel Nuts.
 - l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
 - 5. ICC Evaluation Service (ICC-ES): Reports for each specified product or system. Reports shall be current and not expired.
- B. Qualifications:
- 1. Anchor designer for Contractor-designed post-installed anchors and cast in place anchorage shall be a professional engineer licensed in the State that the Project is located in.
 - 2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
 - 3. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.
- C. Post-installed anchors and related materials shall be listed by the following agencies:
- 1. ICC-ES.
 - 2. Engineer approved equivalent.

1.3 DEFINITIONS

- A. Adhesive Anchors:
- 1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
 - 2. Includes anchors using acrylics, epoxy and other similar adhesives.
- B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.
- C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.
- D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.
- E. Galvanizing: Hot-dip galvanizing per ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
- F. Installer or Applicator:
- 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 - 2. Installer and applicator are synonymous.
- G. MPII: Manufacturer's printed installation instructions.
- H. Mechanical Anchors:
- 1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.

2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
 3. Drop-in anchors and other similar anchors are not allowed.
- I. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
 - a. Acknowledgement that submitted products meet requirements of referenced standards.
 - b. Manufacturer material data sheet for each anchor.
 - 1) Clearly indicate which products on the data sheet are proposed for use on the Project.
 - c. Manufacturer's printed installation instructions.
 - d. Current ICC-ES report for each post-installed anchor system indicating the following:
 - 1) Certification that anchors meet all requirements indicated in this Specification.
 - 2) Performance data showing that anchor is approved for use in cracked concrete.
 - 3) Seismic design categories for which anchor system has been approved.
 - 4) Required installation procedures.
 - 5) Special inspection requirements for installation.
 - e. Anchorage layout drawings and details:
 - 1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
 - 2) Drawings showing location, configuration, spacing and edge distance.
 - f. Contractor Designed Post-Installed Anchors:
 - 1) Show diameter and embedment depth of each anchor.
 - 2) Indicate compliance with ACI 318, Chapter 17, or ACI 350 Appendix D.
 - 3) Design tension and shear loads used for anchor design.
 - 4) Engineering design calculations:
 - a) Indicate design load to each anchor.
 - b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
 - c) Sealed and signed by contractor's professional engineer.
 - d) Calculations will be submitted for information purposes only.
 - 5) Type of post-installed anchor system used.
 - a) Provide manufacturer's ICC-ES report for the following:

B. Samples:

- (1) Mechanical anchorage per ICC-ES AC193.
- (2) Adhesive anchorage per ICC-ES AC308.
 1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Contractor.

C. Informational Submittals:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Certification of qualifications for each installer of post-installed anchors.
 - a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.
 - b. Provide one of the following for each type of anchor, as required by this specification section:
 - 1) Letter from manufacturer documenting successful training completion.
 - 2) Certification of completion for Engineer approved program.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to job site in manufacturer's or distributor's packaging undamaged and complete with installation instructions.
- B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.
- C. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cast-in-place Concrete Anchors:
 1. Building, nonbuilding structures, and equipment:
 - a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
 - b. ASTM A307, Grade A for galvanized headed bolts.
 2. All other cast-in-place concrete anchors:
 - a. Stainless steel with matching nut and washer.
 - b. Submerged application: ASTM F593, Type 316.
 - c. Non-submerged application: ASTM F593, Type 304 or Type 316.
- B. Post-Installed Mechanical and Adhesive Concrete Anchors:
 1. Stainless steel with matching nut and washer.
 2. Submerged application: ASTM F593, Type 316.
 3. Non-submerged application: ASTM F593, Type 304 or Type 316.

C. Reinforcement: See Section 03200.

- D. Washers:
1. ASTM F436 unless noted otherwise.
 2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
 3. Plate washers: Minimum 1/2 IN thick fabricated ASTM A36 square plates as required.
 4. Follow manufacturer's requirements for all post-installed anchorage.
- E. Nuts:
1. ASTM A563 for all cast-in-place anchorage.
 2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
 3. Follow manufacturer's requirements if using post-installed anchorage.
- F. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
 2. ASTM A780.
 3. Zinc content: Minimum 92 PCT in dry film.
 4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

2.2 CONTRACTOR DESIGNED ANCHORAGE

- A. Manufacturers:
1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Engineer.
 - a. Hilti.
 - b. Dewalt.
 - c. Simpson Strong-Tie.
 2. Submit request for substitution in accordance with Specification Section 01600.
- B. Design the anchorage when any of the following occur:
1. Design load for concrete anchorage is shown on the Drawings.
 2. When specifically required by the Contract Documents.
 3. When an anchorage is required but not specified in the Drawings.
 4. When anchorage is shown on Drawings other than Structural Drawings.
- C. Anchorage Design Loads:
1. Determine all of the design loads, including wind and seismic loads, per the building code.
 - a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.
 - b. Additional support requirements for utilities: See appropriate Specification Section.
- D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Contractor design shall incorporate these as "minimums."

E. Cast-in-Place Concrete Anchors:

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03150-5

Anchorage to Concrete

City of Arvada North Trunk Sewer
Improvements

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1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the building code including ACI 318 Chapter 17, ACI 350, Appendix D.
 2. Design assuming cracked concrete.
- F. Post-installed Concrete Anchors:
1. Provide the manufacturer's system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified or calculated load based on requirements given in the building code, ACI 318, Chapter 17, or ACI 350, Appendix D, and current ICC-ES report, for the anchor to be used.
 2. Design assuming cracked concrete.

2.3 ENGINEER DESIGNED ANCHORAGE

- A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required unless otherwise indicated.
- B. Manufacturers:
1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by the Engineer.
 2. Mechanical Anchors:
 - a. Hilti:
 - 1) Kwik Bolt TZ2
 - b. Simpson Strong-Tie:
 - 1) Strong-Bolt 2
 3. Adhesive Concrete Anchors:
 - a. Hilti:
 - 1) HIT RE 500 V3
 - 2) HIT-HY 200 V3
 - b. Simpson Strong-Tie: SET-XP
 4. Concrete Screw Anchors:
 - a. Hilti:
 - 1) Kwik HUS-EZ Screw
 - b. Simpson Strong-Tie:
 - 1) Titen HD
 5. Submit request for substitution in accordance with Contract requirements.
 - a. Substitution request to indicate the proposed anchor has the at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
 - b. Calculations to be stamped by a Professional Engineer registered in the state that the Project is located in.

PART 3 - EXECUTION

3.1 GENERAL

- A. Cast-in-Place Anchorage:
 - 1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.
 - 2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.
- B. Adhesive Anchorage:
 - 1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
 - 2. May be used where subjected to vibration or where buried or submerged.
 - 3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
 - 4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.
- C. Mechanical Anchorage:
 - 1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
 - 2. Do not use where subjected to vibration.
 - 3. May be used in overhead applications.
 - 4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.
- D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

3.2 PREPARATION

- A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.
- B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
 - 1. Notify Engineer of conditions detrimental to proper and timely completion of work.
 - 2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
- C. Special Inspection is required in accordance with the building code for all concrete anchorage.
 - 1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
 - 2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.
- D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.
 - 1. Follow such procedures to assure acceptable installation.
 - 2. Adhesive anchors must be installed in concrete aged a minimum of 21 days.

3.3 INSTALLATION

- A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.

1. Tack welding of anchorage is prohibited.
 2. Coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
 3. Anchorage location tolerance shall be in accordance with AISC 303.
 4. Provide steel or durable wood templates for all column and equipment anchorage.
 - a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.
- B. Unless noted or specified otherwise:
1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
 2. Provide washers for all anchorage.
 3. Where exposed, extend threaded anchorage a minimum of 1/2 IN above the top of the fully engaged nut.
 - a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.
- C. Do the following after nuts are snug-tightened down:
1. If using post-installed anchorage, follow MPII.
 2. Upset threads of anchorage to prevent nuts from backing off.
 - a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
 3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off.
 4. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two nuts together.
 5. If using post-installed anchorage, follow manufacturer's installation procedures.
- D. Assure that embedded items are protected from damage and are not filled in with concrete.
- E. Secure architectural components such that it will not be aesthetically distorted nor fasteners overstressed from expansion, contraction or installation.
- F. Coat aluminum surfaces in contact with dissimilar materials.
- G. Repair damaged galvanized surfaces in accordance with ASTM A780.
- H. Prepare damaged surfaces by abrasive blasting or power sanding.
1. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.
- I. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
1. Use hammer drills to create holes.
 2. Properly clean out the hole per the ICC-ES reports utilizing a non-

metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

- A. Special Inspection:
 - 1. See Structural Drawings.
 - 2. See Section 03330.

3.5 CLEANING

- A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

END OF SECTION

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SECTION 03200

REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reinforcing bar requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03330 - Concrete Testing and Inspection.
 - 4. Section 03150 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. SP 66, ACI Detailing Manual.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - d. 318, Building Code Requirements for Structural Concrete.
 - e. 350, Code Requirements for Environmental Engineering Concrete Structures.
 - 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - d. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 3. Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Standard Practice.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Mill certificates for all reinforcing.
 - d. Manufacturer and type of proprietary reinforcing mechanical splices.
 - 3. Qualifications of welding operators, welding processes and procedures.
 - 4. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and

- reinforcing supports.
- 5. Sufficient reinforcing details to permit installation of reinforcing.
- 6. Reinforcing details in accordance with ACI SP 66 and ACI 315.
- 7. Locations where proprietary reinforcing mechanical splices are required or proposed for use.
- 8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
 - a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
 - b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Support and store all reinforcing above ground.
- B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Reinforcing adhesive anchors:
 - a. See Specification Section 03150.
- B. Submit request for substitution in accordance with Contract Requirements.

2.2 MATERIALS

- A. Reinforcing Bars: ASTM A615, grade 60, deformed.
- B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.
- C. Smooth Dowel Bars:
 - 1. Water containing structures: ASTM A276, Type 316.
 - 2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.
- D. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125 PCT of the yield strength of the reinforcing bars being spliced.
- E. Reinforcing Adhesive Anchors:
 - 1. See Specification 03150.

2.3 ACCESSORIES

- A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
 - 1. Metal fabrications with plastic-coated tips in contact with forms.

- a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
- 2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
 - a. 100 PCT non-metallic, non-corrosive.
 - b. Required for all walls and elevated construction exposed to liquid containing structures.
- B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

- A. Tolerances:
 - 1. Conforms to ACI 117, except as modified herein.
 - 2. Sheared lengths: +1 IN.
 - 3. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
 - 4. All other bends: +0 IN, -1/2 IN.
- B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.
- C. Ship reinforcing to jobsite with attached plastic or metal tags.
 - 1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
 - 2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Tolerances:
 - 1. Conform to ACI 117, except as modified herein.
 - 2. Reinforcing placement:
 - a. Clear distance to formed surfaces: +1/4 IN.
 - b. Minimum spacing between bars: -1/4 IN.
 - c. Top bars in slabs and beams:
 - 1) Members 8 IN deep or less: +1/4 IN.
 - 2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
 - 3) Members more than 2 FT deep: -1/4 IN, +1 IN.
 - d. Crosswise of members: Spaced evenly within +1 IN.
 - e. Lengthwise of members: +2 IN.
 - 3. Minimum clear distances between reinforcing bars:
 - a. Beams, walls and slabs: Distance equal to bar diameter or 1 IN, whichever is greater.
 - b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 IN, whichever is greater.
 - c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.
- B. Minimum concrete protective covering for reinforcement, unless indicated otherwise on Drawings:
 - 1. Concrete deposited against earth: 3 IN.

2. Formed surfaces exposed to weather or in contact with earth:
 - a. 2 IN for all reinforcing sizes
 3. Formed surfaces exposed to or located above any liquid: 2 IN for all reinforcing sizes.
 4. Interior surfaces:
 - a. 2 IN for all reinforcing sizes
- C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
1. For reinforcing: Class B splice meeting the requirements of ACI 350.
 2. For welded wire reinforcement:
 - a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
 - b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 350.
 3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
 - a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.
- D. Welding:
1. Welding reinforcing is not permitted without written acceptance by the Engineer for the specific application.
- E. Placing Reinforcing:
1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
 2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
 3. Reinforcing support:
 - a. Uncoated reinforcing:
 - 1) Support reinforcing and fasten together to prevent displacement by construction operations.
 - a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
 - c) Reinforcement shown on the Contract Documents may not be repositioned for use as a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
 - 2) Reinforcing supported on ground:
 - a) Slab on grade and other members with only one mat of reinforcing:
 - (1) Provide metal bar supports with bottom plate.
 - (2) Do not use concrete blocks to support slab-on-grade reinforcing.
 - b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
 - 3) Reinforcing supported on formwork:

- a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
- b) All other formed surfaces:
 - (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
 - (2) Only tips in contact with the forms need to be plastic coated.
- 4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
- 5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 IN.
 - a. Place spacer bars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
- 6. Extend reinforcement to within 2 IN of concrete perimeter edges.
 - a. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
- 7. To assure proper placement, furnish templates for all column vertical bars and dowels.
- 8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
 - a. Do not bend reinforcing by means of heat.
- 9. Do not tack weld reinforcing.
- 10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
 - a. See Specification Section 03150.

3.2 FIELD QUALITY CONTROL

- A. Reinforcement Congestion and Interferences:
 - 1. Notify Engineer whenever the specified clearances between bars cannot be met.
 - 2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
 - 3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
 - 4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
 - 5. No cutting of reinforcing shall be done without written approval of Engineer.
- B. Special Inspection:
 - 1. See Section 01450.
 - 2. See Section 03330.

END OF SECTION

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SECTION 03300

CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete materials, strengths and proportioning for concrete work.
 - 2. Grouting:
 - a. Base plates for columns and equipment.
 - b. As specified and indicated in the Contract Document.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03330 - Concrete Testing and Inspection.
 - 4. Section 03100 - Formwork.
 - 5. Section 03150 - Anchorage to Concrete.
 - 6. Section 03350 - Concrete Mixing, Placing, Jointing, and Curing.
 - 7. Section 03351 - Concrete Finishing and Repair of Surface Defects.
 - 8. Section 02080 - Precast Concrete Sectional Manholes.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - c. 212.3R, Chemical Admixtures for Concrete.
 - d. 232.2R, Use of Fly Ash in Concrete.
 - 2. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.
 - b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - d. C150, Standard Specification for Portland Cement.
 - e. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
 - f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
 - h. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
 - i. C494, Standard Specification for Chemical Admixtures for Concrete.
 - j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - k. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

- l. C1116, Standard Specification for Fiber-Reinforced Concrete.
- m. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
- n. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber- Reinforced Concrete.
- o. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- p. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
- q. C1611/C1611M, Standard Test Method for Slump Flow of Self-Consolidating Concrete.
- 3. Colorado Department of Transportation (CDOT):
 - a. Standard Specification for Road and Bridge Construction.

1.3 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI CT-13.
- B. Water-Bearing Concrete: Any concrete surface to be in contract with process fluids during normal operation of the facility, including, but not limited to, tank, channels, wet wells and distribution chambers.
- C. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Div 01 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's instructions.
 - c. Concrete mix designs as required by Specification Section 03330.
 - d. Manufacturer and type of proposed admixtures.
 - e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
 - 3. Certifications:
 - a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
 - b. Certification that the SCM meet the quality requirements stated in this Specification Section, and SCM supplier's certified test reports for each shipment of SCM delivered to concrete supplier.
 - c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
 - d. Certification of aggregate gradation.
 - e. Certification of coarse aggregate impurities as relates to alkali-silica

- reactivity per ASTM C33, Appendix X.
- f. Certification of shrinkage test results.
- 4. Test reports:
 - a. Cement and SCM mill reports for all cement to be supplied.
 - b. Provide test results for alkali-silica reactive impurities on coarse aggregates per referenced ASTM standards.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage of Materials:
 - 1. Store cement and SCM in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
 - 2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
 - 3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
 - 4. Do not use frozen or partially frozen aggregates.
 - 5. Do not use bottom 6 IN layer of stockpiled material in contact with ground.
 - 6. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
 - a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
 - b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:
 - 1. Non-shrink grout:
 - a. BASF Corporation.
 - b. Euclid Chemical Company.
 - c. Five Star Products, Inc.
 - d. Sika Corporation.
 - e. US Spec
 - 2. Epoxy grout:
 - a. BASF Corporation.
 - b. Five Star Products, Inc.
 - c. Euclid Chemical Company.
 - d. Sika Corporation.
 - 3. Synthetic fibers:
 - a. GCP Applied Technologies, Inc.
 - b. BASF Corporation.
 - c. Euclid Chemical Company.
 - d. Sika Corporation.
- B. Submit request for substitution in accordance with Div 01.

2.2 MATERIALS

A. Cement:

1. ASTM C150, Type I/ II for general use
2. ASTM C150, Type V for vaults
3. Blended Cement ASTM C150, Type II for sulfate resistance for vaults, with expansion limits described in items 6 or 7 below for vaults.
4. Mass concrete: ASTM C150, Type II (HS).
5. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.
6. Less than 0.040 percent expansion at 14 days when tested according to ASTM C452 (CDOT S2 Mix)
7. Less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. (CDOT S3 Mix)

B. SCM:

1. Fly Ash:
 - a. ASTM C618, Class F.
 - b. Non-staining.
 - c. Suited to provide hardened concrete of uniform light gray color.
 - d. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
 - e. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
 - f. Evaluate and use in accordance with ACI 232.2R.
 - g. 20 percent substitution by weight of blended cement for sulfate resistance.
2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:

1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. All concrete mixes require the use of water reducers to maintain the specified water-to- cement ratios without additional cement.
5. SCM: Per above.
6. Admixtures to be chloride free.
 - a. Do not use calcium chloride.
7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
8. Provide admixtures certified by manufacturer to be compatible with other admixtures.
9. Shrinkage reducing admixtures:
 - a. Conform to ASTM C494, Type S.
 - b. Admixture used to reduce the shrinkage of Portland Cement concrete.
 - c. Utilize at dosage necessary to help achieve required shrinkage value stated herein.
 - d. Similar to:
 - 1) Eclipse 4500 by GCP Applied Technologies, Inc.

- 2) Conex by Euclid Chemical Co.
- 3) MasterLife SRA 20 or MasterLife CRA 007 by BASF Corporation.

10.

D. Microsynthetic Fibers:

1. Conform to ASTM C1116.
2. Minimum average residual strength at a net deflection of L/150: PSI in accordance with ASTM C1609.
3. Acceptable manufacturers:
 - a. BASF Corporation; MasterFiber F or M Series.
 - b. Fiberstrand by Euclid Chemical Company.
 - c. Gilco Fibers by GCP Applied Technologies, Inc.

E. Water:

1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

F. Aggregates for Normal Weight Concrete:

1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Provide aggregates approved for bridge construction by the Department of Transportation of the State the project is located.
4. Coarse aggregate:
 - a. Use only washed aggregates.
 - b. Coarse aggregate sieve analysis:
 - 1) Per Table 1 IN the PART 2 MIXES Article.
5. Fine aggregates to be natural, not manufactured.
6. Do not use aggregates that may be deleteriously reactive when combined with alkalis in cement.
 - a. Evaluate proposed aggregates for potential deleterious expansion due to alkali silica reactivity per ASTM C33 (Appendix X), ASTM C227, ASTM C1260, ASTM 1293, or ASTM C1567.

G. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218:

1. Prestressed concrete: 0.06.
2. All other concrete: 0.10.

H. Sand Cement Grout (referred to as "Grout" or "Grout Fill" on the Drawings):

1. Approximately three parts sand, one part Portland cement, 6 ± 1 PCT entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
 - a. Provide sand in accordance with requirements for fine aggregate for concrete.
2. Minimum 28 day compressive strength:
 - a. 4000 PSI.
 - b. Shall be at least strength of parent concrete when used at construction joints.

I. Non-shrink Grout:

1. Non-shrink, nonmetallic, noncorrosive, and nonstaining.
 - a. Conform to ASTM C1107.
2. Premixed with only water to be added in accordance with

- manufacturer's instructions at jobsite.
- 3. Grout to produce a positive but controlled expansion.
 - a. Mass expansion shall not be created by gas liberation or by other means.
- 4. Minimum 28 day compressive strength: 7,000 PSI.
- 5. Acceptable manufacturers:
 - a. BASF Admixtures, Inc. "Masterflow, 713".
 - b. Euclid Chemical "NS Grout".
 - c. Sika Corporation "Sika Grout 212".
 - d. Sauereisen, Inc. "F-100 Level Fill Grout".
 - e. US Spec "STR Mortar CI"
- J. Epoxy Grout:
 - 1. Three-component epoxy resin system:
 - a. Two liquid epoxy components.
 - b. One inert aggregate filler component.
 - 2. Adhesive acceptable manufacturers:
 - a. BASF "Masterflow 648".
 - b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
 - c. Euclid Chemical "E3 Flowable."
 - d. Sika "Sikadur Hi-Mod."
 - 3. Aggregate acceptable manufacturers:
 - a. BASF "Masterflow 648".
 - b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
 - c. Euclid Chemical "Euclid aggregate."
 - d. Sika aggregate.
 - 4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
 - 5. The aggregate shall be compatible with the adhesive.
 - 6. Each component furnished in separate package for mixing at jobsite.

2.3 MIXES

- A. General:
 - 1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
 - 2. Ready-mixed concrete shall conform to ASTM C94/C94M.
 - 3. All concrete to be normal weight concrete weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.
- B. Concrete Mixes: Refer to Table 1 below.
- C. Air Entrainment:
 - 1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
 - a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.
- D. Slump:
 - 1. Measure slump at point of discharge into concrete members.
 - 2. Walls and columns:
 - a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
 - b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.

3. All other members:
 - a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
 - b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.
 4. Self-consolidating concrete:
 - a. Measure slump using concrete spread per ASTM C1611.
 - b. Concrete spread: 20 IN to 30 IN.
 - c. Stability index: 0 or 1.
 5. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
 6. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
 - a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ration is not exceeded.
 7. Slump may be adjusted in the field through the use of water reducers.
 - a. Coordinate dosage and mixing requirements with concrete supplier.
 8. Slump tolerances shall comply with the requirements of ACI 117.
- E. Proportioning:
1. General:
 - a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
 - b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
 2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
 - a. Target cementitious materials contents are intended to provide a crack free, durable finished product, not one with excessive strength
 3. SCM:
 - a. Fly ash:
 - 1) For cast-in-place concrete only, a maximum of 25 PCT by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
 - 2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
 4. Water reducing, retarding, and accelerating admixtures:
 - a. Use in accordance with manufacturer's instructions.
 - b. Add to mix at batching plant.
 - c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
 - 1) Water reducers are required to maintain specified maximum water to

- cement ratios.
5. High range water reducers (superplasticizers):
 - a. Use required for:
 - 1) All concrete to be pumped except slabs on grade.
 - 2) All concrete for water containing structures.
 - 3) Other concrete members at Contractor's option.
 - b. Maximum concrete slump before addition of admixture to be 3 IN
maximum slump after addition to be 8 IN.
 6. Self Consolidating Admixture:
 - a. Per ASTM C1017.
 7. Concrete mix proportioning methods for normal weight concrete:
 - a. Method 1:
 - 1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
 - 2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
 - 3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 PCT specified.
 - 4) For each water cement ratio or cement content, make at least three trial strength tests for specified test age, and cure in accordance with ASTM C192.
 - a) Cylinder size: Per ASTM C31.
 - b) Test for strength at 28 days in accordance with ASTM C39.
 - (1) Quantity of cylinders per trial strength test:
 - (a) 6 IN DIA cylinders: Two.
 - (b) 4 IN DIA cylinders: Three.
 - 5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
 - 6) From this curve select water cement ratio or cement content to be used to produce required average strength.
 - 7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
 - 8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
 - 9) See paragraph hereafter for definition of required average strength.
 - b. Method 2:
 - 1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
 - 2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
 - 3) Field test records to represent materials, proportions and conditions

similar to those specified.

- a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
- b) Field test records shall meet the requirements of ACI 350.
- 4) Required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records each of which meets the requirements of this Specification Section.
- 8. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with ACI 350, Chapter 5 using the standard deviation of the proposed concrete production facility as described in ACI 350, Chapter 5.

F. Controlled Low-Strength Material (CLSM):

- 1. A mixture of cement, fly ash, fine sand, water and air having a consistency which will flow under a very low head.
- 2. Flowable Fill and Controlled Low-Strength Material are synonymous.
- 3. Approximate quantities of each component per cubic yard of mixed material:
 - a. Cement (Type I or II): 50 LBS.
 - b. Fly ash: 200 LBS.
 - c. Fine sand: 2,700 LBS.
 - d. Water (approximate): 420 LBS.
 - e. Air content (approximate): 10 PCT.
- 4. Actual quantities shall be adjusted to provide a yield of 1 CUYD with the materials used.
- 5. Approximate compressive strength should be 85 to 175 PSI.
- 6. Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.

G. Allowable Shrinkage:

- 1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.
- 2. Continue testing to 64 weeks for informational purposes.

TABLE 1							
TYPE OF CONCRETE	28 DAY COMPRESSIVE STRENGTH	W/C RATIO	TARGET TOTAL CEMENT	SCM	ASTM C33 Size No.	AIR CONTENT	ALLOWABLE SHRINKAGE LIMIT
Normal weight concrete fill-utility encasement concrete	4000 PSI	0.45	517	Note 1	57	4-1/2 to 7-1/2	None
Normal weight precast concrete	5000 PSI	0.42	611		57	4-1/2 to 7-1/2	None

Normal weight water-bearing concrete and all other concrete	4500 PSI	0.42	564	Note 1	57 or 67	4-1/2 to 7-1/2	0.042 PCT
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Table 1 Notes:

1. If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.

2.4 SOURCE QUALITY CONTROL

- A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Special Inspection:
 1. See Structural Drawings.
 2. See Specification Section 03330.
- B. Perform concrete tests per Specification Section 03330.
 1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
 - a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

SECTION 03330

CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Contractor requirements for testing of concrete and grout.
 - 2. Definition of Owner provided testing.
 - 3. Acceptance criteria for concrete.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03200 - Reinforcement.
 - 4. Section 03300 - Concrete, Materials and Proportioning.
 - 5. Section 03350 - Concrete Mixing, Placing, Jointing and Curing.

1.2 RESPONSIBILITY AND PAYMENT

- A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
 - 1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
 - 2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
 - 3. Strength testing on concrete required by the Engineer or Special Inspector when the water- cement ratio exceeds the water-cement ratio of the typical test cylinders.
 - 4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
 - 5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
 - 6. Contractor shall provide a minimum 24-hour notice prior to testing
 - 7. Owner will pay for services defined in Paragraph 1.2A.1.
 - 8. See Specification Section 01300.
- B. The Owner will hire a qualified testing agency to perform the following testing and provide test results to the Engineer and Contractor.
 - 1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
 - 2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
 - 3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
 - 4. Reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
 - 5. See Specification Section 01300.

- C. Duties and Authorities of Testing Agency/Service Provider:
1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
 2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
 3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
 - a. All test reports to include exact location in the work at which batch represented by a test was deposited.
 - b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
 4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
2. ASTM International (ASTM):
 - a. ASTM Cement and Concrete Reference Laboratory (CCRL).
 - b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. C94, Standard Specification for Ready-Mixed Concrete.
 - f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - h. C172, Standard Practice for Sampling Freshly Mixed Concrete.
 - i. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - j. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - k. C1019, Standard Test Method for Sampling and Testing Grout.
 - l. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - m. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Qualifications:

1. Contractor's Testing Agency:
 - a. Meeting requirements of ASTM E329 and ASTM C94.
 - b. Provide evidence of recent inspection by CCRL of NBS, and correction

of deficiencies noted.

- C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

- A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 - 1. Product technical data including:
 - a. Concrete materials and concrete mix designs proposed for use.
 - 1) Include results of all testing performed to qualify materials and to establish mix designs.
 - 2) Place no concrete until approval of mix designs has been received in writing.
 - 3) Submittal for each concrete mix design to include:
 - a) Sieve analysis and source of fine and coarse aggregates.
 - b) Test for aggregate organic impurities.
 - c) Proportioning of all materials.
 - d) Type of cement with mill certificate for the cement.
 - e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03300.
 - f) Slump.
 - g) Brand, type and quantity of air entrainment and any other proposed admixtures.
 - h) Shrinkage test results.
 - i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
 - j) 28-day compression test results and any other data required by Specification Section 03300 to establish concrete mix design.
 - 2. Certifications:
 - a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

- A. The following concrete testing will be performed by the Service Provider/Testing Agency:
 - 1. Concrete strength testing:

- a. Secure concrete samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
- b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
 - 1) Record any deviations from requirements on test report.
 - 2) Cylinder size: Per ASTM C31.
 - a) 4 IN cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 IN.
 - b) Use the same size cylinder for all tests for each concrete mix.
 - 3) Quantity:
 - a) 6 IN DIA by 12 IN high: Four cylinders.
 - b) 4 IN DIA by 8 IN high: Six cylinders.
- c. Field cure one cylinder for the seven day test.
 - 1) Laboratory cure the remaining.
- d. Test cylinders in accordance with ASTM C39.
 - 1) 6 IN DIA cylinders:
 - a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
 - b) Hold remaining cylinder in reserve.
 - 2) 4 IN DIA cylinders:
 - a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
 - b) Hold remaining cylinders in reserve.
- e. Strength test result:
 - 1) Average of strengths of two, 6 IN DIA cylinders or three, 4 IN DIA cylinders from the same sample tested at 28 days.
 - 2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
 - 3) Should all cylinders in any test show any of above defects, discard entire test.
- f. Frequency of tests:
 - 1) Concrete sand cement grout: One strength test for each 4 HR period of grout placement or fraction thereof.
 - a) Test grout in accordance with ASTM C1019.
 - 2) Concrete topping, concrete fill and lean concrete: One strength test for each 5 CUYD of each type of concrete or fraction thereof placed.
 - 3) All other concrete:
 - a) One strength test to be taken not less than once a day, nor less than once for each 60 CUYD or fraction thereof placed in any one day.
 - b) Once for each 5000 SQFT of slab or wall surface area placed each day
 - c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five

strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.

2. Slump testing:
 - a. Determine slump of concrete sample for each strength test.
 - 1) Determine slump in accordance with ASTM C143.
 - b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
 - 1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231, ASTM C173, or ASTM C138.
4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

- A. See Structural Drawings.
 1. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
- B. Formwork Special Inspections:
 1. Shape, location, and dimensions.
 - a. Inspect in accordance with dimensions and details on Drawings.
 - b. Frequency: Inspect prior to each concrete pour.
- C. Reinforcing Special Inspections:
 1. Reinforcing size, spacing, lap length and concrete cover.
 - a. Inspect in accordance with Drawings and Specification.
 - b. Frequency: Inspect prior to each concrete pour.
 2. Reinforcing adhesive anchoring system:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all adhesive anchors for the first 4 HRS of installation.
 - 2) Inspect approximately 25 PCT of adhesive anchors thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

3. Mechanical splices:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all mechanical splices prior to placing concrete .
 - 2) Inspect approximately 25 PCT of mechanical splices thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
- D. Mixing, Placing, Jointing, and Curing Special Inspections:
 1. Perform concrete tests per the requirements of this Specification Section.
 2. Verification of proper mix design.
 - a. Frequency: Periodically, prior to concrete pour.
 3. Proper concrete placement techniques.
 - a. Inspect per requirements of Section 03350.
 - b. Frequency: During concrete pour.
 4. Proper curing temperature and techniques.
 - a. Inspect per requirements of Section 03350.
 - b. Frequency: Periodically, but not less than every third day.
 5. Joints:
 - a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
 - b. Frequency: Prior to each concrete pour.
 6. Waterstops:
 - a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
 - b. Frequency:
 - 1) Prior to each concrete pour.
- E. Anchorage to Concrete Special Inspection:
 1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
 - a. Frequency: Per ICC-ES Report.
 2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
 - a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

- A. To facilitate testing and inspection, perform the following:
 1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
 2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.
 3. Take samples at point of placement into concrete member.
- B. Notify Engineer and Contractor's Testing Agency sufficiently in advance of operations (minimum of 48 HRS) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

- A. Completed concrete work which meets applicable requirements will be accepted without qualification.
- B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
- C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
 - 1. In this event, modifications may be required to assure that concrete work complies with requirements.
 - 2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.
- D. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
 - 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
 - a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
 - 3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
 - 4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
 - a. Repair or remove and replace if required.
 - 5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
 - a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.
- E. Appearance:
 - 1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
 - 2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.
- F. High Water-Cement Ratio:
 - 1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
 - 2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.
- G. Strength of Structure:
 - 1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure,

including but not necessarily limited to following:

- a. Low concrete strength:
 - 1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
 - a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
 - b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
 - c) A strength test shall be the average of two, 6 IN diameter cylinders or three, 4 IN diameter cylinders from the same sample tested at 28 days.
 - 2) Acceptance:
 - a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
 - (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
 - (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 PSI.
- b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03200 or requirements of the Contract Drawings or approved Shop Drawings.
- c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
- d. Curing time and procedure not meeting requirements of this Specification Section.
- e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
- f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
- g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
 - a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
 - 1) Such tests shall not be used as a basis for acceptance or rejection.
 - b. Core tests:
 - 1) Where required, test cores will be obtained in accordance with ASTM C42.
 - a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DEGF, relative humidity less

- than 60 PCT) for seven days before test then test dry.
- b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
 - c) Testing wet or dry to be determined by Engineer.
- 2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
 - a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
 - b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
 - 3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85 PCT of specified strength and no single core is less than 75 PCT of specified strength.
 - 4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
- 4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
 - 5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
 - 6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

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SECTION 03350

CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mixing, placing, jointing, and curing of concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03350 - Concrete Testing and Inspection.
 - 4. Section 03100 - Formwork.
 - 5. Section 03200 - Reinforcement.
 - 6. Section 03300 - Concrete, Materials and Proportioning.
 - 7. Section 03351 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. 304.2R, Placing Concrete by Pumping Methods.
 - e. 305R, Guide to Hot Weather Concreting.
 - f. 305.1, Specification for Hot Weather Concreting.
 - g. 306R, Guide to Cold Weather Concreting.
 - h. 306.1, Standard Specification for Cold Weather Concreting.
 - i. 308.1, Specification for Curing Concrete.
 - j. 309R, Guide for Consolidation of Concrete.
 - k. 318, Building Code Requirements for Structural Concrete and Commentary.
 - l. 350, Code Requirements for Environmental Engineering Concrete Structures.
 - m. 360R, Guide to Design of Slabs-on-Ground.
 - 2. ASTM International (ASTM):
 - a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

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3. Corps of Engineers (COE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstop.
4. National Ready Mixed Concrete Association (NRMCA):
Checklist for Certification of Ready Mixed Concrete Production

Facilities.

- B. Qualifications:
 1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.
 2. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost to Owner.

1.3 DEFINITIONS

- A. Words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 1) Procedure for adding high-range water reducer at the jobsite.
 - c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
 - d. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Construction joint bonding adhesive.
 - 4) Waterstops.
 3. Certifications:
 - a. Ready mix concrete plant certification.
 - b. Waterstops: Certificate of training from the waterstop manufacturer for the individuals performing field welds of waterstops.
- B. Informational Submittals:
 1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 2. Copies of concrete delivery tickets.
 3. Description of proposed curing methods.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Concrete Delivery:
 1. Prepare a delivery ticket for each load of ready mixed concrete.
 2. Truck operator shall hand ticket to Contractor at the time of delivery.
 3. Ticket to show:
 - a. Mix identification.
 - b. Quantity delivered.

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- c. Amount of material in each batch.
- d. Outdoor temperature in the shade.
- e. Time at which cement was added.
- f. Time of delivery.
- g. Time of discharge.
- h. Amount of water that may be added at the site without exceeding the specified water- cement ratio.
- i. Amount of any approved water added at the site.

1.6 PROJECT CONDITIONS

- A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
 - 1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.7 SEQUENCING AND SCHEDULING

- A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
 - 1. Approval of concrete mix design does not relieve Contractor of his responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.
- B. Neoprene Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. Permaglaze.
 - b. Rubatex.
 - c. Williams Products.
 - 2. Materials:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Type 2, Class A or C.
 - c. Grade: Compression deflection as required to limit deflection to 25 PCT of joint thickness under pressure from concrete pour height.
- C. Asphalt Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. W.R Meadows.
 - b. J and P Petroleum Products.
 - 2. Materials: ASTM D994.
- D. Fiber Expansion Joint Fillers:
 - 1. Materials: ASTM D1751.
- E. Waterstops, PVC Type:
 - 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastic Products.
 - b. W.R Meadows.

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- c. Vinylex Corporation.
 - d. Bometals, Inc.
 - 2. Materials:
 - a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
 - b. Cast-in-place type: COE CRD-572.
 - 3. Approved profiles as listed unless otherwise shown in the Drawings.
 - a. Construction joints:
 - 1) Ribbed: 6 IN wide by 3/8 IN, Sika Greenstreak Plastic Products Style #679, or equal. Provide 6 IN waterstop unless otherwise specifically called out in the Drawings.
 - 2) Ribbed: 4 IN wide by 3/16 IN, Sika Greenstreak Plastic Products Style #701, or equal.
 - 4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum 6 IN clear of the intersection.
 - 5. Factory prepunched (less than 18 IN centers, each edge, staggered) for wire supports.
 - a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
 - 6. See Drawings for application and other requirements.
- F. Waterstops, Preformed Strip Type:
- 1. Acceptable manufacturers:
 - a. Sika, USA. (Hydrotite).
 - b. Adeka Ultra Seal USA (MC-2010MN).
 - c. DeNeef (Swellseal 2010).
 - d. Sika, USA. (Swellstop).
 - 2. Hydrophilic, non-bentonite composition.
 - 3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
 - 4. Volumetric expansion limited to 3 times maximum.
 - 5. See Drawings for application and other requirements.
- G. Water Swelling Sealant:
- 1. Required adhesive for use with strip-type waterstop.
 - 2. Compatible with strip-type waterstop.
 - 3. Single component, gun applied.
 - 4. Moisture cured.
 - 5. Minimum 70 PCT volumetric expansion swelling capability.
- H. Curing Products to conform to one or more of the following:
- 1. Absorbent Covers.
 - 2. Moisture Retaining Covers.
 - a. Moisture Retaining Fabric.
 - 3. Dissipating curing compound:
 - a. Fugitive dye, waterborne, membrane-forming.
 - b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks

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after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition and performance of applied finishes.

- c. Acceptable Products:
 - 1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
 - 2) Euclid Chemical Company (The); Kurez DR VOX.
 - 3) L&M Construction Chemicals, Inc.; L&M Cure R.
- 4. Clear, water or solvent-borne, membrane-forming curing and sealing compound:
 - a. ASTM C1315, Type 1, Class A.
 - b. Moisture loss shall be not more than 0.40 KG/M² when applied at 300 SQFT/GAL.
 - c. Manufacturer's certification is required.
 - d. Subject to project requirements, provide one of the following products:
 - e. Products:
 - 1) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
 - 2) L&M Construction Chemicals, Inc.; Lumiseal Plus.
 - 3) Meadows, W.R., Inc.; CS-309/30.
 - 4) Euclid Chemical Company; Super Diamond Clear VOX.
 - 5) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - 6) Meadows, W.R., Inc.; Vocomp-30.
- I. Bonding Agent:
 - 1. Acceptable manufacturers:
 - a. L&M Construction Chemicals, Inc.
 - b. Sika.
 - c. Euclid Chemical Co.
 - 2. Materials:
 - a. Latex: ASTM C1059, Type II.
 - b. Epoxy: ASTM C881, Type V.
- J. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03300 for this non-structural material and use.

2.2 SOURCE QUALITY CONTROL

- A. The concrete plant shall conform to the Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General:
 - 1. All materials and construction shall conform to the tolerances as specified in ACI 117.
 - 2. Complete formwork.
 - a. See Specification Section 03100.
 - 3. Remove earth, snow, ice, water, and other extraneous/foreign materials from areas that will receive concrete.
 - 4. Secure reinforcement in place.
 - a. See Specification Section 03200.

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5. Position expansion joint material, anchors and other embedded items.
 6. Obtain approval of formwork, reinforcement installation and placement prior to placing concrete.
 7. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and prior Engineer approval is obtained.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
 - b. Do not allow rainwater to increase mixing water nor to damage surface finish.
 8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
 9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
 - a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.
- B. Preparation of Subgrade for Slabs On Ground:
1. Subgrade to be wetted without standing water immediately prior to placing concrete.
 2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
- C. Edge Forms and Screeds:
1. Set accurately to produce designated elevations and contours of finished surface.
 2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
 3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

- A. General:
1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
 2. Batch, mix, and transport in accordance with ASTM C94/C94M.
- B. Control of Admixtures:
1. Control at the batch plant:
 - a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.
 - b. Charge admixtures into mixer as solutions.
 - 1) Measure by means of an approved mechanical dispensing device.

- 2) Liquid considered a part of mixing water.
- 3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
- c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
- d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.
- 2. Control of Admixtures in the field:
 - a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
 - 1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
 - 2) Addition of each admixture to be documented on the delivery ticket.
 - 3) Provide additional mixing per ASTM C94.
- C. Tempering and Control of Mixing Water:
 - 1. Mix concrete only in quantities for immediate use.
 - 2. Discard concrete which has set.
 - 3. Discharge concrete from ready mix trucks within time limit stated in ASTM C94.
 - 4. Addition of water at the jobsite:
 - a. See Specification Section 03300 for specified water cement ratio and slump.
 - b. Do not exceed maximum specified water cement ratio or slump.
 - c. Incorporate water by additional mixing equal to at least half of total mixing required.
- D. If the time required to discharge concrete exceeds the time limits per ASTM C94, consider the use of hydration stabilizers added at the batch plant.

3.3 PLACING OF CONCRETE

- A. General:
 - 1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
 - a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
 - 2. Contractor may choose to submit an equivalent self-consolidating concrete mix in order to reduce consolidation and placement issues.
 - a. Self-consolidating concrete shall be used for vault walls around pipe penetrations to mitigate consolidation issues below the pipe.
 - 3. Provide additional equipment to place mass concrete if deemed required to avoid placement issues.
 - 4. Comply with ACI 304R and ACI 304.2R.
 - 5. Do not begin placing concrete during rain, sleet, or snow.
 - a. Protect fresh concrete from ensuing inclement weather.
 - 6. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.

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7. Begin work only when work of other trades affecting concrete is complete.
8. Do not use excess grout or mortar to lubricate lines when pumping concrete.
9. Do not use excess water for workability or any reason when placing concrete by freefall.
10. Deposit concrete continuously to avoid cold joints.
11. Locate construction joints at locations specified or approved by Engineer.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
12. Spreaders:
 - a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
 - b. Embedded:
 - 1) Obtain approval of Engineer for their use.
 - 2) Materials: Concrete or metal.
 - 3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
13. Deposit concrete as nearly as practicable in its final position to avoid segregation.
 - a. Maximum free fall: 4 FT.
 - b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface.
14. Perform the following operations before bleeding water has an opportunity to collect on surface:
 - a. Spread.
 - b. Consolidate.
 - c. Straightedge.
 - d. Darby or bull float.
15. No water shall be added to the concrete surface to ease finishing operation.
16. Do not discharge water into forms.
17. Consider use of form vibrators for certain placement situations.

B. Cold Weather Concrete Placement:

1. Comply with ACI 306.1.
2. Do not place concrete on forms or subgrades that are below 32 DEGF or contain frozen material.
3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
4. Temperature of concrete when discharged at site: Per ACI 306.1.
5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DEGF, when temperature of surrounding air is 40 DEGF or below at time concrete is placed.
 - a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DEGF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DEGF.
8. Follow ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

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- C. Hot Weather Concrete Placement:
1. Comply with ACI 305.1.
 2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
 3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
 - a. Not to exceed 90 DEGF.
 - b. Not so high as to cause:
 - 1) Shrinkage cracks.
 - 2) Difficulty in placement due to loss of slump.
 - 3) Flash set.
 4. Temperature of forms and reinforcing when placing concrete:
 - a. Not to exceed 90 DEGF.
 - b. May be reduced by spraying with water to cool below 90 DEGF.
 - 1) Leave no standing water to contact concrete being placed.
 5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.
- D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
 2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
 - a. Ensure no displacement of reinforcing or other embeds from final position.
 - b. Eliminate:
 - 1) Air or stone pockets.
 - 2) Honeycombing or pitting.
 - 3) Planes of weakness.
 3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
 - a. Size and coordinate external vibrators to specifically match forming system used.
 4. Internal vibrators:
 - a. Minimum frequency of 8000 vibrations per minute.
 - b. Insert and withdraw at points approximately 18 IN apart.
 - 1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
 - c. Use in:
 - 1) Beams and girders of framed slabs.
 - 2) Columns and walls.
 - 3) Vibrating concrete around all waterstops.
 - d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
 5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
 6. Do not use vibrators to transport concrete within forms.
 7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the work.
 8. Provide sufficient spare vibrators on jobsite during all concrete placing

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- operations to assure continuous vibration.
9. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
 10. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.
- E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
 2. Horizontal belt conveyors:
 - a. Mount at a slope which will not cause segregation or loss of ingredients.
 - b. Protect concrete against undue drying or rise in temperature.
 - c. Use an arrangement at discharge end to prevent segregation.
 - d. Do not allow mortar to adhere to return length of belt.
 - e. Discharge conveyor runs into equipment specially designed for spreading concrete.
 3. Metal or metal lined chutes:
 - a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
 - b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
 - c. Provide end of each chute with a device to prevent segregation.
 4. Pumping or pneumatic conveying equipment:
 - a. Designed for concrete application and having adequate pumping capacity.
 - b. Control pneumatic placement so segregation is avoided in discharged concrete.
 - c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
 - d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
 - e. Provide pumping equipment without Y sections.

3.4 JOINTS AND EMBEDDED ITEMS

- A. Construction Joints - General:
1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
 - a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Specification Section.
 2. Unplanned construction joints will not be allowed.
 - a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
 3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in

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- girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
 - a. At Contractor's option, beam pockets may be formed into concrete walls.
 - b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
 5. Place beams, girders, column capitals and drop panels at same time as slabs.
 6. Place corbels monolithically with their supporting members.
 - a. Locate wall vertical construction joints midway between corbels.
 - b. Where only a single corbel is located, place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
 7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
 8. Provide the following joints unless noted otherwise on Drawings:
 - a. Roughen joints: horizontal construction joints.
 - b. Keyed joints: vertical construction joints.
 9. Roughen construction joints:
 - a. Clean the previously hardened concrete interface and remove all laitance.
 - b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
 10. Minimum time before placement of adjoining concrete construction:
 - a. All other concrete: 60 HRS, unless otherwise noted.
- B. Construction Joints - Spacing Unless Otherwise Specified:
1. Water retaining structures:
 - a. Wall and slab construction joints:
 - 1) 30 FT maximum centers.
 - 2) At wall intersections, 10FT minimum from corner.
 - b. Other: refer to Drawings
- C. Construction Joints - Bonding:
1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
 2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as outlined below:
 3. Roughen construction joints:
 - a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 1/4 IN minimum amplitude.
 - 1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
- D. Slab On Grade Joints:
1. Locate construction and control joints in slabs on grade as indicated on Drawings.
 2. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
 - a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
 - b. Complete before shrinkage stresses become sufficient to produce cracking.
- E. Expansion Joints:

1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
 2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
 3. Seal expansion joints as shown on Drawings.
- F. Waterstops - General:
1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
 2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
 3. Preformed strip type:
 - a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
 - 1) Maintain at least 3 IN from edge of concrete or as recommended by manufacturer.
 - b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
 - c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
 - d. Use in joints against existing concrete where indicated on Drawings.
 4. PVC waterstops:
 - a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
 - b. Secure waterstops in correct position using hog rings or grommets spaced no more than 18 IN maximum staggered along each edge full length and passed through the edge of the waterstop.
 - 1) Tie wire to adjacent reinforcing.
 - c. Hold horizontal waterstops in place with continuous supports.
 - d. Install according to manufacturer's instructions.
 - 1) Do not displace reinforcement from required location.
 - e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
 - 1) Use factory fabricated "T" and corner intersection fittings.
 - 2) Field splice straight runs of material.
 - f. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.
- G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
 - a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.
 2. Do not route electrical conduit, drains, or pipes in concrete slabs,

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walls, columns, foundations, beams or other structural members unless approved by Engineer.

H. Placing Embedded Items:

1. Support against displacement.
2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
3. Provide adequate means for anchoring waterstop in concrete.
 - a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.5 FINISHING

- A. See Specification Section 03351.
- B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

A. Grout Schedule:

1. Sand cement grout or "Grout Fill":
 - a. General use.
 - b. As noted on Drawings.
2. Non-shrinking non-metallic grout:
 - a. Filling form tie holes.
 - b. Under column and beam base plates.
 - c. Other uses indicated on the Drawings.
3. Epoxy grout:
 - a. Grouting of rotating or oscillating equipment base plates.
 - b. As noted on the Drawings.

B. Grout Installation:

1. Non-shrink non-metallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 HRS prior to grouting.
 - c. Mix in a mechanical mixer.
 - d. Use no more water than necessary to produce flowable grout.
 - e. Place in accordance with manufacturer's instructions.
 - f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast slabs, and in other locations indicated on the Drawings.
 - g. Completely fill all spaces and cavities below the top of base plates.
 - h. Provide forms where base plates and bed plates do not confine grout.
 - i. Where exposed to view, finish grout edges smooth.
 - j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
 - k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
2. Epoxy grout:
 - a. Mix and place in accordance with manufacturer's instructions.
 - b. Apply only to clean, dry, sound surface.
 - c. Completely fill all cavities and spaces around dowels and anchors without voids.

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- d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
- e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
 - 1. Follow recommendations of ACI 308.1 except as modified herein.
 - 2. All traffic shall be kept from the surface as necessary to protect the concrete but not less than the first 48 HRS of curing.
- B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
 - 1. Ponding or continuous sprinkling. Take care to avoid eroding the surface of freshly placed concrete.
 - 2. Application of wet Absorbent Covers:
 - a. Minimum lap: 12 IN.
 - b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as required to keep concrete surface continuously wet.
 - c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
 - 3. Continuous application of steam (not exceeding 150 DEGF) or mist spray.
 - 4. Application of Moisture Retaining Cover sheet materials.
 - a. Place as soon as possible after final finishing and without marring the surface.
 - b. Minimum lap: 12 IN.
 - c. Seal all edges to make water-tight.
 - d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
 - e. Hold cover and edges in place as required to prevent wind from displacing the cover.
 - f. Moisture Retaining Fabric:
 - 1) Install in accordance with manufacturer's written recommendations.
 - 2) Saturate concrete surface and fabric side of cover immediately prior to placing.
 - g. Monitor continuously during the curing period:
 - 1) Repair any holes, tears or displaced cover.
 - 2) Rewet as required to keep concrete moist under cover.
 - 5. Application of other moisture retaining covering as approved by Engineer.
 - 6. Water used for curing shall be within 20 DEGF of the concrete temperature.
 - 7. Application of a curing compound.
 - a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
 - b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.

- c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
 - 1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
 - 2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - 3) Allow the preceding coat to completely dry prior to applying the next coat.
 - 4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
- 8. Surfaces In Contact with Forms:
 - a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
 - 1) See Section 03200.
 - b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
 - c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
 - d. After form removal, cure concrete until end of time prescribed.
 - e. Use one of the methods listed above.
 - f. Forms left in place shall not be used as a method of curing in hot weather.
 - g. The term "hot weather", where used in these specifications, is defined in ACI 305.1.
 - h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.
- C. Curing Period:
 - 1. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
 - a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.
- D. Cold Weather:
 - 1. Follow recommendations of ACI 306.1.
 - 2. Maintain temperature of concrete per ACI 306.1 for a minimum of 72 HRs after concrete is placed, when outdoor temperature is 40 DEGF, or less.
 - a. Maximum temperature rate of decrease: Per ACI 306.1.
 - 3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
 - 4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 - 5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

- E. Hot Weather:
 - 1. Follow recommendations of ACI 305.1 and ACI 308.1.
 - 2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
 - 3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
 - 4. Maximum temperature rate of decrease: Per ACI 305.1.
- F. Rate of Temperature Change:
 - 1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
- G. Protection from Mechanical Injury:
 - 1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
 - 2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
 - 3. Do not load self-supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

- A. Special Inspections per building code:
 - 1. See Structural Drawings and 03330.

END OF SECTION

SECTION 03351

CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete finishing and repair of surface defects.
 - 2. Chemical Sealers.
 - 3. Polymer Modified Cementitious Coating.
 - 4. Resurfacing Mortar.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03100 - Formwork.
 - 4. Section 03300 - Concrete, Materials and Proportioning.
 - 5. Section 03350 - Concrete Mixing, Placing, Jointing and Curing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
 - d. 308, Standard Practice for Curing Concrete.
 - 2. ASTM International (ASTM):
 - a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
 - b. C150, Standard Specification for Portland Cement.
 - c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - i. D4259, Standard Practice for Abrading Concrete.
 - j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
 - k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.

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3. International Concrete Repair Institute (ICRI):
 - a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 4. National Council Highway Research Program (NCHRP):
 - a. 244, Concrete Sealers for the Protection of Bridge Structures.
 5. The Society for Protective Coatings/NACE International (SSPC/NACE):
 - a. SP 13/NACE No. 6, Surface Preparation of Concrete.
- B. Qualifications:
1. Chemical Sealer CS-2:
 - a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
 - b. Applicator shall have a minimum of five years of experience successfully applying materials specified.

1.3 DEFINITIONS

- A. Vertical Surface Defects:
1. Any void in the face of the concrete deeper than 1/8 IN, such as:
 - a. Tie holes.
 - b. Air pockets (bug holes).
 - c. Honeycombs.
 - d. Rock holes.
 2. Scabbing:
 - a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
 3. Foreign material embedded in face of concrete.
 4. Fins 1/16 IN or more in height.
- B. Installer or Applicator:
1. Installer or applicator is the person installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.
- C. Other words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 3. Certifications:
 - a. Certification of aggregate gradation.
 - b. Certification of manufacturer experience qualifications and performance history.
 - c. Certification of applicator's qualifications.
 - 1) Refer to Qualifications paragraph.
 - 2) Provide manufacturer's written approval of applicators.

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3) Provide references substantiating specialty experience.

B. Informational Submittals:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Bonding Agents:
 - a. BASF Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
2. Polymer Modified Cementitious Coating:
 - a. Aquafin International.
 - b. BASF Master Builders Solutions.
 - c. Euclid Chemical Co.
3. Patching Mortar:
 - a. BASF Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - d. Sika Corporation.

- B. Submit request for substitution in accordance with Div 01.

2.2 MATERIALS

- A. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.

1. Portland cement-based, rapid set repair mortar for interior or exterior use.
2. Compressive Strength, ASTM C109:
 - a. Minimum 3000 PSI at 7 days.
 - b. Minimum 5000 PSI at 28 days.
3. Freeze Thaw Durability, ASTM C666: 96.75 PCT at 300 Cycles.
4. Shrinkage, ASTM C157: 0.069 PCT.
5. Euclid Chemical Speed Crete Red Line.

- B. Bonding Agents:

1. For use only on concrete surfaces not receiving liquid water repellent coating:
 - a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
 - 1) BASF Master Builders MasterEmaco A 660.
 - 2) Euclid Chemical Co. Flex-Con.
 - 3) Laticrete L&M Everbond.
2. For use only on concrete surface receiving liquid water repellent:

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- a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
- C. Cement:
 - 1. ASTM C150, Type II Portland for areas exposed to sewage.
 - 2. ASTM C150, Type V Portland where specified or indicated on Drawings.
 - 3. ASTM C150, Type I or I/II Portland elsewhere.
- D. Aggregate:
 - 1. Sand: Maximum size #30 mesh sieve.
 - 2. For exposed aggregate finish surfaces: Same as surrounding wall.
- E. Water: Potable.
- F. Polymer modified cementitious coating:
 - 1. Polymer modified Portland cement based coating for concrete and masonry.
 - a. Waterproof.
 - b. Resistant to both positive and negative hydrostatic pressure.
 - c. Breathable.
 - 2. BASF MasterSeal 581 or Euclid Chemical Tamoseal.
 - a. Color:
 - 1) Interior surfaces: Standard gray
 - 2) Exterior surfaces: Standard gray.
 - b. Texture: Fine.

G. Nonshrink Grout: See Specification Section 03300 and Specification Section 03350

2.3 MIXES

- A. Bonding Grout: One part cement to one part aggregate.
- B. Patching Mortar:
 - 1. One part cement to 2-1/2 parts aggregate by damp loose volume.
 - a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

- A. For methods of curing, see Specification Section 03350.
- B. Surface Preparation:
 - 1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
 - 2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
 - a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
 - 1) Areas to receive Repair Mortar:
 - a) Areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.

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- b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c. No feathered edges will be permitted.
 - d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.
- C. Preparation of Bonding Grout Mixture:
 - 1. Mix cement and aggregate.
 - 2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
 - 3. Add bonding agent/water mixture to cement/aggregate mixture.
 - 4. Mix to consistency of thick cream.
 - 5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.
- D. Preparation of Patching Mortar Mixture:
 - 1. Mix specified patching mortar per manufacturer's published recommendations.
 - 2. For repairs exceeding 2 IN in depth, mix with clean, pre-dampened 3/8 IN pea gravel in accordance with the manufacturer's recommendations.
- E. Polymer modified cementitious coating:
 - 1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

- A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DEGF.
 - 1. If necessary, enclose and heat area to between 50 and 70 DEGF during repair of surface defects and curing of patching material.
 - a. Use only clean fuel, indirect fired heating apparatus.
 - b. Exhaust combustion byproducts outside of work area.
- B. Repairing Surface Defects:
 - 1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
 - a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
 - 1) Fluid Applied Waterproofing: See Specification Section 07 14 00.
 - 2) Concrete Coating/Lining, 100% Solids High Build Epoxy: See Specification Section 09 96 01
 - 3) Concrete Coating/Lining, Polyurethane: See Specification Section 09 96 02
 - 2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
 - a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
 - b. Scrub bond coat:

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- 1) Wet substrate to a saturated surface dry (SSD) condition.
- 1) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire

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area.

- c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
 - d. Patching Mortar Application:
 - 1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
 - 2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.
 - 3. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
 - 4. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
 - a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
 - 5. Cure patching mortar in accordance with ACI 308.
- C. Concrete Finishes for Vertical Wall Surfaces:
- 1. General:
 - a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
 - b. Finish numbers not listed are "Not Used".
 - 2. Finish #1 - As cast rough form finish:
 - a. Selected forming materials are not required.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - c. Repair the following surface defects using patching mortar specified in PART 2:
 - 1) Tie holes.
 - 2) Honeycombs deeper than 1/4 IN.
 - 3) Air pockets deeper than 1/4 IN.
 - 4) Rock holes deeper than 1/4 IN.
 - d. Chip or rub off fins exceeding 1/4 IN in height.
 - e. Provide at unexposed surfaces such as:
 - 1) Foundations.
 - 2) Below-grade walls not to be waterproofed.
 - 3) Concealed surface of concrete back-up wythe in cavity wall construction.
 - 3. Finish #2 - As cast form finish:
 - a. Form facing material shall produce a smooth, hard, uniform texture.
 - 1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03200.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - 1) Chip or rub off fins exceeding 1/8 IN in height.
 - 2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
 - a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.

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- (1) For contiguous repair areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
 - b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c) No feather edges will be permitted.
- 3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
- 4) Repair the following surface defects using patching mortar specified in PART 2:
 - a) Tie holes.
 - b) Honeycombs deeper than 1/4 IN or larger than 1/4 IN DIA.
 - c) Air pockets deeper than 1/4 IN or larger than 1/4 IN DIA.
 - d) Rock holes deeper than 1/4 IN or larger than 1/4 IN DIA.
 - e) Scabbing.
- 5) Brush blast repaired areas to match adjacent surface texture.
- c. Provide this finish for:
 - 1) Interior walls of underground vaults.
 - 2) Underside of horizontal elements adjacent to the finished surface.
 - 3) Exposed surfaces not specified to receive another finish.

D. Related Unformed Surfaces (Except Slabs):

1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float surface to a texture consistent with that of formed surfaces.
 - a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
3. Continue treatment uniformly across unformed surfaces.

E. Concrete Finishes for Horizontal Slab Surfaces:

1. General:
 - a. Tamp concrete to force coarse aggregate down from surface.
 - b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
 - c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
 - a. When type of finish is not indicated, use following finishes as applicable:
 - 1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 - 2) Surfaces intended to receive roofing or waterproofing membranes: Floated finish.
 - 3) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
 - 4) All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes

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- or rakes before final set.
4. Floated finish:
 - a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
 - b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
 - 1) Use wood or cork float.
 - c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
 5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
 - a. Refloat slab immediately to a uniform texture.
 6. Troweled finish:
 - a. Float finish surface to true, even plane.
 - b. Power trowel, and finally hand trowel.
 - c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
 - d. Perform additional trowelings by hand after surface has hardened sufficiently.
 - e. Final trowel when a ringing sound is produced as trowel is moved over surface.
 - f. Thoroughly consolidate surface by hand troweling.
 - g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
 - 1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 - h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.
 7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
 8. Underside of concrete slab finish:
 - a. Match finish as specified for adjacent vertical surfaces.
 - b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

- A. Tolerances:
 1. Finished floor slabs:
 - a. Provide Floor Flatness (FF) and Floor Levelness (FL) in accordance with ACI 117.
 - 1) Measure in accordance with ASTM E1155.
 - b. Slabs not indicated to be sloped:
 - 1) FF: Equal or greater than 35.
 - 2) FL: Equal or greater than 25.
 - c. Slabs indicated to be sloped or curved:

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- 1) Measure in accordance with ASTM E1486.
 - 2) Provide slopes or curves as indicated on the Drawings.
 - d. Slabs indicated to receive polished concrete floor:
 - 1) FF: Equal or greater than 45.
 - 2) FL: Equal or greater than 35.
 - 3) Refer to Room Finish Schedule on Drawings.
 2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
 - a. Gap between a 10 FT straightedge placed anywhere and the finished surface shall not exceed:
 - 1) Class A tolerance: 1/4 IN.
 - 2) Class B tolerance: 3/8 IN.
 - 3) Class C tolerance: 1/2 IN.
 - b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 IN.
- B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
 1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.
- C. Provide services of manufacturer's technical representative:
 1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
 2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.

3.4 PROTECTION

- A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 HRS following installation of sealer.

3.5 CONCRETE FINISH SCHEDULE

- A. Concrete surfaces shall be broom finished unless otherwise directed by the Engineer.

END OF SECTION

SECTION 05500

METAL FABRICATIONS (MISCELLANEOUS METAL)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. All metal fabrications and other miscellaneous metal items together with related accessory items and fasteners, including:
 - a. All other metal fabrications and miscellaneous metal not covered under other sections.

1.02 REFERENCES

A. American National Standards Institute:

1. B18.23.1 Beveled Washers

B. ASTM International (ASTM):

1. A36 Specification for Carbon Structural Steel
2. A53 Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated Welded and Seamless
3. A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. A283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
6. A307 Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
7. A500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
8. A501 Specifications for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
9. A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Gavannealed) by the Hot-Dip Process
10. A786 Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy and Alloy Steel Floor Plates
11. A793 Specification for Rolled Floor Plate, Stainless Steel
12. B632 Specification for Aluminum-Alloy Rolled Tread Plate
13. C595 Specification for Blended Hydraulic Cement
14. F844 Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
15. F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

C. Publications of the National Association of Architectural Metal Manufacturers (NAAMM):

1. "Metal Product Outline; Division 5 Metal"
2. "Metal Finishes Manual"

- D. The Society for Protective Coatings (SSPC), Volume 2. Standards for Surface Preparation are specified by SSPC followed by SP and a number indicating the specified type of surface preparation.
- E. International Building Code (IBC)
- F. International Code Council (ICC).

1.03 SUBMITTALS

- A. Product Data: Fully describe every product proposed for use.
- B. Shop Drawings:
 - 1. Show dimensions, finishes, joining, attachments, inserts, and relationship of work to adjoining construction.
 - 2. Indicate all shop and erection details including cuts, copes, connections, holes, threaded fasteners and welds. Indicate welds using AWS "Welding Symbols."
 - 3. Show field measured dimensions of this and adjacent work and location of inserts on fabrication drawings.
 - 4. Submit a full floor plan layout and details for all gratings and grating support frames.

1.04 QUALITY ASSURANCE

- A. Contractor's Qualifications:
 - 1. Welding procedures, welders, and welding operations shall be qualified for the type of work required in accordance with AWS Standard Qualification Procedures.
 - 2. Apply fusion epoxy coating by a specialty contractor regularly engaged in the application of fusion epoxy coatings for industrial corrosion protection applications. Application of decorative epoxy coatings to ornamental iron work is not considered an acceptable qualification.
- B. Regulatory Requirements: Comply with the following codes and reference standards unless higher standards are specified, shown or required by applicable codes:
 - 1. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," American Institute of Steel Construction (AISC), latest edition.
 - 2. Structural Welding Code of the American Welding Society, AWS D1.1, latest edition.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver anchorage devices that will be embedded in the work of other trades in sufficient time to permit their timely installation. Provide proper setting drawings, templates, and directions for installation.
- B. Store materials above ground on platforms, skids, or other supports. Store all fasteners and welding electrodes in a weathertight and dry location until ready for use. Store packaged materials in their original labeled containers.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Standard Structural Steel Shapes, Bars and Plates: ASTM A36.
- B. Steel Tubing: ASTM A500, (cold formed) Grade A, or ASTM A501 (hot formed), welded or seamless.
- C. Steel Pipe: Seamless, conforming to ASTM A53, Type E or S, Grade B.
- D. Aluminum: ASTM B483, Alloy 6061-T6 or 6063-T5 or T6.
- E. Bolts and Nuts: ASTM A307, Grade A.
- F. Plain Washers: ASTM F844.
- G. Beveled Washers: ANSI B18.23.1.
- H. Stainless Steel Bars and Shapes: ASTM A276
- I. Stainless Steel Bolts: ASTM F593
- J. Stainless Steel Nuts: ASTM F594

2.02 GALVANIZING

- A. Hot-dip galvanize all exterior ferrous metal work and all noted interior ferrous metal work.
- B. Hot-dip galvanize all sheet steel, plain or shaped in accordance with ASTM A653, G-90 Commercial Grade.
- C. Hot-dip galvanize all products fabricated from rolled, pressed and forged steel shapes, plates, bars and strip 1/8-inch thick or heavier, in accordance with ASTM A123.
- D. Hot-dip galvanize all steel hardware, nuts, bolts, washers, anchors, and threaded rods in accordance with ASTM A153 or F2329. Size thread clearance to allow for galvanized coating; rerun threads after galvanizing, if required, to assure a smooth fit.

2.03 GALVANIZING REPAIR

- A. Repair damaged galvanizing by heated repair method. Repair materials: ReGalv by Rotometals, Inc., San Francisco, CA; or equal. Specifier knows of no equal.

2.04 ISOLATION COATINGS

- A. Coat aluminum in contact with other metals in accordance with aluminum pigmented asphalt paint or two coats of a high build polyamide epoxy paint, Tnemec 66 or equal, with a total thickness of system DF = 8.0 mils, minimum.
- B. Coat aluminum in contact with concrete, masonry or plaster in accordance with bituminous mastic or zinc chromate coating, Tnemec 46-465 or equal, with a total thickness of system DFT = 8.0 mils, minimum.
- C. Provide neoprene or phenolic washers and isolation bolt sleeves or insulating compound at all stainless steel fasteners to aluminum interfaces. Isolation washers shall be capped under a stainless steel washer. Insulating compounds shall be Tef-Gel by Ultra Safety Systems Company, Lanocote by Forespar, or equal.

PART 3 - EXECUTION

3.01 ERECTION TOLERANCES

- A. Conform to straight plumb and horizontal lines which also form a true flat plane to within 1/8-inch in 2 feet and 1/4-inch in 10 feet and 1/2 maximum overall.
- B. Curved surfaces shall conform to a true arc of a circle to within 1/8-inch in 12 inches and 1/4-inch maximum overall.

3.02 INSTALLATION GENERAL

- A. Fabricate and pre-fit metal work in the shop, in transportable components ready for field erection.
- B. Make proper allowance for expansion and contraction of the metals and of the materials to which they are fastened.
- C. Where metal is fastened to concrete, make the connection by means of sleeves and fastenings embedded in concrete or by expansion shield anchor bolts or wedge anchor bolts. Wood plugs, plastic plugs or powder driven studs are not acceptable.
- D. Construct steel work in accordance with AISC Standard practices to withstand the forces normally applied and in compliance with IBC and OSHA requirements.
- E. Grind welds smooth on all metal work exposed to view. Provide work that has:
 - 1. Surfaces that are flat, straight, square, plumb and level.
 - 2. Smooth curves, free of flat spots, and of uniform radius or, if intended to be of changing radius, follow a flowing fair curve.
 - 3. Make transitions between curved and straight portions of work at tangent points to achieve smooth and free flowing lines and surfaces without flat spots or abrupt changes in direction.
- F. Provide 1/8-inch radius corners and edges on all exposed work.
- G. Perform all welding in accordance with AWS Code D1.1. Employ methods and techniques to achieve strength and good appearance.
- H. Field Assembly: Set members to lines and elevations indicated. Align and adjust members before making permanent connections.
- I. Galvanized Metal Repair: Repair damaged galvanized metal by the heated substrate method as specified in Paragraph 2.03.
- J. Touch-up Painting (Ferrous Metals): After field assembly, clean all bare metal and all abrasions to shop coat, and spot paint with same primer used in the shop.

3.03 REPAIRS

- A. Repair or replace all defective work including:
 - 1. Unsightly welds.
 - 2. Discontinuous welds.
 - 3. Uneven connections.
 - 4. Variations exceeding specified tolerances.
 - 5. Kinks, bends.

6. Other defects affecting the quality, strength, utility, and appearance of the work.

3.04 CLEANING

- A. Wash thoroughly using clean water and detergent.
- B. Do not use acid solutions, steel wool or other abrasives.
- C. Remove stubborn grease stains with mineral spirits.

END OF SECTION

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SECTION 06600

FIBERGLASS FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section is applicable to fiberglass-reinforced polymer (FRP) grating, FRP members, channels, angles, extruded members, miscellaneous FRP items, and appurtenances associated with fabrication of the FRP grating system.

1.02 REFERENCES

- A. American Iron and Steel Institute (AISI).
- B. ASTM International (ASTM):
 - 1. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
 - 2. ASTM D638 Standard Test Method for Tensile Properties of Plastics
 - 3. ASTM D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
 - 4. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - 5. ASTM D2344 Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
 - 6. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- C. Occupational Safety and Health Administration (OSHA)
- D. International Building Code (IBC)

1.03 SUBMITTALS

- A. Product Data: Fully describe all products proposed for use. Include data on physical, chemical, and structural engineering properties. Include submittal for catalyzed resin sealant for repairs.
 - 1. For grating, provide additional Manufacturer's published literature including:
 - a. Structural design data.
 - b. Structural properties data.
 - c. Grating load/deflection tables.
 - d. Corrosion resistance tables.
 - e. Certificates of compliance.
 - f. Test reports as applicable.
- B. Shop Drawings: Custom prepared project specific shop drawings showing dimensions, joint locations and connection details.
 - 1. For grating: Furnish manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication and erection of components including, but not limited to, location,

- lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
 - 2. Grating shop drawing shall accurately show all penetrations through grating, coordinated with favorably reviewed shop drawings of elements penetrating grating.
 - 3. Shop drawings shall clearly show the segments of grating and the self-weight of the grating in terms of pounds (lbs).
 - 4. Verify the actual field dimensions prior to fabrication. Clearly indicate any deviations on the shop drawings.
- C. Calculations: Design calculations for systems not sized or designed in the contract documents sealed and signed by a Professional Civil Engineer in the State of Colorado.

1.04 QUALITY ASSURANCE

- A. Qualifications: Provide work fabricated and installed by a licensed specialty contractor who has been exclusively engaged in fiberglass fabrication work of the type required for the past 5 years.
- B. Regulatory Requirements:
 - 1. Comply with the:
 - a. IBC

1.05 DELIVERY AND STORAGE

- A. Inspect all items delivered to the site for damage. Replace items that have splintered or suffered surface damage.
- B. Store in a clean area without adding other concentrated or distributed loads above the items.
- C. Store in accordance with Manufacturer's requirements.

PART 2 - PRODUCTS

2.01 GRATING

- A. Provide fiberglass grating manufactured by Grating Pacific, Fibergrate Composite Structures; Mona Composites; or equal.
- B. FRP grating shall be suitable for extended exposure in wastewater environments.
- C. Size grating and support members as shown on the Drawings. Where not shown, grating shall be size for 100 pounds per square foot superimposed load with a grating deflection not to exceed 1% of span or 1/4 of an inch, whichever is less. Fiberglass is to be manufactured by the molded process.
- D. Grating shall be of a one piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern providing bidirectional strength. Install grating flush with adjacent concrete or other walking surfaces. All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance.
- E. Provide grating panels that are absolutely flat, correctly sized, and fabricated to lie in their frames with uniform, non-rattling bearing on all supporting surfaces.

- F. Provide stainless steel type AISI 316 hold-down clips and other connection devices as required by manufacturer or Drawings.
- G. Band ends of all fixed and removable grating section with banding bars of the same thickness and the same depth as the main bearing bars to the ends of all bearing and cross bars.
- H. Leave "split" openings in the gratings when required for the passage of pipes, valve stems or other devices.
- I. Provide "fixed" grating for all operating grating platforms. Bolt "fixed" grating to support members with stainless steel saddle clips and stud bolts.
- J. Where required for access or where noted, provide removable grating sections sized to limit the weight of any one section to 50 pounds. Bolt removable sections in place by the same method used for fixed grating. Mark removable sections by painting the banding bars red.
- K. Provide a non-skid walking surface to the top of the grating.
- L. Color: Safety Yellow or as required by the Owner.

2.02 STRUCTURAL FIBERGLASS MEMBERS

- A. Provide products manufactured by Morrison Molded Fiberglass Company, Creative Pultrusions, or equal. Provide the grade of fiberglass specified on the Drawings OR necessary to satisfy the specified criteria.
- B. Provide structural shapes with minimum ultimate tensile (ASTM D638) and bending strength (ASTM D790) of 30,000 pounds per square inch minimum in the longitudinal direction and short beam shear of 4,500 pounds per square-inch minimum (ASTM D2344).
- C. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, and free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

2.03 STRUCTURAL FIBERGLASS FASTENINGS

- A. Provide stainless steel type AISI 316 bolt assemblies and other connection devices as required by the manufacturer and as specified on the Drawings.
- B. Provide fiberglass bolt assemblies and other connection devices as required by the manufacturer or specified on the Drawings.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Fabricate all grating assemblies and structural components in the shop to the greatest extent possible.
- B. Sealing: All shop fabricated cuts or drilling shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

- C. Gratings:
 - 1. Install support frames so that gratings have continuous support and will sit in their frames without rattling or rocking in any direction including across diagonal corners.

3.02 INSTALLATION

- A. Set structural components accurately in position and hold with support devices until permanent anchors are secured.
- B. Set grating accurately in position and install all fastenings as directed by manufacturer or drawings.
- C. Repair all damaged surfaces with catalyzed resin sealant.

END OF SECTION

SECTION 08307

ACCESS HATCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Vault access hatches.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C1802 Standard Specification for Design, Testing, Manufacture, Selection, and Installation of Horizontal Fabricated Metal Access Hatches for Utility, Water, and Wastewater Structures
- B. International Code Council (ICC):
 - 1. International Building Code (IBC), current adopted edition.
- C. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

- A. Product Data: Fully describe all items proposed for use. Include sufficient data to show that products conform to specification requirements as indicated herein and in Related Sections.
- B. Shop Drawings: Show dimensions, attachments, inserts and relationship of work to adjoining construction.
- C. Warranty.
- D. Special Guarantee.
- E. Certification, in the form of a letter, shop drawing, and/or calculations, signed and sealed by a professional engineer, attesting that the hatch is designed for the specified loading.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Occupational Safety and Health (OSHA) Regulations.
 - 2. International Building Code, 2018.

PART 2 - PRODUCTS

2.01 ACCESS HATCHES

- A. Provide single leaf or double leaf hatches as indicated in the Access Hatch Schedule, or as recommended by the manufacturer for the overall hatch dimensions.
 - 1. Single Leaf: Bilco "J" series; equivalent by L.W. Products Co.; equivalent by EJ; equivalent by Babcock-Davis; equivalent by U.S.F. Fabrication; or equal.

- B. Material: ANSI Type 316 stainless steel with ANSI Type 316 stainless steel hardware and components.
- C. Live load: Provide hatches to withstand the loads indicated in the Access Hatch Schedule.
- D. Door Leaves: 1/4-inch thick stainless steel, diamond pattern, reinforced as required to withstand the specified loads.
- E. Frame: Minimum 1/4-inch thick stainless steel channel with anchor flange around perimeter for embedment into concrete. Provide channel to collect rain water and provide 1-1/2-inch drainage coupling for connection to drain lines. Contractor shall provide and route drain lines into the vault to discharge into the channel. Freefalling of drainage water directly from the hatch frame is not acceptable.
- F. Doors: Doors shall open to minimum 90 degrees and shall include an automatic hold-open arm with a positive automatic latch that will secure the door in the open position until the release handle is activated. Provide stainless steel hold-open pin through holes in hold-open arms to ensure against accidental hatch closure. Attach pin to hatch with a short stainless steel chain to prevent loss. Submit details of latch for review. Door hinges shall be recessed or flush.
- G. Lock: Provide recessed padlock hasp. Coordinate locking requirements with the Owner.
- H. Lift-Assist Mechanism: Provide stainless steel compression spring(s) or pneumatic spring(s) enclosed in sealed telescoping tube(s).
- I. Safety Grate: Where indicated in the Access Hatch Schedule, provide a secondary fall protection safety grate located beneath the solid hatch cover, which lifts independently from the cover and is equipped with a latch to hold it in the open position. The grate shall be manufactured from aluminum flat bars, load-rated for 300 pounds per square foot, and safety orange in color. The grate shall have a padlock hasp for locking in the closed position. The grate shall comply with OSHA Standard 1910.28 for fall protection.
- J. All metals and hardware: ANSI Type 316 stainless steel.
- K. Finish: Mill finish stainless steel.
- L. Weather-Tightness: All hatches shall be rated "weather tight" unless noted otherwise in the Access Hatch Schedule. Provide an EPDM or neoprene rubber rim gasket to prevent infiltration of rainwater. Include gaskets and o-rings for accessory penetrations as applicable.
- M. Odor-Tightness: Where indicated in the Access Hatch Schedule, provide EPDM or neoprene rubber gaskets to limit the transmission of odors when the hatch doors are closed. Air leakage shall not be greater than 1 cfm per liner foot of gasket at a 1-inch water column (WC) pressure differential.
- N. Warning Sign:
 - 1. Provide a sign or decal permanently attached to the underside of hatch doors reading: "Warning: Permit Confined Space Entry."

2.02 ACCESS HATCH SCHEDULE

Hatch Location	No. of Leaves	Live Load	Safety Grate	Special Requirements
Metering Vault	Single	ASTM C1802, Load Level 6	Yes	1. Odor tight 2. Water tight 3. Coordinate locking requirements with the Owner 4. Provide (1) Warning Sign

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Deliver hatches to job site in time for installation in the concrete pour.
- B. Make connection of drainage coupling to plumbing drain line prior to the concrete pour.
- C. Install in conformance with the manufacturer's installation instructions. Set frame level and true to plane at all four corners, and flush with adjacent finished surfaces. Doors, when closed, shall be flush with frames and flush with each other.
- D. Install specified warning sign(s).

END OF SECTION

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SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work Included:

1. Provide all required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment, and satisfactorily complete all electrical work shown on the Drawings, included in these Specifications, or required for a complete and fully operating facility. In addition, provide wiring for the equipment that will be provided under other Divisions of these Specifications.
2. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions. Coordinate with the supplier of electrical equipment specified under other Divisions.
3. Provide all conduit, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. This also includes lightning and surge protection equipment wiring at process instrumentation transmitters if required. Contractor shall install vendor furnished cables specified under other Divisions.
4. Provide a complete raceway system for the specialty cable systems. Install the specialty cable systems in accordance with the system manufacturer's installation instructions. Review of the raceway layout, prior to installation, with the system supplier and cable manufacturer to ensure raceway compatibility with the system and materials being furnished. Where redundant cables are furnished, install them in separate raceways.
5. Provide raceway and power wiring for all heating, ventilation and air conditioning equipment furnished under other related Divisions. Refer to HVAC drawings and related specifications for power requirements. .
6. Auxiliary Devices: Provide conduit and wire for power and control for all auxiliary devices such as solenoid valves, pressure switches, and instruments that are included as part of a manufacturer's packaged system (i.e., all systems specified in Divisions 11 (40) through 15 (48). Contractor shall be responsible for conduit and wire to these auxiliary devices even if not specifically shown on the Drawings or specified herein.
7. Provide concrete, excavation, backfill and steel reinforcement required for encasement, installation or construction of the WORK of the various Sections of Division 16 (26) as a part of the WORK under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads and light pole bases.

B. Work to be Done by Utilities:

1. Providing and connecting power company meters and instrument transformers.

C. Safety: Conduct operations in accordance with NFPA 70E, Standard for Electrical Safety Requirements for Employee Workspaces.

1.02 CODE COMPLIANCE AND REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:
 - 1. National Electrical Safety Code (NESC)
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. American National Standards Institute (ANSI)
 - 6. Insulated Cable Engineers Association (ICEA)
 - 7. Instrument Society of America (ISA)
 - 8. Underwriters Laboratories (UL)
 - 9. Factory Mutual (FM)
 - 10. Institute of Electrical and Electronics Engineers
 - 11. American Society of Testing Materials (ASTM)
 - 12. Local Telephone Company requirements
 - 13. Local Utility Company requirements
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All materials and equipment for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without a UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

1.03 SUBMITTALS

- A. Shop Drawings shall be custom prepared for this project and submitted as listed in each of the Electrical Specification Sections. Shop drawings shall include the following:
 - 1. Complete materials list stating manufacturer, brand name and catalog number of each item or class of material.
 - 2. For equipment, panels, boxes, control devices, wiring devices, and other uniquely-tagged items as indicated on the Drawings, include the respective tag(s) on each applicable shop drawing and cut sheet.
 - 3. Shop drawings for grounding work not specifically indicated on the drawings but required under the NEC.
 - 4. Front, side and rear elevations along with top views with required dimensional data.
 - 5. Location of conduit entrances and access plates.
 - 6. Catalog cuts defining component data.

7. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size and cable numbers.
 8. Method of anchoring, seismic requirements and weight.
 9. Types of materials and finish.
 10. Nameplates.
 11. Temperature limitations, as applicable.
 12. Voltage requirements, phase and current, as applicable.
 13. Front and rear access requirements.
 14. Test reports.
- B. O&M Manuals and other documentation, shall be submitted in accordance with these contract documents. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc. to instruct operating and maintenance personnel unfamiliar with such equipment. All manuals and other documentation shall be submitted as listed in each of the Electrical Specification Sections and include the following:
1. A comprehensive index.
 2. A complete "As-built" set of approved shop drawings.
 3. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
 4. A table listing of the "as left" settings for all timing relays and alarm and trip set points.
 5. System schematic drawings "As-Built", illustrating all components, piping and electrical connections of the system supplied under this Section.
 6. Detailed service, maintenance and operation instructions for each item supplied.
 7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 8. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
 9. Complete parts list with stock numbers, including spare parts.
- C. Record Drawings shall be promptly furnished when the equipment installation is complete. Payment may be withheld until Record Drawings have been furnished and approved.
- D. At the time of delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner's Inspector and/or Owner's Engineer for verification.
- E. As-Built Drawings: As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called "As-Built Drawings". The As-Built Drawings and specifications shall be kept up to date throughout the project. As-Built Drawings shall accurately show the installed condition of the following items at a minimum:
1. One-line Diagram(s).
 2. Raceways and pullboxes.
 3. Conductor sizes and conduit fills.
 4. Panelboard Schedule(s).
 5. Control Wiring Diagram(s).
 6. Luminaire Schedule(s)
 7. Luminaire, receptacle and switch outlet locations.

8. Underground raceway and duct bank routing including manhole/handhole locations.
9. Plan view, sizes and locations of switchgear, switchboards, distribution transformers, motor control centers and panelboards.

1.04 TESTS

- A. The Contractor shall be responsible for factory and field tests indicated in Division 16, as required by the Engineer and as required by other authorities having jurisdiction.
- B. Furnish necessary testing equipment
- C. Pay the costs of the tests, including replacement parts and labor due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
 1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
 2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.
 3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the Engineer approves, repair and retest for compliance.
- F. Connections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.05 PERMITS AND INSPECTIONS

- A. Obtain permits and pay all fees required for permits inspections.
- B. Pay inspection, connection and turn-on service charges required by the utility company.
- C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

1.06 DEMOLITION AND RELATED WORK

- A. General
 1. Perform electrical demolition work as indicated.
 2. The Contractor is cautioned that demolition work may also be indicated on non-electrical Drawings.
 3. Coordinate with all trades regarding electrical de-energization, disconnection and removal, and the overall sequence of construction.
- B. Electrical Requirements for Removed Equipment
 1. Remove dedicated wiring and exposed conduits back to the source.
 2. Where control wiring to be demolished shares a conduit with other wiring to remain, the control wiring shall be abandoned in place. Where power wiring to be demolished shares a conduit with other wiring to remain, the power wiring shall be removed.

3. Remove power wiring from the power source to the first pullbox or manhole remote from the panel and abandon in place the remaining wiring.
4. Abandon in place wiring routed through encased conduits and cut encased conduits flush to the floor and grout flush with the floor.
5. Remove remote mounted starters, disconnect switches, circuit breakers, sensors and transmitters

1.07 COORDINATION

- A. Coordinate the electrical work with the other trades, code authorities, utilities, and the Owner.
- B. Where connections must be made to existing installations, properly schedule all the required work with the Owner, including the power shutdown periods. Schedule and carry out shutdowns so as to cause the least disruption to operation of the plant and privately owned facilities.
- C. Submit a written sequencing request indicating the sequence and duration of activities to be performed during the plant shutdown.
- D. Switching, safety tagging and other project related tasks required for shutdown or to isolate existing equipment, shall be performed by the Contractor.
- E. In no case shall the Contractor begin any work in, on or adjacent to existing equipment without written authorization from the Engineer.
- F. Existing Utilities
 1. Exercise extreme caution when digging trenches to not damage existing underground utilities.
 2. The cost of repairs of damages caused during construction shall be included as a part of the Work.
- G. Field Verifications
 1. Visit the site before submitting a Bid to become better acquainted with the Work of this Contract.
 2. The lack of knowledge will not be accepted as justification for extra compensation to perform the Work.
 3. The cost for the above field verifications shall be included as part of the Work.
- H. Installation of Temporary Power
 1. To facilitate the continuous operation of existing equipment, provide temporary equipment as indicated.
 2. Submit installation and connection details for favorable review and acceptance by the Engineer.
 3. Costs associated with these temporary installations shall be included as part of the Work.
 4. Temporary wiring and equipment shall remain the property of the Contractor unless indicated otherwise.

1.08 ELECTRICAL SERVICES

- A. Contact the serving utility and verify compliance with requirements before construction.
- B. Coordinate schedules and payments for Work by utilities.

- C. Where conduits and conductors in the Work are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule or greater protection.
- D. Provide electrical service as indicated and as required by the serving utility.
- E. Verify and provide service conduits, fittings, transformer pad, grounding devices and service wires not provided by the serving utility.
- F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the Work.

1.09 LOCATIONS

- A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located, as defined in Paragraph B. herein.
- B. Definitions of Types of Locations:
 - 1. Dry Locations: All those indoor areas which do not fall within the definitions below for Wet, Damp, Hazardous, or Corrosive Locations and which are not otherwise designated on the Drawings.
 - 2. Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.
 - 3. Damp Locations: All spaces wholly or partially underground, or having a wall or ceiling forming part of a channel or tank, unless otherwise designated on the Drawings.
 - 4. Hazardous Locations: All areas in which fire or explosion hazards may exist, normally or accidentally, due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings. These areas are shown on the Drawings, together with the Class and Division designations as defined in the NEC, determining the enclosure types and wiring methods required.
- C. Unless otherwise specified herein or shown on the Drawings, electrical enclosures and associated installations shall have the following ratings:
 - 1. NEMA 1 gasketed for dry, non-process indoor above grade locations
 - 2. NEMA 3R for outdoor installations identified not to be hazardous or corrosive.
 - 3. NEMA 4X enclosures of Type 304 or 316 stainless steel in corrosive areas except in chlorine and HFS areas where non-metallic enclosures shall be provided.
 - 4. NEMA 6 or 6P enclosures for submersible, indoor or outdoor use. Enclosures for temporary submersion shall be rated NEMA 6 and prolonged submersion shall be rated 6P at limited depth.
 - 5. NEMA 7 enclosures (and listed for use in the area classifications shown) for "Class 1 Div. 1 Group D" and "Class 1 Div. 2 Group D" hazardous locations shown on the Drawings or as defined in NFPA 820 or other codes.
 - 6. NEMA 9 enclosures (and listed for use in the area classifications shown) for "Class 1 Div. 1 Group E, F and G" and "Class 1 Div. 2 Group E, F and G" hazardous locations shown on the Drawings or as defined in NFPA 820 or other codes.
- D. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503.
- E. Equipment and materials installed in areas designated as hazardous on the Drawings shall be UL Listed for the appropriate hazardous area classification.

1.10 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly distributed loads across all three phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements defined in Section 16120.

1.11 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure the tilting does not impair the functional integrity of the equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Engineer prior to installation.
- B. It is the intent of these Specifications and Drawings to secure high quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses, which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- C. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light-duty, fragile and competitive grade devices of doubtful durability shall not be used.
- D. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- E. Temperature Ratings of Equipment Terminations and lugs shall be rated for use with 75-degree C conductors. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

2.02 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts and washers constructed of stainless steel.
2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.
3. Slotted channel
 - a. Construct struts for mounting of conduits and equipment of aluminum slotted channel.
 - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
 - c. Slotted channel manufacturer shall be Unistrut, B-Line or approved equal.
4. Provide plastic protective end caps for all exposed slotted channel ends. End caps shall be manufactured by Unistrut P2860-33 or approved equal
5. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors and ceilings. Expansion anchors shall be manufactured by Power Fasteners, Inc and be the "Power-Bolt" or "Power-Stud" series or approved equal.

2.03 NAMEPLATES

- A. For each piece of electrical equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings and the model designation.
- B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using fasteners constructed of brass, cadmium plated steel or stainless steel and screwed into inserts or tapped holes as required. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.
- C. Provide engraved characters of the block style, with no characters smaller than 1/8 inch top to bottom.

2.04 PROTECTIVE MATTING

- A. Provide full-length, high-voltage switchboard matting in front of indoor switchgear, service equipment and motor control centers.
- B. For equipment rated at 600-volt, provide matting that is 1/4-inch thick and 42" wide.
- C. Protective matting shall be as manufactured by Rhino or approved equal

2.05 PAINTING

- A. Equipment: Refer to each electrical equipment section of these Specifications for painting requirements of equipment enclosures. Repair any final paint finish, which has been damaged or is otherwise unsatisfactory, to the satisfaction of the Engineer.
- B. Wiring System: Paint all exposed conduits, boxes and fittings to match the color of the surface to which they are affixed. Paint finishes shall include proper surface preparation, prime coat and a final finish coat, and shall conform to Section 09960.

PART 3 - EXECUTION

3.01 REQUIREMENTS

- A. All electrical installations shall conform to the codes and standards outlined in this Section.

3.02 WORKMANSHIP

- A. Assign a qualified representative who shall supervise the electrical construction work from beginning to completion and final acceptance.
- B. Perform all labor using qualified craftsmen, who have had experience on similar projects. Provide first-class workmanship for all installations.
- C. Ensure that all equipment and materials fit properly in their installations.
- D. Perform any required work to correct improperly fit installations at no additional expense to the Owner.
- E. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
- F. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

3.03 EXCAVATION AND BACKFILL

- A. Provide the excavations for electrical equipment foundations and trenches for conduits as shown on the Drawings.
- B. Exercise caution during all excavation work and avoid damage to existing underground pipes. Exercise extreme caution when working near existing electrical conduits and facilities. Field verify the location of all electrical facilities before proceeding with any nearby work.
- C. Refer to Division 2, Earthwork, of these Specifications for all excavation and backfilling work.

3.04 CONCRETE

- A. Where shown on the Drawings or specified, provide the required concrete installations for conduit encasement and equipment foundations.
- B. Refer to Division 3, Concrete, of these Specifications for all concrete work.

3.05 CONDUCTOR IDENTIFICATION

- A. Identify all wires and cables in conformance with the requirements of Sections 16120, 16122, and 16124. This requirement applies to all equipment provided under this contract, regardless of Division, as well as to all conductors provided or worked on during this contract.

3.06 CUTTING, DRILLING, AND WELDING

- A. Provide any cutting, drilling, and welding that is required for the electrical construction work.

- B. Structural members shall not be cut or drilled, except when favorably reviewed by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry.
- C. Provide the required welding for equipment supports. Conduits and fittings shall not be welded to structural steel.
- D. Perform patch work with the same materials as the surrounding area and finish to match, as specified in Division 3 of these Specifications.

3.07 METAL PANELS

- A. Mount all metal panels which are mounted on or abutting concrete walls in damp locations or any outside walls 1/4 inch from the wall, and paint the back sides of the panels with a high build epoxy primer. Film thickness shall be 10 mils minimum.

3.08 PROTECTIVE DEVICE COORDINATION

- A. Perform power system studies and provide protective device coordination in accordance with Section 16961.

3.09 TESTING

- A. Perform acceptance testing in accordance with Section 16950.
- B. Perform additional testing as indicated within specific equipment sections.

3.10 EQUIPMENT STORAGE AND PROTECTION

- A. During construction, provide adequate storage for all equipment and materials that will become part of the completed facility so that it is protected from weather, dust, water, and other environmental impacts, or damage from construction operations.
- B. Store and protect products in accordance with manufacturer's instructions. Seals and labels shall be intact and legible.
- C. Store moisture sensitive products including electrical equipment, instruments and controls in weathertight, humidity and temperature-controlled enclosures to avoid condensation and dust buildup.
- D. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- E. Exercise care at all times after installation of equipment, motor control centers, etc., to keep out foreign matter, dust, dirt, debris, or moisture. Use protective sheet-metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection.

3.11 CLEANING EQUIPMENT

- A. Before final acceptance, thoroughly clean the electrical Work of cement, plaster and other materials.
- B. Clean out and vacuum all construction debris from the bottom of all equipment.
- C. Provide and touch-up to original condition any factory painting that has been marred or scratched during shipment or installation, using paint furnished by the equipment manufacturer.

- D. Remove temporary tags, markers, stickers and the like.
- E. Remove all oil and grease spots with a non-flammable cleaning solvent by carefully wiping and scraping cracks and corners.
- F. Clean luminaires inside and out.
- G. Dispose of cleaning debris and refuse off-site.

END OF SECTION

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SECTION 16110

ELECTRICAL RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the drawings and as specified herein.
- B. Raceways and conductors that are listed on the conduit and cable schedules are generally not shown on the Drawings, except where they are required to pass through a restricted or designated space and the Contractor would benefit from additional information. Conduit block diagrams indicate exposed conduits as solid lines and shall be run near the ceilings or along walls of the areas through which they pass and shall be routed to avoid interferences with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches, etc. Conduit block diagrams indicate concealed or buried conduits as dashed lines and shall be run in underground duct banks, center of concrete floor slabs, in partitions, or above hung ceilings as required.
- C. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publications:
 - 1. C80.1 Specification for Zinc Coated Rigid Steel Conduit
 - 2. C80.5 Specifications for Rigid Aluminum Conduit
- B. Federal Specifications (FS):
 - 1. FS W C 1094 W C 1094A Conduit and Conduit Fittings, Plastic, Rigid
 - 2. FS WW C 540 WW C 540A Conduit, Metal, Rigid, (Electrical, Aluminum)
 - 3. WW C 540C Conduit, Metal, Rigid & Coupling, Elbow & Nipple, Electrical Conduit, Aluminum
 - 4. FS WW C 566 WW C 566C Flexible Metal Conduit
- C. National Electrical Manufacturers Association (NEMA) Publications:
 - 1. RN 1 Polyvinyl Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
 - 2. TC2 Electrical Polyvinyl Chloride (PVC) Conduit
 - 3. TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation
 - 4. TC14 Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- D. Underwriters Laboratories (UL) Standards:
 - 1. 6 Rigid Metal Electrical Conduit
 - 2. 6A Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless Steel
 - 3. 360 Liquid-Tight Flexible Metal Conduit
 - 4. 651 Electrical Rigid Nonmetallic Conduit and Fittings

- 5. 651A Type EB and A Rigid PVC Conduit and HDPE Conduit
- 6. 2515 Aboveground Reinforced Thermosetting Resin Conduit

1.03 SUBMITTALS

- A. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
- B. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Pull and junction boxes, fittings and other indicated enclosures that are dedicated to the raceway system shall comply with the requirements of this Section.
- B. Provide exposed conduit of 3/4-inch minimum trade size and encased conduit of 1-inch minimum trade size.
- C. The use of short sections of 1/2-inch flexible conduit for final termination of field control devices and instrumentation is permitted. They may not be longer than 36 inches in length, and may only transition to the smaller size junction boxes or condulets at the field device.

2.02 CONDUIT RACEWAYS

- A. Galvanized Rigid Steel Conduit (GRS) shall be manufactured from mild steel, hot-dip galvanized inside and out, conforming to ANSI C80.1 and UL 6. Couplings shall be threaded type. Manufacturers shall be Allied Tube and Conduit, Wheatland Tube or approved equal.
- B. PVC coated rigid steel conduit (PGRS) shall meet the requirements of GRS above. A PVC coating shall be bonded to the outer surface with a thickness not less than 40 mils. The inside surfaces and threads of the conduit shall be provided with a 2-mil urethane coating. PGRS shall be manufactured in accordance with UL-6, ANSO C80.1 and NEMA RN1. Manufacturers shall be Robroy Industries Perma-Cote or Plasti-Bond series, Thomas & Betts Ocal Blue or approved equal.
- C. Liquidtight Flexible Conduit shall be constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket. Conduit shall be manufactured in accordance with UL 360. Flexible conduit in hazardous areas shall be rated for the Class, Division and Group in which its installed. Manufacturers shall be Anaconda Sealtite, Electriflex Liqueflex or approved equal.
- D. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be PVC Schedule 40 (PVC 40) or PVC Schedule 80 (PVC 80) and sunlight resistant. Conduit shall be approved for underground use and for use with 90°C wires, and shall conform to

NEMA TC-2 and UL 651. Manufacturers shall be Carlon, Cantex or approved equal.

2.03 CONDUIT SUPPORTS

- A. For indoor, dry locations, supports for individual conduits shall be galvanized malleable iron one-hole type with conduit back spacer. All other locations shall be Type 316 stainless steel.
- B. For indoor, dry locations, supports for multiple conduits shall be hot-dip galvanized Unistrut or Superstrut channels, or equal. All associated hardware shall be hot-dip galvanized. All other locations shall be Type 316 stainless steel.

2.04 FITTINGS

- A. General
 - 1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.
 - 2. Fittings
 - a. Provide fittings with neoprene gaskets and non-magnetic stainless steel screws.
 - b. Attach covers by means of holes tapped into the body of the fittings.
 - c. Covers for fittings attached by means of clips or clamps will not be accepted.
 - 3. Terminations
 - a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton or approved equal.
 - b. In other than outdoor areas, provide sealed locknuts and bushings.
- B. Fittings for use with rigid steel shall be hot dipped galvanized steel or galvanized cast ferrous metal; access fittings shall have gasketed cast covers and be Crouse-Hinds Condulets, Appleton Unilets, or equal. Provide threaded-type couplings and connectors; set-screw type and compression-type are not acceptable.
- C. Fittings for use with PVC-coated GRS conduit shall be PVC-coated that are the products of the same manufacturer as the conduit. Both male and female threads and internal surfaces shall contain a 2-mil urethane coating.
- D. Fittings for use with rigid nonmetallic conduit shall be PVC and have solvent-weld-type conduit connections. Boxes shall be manufactured of PVC or fiberglass reinforced polyester (FRP). Manufacturers shall be Carlon, Crouse-Hinds, Hoffman or approved equal. If such are not available, then the Specification for PVC coated galvanized rigid steel fittings shall apply.
- E. Fittings for flexible conduit shall be Appleton Type ST, O.Z. Gedney Series 4Q, or approved equal.
- F. Combination expansion-deflection fittings with internal grounding shall be installed where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur. Combination expansion/deflection fittings shall be manufactured by Crouse-Hinds Type XJGD or approved equal.
- G. Expansion fittings with internal grounding shall be installed wherever exposed raceway cross building expansion joints. Expansion fittings shall be Crouse Hinds Type XLGSA or approved equal.

- H. Union couplings for conduits shall be the Erickson type and shall be Appleton Type EC, O.Z. Gedney 3-piece Series 4, or approved equal. Threadless couplings shall not be used.
- I. Bushings:
 - 1. Bushings shall be the insulated type.
 - 2. Bushings for rigid steel conduit shall be hot dip galvanized insulated grounding type, O.Z. Gedney Type HBLG, Appleton Type GIB, or approved equal.
- J. Conduit seals in hazardous areas shall have zinc electroplate and shall be Crouse-Hinds Type EYS or EZS; Appleton Type EYS, ESU, or EY series; or approved equal.

2.05 BOXES

- A. Boxes specified herein are for use with raceway systems only. Boxes used for housing electrical and instrumentation equipment shall be as described elsewhere in these Specifications.
- B. NEMA 1 Areas: NEMA 1 terminal boxes, junction boxes, pull boxes, etc. shall be either sheet or cast malleable iron or aluminum depending on raceway material. Boxes shall be suitable for wall mounting or have feet where self-standing. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. All boxes shall have hinged gasketed doors with quarter turn latches or 3-point latch (single operator) system on enclosures larger than 36 inches wide or 32 inches tall. Terminal boxes shall be furnished with terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20A, 600V. Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or approved equal.
- C. NEMA 4X Areas: NEMA 4X terminal boxes, junction boxes, pull boxes, etc. shall be Type 316 stainless steel. Boxes shall be suitable for wall mounting or have feet where self-standing. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. All boxes shall have hinged gasketed doors with quarter turn latches or 3-point latch (single operator) system on enclosures larger than 36 inches wide or 32 inches tall. Terminal boxes shall be furnished with terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20A, 600V. Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or approved equal.
- D. NEMA 7 Areas: Explosion-proof boxes shall be designed for the Class, Division and Group with which it is to be installed. Boxes shall have O-ring seals to meet NEM 4 requirements. Boxes shall be aluminum, with stainless steel hinged covers and stainless steel bolts. Boxes shall be as manufactured by Crouse Hinds Type EJB-N4, Appleton Electric, Adalet PLM or approved equal.

2.06 CONDUIT SEALANTS

- A. Moisture Barrier Types: Sealant shall be a non-toxic, non-shrink, non-hardening, putty type hand applied material providing an effective barrier under submerged conditions.
- B. Fire Retardant Types: Fire stop material shall be a reusable, non-toxic, asbestos-free, expanding, putty type material with a 3 hour rating in accordance with UL 1479. Provide products indicated by the manufacturer to be suitable for the type and size of penetration.

PART 3 - EXECUTION

3.01 CONDUIT, RACEWAY AND FITTING INSTALLATION

- A. No wire shall be pulled until the raceway system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the raceway system has been completed in every detail.
- B. From pull point to pull point, the sum of the angles of all of the bends and offsets shall not exceed 270 degrees.
- C. Coat threads with a conductive lubricant before assembly.
- D. Provide joints that are tight, thoroughly grounded, secure and free of obstructions by use of a mandrel. Adequately ream the conduit in order to prevent damage to the wires and cables inside. Use strap wrenches and vises to install the conduit in order to prevent wrench marks on the conduit. Any conduit with wrench marks shall be replaced.
- E. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction. Duxseal, or 3M seal spray shall be used in all applications. Plugging with tape is prohibited, even for short periods of time.
- F. For power, control and signal circuits, provide conduit per Conduit Use Tables below, unless specifically indicated otherwise on the Drawings:
 - 1. Exception: For raceways leaving a building above grade and then going below grade, provide PVC-coated GRS from a point 3 feet above grade to a point 5 feet from the building wall.
- G. Unless boxes have cast, threaded hubs, provide insulated type metallic grounding bushings for metallic conduits at all boxes. Bond together all conduits to provide continuity of the equipment grounding system. Size bonding conductor per NEC.
- H. Provide flexible conduit in lengths of not more than 36 inches at connections to motors, valves and any equipment subject to vibration or relative movement. All flexible conduits, regardless of length or manufacturer rating, shall have a dedicated ground bonding conductor pulled through, whether it is included in the conduit fill schedules or not.
- I. Damage to PVC coating of coated conduits or fittings shall be repaired with factory-approved PVC patching material to the original factory condition.

- J. Install fiberglass conduit in accordance with the manufacturer's instructions. Connections between sections of conduit may be either glued or threaded, at the Contractor's option.
- K. Underground Raceways: Slope all underground raceways to provide drainage; for example, slope conduit from equipment located inside a building to the handhole located outside the building. For additional requirements see Section 16402.
- L. Conduit Supports: Properly support all conduits as required by the NEC. Run all conduits exposed except where the Drawings indicate that they are to be embedded in the floor slab, walls, or ceiling, or to be installed underground.
 - 1. Exposed Conduits:
 - a. Support exposed conduits within 1 foot of any outlet and at intervals not exceeding NEC requirements; wherever possible, group conduits together and support on common supports. Support exposed conduits fastened to the surface of the concrete structure by one-hole clamps, or with channels. Use conduit spacers with one-hole clamps. Coordinate conduit locations with piping, equipment, fixtures, and with structural and architectural elements. Conduits attached to walls or columns shall be as unobtrusive as possible and shall avoid windows. Run all exposed conduits parallel to building lines. No diagonal runs will be accepted. Bends in parallel runs shall be concentric and shall be run straight and true.
 - b. Group together exposed conduits in horizontal runs located away from walls and support on trapeze hangers. Arrange such conduits uniformly and neatly. Trapeze hangers shall consist of channels of adequate size, suspended by means of minimum 3/8" diameter rods or other suitable means from the ceiling or from pipe hangers. Install such runs so as not to interfere with the operation of valves or any other equipment, and keep at least 6 inches clear of any pipe which may operate at more than 100°F. Treat cut surfaces or damaged ends with corrosion-resistant coatings such as "Devcon Z", prepared by Subox Coatings; "Galvanox Type I", prepared by Pedley-Knowles; or approved equal. Application shall follow manufacturer's recommendation.
- M. All penetrations through walls into or out of corrosive locations, as defined in Section 16010 shall be made gas-tight. In concrete walls, pour concrete after the conduit is in place, if possible. If not, core drill concrete or CMU walls, install conduit and caulk around it with non-shrink grout. Install conduit seal in each conduit near the penetration.
- N. All conduit penetrations through interior walls and floors shall be sealed with fire retardant type conduit sealant.
- O. Conduit Identification: In each handhole, pullbox, cabinet, motor control center or other equipment enclosure, identify each conduit using the conduit number shown on the Drawings by means of a stamped brass tag affixed with stainless steel wire; where affixing a tag is not feasible, identify conduits by affixing a brass tag with epoxy or other approved method of stenciling to the wall or structure adjacent to the conduit terminus.
- P. Conduit Seals:
 - 1. Moisture Seals: Provide in accordance with NEC Paragraph 300.5(g).
 - 2. Gas Seals: Provide in accordance with NEC Paragraph 501.5.

- Q. Aluminum conduit shall not be installed underground or encased in concrete. If necessary to run through concrete, install in a non-metallic conduit sleeve or use PVC coated conduit.
- R. Rigid PVC conduit shall be stored on a flat surface and shielded from the sun.

CONDUIT USE TABLE 1

	Inside	
	Exposed	
Circuit Type	Standard	Hazardous
Power & 120 Vac Control	GRS	PVC Coated GRS
Signal	GRS	PVC Coated GRS

CONDUIT USE TABLE 2

	Outside			Transition
Circuit Type	Exposed	Buried In Soil	Duct Bank Encased In Concrete	Within 5 Feet of Building
Power & 120 Vac Control	PVC Coated GRS	PVC Coated GRS	PVC-40	PVC Coated GRS
Signal	PVC Coated GRS	PVC Coated GRS	GRS	PVC Coated GRS

* Provide ground wire sized per NEC requirements for all circuits.

Notes:

1. Generally, the Conduit Use Tables apply.
2. Signal circuits are those subject to RF interference or induced current. MSPs, TSPs, telephone cable, coaxial cable, and manufacturer's cables specially designed for low level signals are all presumed to be part of signal circuits.

END OF SECTION

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SECTION 16120

LOW VOLTAGE WIRE AND CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment and incidentals necessary to install wire and cable specified under this Section. Electrical work shall be in accordance with Specification 16010 – General Electrical Requirements.
- B. Work shall include building wire, cable, wiring connections and terminations and modular wiring systems.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. B3-74 Specification for Soft or Annealed Copper Wire
 - 2. B8-77 Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 3. B173-71 Specification for Rope Lay Stranded Copper Conductors Having Concentric Stranded Members
- B. Insulated Cable Engineers Association (ICEA):
 - 1. S-66-524 Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable
- C. International Electrical Testing Association (NETA);
 - 1. ATS Acceptance Testing Specifications
- D. National Electrical Manufacturers Association
 - 1. WC-3 Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 - 2. WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- E. Underwriters Laboratories (UL) Standards:
 - 1. 62 Flexible Cords and Fixture Wire
 - 2. 510 Insulating Tape
 - 3. 1063 Stranded Conductors for Machine Tool Wire

1.03 SUBMITTALS

- A. Submit the following material or equipment data:
 - 1. Each type of cable and wire to be used.
 - 2. Cable and wire splices
 - 3. Wire markers

1.04 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall protect all cable and wire from being damaged at all times.
- B. Cable ends shall be protected from water entry in accordance with the manufacturer's recommended procedures. Cable ends shall not be left open in

manholes or other locations subject to submergence. If the cable ends become submerged prior to splicing or termination, the cables shall be replaced in their entirety.

- C. Cables shall be pulled into raceways in accordance with the manufacturer's requirements. Under no circumstances shall cable pulling tensions exceed the manufacturer's written instructions.
- D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. General: Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor and/or solid conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.
- B. Power and Control Conductors, 600 Volts and Below:
 - 1. Solid copper wires shall be 600 volt Type XHHW, sizes #12 and #10 AWG for use with lighting and receptacle circuits only.
 - 2. Stranded copper wire for power circuits shall be 600 volt Type XHHW or RHW, Class B stranding, sizes #12 AWG and larger.
 - 3. Stranded copper wire for control circuits shall be 600 volt Type XHHW or RHW, Class B stranding, size #14 AWG.
 - 4. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.
 - 5. Fixture wire shall be 600 volt, silicone rubber insulated, 200°C, UL Type SF 2, with stranded copper conductors.
 - 6. Cords shall be 600 volt, 2 conductor plus ground, Type SO, hard service, of adequate length and with grounding type plug attached, rated in amperes as shown on the Drawings.
 - 7. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
 - 8. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

2.02 SPLICES AND TERMINATIONS OF CONDUCTORS

A. Splices:

1. Wire and Cable Splicing Materials and Applications:

- a. For Lighting Systems and Power Outlets: Wire nuts shall be twist-on type insulated connectors utilizing an outer insulating cover and a means for connecting and holding the conductors firmly. They shall be UL listed and suitable for connecting two to four solid copper conductors of #14 or #12 AWG size or two or three #10 AWG solid copper conductors.
- b. All Equipment: Crimp type connectors shall be insulated type with nylon jacket, suitable for the size and material of the wires and the number of wires to be spliced and for use with either solid or stranded conductors. They shall be UL listed.
- c. Division 16 Equipment and Power Conductors: Bolted pressure connectors shall be suitable for the size and material of the conductors to be spliced. They shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor.
- d. All Equipment: Epoxy splice kits shall include epoxy resin, hardener, and mold, and shall be suitable for use in wet locations and hazardous locations.

B. Terminations:

1. Low Voltage Terminations:

- a. Crimp type terminals shall be UL listed, self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated, and for use with either solid or stranded conductors.
- b. Terminal lugs shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor. Tongues shall have NEMA standard drilling.
- c. Crimp with manufacturer recommended ratchet-type tool with calibrated dies. Hand crimping tools are not acceptable.

C. Tape used for splices and terminations shall be compatible with the insulation and jacket of the cable and shall be of plastic material. Tape shall conform with UL 510. Varnished cambric, rubber and thermoplastic tape shall be used for all split-bolt terminations.

D. Wire markers shall be heat shrink type (Raychem; T&B; or equal). Wire identification numbers shall be permanently imprinted on the markers. In locations which are not practical for heat shrink type labels, such as conduit bodies and small pull boxes, machine-printed, adhesive backed wire markers shall be used. Markers shall be custom-printed with the full identification string. Individual character markers and clip-on wire markers are not acceptable.

PART 3 - EXECUTION

3.01 CONDUCTOR INSTALLATION

- A. The Contractor shall provide, terminate and test all power, control, and instrumentation conductors.
- B. The Contractor shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares for future use.
- C. Conductors shall not be pulled into any raceway until raceway has been cleared of moisture and debris.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be neatly fanned out to terminals.
- E. Provide the following types and sizes of conductors for the uses indicated for 600 volts or less:
 - 1. Solid Copper, Sizes #12 and #10 AWG: As shown on the Drawings for circuits for receptacles, switches and light fixtures with screw-type terminals.
 - 2. Stranded Copper, Size #14 AWG and Larger, Individual Conductors or CC: As shown on the Drawings for the control of motors or other equipment. Size #14 shall not be used for power supplies to any equipment.
 - 3. Stranded Copper, Sizes #12 AWG and Larger: As shown on the drawings for motors and other power circuits.
 - 4. Stranded Copper, #6 AWG and Larger.
 - 5. Fixture Wire: For connections to all fixtures in which the temperature may exceed the rating of branch circuit conductors.
- F. Color Coding: All wire shall be coded with specific colors infused in the conductor insulation at the time of manufacture. If a conductor is specified in a gauge not available with integrally colored insulation, it shall be marked by the Contractor at the time of installation using colored electrical coding tape or an approved marking paint. Where tape or paint is used as the conductor identification system, it shall clearly distinguish the conductor over its entire exposed length in all junction boxes, manholes, conduit bodies, or other accessible intermediate locations, and at every termination. All wiring shall conform to the following wiring color code:

SYSTEM	CONDUCTOR	COLOR
120/240 Volt AC, 1-Phase, 3 Wire	Neutral Line 1 Line 2	White Black Red
120/208 Volt AC, 3-Phase, 4 Wire;	Neutral Phase A Phase B Phase C	White Black Red Blue
277/480 Volt AC, 3-Phase 4 Wire	Neutral Phase A Phase B Phase C	Grey Brown Orange Yellow

SYSTEM	CONDUCTOR	COLOR
All Systems	Earth, System, or Equipment Ground	Green Insulation, Green w/ Yellow Tracer, or Bare Conductor
120 Volt AC Control Power Circuits (In field or in Control Cabinets)	Neutral Line 1 Line 2	White Black Red
120 Volt AC UPS-derived Control Power (secondary side)	Neutral Line	White w/ Red Tracer Red w/ White Tracer
24 VAC Control Power Circuits (In field or in Cabinets)	Neutral Line	White or Grey, with Yellow Tracer Brown
12 or 24 Volt DC Control Wiring (PLC Discrete I/O, etc.)	DC Negative DC Positive DC Switched (DI/DO)	Yellow Orange Blue
120 Volt AC Control Wiring inside or outside cabinets to/from PLC Discrete I/O	Common or Neutral 120 VAC discrete inputs 120 VAC relay or discrete outputs	White or Grey, w/ Blue Tracer Blue Red
Instrumentation Twisted-shielded Cabling (PLC Analog I/O @ 4-20mA, or 1-5 Volt DC, etc.) Process Signals to/from Transmitters, Analyzers, etc.	Negative Polarity Positive Polarity (1st Conductor) Positive Polarity (2nd Conductor) Shield Drain Wire	Black White (or clear) Red Bare Conductor, or covered w/ heat-shrink tubing of a unique color
Instrumentation wiring in cabinets (PLC Analog I/O from field terminations of shielded cables).	PLC Analog Input Connections PLC Analog Output Connections	Grey Brown

- G. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, putting undue stress on the cables or otherwise abrading them. No grease will be permitted in pulling cables. Only soapstone, talc, or UL listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab conduits before installing cables and exercise care in pulling, to avoid damage to conductors.
- H. Wrap all cables in manholes with fireproofing tape. Extend tape 1-inch into ducts.
- I. Cable bending radius shall be per applicable code. Install feeder cables in one continuous length unless splices are favorably reviewed.
- J. Provide an equipment grounding conductor, whether or not it is shown on the Drawings, in any flexible conduit or any raceway in which all or any portion of a run consists of non-metallic duct or conduit. For flexible conduit, an external bonding jumper is an acceptable alternative.

- K. In panels, bundle incoming wire and cables, No. 6 AWG and smaller, lace at intervals not greater than 6 inches, neatly spread into trees and connect to their respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for cable runs, lacing is not necessary when the cable is properly installed in the duct.
- L. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange so that they will be protected from chafing and excess flexing when the hinged member is moved.

3.02 CONDUCTOR SPLICES AND TERMINATIONS

- A. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices, when permitted, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions. Splice or terminate wire and cable as follows:
 - 1. Watertight Splices: Splices in concrete pullboxes, for any type of cable or wire, shall be watertight and rated for continuous submergence. Make splices in low voltage cables using epoxy resin splicing kits rated for application up to 600 volts.
- B. Terminations:
 - 1. Terminate stranded #14 wire using crimp type terminals where not terminated in a box lug type terminal. Terminals must be coordinated with type of terminal board where provided.
 - 2. Excess control wire shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin and be neatly coiled.

3.03 CONDUCTOR IDENTIFICATION

- A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

3.04 FIELD TESTS

- A. Refer to Specification 16950 – Electrical Tests for all cable testing requirements.

END OF SECTION

SECTION 16124

SIGNAL CABLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Related Work Described Elsewhere:
 - 1. Division 17: Instrumentation and Controls

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA):
 - 1. 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- B. American Society for Testing and Materials (ASTM):
 - 1. B8-11 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. 1143 Shielding Practice for Low Voltage Cables, Guide on
- D. Insulated Cable Engineers Association (ICEA)
 - 1. S-73-532 Standard for Control, Thermocouple, Extension, and Instrumentation Cable
- E. National Fire Protection Association (NFPA):
 - 1. 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
- F. Underwriters Laboratories Incorporated (UL):
 - 1. 13 Standard for Power-Limited Circuit Cables
 - 2. 83 Thermoplastic-Insulated Wires and Cables
 - 3. 444 Communications Cables
 - 4. 1666 Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Conditions and the submittal requirements of Section 16010.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CABLE

- A. Provide UL listed, twisted pair instrumentation Tray Cable (TC) conforming to ICEA S-73-532, and suitable for transmission of 4-20mA analog, low voltage signals.

- B. The cable shall be two-conductor (2/C), three-conductor (3/C), four-conductor (4/C), or more as indicated on the Drawings.
- C. Each conductor in the cable shall be #16 AWG 7x24 stranded bare copper, or as indicated on the Drawings.
- D. Conductor insulation: Polyvinyl Chloride/Nylon
- E. Shield: Aluminum Foil, 100 percent coverage
- F. Drain wire: #18 AWG, stranded, tinned copper
- G. Jacket material: Polyvinyl Chloride, minimum thickness 0.047 inches.
- H. Insulation shall be rated at 600 volts.
- I. Temperature rating: UL dry, 90 degrees C; UL web, 75 degrees C
- J. Instrumentation cable installed in underground conduits shall be rated as suitable for the application.
- K. Instrumentation cable shall be Belden 3090A, 3091A, or approved equal.

2.02 ETHERNET (TCP/IP) CABLE

- A. Industrial use, unshielded:
 - 1. Provide UL listed, Category 6 unshielded twisted pair (UTP) Ethernet cable conforming to ANSI/TIA-568-C.2 and suitable for use in harsh environments.
 - 2. Conductors: 4 pairs of #23 AWG solid bare copper
 - 3. Conductor insulation: Fluorinated Ethylene Propylene, minimum thickness 0.01 inches
 - 4. Jacket material: Fluorinated Ethylene Propylene, factory marked at regular intervals indicating verifying organization and performance level. Minimum thickness 0.03 inches.
 - 5. Insulation shall be 600 volt class.
 - 6. Insulation temperature range: -55 to +150 degrees C
 - 7. Electrical Characteristics: Cable shall have a maximum attenuation of 20 dB per 100 meters at 100 MHz and 33 dB per 100 meters at 250 MHz
 - 8. Terminations/Connectors: Cables shall terminate in Category 6 RJ-45 crimp connectors with strain-relief boots, or at Category 6 punch down blocks at both ends.
 - 9. Cable shall be plenum-rated for flammability in accordance with NFPA 262, and suitable for use as riser cable.
 - 10. Ethernet cable installed in underground conduits shall be rated as suitable for the application.
 - 11. Industrial, unshielded Ethernet cable shall be Belden 7931A or approved equal.

2.03 ANTENNA FEEDER CABLE

- A. Antenna feeder cable shall be coaxial type suitable for use with a 450 MHz radio system.
- B. Use only coaxial cable recommended for specific applications such as radio antenna systems as required by the radio manufacturer or system supplier. Due to wide differences in electrical ratings and physical characteristics between cable

types, any deviations from manufacturers recommended types, cable is not acceptable.

PART 3 - EXECUTION

3.01 CABLE INSTALLATION

- A. Signal cable shall be installed by personnel who have a minimum of 3 years' experience in terminating and splicing shielded twisted pair cables and coaxial cables.
- B. Adequate care shall be exercised by the installers to prevent cable damage or sheath distortion. Bending radius shall not be less than 10 times the cable outside diameter.
- C. Raceways shall be swabbed before installation of cable to remove moisture and debris.
- D. Cables shall be continuous from initiation to termination without splices except where specifically indicated.
- E. Cable shielding shall be grounded at one end only of the cable. Bonding shall be to a single ground point only. Bonding from cable to cable in multiple run installations shall not be permitted.
- F. Heat shrinkable sleeving shall be installed on all cables to insulate shielding at the ungrounded cable terminations.
- G. Signal cable shall not be run in the same raceway with power and control wiring except where specifically indicated.
- H. Where installed in control consoles containing power circuits, cables shall be routed a minimum of 2 inches distant. Color coding shall be strictly observed throughout the installation.
- I. Cable in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- J. Manufacturer's cable pulling tension shall not be exceeded.
- K. Pulling lubricant shall be UL approved.

3.02 CONDUCTOR SPLICES AND TERMINATIONS

- A. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices, where approved, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions.
- B. Terminations:
 - 1. Crimp-type terminals shall be UL listed, self-insulating, sleeve type with ring or rectangular tongue, suitable for size and material of the wire to be terminated and for use with either stranded or solid wire. Spade type lugs are acceptable with telephone cable systems only.
 - 2. Crimp with manufacturer's recommended ratchet-type tool with calibrated dies. Hand crimping tools are not acceptable.
 - 3. Coaxial cable and connectors shall be terminated in accordance with the manufacturer's instructions.

3.03 CONDUCTOR IDENTIFICATION

- A. Identify each wire or cable at each termination, in each pullbox, and in each handhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer. Conductor numbering shall be coordinated with the Interconnection Diagrams specified in Division 17.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

3.04 FIELD TESTS

- A. Perform testing in accordance with Section 16950 – Electrical Tests.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included:
 - 1. Installation, connection and furnishing all single, duplex, GFI and special purpose receptacles complete with wall plates and/or covers as shown on the Drawings.
 - 2. Installation, connection and furnishing of all single pole, three-way, pilot light and momentary position toggle switches complete with wall plates and or handle operators as shown on the Drawings.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publication:
 - 1. C73 Plugs and Receptacles
 - 2. C73a Plugs and Receptacles
 - 3. 568 Communication Cables
- B. Federal Specifications (FS):
 - 1. W-C-596 D & E General Specifications for Cable Outlet Electrical Connector
 - 2. W-S-896 D & E General Specifications for Flush Mounted Toggle and Lock Switches
- C. National Electrical Manufacturers Association (NEMA) Publications:
 - 1. WD 1 General Color Requirements for Wiring Devices
 - 2. WD 6 Wiring Devices - Dimensional Specifications
- D. Underwriters Laboratories (UL) Standards:
 - 1. 20 General-Use Snap Switches
 - 2. 498 Standard for Attachment Plugs and Receptacles
 - 3. 514 Electrical Outlet Boxes
 - 4. 943 Ground-Fault Circuit-Interruptioners

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Requirements and the submittal requirements of Section 16010.
- B. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.
- C. Submit documentation showing that the proposed materials comply with the requirements of the NEC and UL.

1.04 LOCATIONS

- A. Refer to Section 16010, General Electrical Requirements, for definitions of types of locations.

PART 2 - PRODUCTS

2.01 RECEPTACLES

- A. General: Receptacles shall be heavy duty, high abuse, grounding type conforming to NEMA configurations, NEMA WD1 and UL 514 Standards.
- B. Single and Duplex Receptacles:
 - 1. Receptacles shall be of back and side wire design utilizing screw type terminals. Receptacles shall be rated 20 ampere, two-pole, 3-wire, 120-volt, NEMA 5-20 configuration, self-grounding. Color shall be brown in industrial areas and ivory or white in office and laboratory areas. Power contacts shall be a T-type design and shall be brass. Ground contacts shall be brass.
 - 2. Devices shall have a nylon composition face with a nylon or melamine body. Units shall comply with Federal Specification W-C-596E and meet UL 498 test requirements. Receptacles shall be Hubbell HBL Series; Daniel Woodhead; or equal.
- C. GFI Receptacles:
 - 1. Device shall be rated 20 ampere, 2 pole, 3 wire, 120 volt, conforming to NEMA WD-1 configuration. Face shall be nylon composition meeting UL 498 test standards. Unit shall have test and reset push buttons. Reset push button shall have a visible indicator band to indicated tripped condition.
 - 2. GFCI component shall meet UL 498 Class A standards with a tripping time of 1/40 second at 5 milliamperes current unbalance. Operating range shall extend from 31°F to 158°F. Unit shall have transient voltage protection and shall be ceramic encapsulated for protection against moisture.
 - 3. Provide Hubbell 5362SG, Daniel Woodhead, or equal.
- D. Explosion Proof Receptacles: Devices shall be UL listed for use in Class 1, Division 1 or Division 2, or for Class 2, Division 1 areas as indicated on the Drawings. Units shall be factory sealed types where available and shall contain disconnecting mechanisms which must function prior to plug withdrawal or after insertion.
 - 1. All 20 amp, 125 and 250 volt, 2 pole, 3 wire receptacles shall be NEMA 5-20R and NEMA 6-20R. Receptacles shall be UL classified as interchangeable with male plugs of other manufacturers. Provide Killark KRS series; Crouse-Hinds; or equal.
 - 2. For corrosive areas, devices shall be Killark KP Series non-metallic plugs and switched receptacles suitable for Class 1, Division II Groups A, B, C, D; Class 2, Division I and II E, F, G; and Class 3, NEMA 3, 3R, 3S, 7, Division II and NEMA 9; Crouse-Hinds; or equal.

2.02 SWITCHES

- A. Line Voltage Types: Switches shall be rated 20 amperes at 120 or 277 Volts ac only. Units shall be flush mounted, self-grounding, quiet operating toggle devices. Handle color shall be brown in industrial areas and white or ivory in office and laboratory areas. Units shall conform to Federal Specifications W-S-896 D and E,

UL 20, and NEMA WD1 standards. Hubbell PRO Series; Daniel Woodhead; or equal.

- B. Explosion Proof Types: Units shall conform to the standards listed in Item A above, but in addition shall have UL listings for use in hazardous areas classified as Class 1, Division I or II, and Class 2, Division I. Units shall be factory sealed devices. Material shall be copper-free aluminum for metallic types. Provide Crouse Hinds EDS Series; Killark; or equal. Provide fiberglass or polyamide for non-metallic types.

2.03 PLATES

- A. General: Plates shall be of the style and color to match the wiring devices, and of the required number of gangs. Plates shall conform with NEMA WD1, UL 514, and ANSI C73. Plates on finished walls shall be non-metallic or stainless steel. Plates on unfinished walls and on fittings shall be of zinc plated steel or cast metal having rounded corners and beveled edges.
- B. Galvanized: Plates shall be galvanized sheet steel raised 1/2 inch, with rounded corners.
- C. Cast Metal: Plates shall be cast or malleable iron covers with gaskets so as to be moisture resistant or weatherproof.
- D. Damp or Wet and Corrosive Locations: Plates shall be provided with a hinged non-metallic cover/enclosure marked with "Suitable for Wet Locations when in use" and "UL Listed." Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base. The cover shall be TayMac Specification Grade; or equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

- A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.
- B. Damp or Wet Exterior Locations: Install only wiring devices approved for outdoor service in these locations.
- C. Mounting Heights: Locations of wall outlets shall be measured from the finished floor to the center of the outlet box. Boxes shall be adjusted so that the front edge of the box shall not be further back from the finished wall plane than 1/4 inch. Boxes shall be adjusted so that they do not project beyond the finished wall. Height above finished floor shall be as follows:

	<u>Inches From Floor</u>
Receptacles - Industrial Areas	46
Toggle Switches	46

- D. Damp or Wet Interior Locations: Install only wiring devices approved for outdoor service. Adjust boxes so that front edge will be 1/4 inch beyond the rear edge of the finished wall. Use metal tubing sleeves to bring device mounting straps flush with the front edge of the finished wall.
- E. Receptacles:

1. Receptacles shall be grounded by a grounding conductor, not by a yoke or screw contact.
2. Receptacles shall be oriented so that the grounding slot is located at the top of the outlet.
3. Receptacles shall be installed with connections pigtailed (spliced) to the branch circuit wiring so that removal of the receptacle will not lose neutral continuity and branch circuit power will not be lost to other receptacles on the same circuit.

3.02 INSTALLATION OF WALL PLATES

- A. General: Plates shall match the style of the device and shall be plumb within 1/16-inch of the vertical or horizontal.
- B. Exterior and/or Wet Locations: Install plates with gaskets on wiring devices in such a manner as to provide a raintight weatherproof installation. Cover type shall match box type.

3.03 GROUNDING

- A. Devices including switches and receptacles, shall be grounded in accordance with NEC, Article 250 and Specification 16450.
- B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

3.04 TESTS

- A. See Specification 16950 for Testing Requirements.

END OF SECTION

SECTION 16160

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provide panelboards complete and operable, in accordance with the Contract Documents.
- B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. Z55.1 Gray Finishes for Industrial Apparatus and Equipment
- B. National Electrical Manufacturers Association (NEMA):
 - 1. PB1 Panelboards
 - 2. 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)
- C. Federal Specifications (FS):
 - 1. W-P-115 Panel, Power Distribution
 - 2. W-C-375 Circuit Breakers, Molded Case, Branch Circuit, and Service
- D. Underwriters Laboratories (UL):
 - 1. 50 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - 2. 67 Standard for Panelboards
 - 3. 869A Reference Standard for Service Equipment
 - 4. 1699 Standard for Arc-Fault Circuit-Interrupters
- E. National Fire Protection Association (NFPA):
 - 1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Shop Drawings: For each panelboard, submit manufacturer's name and data as required:
 - 1. Bill of materials.
 - 2. Panelboard enclosure type.
 - 3. Main bus and terminal connection sizes.
 - 4. Main bus configuration
 - 5. Bus materials
 - 6. Location of line connections.
 - 7. Scaled and dimensioned cabinet drawings showing conduit entrance and exit locations.
 - 8. Gutter space.

9. Gauge of boxes and fronts
 10. Finish data.
 11. Voltage rating.
 12. Continuous current rating.
 13. Short circuit rating.
 14. Breaker types, trip ratings, and interrupting ratings.
 15. Mounting method.
 16. Circuit breaker layout drawing with dimensions and nameplate designations matching the Drawings.
- C. Submit catalog cuts for panelboard, circuit breakers, protective devices, metering, and any other included accessories.
- D. Submit time current curves for each circuit breaker type included.
- E. Submit field acceptance test results.

1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Panelboards shall be factory assembled, dead-front units conforming to NEMA PB 1, UL 50, and UL 67. All panelboards shall be UL labeled.
- B. Unless otherwise indicated, provide enclosure types to match the ratings required for the location in which the panelboard is installed, in accordance with Section 16010.
- C. Provide service entrance rated panelboards where used as a service entrance. Service entrance rated panelboards shall conform to UL 869A and be labeled as such.
- D. Each panelboard shall have a manufacturer's nameplate showing the voltage, bus rating, phase, frequency and number of wires.
- E. Panelboards, circuit breakers, and all major components installed within shall be the product of a single manufacturer.
- F. The number and arrangement of circuits, spares and blank spaces for future circuit breakers shall be as shown on the Drawings.
- G. Circuit breaker ampere trip ratings shall be as required by the equipment.
- H. Ratings:
1. Voltage: As shown on the Drawings
 2. Continuous current: As shown on the Drawings
 3. Main circuit breaker: As shown on the Drawings
 4. Short circuit:
 - a. Service entrance panelboards rated 240 VAC or less shall have short circuit ratings not less than 22,000 amperes RMS symmetrical or as indicated by the Short Circuit Study, whichever is greater.

- b. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

2.02 PANELBOARDS

- A. Panelboards shall meet the requirements of Federal Specification W-P-115 for Type I, Class 1 panelboards with circuit breakers.
- B. Construction:
 - 1. Busbars shall be tinned copper.
 - 2. All circuit breakers shall be bolt-on type, with 1, 2 or 3 poles, as shown on the Drawings. Breakers shall be quick-make, quick-break, inverse time trip characteristics, to trip free on overload or short circuit. Each breaker shall have a single operating handle which indicates the trip condition of the breaker by its position. Circuit breakers shall meet the requirements of Federal Specification W-C-375.
 - 3. Where GFCI circuit breakers are shown on the Drawings or required by NEC, a unit shall be provided that contains a conventional thermal-magnetic trip and a ground-fault sensor, rated to trip the circuit breaker in approximately 0.025 second for a 5-milliampere ground fault, UL Class A sensitivity. The ground-fault sensor shall have the same rating as the circuit breaker and shall have a push-to-test button.
 - 4. Panelboards shall have hinged doors with combination catch and latch and common keying for locks. The front panels shall be arranged such that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.
 - 5. Unless dictated otherwise by the enclosure type, panelboards shall be constructed of hot dipped zinc galvanized steel with stainless steel screws. Enclosures shall have a factory-applied finish in ANSI 61 grey, in accordance with ANSI Z55.1.
- C. Provide surge protective devices (SPDs) as shown on the Drawings and in accordance with Section 16280.
- D. Manufacturers:
 - 1. 240V and below: Eaton Pow-R-Line 1a/2a, Schneider Electric NQ/NF, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Panelboards shall be installed as indicated on the Drawings and in accordance with the manufacturer's instructions.
- B. Provide neutral-ground bonding at service entrances as shown on the Drawings and as required by the NEC.
- C. Provide grounding where shown on the drawings and as required by the NEC. Grounding shall be in accordance with Section 16450.

3.02 IDENTIFICATION

- A. Provide a nameplate for each panelboard as required by Section 16010.
- B. Provide a typewritten and printed circuit schedule in each panelboard. Handwritten schedules will not be accepted. Circuit schedule shall be placed within a clear pocket affixed to the inside of the hinged panelboard door.

3.03 FIELD ACCEPTANCE TESTS

- A. Test per Specification 16950.

END OF SECTION

SECTION 16180

PROTECTIVE DEVICES AND SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Provide all necessary labor, tools and material to install circuit protective devices as shown on the Drawings and as described in these Specifications.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publication:
 - 1. Z55.1 Gray Finishes for Industrial Apparatus and Equipment
- B. National Electrical Manufacturers Association (NEMA) Publications:
 - 1. ICS 3 Industrial Systems
 - 2. ICS 6 Enclosures for Industrial Controls and Systems
 - 3. 250 Type 1 Enclosures for Electrical Equipment (1,000 Volts Maximum)
- C. Federal Specifications (FS):
 - 1. W C 375 Circuit Breakers, Molded Case, Branch Circuit and Series Service, Series Trip
 - 2. W F 1726 Class H Cartridge Fuses
- D. Underwriters Laboratories (UL) Standards:
 - 1. 50 Electrical Cabinets and Boxes
 - 2. 198C Fuses, High-Interrupting-Capacity-Current Limiting Types
 - 3. 489 Molded Case Circuit Breakers and Enclosures
 - 4. 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
 - 5. 894 Switches for Use in Hazardous (Classified) Locations
- E. National Fire Protection Association (NFPA) Publication:
 - 1. 70 National Electric Code

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.

1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Fusible switches shall be heavy duty safety switches with the voltage ratings, current ratings, and number of poles as indicated by the Drawings. The switches shall be horsepower rated. Auxiliary contacts shall be provided as indicated on the Drawings. Stationary contacts shall be equipped with arc chutes. Fuse clips shall accept only Class J current limiting cartridge fuses. Where indicated on the Drawings, units shall have service entrance labels and shall be equipped with an insulated neutral lug. Switches shall be Square D, Type HD; Westinghouse Type H600; or equal.
- B. Enclosures shall be as follows:
 - 1. Wet locations: NEMA Type 3R.
- C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the equipment it protects.
- D. Fuses:
 - 1. General: Provide one complete set of fuses of each ampere rating shown on the Drawings plus one spare set for each size shown.
 - 2. Fuse Type: Units shall be Class J current limiting, 700 volt, in the ampere ratings shown. Plug fuses are unacceptable. Barrels shall be non-hygroscopic with brass knurled ferrules.
 - 3. Fuses shall conform to FS W F 1726 and UL 198B, and shall carry labels showing UL class, interrupting rating, time delay characteristics, and voltage rating.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units plumb within 1/8 inch of vertical, and in accordance with manufacturer's instructions. Make sure that fuse ratings are as shown on the Drawings, and that breaker trip settings are per the Engineer's instructions.

3.02 MOUNTING HEIGHTS

- A. Fusible switches and enclosed circuit breakers shall be centered 5' 0" above the floor.

3.03 FIELD TESTS

- A. Insulation Resistance Tests: Perform insulation resistance tests on circuits to be energized with a line-to-neutral voltage of 120 volts or more. Make these tests after all equipment has been connected, except that equipment which may be damaged by the test voltage shall not be connected. Test the insulation with a 500 Vdc insulation resistance tester with a scale reading 100 megohms. The insulation resistance shall be 20 megohms or more. Submit results for review.
- B. Continuity Tests: Perform circuit continuity tests from a low powered dc test source to operate a buzzer or bell. Tests shall be made prior to energizing the protected circuit.

- C. Operating Tests: Demonstrate that the protected circuit can be manually controlled by the installed equipment.

END OF SECTION

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SECTION 16280

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section describes the materials and installation requirements for surge protective devices (SPD). These devices are used to protect AC electrical circuits from the effect of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and or capacitive load switching.

1.02 REFERENCES

- A. Underwriters Laboratories (UL):
 - 1. 67 – Standards for Panelboards
 - 2. 1558 – Standard for Safety Metal Enclosed Low Voltage Switchgear
 - 3. 1449 Fourth Edition 2016 - Surge Protective Devices (SPD)
 - 4. 1283 - Electromagnetic Interference Filters
- B. American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41.1-2002 - IEEE Guide on the Surge Environment in Low Voltage (1000 V and Less) AC Power Circuits
 - 2. C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits
 - 3. C62.45-2002 - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
- C. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC) Article 285

1.03 SUBMITTALS

- A. Submit surge protective device catalog cut sheets, dimensional data, and shop drawings with the applicable equipment in which the device is installed or to which it is connected.

PART 2 - PRODUCTS

2.01 GENERAL

- A. SPD shall be Listed in accordance with UL 1449 Fourth Edition 2016 and UL 1283, Electromagnetic Interference Filters.
- B. SPD shall be Component Recognized in accordance with UL 1449 Fourth Edition, at the standard's highest short circuit current rating (SCCR) of 200 kA.
- C. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50 s, 10kA-8/20 s).
- D. SPD shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems.

- E. The manufacturer of the SPD shall be the same as the manufacturer of the service entrance and distribution equipment in which the devices are installed and shipped or coordinated with the manufacturer of the panel in which it is installed so as to maintain the proper UL listing.

2.02 SPD RATINGS

- A. Minimum surge current rating shall be 250 kA per phase (100 kA per mode) for service entrance and 120 kA per phase (50 kA per mode) for distribution applications.
- B. UL 1449 voltage protection rating (VPR) must not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
240/120	700V	700V	700V
208Y/120	700V	700V	700V
480Y/277	1200V	1200V	1200V

- C. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.
- D. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
- E. SPD shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing.
- F. Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.
- G. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.
- H. SPD shall be equipped with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system for the following conditions:
 - 1. End-of-life condition for the complete SPD or module.
 - 2. SPD has operated to protect the equipment from a surge.
- I. Terminals shall be provided for necessary power and ground connections.

2.03 MANUFACTURERS

- A. Eaton SPD, Square D, Surgellogic IMA Series, ASCO Power Technologies (APT), or approved equal.

PART 3 - EXECUTION

3.01 NOT USED

END OF SECTION

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SECTION 16402

UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.

1.02 APPLICABLE STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. Federal Specifications (Fed. Spec.):
 - a. RR-F-621C Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
 - b. RR-G-661D Grating, Metal, Bar Type (Floor, except for Naval Vessels)
 - 2. American Concrete Institute (ACI) Publication:
 - a. 318 Building Code Requirements for Reinforced Concrete
 - 3. American Society of Testing and Materials (ASTM) Publications:
 - a. A36 Structural Steel
 - b. A153 Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - c. A615 Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
 - d. C33 Concrete Aggregates
 - e. C139 Concrete Masonry Units for Construction of Catch Basins and Manholes, Specification for
 - f. C150 Portland Cement
 - g. C478 Precast Reinforced Concrete Manhole Sections, Specification for
 - h. C857 Recommended Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 - i. C858 Standard Specification for Underground Precast Concrete Utility Structures
 - 4. American Association of State Highway and Transportation Officials (AASHTO) Publication:
 - a. HB-13 Standard Specifications for Highway Bridges
 - 5. American National Standard Institute (ANSI) Publication:
 - a. C2 National Electrical Safety Code
 - 6. National Fire Protection Association (NFPA) Publication:
 - a. 70 National Electrical Code (NEC)
 - [7. Pacific Gas and Electric Company (PG&E) Standard:
 - a. Drawing Primary Electric Underground Equipment 062000 enclosures.]
 - [8. State of California Public Utilities Commission (Cal. PUC) Publication:
 - a. G.O.128 Construction of Underground Electric Supply and Communication System, Rule for]

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Manufacturer's Data and Shop Drawings:
 - 1. Manhole and Handhole - Include a table of dimensions which shows proposed size of each manhole and handhole.
 - 2. Manhole Frame and Cover
 - 3. Handhole Frame and Cover
 - 4. Sealing Material for Precast Manhole and Handhole Joints
- C. Certificates
 - 1. Test Reports: Submit for approval 30 days before the materials are used, copies of laboratory test reports for the following:
 - a. Arc-proofing test for cable fireproofing materials

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.
- B. Conduit: Provide per Section 16110.
- C. Wire and Cable: Provide per Section 16120, Section 16122, and Section 16124.

PART 3 - EXECUTION

3.01 TRENCHING, BACKFILL, AND COMPACTION

- A. See Section 02300.

3.02 WIRE AND CABLE INSTALLATION

- A. See Section 16120, Section 16122, and Section 16124.

3.03 UNDERGROUND RACEWAYS WITH CONCRETE ENCASEMENT

- A. All underground raceways shall be encased in concrete unless otherwise specifically shown otherwise on the Drawings.
 - 1. Concrete encasement shall be minimum of 3 inches around outer walls of raceways and minimum of 2 inches between raceways. Conduits shall be PVC Type EB.
 - 2. Concrete shall be portland cement type with 4 sacks cement per cubic yard of concrete, maximum coarse aggregate size of 3/8-inches and shall have minimum strength of 2,000 psi after 28 days. Amount of water shall not exceed slump required for placement. Five pounds red lead oxide shall be added per cubic yard of concrete for medium voltage raceway encasement only.
 - 3. Underground raceways shall slope toward manholes, pullboxes, etc., at minimum rate of 3 inches per 100 feet unless indicated otherwise on Drawings. Raceway entrances in manholes, handholes, etc., shall be by

means of bell ends and shall be sealed against entry of silt, debris, rodents, etc., into raceways.

4. Top of concrete encasement shall be minimum of 24 inches below grade.
5. Minimum radius of all horizontal bends in underground duct banks shall be 25 feet. Bends shall be formed of factory made sweeps or continuous assembly of bend segments or curved segments, except that polyvinyl chloride conduits may be field formed. Minimum radius of all vertical bends in underground raceways shall be ten times nominal size of conduit. Vertical bends shall be made of rigid steel or permanently coated aluminum conduit.
6. Underground raceways within roadways shall be run parallel or perpendicular to road centerline.
7. Pull wires left in underground raceways shall be 1/8-inch nylon rope or 3/16-inch polypropylene.
8. Terminate conduits in end-bells where duct lines enter manholes and handholes. Provide structural support for concrete encased duct banks at the point where they terminate. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.

B. See Section 16110 for additional requirements.

END OF SECTION

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SECTION 16450

ELECTRICAL GROUNDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Furnish all labor, material, equipment, tools and services necessary for the installation, connection and testing of all grounding as specified herein and as shown on the Drawings.

1.02 REFERENCE STANDARD

- A. American Society for Testing and Materials (ASTM) Publication:
 - 1. B228 Copper Clad Steel Conductors Specification
 - 2. D178 Specifications for Rubber Insulating Matting
- B. Institute of Electrical and Electronics Engineers:
 - 1. 142 Grounding of Industrial and Commercial Power Systems (Green Book)
- C. International Electrical Testing Association (NETA) Publication:
 - 1. ATS Acceptance Testing Specifications for Electrical Equipment for Power Systems
- D. National Fire Protection Association (NFPA):
 - 1. 70 National Electrical Code (NEC)
- E. Telecommunications Industry Association (TIA)
 - 1. 607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- F. Underwriters Laboratories (UL) Standards:
 - 1. 467 UL Standard for Safety Grounding and Bonding Equipment

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Conditions and the submittal requirements of Section 16010.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The grounding systems shall consist of the ground rods, grounding conductors, ground bus, ground fittings and clamps, and bonding conductors to water piping, structural steel and UFER grounding as shown on the Drawings. One system shown provides service and separately derived system grounds. A second system is an electronic ground system to provide for the discharge of static electricity.

2.02 SYSTEM COMPONENTS

- A. Ground Rods: Ground rods shall be cone pointed copper clad Grade 40 HS steel rods conforming to UL 467. The welded copper encased steel rod shall have a conductivity of not less than 27% of pure copper. Rods shall be not less than 3/4-inch in diameter and 10 feet long, unless otherwise indicated. Rods longer than 10 feet shall be made up of 10-foot units joined together with threaded couplings. The manufacturer's trademark shall be stamped near the top.
- B. Ground Conductors: Buried conductors shall be medium-hard drawn bare copper; other conductors shall be soft drawn copper. Sizes over No. 6 AWG shall be stranded. Coat all ground connections except the exothermic welds with electrical joint compound, non-petroleum type, UL listed for copper and aluminum applications.
- C. Ground Connections: Connection to ground rods and buried connections shall be by exothermic weld. Lugs for attachment of cables to steel enclosures shall be of the binding post type with a 1/2-13NC stud. Each post shall accommodate cables from #4 AWG to #4/0 AWG.
- D. Ground Rod Boxes: Boxes shall be a 12-inch-diameter (minimum) precast concrete traffic rated unit with cast iron lid. Units shall be 12-inches deep. Covers shall be embossed with the wording "Ground Rod."
- E. Exothermic Welds: Exothermic welded connections shall be Erico CADWELD, Hubbell BURNDYWeld, or approved equal.
- F. Insulating Tape: Insulating tape for copper conductors passing through concrete slabs shall be UL Listed, premium grade, 10-mil thick, pressure-sensitive vinyl insulating tape. Tape shall have elastic backing with strong adhesive strength. Tape shall be 3M/Scotch Vinyl Insulation Tape 22, or approved equal.
- G. Ground Enhancement Material (GEM): GEM must be permanent and maintenance free (no recharging with salts or chemicals which may be corrosive), maintain its earth resistance with time and not depend on water to maintain its conductivity. GEM in its set form shall have a resistivity of not more than 20 ohm-cm. GEM shall be suitable for installation in dry form or slurry form, set up firmly and not dissolve or decompose or otherwise pollute the soil or local water table. GEM shall be manufactured by Erico Products or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ground all equipment for which a ground connection is required per NEC whether or not the ground connection is specifically shown on the Drawings.
- B. Provide a ground wire in every conduit carrying a circuit of over 50 volts to ground.
- C. Sizes shall be as indicated on the Conduit/Cable Schedule and in accordance with NEC Article 250.
- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.

- F. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- G. Interconnect the panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.
- H. Provide a ground ring with minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.
- I. Embed a grounding conductor in every duct bank as indicated. The ground conductor shall be terminated at the ground grid at each end of the duct bank. Where no ground grid is installed, terminate at a suitable grounding electrode conductor near the end of the duct bank in accordance with the NEC.
- J. Provide a ground rod box for each ground rod so as to permit ready access for the connection and/or removal of any pressure connectors to facilitate testing.
- K. Install ground enhancement material around each ground rod per GEM manufacturer's installation instructions. GEM shall extend 6 inches in all directions around the ground rod surface. GEM shall extend from 8 inches below top of ground rod to bottom of ground rod.
- L. Bond metallic water piping at its entrance into each building. Ground separately derived electrical system neutrals to the metallic water piping in addition to the system driven ground, per NEC requirements.
- M. Make embedded or buried ground connections, taps and splices with exothermic welds. Do not conceal or cover ground connections until the Engineer or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the Contractor written confirmation.
- N. Where bare copper ground conductor is installed through a new concrete slab, wrap the conductor with insulating tape before pouring concrete. Apply tape in half-lapped layers with sufficient tension to produce a uniform wind, with no tension on the last wrap to prevent flagging.
- O. Provide supplemental external bonding jumpers from equipment to the grounding electrode system as shown on the Drawings.
- P. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate otherwise. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable. The termination of the shield drain wire shall be on its own terminal. Form a instrument signal ground block by jumping together the shield drain wire terminals, using manufactured terminal block jumpers or a #14 AWG green insulated conductor. Bond the instrument signal ground block to the main ground bus for the panel via a #12 AWG green insulated conductor.

3.02 TESTING

- A. Testing shall be in accordance with Specification 16950– Electrical Tests.

- B. Furnish to the Engineer a test report with recorded data of each ground rod location.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Provide a lighting system complete, including fixtures, lamps, standards, bases, hangers, reflectors, glassware, lenses, auxiliary equipment, ballasts, sockets, and photoelectric cells.

1.02 REFERENCE STANDARDS

- A. Federal Regulations
 - 1. Title 21 Performance Standards for Light Emitting Products CFR 1040
- B. Underwriters Laboratories (UL) Standards
 - 1. 57 Electric Lighting Fixtures
 - 2. 844 Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Submit photometric curves for each fixture configuration proposed. Substitutions will not be considered unless the photometric distribution curve indicates the proposed fixture is equal to or exceeds the specified luminaire.
- C. Submit shop drawings showing proposed methods for mounting interior lighting fixtures which are not attached directly to the ceiling or wall.
- D. Submit seismic design certifications and anchorage descriptions as required by Section 01190.

1.04 GUARANTEE

- A. Lamps which fail within 90 days after acceptance by the Owner shall be replaced at no cost to the Owner.

PART 2 - PRODUCTS

2.01 FIXTURES

- A. Fixtures shall be of the types, wattages and voltages shown on the Drawings, comply with UL 57, and be UL classified and labeled for intended use. Fixtures for use in hazardous locations shall be UL listed per UL Standard 844.
- B. Luminaire wire, and the current carrying capacity thereof, shall be in accordance with the NEC.

- C. Luminaires and lighting equipment shall be delivered to the project site complete, with suspension accessories, aircraft cable, stems, canopies, hickeyes, castings, sockets, holders, ballasts, diffusers, louvers, frames, recessing boxes and related items, including supports and braces.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. All fixtures and luminaires shall be clean and lamps shall be operable at the time of acceptance.
 - 2. Install luminaires in accordance with manufacturer's instructions ready for operation as indicated.
 - 3. Align, mount, and level the luminaires uniformly.
 - 4. Avoid interference with and provide clearance for equipment. Where an indicated position conflicts with equipment locations, change the location of the luminaire by the minimum distance necessary.
- B. Mounting and Supports:
 - 1. Mounting heights shall be as shown on the Drawings. Unless otherwise shown, mounting height shall be measured to the centerline of the outlet box for a wall mounted fixture and to the bottom of the fixture for all other types.
 - 2. Luminaire supports shall be anchored to the structural slab or structural members as indicated. Supports shall maintain the luminaire positions after relamping and cleaning.
 - 3. Surface mounted fixtures shall be rigidly bracketed from mounting surfaces. Luminaires installed in rows shall have a non-cumulative dimensional alignment tolerance of 1/16 inch. Nipples carrying wiring between luminaires shall be watertight.

END OF SECTION

SECTION 16950

ELECTRICAL TESTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the work necessary to test, commission, and demonstrate that the electrical system satisfies the requirements of these Specifications and functions as required by the Contract Documents. The work of this Section is applicable to both pre and post energization testing required by the Manufacturer to facilitate sign-off on their respective equipment as well as pre and post energization testing performed by an independent third party entity independent of manufacturers, suppliers and installers of electrical equipment, installations and systems.
- B. The Work shall include furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under Division 17 – Instrumentation, shall be completed before commencement of the Initial Operation Period as defined in Section 01650, for each phase of construction as indicated on the Drawings. This scope may require the Contractor to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.
- C. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.
- D. Factory Acceptance Testing and other off-site test requirements are included in other Sections.
- E. Corrections and Replacements
 1. Before final acceptance, each part of the work shall be thoroughly tested, and each test shall be documented and submitted in accordance with the Contract Documents.
 2. Any materials or equipment failing any test shall be corrected or replaced as required to pass the test at no additional cost to the Owner.
 3. Any materials or equipment failing any test shall be re-tested after correction or replacement to verify compliance.
 4. Any failures shall again be corrected or replaced, and then re-tested.
 5. The correction/replacement/re-testing cycle shall continue until the item passes the required test(s).

1.02 REFERENCE STANDARDS

- A. Electric equipment, materials, installation, and testing shall comply with the National Electrical Code (NEC), and shall also conform to the following codes and standards:
 1. American National Standards Institute (ANSI)
 2. InterNational Electrical Testing Association (NETA)
 3. Institute of Electrical and Electronics Engineers (IEEE)

4. Occupational Health and Safety Administration (OSHA)
5. ASTM International Standard E329
6. IEEE 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
7. IEEE 576, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
8. National Fire Protection Association (NFPA) 70B, NEC for Maintenance
9. Telecommunications Industry Association (TIA) 568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

1.03 SUBMITTALS

- A. Submit complete system test procedures and test record forms for review. Test procedures shall include but not be limited to:
 1. Detailed procedures, both pre and post energization testing requirements of the Manufacturer and independent third-party entity, in sufficient detail to verify conformance with these Specifications.
 2. Incorporation of data collection and measurement values as shown in the sample test record forms provided at the end of this Section. Submitted test record forms shall include space for each of the fields listed, at a minimum.
 3. Detailed comprehensive testing schedule including:
 - a. Electrical testing of each major area.
 - b. Each major piece of electrical distribution equipment.
 - c. Each major electrical subsystem.
 - d. Duration of each test.
 - e. Milestone test completion date.
 - f. Date of test results submittals following completion of the tests.
 - g. Names and qualifications of the individual(s) responsible for performing the testing, including a copy of current NETA Technician cards.
 - h. Proof of NETA accreditation for the testing agency.
- B. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the "as-left" settings of all devices, relays, circuit breakers, etc.
- C. Test results shall be submitted in one submittal.
- D. Test reports shall be based on NETA's latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA's Acceptance Testing Specifications latest edition.

1.04 QUALITY ASSURANCE

- A. Testing Firm Qualifications:
 1. Corporately and financially independent organization functioning as an unbiased testing authority.
 2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
 3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
 4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years testing experience on similar projects.
 5. Technicians certified by NICET or NETA.

6. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
 7. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.
- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.
- C. Test instrument calibration shall be in accordance with NETA ATS.

1.05 FIELD TESTS

- A. All testing shall be performed in the presence of the Owner.
- B. Any system material or workmanship that is found to be defective on the basis of acceptance tests shall be reported directly to the Owner.

PART 2 - PRODUCTS

2.01 PRE-ENERGIZATION AND OPERATING TESTS

- A. The complete electrical system for each phase of construction shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the Protective Device Coordination Study required by Section 16961 and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the Owner.
1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.
 2. Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.
 3. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.
 4. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.
 5. Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources, similarly to protective relay circuits.
 6. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.
 7. Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.
- B. Test Report. A test report covering the results of the tests required in the Pre-Energization and Operating Tests shall be delivered to the Engineer prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2017, *Standard for Acceptance Testing Specifications for Electrical Power Equipment*

and Systems, published by the InterNational Electrical Testing Association. Tests shall be provided by both the manufacturer representative and independent third-party NETA accredited testing agency where required.

2.02 FIELD TESTS BY MANUFACTURER'S OR SUPPLIERS

- A. All field tests shall be performed by the Manufacturers or Suppliers.

2.03 TEST REQUIREMENTS

- A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.
1. Lighting: Switching. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.
 2. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known and reasonable current in the ground current sensor circuit. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.
- B. Low Voltage Cables-600 volts Maximum
1. Visual and Mechanical Inspection
 - a. Compare cable data with Drawings and Specifications.
 - b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
 - c. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - d. Inspect compression-applied connectors for correct cable match and indentation.
 - e. Inspect for correct identification and arrangements.
 - f. Inspect cable jacket insulation and condition.
 2. Electrical Tests
 - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be 1 minute.
 - 1) Motor feeders tested with motors disconnected and controller open.
 - 2) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.
 - 3) Panelboard feeders tested with feeder breaker open and panelboard connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.
 - 4) Conductors of main lighting feeders, including lighting panel with branch circuits open.
 - 5) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.

- 6) Equipment which may be damaged during this test shall be disconnected.
 - 7) The Engineer shall be consulted if minimum insulation values cannot be obtained.
 - b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
 - c. Perform continuity test to ensure correct cable connection.
 - d. Perform the following industry-standard operational and performance tests on each Category 6 Ethernet cable as detailed in ANSI/EIA-568-C:
 - 1) Wire map (pass/fail)
 - 2) Propagation delay (pass/fail)
 - 3) Delay skew (pass/fail)
 - 4) Cable length
 - 5) Insertion loss (attenuation)
 - 6) Return loss (pass/fail)
 - 7) Near-end crosstalk (NEXT) (pass/fail)
 - 8) Power sum near-end crosstalk (PSNEXT) (pass/fail)
 - 9) Equal level far-end crosstalk (ELFEXT)
 - 10) Power sum equal level far-end crosstalk (PSELFEXT).
 - 3. Test Values - Visual and Mechanical
 - a. Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Bolt-torque levels shall be in accordance with NETA ATS Table 100.12 unless otherwise specified by the manufacturer.
 - 4. Test Values - Electrical
 - a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
 - c. Cable shall exhibit continuity.
 - d. Deviations in resistance between parallel conductors shall be investigated.
 - e. Compare Category 6 Ethernet test values against TIA 568-C for determination of pass/fail status.
- C. Low Voltage Safety Switches
- 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify the unit is clean.
 - e. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
 - f. Verify that fuse sizes and types are in accordance with drawings, short-circuit studies, and coordination study.
 - g. Verify that each fuse has adequate mechanical support and contact integrity.

- h. Inspect bolted electrical connections for high resistance using one or more of the following methods:
 - 1) Use of a low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12
 - i. Verify operation and sequencing of interlocking systems.
 - j. Verify correct phase barrier installation.
 - k. Verify correct operation of all indicating and control devices.
 - l. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests
- a. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter, if applicable.
 - b. Measure contact resistance across each switchblade and fuse holder.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1
 - d. Measure fuse resistance.
3. Test Values – Visual and Mechanical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
4. Test Values – Electrical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
 - d. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- D. Molded and Insulated Case Circuit Breakers
1. Visual and Mechanical Inspection
- a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage and alignment.
 - d. Verify the unit is clean.

- e. Operate the circuit breaker to insure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one or more of the following methods:
 - 1) Use of a low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12
 - g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1.
 - c. Perform a contact/pole-resistance test.
 - d. Determine long-time pickup and delay by primary current injection.
 - e. Determine short-time pickup and delay by primary current injection.
 - f. Determine ground-fault pickup and time delay by primary current injection.
 - g. Determine instantaneous pickup by primary current injection.
 - h. Test functions of the trip unit by means of secondary injection.
 - i. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
 - j. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators
 - k. Verify operation of charging mechanism.
3. Test Values – Visual and Mechanical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - c. Settings shall comply with coordination study recommendations.
4. Test Values – Electrical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.
 - c. Microohm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that

deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

- d. Insulation-resistance values of control wiring shall not be less than two megohms.
- e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS Table 100.7.
- f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- h. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, refer to NETA ATS Table 100.8.
- i. Pickup values and trip characteristics shall be within manufacturer's published tolerances.
- j. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of the manufacturer's published data, refer to NETA ATS Table 100.20.
- k. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
- l. The charging mechanism shall operate in accordance with manufacturer's published data.

E. Metering Devices

1. Visual and Mechanical Inspection

- a. Compare equipment nameplate data with drawings and specifications.
- b. Inspect meters and cases for physical damage.
- c. Clean front panel and remove shipping restraint material.
- d. Verify tightness of electrical connections.
- e. Record model number, serial number, firmware revision, software revision, and rated control voltage.
- f. Verify operation of display and indicating devices.
- g. Record passwords.
- h. Verify unit is grounded in accordance with manufacturer's instructions.
- i. Verify unit is connected in accordance with manufacturer's instructions and project drawings.
- j. Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.

2. Electrical Tests

- a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
- b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.
- c. After initial system energization, confirm measurements and indications are consistent with loads present.

3. Test Values – Visual and Mechanical

- a. Nameplate data shall be per drawings and specifications.
 - b. Tightness of electrical connections shall assure a low resistance connection.
 - c. Display and indicating devices shall operate per manufacturer's published data.
 - 4. Test Values – Electrical
 - a. Measurement and indication of applied values of voltage and current shall be within manufacturer's published tolerances for accuracy.
 - b. All auxiliary input/output features shall operate per settings and manufacturer's published data.
 - c. Measurements and indications shall be consistent with energized system loads.
- F. Grounding System
- 1. Visual and Mechanical Inspection
 - a. Verify ground system is in compliance with drawings, specifications, and NFPA 70 National Electrical Code Article 250.
 - b. Inspect physical and mechanical condition.
 - c. Inspect bolted electrical connections for high resistance using one or more of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - d. Inspect anchorage.
 - 2. Electrical Tests
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
 - b. Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system.
 - c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points.
 - 3. Test Values – Visual and Mechanical
 - a. Grounding system electrical and mechanical connections shall be free of corrosion.
 - b. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - c. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - 4. Test Values – Electrical
 - a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. The resistance between the main grounding electrode and ground shall be no greater than five ohms for large commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)
 - c. Investigate point-to-point resistance values that exceed 0.5 ohm.

- G. Test ground fault interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.
- H. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:
 - 1. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.
 - 2. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels, as required by Section 16961.
 - 3. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 16961 and testing of relays to assure that relays will trip at the current value and time required by the Study.
 - 4. Circuit Breakers:
 - a. Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.
 - b. Time and pickup setting shall correspond to the recommendations of the Short Circuit Study.
 - c. Setting shall be tabulated and proven for each circuit breaker in its installed position.
 - d. Test results shall be certified by the person performing the tests and shall be submitted to the Engineer.
- I. Subsystem testing for each phase of construction shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the Owner and after process control devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper operation. It is intended that the Contractor will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
- J. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.
- K. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
- L. Voltage Field Test:
 - 1. Check and record voltage at point of termination of Xcel Energy supply system after the installation is essentially complete and has been made operational.
 - 2. Check and record voltage amplitude and balance between phases for loaded and unloaded conditions.
 - 3. Unbalance Corrections:

- a. Notify the Owner if balance (as defined by NEMA) exceeds 1%, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4% of nominal.
- 4. Voltage Balance Report:
 - a. Submit Voltage Balance Report for each switchboard, distribution panel-board, load center, motor control center, and transformer.
- M. Equipment Line Current Tests:
 - 1. Check and record line current in each phase for each major piece of electrically-operated equipment.
 - 2. Make a line current check after Xcel Energy has made final adjustments to supply voltage magnitude or balance.
 - 3. If any phase current for any piece of equipment is above rated nameplate current, prepare a supplement to the Equipment Line Current Report that identifies any causes of problems and corrective action that was taken.
 - 4. Submit Equipment Line Current Report for each point of connection to motors, transformers, branch circuit distribution connections, and incoming utility service connection.

2.04 TEST REPORTS

- A. The test report shall include the following:
 - 1. Summary of project.
 - 2. Description of equipment tested.
 - 3. Description of test.
 - 4. Test data.
 - 5. Analysis and recommendations.
- B. Test data records shall include the following minimum requirements:
 - 1. Identification of the testing organization.
 - 2. Equipment identification.
 - 3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
 - 4. Date of inspections, tests, maintenance, and/or calibrations.
 - 5. Identification of the testing technician.
 - 6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
 - 7. Indication of expected results when calibrations are to be performed.
 - 8. Indication of "as-found" and "as-left" results.
 - 9. Sufficient spaces to allow all results and comments to be indicated.
- C. The Contractor shall submit the complete report to the Engineer for review.

PART 3 - EXECUTION

3.01 FIELD TESTS

- A. The Contractor shall provide ten Working Days' notice to the Owner prior to any field testing to permit witnessing of the testing.

TEST RECORD SHEETS

The test record sheets listed below are provided as an example to demonstrate the minimum requirements to be included on test record sheets for electrical equipment and of the electrical installation as required by these specifications. Sample copies of each sheet are attached.

Sheet No.	Title
1	Insulation Resistance (Power, Control Wire, and Cable) Test Record
2	Insulation Resistance (Instrument Wire and Cable) Test Record
3	Ground Electrode Testing Test Record
4	Neutral Grounding Resistor Test Record
5	Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record
6	Bonding Resistance Readings (Electrical Equipment) Test Record
7	Insulation Resistance (Equipment) Test Record
8	Equipment Absorption Ratio and Polarization Index Test Record

**INSULATION RESISTANCE
(POWER, CONTROL WIRE, AND CABLE)
TEST RECORD**

TEST EQUIPMENT: _____ TEST VOLTAGE: _____
 TEST EQUIPMENT: _____ TEST VOLTAGE: _____
 AMBIENT TEMPERATURE: _____ °C _____ °F DATE: _____

- NOTES: 1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with nonshielded conductors. Test between each conductor and shield for multiconductor cables with shielded conductors. Record lowest reading for each cable.
2. Use 1,000-V test set for cable rated 600 volts and 2,500-V test set for cable rated over 600 volts.
3. Readings will vary inversely with temperature and cable length. When the use of temperature correction factors is specified, attach a second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Panel No. Circuit No. Feeder No.	Wire Tagging	Cable Rated Voltage	Wire or Cable				Insulation Resistance (megohms) *	Initial s
			Quantity	Size	From	To		

*Minimum acceptable values:

Cable Rated <u>Voltage</u>	Test <u>Duration</u>	Resistance for <u>Cable Only</u>	Cable/Wire Size <u>or Amperage</u> (megohms)	Resistance When Cable <u>Connected to Equipment</u> (ohms)
-------------------------------	-------------------------	-------------------------------------	--	--

 DISTRIBUTION:

CONTRACTOR/Date _____

**INSULATION RESISTANCE
(INSTRUMENT WIRE AND CABLE)
TEST RECORD**

TEST EQUIPMENT: _____ TEST VOLTAGE: _____
 TEST EQUIPMENT: _____ TEST VOLTAGE: _____
 AMBIENT TEMPERATURE: _____ °C _____ °F DATE: _____

- NOTES: 1. Record only the lowest value.
 2. MP - Multi-pair cable. SP - Single pair cable.
 3. Megger with instruments disconnected.
 4. Use 250 volt (or lower voltage, when specified) range on DC test set.
 5. Readings will vary with temperature and cable length.

Cable Number or Instrument Number	Indicate MP or SP Type (2)	Conductor to Conduit (Single Pair Non-Shielded Cables) (megohms)	Conductor to Conductor (megohms) (1)	Shield to Conductor to Shield (megohms) (1)	Overall Shield to Shield (Multipair Cables Only) (megohms) (1)	Lead and Armor (Multipair Cables Only) (megohms)	Shield to Conduit (Single Pair Cables Only) (megohms)	Initials

 DISTRIBUTION: _____ CONTRACTOR/Date _____

**GROUND ELECTRODE TESTING
TEST RECORD**

TEST EQUIPMENT: _____ (Note 1) _____ (Note 2)

REFERENCE DRAWING: _____

- NOTES: 1. Record resistance-to-earth for each electrode with all other conductors disconnected. Resistance not to exceed 25 ohms for any single anode.
2. Check continuity from each electrode to any test bar or other electrode such that the complete ground loop is tested.

Rod Number	Resistance to Earth (ohms)	Ambient Temperature (°C/°F)	Weather	Taps	Initials/Date

DISTRIBUTION: _____ CONTRACTOR/Date _____

NEUTRAL GROUNDING RESISTOR TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

- NOTES: 1. Use 1,000-volt test set for 600-volt equipment and below, 2,500-volt test set for equipment rated over 600 volts.
2. Resistor must be disconnected from ground and neutral during Insulation Resistance (megger) and DC Overpotential Tests.
3. Resistor must be disconnected from neutral during Cold Resistance Test.
4. Apply DC Overpotential Test between terminals and ground for the complete device. (The voltage applied between the terminals of each assembly and its grounded enclosure shall be twice the rated AC voltage plus 1000 V when rated 600 V or less, or 2.25 times the rated AC voltage plus 2000 V when rated over 600 V for 1 minute.) This test is a Pass/Fail test based purely on withstand alone.
5. Inspect assembly for damage and missing parts.
6. Check to assure that the center tap ratio is correct, when CT is supplied with resistor.

Verify resistor reterminated.

Tag. No.	Cold Res. (ohms)	Insul. Res. (megohms)*	Overpot. (4)	CT Ratio Pri-Sec	Reterm (4)	Initials/Date

*Minimum acceptable values:

VOLTAGE CLASS

INSULATION RESISTANCE (megohms)

DISTRIBUTION: _____

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS (NONELECTRICAL EQUIPMENT/STRUCTURES) TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Vessels, tanks, and structural steel bonded to the main grounding system, dedicated ground rod or foundation, as indicated on drawings listed below.

2. Measure resistance from ground wiretap (or anchor bolt) to tagged equipment frame or structural steel.

[illegible]

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS (ELECTRICAL EQUIPMENT) TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

- NOTES: 1. Electrical equipment bonded to the main grounding system or dedicated ground rod, as indicated on drawings listed below.
2. Measure resistance from ground wiretap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

[illegible]

DISTRIBUTION:

CONTRACTOR/Date _____

**INSULATION RESISTANCE (EQUIPMENT)
TEST RECORD**

TEST EQUIPMENT: _____ SUBSTATION: _____
AMBIENT TEMPERATURE: _____ °C _____ °F DATE: _____
REFERENCE DRAWING: _____ REF. SEC.: _____

NOTES: 1. Use 1,000-V test set for equipment rated 600 volts and below, 2,500/5,000-V test set for equipment rated over 600 volts.
2. For equipment with solid state control circuits, consult manufacturer's literature for maximum test voltages.

Switchgear or MCC (or other)	INSULATION RESISTANCE (megohms) *						Test Voltage (kV)	Rated Voltage (kV)	Initials/Date
	ØA to G	ØB to G	ØC to G	ØA to ØB	ØB to ØC	ØC to ØA			

*Minimum acceptable values:

<u>EQUIPMENT VOLTAGE CLASS</u>	<u>RESISTANCE (megohms)</u>
--------------------------------	-----------------------------

TESTER'S INITIALS/DATE _____

DISTRIBUTION: _____ CONTRACTOR/Date _____

EQUIPMENT ABSORPTION RATIO AND POLARIZATION INDEX TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____
 AMBIENT TEMPERATURE: _____ °C _____ °F DATE: _____
 EQUIP. TEMP., IF KNOWN: _____ °C _____ °F REL. HUMIDITY: _____

NOTES: 1. Perform test as indicated on Test Records for each individual equipment type. Reference the following sheets:

Transformers 8
 Equipment 9
 Motors and Generators 10

2. Absorption Ratio = $\frac{\text{1-Minute Resistance Value}}{\text{30-Second Resistance Value}}$
 3. Polarization Index = $\frac{\text{10-Minute Resistance Value}}{\text{1-Minute Resistance Value}}$

OHMS TO GROUND 30-SECOND READING ØA TO GROUND	OHMS TO GROUND 1-MINUTE READING ØA TO GROUND	OHMS TO GROUND 10-MINUTE READING ØA TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ØB TO GROUND	OHMS TO GROUND 1-MINUTE READING ØB TO GROUND	OHMS TO GROUND 10-MINUTE READING ØB TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ØC TO GROUND	OHMS TO GROUND 1-MINUTE READING ØC TO GROUND	OHMS TO GROUND 10-MINUTE READING ØC TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX

TESTER'S INITIALS/DATE _____

 DISTRIBUTION:

CONTRACTOR/Date _____

SECTION 16961

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.

1.02 SCOPE OF WORK

- A. Obtain the services of an independent firm to provide complete Short-Circuit and Protective Device Coordination studies, and Arc Flash Risk Assessment for the electrical system as defined below. The firm performing the work shall have been regularly engaged in short-circuit and protective device coordination services for a period of at least 10 years.
- B. The firm performing the work shall be responsible for the collection of all data required to perform the studies, including the electrical utility company's short-circuit current contribution.
- C. For the purpose of this specification Section, the "Electrical System" shall be defined as the entire power distribution system, including the utility company's main service disconnect down through the main circuit breaker on each 240/120VAC and 208/120 VAC panelboard of all distributed branch circuits. Some equipment not modified as part of this contract is required to be included in the studies defined in this Section. Items within the "Electrical System" are comprised of:
 - 1. All utility transformers
 - 2. All medium voltage equipment
 - 3. All medium voltage to low voltage transformers
 - 4. All 240 VAC panelboards and distribution equipment
- D. The Short-Circuit Study shall provide for the calculation of fault currents at each piece of gear in the Electrical System for the entire Site. Fault currents shall be calculated for scenarios of utility and standby power, as outlined in this Section.
- E. The Protective Device Coordination Study shall include trip characteristics for all protective devices in the Site Electrical System, from the utility company's main service disconnect through the main circuit breaker on each 208/120 VAC panelboard of all distributed branch circuits. Trip characteristics shall be analyzed for scenarios of utility and standby power, as outlined in this Section.
- F. The Arc Flash Risk Assessment shall provide for arc flash incident energy calculations at all panels as required by IEEE 1584 (2018 Edition) and NFPA 70E.
- G. Reports:
 - 1. Reports for the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be stamped and signed by a *California* Registered Electrical Engineer.
 - 2. Report calculations shall be generated by a software analysis application with proven accuracy and reliability at performing 3-phase fault calculations.

1.03 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- B. American National Standards Institute (ANSI)
- C. The National Fire Protection Association (NFPA)
- D. InterNational Electrical Testing Association (NETA) Standard for Acceptance Testing Specifications (ATS)
- E. NFPA 70E, Standard for Electrical Safety in the Workplace
- F. IEEE 1584 (2018 Edition), Guide for Performing Arc-Flash Hazard Calculations
- G. Occupational Safety and Health Administration (OSHA) (29 CFR PART 1910), Occupational Safety and Health Standards for General Industry

1.04 SUBMITTALS

- A. Submit data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010 (26 05 00).
- B. Submit credentials of firm performing the studies to demonstrate sufficient experience with performing this type of work, as specified herein.
- C. Preliminary: Preliminary Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be submitted to the Engineer for review prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- D. Results of the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be summarized in a final report. Submit hardbound copies of the complete final report and one digital copy in PDF on a CD. Electronic delivery shall contain full searchable text, and include any computer models developed for the studies at no additional cost.
- E. Sample arc flash warning labels for each piece of equipment. Submit copies of labels at full size, with all required information as calculated by the Arc Flash Risk Assessment.

1.05 DATA COLLECTION

- A. The firm performing the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall furnish the Contractor with a listing of required data. The Contractor shall collect and furnish all required data. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final acceptance of the equipment shop drawings and/or prior to the release of the equipment for manufacturing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The Short-Circuit Study and Protective Device Coordination Study shall be performed as outlined in International Electrical Testing Association (NETA) Standard for Acceptance Testing Specifications, Section 6 with exceptions as included in this Section.
- B. In order to select relays and fuse characteristics as required for optimum coordination, the coordination study shall be performed as soon as the vendors for the new electrical equipment are identified. Relays and fuse selection by the power distribution equipment suppliers shall be based on the results of the favorably reviewed study.
- C. The studies shall be submitted to the Engineer for acceptance before final acceptance of power distribution equipment submittals and before any settings are made on equipment.
- D. The final report for the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be bound in a standard 8 1/2-inch by 11 inch sized report. The selection of all protective relay types, current transformers, and fuse types and ratings shall be the responsibility of the manufacturer and shall be based on the preliminary draft of the coordination study, which shall be submitted with the equipment shop drawings (or earlier). The studies shall be accepted by the Engineer before any equipment is shipped. See Paragraph 1.04 for submittal requirements.
- E. The report shall include a single line diagram depicting the entire Electrical System included in the analysis. At a minimum, the single line diagram shall be on an 11-inch by 17-inch sheet, and include the following information:
 - 1. Equipment/bus tags which match the contract documents
 - 2. Equipment/bus ampacity ratings
 - 3. Motor horsepower
 - 4. Protective device frame rating, trip setting, and curve options, as applicable
 - 5. Transformer primary/secondary voltages, kVA rating, and impedance
 - 6. Conductor materials, insulation types, and lengths
- F. The studies shall be run on each of the following scenarios:
 - 1. Utility power

3.02 SHORT-CIRCUIT STUDY

- A. Provide a complete Short-Circuit Study. The study shall include, but shall not be limited to, the following, as applicable:
 - 1. Full compliance with applicable ANSI and IEEE Standards.
 - 2. Performed on nationally recognized computer software, such as ETAP or SKM Power Tools.
 - 3. Overall system impedance diagram. The diagram shall include the power company's impedance and X/R ratios and circuit element impedances (e.g.,

- transformers, generators, motors, VFDs, feeders, distribution buses as applicable).
4. Available three phase and ground fault asymmetrical and symmetrical short-circuit fault currents at each piece of electrical equipment, bus, transformer, etc.
 5. The momentary and interrupting rating of all elements of the distribution system shall be listed. The maximum available short-circuit fault current available at each element shall be calculated.
 6. Executive summary describing the distribution system, the procedures used to develop the study, utility related information furnished by the utility company, including the name and telephone number of the individual supplying the information, identification of all assumptions made in the preparation of the study, identification of any problem areas, and a definitive statement concerning the adequacy of the distribution system to interrupt and withstand the maximum possible short-circuit fault current.
 7. Computer printouts for the three phase, single phase and ground fault studies. Printouts shall indicate the short-circuit fault current available at each major equipment and distribution bus within the medium and low voltage distribution systems.

3.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide a complete Protective Device Coordination Study. The Protective Device Coordination Study shall include, but shall not be limited to:
 1. Utility protective devices.
 2. Service entrance and distribution switchgear.
 3. Medium and low voltage power system transformers.
 4. Low voltage switchgear, switchboards, power distribution panels and motor control centers.
 5. Power factor correction and harmonic mitigation equipment.
 6. Motor starters and variable frequency drives.
 7. Standby generators.
 8. A tabulation of all the settings for every over current protective device, timer, power system relays (e.g., ANSI 50, 51), circuit breaker, recommended fuse and current transformer ratings, etc.
 9. Transformer excitation current.
 10. Motor and cable damage curves in accordance with the manufacturer's recommendations.
 11. Select relay types (e.g., inverse, very inverse, extremely inverse, overcurrent with or without voltage restraint, timers), current transformer ratings and types, fuse, residually or zero sequence connected ground faults protection, etc. that will allow the system to be protected within the equipment fault ratings and provide the maximum possible coordination between the protective devices.
 12. Provide recommended settings for protective devices, such as relays and circuit breakers, to achieve the best selectivity to minimize system disturbances during fault clearing.
 13. Provide a complete set of time-current coordination curves on log-log paper for every protective relay, circuit breaker, fuse, timer, etc. serving or located in the electrical equipment furnished for the project, including the utility protective devices. Provide a separate time-current curve for each unique feeder system, without displaying parallel devices powered from a common

bus. The time-current curves shall display the coordination from the lowest device in the distribution system up through the utility's protective device. Clearly identify each device curve displayed on the graph, by color coding and text callouts. Include specific settings used for the curve (as applicable) in the text callout. A single line diagram depicting the portion of the distribution system under study shall appear with each curve. The minimum size log paper to be submitted shall be 11-inch by 17-inch.

14. Time current curves shall include transformer ANSI damage and inrush curves, cable damage curves, circuit breaker and fuse ratings and settings, protective relay settings, and any other information required by ANSI and good design practices. As a minimum, provide curves for:
 - a. Each medium voltage and low voltage feeder down to 480-volt motor control centers and panelboards.
 - b. Each main, tie and feeder circuit breakers located in medium voltage and low voltage switchgear, motor control centers and panelboard. Include the largest feeder circuit breaker in each motor control center and panelboard.
 - c. Each ground fault protective device provided for the medium voltage and low voltage power distribution systems.

- B. The report shall include a reference to any part of the Electrical System where selectivity cannot be achieved, and a brief explanation of the cause. Provide recommendations where applicable for alternate methods that would improve selectivity.

3.04 ARC FLASH RISK ASSESSMENT

- A. Provide a detailed Arc Flash Risk Assessment. The analysis shall include, but shall not be limited to:
 1. Determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protection equipment (PPE) for all energized electrical equipment.
 2. The study shall determine worst-case scenarios for the arc flash energy level calculations, and any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety.
 3. The study shall indicate the worst-case values for each of the scenarios listed in Paragraph 3.01F. Provide values in tabular format including at a minimum, location of fault, incident energy, arc flash boundary, working distance, acting protective device, protective device activation time, and arcing fault current.
 4. Provide executive summary, including introduction, methodology, information sources, key assumptions, NFPA 70E considerations and calculations.
 5. Develop and install arc flash warning labels based on arc flash study results.

3.05 FIELD ADJUSTMENT

- A. All field adjustment and modifications shall be performed in the presence of the Owner, before energizing equipment.
- B. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments shall be completed by the equipment manufacturer.
- C. Make minor modifications to equipment as required to accomplish conformance with Short-Circuit and Protective Device Coordination studies.

3.06 MODIFICATIONS

- A. Notify the Owner in writing of any required major equipment modifications. Major modifications to the equipment shall not be allowed unless otherwise approved in writing by the Engineer and the Owner.

3.07 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 4 inch by 4 inch thermal transfer type label of high adhesion polyester for each work location analyzed. Labels shall be machine printed, with no field markings.
- B. The label shall have an orange header, compliant with ANSI Z535, with the wording, "WARNING, SHOCK & ARC FLASH HAZARD", and shall include the following information:
 - 1. Location designation (equipment identification tag)
 - 2. Nominal voltage
 - 3. Arc flash boundary
 - 4. Incident energy at working distance (in calories/centimeter-squared)
 - 5. Working distance
 - 6. Shock boundaries
 - a. Limited approach distance
 - b. Restricted approach distance
 - 7. Required personal protective equipment,
 - 8. Engineering report number, revision number and issue date.
 - 9. Where voltage exceeds 600 VAC or incident energy is greater than 40 cal/cm², label header shall be changed to "DANGER, SHOCK & ARC FLASH HAZARD."
- C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 600, 480 and applicable 240 and 208 VAC panelboards and disconnects, one arc flash label shall be provided.
 - 2. For each industrial control panel, provide one arc flash label.
 - 3. For each transformer, provide one arc flash label at both the front and rear access points, as applicable.
 - 4. For each low voltage motor control center, at least one arc flash label shall be provided. Motor control centers larger than five sections shall bear one arc flash label for each five sections. Back-to-back or turned corner configurations shall be treated as two motor control centers for the purpose of labeling.
 - 5. For each 96-inches of low voltage switchboard, one arc flash label shall be provided.
 - 6. For each standalone VFD or motor starter, one arc flash label shall be provided.
 - 7. For each switchgear, provide one arc flash label for each the front and rear of the incoming compartment and one arc flash label on each compartment that houses a draw-out device.
 - 8. For each medium voltage motor control center, provide one arc flash label each for the front and rear of the incoming compartment, one label for each individual starter or switch operating handle, and one label each for any draw-out power drawers.
 - 9. Where equipment includes a "maintenance mode" bypass setting on a protective device as a temporary arc-flash reduction measure, provide one

arc flash label at the applicable protective device which indicates the calculated values when maintenance mode is enabled. This label shall be clearly marked to indicate what it represents.

- D. The Contractor shall affix the labels in accordance with the following:
1. Labels shall be in a clearly visible location on the front panel of the equipment near the incoming service or main protective device. Labels on equipment with bottom-entry incoming service shall be placed a minimum of 60-inches from the bottom of the equipment.
 2. Labels affixed to outdoor equipment which includes an outer door and inner deadfront panel shall be placed on the deadfront panel to avoid fading due to exposure to the elements.
 3. For labels affixed to removable compartment doors or covers, the removable cover shall be clearly marked to identify the specific compartment for which it is intended to be used.

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SECTION 17010

INSTRUMENTATION AND CONTROLS, GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Work Included:
 - 1. Provide all tools, equipment, materials, and supplies and be responsible for all labor required to complete the installation, startup and operational testing of a complete and operable Instrumentation and Control (I&C) System as indicated on the Drawings and as specified herein.
 - 2. Provide all the necessary equipment components and interconnections along with the services of manufacturers' engineering representatives necessary to ensure that the Owner receives a completely integrated and operational I&C system as herein specified.
 - 3. Provide all terminations for wiring at field mounted instruments, equipment enclosures, alarm and status contacts.
 - 4. Provide all Instrumentation and Control wire required for a fully functioning Instrumentation and Controls System as shown on the Drawings except for wire specifically specified in Division 16. See Section 16010.

1.02 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI) Publications:
 - 1. Y14.15a Drafting Practice
 - 2. C62.1 Surge Arrestors
- B. Instrumentation Society of America (ISA) Publications:
 - 1. S5.4 Instrument Loop Diagrams
 - 2. S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

1.03 I&C SUBCONTRACTOR QUALIFICATIONS

- A. An I&C Subcontractor shall be an electrical contractor who has demonstrated experience in purchasing, calibrating, fabricating, installing and testing the Instrumentation and Control (I&C) products listed in this Specification Section. Normally, the I&C Subcontractor is a systems house regularly engaged in the business of panel fabrication, control component procurement, programmable logic controller and personal computer (PC) application in the process control industry.
- B. The I&C Subcontractor has been regularly engaged for a period greater than five years in performing all aspects of the type of work specified in this Section and shown on the Drawings and must prequalify as specified below.

1.04 I&C SUBCONTRACTOR SYSTEM RESPONSIBILITIES

- A. General: The I&C equipment as specified in this Division shall be considered an integrated system. Entire system installation including calibration, verification, startup, operation testing, and training shall be performed by qualified personnel, possessing all the necessary skills and equipment, and who have had experience performing similar installations. Instrumentation and control systems drawings are

diagrammatic only; it is the responsibility of the Contractor to obtain technical data, determine performance requirements, develop instrumentation detail installation designs, and coordinate the selection of specified equipment with Contractor supplied equipment to meet the design conditions stated.

B. System Responsibilities:

1. Instrumentation and control system drawings are diagrammatic only. Ensure that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, and alarming devices and all appurtenances are completely compatible and shall function as outlined and shall furnish and install such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.
2. Compatibility: See that all components of the instrumentation system, including equipment specified under other Divisions, are completely compatible and function properly as a system. Provide such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.
3. Coordination: As shown on the Drawings.
 - a. Provide technical advice to mechanical and electrical subcontractors as necessary regarding their installation of instruments.
 - b. Verify the correctness of installation of all instruments.
 - c. Verify that the proper type, size, and number of control wires with their conduits are provided.
 - d. Verify that the proper type, size, and number of pneumatic tubes with their conduits are provided.
 - e. Verify that proper electric power circuits provided for all components and systems.
 - f. Resolve all manufacturers' installation discrepancies between requirements and the detail requirements of the Drawings and Specifications.
 - g. Supervise final signal connections, both electric and pneumatic, to all process instrumentation and control equipment.
 - h. Adjust, startup, and test all process instrumentation and control equipment.
 - i. Provide specified documentation and training.
4. Performance: While the Drawings provide sufficient information to establish the form and function of the systems and their relationships, the responsibility for system integration and performance rests solely with the Contractor. The Engineer provides technical instruction and guidance where needed.
5. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying special attention to space allocation and dimensions shown or required on Drawings. Inspect completed work and verify that it is ready for installation of instruments and equipment. Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing.

1.05 SUBMITTALS

- A. Refer to Division 1 for required method of preparation and transmittal and conform to requirements herein.

- B. Shop Drawings: Submit shop drawings (diagrams) for review in complete bound sets indexed by Specification number, with exterior tabs marked by subject. Submit manufacturer's catalog cuts for each item for which shop drawings are not required. Manufacturer's catalog cuts, specifications or data sheets shall be clearly marked to delineate the options or styles to be furnished. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Drawings shall be complete with device tag numbers, wire numbers and terminal board numbers. Submit fabrication details, nameplate legends, and control panel internal wiring and piping schematic drawings. Submit panel graphic drawings where applicable. Include material lists and/or bills of material.
1. Loop/Interconnect Diagrams: Submit a set of analog and discrete wiring diagrams that shows the complete details of installation of instruments and control system components. Include on each drawing the conduit number, wire numbers, the conduit run (via pullboxes, handholes, terminal cabinets, etc.) wiring interconnection and termination points.
- C. Specification Forms:
1. Submit completed Specification Forms per ISA S20, including those instrumentation and control components directly related to process control, but specified in other Divisions of these Specifications.
 2. Include on each form the assigned tag numbers, manufacturer's part numbers, and device data. More than one tag numbered item may be included on a sheet.
- D. As-Built Drawings: Submit a revised set of shop drawings that incorporates all change orders and modifications made during performance of the work. In addition to updated loop diagrams, submit equipment and device wiring diagrams (see Sketch 17010-4) and other drawings as necessary to depict the "as-built" condition of equipment. Include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, interconnection diagrams with cable, wire, tube and termination numbers. Coordinate all drawings with the conductor identification requirements in Section 16120 and Section 16124.
- E. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals, including Instruction Manuals and Part Lists, for equipment provided under Division 17 as required by Division 1. Obtain data from manufacturers, and format and bind as specified. Obtain distribution method instructions from the Owner or his representative.
1. Schedule: Deliver at least two (2) copies of manuals in 3-ring binders (8-1/2 by 11-inch format) not later than the equipment shipment date.
 2. Contents: Include in manuals not less than the following information, as applicable, for each instrument, equipment, subsystem and/or control loop:
 - a. General, introduction and overall description, purpose, functions, simplified theory of operations, etc.
 - b. Specifications (including equipment specification data sheet as described above under Shop Drawings), sufficiently detailed for reordering exact duplicates of the original items.
 - c. Installation instructions, procedures, sequences, tolerances, and precautions.
 - d. Operational procedures.
 - e. Shutdown procedures.

- f. Maintenance, calibration, and repair instructions.
 - g. Parts list and spare parts recommendations.
 - h. Calibration curves, rating tables, and any other data showing the relationship of the variable inputs and the calibrated output of all measuring devices and controlled equipment.
 - 3. Format:
 - a. Use drawings and pictorials to illustrate the text to the extent necessary to insure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasize applicable portion by heavily weighted arrows, circles or boxes; whichever provides the clearest and neatest presentation.
 - b. Group manuals by system control panels, including field instrumentation connected or associated with the panel. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, per panel grouping; however, an index by tag number for all instruments shall identify its location in that manual.
 - c. Provide control loop and/or subsystem operational descriptions to identify the function of each instrument and its relation to the other instruments in the loop.
 - 4. Binding: Bind each manual in a cover which indicates the panel or process area to which it applies, manufacturer's name, local address and telephone number, and year of purchase. Punch and bind manuals in standard three ring binders and include system name and subcontractor's name on binding.
- F. Accessory and Maintenance Materials: Submit data for the following items:
- 1. Special Tools and Accessories: Special tools, instruments, and accessories for maintaining instruments and equipment requiring periodic repair and adjustment as specified elsewhere herein. Also, furnish special lifting and handling devices for equipment requiring such devices.
 - 2. Maintenance Materials and Spare Parts: Submit a list of manufacturer recommended spare parts for each item specified. Refer to other sections of these Specifications.
- G. Test Reports: Submit the following test reports as described herein:
- 1. Instrument Calibration Data Sheets (para. 2.13)
 - 2. Factory Testing of Control Panels (para. 2.14)
 - 3. Instrument Verification Report (para. 3.08.B)
 - 4. Final Operational Testing (para. 3.08.C)
- H. Demonstration and Final Operation Test Plan and Results: Submit a document that outlines all procedures to be used in final operational testing of instrument and control systems. Include a description of each system, the scope of testing, test methods and materials, testing instruments and recorders, a list of functional parameters to be recorded on each item, and Shop Drawings showing temporary bypasses, jumpers, and devices.

1.06 QUALITY ASSURANCE

- A. Standard of Quality: The Contractor shall provide equipment of the types and sizes specified which has been demonstrated to operate successfully. Provide equipment which is new and of recent proven design.

1.07 INSPECTIONS

- A. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. Provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory.
- B. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.
- C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

1.08 DRAWINGS

- A. Drawings: The Instrumentation Drawings are diagrammatic; exact locations of instrumentation products shall be determined in the field by the Engineer. Except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this Specification shall take precedence in the event of conflict.
 - 1. Locations of equipment, inserts, anchors, motors, panels, pull boxes, manholes, conduits, stub-ups, fittings, power and convenience outlets, and ground wells are approximate unless dimensioned; verify locations with the Engineer prior to installation. Field verify scaled dimensions on Drawings.
 - 2. Review the Drawings and Specification Divisions of other trades and perform the instrumentation work that will be required for the installations.
 - 3. Should there be a need to deviate from the Instrumentation Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.
 - 4. Resolution of varying interpretations of the Contract Documents shall conform to Division 0, General and Supplementary Conditions.
 - 5. The Drawings provide details of installation and supersede the manufacturer's recommendation where a conflict exists.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element that could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain prior favorable review by the Engineer before making repairs to damaged products.

1.10 INSTRUMENT SCHEDULE

Page No. 1									
INSTRUMENT SCHEDULE ATTACHMENT TO SPECIFICATION 17010									
Type	L o o p N o.	Descripti on	I/ O	Sig nal	Range Calib. Range Setpoi nt	P&I D	Sp ec. Par a.	PN L	Manu - factur er Serial No.
LIT	0 0 1	Level Transmitt er Parshall Flume (Flow)	AI	4- 20 MA	0- 20,000 GPM	I- 011	171 20	N/ A	See Spec
LE	0 0 1 A	Radar Level Element Flume Influent	N/ A	4- 20 MA	0-5FT	I- 011	171 20	N/ A	See Spec
LE	0 0 1 B	Radar Level Element Flume Effluent	N/ A	4- 20 MA	0-5FT	I- 011	171 20	N/ A	See Spec
ZS	0 0 1	Metro Metering Vault Hatch Switch	N/ A	120 VA C	0-1	I- 011	171 70	N/ A	See Spec
AIT/AE-011	0 1 1	Autosam pler	DI					N/ A	See Spec

PART 2 - PRODUCTS

2.01 MATERIALS AND STANDARD SPECIFICATIONS

- A. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as ANSI, ASTM, ISA, and SAMA. The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the plant. All instruments in the plant of the same type shall be made by the same manufacturer.

2.02 DATA LOGGER

- A. Integrate data logger with the radio communication system using Ethernet/IP, as depicted in the drawings. Ensure seamless connectivity for efficient data transfer.

- B. Include a high-capacity SD Card with a minimum storage capacity of 32GB to be used in conjunction with the data logger.
- C. Manufacturer: Data logger shall be Sutron Xlite 3210B or engineer-approved equal.

2.03 RADIO COMMUNICATIONS

- A. Radio
 - 1. Securely mount radio within Metro Electrical Cabinet with a radio shelf. Radio Shelf shall be Saginaw SCE-FS1212 or engineer-approved equal.
 - 2. Manufacturer: GE MDS SD4MD-CES-NNSNN or engineer-approved equal.
- B. Antenna
 - 1. Existing Yagi Style Antenna (suitable for communication in the 450MHZ to 470MHZ shall be re-utilized).
 - 2. Existing polyphaser at each location shall be re-purposed.
- C. Polyphaser (Antenna Cable Surge Protector)
 - 1. Manufacturer: Talley Polyphaser IS-B50LN-C2 or engineer-approved equal.

2.04 NAMEPLATES

- A. For each piece of equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings and the model designation.
- B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using two stainless steel screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.
- C. Each control device, including pushbuttons, control switches, and indicating lights, shall have an integral legend plate or nameplate indicating the device function. These shall be inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.
- D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that may result in faulty equipment operations. Devices containing batteries that must be replaced periodically must be clearly identified. Nameplates are not required if the device senses and displays a low battery warning.

2.05 NAME TAGS

- A. All instrumentation and equipment items or systems shall be identified by name tags. Field equipment shall be tagged with the assigned instrumentation tag number listed in the Instrument Schedule.
- B. Name tags shall be stainless steel with engraved or stamped black characters of 3/16 inch minimum height. Tags shall be attached to equipment with a tag holder and stainless steel band with a worm screw clamping device. Use 20-gauge stainless steel wire where banding is impractical. For field panels or large equipment cases use stainless steel screws; however, such permanent attachment shall not be on an ordinarily replaceable part.

2.06 FIELD-MOUNTED EQUIPMENT

- A. All instrument and control equipment mounted outside of protective structures shall be equipped with suitable surge arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Protective devices used on 120 Vac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of ANSI C62.1.

2.07 EQUIPMENT OPERATING CONDITIONS

- A. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
 - 1. Electrical Power: 120 Vac $\pm$ 10%, 60 Hz, unregulated, except where specifically stated otherwise on the Drawings or in the Specifications, or when two-wire, loop-powered devices are specified.
 - 2. Field Instruments:
 - a. Outdoor Areas:
Ambient Temperature: 0°F to +120°F
Ambient Relative Humidity: 5% to 100%
Weather: Rain, sleet, snow and ice

2.08 EQUIPMENT LOCATIONS

- A. Provide equipment and materials suitable for the types of locations in which they are located as defined under Division 16. All equipment specified for field mounting shall be weatherproof and splash proof as a minimum.

2.09 ANALOG SIGNAL INDICATED UNITS

- A. For all instruments with local or remote indicators, provide indicators scaled in actual engineering units, i.e., gallons per minute, feet, psi, etc., rather than 0 to 100%, unless noted otherwise on the Drawings or Instrument Schedule.

2.10 SIGNAL TRANSMISSION

- A. Analog:
 - 1. Signal transmission between electric or electronic instruments shall be 4 20 mA and shall operate at 24 Vdc. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Where practical, milliampere signals from the field shall be converted to a voltage signal at the external terminals of each panel, and all instruments within a panel shall be parallel wired.
 - 2. Nonstandard transmission systems such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted in the Instrument Schedule or shown on the Drawings. When transmitters with nonstandard outputs do occur, their output shall be converted to 4 20 mA prior to transmission.
- B. Discrete: All alarm and status signals shall be 120 Vac unless specified otherwise on the Instrument Schedule.

2.11 PAINTING

- A. Factory paint all instruments and equipment except where installed in pipelines. Where instrument panels are installed adjacent to electrical control panels provided under Division 16, provide instrument panels of identical color to that of electrical control panels. Paint as required in Division 9 for structural supports, brackets, etc. Repair damaged factory paint to satisfaction of the Engineer. Feathering, priming and painting shall produce a reasonable match to the surrounding paint work.

2.12 FASTENERS

- A. Fasteners for securing equipment to walls, floors and the like shall be either hot-dip galvanized after fabrication or stainless steel. Provide stainless steel fasteners in corrosive locations. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8 inch.

2.13 INSTRUMENT CALIBRATION

- A. Each field instrument shall be calibrated at 0%, 25%, 50%, 75% and 100% of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Such test instruments have accuracies traceable to the National Institute of Standards and Technology (NIST).
- B. Submit a written report to the Engineer on each instrument. This report shall include a laboratory calibration sheet or the manufacturer's standards calibration sheet on each instrument and calibration reading as finally adjusted within tolerances.
- C. The Contractor may, at his option, choose to perform calibration on an instrument by acquiring the services of an independent test lab, or by obtaining the required test instruments and performing the calibration.

2.14 FACTORY TESTING OF PANELS

- A. All fabricated equipment shall be tested before it leaves the factory.
- B. Factory testing of control panels/devices/equipment shall be accomplished. Refer to individual Specification sections for tests requiring favorable review.
- C. Upon completion of factory testing, submit a report certifying the control panels/devices/equipment are operable and meet the Specifications.

PART 3 - EXECUTION

3.01 MOUNTINGS

- A. Mount and install equipment as indicated. Mount field instruments on pipe mounts or other similar means in accordance with suppliers' recommendation. Where mounted in control panels, mount according to requirements of that section.
- B. Equipment specified for field mounting shall be suitable for direct pipe mounting or surface mounting, surface-mounted indicators and equipment with calibration

adjustments or requiring periodic inspection shall be mounted not lower than 3 feet 6 inches nor higher than 6 feet above walkways, platforms, catwalks, and the like.

- C. Note that applicable specifications require detail drawings showing seismic sway bracing design and anchorage requirements for their equipment. Seismic zone requirements are specified in Division 1.
- D. All devices shall be accessible to operators for servicing, operating, reading, etc. Provide permanent platforms to assure devices are continuously accessible.

3.02 PROCESS CONNECTIONS

- A. Provide instrument impulse tubing (see Part 2) to meet the intended process service and ambient environmental condition for corrosion resistance, etc. Install impulse tubing with a continuous slope according to service to promote self-draining or venting back to the process. Terminate connection to process lines or vessels in a service rated roof valve, provided under other Divisions, that will permit closing off the impulse line or removal of the element without requiring shut down of the process. Include blowdown of drip legs and valves for terminations of impulse lines at the instruments.
- B. Process vessels, line penetrations, and root valves shall be furnished and installed under other Divisions of these Specifications. Instrument tubing and valve manifolds are installed as part of this Specification.

3.03 FIELD WIRING

- A. Ring out signal wiring prior to termination and perform surge withstand tests where required (see Section 16010 (26 05 00), Part 3 for methods). Verify wire number and terminations are satisfactory as designated on the Loop and Interconnect Diagrams. Verify all terminations are tight and shields are uniformly grounded at one location.

3.04 ELECTROMAGNETIC INTERFERENCE (EMI)

- A. Construction shall proceed in a manner which minimizes the introduction of noise (RFI/EMI) into the I&C System.
- B. Cross signal wires and wires carrying ac power or control signals at right angles.
- C. Separate signal wires from wires carrying ac power or switched ac/dc control signals within control panels, terminal cabinets, telemetry equipment, multiplexer cabinets, and data loggers as much as possible. Provide the following minimum separations within such equipment unless indicated otherwise on the Drawings:

Power Wiring Capacity	Separation (Inches)
120 volts ac or 10 amps	12
240 volts ac or 50 amps	18
480 volts ac or 200 amps	24
4,160 volts ac or 800 amps	48

3.05 SIGNAL GROUNDING

- A. Proper grounding of equipment and systems in this Division is critical. The Drawings and Division 16, Section 16450, specify safety grounding for all equipment in this Division.
- B. A single-point grounding system for instrument signals is required for all panels. This instrument single point grounding system does not use building steel or conduit systems for its ground path.
 - 1. Ground all signal shields, signal grounds, and power supplies at an isolated signal bus within each instrument panel, rack, or enclosure. The shields at the far ends of these signal cables must be disconnected (floated) from any ground to prevent ground loops.
 - 2. Do not connect the rack or enclosure frames to the signal grounding buses.
 - 3. Connect each isolated signal ground bus within each panel using a stranded, insulated copper wire of size 6 AWG or larger directly to a system ground rod installed per the Drawings.

3.06 PREPARATION

- A. Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a broom-clean condition during installation operations.
- B. Panels shall be protected during construction to prevent damage to front panel devices and prevent dust accumulation in the intervals. Other protective measures (lamp, strip heaters, etc.) shall be included as weather conditions dictate.

3.07 FIELD TESTING

- A. General: The purpose of the field testing is to verify instruments are calibrated and operationally performing their intended function. Provide the services of factory trained and experienced engineers to perform verification and operational testing as prescribed below. Since the initial calibration of instruments may not satisfy the final operation of system, perform recalibration or adjust setpoints as required to satisfy the performance requirements of the system. Notify the Engineer and Owner in writing a minimum of 48 hours prior to the proposed date for commencing final operational testing and acceptance.
- B. System Verification Testing: Verify that each instrument shown on the Instrument Schedule is operating and calibrated as specified in the Instrument Schedule by simulating inputs at the primary element in each system loop and verify performance at loop output devices (i.e. recorder, indicator, alarm, etc., except controllers). Simulate inputs at 0%, 25%, 50%, 75%, and 100% of span or with on-off inputs, as applicable. During system verification:
 - 1. Make initial or provisional settings on levels, alarms, etc. listed in the Instrument Schedule.
 - 2. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.
 - 3. Cause malfunctions to sound alarms or switch to standby to check system operation.
 - 4. Check all loop instruments thoroughly for correct operation.
 - 5. Immediately correct all defects and malfunctions disclosed by tests.
 - 6. Submit a report certifying completion of verification of each instrument system. This report shall include a data sheet on each instrument tested that

indicates instrument tolerances, instrument calibration verification, data and initial settings made to devices.

- C. Final Operational Testing: Upon completion of instrument verification, test all systems under process conditions in the presence of the Owner or designated representative. System testing shall be accomplished in accordance with the approved Test Plan (Paragraph 1.07I) The test for each portion thereof shall be witnessed, documented and signed off upon completion by the Engineer. The intent of this test is to demonstrate and certify the operational interrelationship of plant instrumentation and control systems. This testing shall include, but not be limited to:
1. Making final adjustments to levels, alarms, etc.
 2. Optimum tuning of controllers.
 3. Checking all alarms, failure interlocks, and operational interlocks.
 4. Immediately correcting all defects and malfunctions and retesting.
 5. Submit the witnessed test results and a transmittal letter indicating that all required systems have been tested satisfactorily and the systems meet all the functional requirements of their applicable specifications.

END OF SECTION

SECTION 17120

FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Requirements of Division 1 and Section 17010 form a part of this Section. This Section specifies flow measurement devices for process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these flow measurement devices, to perform the required functions in conjunction with information and equipment specified in other sections of Division 17.
- B. Provide all instruments identified in the Drawings.

1.02 REFERENCES

- A. US Department of Interior Bureau of Reclamation – Water Measurement Manual

1.03 SUBMITTALS

- A. Shop drawings and product data to be submitted in this Section shall be made in one package under the Product Review Category of Shop Drawings. See Section 01300.
- B. Shop Drawings and Product Data:
 - 1. In addition to the requirements of section 17010, shop drawings shall include for each type of instrument: supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.
 - 2. Furnish Shop Drawings and Product Data for each item of mechanical equipment presenting sufficient data to determine compliance to these Specifications. Submit completed ISA S20 forms for each device and physical dimensions. Also submit manufacturer's recommended upstream and downstream straight piping lengths, recommended location of any pressure taps, and estimates of pressure losses through the device.
 - 3. Operations and Maintenance Manuals.
- C. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.
- D. Parts List: Submit a Parts List with current net prices and a list of recommended spares.
- E. Factory Testing and Calibration:
 - 1. The flume supplier shall provide product information data to the transmitter supplier or, where practical, test the flume and transmitter as an integral assembly in the field. The integral test shall be accomplished at no extra cost to the customer.
- F. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

- G. Affidavits: Furnish affidavits from the manufacturers stating that transmitters have been properly installed and tested and each is ready for full time operation.

1.04 QUALITY ASSURANCE

- A. Manufacturer: In addition to the requirements of Section 17010, flow measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.
- B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.
- C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or as specified.
 - 1. Provide instruments suitable for the site conditions including, but not limited to, ambient temperatures, altitude, humidity, material compatibility, and process conditions.

1.05 INDICATING UNITS

- A. Provide flow indication in engineering units (GPM, CFS, MGD, etc.). Indicators which read 0 to 100%, 4-20 mA, etc. shall not be acceptable.

1.06 SERVICE CONDITIONS

- A. The flume shall measure raw municipal wastewater flows from an upstream sanitary sewer system prior to discharge to Metro Water Recovery. Typical characteristics of raw municipal wastewater should be anticipated for the design of flow measurement devices.

PART 2 - PRODUCTS

2.01 OPEN CHANNEL FLOW MEASUREMENT

- A. Parshall Flume with Level Measurement
 - 1. General: Uses the geometry of the flume to predict a flow rate based on a level measurement. Flume liners shall have throat widths and dimensions as shown on the Drawings. Other dimensions of Parshall flume liners shall conform with the standard design dimension for flumes of the specified throat widths stated in the latest edition of the Bureau of Reclamation Water Measurement Manual. Flume liners shall be equipped for installing an ultrasonic or radar level sensor suspended above the surface of the flume. Accuracy shall be 5% or greater.
 - 2. Construction: Flume liners shall be molded in one piece from fiberglass reinforced polyester (FRP) with sufficient wall thickness and reinforcing ribs to

prevent distortion while being shipped or installed. Stainless steel inside surfaces of the liner shall be smooth and free from irregularities. Outside surfaces shall be furnished with side clips for fastening to rebar with the wire in grout or concrete. Liners shall be equipped with removable top cross ties to facilitate installation.

- a. Cross braces shall be fiberglass material.
- b. Interconnection piping shall be fiberglass or stainless steel.
3. Design and Fabrication Requirements:
 - a. Wall thickness: 5/16 inch
 - b. Smooth gel-coat on wetted surfaces
 - c. Integral reinforcing ribs
 - d. Flume dimensions shall be per the Bureau of Water Reclamation Water Measurement Manual
 - e. Minimum number of top cross braces: 4
 - 1) Cross braces shall be 4 x 4 x 1/4 inch angle
 - f. Head gage:
 - 1) Mount on sidewall at H_a and H_b locations
 - 2) Markings:
 - a) Inches, tenths of inches, and mgd
 - b) 3/8 inch high characters
 - 3) Scale protected from fluid by smooth clear fiberglass laminate
 - 4) Smooth and flush with sidewall
 - 5) Head gage for determining whether submerged flow conditions exist shall be mounted at the H_b position in the throat of the flume as specified in the Bureau of Reclamation Water Measurement Manual.
 - a) Same side as H_a gage
 - b) Same elevation as H_a gage
 - c) Elevation markings only
 - g. Anchor clips:
 - 1) Permanently attached to exterior sidewall, midway up side.
 - h. Removable block to prevent distortion during shipment and installation
 - i. Self-supporting
 - j. Designed for grouted-in installation in channel with no additional internal or external supports.
 - k. Inlet and outlet transition pieces with calking collar.
4. Measuring well connections shall be cast into the side of the flume at the H_a and H_b dimension points. Measuring wells shall extend below the invert. The supplier shall coordinate with sonic probe supplier for exact mounting method and location above the fluid surface.
5. Level sensor using radar used in conjunction with the channel dimensions shall be used to obtain a cross-sectional flow area. This level sensor shall be capable of computing flows utilizing flume head-flow calculations. Instruments within hazardous areas shall be intrinsically safe, explosion proof.
6. Manufacturer:
 - a. Plasti-Fab
 - b. Or approved equal

2.02 LEVEL TRANSMITTER – RADAR TYPE

A. Pulsed Time-of-Flight (PTOF) Radar

1. General:
 - a. This type of level sensor shall use the following principle: A burst of microwave energy in the form of a “chirp” of a specific frequency profile is directed toward a target surface of interface. The interface may be air-liquid, air-solid, liquid-solid, and liquid-liquid if the densities of the two liquids are sufficiently different and provide a clearly definable interface. The return time and frequency profile of the reflected radiation is measured and converted into an electrical signal proportional to the distance from the sensor to the interface, or alternatively the distance from another reference level, such as the flume bottom, when the sensor is top mounted. As such, these are radio emitters regulated by FCC Part 15, and all applications must be approved by the vendor as conforming.
2. Specific Requirements:
 - a. Specific applications shall be as shown on the Drawings.
 - b. Sensor shall be certified by the vendor as complying with FCC Part 15 for the specific application and mounting geometry in the design.
 - c. Level ranges, output signals and setpoints are specified in the Instrument List.
 - d. Frequency Band: 80 GHz.
 - e. The sensor beam angle shall be 10 degrees maximum.
 - f. Accuracy: +/- 2 mm.
3. Construction:
 - a. The unit shall consist of sensing probes with remote mounted electronic transmitter as indicated in the Instrument List and the Drawings. In a remote mount application, the interconnecting cable between sensing probes and electronic transmitter shall be provided by the manufacturer with the instrument.
 - b. A level indicator shall be provided on the transmitter where indicated in the Instrument List or on the Drawings. The indicator shall be of the type and in the units specified in the Instrument List.
 - c. The housing for the probe and transmitter shall be rated NEMA 4X.
 - d. All instruments and sensors to be installed in hazardous locations shall be rated for the class, division, and group indicated on the Drawings.
4. Mounting:
 - a. The probes shall be suspended, and the transmitter shall be panel mounted as indicated on the Drawings. Probe installation shall be per manufacturer's instructions.
5. Signal/Output:
 - a. 4 to 20 milliamperes into 0 to 600 ohms with Hart.
6. Power:
 - a. The system shall operate from 120 Vac, 60 Hertz power.
 - b. Variations of $\pm 10\%$ in voltage or frequency shall not affect the accuracy in excess of 0.5%.
7. Accessories:
 - a. Manufacturer (PTOF Type): Siemens SITRANS LT500 Transmitter with SITRANS LR100 Radar Elements, or engineer-approved equal.

2.03 STOP LOGS AND GUIDES

A. Materials

1. General: Stop logs shall be comprised of engineered composite FRP completely encapsulating an internal reinforcing structure.
 - a. Molded to create a seamless corrosion barrier impervious to moisture.
 - b. Reinforce with carbon steel as needed.
 - c. Internal core foam: 6 lb polyisocyanurate closed cell rigid foam
2. Guide Frames:
 - a. Materials: FRP
3. Handles and Gate Hardware:
 - a. Materials: 316 stainless steel
4. Seals
 - a. Side seals shall be hollow bulb J-seal molded of extruded EPDM
 - b. Bottom seals shall be flush bottom seal of extruded EPDM
5. J-Seal Clamping Bar and Fasteners
 - a. Materials: 316 stainless steel
6. Anchor bolts
 - a. Materials: 316 stainless steel

B. Design criteria

1. Deflection across the logs shall be limited to length/360 or ¼", whichever is less, at the maximum operating head.
2. Logs shall be designed to withstand head pressure from a gravity sewer system with an expected maximum head differential of 42".
3. All logs shall be flat and level. Warpage throughout the entire log shall not produce a crown of more than 1/16" in any direction.
4. Guides shall have a slot suitable for mating with the log body.
5. Each log shall be sealed on the sides and bottom with extruded EPMD material.

C. Manufacturers:

1. National Oilwell Varco (NOV)
2. Or approved equal

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide installation, testing, calibration, verification, and startup instructions in accordance with Section 17010 and the manufacturer's instructions. Coordinate the installation with all trades to ensure the mechanical system is proper for the instrument.
- B. Startup Assistance and commissioning shall be provided by a factory certified representative.
- C. Where instruments are located outdoors provide surge protectors at the transmitters. Provide isolators, relays, conditions, or other devices as required for a functional system.
- D. Instruments without approved submittals shall not be installed.

- E. Top-Mounted Non-Contact Instruments:
 - 1. Level instruments which rely upon ultrasonic, radar, or laser type sensing shall be mounted such that the emitted beam can measure the full range of the medium without interference or obstruction.
- F. Where instrument cables exit the open end of a conduit into a tank or wet well, provide a removable bushing around the cable at the conduit opening. The bushing shall support the cable to prevent chafing and seal the opening to reduce moisture accumulation in the conduit. Bushings shall be Emerson/OZ Gedney Type CSBI or equal.
- G. The Contract Drawings and Specifications are intended show basic functional requirements. Insufficient detail does not relieve the Contractor from the responsibility to provide a complete and functioning system.
- H. The Parshall flume manufacturer shall be present for the flume installation and shall provide written verification to the Engineer that the flume was installed per the manufacturer's specifications.

3.02 FIELD TESTING

- A. The installation shall be examined to verify the instrument will work properly when installed and the Project Engineer promptly notified if it does not meet manufacturer recommendations or the Specifications.
- B. Verify factory calibration of instruments in accordance with the manufacturer's instructions.
- C. All instrumentation calibration and configuration shall be completed prior to the start of field testing.
- D. Totalizer tests are not to be performed in the field.

END OF SECTION

SECTION 17170

POSITION AND MOTION MEASUREMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Requirements of Division 1 and Section 17010 form a part of this Section. This Section specifies position and motion measurement devices, auxiliary equipment and supplies directly related to the installation of and operation of these position and motion measurement devices, to perform the required functions in conjunction with information and equipment specified in other sections of Division 17.

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop drawings to be submitted in this Section shall be made in one package under Product Review category of shop drawings.
 - 2. In addition to the requirements of Section 17010, shop drawings shall include for each type of instrument: physical dimensions, supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.
 - 3. All shop drawings, catalog pages, and cut sheets shall be clearly marked with the unique tag for the instrument(s) to which they apply.
 - 4. Shop drawings shall include a completed ISA S20 form for each device.
 - 5. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.
- B. Manuals:
 - 1. Submit manuals in accordance with the requirements of Section 17010.
 - 2. ISA S20 forms: Include a completed final S20 form for each device with the manuals. S20 forms shall be updated to include final values or notes from testing, startup, and commissioning.
 - 3. Parts List: Include a parts list showing current net prices and a list of recommended spares with the manuals.

1.03 QUALITY ASSURANCE

- A. Manufacturer: In addition to the requirements of Section 17010, position and motion measurement devices furnished shall be provided from manufacturers regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.
- B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover or through use of an external handheld device.
- C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the

same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Instrument List.

PART 2 - PRODUCTS

2.01 INTRUSION SWITCHES – LIMIT TYPE

- A. Limit switches used for intrusion detection shall be heavy duty snap action type, with the following features:
 - 1. Metal body
 - 2. -20°F to 185°F temperature operating range
 - 3. Single-pole, double-throw
 - 4. Spring return
 - 5. 600V class contacts
 - 6. NEMA enclosure rated for the environment in which the switch is installed.
 - a. Intrusion Switches shall be rated for a Classified environment, Class I, Division I,
 - 7. 1/2-inch NPT conduit entry
 - 8. Provide lever arm where required.
- B. Manufacturer: Eaton 10316 series, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation, testing, calibration, validation, startup, and instruction shall be in accordance with Section 17010.
- B. Provide brackets as needed, and adjust location of intrusion switches in the field for proper operation with the hatch, door, or cover with which they are used.

END OF SECTION

SECTION 17330

PROCESS CONTROL STRATEGY- FLOW MEASUREMENT

PART 1 - GENERAL

1.01 AREA

- A. South end of Project adjacent to Tennyson Street at the subgrade meter vault and above grade electrical cabinet. Station approximately 01+56.

1.02 RELATED EQUIPMENT:

- A. Level Rader Element, LE-001A (Ha)
B. Level Rader Element, LE-001B (Hb)
C. Level Transmitter, LIT-001

1.03 SUMMARY

- A. General
1. Water level measurements shall be taken at points LE-001A and LE-001B as indicated on the drawings. These measurements shall be used to determine flow rate through the flume.
- B. Control Strategy Narrative
1. If $H_b / H_a < 70\%$ then the formula F.1 shall be used to determine the flow rate.

$$Q_{free} = K * H_a^n \quad \text{F.1}$$

Q	discharge	Variable to solve for	
H _a	depth at primary point of measurement (ft)	Input from transmitter	
H _b	depth at secondary point of measurement (ft)	Input from transmitter	
S	Submergence ratio	(H _b /H _a)	
K	Flume discharge constant	Constant	8
n	Free-flow exponent	Constant	1.55

2. If $H_b / H_a > 70\%$ then the free flow equation shall be corrected using equation F.2 and Peck's Equation F.3. where Q is the flow rate in cfs, and H_a is measured in feet.

$$Q_{net} = Q_{free} - Q_{correction} \quad \text{F.2}$$

$$Q_{correction} = M(0.000132 * h_a^{2.123} e^{9.284S}) \quad \text{F.3}$$

M	Multiplying Factor	Constant	1.8
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3. The flow rate shall be transmitted to the data logger. The data logger shall communicate with the radio system and be transmitted to Metro's SCADA interface.

END OF SECTION



ANALYTICAL REPORT

PREPARED FOR

Attn: Erica Wirski
Kennedy/Jenks Consultants
143 Union Blvd
Lakewood, Colorado 80228

Generated 8/10/2023 11:44:01 AM

JOB DESCRIPTION

Arvada NTS Metro Water Quality Analysis

JOB NUMBER

280-178681-1

Eurofins Denver

Job Notes

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Definitions/Glossary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Qualifiers

GC/MS Semi VOA

Qualifier	Qualifier Description
D	Sample results are obtained from a dilution; the surrogate or matrix spike recoveries reported are calculated from diluted samples.
S1+	Surrogate recovery exceeds control limits, high biased.

HPLC/IC

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time. This does not meet regulatory requirements.

LCMS

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
*-	LCS and/or LCSD is outside acceptance limits, low biased.
*1	LCS/LCSD RPD exceeds control limits.
b	Result Detected in the Unseeded Control blank (USB).
F1	MS and/or MSD recovery exceeds control limits.
F5	Duplicate RPD exceeds limit, and one or both sample results are less than 5 times RL, and the absolute difference between results is < the upper reporting limits for both.
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Rad

Qualifier	Qualifier Description
G	The Sample MDC is greater than the requested RL.
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
α	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive

Eurofins Denver

Definitions/Glossary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Glossary (Continued)

Abbreviation	These commonly used abbreviations may or may not be present in this report.
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Job ID: 280-178681-1

Laboratory: Eurofins Denver

Narrative

CASE NARRATIVE

Client: Kennedy/Jenks Consultants

Project: Arvada NTS Metro Water Quality Analysis

Report Number: 280-178681-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date.

RECEIPT

The samples were received on 7/6/2023 11:21 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperatures of the 2 coolers at receipt time were 1.3°C and 14.7°C.

RECEIPT EXCEPTIONS

There are multiple sample IDs and sample collection times listed on the Chain of Custody (COC). Per client instruction, all of the containers except for the field rinse blanks were logged as one sample using the sample ID "S-1" with the latest sample collection time listed on the COC.

The containers for the field rinse blank (FRB) were logged as the following sample using the latest time listed on the containers: FRB (280-178681-2).

The container label for the following sample did not match the information listed on the Chain-of-Custody (COC): S-1 (280-178681-1). The container labels list 10:52, while the COC lists 10:55.

The container label for the following sample did not match the information listed on the Chain-of-Custody (COC): S-1 (280-178681-1). The container labels list S-2.5 and S-2.6, while the COC lists S-1.

ORGANIC PREP

Method 8270E: The following sample was pale yellow and exhibited mild turbidity: S-1 (280-178681-1).

Method 8270E: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-619045.

Method 1633_B24: In preparation batch 280-619039, the following sample was diluted due to the nature of the sample matrix: S-1 (280-178681-1) (10x dilution). Elevated reporting limits (RLs) are provided. Because the sample was extracted as a dilution, the original sample container could not be rinsed.

Method D7065_11: In preparation batch 280-619212, the following sample was pale yellow in color: S-1 (280-178681-1).

Case Narrative

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Job ID: 280-178681-1 (Continued)

Laboratory: Eurofins Denver (Continued)

Method D7065_11: In preparation batch 280-619212, the following sample exhibited moderate turbidity: S-1 (280-178681-1).

Method D7065_11: In preparation batch 280-619212, the following sample formed emulsions during the extraction procedure: S-1 (280-178681-1). The emulsions were broken up using the pour back method for the second extraction only.

Method 1633_B24: In preparation batch 280-619208, the following sample was diluted due to the nature of the sample matrix: FRB (280-178681-2) (2x dilution). Elevated reporting limits (RLs) are provided. Because the sample was extracted at a dilution, the original sample container could not be rinsed.

Method 8081B: The following sample was brown in color, exhibited high turbidity, and contained brown sediment: S-1 (280-178681-1).

Method 8081B: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-619392.

Method 1633_B24: In preparation batch 280-619711, the following sample was diluted due to the nature of the sample matrix: FRB (280-178681-2) (4x). Elevated reporting limits (RLs) are provided. Because the sample was extracted at a dilution, the original sample container could not be rinsed.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

SEMIVOLATILE ORGANIC COMPOUND (GC/MS)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

NONYLPHENOLS

4-nonylphenol monoethoxylate (Surr) failed the surrogate recovery criteria high for S-1 (280-178681-1). Refer to the QC report for details.

Sample S-1 (280-178681-1)[5X] required dilution prior to analysis. The reporting limits have been adjusted accordingly.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ORGANOCHLORINE PESTICIDES (GC)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

FORMALDEHYDE

The following sample was received with less than 2 days remaining on the holding time or less than one shift (8 hours) remaining on a test with a holding time of 48 hours or less. As such, the laboratory had insufficient time remaining to perform the analysis within holding time: S-1 (280-178681-1).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

PERFLUORINATED HYDROCARBONS (PFAS)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL METALS (ICPMS)

The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 280-618940 and analytical batch 280-619314 were outside control limits for one or more analytes. See QC Sample Results for detail. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery is within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL DISSOLVED SOLIDS

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL SUSPENDED SOLIDS

The laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) for analytical batch 280-619138 recovered outside

Case Narrative

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Job ID: 280-178681-1 (Continued)

Laboratory: Eurofins Denver (Continued)

control limits for the following analytes: Total Suspended Solids. These analytes were biased low in the LCS and LCSD and were not detected in the associated samples as confirmed by reanalysis; therefore, the data have been reported.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ANIONS (28 DAYS)

Sample S-1 (280-178681-1)[10X] required dilution prior to analysis. The reporting limits have been adjusted accordingly.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

AMMONIA

The continuing calibration verification low (CCVL) associated with batch 280-619790 recovered above the upper control limit for ammonia. The samples associated with this CCVL were non-detects for the affected analytes; therefore, the data have been reported. The associated sample is impacted: (CCVL 280-619790/85).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL KJELDAHL NITROGEN

The matrix spike and matrix spike duplicate (MS/MSD) recoveries for preparation batch 280-621028 and analytical batch 280-621184 were outside control limits for one or more analytes. See QC Sample Results for detail. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery is within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

NITRATE-NITRITE AS NITROGEN

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL PHOSPHORUS

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

CHEMICAL OXYGEN DEMAND

Chemical Oxygen Demand was detected in method blank MB 280-621436/5 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged. Refer to the QC report for details.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

CORROSIVITY (PH)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL NITROGEN

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

BIOCHEMICAL OXYGEN DEMAND

Biochemical Oxygen Demand was detected in method blank SCB 280-618771/1 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged. Refer to the QC report for details.

Biochemical Oxygen Demand exceeded the RPD limit for the duplicate of sample S-1DU (280-178681-1). Refer to the QC report for details.

The sample duplicate (DUP) precision for analytical batch 280-618771 was outside control limits. Sample matrix interference is suspected.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Case Narrative

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Job ID: 280-178681-1 (Continued)

Laboratory: Eurofins Denver (Continued)

ISOTOPIC URANIUM (ALPHA SPECTROMETRY)

The following sample was prepared at a reduced aliquot due to matrix interference: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

RADIUM-226 (GFPC)

The following sample was prepared at a reduced aliquot due to the matrix: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

RADIUM-228 (GFPC)

The following sample was prepared at a reduced aliquot due to the matrix: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ISOTOPIC THORIUM (ALPHA SPECTROMETRY)

The following sample was prepared at a reduced aliquot due to discoloration and heavy sediment levels: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Client Sample ID: S-1

Lab Sample ID: 280-178681-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanoic acid (PFHxA)	15	J	40	9.9	ng/L	1		Draft 1633	Total/NA
Perfluorooctanoic acid (PFOA)	24	J	40	13	ng/L	1		Draft 1633	Total/NA
Perfluorobutanesulfonic acid (PFBS)	14	J	40	6.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	11	J	40	11	ng/L	1		Draft 1633	Total/NA
Perfluorooctanesulfonic acid (PFOS)	120		40	9.9	ng/L	1		Draft 1633	Total/NA
Manganese	4300		3.0	0.51	ug/L	1		200.8	Total/NA
Chloride	270		30	10	mg/L	10		300.0	Total/NA
Sulfate	59		5.0	1.0	mg/L	1		300.0	Total/NA
Ammonia	0.13		0.10	0.029	mg/L	1		350.1	Total/NA
Nitrate Nitrite as N	4.3		0.10	0.044	mg/L	1		353.2	Total/NA
Phosphorus, Total	0.65		0.050	0.025	mg/L	1		365.1	Total/NA
pH adj. to 25 deg C	7.3	HF	0.1	0.1	SU	1		9040C	Total/NA
Temperature	21.2	HF	1.0	1.0	Degrees C	1		9040C	Total/NA
Total Inorganic Nitrogen	4.4		0.10	0.019	mg/L	1		Inorganic N	Total/NA
Total Dissolved Solids (TDS)	700		10	4.7	mg/L	1		SM 2540C	Total/NA
Total Suspended Solids	500	*- *1	40	11	mg/L	1		SM 2540D	Total/NA
Biochemical Oxygen Demand	7.1	b	5.0	0.59	mg/L	1		SM5210B	Total/NA

Client Sample ID: FRB

Lab Sample ID: 280-178681-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	9.0	J	16	4.0	ng/L	1		Draft 1633	Total/NA
Perfluoropentanoic acid (PFPeA)	10		8.0	2.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanoic acid (PFHxA)	11		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluoroheptanoic acid (PFHpA)	7.9		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorooctanoic acid (PFOA)	17		4.0	1.3	ng/L	1		Draft 1633	Total/NA
Perfluorononanoic acid (PFNA)	6.5		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorodecanoic acid (PFDA)	7.1		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorobutanesulfonic acid (PFBS)	14		4.0	0.60	ng/L	1		Draft 1633	Total/NA
6:2 FTS	20		16	5.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	6.3	J	8.0	2.3	ng/L	1		Draft 1633	Total/NA
- RE									
Perfluorooctanesulfonic acid (PFOS) - RE	130		8.0	2.0	ng/L	1		Draft 1633	Total/NA

This Detection Summary does not include radiochemical test results.

Eurofins Denver

Method Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method	Method Description	Protocol	Laboratory
8270E	Semivolatile Organic Compounds (GC/MS)	SW846	EET DEN
D7065-11	Determination of Nonylphenols	ASTM	EET DEN
8081B	Organochlorine Pesticides (GC)	SW846	EET DEN
8315A	Carbonyl Compounds by HPLC	SW846	ELLE
Draft 1633	Per- and Polyfluoroalkyl Substances by LC/MS/MS	EPA	EET DEN
200.8	Metals (ICP/MS)	EPA	EET DEN
300.0	Anions, Ion Chromatography	EPA	EET DEN
350.1	Nitrogen, Ammonia	EPA	EET DEN
351.2	Nitrogen, Total Kjeldahl	EPA	EET DEN
353.2	Nitrogen, Nitrate-Nitrite	EPA	EET DEN
365.1	Phosphorus, Total	EPA	EET DEN
410.4	COD	EPA	EET DEN
9040C	pH	SW846	EET DEN
Inorganic N	Nitrogen, Total Inorganic	EPA	EET DEN
SM 2540C	Solids, Total Dissolved (TDS)	SM	EET DEN
SM 2540D	Solids, Total Suspended (TSS)	SM	EET DEN
SM5210B	BOD, 5 Day	SM	EET DEN
903.0	Radium-226 (GFPC)	EPA	EET SL
904.0	Radium-228 (GFPC)	EPA	EET SL
A-01-R	Isotopic Thorium (Alpha Spectrometry)	DOE	EET SL
A-01-R	Isotopic Uranium (Alpha Spectrometry)	DOE	EET SL
1633	Solid-Phase Extraction (SPE)	EPA	EET DEN
200.8	Preparation, Total Metals	EPA	EET DEN
351.2	Nitrogen, Total Kjeldahl	EPA	EET DEN
3510C	Liquid-Liquid Extraction (Separatory Funnel)	SW846	EET DEN
365.2/365.3/365	Phosphorus, Total	EPA	EET DEN
8315A Prep	Solid Phase Extraction (SPE)	SW846	ELLE
D7065-11	Liquid-Liquid Extraction (Continuous)	ASTM	EET DEN
ExtChrom	Preparation, Extraction Chromatography Resin Actinide Separation	None	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

Protocol References:

ASTM = ASTM International
DOE = U.S. Department of Energy
EPA = US Environmental Protection Agency
None = None
SM = "Standard Methods For The Examination Of Water And Wastewater"
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

EET DEN = Eurofins Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100
EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566
ELLE = Eurofins Lancaster Laboratories Environment Testing, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Eurofins Denver

Sample Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
280-178681-1	S-1	Water	07/06/23 10:55	07/06/23 11:21
280-178681-2	FRB	Water	07/06/23 09:44	07/06/23 11:21

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17

Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: SW846 8270E - Semivolatile Organic Compounds (GC/MS)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Butyl benzyl phthalate	ND		3.8	1.5	ug/L		07/11/23 09:25	07/12/23 12:56	1

Method: ASTM D7065-11 - Determination of Nonylphenols

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nonylphenol	ND		26000	5900	ng/L		07/12/23 10:53	07/13/23 14:47	5
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
4-nonylphenol (Surr)	61	D	58 - 115				07/12/23 10:53	07/13/23 14:47	5
4-nonylphenol monoethoxylate (Surr)	175	S1+ D	54 - 139				07/12/23 10:53	07/13/23 14:47	5

Method: SW846 8081B - Organochlorine Pesticides (GC)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
beta-BHC	ND		0.051	0.0093	ug/L		07/13/23 12:16	07/17/23 21:03	1
delta-BHC	ND		0.051	0.0080	ug/L		07/13/23 12:16	07/17/23 21:03	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
DCB Decachlorobiphenyl (Surr)	17		10 - 157				07/13/23 12:16	07/17/23 21:03	1
Tetrachloro-m-xylene (Surr)	88		12 - 129				07/13/23 12:16	07/17/23 21:03	1

Method: SW846 8315A - Carbonyl Compounds by HPLC

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Formaldehyde	ND	H	120	54	ug/L		07/10/23 17:06	07/11/23 10:21	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Butyraldehyde	101		60 - 130				07/10/23 17:06	07/11/23 10:21	1

Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoropentanoic acid (PFPeA)	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorohexanoic acid (PFHxA)	15	J	40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroheptanoic acid (PFHpA)	ND		40	10	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorooctanoic acid (PFOA)	24	J	40	13	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorononanoic acid (PFNA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorodecanoic acid (PFDA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroundecanoic acid (PFUnA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1

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Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorododecanoic acid (PFDoA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorotridecanoic acid (PFTrIA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorotetradecanoic acid (PFTeDA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorobutanesulfonic acid (PFBS)	14	J	40	6.0	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoropentanesulfonic acid (PFPeS)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorohexanesulfonic acid (PFHxS)	11	J	40	11	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		40	7.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorooctanesulfonic acid (PFOS)	120		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorononanesulfonic acid (PFNS)	ND		40	7.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorodecanesulfonic acid (PFDS)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorododecanesulfonic acid (PFDoS)	ND		40	18	ng/L		07/11/23 10:52	07/12/23 16:12	1
4:2 FTS	ND		160	34	ng/L		07/11/23 10:52	07/12/23 16:12	1
6:2 FTS	ND		160	50	ng/L		07/11/23 10:52	07/12/23 16:12	1
8:2 FTS	ND		160	52	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorooctanesulfonamide (PFOSA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSA	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSA	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSAA	ND		79	24	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSAA	ND		40	14	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSE	ND		400	99	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSE	ND		400	99	ng/L		07/11/23 10:52	07/12/23 16:12	1
HFPO-DA (GenX)	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		160	30	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFMBA	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
NFDHA	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFMPA	ND		79	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
9CI-PF3ONS	ND		160	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
11CI-PF3OUdS	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFEESA	ND		79	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
3:3 FTCA	ND		200	30	ng/L		07/11/23 10:52	07/12/23 16:12	1
5:3 FTCA	ND		990	200	ng/L		07/11/23 10:52	07/12/23 16:12	1
7:3 FTCA	ND		990	200	ng/L		07/11/23 10:52	07/12/23 16:12	1
Isotope Dilution	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
13C4 PFBA	72		10 - 130				07/11/23 10:52	07/12/23 16:12	1
13C5 PFPeA	71		35 - 150				07/11/23 10:52	07/12/23 16:12	1
13C5 PFHxA	71		55 - 150				07/11/23 10:52	07/12/23 16:12	1
13C4 PFHpA	68		55 - 150				07/11/23 10:52	07/12/23 16:12	1
13C8 PFOA	70		60 - 140				07/11/23 10:52	07/12/23 16:12	1
13C9 PFNA	66		55 - 140				07/11/23 10:52	07/12/23 16:12	1
13C6 PFDA	67		50 - 140				07/11/23 10:52	07/12/23 16:12	1
13C7 PFUnA	66		30 - 140				07/11/23 10:52	07/12/23 16:12	1
13C2 PFDoA	58		10 - 150				07/11/23 10:52	07/12/23 16:12	1
13C2 PFTeDA	34		10 - 130				07/11/23 10:52	07/12/23 16:12	1
13C3 PFBS	66		55 - 150				07/11/23 10:52	07/12/23 16:12	1

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Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 PFHxS	58		55 - 150	07/11/23 10:52	07/12/23 16:12	1
13C8 PFOS	63		45 - 140	07/11/23 10:52	07/12/23 16:12	1
13C8 FOSA	86		30 - 130	07/11/23 10:52	07/12/23 16:12	1
d3-NMeFOSAA	93		45 - 200	07/11/23 10:52	07/12/23 16:12	1
d5-NEtFOSAA	83		10 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-4:2 FTS	85		60 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-6:2 FTS	91		60 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-8:2 FTS	120		50 - 200	07/11/23 10:52	07/12/23 16:12	1
13C3 HFPO-DA	71		25 - 160	07/11/23 10:52	07/12/23 16:12	1
d7-N-MeFOSE-M	57		10 - 150	07/11/23 10:52	07/12/23 16:12	1
d9-N-EtFOSE-M	48		10 - 150	07/11/23 10:52	07/12/23 16:12	1
d5-NEtPFOSA	41		10 - 130	07/11/23 10:52	07/12/23 16:12	1
d3-NMePFOSA	45		15 - 130	07/11/23 10:52	07/12/23 16:12	1

Client Sample ID: FRB
Date Collected: 07/06/23 09:44
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	9.0	J	16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoropentanoic acid (PFPeA)	10		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorohexanoic acid (PFHxA)	11		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoroheptanoic acid (PFHpA)	7.9		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorooctanoic acid (PFOA)	17		4.0	1.3	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorononanoic acid (PFNA)	6.5		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorodecanoic acid (PFDA)	7.1		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoroundecanoic acid (PFUnA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorododecanoic acid (PFDoA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorotridecanoic acid (PFTriA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorotetradecanoic acid (PFTeDA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorobutanesulfonic acid (PFBS)	14		4.0	0.60	ng/L		07/12/23 11:15	07/13/23 18:07	1
4:2 FTS	ND		16	3.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
6:2 FTS	20		16	5.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
8:2 FTS	ND		16	5.2	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorooctanesulfonamide (PFOSA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSAA	ND		8.0	2.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSAA	ND		4.0	1.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSE	ND		40	10	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSE	ND		40	10	ng/L		07/12/23 11:15	07/13/23 18:07	1
HFPO-DA (GenX)	ND		16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		16	3.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFMBA	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NFDHA	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFMPA	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
9CI-PF3ONS	ND		16	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
11CI-PF3OUdS	ND		16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFEESA	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1

Eurofins Denver

Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Client Sample ID: FRB
Date Collected: 07/06/23 09:44
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
3:3 FTCA	ND		20	3.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
5:3 FTCA	ND		100	20	ng/L		07/12/23 11:15	07/13/23 18:07	1
7:3 FTCA	ND		100	20	ng/L		07/12/23 11:15	07/13/23 18:07	1
Isotope Dilution	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
13C4 PFBA	68		10 - 130				07/12/23 11:15	07/13/23 18:07	1
13C5 PFPeA	70		35 - 150				07/12/23 11:15	07/13/23 18:07	1
13C5 PFHxA	70		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C4 PFHpA	71		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C8 PFOA	66		60 - 140				07/12/23 11:15	07/13/23 18:07	1
13C9 PFNA	71		55 - 140				07/12/23 11:15	07/13/23 18:07	1
13C6 PFDA	64		50 - 140				07/12/23 11:15	07/13/23 18:07	1
13C7 PFUnA	50		30 - 140				07/12/23 11:15	07/13/23 18:07	1
13C2 PFDoA	37		10 - 150				07/12/23 11:15	07/13/23 18:07	1
13C2 PFTeDA	21		10 - 130				07/12/23 11:15	07/13/23 18:07	1
13C3 PFBS	65		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C8 FOSA	57		30 - 130				07/12/23 11:15	07/13/23 18:07	1
d3-NMeFOSAA	66		45 - 200				07/12/23 11:15	07/13/23 18:07	1
d5-NEtFOSAA	58		10 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-4:2 FTS	131		60 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-6:2 FTS	98		60 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-8:2 FTS	70		50 - 200				07/12/23 11:15	07/13/23 18:07	1
13C3 HFPO-DA	72		25 - 160				07/12/23 11:15	07/13/23 18:07	1
d7-N-MeFOSE-M	28		10 - 150				07/12/23 11:15	07/13/23 18:07	1
d9-N-EtFOSE-M	19		10 - 150				07/12/23 11:15	07/13/23 18:07	1
d5-NEtPFOSA	29		10 - 130				07/12/23 11:15	07/13/23 18:07	1
d3-NMePFOSA	35		15 - 130				07/12/23 11:15	07/13/23 18:07	1

Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS - RE

Client Sample ID: FRB
Date Collected: 07/06/23 09:44
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanesulfonic acid (PFPeS)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorohexanesulfonic acid (PFHxS)	6.3	J	8.0	2.3	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		8.0	1.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorooctanesulfonic acid (PFOS)	130		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorononanesulfonic acid (PFNS)	ND		8.0	1.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorodecanesulfonic acid (PFDS)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorododecanesulfonic acid (PFDoS)	ND		8.0	3.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
Isotope Dilution	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
13C3 PFHxS	67		55 - 150				07/17/23 11:33	07/18/23 18:21	1
13C8 PFOS	66		45 - 140				07/17/23 11:33	07/18/23 18:21	1

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Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: EPA 200.8 - Metals (ICP/MS)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Manganese	4300		3.0	0.51	ug/L		07/11/23 09:04	07/12/23 03:34	1

General Chemistry

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride (EPA 300.0)	270		30	10	mg/L			07/28/23 04:03	10
Sulfate (EPA 300.0)	59		5.0	1.0	mg/L			07/28/23 03:46	1
Ammonia (EPA 350.1)	0.13		0.10	0.029	mg/L			07/13/23 15:52	1
Nitrogen, Kjeldahl (EPA 351.2)	ND	F1	1.0	0.69	mg/L		07/27/23 15:27	07/28/23 15:10	1
Nitrate Nitrite as N (EPA 353.2)	4.3		0.10	0.044	mg/L			07/11/23 11:50	1
Phosphorus, Total (EPA 365.1)	0.65		0.050	0.025	mg/L		07/07/23 10:34	07/07/23 15:21	1
Chemical Oxygen Demand (EPA 410.4)	ND		20	8.7	mg/L			08/01/23 11:15	1
pH adj. to 25 deg C (SW846 9040C)	7.3	HF	0.1	0.1	SU			07/13/23 14:56	1
Temperature (SW846 9040C)	21.2	HF	1.0	1.0	Degrees C			07/13/23 14:56	1
Total Inorganic Nitrogen (EPA Inorganic N)	4.4		0.10	0.019	mg/L			07/20/23 12:08	1
Total Dissolved Solids (TDS) (SM 2540C)	700		10	4.7	mg/L			07/11/23 11:19	1
Total Suspended Solids (SM 2540D)	500	*- *1	40	11	mg/L			07/11/23 14:50	1
Biochemical Oxygen Demand (SM5210B)	7.1	b	5.0	0.59	mg/L			07/07/23 11:16	1

Method: EPA 903.0 - Radium-226 (GFPC)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	4.79		0.993	1.08	1.00	0.763	pCi/L	07/13/23 09:29	08/04/23 09:40	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	62.3		30 - 110					07/13/23 09:29	08/04/23 09:40	1

Method: EPA 904.0 - Radium-228 (GFPC)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	8.65	G	2.83	2.94	1.00	3.34	pCi/L	07/13/23 09:38	07/28/23 12:44	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	62.3		30 - 110					07/13/23 09:38	07/28/23 12:44	1
Y Carrier	82.2		30 - 110					07/13/23 09:38	07/28/23 12:44	1

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Client Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: DOE A-01-R - Isotopic Thorium (Alpha Spectrometry)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	6.03	G	2.60	2.65	1.00	2.32	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-230	3.13	G	1.90	1.92	1.00	1.83	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-232	3.74	G	1.90	1.92	1.00	1.10	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	80.7		30 - 110					07/11/23 12:12	07/18/23 13:12	1

Method: DOE A-01-R - Isotopic Uranium (Alpha Spectrometry)

Client Sample ID: S-1
Date Collected: 07/06/23 10:55
Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1
Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	3.60	G	1.97	2.00	1.00	1.74	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-235/236	0.914		1.06	1.06	1.00	0.914	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-238	4.60	G	2.13	2.17	1.00	1.11	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	78.6		30 - 110					07/11/23 12:22	07/18/23 13:17	1

Surrogate Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: D7065-11 - Determination of Nonylphenols

Matrix: Water

Prep Type: Total/NA

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	4NPH (58-115)	4NPME (54-139)
280-178681-1	S-1	61 D	175 S1+ D
LCS 280-619212/2-A	Lab Control Sample	86	115
MB 280-619212/1-A	Method Blank	65	70

Surrogate Legend

4NPH = 4-nonylphenol (Surr)

4NPME = 4-nonylphenol monoethoxylate (Surr)

Method: 8081B - Organochlorine Pesticides (GC)

Matrix: Water

Prep Type: Total/NA

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	DCBP1 (10-157)	TCX1 (12-129)
280-178681-1	S-1	17	88
LCS 280-619392/2-A	Lab Control Sample	75	73
LCSD 280-619392/3-A	Lab Control Sample Dup	67	65
MB 280-619392/1-A	Method Blank	68	81

Surrogate Legend

DCBP = DCB Decachlorobiphenyl (Surr)

TCX = Tetrachloro-m-xylene (Surr)

Method: 8315A - Carbonyl Compounds by HPLC

Matrix: Water

Prep Type: Total/NA

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	BTRA (60-130)
280-178681-1	S-1	101
LCS 410-395283/2-A	Lab Control Sample	105
LCSD 410-395283/3-A	Lab Control Sample Dup	105
MB 410-395283/1-A	Method Blank	103

Surrogate Legend

BTRA = Butyraldehyde

QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 8270E - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 280-619045/1-A

Matrix: Water

Analysis Batch: 619193

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619045

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Butyl benzyl phthalate	ND		4.0	1.5	ug/L		07/11/23 09:25	07/12/23 09:56	1

Lab Sample ID: LCS 280-619045/2-A

Matrix: Water

Analysis Batch: 619193

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619045

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Butyl benzyl phthalate	80.0	62.6		ug/L		78	49 - 141

Lab Sample ID: LCSD 280-619045/3-A

Matrix: Water

Analysis Batch: 619193

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 619045

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Butyl benzyl phthalate	80.0	73.8		ug/L		92	49 - 141	16	35

Method: D7065-11 - Determination of Nonylphenols

Lab Sample ID: MB 280-619212/1-A

Matrix: Water

Analysis Batch: 619388

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619212

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nonylphenol	ND		5000	1100	ng/L		07/12/23 10:53	07/13/23 10:38	1

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
4-nonylphenol (Surr)	65		58 - 115	07/12/23 10:53	07/13/23 10:38	1
4-nonylphenol monoethoxylate (Surr)	70		54 - 139	07/12/23 10:53	07/13/23 10:38	1

Lab Sample ID: LCS 280-619212/2-A

Matrix: Water

Analysis Batch: 619388

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619212

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nonylphenol	51300	47800		ng/L		93	56 - 125

Surrogate	LCS %Recovery	LCS Qualifier	Limits
4-nonylphenol (Surr)	86		58 - 115
4-nonylphenol monoethoxylate (Surr)	115		54 - 139

Method: 8081B - Organochlorine Pesticides (GC)

Lab Sample ID: MB 280-619392/1-A

Matrix: Water

Analysis Batch: 619741

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619392

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
beta-BHC	ND		0.050	0.0091	ug/L		07/13/23 12:16	07/17/23 19:36	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 8081B - Organochlorine Pesticides (GC) (Continued)

Lab Sample ID: MB 280-619392/1-A

Matrix: Water

Analysis Batch: 619741

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619392

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
delta-BHC	ND		0.050	0.0078	ug/L		07/13/23 12:16	07/17/23 19:36	1
Surrogate	%Recovery	MB Qualifier	Limits				Prepared	Analyzed	Dil Fac
DCB Decachlorobiphenyl (Surr)	68		10 - 157				07/13/23 12:16	07/17/23 19:36	1
Tetrachloro-m-xylene (Surr)	81		12 - 129				07/13/23 12:16	07/17/23 19:36	1

Lab Sample ID: LCS 280-619392/2-A

Matrix: Water

Analysis Batch: 619741

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619392

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
beta-BHC	0.500	0.405		ug/L		81	58 - 120		
delta-BHC	0.500	0.449		ug/L		90	63 - 128		
Surrogate	%Recovery	LCS Qualifier	Limits						
DCB Decachlorobiphenyl (Surr)	75		10 - 157						
Tetrachloro-m-xylene (Surr)	73		12 - 129						

Lab Sample ID: LCSD 280-619392/3-A

Matrix: Water

Analysis Batch: 619741

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 619392

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	Limit
beta-BHC	0.500	0.361		ug/L		72	58 - 120	12	21
delta-BHC	0.500	0.406		ug/L		81	63 - 128	10	22
Surrogate	%Recovery	LCSD Qualifier	Limits						
DCB Decachlorobiphenyl (Surr)	67		10 - 157						
Tetrachloro-m-xylene (Surr)	65		12 - 129						

Method: 8315A - Carbonyl Compounds by HPLC

Lab Sample ID: MB 410-395283/1-A

Matrix: Water

Analysis Batch: 395541

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 395283

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Formaldehyde	ND		60	27	ug/L		07/10/23 17:06	07/11/23 09:48	1
Surrogate	%Recovery	MB Qualifier	Limits				Prepared	Analyzed	Dil Fac
Butyraldehyde	103		60 - 130				07/10/23 17:06	07/11/23 09:48	1

Lab Sample ID: LCS 410-395283/2-A

Matrix: Water

Analysis Batch: 395541

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 395283

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Formaldehyde	500	492		ug/L		98	77 - 122		

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 8315A - Carbonyl Compounds by HPLC (Continued)

		LCS	LCS		
Surrogate	%Recovery	Qualifier	Limits		
Butyraldehyde	105		60 - 130		

Lab Sample ID: LCSD 410-395283/3-A				Client Sample ID: Lab Control Sample Dup			
Matrix: Water				Prep Type: Total/NA			
Analysis Batch: 395541				Prep Batch: 395283			

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Formaldehyde	500	479		ug/L		96	77 - 122	3	30

		LCSD	LCSD		
Surrogate	%Recovery	Qualifier	Limits		
Butyraldehyde	105		60 - 130		

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Lab Sample ID: MB 280-619039/1-A				Client Sample ID: Method Blank			
Matrix: Water				Prep Type: Total/NA			
Analysis Batch: 619263				Prep Batch: 619039			

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/11/23 10:52	07/12/23 15:21	1
4:2 FTS	ND		8.0	1.7	ng/L		07/11/23 10:52	07/12/23 15:21	1
6:2 FTS	ND		8.0	2.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
8:2 FTS	ND		8.0	2.6	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSA	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSA	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSE	ND		20	5.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSE	ND		20	5.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: MB 280-619039/1-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619039

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFMBA	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
NFDHA	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFMPA	ND		4.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFEESA	ND		4.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
3:3 FTCA	ND		10	1.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
5:3 FTCA	ND		50	10	ng/L		07/11/23 10:52	07/12/23 15:21	1
7:3 FTCA	ND		50	10	ng/L		07/11/23 10:52	07/12/23 15:21	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	69		10 - 130	07/11/23 10:52	07/12/23 15:21	1
13C5 PFPeA	69		35 - 150	07/11/23 10:52	07/12/23 15:21	1
13C5 PFHxA	70		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C4 PFHpA	65		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C8 PFOA	65		60 - 140	07/11/23 10:52	07/12/23 15:21	1
13C9 PFNA	68		55 - 140	07/11/23 10:52	07/12/23 15:21	1
13C6 PFDA	67		50 - 140	07/11/23 10:52	07/12/23 15:21	1
13C7 PFUnA	69		30 - 140	07/11/23 10:52	07/12/23 15:21	1
13C2 PFDoA	67		10 - 150	07/11/23 10:52	07/12/23 15:21	1
13C2 PFTeDA	60		10 - 130	07/11/23 10:52	07/12/23 15:21	1
13C3 PFBS	66		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C3 PFHxS	63		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C8 PFOS	67		45 - 140	07/11/23 10:52	07/12/23 15:21	1
13C8 FOSA	73		30 - 130	07/11/23 10:52	07/12/23 15:21	1
d3-NMeFOSAA	79		45 - 200	07/11/23 10:52	07/12/23 15:21	1
d5-NEtFOSAA	81		10 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-4:2 FTS	76		60 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-6:2 FTS	84		60 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-8:2 FTS	94		50 - 200	07/11/23 10:52	07/12/23 15:21	1
13C3 HFPO-DA	66		25 - 160	07/11/23 10:52	07/12/23 15:21	1
d7-N-MeFOSE-M	64		10 - 150	07/11/23 10:52	07/12/23 15:21	1
d9-N-EtFOSE-M	59		10 - 150	07/11/23 10:52	07/12/23 15:21	1
d5-NEtPFOSA	53		10 - 130	07/11/23 10:52	07/12/23 15:21	1
d3-NMePFOSA	51		15 - 130	07/11/23 10:52	07/12/23 15:21	1

Lab Sample ID: LCS 280-619039/3-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	128	143		ng/L		112	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	69.5		ng/L		109	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	35.8		ng/L		112	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	35.2		ng/L		110	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	35.0		ng/L		109	52 - 161
Perfluorononanoic acid (PFNA)	32.0	35.7		ng/L		112	59 - 149

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619039/3-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorodecanoic acid (PFDA)	32.0	37.2		ng/L		116	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	33.6		ng/L		105	48 - 159
Perfluorododecanoic acid (PFDoA)	32.0	36.1		ng/L		113	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	33.3		ng/L		104	49 - 148
Perfluorotetradecanoic acid (PFTeDA)	32.0	37.8		ng/L		118	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	31.7		ng/L		112	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	35.4		ng/L		118	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	33.2		ng/L		114	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	36.3		ng/L		119	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	34.5		ng/L		116	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	38.6		ng/L		125	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	37.0		ng/L		120	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	32.4		ng/L		104	36 - 145
4:2 FTS	120	136		ng/L		114	67 - 146
6:2 FTS	121	135		ng/L		111	61 - 151
8:2 FTS	123	147		ng/L		120	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	34.6		ng/L		108	61 - 148
NMeFOSA	32.0	40.4		ng/L		126	63 - 145
NEtFOSA	32.0	37.2		ng/L		116	65 - 139
NMeFOSAA	32.0	34.3		ng/L		107	58 - 144
NEtFOSAA	32.0	33.7		ng/L		105	59 - 146
NMeFOSE	320	363		ng/L		113	71 - 136
NEtFOSE	320	361		ng/L		113	69 - 137
HFPO-DA (GenX)	128	138		ng/L		108	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	145		ng/L		120	68 - 146
PFMBA	64.0	74.9		ng/L		117	55 - 148
NFDHA	64.0	75.0		ng/L		117	48 - 161
PFMPA	64.0	71.6		ng/L		112	51 - 145
9Cl-PF3ONS	119	142		ng/L		119	56 - 156
11Cl-PF3OUdS	121	119		ng/L		99	46 - 156
PFEESA	57.0	60.4		ng/L		106	56 - 151
3:3 FTCA	160	186		ng/L		116	62 - 129
5:3 FTCA	800	941		ng/L		118	63 - 134
7:3 FTCA	800	885		ng/L		111	50 - 138

Isotope Dilution	%Recovery	LCS Qualifier	Limits
¹³ C4 PFBA	71		10 - 130
¹³ C5 PFPeA	70		40 - 150

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619039/3-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C5 PFHxA	69		40 - 150
13C4 PFHpA	69		40 - 150
13C8 PFOA	71		30 - 140
13C9 PFNA	71		30 - 140
13C6 PFDA	74		20 - 140
13C7 PFUnA	80		20 - 140
13C2 PFDoA	76		10 - 150
13C2 PFTeDA	68		10 - 130
13C3 PFBS	70		25 - 150
13C3 PFHxS	65		25 - 150
13C8 PFOS	69		20 - 140
13C8 FOSA	83		10 - 130
d3-NMeFOSAA	97		10 - 200
d5-NEtFOSAA	100		10 - 200
M2-4:2 FTS	74		25 - 200
M2-6:2 FTS	87		25 - 200
M2-8:2 FTS	104		25 - 200
13C3 HFPO-DA	72		25 - 160
d7-N-MeFOSE-M	70		10 - 150
d9-N-EtFOSE-M	66		10 - 150
d5-NEtPFOSA	54		10 - 130
d3-NMePFOSA	53		10 - 130

Lab Sample ID: LLCS 280-619039/2-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	12.8	14.6		ng/L		114	44 - 157
Perfluoropentanoic acid (PFPeA)	6.40	7.74		ng/L		121	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.90		ng/L		122	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.62		ng/L		113	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.60		ng/L		112	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.98		ng/L		124	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.64		ng/L		114	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.94		ng/L		123	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	4.00		ng/L		125	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.32		ng/L		104	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	3.92		ng/L		122	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	3.16		ng/L		111	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.41		ng/L		113	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.32		ng/L		114	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.61		ng/L		119	51 - 150

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619039/2-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorooctanesulfonic acid (PFOS)	2.98	3.45		ng/L		116	43 - 162
Perfluorononanesulfonic acid (PFNS)	3.08	3.80		ng/L		123	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.56		ng/L		115	50 - 144
Perfluorododecanesulfonic acid (PFDoS)	3.10	3.32		ng/L		107	30 - 138
4:2 FTS	12.0	14.4		ng/L		120	52 - 158
6:2 FTS	12.1	13.8		ng/L		113	48 - 158
8:2 FTS	12.3	13.6		ng/L		111	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.77		ng/L		118	47 - 163
NMeFOSA	3.20	4.04		ng/L		126	54 - 155
NEtFOSA	3.20	4.16		ng/L		130	49 - 156
NMeFOSAA	3.20	3.91	J	ng/L		122	32 - 160
NEtFOSAA	3.20	4.09		ng/L		128	51 - 154
NMeFOSE	32.0	37.7		ng/L		118	56 - 151
NEtFOSE	32.0	40.2		ng/L		126	60 - 147
HFPO-DA (GenX)	12.8	15.2		ng/L		119	58 - 154
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	12.1	15.2		ng/L		126	61 - 148
PFMBA	6.40	7.53		ng/L		118	49 - 154
NFDHA	6.40	7.38		ng/L		115	47 - 160
PFMPA	6.40	7.34		ng/L		115	48 - 150
9Cl-PF3ONS	11.9	13.8		ng/L		115	44 - 167
11Cl-PF3OUdS	12.1	12.6		ng/L		105	36 - 158
PFEESA	5.70	6.57		ng/L		115	56 - 144
3:3 FTCA	16.0	19.4		ng/L		121	32 - 161
5:3 FTCA	80.0	95.4		ng/L		119	39 - 156
7:3 FTCA	80.0	94.6		ng/L		118	36 - 149

Isotope Dilution	LLCS %Recovery	LLCS Qualifier	Limits
13C4 PFBA	70		10 - 130
13C5 PFPeA	73		35 - 150
13C5 PFHxA	71		55 - 150
13C4 PFHpA	70		55 - 150
13C8 PFOA	68		60 - 140
13C9 PFNA	66		55 - 140
13C6 PFDA	70		50 - 140
13C7 PFUnA	66		30 - 140
13C2 PFDoA	62		10 - 150
13C2 PFTeDA	66		10 - 130
13C3 PFBS	72		55 - 150
13C3 PFHxS	68		55 - 150
13C8 PFOS	66		45 - 140
13C8 FOSA	68		30 - 130
d3-NMeFOSAA	70		45 - 200
d5-NEtFOSAA	69		10 - 200
M2-4:2 FTS	74		60 - 200

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619039/2-A

Matrix: Water

Analysis Batch: 619263

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619039

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
M2-6:2 FTS	77		60 - 200
M2-8:2 FTS	82		50 - 200
13C3 HFPO-DA	73		25 - 160
d7-N-MeFOSE-M	64		10 - 150
d9-N-EtFOSE-M	60		10 - 150
d5-NEtPFOSA	51		10 - 130
d3-NMePFOSA	50		15 - 130

Lab Sample ID: MB 280-619208/1-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619208

Analyte	MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/12/23 11:15	07/13/23 13:36	1
4:2 FTS	ND		8.0	1.7	ng/L		07/12/23 11:15	07/13/23 13:36	1
6:2 FTS	ND		8.0	2.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
8:2 FTS	ND		8.0	2.6	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSA	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSA	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSE	ND		20	5.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSE	ND		20	5.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
PFMBA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
NFDHA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: MB 280-619208/1-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619208

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PFMPA	ND		4.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
PFEESA	ND		4.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
3:3 FTCA	ND		10	1.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
5:3 FTCA	ND		50	10	ng/L		07/12/23 11:15	07/13/23 13:36	1
7:3 FTCA	ND		50	10	ng/L		07/12/23 11:15	07/13/23 13:36	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	79		10 - 130	07/12/23 11:15	07/13/23 13:36	1
13C5 PFPeA	79		35 - 150	07/12/23 11:15	07/13/23 13:36	1
13C5 PFHxA	78		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C4 PFHpA	74		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C8 PFOA	81		60 - 140	07/12/23 11:15	07/13/23 13:36	1
13C9 PFNA	80		55 - 140	07/12/23 11:15	07/13/23 13:36	1
13C6 PFDA	74		50 - 140	07/12/23 11:15	07/13/23 13:36	1
13C7 PFUnA	77		30 - 140	07/12/23 11:15	07/13/23 13:36	1
13C2 PFDoA	76		10 - 150	07/12/23 11:15	07/13/23 13:36	1
13C2 PFTeDA	80		10 - 130	07/12/23 11:15	07/13/23 13:36	1
13C3 PFBS	78		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C3 PFHxS	76		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C8 PFOS	79		45 - 140	07/12/23 11:15	07/13/23 13:36	1
13C8 FOSA	69		30 - 130	07/12/23 11:15	07/13/23 13:36	1
d3-NMeFOSAA	84		45 - 200	07/12/23 11:15	07/13/23 13:36	1
d5-NEtFOSAA	85		10 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-4:2 FTS	83		60 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-6:2 FTS	79		60 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-8:2 FTS	81		50 - 200	07/12/23 11:15	07/13/23 13:36	1
13C3 HFPO-DA	76		25 - 160	07/12/23 11:15	07/13/23 13:36	1
d7-N-MeFOSE-M	78		10 - 150	07/12/23 11:15	07/13/23 13:36	1
d9-N-EtFOSE-M	75		10 - 150	07/12/23 11:15	07/13/23 13:36	1
d5-NEtPFOSA	67		10 - 130	07/12/23 11:15	07/13/23 13:36	1
d3-NMePFOSA	61		15 - 130	07/12/23 11:15	07/13/23 13:36	1

Lab Sample ID: LCS 280-619208/3-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Perfluorobutanoic acid (PFBA)	128	144		ng/L		113	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	69.6		ng/L		109	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	35.2		ng/L		110	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	34.3		ng/L		107	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	34.5		ng/L		108	52 - 161
Perfluorononanoic acid (PFNA)	32.0	35.4		ng/L		111	59 - 149
Perfluorodecanoic acid (PFDA)	32.0	34.6		ng/L		108	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	34.8		ng/L		109	48 - 159

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619208/3-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorododecanoic acid (PFDoA)	32.0	34.1		ng/L		107	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	33.4		ng/L		104	49 - 148
Perfluorotetradecanoic acid (PFTeDA)	32.0	37.6		ng/L		118	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	29.7		ng/L		104	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	33.8		ng/L		113	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	33.6		ng/L		115	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	34.2		ng/L		112	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	31.3		ng/L		105	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	32.3		ng/L		105	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	31.6		ng/L		102	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	28.7		ng/L		92	36 - 145
4:2 FTS	120	140		ng/L		117	67 - 146
6:2 FTS	121	131		ng/L		108	61 - 151
8:2 FTS	123	142		ng/L		116	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	36.2		ng/L		113	61 - 148
NMeFOSA	32.0	35.6		ng/L		111	63 - 145
NEtFOSA	32.0	37.0		ng/L		116	65 - 139
NMeFOSAA	32.0	36.1		ng/L		113	58 - 144
NEtFOSAA	32.0	38.2		ng/L		119	59 - 146
NMeFOSE	320	365		ng/L		114	71 - 136
NEtFOSE	320	361		ng/L		113	69 - 137
HFPO-DA (GenX)	128	144		ng/L		112	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	149		ng/L		123	68 - 146
PFMBA	64.0	68.3		ng/L		107	55 - 148
NFDHA	64.0	70.5		ng/L		110	48 - 161
PFMPA	64.0	65.1		ng/L		102	51 - 145
9Cl-PF3ONS	119	138		ng/L		116	56 - 156
11Cl-PF3OUdS	121	130		ng/L		108	46 - 156
PFEESA	57.0	59.5		ng/L		104	56 - 151
3:3 FTCA	160	171		ng/L		107	62 - 129
5:3 FTCA	800	884		ng/L		110	63 - 134
7:3 FTCA	800	823		ng/L		103	50 - 138
		LCS	LCS				
Isotope Dilution	%Recovery	Qualifier	Limits				
13C4 PFBA	78		10 - 130				
13C5 PFPeA	81		40 - 150				
13C5 PFHxA	80		40 - 150				
13C4 PFHpA	81		40 - 150				
13C8 PFOA	75		30 - 140				

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619208/3-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C9 PFNA	76		30 - 140
13C6 PFDA	79		20 - 140
13C7 PFUnA	72		20 - 140
13C2 PFDoA	75		10 - 150
13C2 PFTeDA	78		10 - 130
13C3 PFBS	79		25 - 150
13C3 PFHxS	71		25 - 150
13C8 PFOS	82		20 - 140
13C8 FOSA	71		10 - 130
d3-NMeFOSAA	83		10 - 200
d5-NEtFOSAA	82		10 - 200
M2-4:2 FTS	78		25 - 200
M2-6:2 FTS	81		25 - 200
M2-8:2 FTS	74		25 - 200
13C3 HFPO-DA	75		25 - 160
d7-N-MeFOSE-M	75		10 - 150
d9-N-EtFOSE-M	73		10 - 150
d5-NEtPFOSA	57		10 - 130
d3-NMePFOSA	57		10 - 130

Lab Sample ID: LLCS 280-619208/2-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	12.8	14.2		ng/L		111	44 - 157
Perfluoropentanoic acid (PFPeA)	6.40	6.95		ng/L		109	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.58		ng/L		112	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.55		ng/L		111	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.81		ng/L		119	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.47		ng/L		109	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.42		ng/L		107	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.56		ng/L		111	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	3.36		ng/L		105	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.31		ng/L		103	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	3.56		ng/L		111	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	2.67		ng/L		94	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.38		ng/L		113	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.22		ng/L		110	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.42		ng/L		112	51 - 150
Perfluorooctanesulfonic acid (PFOS)	2.98	3.24		ng/L		109	43 - 162

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619208/2-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorononanesulfonic acid (PFNS)	3.08	3.38		ng/L		110	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.32		ng/L		108	50 - 144
Perfluorododecanesulfonic acid (PFDoS)	3.10	2.78		ng/L		89	30 - 138
4:2 FTS	12.0	13.0		ng/L		109	52 - 158
6:2 FTS	12.1	13.3		ng/L		110	48 - 158
8:2 FTS	12.3	15.2		ng/L		124	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.54		ng/L		111	47 - 163
NMeFOSA	3.20	4.07		ng/L		127	54 - 155
NEtFOSA	3.20	3.65		ng/L		114	49 - 156
NMeFOSAA	3.20	3.51	J	ng/L		110	32 - 160
NEtFOSAA	3.20	3.67		ng/L		115	51 - 154
NMeFOSE	32.0	36.0		ng/L		113	56 - 151
NEtFOSE	32.0	37.4		ng/L		117	60 - 147
HFPO-DA (GenX)	12.8	15.3		ng/L		119	58 - 154
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	12.1	14.5		ng/L		120	61 - 148
PFMBA	6.40	7.25		ng/L		113	49 - 154
NFDHA	6.40	6.59		ng/L		103	47 - 160
PFMPA	6.40	6.89		ng/L		108	48 - 150
9CI-PF3ONS	11.9	11.5		ng/L		96	44 - 167
11CI-PF3OUdS	12.1	12.3		ng/L		102	36 - 158
PFEESA	5.70	5.89		ng/L		103	56 - 144
3:3 FTCA	16.0	17.9		ng/L		112	32 - 161
5:3 FTCA	80.0	96.4		ng/L		121	39 - 156
7:3 FTCA	80.0	90.4		ng/L		113	36 - 149

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
13C4 PFBA	77		10 - 130
13C5 PFPeA	78		35 - 150
13C5 PFHxA	77		55 - 150
13C4 PFHpA	76		55 - 150
13C8 PFOA	80		60 - 140
13C9 PFNA	81		55 - 140
13C6 PFDA	79		50 - 140
13C7 PFUnA	80		30 - 140
13C2 PFDoA	77		10 - 150
13C2 PFTeDA	80		10 - 130
13C3 PFBS	84		55 - 150
13C3 PFHxS	78		55 - 150
13C8 PFOS	82		45 - 140
13C8 FOSA	79		30 - 130
d3-NMeFOSAA	91		45 - 200
d5-NEtFOSAA	91		10 - 200
M2-4:2 FTS	86		60 - 200
M2-6:2 FTS	83		60 - 200
M2-8:2 FTS	85		50 - 200

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619208/2-A

Matrix: Water

Analysis Batch: 619400

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619208

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
¹³ C3 HFPO-DA	77		25 - 160
d7-N-MeFOSE-M	83		10 - 150
d9-N-EtFOSE-M	77		10 - 150
d5-NEtPFOSA	64		10 - 130
d3-NMePFOSA	60		15 - 130

Lab Sample ID: MB 280-619711/1-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619711

Analyte	MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/17/23 11:33	07/18/23 13:18	1
4:2 FTS	ND		8.0	1.7	ng/L		07/17/23 11:33	07/18/23 13:18	1
6:2 FTS	ND		8.0	2.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
8:2 FTS	ND		8.0	2.6	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSA	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSA	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSE	ND		20	5.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSE	ND		20	5.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFMBA	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
NFDHA	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFMPA	ND		4.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: MB 280-619711/1-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619711

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFEESA	ND		4.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
3:3 FTCA	ND		10	1.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
5:3 FTCA	ND		50	10	ng/L		07/17/23 11:33	07/18/23 13:18	1
7:3 FTCA	ND		50	10	ng/L		07/17/23 11:33	07/18/23 13:18	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	81		10 - 130	07/17/23 11:33	07/18/23 13:18	1
13C5 PFPeA	73		35 - 150	07/17/23 11:33	07/18/23 13:18	1
13C5 PFHxA	80		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C4 PFHpA	76		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C8 PFOA	79		60 - 140	07/17/23 11:33	07/18/23 13:18	1
13C9 PFNA	78		55 - 140	07/17/23 11:33	07/18/23 13:18	1
13C6 PFDA	77		50 - 140	07/17/23 11:33	07/18/23 13:18	1
13C7 PFUnA	74		30 - 140	07/17/23 11:33	07/18/23 13:18	1
13C2 PFDoA	69		10 - 150	07/17/23 11:33	07/18/23 13:18	1
13C2 PFTeDA	67		10 - 130	07/17/23 11:33	07/18/23 13:18	1
13C3 PFBS	77		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C3 PFHxS	73		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C8 PFOS	71		45 - 140	07/17/23 11:33	07/18/23 13:18	1
13C8 FOSA	59		30 - 130	07/17/23 11:33	07/18/23 13:18	1
d3-NMeFOSAA	78		45 - 200	07/17/23 11:33	07/18/23 13:18	1
d5-NEtFOSAA	71		10 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-4:2 FTS	85		60 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-6:2 FTS	86		60 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-8:2 FTS	91		50 - 200	07/17/23 11:33	07/18/23 13:18	1
13C3 HFPO-DA	82		25 - 160	07/17/23 11:33	07/18/23 13:18	1
d7-N-MeFOSE-M	61		10 - 150	07/17/23 11:33	07/18/23 13:18	1
d9-N-EtFOSE-M	59		10 - 150	07/17/23 11:33	07/18/23 13:18	1
d5-NEtPFOSA	46		10 - 130	07/17/23 11:33	07/18/23 13:18	1
d3-NMePFOSA	47		15 - 130	07/17/23 11:33	07/18/23 13:18	1

Lab Sample ID: LCS 280-619711/3-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619711

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Perfluorobutanoic acid (PFBA)	128	144		ng/L		113	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	72.8		ng/L		114	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	36.9		ng/L		115	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	34.7		ng/L		109	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	38.7		ng/L		121	52 - 161
Perfluorononanoic acid (PFNA)	32.0	36.9		ng/L		115	59 - 149
Perfluorodecanoic acid (PFDA)	32.0	36.8		ng/L		115	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	36.9		ng/L		115	48 - 159
Perfluorododecanoic acid (PFDoA)	32.0	36.7		ng/L		115	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	38.8		ng/L		121	49 - 148

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619711/3-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619711

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorotetradecanoic acid (PFTeDA)	32.0	39.3		ng/L		123	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	34.5		ng/L		121	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	32.4		ng/L		108	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	36.7		ng/L		126	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	36.3		ng/L		119	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	33.8		ng/L		114	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	37.3		ng/L		121	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	30.9		ng/L		100	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	26.9		ng/L		87	36 - 145
4:2 FTS	120	126		ng/L		105	67 - 146
6:2 FTS	121	142		ng/L		117	61 - 151
8:2 FTS	123	135		ng/L		110	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	35.0		ng/L		109	61 - 148
NMeFOSA	32.0	43.7		ng/L		137	63 - 145
NEtFOSA	32.0	38.2		ng/L		119	65 - 139
NMeFOSAA	32.0	36.6		ng/L		114	58 - 144
NEtFOSAA	32.0	35.5		ng/L		111	59 - 146
NMeFOSE	320	389		ng/L		122	71 - 136
NEtFOSE	320	380		ng/L		119	69 - 137
HFPO-DA (GenX)	128	145		ng/L		113	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	144		ng/L		120	68 - 146
PFMBA	64.0	78.5		ng/L		123	55 - 148
NFDHA	64.0	71.1		ng/L		111	48 - 161
PFMPA	64.0	73.5		ng/L		115	51 - 145
9CI-PF3ONS	119	116		ng/L		97	56 - 156
11CI-PF3OUdS	121	120		ng/L		99	46 - 156
PFEESA	57.0	59.8		ng/L		105	56 - 151
3:3 FTCA	160	170		ng/L		107	62 - 129
5:3 FTCA	800	928		ng/L		116	63 - 134
7:3 FTCA	800	903		ng/L		113	50 - 138

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C4 PFBA	81		10 - 130
13C5 PFPeA	73		40 - 150
13C5 PFHxA	76		40 - 150
13C4 PFHpA	77		40 - 150
13C8 PFOA	81		30 - 140
13C9 PFNA	77		30 - 140
13C6 PFDA	79		20 - 140
13C7 PFUnA	76		20 - 140

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LCS 280-619711/3-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619711

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C2 PFDoA	73		10 - 150
13C2 PFTeDA	69		10 - 130
13C3 PFBS	75		25 - 150
13C3 PFHxS	74		25 - 150
13C8 PFOS	73		20 - 140
13C8 FOSA	66		10 - 130
d3-NMeFOSAA	84		10 - 200
d5-NEtFOSAA	83		10 - 200
M2-4:2 FTS	99		25 - 200
M2-6:2 FTS	88		25 - 200
M2-8:2 FTS	96		25 - 200
13C3 HFPO-DA	78		25 - 160
d7-N-MeFOSE-M	65		10 - 150
d9-N-EtFOSE-M	66		10 - 150
d5-NEtPFOSA	47		10 - 130
d3-NMePFOSA	45		10 - 130

Lab Sample ID: LLCS 280-619711/2-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619711

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	12.8	14.5		ng/L		114	44 - 157
Perfluoropentanoic acid (PFPeA)	6.40	7.28		ng/L		114	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.70		ng/L		116	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.48		ng/L		109	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.99		ng/L		125	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.92		ng/L		122	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.61		ng/L		113	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.44		ng/L		108	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	3.78		ng/L		118	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.55		ng/L		111	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	4.41		ng/L		138	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	3.33		ng/L		117	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.01		ng/L		100	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.56		ng/L		122	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.29		ng/L		108	51 - 150
Perfluorooctanesulfonic acid (PFOS)	2.98	3.09		ng/L		104	43 - 162
Perfluorononanesulfonic acid (PFNS)	3.08	3.27		ng/L		106	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.02		ng/L		98	50 - 144

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619711/2-A

Matrix: Water

Analysis Batch: 619866

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619711

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorododecanesulfonic acid (PFDoS)	3.10	2.38		ng/L		77	30 - 138
4:2 FTS	12.0	13.2		ng/L		111	52 - 158
6:2 FTS	12.1	13.6		ng/L		112	48 - 158
8:2 FTS	12.3	11.8		ng/L		96	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.39		ng/L		106	47 - 163
NMeFOSA	3.20	4.41		ng/L		138	54 - 155
NEtFOSA	3.20	3.36		ng/L		105	49 - 156
NMeFOSAA	3.20	3.82	J	ng/L		119	32 - 160
NEtFOSAA	3.20	4.10		ng/L		128	51 - 154
NMeFOSE	32.0	38.1		ng/L		119	56 - 151
NEtFOSE	32.0	37.6		ng/L		117	60 - 147
HFPO-DA (GenX)	12.8	14.9		ng/L		116	58 - 154
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	12.1	14.7		ng/L		122	61 - 148
PFMBA	6.40	7.71		ng/L		120	49 - 154
NFDHA	6.40	6.81		ng/L		106	47 - 160
PFMPA	6.40	7.54		ng/L		118	48 - 150
9CI-PF3ONS	11.9	11.0		ng/L		92	44 - 167
11CI-PF3OUdS	12.1	13.0		ng/L		108	36 - 158
PFEESA	5.70	6.19		ng/L		109	56 - 144
3:3 FTCA	16.0	17.3		ng/L		108	32 - 161
5:3 FTCA	80.0	89.0		ng/L		111	39 - 156
7:3 FTCA	80.0	85.6		ng/L		107	36 - 149

Isotope Dilution	LLCS %Recovery	LLCS Qualifier	Limits
13C4 PFBA	82		10 - 130
13C5 PFPeA	74		35 - 150
13C5 PFHxA	80		55 - 150
13C4 PFHpA	80		55 - 150
13C8 PFOA	78		60 - 140
13C9 PFNA	77		55 - 140
13C6 PFDA	82		50 - 140
13C7 PFUnA	79		30 - 140
13C2 PFDoA	80		10 - 150
13C2 PFTeDA	73		10 - 130
13C3 PFBS	77		55 - 150
13C3 PFHxS	76		55 - 150
13C8 PFOS	79		45 - 140
13C8 FOSA	64		30 - 130
d3-NMeFOSAA	79		45 - 200
d5-NEtFOSAA	80		10 - 200
M2-4:2 FTS	94		60 - 200
M2-6:2 FTS	89		60 - 200
M2-8:2 FTS	96		50 - 200
13C3 HFPO-DA	79		25 - 160
d7-N-MeFOSE-M	66		10 - 150
d9-N-EtFOSE-M	67		10 - 150

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619711/2-A
Matrix: Water
Analysis Batch: 619866

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 619711

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
d5-NEtPFOSA	53		10 - 130
d3-NMePFOSA	50		15 - 130

Method: 200.8 - Metals (ICP/MS)

Lab Sample ID: MB 280-618940/1-A
Matrix: Water
Analysis Batch: 619314

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618940

Analyte	MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Manganese	ND		3.0	0.51	ug/L		07/11/23 09:04	07/12/23 09:13	1

Lab Sample ID: LCS 280-618940/2-A
Matrix: Water
Analysis Batch: 619314

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618940

Analyte	Spike Added	LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Manganese	40.0	41.7		ug/L		104	87 - 115

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 280-620991/48
Matrix: Water
Analysis Batch: 620991

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Chloride	ND		3.0	1.0	mg/L			07/28/23 03:29	1
Sulfate	ND		5.0	1.0	mg/L			07/28/23 03:29	1

Lab Sample ID: MB 280-620991/6
Matrix: Water
Analysis Batch: 620991

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Chloride	ND		3.0	1.0	mg/L			07/27/23 15:35	1
Sulfate	ND		5.0	1.0	mg/L			07/27/23 15:35	1

Lab Sample ID: LCS 280-620991/4
Matrix: Water
Analysis Batch: 620991

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Chloride	100	104		mg/L		104	90 - 110
Sulfate	100	99.6		mg/L		100	90 - 110

Lab Sample ID: LCS 280-620991/46
Matrix: Water
Analysis Batch: 620991

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Chloride	100	108		mg/L		108	90 - 110

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 300.0 - Anions, Ion Chromatography (Continued)

Lab Sample ID: LCS 280-620991/46

Matrix: Water

Analysis Batch: 620991

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Sulfate	100	101		mg/L		101	90 - 110

Lab Sample ID: LCSD 280-620991/47

Matrix: Water

Analysis Batch: 620991

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chloride	100	108		mg/L		108	90 - 110	0	10
Sulfate	100	100		mg/L		100	90 - 110	1	10

Lab Sample ID: LCSD 280-620991/5

Matrix: Water

Analysis Batch: 620991

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chloride	100	104		mg/L		104	90 - 110	0	10
Sulfate	100	99.4		mg/L		99	90 - 110	0	10

Lab Sample ID: MRL 280-620991/3

Matrix: Water

Analysis Batch: 620991

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Analyte	Spike Added	MRL Result	MRL Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	5.00	5.29		mg/L		106	50 - 150
Sulfate	5.00	4.74	J	mg/L		95	50 - 150

Method: 350.1 - Nitrogen, Ammonia

Lab Sample ID: MB 280-619790/64

Matrix: Water

Analysis Batch: 619790

Client Sample ID: Method Blank

Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia	ND		0.10	0.029	mg/L			07/13/23 14:10	1

Lab Sample ID: LCS 280-619790/65

Matrix: Water

Analysis Batch: 619790

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Ammonia	2.50	2.51		mg/L		100	90 - 110

Method: 351.2 - Nitrogen, Total Kjeldahl

Lab Sample ID: MB 280-621028/2-A

Matrix: Water

Analysis Batch: 621184

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 621028

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl	ND		1.0	0.69	mg/L		07/27/23 15:27	07/28/23 15:09	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 351.2 - Nitrogen, Total Kjeldahl (Continued)

Lab Sample ID: LCS 280-621028/1-A
Matrix: Water
Analysis Batch: 621184

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 621028

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrogen, Kjeldahl	6.00	5.91		mg/L		98	90 - 110

Lab Sample ID: 280-178681-1 MS
Matrix: Water
Analysis Batch: 621184

Client Sample ID: S-1
Prep Type: Total/NA
Prep Batch: 621028

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrogen, Kjeldahl	ND	F1	3.00	2.30	F1	mg/L		77	90 - 110

Lab Sample ID: 280-178681-1 MSD
Matrix: Water
Analysis Batch: 621184

Client Sample ID: S-1
Prep Type: Total/NA
Prep Batch: 621028

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	Limit
Nitrogen, Kjeldahl	ND	F1	3.00	2.36	F1	mg/L		79	90 - 110	3	25

Method: 353.2 - Nitrogen, Nitrate-Nitrite

Lab Sample ID: MB 280-619143/22
Matrix: Water
Analysis Batch: 619143

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrate Nitrite as N	ND		0.10	0.044	mg/L			07/11/23 10:42	1

Lab Sample ID: LCS 280-619143/21
Matrix: Water
Analysis Batch: 619143

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrate Nitrite as N	5.00	5.07		mg/L		101	90 - 110

Method: 365.1 - Phosphorus, Total

Lab Sample ID: MB 280-618759/5-A
Matrix: Water
Analysis Batch: 618823

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618759

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phosphorus, Total	ND		0.050	0.025	mg/L		07/07/23 10:34	07/07/23 15:20	1

Lab Sample ID: LCS 280-618759/3-A
Matrix: Water
Analysis Batch: 618823

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618759

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Phosphorus, Total	0.500	0.502		mg/L		100	90 - 110

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 365.1 - Phosphorus, Total (Continued)

Lab Sample ID: LCSD 280-618759/4-A
Matrix: Water
Analysis Batch: 618823

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 618759

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Phosphorus, Total	0.500	0.499		mg/L		100	90 - 110	0	10

Method: 410.4 - COD

Lab Sample ID: MB 280-621436/5
Matrix: Water
Analysis Batch: 621436

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chemical Oxygen Demand	9.40	J	20	8.7	mg/L			08/01/23 11:15	1

Lab Sample ID: LCS 280-621436/3
Matrix: Water
Analysis Batch: 621436

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Chemical Oxygen Demand	100	103		mg/L		103	90 - 110		

Lab Sample ID: LCSD 280-621436/4
Matrix: Water
Analysis Batch: 621436

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chemical Oxygen Demand	100	104		mg/L		104	90 - 110	1	11

Method: 9040C - pH

Lab Sample ID: LCS 280-619585/5
Matrix: Water
Analysis Batch: 619585

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
pH adj. to 25 deg C	7.00	7.1		SU		101	99 - 101		

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 280-619088/1
Matrix: Water
Analysis Batch: 619088

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (TDS)	ND		10	4.7	mg/L			07/11/23 11:19	1

Lab Sample ID: LCS 280-619088/2
Matrix: Water
Analysis Batch: 619088

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Total Dissolved Solids (TDS)	505	506		mg/L		100	88 - 114		

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: SM 2540C - Solids, Total Dissolved (TDS) (Continued)

Lab Sample ID: LCSD 280-619088/3

Matrix: Water

Analysis Batch: 619088

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Dissolved Solids (TDS)	505	510		mg/L		101	88 - 114	1	20

Method: SM 2540D - Solids, Total Suspended (TSS)

Lab Sample ID: MB 280-619138/1

Matrix: Water

Analysis Batch: 619138

Client Sample ID: Method Blank

Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Suspended Solids	ND		4.0	1.1	mg/L			07/11/23 14:50	1

Lab Sample ID: LCS 280-619138/2

Matrix: Water

Analysis Batch: 619138

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Total Suspended Solids	508	280	*-	mg/L		55	79 - 114		

Lab Sample ID: LCSD 280-619138/3

Matrix: Water

Analysis Batch: 619138

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Suspended Solids	508	362	*- *1	mg/L		71	79 - 114	26	20

Method: SM5210B - BOD, 5 Day

Lab Sample ID: MB 280-618771/4

Matrix: Water

Analysis Batch: 618771

Client Sample ID: Method Blank

Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	ND		2.0	0.24	mg/L			07/07/23 11:16	1

Lab Sample ID: SCB 280-618771/1

Matrix: Water

Analysis Batch: 618771

Client Sample ID: Method Blank

Prep Type: Total/NA

Analyte	SCB Result	SCB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	0.974	J	2.0	0.24	mg/L			07/07/23 11:16	1

Lab Sample ID: USB 280-618771/2

Matrix: Water

Analysis Batch: 618771

Client Sample ID: Method Blank

Prep Type: Total/NA

Analyte	USB Result	USB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	1.00	J	2.0	0.24	mg/L			07/07/23 11:16	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: SM5210B - BOD, 5 Day (Continued)

Lab Sample ID: LCS 280-618771/3

Matrix: Water

Analysis Batch: 618771

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Biochemical Oxygen Demand	198	174		mg/L		88	85 - 115

Lab Sample ID: 280-178681-1 DU

Matrix: Water

Analysis Batch: 618771

Client Sample ID: S-1

Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Biochemical Oxygen Demand	7.1	b	11.8	J F5	mg/L		50	20

Method: 903.0 - Radium-226 (GFPC)

Lab Sample ID: MB 160-620038/1-A

Matrix: Water

Analysis Batch: 622932

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 620038

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.05258	U	0.0606	0.0608	1.00	0.0977	pCi/L	07/13/23 09:29	08/04/23 09:32	1
Carrier	MB %Yield	MB Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	97.7		30 - 110					07/13/23 09:29	08/04/23 09:32	1

Lab Sample ID: LCS 160-620038/2-A

Matrix: Water

Analysis Batch: 622932

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 620038

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-226	11.3	10.37		1.09	1.00	0.0977	pCi/L	92	75 - 125
Carrier	LCS %Yield	LCS Qualifier	Limits						
Ba Carrier	94.7		30 - 110						

Lab Sample ID: LCSD 160-620038/3-A

Matrix: Water

Analysis Batch: 622932

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 620038

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
Radium-226	11.3	10.29		1.09	1.00	0.111	pCi/L	91	75 - 125	0.04	1
Carrier	LCSD %Yield	LCSD Qualifier	Limits								
Ba Carrier	94.7		30 - 110								

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 904.0 - Radium-228 (GFPC)

Lab Sample ID: MB 160-620040/1-A

Matrix: Water

Analysis Batch: 622120

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 620040

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	-0.03188	U	0.228	0.228	1.00	0.448	pCi/L	07/13/23 09:38	07/28/23 12:40	1
Carrier	MB %Yield	MB Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	97.7		30 - 110					07/13/23 09:38	07/28/23 12:40	1
Y Carrier	82.2		30 - 110					07/13/23 09:38	07/28/23 12:40	1

Lab Sample ID: LCS 160-620040/2-A

Matrix: Water

Analysis Batch: 622120

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 620040

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-228	8.00	7.939		1.14	1.00	0.487	pCi/L	99	75 - 125
Carrier	LCS %Yield	LCS Qualifier	Limits						
Ba Carrier	94.7		30 - 110						
Y Carrier	82.6		30 - 110						

Lab Sample ID: LCSD 160-620040/3-A

Matrix: Water

Analysis Batch: 621992

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 620040

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
Radium-228	8.00	8.159		1.18	1.00	0.559	pCi/L	102	75 - 125	0.09	1
Carrier	LCSD %Yield	LCSD Qualifier	Limits								
Ba Carrier	94.7		30 - 110								
Y Carrier	81.5		30 - 110								

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Lab Sample ID: MB 160-619766/1-A

Matrix: Water

Analysis Batch: 620746

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619766

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	-0.08161	U	0.0752	0.0755	1.00	0.219	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-230	-0.03611	U	0.171	0.171	1.00	0.285	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-232	-0.009937	U	0.0244	0.0244	1.00	0.123	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Tracer	MB %Yield	MB Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	76.9		30 - 110					07/11/23 12:12	07/18/23 13:12	1

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry) (Continued)

Lab Sample ID: LCS 160-619766/2-A

Matrix: Water

Analysis Batch: 620748

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619766

Analyte		Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Thorium-230		7.97	7.662		1.05	1.00	0.266	pCi/L	96	75 - 125		
			LCS	LCS								
Tracer	%Yield	Qualifier	Limits									
Thorium-229	83.4		30 - 110									

Lab Sample ID: LCSD 160-619766/3-A

Matrix: Water

Analysis Batch: 620749

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 619766

Analyte		Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
Thorium-230		7.97	7.747		1.04	1.00	0.275	pCi/L	97	75 - 125	0.04	1
			LCSD	LCSD								
Tracer	%Yield	Qualifier	Limits									
Thorium-229	92.2		30 - 110									

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Lab Sample ID: MB 160-619767/1-A

Matrix: Water

Analysis Batch: 620686

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 619767

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	0.09104	U	0.0971	0.0974	1.00	0.131	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-235/236	0.01666	U	0.0552	0.0552	1.00	0.138	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-238	0.01737	U	0.0435	0.0435	1.00	0.0973	pCi/L	07/11/23 12:22	07/18/23 13:17	1
			MB	MB						
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	86.2		30 - 110					07/11/23 12:22	07/18/23 13:17	1

Lab Sample ID: LCS 160-619767/2-A

Matrix: Water

Analysis Batch: 620688

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 619767

Analyte		Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		
Uranium-233/234		12.7	13.12		1.58	1.00	0.186	pCi/L	103	75 - 125		
4												
Uranium-238		13.0	12.82		1.55	1.00	0.110	pCi/L	98	75 - 125		
			LCS	LCS								
Tracer	%Yield	Qualifier	Limits									
Uranium-232	78.4		30 - 110									

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QC Sample Results

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry) (Continued)

Lab Sample ID: LCSD 160-619767/3-A

Matrix: Water

Analysis Batch: 620690

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 619767

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
Uranium-233/234	12.7	12.85		1.52	1.00	0.100	pCi/L	101	75 - 125	0.09	1
Uranium-238	13.0	12.34		1.47	1.00	0.0659	pCi/L	95	75 - 125	0.16	1

Tracer	LCSD %Yield	LCSD Qualifier	Limits
Uranium-232	86.0		30 - 110

QC Association Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

GC/MS Semi VOA

Prep Batch: 619045

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	3510C	
MB 280-619045/1-A	Method Blank	Total/NA	Water	3510C	
LCS 280-619045/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 280-619045/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

Analysis Batch: 619193

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8270E	619045
MB 280-619045/1-A	Method Blank	Total/NA	Water	8270E	619045
LCS 280-619045/2-A	Lab Control Sample	Total/NA	Water	8270E	619045
LCSD 280-619045/3-A	Lab Control Sample Dup	Total/NA	Water	8270E	619045

Prep Batch: 619212

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	D7065-11	
MB 280-619212/1-A	Method Blank	Total/NA	Water	D7065-11	
LCS 280-619212/2-A	Lab Control Sample	Total/NA	Water	D7065-11	

Analysis Batch: 619388

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	D7065-11	619212
MB 280-619212/1-A	Method Blank	Total/NA	Water	D7065-11	619212
LCS 280-619212/2-A	Lab Control Sample	Total/NA	Water	D7065-11	619212

GC Semi VOA

Prep Batch: 619392

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	3510C	
MB 280-619392/1-A	Method Blank	Total/NA	Water	3510C	
LCS 280-619392/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 280-619392/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

Analysis Batch: 619741

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8081B	619392
MB 280-619392/1-A	Method Blank	Total/NA	Water	8081B	619392
LCS 280-619392/2-A	Lab Control Sample	Total/NA	Water	8081B	619392
LCSD 280-619392/3-A	Lab Control Sample Dup	Total/NA	Water	8081B	619392

HPLC/IC

Prep Batch: 395283

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8315A Prep	
MB 410-395283/1-A	Method Blank	Total/NA	Water	8315A Prep	
LCS 410-395283/2-A	Lab Control Sample	Total/NA	Water	8315A Prep	
LCSD 410-395283/3-A	Lab Control Sample Dup	Total/NA	Water	8315A Prep	

Analysis Batch: 395541

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8315A	395283

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QC Association Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

HPLC/IC (Continued)

Analysis Batch: 395541 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 410-395283/1-A	Method Blank	Total/NA	Water	8315A	395283
LCS 410-395283/2-A	Lab Control Sample	Total/NA	Water	8315A	395283
LCSD 410-395283/3-A	Lab Control Sample Dup	Total/NA	Water	8315A	395283

LCMS

Prep Batch: 619039

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	1633	
MB 280-619039/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619039/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619039/2-A	Lab Control Sample	Total/NA	Water	1633	

Prep Batch: 619208

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2	FRB	Total/NA	Water	1633	
MB 280-619208/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619208/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619208/2-A	Lab Control Sample	Total/NA	Water	1633	

Analysis Batch: 619263

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	Draft 1633	619039
MB 280-619039/1-A	Method Blank	Total/NA	Water	Draft 1633	619039
LCS 280-619039/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619039
LLCS 280-619039/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619039

Analysis Batch: 619400

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2	FRB	Total/NA	Water	Draft 1633	619208
MB 280-619208/1-A	Method Blank	Total/NA	Water	Draft 1633	619208
LCS 280-619208/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619208
LLCS 280-619208/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619208

Prep Batch: 619711

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2 - RE	FRB	Total/NA	Water	1633	
MB 280-619711/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619711/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619711/2-A	Lab Control Sample	Total/NA	Water	1633	

Analysis Batch: 619866

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2 - RE	FRB	Total/NA	Water	Draft 1633	619711
MB 280-619711/1-A	Method Blank	Total/NA	Water	Draft 1633	619711
LCS 280-619711/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619711
LLCS 280-619711/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619711

QC Association Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Metals

Prep Batch: 618940

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	200.8	
MB 280-618940/1-A	Method Blank	Total/NA	Water	200.8	
LCS 280-618940/2-A	Lab Control Sample	Total/NA	Water	200.8	

Analysis Batch: 619314

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	200.8	618940
MB 280-618940/1-A	Method Blank	Total/NA	Water	200.8	618940
LCS 280-618940/2-A	Lab Control Sample	Total/NA	Water	200.8	618940

General Chemistry

Prep Batch: 618759

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	365.2/365.3/365	
MB 280-618759/5-A	Method Blank	Total/NA	Water	365.2/365.3/365	
LCS 280-618759/3-A	Lab Control Sample	Total/NA	Water	365.2/365.3/365	
LCSD 280-618759/4-A	Lab Control Sample Dup	Total/NA	Water	365.2/365.3/365	

Analysis Batch: 618771

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM5210B	
MB 280-618771/4	Method Blank	Total/NA	Water	SM5210B	
SCB 280-618771/1	Method Blank	Total/NA	Water	SM5210B	
USB 280-618771/2	Method Blank	Total/NA	Water	SM5210B	
LCS 280-618771/3	Lab Control Sample	Total/NA	Water	SM5210B	
280-178681-1 DU	S-1	Total/NA	Water	SM5210B	

Analysis Batch: 618823

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	365.1	618759
MB 280-618759/5-A	Method Blank	Total/NA	Water	365.1	618759
LCS 280-618759/3-A	Lab Control Sample	Total/NA	Water	365.1	618759
LCSD 280-618759/4-A	Lab Control Sample Dup	Total/NA	Water	365.1	618759

Analysis Batch: 619088

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM 2540C	
MB 280-619088/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 280-619088/2	Lab Control Sample	Total/NA	Water	SM 2540C	
LCSD 280-619088/3	Lab Control Sample Dup	Total/NA	Water	SM 2540C	

Analysis Batch: 619138

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM 2540D	
MB 280-619138/1	Method Blank	Total/NA	Water	SM 2540D	
LCS 280-619138/2	Lab Control Sample	Total/NA	Water	SM 2540D	
LCSD 280-619138/3	Lab Control Sample Dup	Total/NA	Water	SM 2540D	

QC Association Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

General Chemistry

Analysis Batch: 619143

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	353.2	
MB 280-619143/22	Method Blank	Total/NA	Water	353.2	
LCS 280-619143/21	Lab Control Sample	Total/NA	Water	353.2	

Analysis Batch: 619585

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	9040C	
LCS 280-619585/5	Lab Control Sample	Total/NA	Water	9040C	

Analysis Batch: 619790

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	350.1	
MB 280-619790/64	Method Blank	Total/NA	Water	350.1	
LCS 280-619790/65	Lab Control Sample	Total/NA	Water	350.1	

Analysis Batch: 620181

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	Inorganic N	

Analysis Batch: 620991

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	300.0	
280-178681-1	S-1	Total/NA	Water	300.0	
MB 280-620991/48	Method Blank	Total/NA	Water	300.0	
MB 280-620991/6	Method Blank	Total/NA	Water	300.0	
LCS 280-620991/4	Lab Control Sample	Total/NA	Water	300.0	
LCS 280-620991/46	Lab Control Sample	Total/NA	Water	300.0	
LCSD 280-620991/47	Lab Control Sample Dup	Total/NA	Water	300.0	
LCSD 280-620991/5	Lab Control Sample Dup	Total/NA	Water	300.0	
MRL 280-620991/3	Lab Control Sample	Total/NA	Water	300.0	

Prep Batch: 621028

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	351.2	
MB 280-621028/2-A	Method Blank	Total/NA	Water	351.2	
LCS 280-621028/1-A	Lab Control Sample	Total/NA	Water	351.2	
280-178681-1 MS	S-1	Total/NA	Water	351.2	
280-178681-1 MSD	S-1	Total/NA	Water	351.2	

Analysis Batch: 621184

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	351.2	621028
MB 280-621028/2-A	Method Blank	Total/NA	Water	351.2	621028
LCS 280-621028/1-A	Lab Control Sample	Total/NA	Water	351.2	621028
280-178681-1 MS	S-1	Total/NA	Water	351.2	621028
280-178681-1 MSD	S-1	Total/NA	Water	351.2	621028

Analysis Batch: 621436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	410.4	
MB 280-621436/5	Method Blank	Total/NA	Water	410.4	

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QC Association Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

General Chemistry (Continued)

Analysis Batch: 621436 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 280-621436/3	Lab Control Sample	Total/NA	Water	410.4	
LCSD 280-621436/4	Lab Control Sample Dup	Total/NA	Water	410.4	

Rad

Prep Batch: 619766

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	ExtChrom	
MB 160-619766/1-A	Method Blank	Total/NA	Water	ExtChrom	
LCS 160-619766/2-A	Lab Control Sample	Total/NA	Water	ExtChrom	
LCSD 160-619766/3-A	Lab Control Sample Dup	Total/NA	Water	ExtChrom	

Prep Batch: 619767

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	ExtChrom	
MB 160-619767/1-A	Method Blank	Total/NA	Water	ExtChrom	
LCS 160-619767/2-A	Lab Control Sample	Total/NA	Water	ExtChrom	
LCSD 160-619767/3-A	Lab Control Sample Dup	Total/NA	Water	ExtChrom	

Prep Batch: 620038

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	PrecSep-21	
MB 160-620038/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-620038/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	
LCSD 160-620038/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep-21	

Prep Batch: 620040

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	PrecSep_0	
MB 160-620040/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-620040/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	
LCSD 160-620040/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep_0	

Lab Chronicle

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Client Sample ID: S-1

Lab Sample ID: 280-178681-1

Date Collected: 07/06/23 10:55

Matrix: Water

Date Received: 07/06/23 11:21

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			131.8 mL	1 mL	619045	07/11/23 09:25	KAS	EET DEN
Total/NA	Analysis	8270E		1	1 mL	1 mL	619193	07/12/23 12:56	MRS	EET DEN
Total/NA	Prep	D7065-11			964.4 mL	1 mL	619212	07/12/23 10:53	KAS	EET DEN
Total/NA	Analysis	D7065-11		5	200 uL	200 uL	619388	07/13/23 14:47	MRS	EET DEN
Total/NA	Prep	3510C			244.9 mL	5 mL	619392	07/13/23 12:16	KAS	EET DEN
Total/NA	Analysis	8081B		1	1 mL	1 mL	619741	07/17/23 21:03	SMQ	EET DEN
Total/NA	Prep	8315A Prep			50 mL	10 mL	395283	07/10/23 17:06	A2VL	ELLE
Total/NA	Analysis	8315A		1			395541	07/11/23 10:21	GM5C	ELLE
Total/NA	Prep	1633			25.2 mL	5 mL	619039	07/11/23 10:52	MSJ	EET DEN
Total/NA	Analysis	Draft 1633		1	1 mL	1 mL	619263	07/12/23 16:12	SCS	EET DEN
Total/NA	Prep	200.8			50 mL	50 mL	618940	07/11/23 09:04	MSM	EET DEN
Total/NA	Analysis	200.8		1			619314	07/12/23 03:34	LMT	EET DEN
Total/NA	Analysis	300.0		1	10 mL	10 mL	620991	07/28/23 03:46	EJS	EET DEN
Total/NA	Analysis	300.0		10	10 mL	10 mL	620991	07/28/23 04:03	EJS	EET DEN
Total/NA	Analysis	350.1		1	10 mL	10 mL	619790	07/13/23 15:52	MMP	EET DEN
Total/NA	Prep	351.2			25 mL	25 mL	621028	07/27/23 15:27	BCR	EET DEN
Total/NA	Analysis	351.2		1			621184	07/28/23 15:10	BCR	EET DEN
Total/NA	Analysis	353.2		1	100 mL	100 mL	619143	07/11/23 11:50	LRB	EET DEN
Total/NA	Prep	365.2/365.3/365			50 mL	50 mL	618759	07/07/23 10:34	LBR	EET DEN
Total/NA	Analysis	365.1		1	2 mL	2 mL	618823	07/07/23 15:21	LBR	EET DEN
Total/NA	Analysis	410.4		1	2 mL	2 mL	621436	08/01/23 11:15	BCR	EET DEN
Total/NA	Analysis	9040C		1			619585	07/13/23 14:56	KEG	EET DEN
Total/NA	Analysis	Inorganic N		1			620181	07/20/23 12:08	ZPM	EET DEN
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	619088	07/11/23 11:19	LRB	EET DEN
Total/NA	Analysis	SM 2540D		1	25 mL	250 mL	619138	07/11/23 14:50	LRB	EET DEN
Total/NA	Analysis	SM5210B		1	120 mL	300 mL	618771	07/07/23 11:16	BCR	EET DEN
Total/NA	Prep	PrecSep-21			243.00 mL	1.0 g	620038	07/13/23 09:29	KAC	EET SL
Total/NA	Analysis	903.0		1			622954	08/04/23 09:40	SCB	EET SL
Total/NA	Prep	PrecSep_0			243.00 mL	1.0 g	620040	07/13/23 09:38	KAC	EET SL
Total/NA	Analysis	904.0		1			621992	07/28/23 12:44	FLC	EET SL
Total/NA	Prep	ExtChrom			48.42 mL	1.0 mL	619766	07/11/23 12:12	IAG	EET SL
Total/NA	Analysis	A-01-R		1			620752	07/18/23 13:12	FLC	EET SL
Total/NA	Prep	ExtChrom			48.42 mL	1.0 mL	619767	07/11/23 12:22	IAG	EET SL
Total/NA	Analysis	A-01-R		1			620691	07/18/23 13:17	FLC	EET SL

Client Sample ID: FRB

Lab Sample ID: 280-178681-2

Date Collected: 07/06/23 09:44

Matrix: Water

Date Received: 07/06/23 11:21

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	1633	RE		125.2 mL	5 mL	619711	07/17/23 11:33	FBD	EET DEN
Total/NA	Analysis	Draft 1633	RE	1	1 mL	1 mL	619866	07/18/23 18:21	CM	EET DEN

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Lab Chronicle

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Client Sample ID: FRB

Lab Sample ID: 280-178681-2

Date Collected: 07/06/23 09:44

Matrix: Water

Date Received: 07/06/23 11:21

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	1633			250.9 mL	5 mL	619208	07/12/23 11:15	MAC	EET DEN
Total/NA	Analysis	Draft 1633		1	1 mL	1 mL	619400	07/13/23 18:07	SCS	EET DEN

Laboratory References:

EET DEN = Eurofins Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

ELLE = Eurofins Lancaster Laboratories Environment Testing, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Laboratory: Eurofins Denver

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Oregon	NELAP	4025-019	01-08-24
The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.			
Analysis Method	Prep Method	Matrix	Analyte
9040C		Water	Temperature
Inorganic N		Water	Total Inorganic Nitrogen

Laboratory: Eurofins Lancaster Laboratories Environment Testing, LLC

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
A2LA	Dept. of Defense ELAP	0001.01	11-30-24
A2LA	ISO/IEC 17025	0001.01	11-30-24
Alabama	State	43200	01-31-24
Alaska	State	PA00009	06-30-24
Alaska (UST)	State	17-027	02-28-24
Arizona	State	AZ0780	03-12-24
Arkansas DEQ	State	88-00660	08-08-23
California	State	2792	11-30-23
Colorado	State	PA00009	06-30-24
Connecticut	State	PH-0746	06-30-25
DE Haz. Subst. Cleanup Act (HSCA)	State	019-006 (PA cert)	01-31-24
Delaware (DW)	State	N/A	01-31-24
Florida	NELAP	E87997	07-23-23
Georgia (DW)	State	C048	01-31-24
Hawaii	State	N/A	01-31-24
Illinois	NELAP	200027	01-31-24
Iowa	State	361	03-01-24
Kansas	NELAP	E-10151	10-31-23
Kentucky (DW)	State	KY90088	12-31-23
Kentucky (UST)	State	0001.01	11-30-24
Kentucky (WW)	State	KY90088	12-31-23
Louisiana (All)	NELAP	02055	06-30-24
Maine	State	2019012	03-12-25
Maryland	State	100	06-30-24
Massachusetts	State	M-PA009	06-30-24
Michigan	State	9930	01-31-24
Minnesota	NELAP	042-999-487	12-31-23
Mississippi	State	023	01-31-24
Missouri	State	450	01-31-25
Montana (DW)	State	0098	01-01-24
Nebraska	State	NE-OS-32-17	01-31-24
New Hampshire	NELAP	2730	08-01-23
New Jersey	NELAP	PA011	07-27-23
New York	NELAP	10670	04-01-24
North Carolina (DW)	State	42705	07-31-24
North Carolina (WW/SW)	State	521	12-31-23
North Dakota	State	R-205	01-31-24
Oklahoma	NELAP	9804	08-31-23
Oregon	NELAP	PA200001	09-11-23

Eurofins Denver

Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Laboratory: Eurofins Lancaster Laboratories Environment Testing, LLC (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
PALA	Canada	1978	09-16-24
Pennsylvania	NELAP	36-00037	07-20-23
Rhode Island	State	LAO00338	12-31-23
South Carolina	State	89002	01-31-24
Tennessee	State	02838	01-31-24
Texas	NELAP	T104704194-23-46	08-31-23
USDA	US Federal Programs	525-22-298-19481	10-25-25
Vermont	State	VT - 36037	10-28-23
Virginia	NELAP	460182	07-14-23
Washington	State	C457	07-17-23
West Virginia (DW)	State	9906 C	12-31-23
West Virginia DEP	State	055	07-31-24
Wyoming	State	8TMS-L	01-31-24
Wyoming (UST)	A2LA	0001.01	11-30-24

Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-06-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-23
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-23 *
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-23
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-23
Kentucky (DW)	State	KY90125	12-31-23
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-23
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-23
Maryland	State	310	08-08-23
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO000542020-1	08-31-23
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-24
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-23 *
Oklahoma	NELAP	9997	08-31-23
Oregon	NELAP	4157	09-01-23

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Eurofins Denver

Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Laboratory: Eurofins St. Louis (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Pennsylvania	NELAP	68-00540	02-28-24
South Carolina	State	85002001	06-30-23 *
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO000542021-14	07-31-23 *
Virginia	NELAP	10310	06-15-25
Washington	State	C592	08-30-23
West Virginia DEP	State	381	10-31-23

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Eurofins Denver



Client Information Client Contact: Erica Wirski Company: Kennedy/Jenks Consultants Address: 143 Union Blvd City: Lakewood State, Zip: CO, 80228 Phone: _____ Email: ericawirski@kennedyjenks.com Project Name: Arvada NTS Metro Water Quality Analysis Site: Colorado		Lab PM: Stone, Natalie B E-Mail: Natalie.Stone@et.eurofins.com State of Origin: _____ Page: 1 of 1		CQC No: 280-131050-36287.1 Page: 1 of 1 Job #: _____	
Analysis Requested Due Date Requested: _____ TAT Requested (days): _____ Compliance Project: ☐ Yes ☒ No PO #: _____ Purchase Order Requested WO #: _____ Project #: 28024970 SOW#: _____ Analysis Requested A - HCL B - NaOH C - Zn Acetate D - Nitric Acid E - NaHSO4 F - MeOH G - Amchlor H - Ascorbic Acid I - Ice J - DI Water K - EDTA L - EDA Other: _____					
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification Sample Date: 7/6/23 Sample Time: 10:30 Matrix: Water Sample Type: (C=grab) Preservation Code: 15		Field Filtered Sample (Yes or No) ☒ Yes ☐ No			
Sample Identification					



Phone (303) 736-0100 Phone (303) 431-7171

280-178681 Chain of Custody

Client Information Client Contact: Erica Wirski Company: Kennedy/Jenks Consultants Address: 143 Union Blvd City: Lakewood State, Zip: CO, 80228 Phone: _____ Email: ericawirski@kennedyjenks.com Project Name: Arvada NTS Metro Water Quality Analysis Site: Colorado		Lab PM: Stone, Natalie B E-Mail: Natalie.Stone@et.eurofinsus.com State of Origin: _____ Page: 1 of 1 Job #: _____	
Analysis Requested			
Due Date Requested: _____ TAT Requested (days): _____ Compliance Project: ☐ Yes ☒ No PO #: _____ Purchase Order Requested WO #: _____ Project #: 28024970 SOW#: _____		Perform MS/MSD (Yes or No) ☒ Field Filtered Sample (Yes or No) ☒ 903.0 - Radium-226 (Sub to St. Louis) ☒ 904.0 - Radium-228 (Sub to St. Louis) ☒ 8081B - Pesticides ☒ 200.8 - Total Metals ☒ Ammonia/TKN/COD/Total Phos/Nitrate-Nitrite ☒ TDS/TSS/pH/Chloride and Sulfate ☒ SM5210B_BODCalc - BOD ☒ 1633_B24 - PFAS ☒ 8270E - SVOCs ☒ D7065_11 - Nonylphenols ☒ 8315A - Formaldehyde (Sub to Lancaster) ☒ A01R_Th - Thorium (Sub to St. Louis) ☒ A01R_U - Uranium (Sub to St. Louis) ☒ Total Number of Containers ☒	
Sample Identification 500 mL UP (6) - 5-1 - 5-14 250 mL UP 5-5 - 5-6 250 mL UP 5-7 - 5-8 125 mL UP 5-3 250 mL Nitric Acid, 5-14 250 mL Sulfuric Acid, 5-14 500 mL Glass UP 5-2 to 5-26 250 mL Glass UP 5-24 to 5-26 125 mL Glass UP 5-27 to 5-29		Matrix (W=Water, S=solid, O=waste/oli) Preservation Code: _____ Water Water Water Water Water Water Water Water Water	
Sample Date 7/6/23 7/6/23 7/6/23 7/6/23 7/6/23 7/6/23 7/6/23 7/6/23 7/6/23		Sample Time 0930 0930 1000 1007 1008 1032 1041 1046 1051 1055	
Possible Hazard Identification ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological Deliverable Requested: I, II, III, IV, Other (specify) _____			
Sample Disposal (A fee may be assessed if samples are retained longer than 1 month) ☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months Special Instructions/QC Requirements: _____			
Empty Kit Relinquished by: Owen Noun Relinquished by: _____ Relinquished by: _____ Relinquished by: _____		Date/Time: 7/6/23 7/6/23 7/6/23 7/6/23	
Company: Kennedy/Jenks Consultants Date/Time: 7/6/23 Date/Time: 7/6/23 Date/Time: 7/6/23 Date/Time: 7/6/23		Company: Kennedy/Jenks Consultants Date/Time: 7/6/23 Date/Time: 7/6/23 Date/Time: 7/6/23 Date/Time: 7/6/23	
Custody Seal No.: _____ A Yes ☐ A No ☐		Cooler Temperature(s) °C and Other Remarks: 4.7 13 12.7 12.7 12.7 12.7 12.7 12.7 12.7 12.7	

[illegible]

Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

Login Number: 178681

List Number: 1

Creator: Rystrom, Joshua R

List Source: Eurofins Denver

Question	Answer	Comment
Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	Refer to Job Narrative for details.
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

Login Number: 178681

List Source: Eurofins Lancaster Laboratories Environment Testing, LLC

List Number: 2

List Creation: 07/08/23 10:24 AM

Creator: McBeth, Jessica

Question	Answer	Comment
The cooler's custody seal is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable ($\leq 6^{\circ}\text{C}$, not frozen).	True	
Cooler Temperature is recorded.	True	
WV: Container Temperature is acceptable ($\leq 6^{\circ}\text{C}$, not frozen).	N/A	
WV: Container Temperature is recorded.	N/A	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the containers received and the COC.	False	Refer to Job Narrative for details.
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses.	True	
Is the Field Sampler's name present on COC?	False	Received project as a subcontract.
Sample custody seals are intact.	N/A	
VOA sample vials do not have headspace $> 6\text{mm}$ in diameter (none, if from WV)?	N/A	

Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

Login Number: 178681

List Number: 3

Creator: Korrinhizer, Micha L

List Source: Eurofins St. Louis

List Creation: 07/10/23 11:27 AM

Question	Answer	Comment
Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Isotope Dilution Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Matrix: Water

Prep Type: Total/NA

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFBA (10-130)	PFPeA (35-150)	13C5PHA (55-150)	C4PFHA (55-150)	C8PFOA (60-140)	C9PFNA (55-140)	C6PFDA (50-140)	13C7PUA (30-140)
280-178681-1	S-1	72	71	71	68	70	66	67	66
280-178681-2	FRB	68	70	70	71	66	71	64	50
280-178681-2 - RE	FRB								
LLCS 280-619039/2-A	Lab Control Sample	70	73	71	70	68	66	70	66
LLCS 280-619208/2-A	Lab Control Sample	77	78	77	76	80	81	79	80
LLCS 280-619711/2-A	Lab Control Sample	82	74	80	80	78	77	82	79
MB 280-619039/1-A	Method Blank	69	69	70	65	65	68	67	69
MB 280-619208/1-A	Method Blank	79	79	78	74	81	80	74	77
MB 280-619711/1-A	Method Blank	81	73	80	76	79	78	77	74

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFDaA (10-150)	PFTDA (10-130)	C3PFBS (55-150)	C3PFHS (55-150)	C8PFOS (45-140)	PFOSA (30-130)	d3NMFOS (45-200)	d5NEFOS (10-200)
280-178681-1	S-1	58	34	66	58	63	86	93	83
280-178681-2	FRB	37	21	65			57	66	58
280-178681-2 - RE	FRB				67	66			
LLCS 280-619039/2-A	Lab Control Sample	62	66	72	68	66	68	70	69
LLCS 280-619208/2-A	Lab Control Sample	77	80	84	78	82	79	91	91
LLCS 280-619711/2-A	Lab Control Sample	80	73	77	76	79	64	79	80
MB 280-619039/1-A	Method Blank	67	60	66	63	67	73	79	81
MB 280-619208/1-A	Method Blank	76	80	78	76	79	69	84	85
MB 280-619711/1-A	Method Blank	69	67	77	73	71	59	78	71

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	M242FTS (60-200)	M262FTS (60-200)	M282FTS (50-200)	HFPODA (25-160)	NMFM (10-150)	NEFM (10-150)	d5NPFSA (10-130)	d3NMFSA (15-130)
280-178681-1	S-1	85	91	120	71	57	48	41	45
280-178681-2	FRB	131	98	70	72	28	19	29	35
280-178681-2 - RE	FRB								
LLCS 280-619039/2-A	Lab Control Sample	74	77	82	73	64	60	51	50
LLCS 280-619208/2-A	Lab Control Sample	86	83	85	77	83	77	64	60
LLCS 280-619711/2-A	Lab Control Sample	94	89	96	79	66	67	53	50
MB 280-619039/1-A	Method Blank	76	84	94	66	64	59	53	51
MB 280-619208/1-A	Method Blank	83	79	81	76	78	75	67	61
MB 280-619711/1-A	Method Blank	85	86	91	82	61	59	46	47

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
13C5PHA = 13C5 PFHxA
C4PFHA = 13C4 PFHpA
C8PFOA = 13C8 PFOA
C9PFNA = 13C9 PFNA
C6PFDA = 13C6 PFDA
13C7PUA = 13C7 PFUnA
PFDaA = 13C2 PFDaA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
C3PFHS = 13C3 PFHxS
C8PFOS = 13C8 PFOS
PFOSA = 13C8 FOSA

Eurofins Denver

Isotope Dilution Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M242FTS = M2-4:2 FTS
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
HFPODA = 13C3 HFPO-DA
NMFM = d7-N-MeFOSE-M
NEFM = d9-N-EtFOSE-M
d5NPFSA = d5-NEtPFOSA
d3NMFSA = d3-NMePFOSA

Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Matrix: Water

Prep Type: Total/NA

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFBA (10-130)	PFPeA (40-150)	13C5PHA (40-150)	C4PFHA (40-150)	C8PFOA (30-140)	C9PFNA (30-140)	C6PFDA (20-140)	13C7PUA (20-140)
LCS 280-619039/3-A	Lab Control Sample	71	70	69	69	71	71	74	80
LCS 280-619208/3-A	Lab Control Sample	78	81	80	81	75	76	79	72
LCS 280-619711/3-A	Lab Control Sample	81	73	76	77	81	77	79	76

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFDaA (10-150)	PFTDA (10-130)	C3PFBS (25-150)	C3PFHS (25-150)	C8PFOS (20-140)	PFOSA (10-130)	d3NMFOS (10-200)	d5NEFOS (10-200)
LCS 280-619039/3-A	Lab Control Sample	76	68	70	65	69	83	97	100
LCS 280-619208/3-A	Lab Control Sample	75	78	79	71	82	71	83	82
LCS 280-619711/3-A	Lab Control Sample	73	69	75	74	73	66	84	83

Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	M242FTS (25-200)	M262FTS (25-200)	M282FTS (25-200)	HFPODA (25-160)	NMFM (10-150)	NEFM (10-150)	d5NPFSA (10-130)	d3NMFSA (10-130)
LCS 280-619039/3-A	Lab Control Sample	74	87	104	72	70	66	54	53
LCS 280-619208/3-A	Lab Control Sample	78	81	74	75	75	73	57	57
LCS 280-619711/3-A	Lab Control Sample	99	88	96	78	65	66	47	45

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
13C5PHA = 13C5 PFHxA
C4PFHA = 13C4 PFHpA
C8PFOA = 13C8 PFOA
C9PFNA = 13C9 PFNA
C6PFDA = 13C6 PFDA
13C7PUA = 13C7 PFUnA
PFDaA = 13C2 PFDaA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
C3PFHS = 13C3 PFHxS
C8PFOS = 13C8 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M242FTS = M2-4:2 FTS
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
HFPODA = 13C3 HFPO-DA
NMFM = d7-N-MeFOSE-M
NEFM = d9-N-EtFOSE-M

Eurofins Denver

Isotope Dilution Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis
d5NPFSA = d5-NEtPFOSA
d3NMFSa = d3-NMePFOSA

Job ID: 280-178681-1

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
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- 10
- 11
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- 14
- 15
- 16
- 17

Tracer/Carrier Summary

Client: Kennedy/Jenks Consultants
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method: 903.0 - Radium-226 (GFPC)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Ba (30-110)	
280-178681-1	S-1	62.3	
LCS 160-620038/2-A	Lab Control Sample	94.7	
LCSD 160-620038/3-A	Lab Control Sample Dup	94.7	
MB 160-620038/1-A	Method Blank	97.7	
Tracer/Carrier Legend			
Ba = Ba Carrier			

Method: 904.0 - Radium-228 (GFPC)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Ba (30-110)	Y (30-110)
280-178681-1	S-1	62.3	82.2
LCS 160-620040/2-A	Lab Control Sample	94.7	82.6
LCSD 160-620040/3-A	Lab Control Sample Dup	94.7	81.5
MB 160-620040/1-A	Method Blank	97.7	82.2
Tracer/Carrier Legend			
Ba = Ba Carrier			
Y = Y Carrier			

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Th-229 (30-110)	
280-178681-1	S-1	80.7	
LCS 160-619766/2-A	Lab Control Sample	83.4	
LCSD 160-619766/3-A	Lab Control Sample Dup	92.2	
MB 160-619766/1-A	Method Blank	76.9	
Tracer/Carrier Legend			
Th-229 = Thorium-229			

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	U-232 (30-110)	
280-178681-1	S-1	78.6	
LCS 160-619767/2-A	Lab Control Sample	78.4	
LCSD 160-619767/3-A	Lab Control Sample Dup	86.0	
MB 160-619767/1-A	Method Blank	86.2	
Tracer/Carrier Legend			
U-232 = Uranium-232			

LITHOS

ENGINEERING

GEOTECHNICAL BASELINE REPORT

NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON AND 58TH

ARVADA, COLORADO

NOVEMBER 30, 2023



November 30, 2023
Project No. 22134

Kennedy Jenks Consultants, Inc.
165 South Union Boulevard
Suite 570, Lakewood, CO 80228-1828

Attention: Jerry Pena, PE
Client Director

Regarding: Geotechnical Baseline Report - DRAFT
North Trunk Sewer Improvements – Tennyson and 58th
Arvada, CO

Mr. Pena,

Submitted herewith is the Geotechnical Baseline Report for the North Trunk Sewer Improvements – Tennyson and 58th. This report was prepared in general accordance with the Agreement between Lithos Engineering and Kennedy Jenks Consultants, Inc. dated October 3rd, 2023. The Geotechnical Baseline Report includes discussions of the geotechnical data, geotechnical baselines, and construction considerations in support of the subject project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,
Lithos Engineering

Adam Malsam, EIT
Staff Engineer

James Carroll, PE
Project Manager

Robin Dornfest, PG
Principle-in-Charge

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A	Tunnelman's Ground Classification Chart

REPORT ORGANIZATION

The Geotechnical Baseline Report (GBR) is organized as follows:

Section 1: Introduction

Describes the project background and discusses the purpose and intended usage of the GBR.

Section 2: Geology and Subsurface Investigation

Provides background on the regional geology and describes the investigation undertaken to evaluate ground conditions at the site.

Section 3: Baseline Geologic Units and Ground Behavior

Describes the materials found onsite and provides baselines for the materials' index properties and tunneling behavior. Additional baselines are provided for groundwater.

Section 4: Construction Considerations

Discusses shaft excavation and support, as well as the required tunneling and initial support methods. Additional considerations are given for typical construction scenarios that may arise during shaft or tunnel construction, which the Contractor should account for in their bid, consideration of means and methods, and performance. Third party impacts and considerations are also discussed.

Sections 5 and 6: Limitations and References

Describes limitations of the GBR and provides references for citations within the report.

1 INTRODUCTION

1.1 Project Description

Kennedy Jenks (KJ) retained Lithos Engineering (Lithos) for evaluation and tunnel design of the North Trunk Sewer Improvements – Tennyson and 58th project (Project) for the City of Arvada (Arvada). The Project includes a tunnel crossing constructed within Tennyson Street which crosses under five railroad tracks including one owned by Burlington Northern Santa Fe (BNSF), two owned by Union Pacific (UPRR), and two owned by the Regional Transportation District (RTD). The proposed crossing is approximately 210 feet of 48-inch fiberglass reinforced pipe (FRP) at a 0.29% slope downwards from north to south, as part of a sewer line. Initial support will include a 60-inch steel jacked casing pipe with a minimum thickness of 1.0-inch. The location of the project is shown in Figure 1. Tunnel construction has been chosen because it is not feasible to construct trenches for open cut installation of the pipe across the railroad lines.

1.2 Description and Purpose of GBR

The main purpose of this GBR is to establish contractual baselines for anticipated ground conditions and behavior that will be encountered during shaft and tunnel construction. Subsurface conditions observed through geotechnical field explorations and through laboratory analyses of collected samples for purposes of preparing the Contract Documents, including preparation of this GBR, are presented in the Geotechnical Data Report (GDR) (Lithos Engineering, 2023). GBR preparation was performed in general accordance with the ASCE document entitled: “Geotechnical Baseline Reports, Suggested Guidelines,” dated 2022.

The baselines established in this GBR for the anticipated subsurface conditions shall be used as the basis for developing bids and to help the Contractor evaluate allowed means and methods. The baselines will be used to evaluate potential differing site conditions (DSC) during construction. This GBR also summarizes geotechnical and construction considerations that form the basis of the tunnel portion of the Project design and Contract Documents. The GBR is prepared in tandem with the applicable Contract Documents, particularly the Tunnel Excavation and Initial Support specification. In the event of a conflict, the Contract Drawings and Specifications take contractual precedence over the GBR, and the GBR takes precedence over the GDR.

The baselines for anticipated subsurface conditions presented in this GBR reflect the design team’s and Construction Manager’s/General Contractor’s (CMGC) judgment of anticipated subsurface conditions and ground behavior based on assumed construction means and methods expected to be employed in the work. The baselines were established by considering available geologic and geotechnical data, and previous construction experience in similar subsurface conditions. Development of the Project design required interpretation, extrapolation, and interpolation between data obtained for the Project including aerial imagery, geotechnical test boreholes (i.e. borings), groundwater monitoring, and laboratory tests. While actual conditions encountered during tunnel construction are expected to be in accordance with the conditions baselined herein, specific locations where encountered subsurface conditions vary from those described in this GBR may exist. The Contractor should familiarize themselves with the DSC process to judge whether variances justify pursuit of a DSC claim.

2 GEOLOGY AND SUBSURFACE INVESTIGATION

2.1 Regional Geology

The geologic conditions in the area are characterized by surficial materials consisting of alluvial deposits within the historic floodplain of Clear Creek, mapped by Lindvall (1979) as Post Piney Creek Alluvium. These soils overlie interbedded sandstone, siltstone, and claystone bedrock of the Denver Formation (Lindvall, 1979). The project site is located within the Colorado Piedmont section of the Great Plains Physiographic Province. The piedmont, being an erosional inlier, consists of arid plains that are lower than the foothills to the west and slightly lower than the Great Plains to the east. During periods of uplift of the Rocky Mountains, younger sedimentary rock units were eroded and transported by streams and rivers to the piedmont. As rivers have historically meandered, alluvium was deposited in a broad swath across the plain.

Groundwater in the region is heavily influenced by the Rocky Mountains to the west and the local rivers, creeks, and drainages. Groundwater generally flows west to east from the foothills with more localized flow towards and along waterbodies. The Arvada area has semi-confined, unconfined, and perched aquifers within surficial sediments and confined and semi-confined aquifers in bedrock. The historically meandering and braided easterly-flowing rivers have significant influence on the local groundwater levels and hydrogeology. The unconfined aquifer groundwater levels are generally greater in the immediate vicinity of waterbodies such as rivers, creeks, and irrigation ditches and decreases with distance away from waterbodies.

2.2 Subsurface Investigation

Vine Laboratories performed the geotechnical drilling for the Project tunnel with observation by a Lithos representative on January 27, 2023. The field investigation consisted of two borings performed along the alignment and as near to the anticipated shaft locations as access allowed. Both borings were converted to temporary monitoring wells upon completion. In general, Vine Laboratories collected split spoon and Modified California samples. A geotechnical laboratory testing program was performed by Martinez Associates on selected samples and the results assisted in classification and assessment of applicable engineering properties for encountered subsurface materials.

Details of the procedures used for conducting the field work and laboratory testing, and the factual results of the subsurface investigation and laboratory testing performed for this project are summarized in the GDR. Summaries of geotechnical data encountered during the investigation or provided by laboratory testing are embedded within this report.

2.3 Literature Review

In addition to the field investigation, Lithos performed a review of available literature, including aerial imagery for the tunnel location and subsurface data from the United States Geological Survey (USGS), and other public entities. Specific documents reviewed for pertinent data include:

- Aerial imagery through Google Earth and Historic Aerials (historicaerials.com). Images dating from the 1950s through present were reviewed. These images indicate the project site consisted of farmland and gravel pits/ponds where gravel aggregate was mined. The 1960s saw an increase in residential housing construction on the north side of the railroad tracks. The 1970's saw an increase in gravel mining operations with additional gravel pits/ponds being formed. In the 1980's

and 1990's the gravel pits/ponds began to be reclaimed, with the land being used for industrial purposes. This process continues to the present-day. Railroad lines have been present at this site throughout the time period analyzed with the RTD having been recently constructed between 2015 and 2017.

- USGS Geologic Maps available for the tunnel crossing to identify the mapped deposits and bedrock formations. This aided in identifying the geologic processes that shaped the present-day subsurface conditions for the tunnel.
- Project geotechnical data for the relevant historic tunnel projects.

Relevant observations or construction considerations are noted in the GBR text for the tunnel where findings were applicable, and baselines were developed accordingly.

3 BASELINE GEOLOGIC UNITS AND GROUND BEHAVIOR

The soil characteristics and ground conditions described in this section of the GBR constitute the baseline geotechnical conditions to be anticipated during construction of the tunnel. Geotechnical baselines described herein include percent of volume of encountered material, Tunnelman's Ground Classification, abrasivity, potential for obstructions, clogging factor, and material sizes. Baseline values and discussion pertinent to the geologic conditions from which the baselines are derived are provided below.

The shafts and tunnel excavations will encounter cohesive soil and non-cohesive soil. These materials will exhibit different ground behavior. Baselines included in this report are derived based on the Tunnelman's classification system, which is included for reference in Appendix A at the end of this report.

Borings LE-01 and LE-02 were used to baseline geologic unit material parameters and create the Geologic Profile shown on Figure 2. The sections below discuss the geologic and geotechnical characteristics of these units.

3.1 Cohesive Soil

Cohesive soil to be encountered in shaft and tunnel excavations consists of lean clay (CL) with some sand and trace gravel. Cohesive soil generally consists of native materials and artificial fill with greater than 30% fines (clay and silt passing a No. 200 sieve) and exhibits a cohesive (plastic) behavior. Cohesive soil will be encountered above and below groundwater. The table below provides the baseline conditions of cohesive soil.

Table 3.1 – Baseline Conditions of Cohesive Soil

Tunnelman's Classification		Grain Size Distribution (% Composition)	Stickiness (% of excavation)			Soil Abrasivity	Blow Counts (Blow/Foot; ASTM D3550)
Above Groundwater	Below Groundwater		High	Medium	Low		
Slow Raveling	Fast Raveling	Fines Avg: 66 (Range: 54-71)	30	60	10	Low	Avg: 10 Range: 2-13

Cohesive soil has a low to high potential (as defined by Hollman and Thewes, 2012) to create problems with adhesion and/or clogging equipment with the in-situ moisture content. Precipitation, nuisance

water, or added moisture from construction (e.g. lubrication fluids) have the potential to create higher stickiness conditions. Hollman and Thewes suggest that the stickiness of fines, if present, can be correlated based on the consistency index and plasticity index of the clay. The consistency index is a function of the natural moisture content, the liquid limit, and the plasticity index.

Cohesive soil has a medium potential for excessive steel wear. Soil abrasivity is known to affect the wear and replacement rate of steel excavating components. Soil abrasivity is a function of the nature of the soil (e.g. mineralogy, quartz content, abrasiveness, rounding, compaction, and grain size distribution), soil moisture content, soil conditioning during excavation, and rate of excavation (Jakobsen, et al, 2013). Soil abrasivity was estimated based on mineral percentages of quartz-rich sand. Soil abrasivity is defined by Jakobsen, et al, 2013 as having NTNU/SINTEF Soil Abrasion Test (SAT) values less than 7 for low, greater than 7 and less than 22 for medium, and greater than 22 for high.

Cobbles in cohesive soil are anticipated based on the GDR and regional geology at the tunnel location. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 5%;
- 100% of cobbles will have a maximum dimension of 6 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

3.2 Non-Cohesive Soil

Non-cohesive soil to be encountered in shaft and tunnel excavation consists of silty gravel (GM), silty sand (SM), poorly graded sand with few silt (SP-SM), and poorly graded gravel (GP). Non-cohesive soil generally consists of native materials with less than 30% fines (clay and silt passing a No. 200 sieve) and exhibits a non-cohesive (non-plastic) behavior. Non-cohesive soil will be encountered above and below groundwater. The table below provides the baseline conditions of the non-cohesive soil.

Table 3.2 – Baseline Conditions of Non-Cohesive Soil

Tunnelman's Classification		Grain Size Distribution (% Composition)	Stickiness (% of excavation)			Soil Abrasivity	Blow Counts (Blow/Foot; ASTM D3550)
Above Groundwater	Below Groundwater		High	Medium	Low		
Fast Raveling	Flowing	Gravel Avg: 47 (Range: 27-64) Sand Avg: 43 (Range: 26-65) Fines Avg: 10 (Range: 5-18)	0	0	100	High	Avg: 80 Range: 9- 50/1"

Non-cohesive soil has a low potential to create problems with adhesion and/or clogging equipment with the in-situ moisture content and a high potential for excessive steel wear.

Cobbles in non-cohesive soil are anticipated based on the GDR and regional geology at the tunnel location. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 20%;
- 100% of cobbles will have a maximum dimension of 10 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

Other obstructions, including natural or artificial singular features greater than 12 inches will not be encountered.

3.3 Groundwater

Groundwater was encountered in both borings during the subsurface investigation. Both LE-01 and LE-02 were converted to temporary monitoring wells to characterize long term groundwater levels and collect groundwater samples to test for contaminants. Groundwater testing for contaminants was completed by others and is available to the contractor within the Contract Documents. The baseline groundwater elevation for the shafts and tunnel is shown on Figure 2.

The Contractor should anticipate local variations in permeability and aquifer characteristics will be encountered. With respect to construction dewatering design, cohesive soil is problematic in that frequent layers of lower permeability material with a high percentage of fines can hinder dewatering and are difficult to precisely model in traditional drawdown analysis.

The permeability of the geologic units varies with fines content, void ratio, and particle size. The Contractor should be aware that horizontal permeability in these deposits is significantly greater (from 5x to 10x) than vertical permeability. For baseline purposes, the permeability of the materials found onsite is as follows in the table below:

Table 3.3 – Baseline Permeability of Materials

Geologic Unit	Horizontal Permeability (cm/s)	
	Baseline	Range
Cohesive Soil	1×10^{-5}	1×10^{-4} to 1×10^{-8}
Non-cohesive Soil	1×10^{-1}	1×10^{-1} to 1×10^{-3}

4 CONSTRUCTION CONSIDERATIONS

The following sections discuss the methods Lithos anticipates will be used by the Contractor during construction of the shafts and tunnel crossing. Discussed methods are not intended to dictate construction alternatives, but rather to provide Lithos' opinion of various challenges to reasonable construction methods based on our experience and general practice. Within the limitations provided in the Contract Documents, the Contractor is ultimately responsible for selecting shaft and tunnel excavation methods, shaft and tunnel support systems, and ground and surface water control plans. Of primary importance are the railroad lines, as there is limited shallow cover between their base and the crown of the casing pipe (between 6.5 and 8.0 feet) and have strict settlement requirements. Existing utilities as

shown on the Contract Drawings must be crossed without impacts, per the Contract Documents. The Contractor's means and methods must be designed to protect critical infrastructure and meet Project requirements.

The Contractor should notify and coordinate with all Project stakeholders and third parties in advance of shaft and tunnel construction per the Contract Documents. Third party reviews of the Contractor's construction plans and submittals may be required by the City of Arvada, UPRR, BNSF, RTD, or others, and the Contractor should allow time to address third party concerns and requirements.

4.1 Shafts

Two construction shafts (a launch and receiving shaft) will be required for tunnel construction. Due to the location of a 60-inch diameter FRP storm drain immediately below the tunnel alignment and in close proximity to the northern shaft, and discussions with the CMGC, the anticipated direction of tunnel excavation is downhill from north to south. In this configuration the tunnel will proceed from the launch shaft on the north side of the railroad tracks to the receiving shaft on the south side. The optimal sizing and layout of each shaft will be at the Contractor's discretion and may be limited by the location of existing utilities; however, it is assumed the launch shaft will have approximate dimensions of 40 feet long (parallel to alignment) by 20 feet wide (perpendicular to alignment) with a depth extending to two feet below the tunnel invert. This assumes the Contractor will use 20-foot-long steel jacking pipe segments. It is assumed the receiving shaft will be used to recover mining equipment. The receiving shaft is assumed to have approximate dimensions of 20 feet long by 20 feet wide with a depth extending to two feet below the tunnel invert. If alternate sizing is used by the Contractor, the contractor shall notify the engineer for the relevant scaled baseline percentages.

The shafts will be excavated in cohesive soil and non-cohesive soil. See the individual geologic unit discussion in Section 3 for baselines regarding ground behavior. Table 4.1 below presents the relative baseline excavation volumes of each geologic unit that will be encountered during shaft excavation. For purposes of the baselines, shafts are assumed to extend two feet below the invert of the initial support.

Table 4.1 – Baseline Shaft Excavation Volumes by Geologic Unit

Geologic Unit	Shaft Excavation Volume (%)	
	Launch	Receiving
Cohesive Soil	90	90
Non-Cohesive Soil	10	10

Excavation is typically completed by hydraulic excavator for shaft depths up to approximately 20 feet. All excavated materials are anticipated to be rippable with conventional equipment. Blasting, hydraulic breakers, hoe rams, or other auxiliary equipment are not anticipated for the shafts on this project; however, the Contractor is advised to consider need based on the available geotechnical data and engineering properties baselined in Section 3. Shaft construction will need to resist loads from the soil such that movements of railroad tracks, ground surface, roads, and existing utilities are kept within specified tolerances. Additional loading conditions/requirements are presented by live rail (i.e. E-80 loading). When considering handling of excavated materials, or "muck," the Contractor needs to account for potential shrinkage and bulking which are defined as the change in volume of the soil from its in-situ condition following excavation, moisture conditioning, placement or compaction.

Unless watertight shafts are used, dewatering will be necessary for successful construction and use of the shafts. Dewatering internal to the shafts may be sufficient to keep groundwater levels manageable for construction. The Contractor is also encouraged to plan for a means of handling precipitation, internal nuisance or construction water as necessary, such as sump pumps in a gravel cutout.

A variety of ground support methods can be successful in this ground. Best practice in a shallow semi-urban environment will be to provide support as soon as practical after excavation in stages or concurrent with excavation. Possible methods include trench boxes, sheet piles, slide rail, soldier piles and lagging, or erected support. In the absence of groundwater, neither a concrete mud mat nor structural shaft invert plug are anticipated.

Shaft entry/exit eyes are often zones susceptible to over-excavation and running ground, particularly as a pipe or machine is jacked or rammed through the eye transition between shafts/tunnels. Over excavation at these points is often controlled by contact grouting of surficial materials immediately outside the shafts or incorporating a bulkhead which exposes no more ground than is necessary for excavation equipment to pass. The Contractor should assume entry/exit eyes may be accomplished with conventional means, such as torch-cutting a hole with an appropriate overcut to facilitate launch or retrieval of tunnel machinery or casing for excavations above the groundwater table. Lifting/raising plates/piles, or other support members at the excavation face for tunnels below groundwater will not be permitted unless they are sealed prior to lifting with a cast-in-place entry or exit wall. Other means, such as dewatering, portal stabilization, or gasketed concrete eyes, are not anticipated to be required in the absence of groundwater.

4.2 Tunnel

There are several different tunneling methods available for the excavation installation of the casing pipe on this crossing, however working with the design team and the CMGC contractor this GBR focuses the contractor preference for using a Tunnel Boring Machine (TBM). Should an alternative method be identified this GBR should be updated for that approach. Due to the regulatory reequipments from the railroads the Initial Support must employ a jacked steel casing. FRP carrier pipe will be installed in a second pass, followed by backfill grouting of the annulus and contact grouting of the overcut.

The tunnel will be driven downhill from north to south on a 0.29% grade. This alignment is to reduce the risk that the tunnel does not intersect the existing 60-inch diameter FRP storm drain located immediately below the tunnel alignment and in close proximity to the northern launch shaft. The contractor shall make the necessary adjustments to facilitate a downhill drive.

The tunnel will be excavated within cohesive soil and non-cohesive soil. Mixed face conditions are expected to be encountered with harder/denser non-cohesive soil below the relatively softer cohesive soil. These mixed face conditions may cause the tunnel to deflect upwards into the cohesive soil. The Contractor should anticipate minor changes of material content within the ranges portrayed by the GDR and unlikely to affect baseline parameters and ensure a means of controlling the excavation face such that sinkholes or adverse settlement of the railroad and utilities does not occur.

The table below presents baseline excavation volumes of each geologic unit that will be encountered during tunnel excavation. The baselines specific to subsurface characteristics and ground behavior are included in Section 3.

Table 4.2 – Baseline Tunnel Excavation Volumes by Geologic Unit

Geologic Unit	Tunnel Excavation Volume (%)
Cohesive Soil	95
Non-Cohesive Soil	5

Based on drilling observations and regional geology, cobbles are expected to be encountered during tunnel excavation. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 10%;
- 100% of cobbles will have a maximum dimension of 10 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

With pipe jacking a TBM a properly selected jacking frame shall be sufficient to install the casing pipe under tolerable jacking loads in the baselined ground conditions and for the length and diameter of the proposed tunnel using construction best-practices. While the Contractor is responsible for selecting means and methods appropriate to the ground conditions and tunnel layout within the limitations set by the contract documents, use of an Intermediate Jacking Station (IJS) is not anticipated for this tunnel. The cutterhead of the TBM shall have the ability to close the face to limit overexcavation, settlement, and the inflow of groundwater if encountered.

It is important the Contractor closely monitors tunnel excavation out of the launch shaft and into the receiving shaft. These locations are often where ground loss into the shaft and over-excavation of ground occurs due to disturbance from shaft construction, which can create surface settlement and/or sinkholes. If not controlled, the settlement trough can follow the path of excavation and extend beyond the immediate vicinity of the shaft and into areas where settlement control is critical, such as the railroad tracks.

4.3 Pre-Excavation Grouting

Pre-excavation grouting is a form of ground improvement that increases the strength and improves the behavior of the soil, making it more conducive to excavation. It is commonly used to reduce settlement, particularly in granular soils. For this project, pre-excavation grouting is not recommended as the ground conditions are not suitable. The soils contain between 50% to 70% fines, making them ill suited to grouting. Additionally, the use of pre-excavation grouting within this soil has a high risk of causing subsequent ground heave at the surface and displacement of the railroad tracks and or roadway.

4.4 Environmental Considerations

Measurement of subsurface gas was not completed or noted during the subsurface investigation. For baseline purposes, material encountered during shaft and tunnel excavation shall be considered “Potentially Gassy” per OSHA 3115-06R (2003).

Contaminated ground water was noted during environmental site assessments within the groundwater in the crossing vicinity. For baseline purposes, extra precautions or measures will be required to handle,

treat, or dispose of contaminated ground. The Contractor shall review the Contract Documents for information regarding the recorded contaminants and disposal requirements.

5 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings and geotechnical laboratory testing performed by others, information provided by the client, engineering judgement, and our experience with similar subsurface conditions and projects.

This report has been prepared exclusively for our client for design, bidding, and construction purposes for the subject project. Lithos is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects.

The baseline values presented in this report are only intended for the proposed design and construction as understood by Lithos at the time of issuing this report. If the proposed design and construction changes, Lithos should be notified immediately and given the opportunity to review the proposed changes and if necessary, modify our baseline values presented herein.

An environmental assessment was not included in Lithos' scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

6 REFERENCES

References listed herein are included as information only. The Contractor may not rely upon the provided references as baseline statements in any phase of the project.

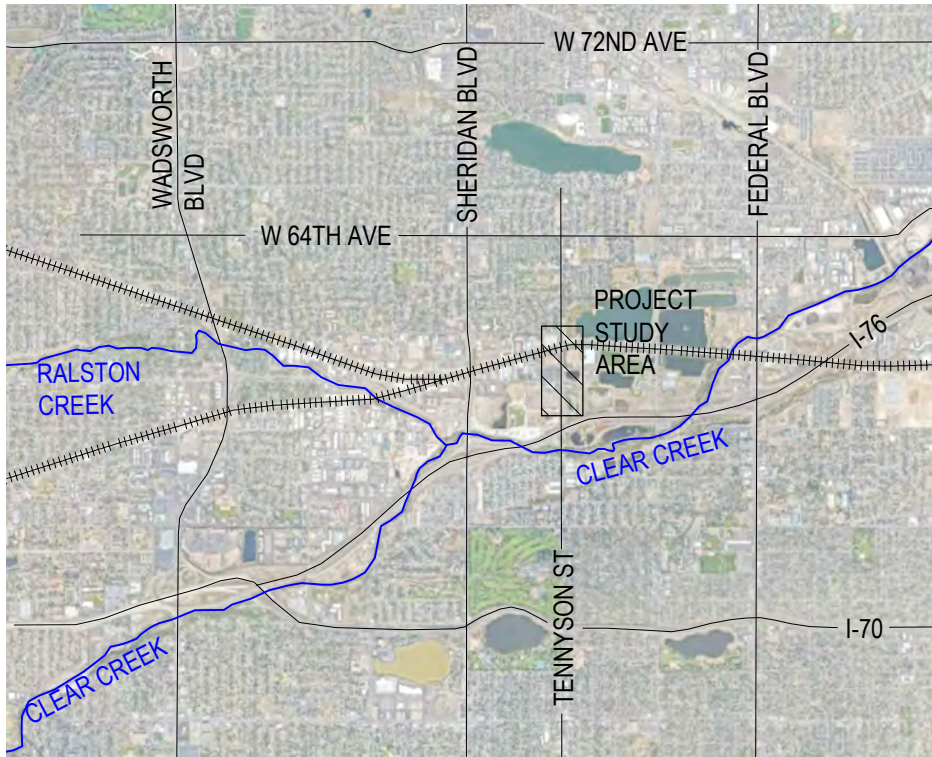
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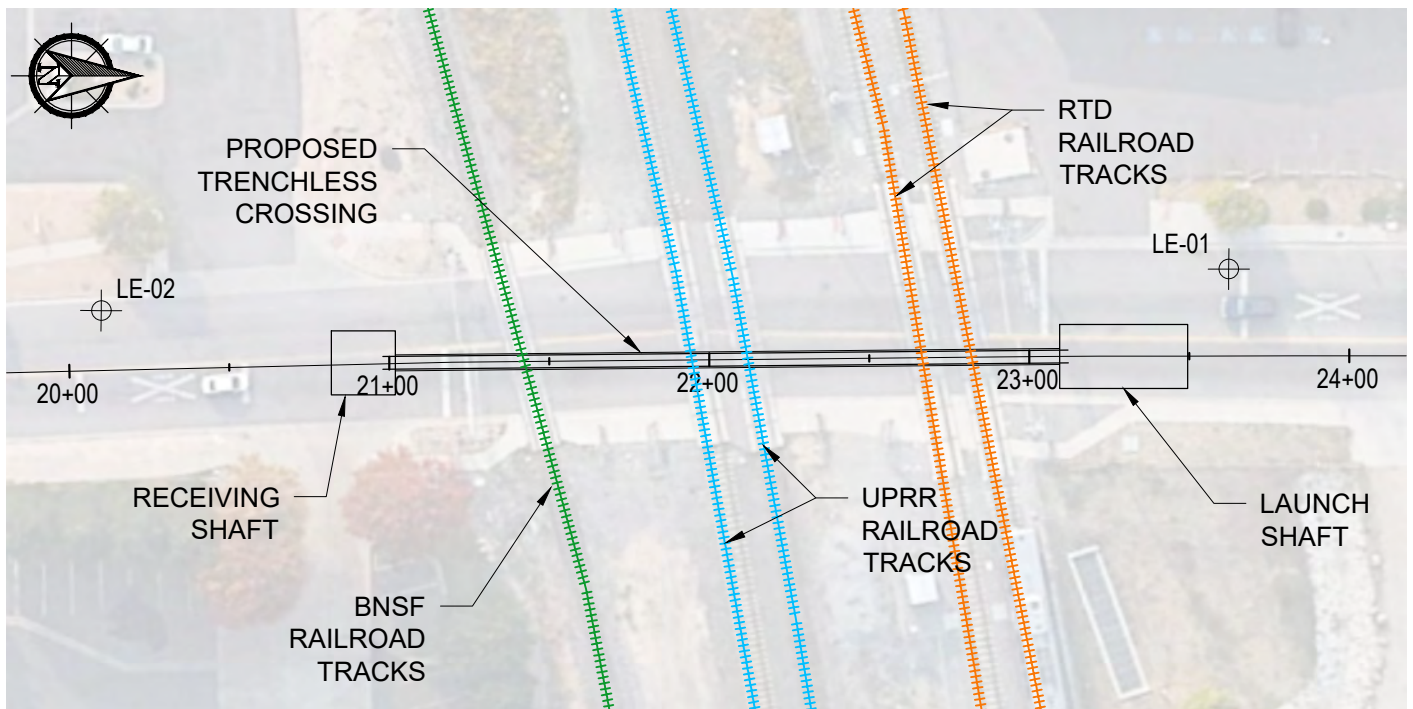


LEGEND:

-  BORING LOCATION
-  ROADWAYS
-  RIVERS AND CREEKS
-  RAILROAD TRACKS

0 1 2 MILES
SCALE

 REGIONAL OVERVIEW MAP



0 60 120 FT
SCALE

 SITE VICINITY MAP

**DRAFT:
NOT FOR
CONSTRUCTION**

LITHOS
ENGINEERING

5205 S. COLLEGE AVENUE, SUITE B
FORT COLLINS, COLORADO 80525
970.373.3195

PROJECT TITLE

NORTH TRUNK SEWER
IMPROVEMENTS - TENNYSON AND
58TH

DRAWING TITLE

SITE VICINITY MAP

OWNER

 CITY OF ARVADA

CLIENT

 KJ
Kearney Jenkins

FIGURE NUMBER

1

PROJECT NO.: 20088

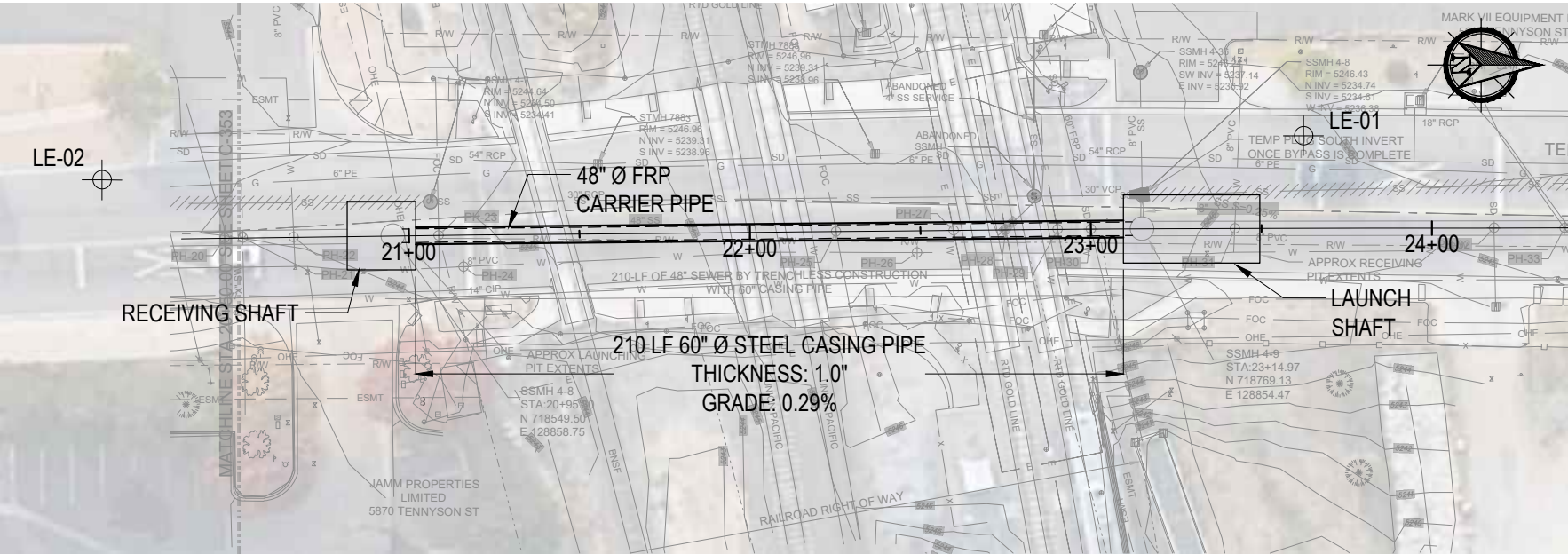
DRAWN BY: AM

LOCATION: ARVADA, CO

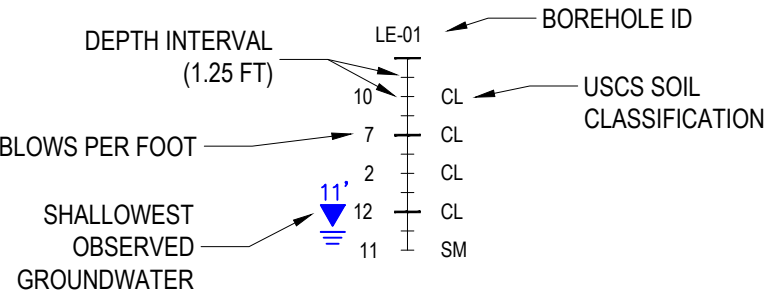
DESIGNED BY: JC

DATE: 11/13/2023

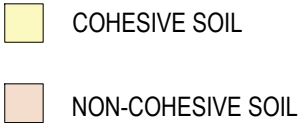
CHECKED BY: RD



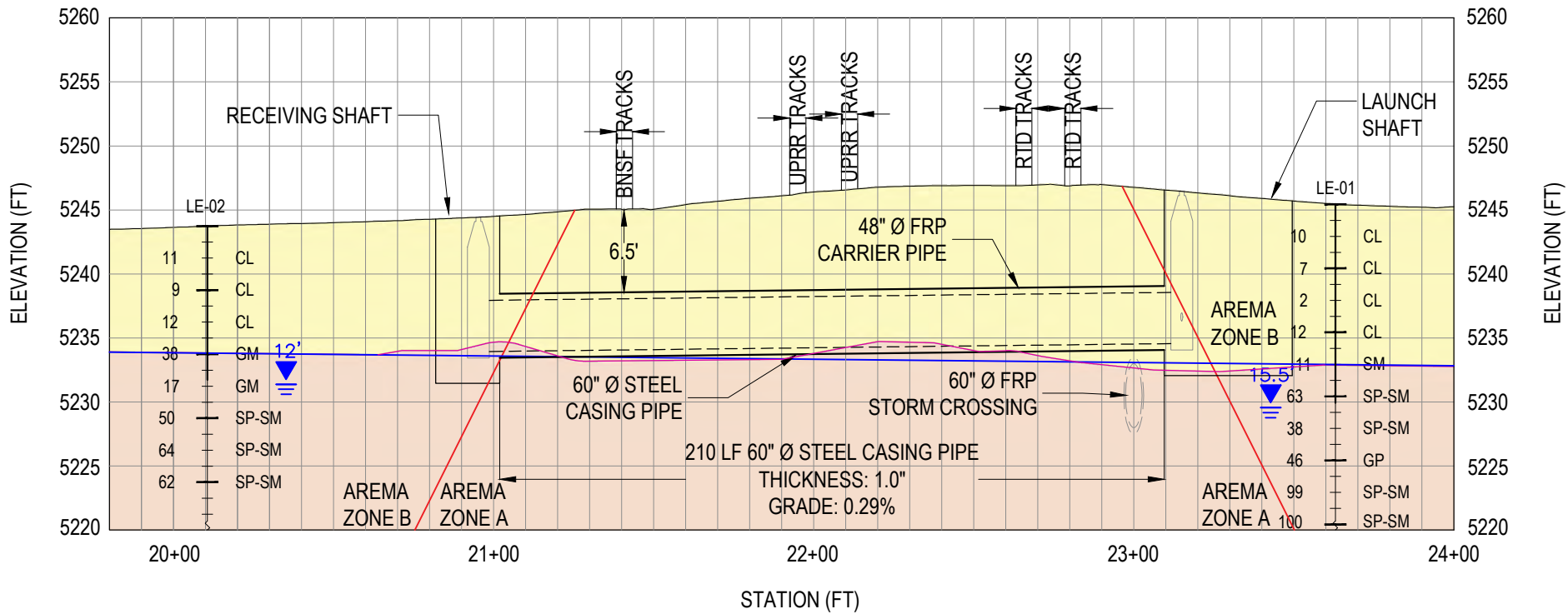
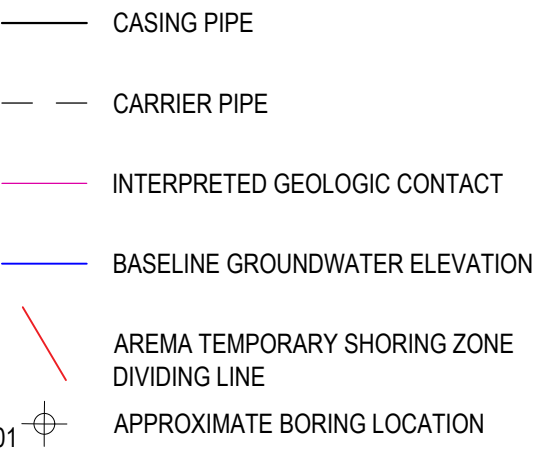
BORHOLE LEGEND:



BASELINE GEOLOGIC UNITS:



LINE TYPES AND SYMBOLS LEGEND:



NOTES:

1. 4:1 VERTICAL EXAGGERATION
2. ALIGNMENT AND INFRASTRUCTURE ARE AS SHOWN IN CONTRACT DOCUMENTS AND ARE PROVIDED HEREIN FOR INFORMATIONAL PURPOSES ONLY.
3. BOREHOLES ARE AS SHOWN IN THE PROJECT GEOTECHNICAL DATA REPORT (GDR) AND PROVIDED HEREIN FOR INFORMATIONAL PURPOSES ONLY.
4. BASELINE GROUNDWATER TABLE IS LOCATED APPROXIMATELY AT THE CONTACT OF THE COHESIVE AND NON-COHESIVE SOILS.

DRAFT:
NOT FOR
CONSTRUCTION

TENNYSON AND 58TH GEOLOGIC PROFILE
HORIZONTAL 1" = 50'
VERTICAL 1" = 12.5'

DRAFT

Tunnelman's Ground Classification Chart (Soil)

Classification	Behavior	Typical Soil Types
Firm	Material at the face is stable and holds a vertical face unsupported.	Hard clay, cemented sand
Slow Raveling	Material ravel from the face within hours after the ground has been exposed.	Sands with fines, fine sands above water table
Fast Raveling	Material ravel from the face within minutes after the ground has been exposed.	Sands with fines, fine sands below water table
Squeezing	Soil slowly advances into tunnel without signs of fracturing	Soft to stiff clays where the overburden pressure is higher than the soil shear strength
Swelling	Soil moves slowly into tunnel, associated with a considerable volume increase in the ground surrounding the tunnel	Highly overconsolidated high plasticity clays
Cohesive Running	Preceded by brief period of raveling, soil will then "run" like a granulated sugar until the slope angle reaches its angle of repose	Clean, fine, moist sand
Running	Immediately upon exposure, the soil will "run" like a granulated sugar until the slope angle reaches its angle of repose	Clean, coarse or medium sand above water table
Flowing	Flows as a mixture of soil and water into the heading.	Silt, sand, and gravel beneath the water table without fines

GEOTECHNICAL DATA REPORT

NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON AND 58TH
ARVADA, COLORADO

November 2023





November 30, 2023
22134

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Fort Collins, Colorado 80525
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Kennedy Jenks Consultants, Inc.
165 South Union Boulevard
Arvada, CO 80003

Attention: Jerry Pena, PE
Client Director

Regarding: Geotechnical Data Report
North Trunk Sewer Improvements – Tennyson and 58th
Arvada, Colorado

Mr. Pena,

Submitted herewith is the Geotechnical Engineering Investigation for the North Trunk Sewer Improvements – Tennyson and 58th project. This study was conducted in accordance with our contract between Lithos Engineering and Kennedy Jenks Consultants, Inc. (KJ) dated October 3rd, 2022. This report contains the results of our findings, an engineering interpretation with respect to the available project characteristics, and recommendations to aid design and construction of earth-related phases of this project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,
Lithos Engineering

Adam Malsam, EIT
Staff Engineer

James Carroll, PE
Project Manager

Robin Dornfest, PG
President



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1	Site Vicinity and Boring Location Map

APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Standard Geotechnical Drilling Keys and Boring Logs
B	Geotechnical Laboratory Testing Results
C	Water Quality Testing Results

1 INTRODUCTION

The North Trunk Sewer Improvements – Tennyson and 58th (Project) includes the installation of approximately 3,600 feet of new sanitary sewer main to meet the demand for increased capacity. The Owner of the Project is The City of Arvada (Arvada) and the lead engineer for the project is Kennedy Jenks (KJ). KJ retained Lithos to function as the Project's geotechnical and tunnel design engineer. The purpose of this report is to provide data collected during the Geotechnical Investigation at the Project site. The following sections generally describe the site and proposed construction.

1.1 Site Description

The Project site is located in Adams County, Colorado along Tennyson Street approximately between the intersection with W 61st Place and the underpass of Interstate 76 (Figure 1). This stretch of Tennyson Street consists of a mixture of residential and industrial uses and parks. Historically, this area served as a source of aggregate, and many gravel ponds were created as aggregates were extracted. Today, many of these gravel pits have been reclaimed and used for other purposes, though several remain.

1.2 Proposed Construction

A new gravity sanitary sewer main is needed to meet expected increases in required capacity. The proposed sewer will tie into an existing 30-inch sanitary sewer at the intersection of N. 61st Place and Tennyson St and will continue south beneath Tennyson St to a vault just north of the I-76 underpass. This alignment will necessitate crossing beneath five railroad tracks belonging to the Regional Transportation District (RTD), Union Pacific (UP) and Burlington Northern and Santa Fe (BNSF) along the way. Open cut trenches will be used to install most of this alignment, but trenchless techniques will be required to install the new sewer main beneath the railroad tracks without disrupting railroad operations. The proposed tunnel crossing beneath the railroad tracks includes the following properties:

- 48-inch FRP carrier pipe
- 0.24% grade
- Minimum depth of cover: 6 feet
- 60-inch steel casing pipe
- Approximately 210-feet long

Tunnel properties are based upon the 60% submittal drawings by KJ and may be adjusted as the design moves forward.

2 GEOLOGIC SETTING

2.1 Regional Geology

Geologically, the site is located within the historic floodplain of Clear Creek. The position of Clear Creek has changed several times over many years within this floodplain with gravel, sand, silt, and clay having been deposited as the creek has meandered. Lindvall (1979) mapped these deposits as Post Piney Creek Alluvium, which is described as being predominately composed of sands and silts within the floodplains of Clear Creek and the South Platte River. Below this alluvium, Lindvall (1979) has mapped the Denver Formation, which outcrops along the south bank of Clear Creek and near the intersection of W 64th St and Tennyson St. The Denver Formation is described as containing interbedded claystone, sandstone, and siltstone with the claystone being prone to swelling when wet. Lindvall (1979) also notes the presence of

artificial fill along Tennyson St. associated with the construction of the railroad tracks discussed in section 1.1.

3 GEOTECHNICAL INVESTIGATION

Lithos conducted a geotechnical investigation for the Project consisting of a subsurface investigation and a geotechnical laboratory testing program. The subsurface investigation included two borings for the proposed tunnel crossing and two borings for the open-cut sections of the pipeline. Borings were drilled on January 27th, 2023. Boring locations are included in Figure 1. Results from the subsurface investigation and the laboratory testing program are presented in Section 4.

3.1 Subsurface Investigation

Geotechnical borings LE-01 and LE-02 are associated with the proposed tunnel crossing and were drilled to depths of 31.5 feet below the existing ground surface (BGS). Geotechnical borings LE-03 and LE-04 are associated with the open cut portion of the new pipeline and were advanced to depths of 16.5 feet BGS. Lithos subcontracted geotechnical drilling to a qualified local subcontractor who utilized a truck-mounted CME-75 rig. Drilling and sampling procedures were conducted in general accordance with the ASTM standards identified in the following table:

Subsurface Investigation ASTM Standards	
Procedure	ASTM Standard
<i>Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils</i>	D 1586
<i>Standard Practice for Thick Wall, Ring-Line, Split Barrel, Drive Sampling of Soils</i>	D 3550

Continuous-flight, hollow-stem augers were used to advance borings LE-01 and LE-02 below the existing ground surface and through surficial soil deposits. Hollow stem augers were used in this instance as the borings were converted to temporary groundwater monitoring wells upon completion so that repeat water level measurements could be taken and water samples could be collected for testing. Continuous-flight solid stem augers, meanwhile, were used to advance borings LE-03 and LE-04. During boring advancement, Modified California (2.0-inch inner diameter) or split-spoon (1.5-inch inner diameter) samples were obtained in 2.5-foot intervals. The modified California barrel sampler was utilized to obtain relatively undisturbed samples of cohesive materials. The split-spoon sampler was used to obtain disturbed samples of non-cohesive materials. The number of blows by a 140-pound hammer falling 30 inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs (Appendix A). Blow counts with less than 6 inches of penetration are presented showing the number of blows for the resulting depth of penetration ($50/2'' = 50$ blows to drive the sampler 2 inches).

3.2 Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by Lithos on representative samples collected during the subsurface investigation. A laboratory summary table and graphical testing results are provided in Appendix B. Laboratory tests conducted in general accordance with associated ASTM standards are presented in the table below.

Geotechnical Laboratory Testing	
Test	Standard
Grain Size Distribution	ASTM D422
#200 Sieve Wash	ASTM D1140
Swell / Consolidation	ASTM D4546
Atterberg Limits	ASTM D4318
Moisture Content & Dry Density	ASTM D2216 & D2937

If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

3.3 Groundwater Testing

Groundwater samples were collected from the temporary wells installed at LE-01 and LE-02 on February 24th, 2023. Laboratory testing was conducted on these water samples to determine the concentration of trace elements and evaluate contaminants. Tests conducted are presented in the table below. Results of groundwater laboratory testing are presented in Appendix C.

Water Quality Laboratory Testing	
Test	Standard
Determination of Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry	EPA 245.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Atomic Emission Spectrometry	EPA 200.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry	EPA 200.8
Determination of Hexavalent Chromium by Colorimetric Method	SM 3500-CR B

4 SUBSURFACE CONDITIONS

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil descriptions noted on the boring logs and below are in general accordance with ASTM D 2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and D 2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

4.1 Subsurface Materials

Primary materials encountered during the subsurface investigation include fill, fine alluvium, and coarse alluvium. Bedrock was not encountered in any of the four borings. Boring logs, including a supplementary boring log key explaining boring log details and additional details regarding sampled materials, are provided in Appendix A.

4.1.1 Fill

Fill was encountered beneath the pavement section (4.5" asphalt, 6" base coarse) in LE-01 and LE-02. Fill extended from the bottom of this pavement section to 2.0 to 2.5 feet BGS. Fill was classified as the following in accordance with USCS:

- Clayey Sand (SC)
- Poorly Graded Sand with Clay (SP-SC)

Fill contained few to mostly fine to coarse sand, little fine to coarse gravel, and few to little clay. Based on recorded blow-counts, fill density is medium dense.

4.1.2 Fine Alluvium

Fine alluvium was encountered in all borings and ranged in depth from the surface or base of fill to 7.5 to 13.3 feet BGS. Fine alluvium was classified as the following in accordance with USCS:

- Lean clay (CL)
- Silt (ML)

In addition to the fine soil grains, fine alluvium also contained few to some fine to coarse sand and occasional trace to few fine to coarse gravel (maximum 2.0-inch diameter). Based on recorded blow-counts, fine alluvium density may generally be described as being medium stiff to stiff, though two samples (out of 15) returned relative densities of very soft to soft. Interbedded layers of sandy silt ranging in thickness from approximately 0.5 to 2.0 feet were documented within the fine alluvium in LE-04 on the southern edge of the project area.

4.1.3 Coarse Alluvium

Coarse alluvium was encountered in all borings and ranged in depth from the base of fine alluvium to the end of exploration between 16.5 and 31.5 feet bgs. Coarse alluvium was classified as the following in accordance with USCS:

- Silty Sand (SM)
- Poorly Graded Sand with Silt (SP-SM)
- Poorly Graded Gravel (GP)
- Silty Gravel (GM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand with Clay (SP-SC)
- Clayey Sand (SC)

Generally, coarse alluvium was some combination of sand and gravel with few to some fines (either clay or silt) present. Flowing behavior was noted at times within the coarse alluvium based on the drilling behavior. Based on recorded blow-counts, the density of coarse alluvium ranges from medium stiff to very dense. Interbedded layers of lean clay approximately six-inches thick were documented within the coarse alluvium in LE-01.

4.2 Groundwater

Groundwater was encountered during the subsurface investigation in all borings at depths ranging from 8 to 17 feet bgs. Temporary monitoring wells were installed in borings LE-1 and LE-02 to measure seasonable changes in the groundwater table elevation, collect groundwater readings through design and prior to construction, and collect water samples for testing. The table below presents initial groundwater levels in the borings at the time of drilling.

Boring	Groundwater Depth						
	Depth BGS (ft)						
	01/27/23	03/02/23	04/10/23	05/03/23	06/06/23	07/06/23	08/10/23
LE-01	17.0	19.2	18.2	18.0	15.75	15.45	16.15
LE-02	13.8	15.0	15.1	14.7	12.45	12.0	12.8
LE-03	11.5	--	--	--	--	--	
LE-04	8.0	--	--	--	--	--	

Groundwater should be expected to fluctuate based on precipitation, localized irrigation, water levels in nearby water bodies and irrigation ditches, site development, and seasonal variations.

5 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings, geotechnical laboratory testing, information provided by the Client, engineering judgement, and our experience with similar subsurface conditions and projects. The boring logs presented in this report only depict the subsurface conditions at the actual boring locations. Subsurface conditions are typically variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types presented in this report are approximate, and in some cases may be more abrupt or gradational than described herein. Groundwater levels may vary with time, adjacent water source levels, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

This report has been prepared exclusively for our client for design purposes for the subject project. Lithos Engineering is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects. If differing site conditions are encountered during further evaluation of the subsurface conditions by others or during construction, Lithos Engineering should be notified immediately to determine if any changes to our recommendations presented in this report are warranted.

An environmental assessment was not included in Lithos Engineering scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos Engineering recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

6 REFERENCES

- ASTM Standards, ASTM International, West Conshohocken, PA (2012).
- Lindvall, R.M. (1979). *Geologic map of the Arvada quadrangle, Adams, Denver, and Jefferson Counties, Colorado*, US Geological Survey, Geological Quadrangle Map GQ-1453
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- U.S. EPA. 1994. *Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry*, Revision 5.4. Cincinnati, OH
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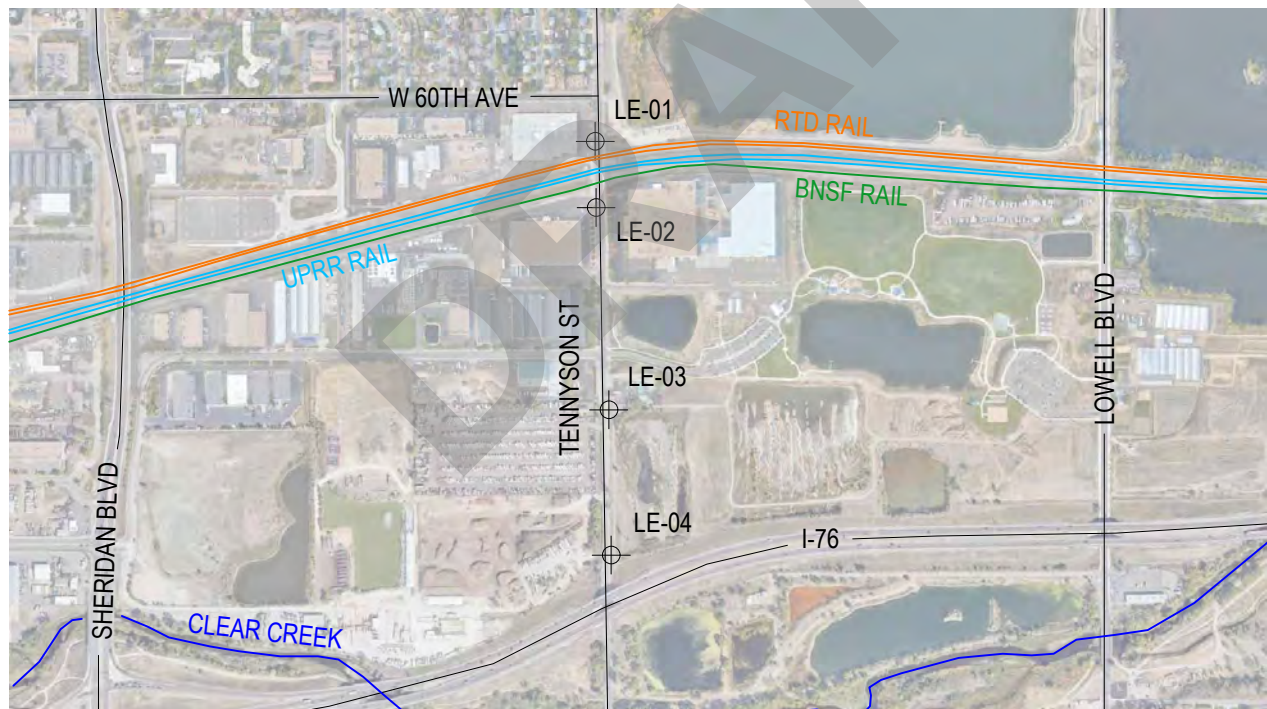


0 1 2 MILES
SCALE

REGIONAL OVERVIEW MAP

LEGEND:

- BORING LOCATION
- ROADWAYS
- RIVERS AND CREEKS
- RAILROAD TRACKS



0 1000 2000 FT
SCALE

SITE VICINITY MAP

LITHOS
ENGINEERING
2750 S. WADSWORTH BLVD., SUITE D-200
DENVER, COLORADO 80227
303.625.9502

PROJECT TITLE

NORTH TRUNK SEWER
IMPROVEMENTS - TENNYSON AND
58TH

DRAWING TITLE

SITE VICINITY AND BORING
LOCATION MAP

OWNER



CLIENT



FIGURE NUMBER

FIG.1

PROJECT NO.:

20088

DRAWN BY:

AM

LOCATION:

ARVADA, CO

DESIGNED BY:

JC

DATE:

02/09/2023

CHECKED BY:

BS

BORING LOG KEY

STANDARD GEOTECHNICAL DRILLING

Soil Classifications:

Clear Square Sieve Openings				U.S. Standard Series Sieve Sizes			
12"	3"	3/4"	4	10	40	200	
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm	

Gradation Estimates by Field Observation	
Description	Quantity (%)
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		Cohesive Soils	
Classification	Blows per 12 in	Classification	Blows per 12 in
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

Color: Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Plasticity	
Description	Criteria
Nonplastic	A $\frac{1}{8}$ " diameter thread cannot be rolled
Low	A $\frac{1}{8}$ " in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{1}{8}$ " in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{1}{8}$ " in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Description of Odor	
Description	Criteria
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

Rock Descriptions:

Weathering	
Description	Criteria
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	Criteria
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$ " diameter
Medium Grained	Grain diameter between $\frac{1}{16}$ " and $\frac{3}{16}$ "
Coarse Grained	Grains diameter between $\frac{3}{16}$ " and $\frac{1}{4}$ "
Very Coarse Grained	Grains larger than $\frac{1}{4}$ " in diameter

Field Hardness	
Description	Criteria
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$ " deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

Geologic Interpretation:

A **Geologic Interpretation** of encountered soil and bedrock units is provided for each specific **Visual Material Description**. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

Sample Graphics and Descriptions:

-  California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.
-  Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.
-  Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.
-  Bulk Sample: Bulk or bagged sample taken from auger cuttings.
-  Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

Groundwater Monitoring Well Graphics:

-  Riser Pipe with Auger Cuttings
-  Well Screen with Silica Sand
-  Riser Pipe with Silica Sand
-  Riser Pipe with Bentonite Chips
-  Auger Cuttings
-  Stick-Up Well
-  Flush Mounted Cap
-  First Groundwater Reading
-  Second Groundwater Reading
-  Third Groundwater Reading

Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.

 Fill	 Lean Clay	 Silt	 Fat Clay	 Elastic Silt	 Well Graded Gravel
 Poorly Graded Gravel	 Well Graded Sand	 Poorly Graded Sand	 Sandstone	 Claystone	 Siltstone

BORING: LE-01Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Hollow Stem Auger (HSA)Bit Type: Cutting HeadCasing Description: HSAHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.80495, -105.044092*Boring Elevation: 5,249.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA						Strength & Compressibility							
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)					
0							PAVEMENT SECTION Asphalt: 4.5-inches Base: 6.0-inches																		
2.5	5247.5	22 16 13	16	6 4	6		FILL Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, little fine to coarse gravel, few clay, medium dense, olive brown, moist, iron oxidation.	0.9 ft.																	
	5245						FINE ALLUVIUM LEAN CLAY (CL), few fine to coarse sand, trace fine gravel, stiff, olive brown, moist.	2.5 ft.																	
5	5242.5	3 4	10				LEAN CLAY with sand (CL), little to some fine to medium sand, trace fine gravel, medium stiff, olive brown, moist.		26.1	95.7				71.4	41	23									
7.5	5240	1 1	11				As above except very soft, olive brown to dark blueish gray.		32.9	87.9				71.1	43	26					N/A		-0.4		
10	5237.5	4 8	11				LEAN CLAY (CL), few fine to coarse sand, stiff, olive brown, moist.		29.2	93.4															
12.5	5235	4 7	10				As above.																		
15		30					COARSE ALLUVIUM Silty SAND (SM), mostly fine to medium sand, little silt, loose, olive brown to yellowish brown, moist, iron oxidation.	13.3 ft.																	
							Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt,																		

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:Date: 01/27/23 Elapsed Time: 0-days Depth to Groundwater: 17.0-feet

BORING: LE-01Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Hollow Stem Auger (HSA)Bit Type: Cutting HeadCasing Description: HSAHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.80495, -105.044092*Boring Elevation: 5,249.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA						Strength & Compressibility		
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
			30 33	12																
17.5			12 16 22	12			very dense, pale olive, moist, calcite, maximum particle size 1.25-inches.					40.4	49.6	10	NV	NP				
							As above except wet.													
20			21 25	12			Poorly graded GRAVEL with sand (GP), mostly fine to coarse gravel, some fine to coarse sand, trace silt, dense, pale olive, wet, maximum particle size 2.0-inches.		2.8	158.5	63.6	31.8	4.6							
22.5			49 50	4			Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt, very dense, pale olive to olive brown, wet, calcite, maximum particle size 1.25-inches. LEAN CLAY Interlayer (CL), few fine sand, olive brown, moist.													
25			49 50 50	18			Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt, very dense, pale olive to olive brown, wet, calcite, maximum particle size 1.25-inches.													
27.5			27 50/5"	18			Poorly graded SAND with gravel (SP), mostly fine to coarse sand, some fine to coarse gravel, trace silt, very dense, olive brown, wet, maximum particle size 1.25-inches.													
30			49 33 27	11			Clayey SAND with gravel (SC), mostly fine to coarse sand, little fine to coarse gravel, little clay, very dense, pale olive, wet, maximum particle size 1.0-inches.													

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	17.0-feet

BORING: LE-01						Drilling and Sampling Methods							LITHOS ENGINEERING							
Project Name: NTSI - Tennyson & 58th						Drill Make and Model: CME-75							Boring Location: 39.80495, -105.044092*							
Project Number: 22134						Drilling Method: Hollow Stem Auger (HSA)							Boring Elevation: 5,249.0-feet*							
Client's Name: Kennedy Jenks						Bit Type: Cutting Head							Notes: *Location and Elevation approximate.							
Owner's Name: City of Arvada						Casing Description: HSA														
Drilling Subcontractor: Vine Laboratories						Hammer Weight (lbs)/Fall (in): 140/30														
Lithos Representative: J. Halverson						Sampler Type(s): Mod. Cal., SPT														
Date(s) of Drilling: 01/27/23						Sampler Diameter(s): 2.0-inches, 1.4-inches														
Sampling Data						Visual Material Description							Laboratory Testing Results							
Depth (ft) Elevation (ft) Sample Identification Blow Count/6 in Recovery (in) / ROD (%) Drilling Rate (min./ft.) Geologic Graphic						Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions							In-Situ StatesINDEX DATAStrength & Compressibility							
													Moisture Content (%)Dry Unit Weight (pcf)Water Soluble Sulfates (%)Gravel Content (%)Sand Content (%)Fines Content (%)Liquid Limit (%)Plasticity Index (%)UCS (psi)Swell Pressure (psf)Swell Percent (%)							
32.5						END OF EXPLORATION31.5 ft.														
5217.5																				
32.5																				
5215																				
35																				
5212.5																				
37.5																				
5210																				
40																				
5207.5																				
42.5																				
5205																				
45																				
5202.5																				
General Notes:											Groundwater Data:									
1) Soil classification is in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).											Date: Elapsed Time: Depth to Groundwater:									
2) The maximum particle size identified in the material description is dependent on sampler dimensions.											01/27/230-days17.0-foot									
3) Additional information is provided on the Boring Log Key.																				
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.																				

BORING: LE-02Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Hollow Stem Auger (HSA)Bit Type: Cutting HeadCasing Description: HSAHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.804011, -105.044089*Boring Elevation: 5,247.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States			INDEX DATA				Strength & Compressibility		
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)
0							PAVEMENT SECTION Asphalt: 4.5-inches Base: 6.0-inches												
							FILL Clayey SAND with gravel (SC), mostly fine to coarse sand, little fine gravel, little clay, medium dense, olive brown, moist.	0.9 ft.											
2.5	5245	11 6	18				FINE ALLUVIUM Sandy LEAN CLAY (CL), some fine to coarse sand, few fine to coarse gravel, very stiff, olive to dark brown, moist. As above except mottled olive to olive brown.	2.0 ft.											
		6 7	10				As above except mottled olive to olive brown.		18.1	104.3			53.5	35	20		N/A	0.0	
5	5242.5	4 5	12				As above except no gravel, olive gray, iron oxidation, calcite.												
7.5	5240	5 7	10																
10	5237.5	15 23	10				COARSE ALLUVIUM Silty GRAVEL with sand (GM), mostly fine to coarse gravel, little to some fine to coarse sand, little silt, dense, yellowish brown, moist, iron oxidation, maximum particle size 2.0-inches.	10.0 ft.	5.2	130.6									
		7 10	9				As above except medium dense.		12.1	117.7		56.1	25.7	18.2	NV	NP			
15	5232.5						Poorly graded SAND with silt and gravel (SP-SM), mostly fine to coarse sand, little to some fine to coarse gravel, few silt,												
		28																	

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:Date: 01/27/23 Elapsed Time: 0-days Depth to Groundwater: 13.8-feet

BORING: LE-02Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Hollow Stem Auger (HSA)Bit Type: Cutting HeadCasing Description: HSAHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.804011, -105.044089*Boring Elevation: 5,247.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA						Strength & Compressibility					
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)			
			50	2			very dense, dark brown, wet, maximum particle size 2.0-inches.																
17.5	5230						As above except olive, maximum particle size 1.25-inches.																
			24 32 32	12																			
	5227.5						As above except olive, maximum particle size 1.25-inches.																
20			17 28 34	17												27.1	64.5	8.4					
	5225																						
22.5																							
	5222.5						As above except olive, maximum particle size 1.25-inches.																
25			27 50/1"	6																			
	5220																						
27.5																							
	5217.5																						
30			15 19 15	16			As above except dense, olive, maximum particle size 1.25-inches.																

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	13.8-feet

BORING: LE-02						Drilling and Sampling Methods							LITHOS ENGINEERING												
Project Name: NTSI - Tennyson & 58th						Drill Make and Model: CME-75							Boring Location: 39.804011, -105.044089*												
Project Number: 22134						Drilling Method: Hollow Stem Auger (HSA)							Boring Elevation: 5,247.0-feet*												
Client's Name: Kennedy Jenks						Bit Type: Cutting Head							Notes: *Location and Elevation approximate.												
Owner's Name: City of Arvada						Casing Description: HSA																			
Drilling Subcontractor: Vine Laboratories						Hammer Weight (lbs)/Fall (in): 140/30																			
Lithos Representative: J. Halverson						Sampler Type(s): Mod. Cal., SPT																			
Date(s) of Drilling: 01/27/23						Sampler Diameter(s): 2.0-inches, 1.4-inches																			
Sampling Data						Visual Material Description										Laboratory Testing Results									
Depth (ft) Elevation (ft) Sample Identification Blow Count/6 in Recovery (in) / RQD (%) Drilling Rate (min./ft.) Geologic Graphic						Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions										In-Situ States INDEX DATA Strength & Compressibility									
						Groundwater Depth / Monitoring Well Configuration										Moisture Content (%) Dry Unit Weight (pcf) Water Soluble Sulfates (%) Gravel Content (%) Sand Content (%) Fines Content (%) Liquid Limit (%) Plasticity Index (%) UCS (psi) Swell Pressure (psf) Swell Percent (%)									
END OF EXPLORATION						31.5 ft.																			
General Notes:						Groundwater Data:										Date: Elapsed Time: Depth to Groundwater:									
1) Soil classificaitons are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)						2) The maximum particle size identified in the material description is dependent on sampler dimensions.										01/27/23 0-days 13.8-foot									
3) Additional information is provided on the Boring Log Key.						4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.																			

BORING: LE-03Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Solid Stem Auger (SSA)Bit Type: Cutting HeadCasing Description: N/AHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.801111, -105.043856*Boring Elevation: 5,244.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA						Strength & Compressibility														
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)												
0			5 7	10			FINE ALLUVIUM LEAN CLAY with sand (CL), little fine to coarse sand, few fine to coarse gravel, stiff, mottled dark brown to olive, moist, bark, roots, maximum particle size 1.5-inches.																									
2.5	5242.5		6 8	6			As above except few fine gravel, iron oxidation, mica grains, maximum particle size 0.5-inches.																									
5	5240		5 7	6			Sandy LEAN CLAY (CL), some to mostly fine to coarse sand, stiff, dark brown to olive, moist, iron oxidation, mica grains.		17.8	96.6						53.4	32	15														
7.5	5237.5		8 10	9			COARSE ALLUVIUM Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, medium dense, olive to olive brown, moist, iron oxidation, maximum particle size 2.0-inches.		4.3	118.6						33.8	58.8	7.4														
10	5235		3 7 10	6			As above except little fine to coarse gravel, olive brown, maximum particle size 1.5-inches.																									
12.5	5232.5		22 29	10			As above except wet.																									
15	5230		24				Clayey SAND with gravel (SC), mostly fine to coarse sand, little clay, little fine to coarse gravel, very dense, olive to olive																									

General Notes:

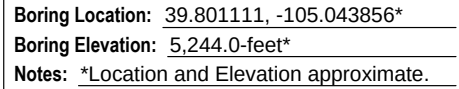
- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	11.5-feet

Project Name: NTSI - Tennyson & 58th
Project Number: 22134
Client's Name: Kennedy Jenks
Owner's Name: City of Arvada
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/27/23

Drill Make and Model: CME-75
 Drilling Method: Solid Stem Auger (SSA)
 Bit Type: Cutting Head
 Casing Description: N/A
 Hammer Weight (lbs)/Fall (in): 140/30
 Sampler Type(s): Mod. Cal., SPT
 Sampler Diameter(s): 2.0-inches, 1.4-inches



EXPLORATION

4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

BORING: LE-04Project Name: NTSI - Tennyson & 58thProject Number: 22134Client's Name: Kennedy JenksOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesLithos Representative: J. HalversonDate(s) of Drilling: 01/27/23**Drilling and Sampling Methods**Drill Make and Model: CME-75Drilling Method: Solid Stem Auger (SSA)Bit Type: Cutting HeadCasing Description: N/AHammer Weight (lbs)/Fall (in): 140/30Sampler Type(s): Mod. Cal., SPTSampler Diameter(s): 2.0-inches, 1.4-inchesBoring Location: 39.799083, -105.043825*Boring Elevation: 5,243.0-feet*Notes: *Location and Elevation approximate.**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA					Strength & Compressibility												
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)									
0	5242.6		6	9			FINE ALLUVIUM Sandy LEAN CLAY (CL), some fine to coarse sand, few fine gravel, stiff, dark brown, moist, roots.																						
2.5	5240		3	5			As above.																						
5	5237.5		2	12			Silty SAND (SM), mostly fine to coarse sand, little silt, olive brown, moist, iron oxidation.																						
							As above except very loose, olive gray.	5.8 ft.		54.6	70.8				74.5	NV	NP												
7.5	5235		6	6			FINE ALLUVIUM SILT with sand (ML), little to some fine to medium sand, soft, dark gray, moist. 6' - Auger grinding indicative of gravel and cobbles.																						
							As above except stiff. Silty SAND with gravel (SM), mostly fine to coarse sand, little fine to coarse gravel, little silt, medium dense, yellowish brown, moist. SILT (ML), stiff, dark gray, moist.	(8.0 ft.)																					
10	5232.5		11	10			COARSE ALLUVIUM Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, dense, dark olive, wet, maximum particle size 1.25-inches.	10.0 ft.						40.3	52.7	7.0													
12.5	5230		11	13			Clayey SAND with gravel (SC), mostly fine to coarse sand, some clay, little fine to coarse gravel, dense, dark olive to olive brown, wet, maximum particle size 1.25-inches.																						
15	5227.5		13				As above.																						

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	8.0-feet

BORING: LE-04 Project Name: NTSI - Tennyson & 58th Project Number: 22134 Client's Name: Kennedy Jenks Owner's Name: City of Arvada Drilling Subcontractor: Vine Laboratories Lithos Representative: J. Halverson Date(s) of Drilling: 01/27/23					Drilling and Sampling Methods Drill Make and Model: CME-75 Drilling Method: Solid Stem Auger (SSA) Bit Type: Cutting Head Casing Description: N/A Hammer Weight (lbs)/Fall (in): 140/30 Sampler Type(s): Mod. Cal., SPT Sampler Diameter(s): 2.0-inches, 1.4-inches					LITHOSENGINEERING Boring Location: 39.799083, -105.043825* Boring Elevation: 5,243.0-feet* Notes: *Location and Elevation approximate.																																						
Sampling Data <table><tr><td>Depth (ft)</td><td>Elevation (ft)</td><td>Sample Identification</td><td>Blow Count/6 in</td><td>Recovery (in) / RQD (%)</td><td>Drilling Rate (min./ft.)</td><td>Geologic Graphic</td></tr><tr><td></td><td></td><td></td><td>35 45</td><td>18</td><td></td><td></td></tr></table>					Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic				35 45	18			Visual Material Description Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions					Laboratory Testing Results <table><tr><td colspan="2">In-Situ States</td><td colspan="5">INDEX DATA</td><td colspan="2">Strength & Compressibility</td></tr><tr><td>Moisture Content (%)</td><td>Dry Unit Weight (pcf)</td><td>Water Soluble Sulfates (%)</td><td>Gravel Content (%)</td><td>Sand Content (%)</td><td>Fines Content (%)</td><td>Liquid Limit (%)</td><td>Plasticity Index (%)</td><td>UCS (psi)</td><td>Swell Pressure (psf)</td><td>Swell Percent (%)</td></tr></table>					In-Situ States		INDEX DATA					Strength & Compressibility		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic																																										
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In-Situ States		INDEX DATA					Strength & Compressibility																																									
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END OF EXPLORATION							16.5 ft.																																									
General Notes: 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2) The maximum particle size identified in the material description is dependent on sampler dimensions. 3) Additional information is provided on the Boring Log Key. 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.										Groundwater Data: Date: 01/27/23 Elapsed Time: 0-days Depth to Groundwater: 8.0-feet																																						

GEOTECHNICAL LABORATORY TESTING RESULTS													
Sample Identification		In-Place States		Material Classification and Index Testing						Stress Strain Behavior		USCS ¹	Description
										One-Dimensional Consolidation/Swell			
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Particle Size Distribution (%)			Atterberg Limits (%)			Swell Percent (%) ²	Swell Pressure (psf)		
				Gravel Content	Sand Content	Fines Content	Liquid Limit	Plastic Limit	Plasticity Index				
LE-01	5.0	26.1	95.7			71.4	41	18	23			CL	LEAN CLAY with sand
LE-01	7.5	32.9	87.9			71.1	43	17	26	-0.4	N/A	CL	LEAN CLAY with sand
LE-01	10.0	29.2	93.4									CL	LEAN CLAY
LE-01	15.0			40.4	49.6	10.0	NV	NP	NP			SP-SM	poorly graded SAND with silt and gravel
LE-01	20.0	2.8	158.5	63.6	31.8	4.6						GP	poorly graded GRAVEL with sand
LE-02	5.0	18.1	104.3			53.5	35	15	20	0.0	N/A	CL	sandy LEAN CLAY
LE-02	10.0	5.2	130.6									GM	silty GRAVEL with sand
LE-02	12.5	12.1	117.7	56.1	25.7	18.2	NV	NP	NP			GM	silty GRAVEL with sand
LE-02	20.0			27.1	64.5	8.4						SP-SM	poorly graded SAND with silt and gravel
LE-03	5.0	17.8	96.6			53.4	32	17	15			CL	sandy LEAN CLAY
LE-03	7.5	4.3	118.6	33.8	58.8	7.4						SP-SC	poorly graded SAND with clay and gravel
LE-04	5.0	54.6	70.8			74.5	NV	NP	NP			ML	SILT with sand
LE-04	10.0			40.3	52.7	7.0						SP-SC	poorly graded SAND with clay and gravel

¹Where Atterberg Limits and Fines Content testing was not performed, USCS classifications visually determined in the field during the subsurface investigation

²Swell percent as measured under an innundation pressure of 500 psf

MOISTURE CONTENT & DENSITY DETERMINATION

PROJECT: 58th and Tennyson JOB NO. 23-0029

TESTED BY A. Godat DATE 2/7/2023 CLIENT JOB NO.: 22134

LAB NO.	11775	11776	11777	11779	11780	11781
Boring No.	LE-01	LE-01	LE-01	LE-01	LE-02	LE-02
Depth, ft.	5'	7.5'	10'	20'	5'	10'
Diameter, in.	1.931	1.923	1.909	1.923	1.947	1.947
Length, in.	4.011	4.091	3.393	3.012	4.172	2.943
Wet Soil + Tare, gm.	380.5	372.6	316.0	382.7	410.2	324.4
Tare, gm.	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil, gm.	372.3	364.5	308.0	374.6	402.0	316.4
Volumn, cu. ft.	0.006798	0.006876	0.005620	0.005062	0.007188	0.005071
Wet Density, pcf	120.6	116.8	120.7	163.0	123.2	137.4
Cup No.	40	15	51	59	MOE	32
Cup Weight, gm	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil + Cup, gm.	380.5	301.6	316.0	382.7	331.7	324.4
Dry Soil + Cup, gm.	303.4	229.0	246.4	372.5	282.2	308.7
Water, gm.	77.1	72.6	69.6	10.2	49.5	15.7
Dry Soil, gm.	295.2	220.9	238.4	364.4	274.0	300.7
Moisture Content, %	26.1	32.9	29.2	2.8	18.1	5.2
Dry Density, pcf	95.7	87.9	93.4	158.5	104.3	130.6

LAB NO.	11782	11784	11785	11786
Boring No.	LE-02	LE-03	LE-03	LE-04
Depth, ft.	12.5'	5'	7.5'	5'
Diameter, in.	1.887	1.875	1.921	1.875
Length, in.	3.990	4.203	3.023	4.014
Wet Soil + Tare, gm.	394.7	355.1	292.4	326.9
Tare, gm.	8.1	8.2	7.9	8.0
Wet Soil, gm.	386.6	346.9	284.5	318.9
Volumn, cu. ft.	0.006457	0.006716	0.005070	0.006414
Wet Density, pcf	131.9	113.8	123.6	109.5
Cup No.	58	33	HBO	7
Cup Weight, gm.	8.1	8.2	7.9	8.0
Wet Soil + Cup, gm.	394.7	355.1	292.4	326.9
Dry Soil + Cup, gm.	353.1	302.8	280.8	214.3
Water, gm.	41.6	52.3	11.6	112.6
Dry Soil, gm.	345.0	294.6	272.9	206.3
Moisture Content, %	12.1	17.8	4.3	54.6
Dry Density, pcf	117.7	96.6	118.6	70.8

* 11782 - approx. 1/2 of the liner was granular; dimensions are approximate

Martinez Associates

14025 W. 66th Avenue
 Arvada, Colorado 80004
 Phone: (303) 459-2216
 Fax: (303) 482-2230

Martinez
 Associates

One Dimensional Swell/Consolidation (ASTM D 4546)**(Denver Area Swell/Consolidation Test)**

Client Project No.: 22134	Proj. Name: 58th and Tennyson	Sampled By: J. Halverson
Martinez Job No.: 23-0029	Lab Tech: R.S. Kay	Test Date: 2/10/23
Sample ID: 11780		Sample Date: 2/7/23
Sample Location: LE-02 Brass Liner @ 5'		Reviewed By: K. Runner
Soil Description:		
USCS:		

Sample Data:

Ring No:	F	Dish No:	MOE
Ring Mass (g):	237.9	Dish Mass (g):	8.2
Sample Height (in):	0.75	Swell Machine #:	6

Pre-test Sample		Post-test Sample	
Ring + Sample (g):	314.2	Ring + Sample (g):	313.9
Dish wt:	8.2	Dish wt:	8.2
Wet wt (g):	331.7	Wet wt (g):	83.8
Dry wt (g):	282.2	Dry wt (g):	71.0

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	18.1%	Moisture Content:	20.4%
Wet Density (pcf):	131.7	Wet Density (pcf):	135.0
Dry Density (pcf):	111.5	Dry Density (pcf):	112.1

Swell/Consolidation

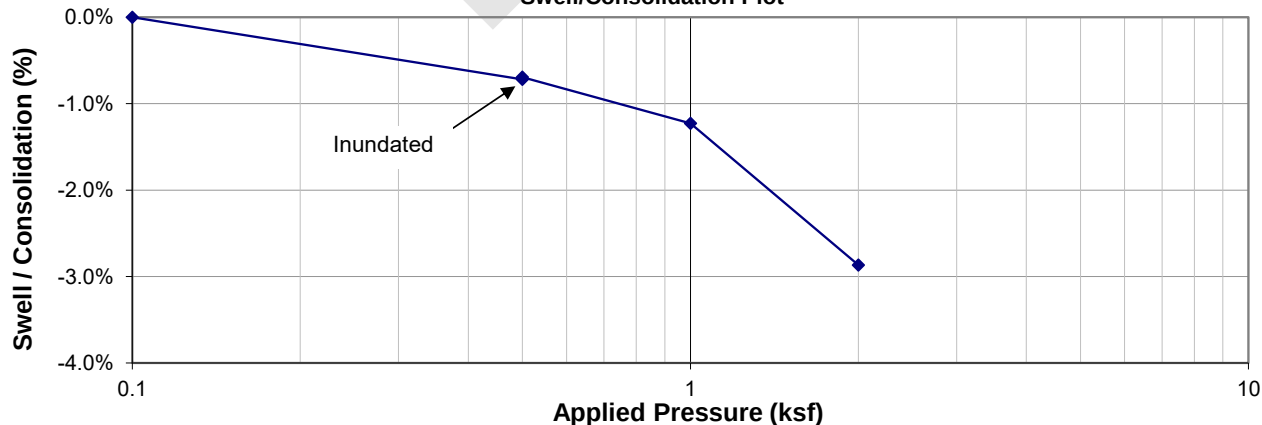
Load (ksf):	0.1	0.5	Add Water	0.5	1	2			
Correction (x 10-4):	0	19		19	39	76			
Dial Reading (x 10-4):	3301	3228		3230	3170	3010			
Swell/Consolidation %:	0.0%	-0.7%		-0.7%	-1.2%	-2.9%			

Results:

Swell Upon Wetting @
 500 psf: **0.0%**

Swell Pressure (psf): **N/A**

Tested By: R. S. Kay
 Checked By: K. Runner

Swell/Consolidation Plot

Martinez Associates

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Martinez
 Associates

One Dimensional Swell/Consolidation (ASTM D 4546)**(Denver Area Swell/Consolidation Test)**

Client Project No.: 22134	Proj. Name: 58th and Tennyson	Sampled By: J. Halverson
Martinez Job No.: 23-0029	Lab Tech: R.S. Kay	Test Date: 2/10/23
Sample ID: 11776		Sample Date: 2/7/23
Sample Location: LE-01 Brass Liner @ 7.5'		Reviewed By: K. Runner
Soil Description:		
USCS:		

Sample Data:

Ring No:	D	Dish No:	15
Ring Mass (g):	236.7	Dish Mass (g):	8.1
Sample Height (in):	0.75	Swell Machine #:	4

Pre-test Sample		Post-test Sample	
Ring + Sample (g):	306.2	Ring + Sample (g):	303.5
Dish wt:	8.1	Dish wt:	8.1
Wet wt (g):	301.6	Wet wt (g):	73.9
Dry wt (g):	229.0	Dry wt (g):	59.8

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	32.9%	Moisture Content:	27.3%
Wet Density (pcf):	119.9	Wet Density (pcf):	128.2
Dry Density (pcf):	90.3	Dry Density (pcf):	100.7

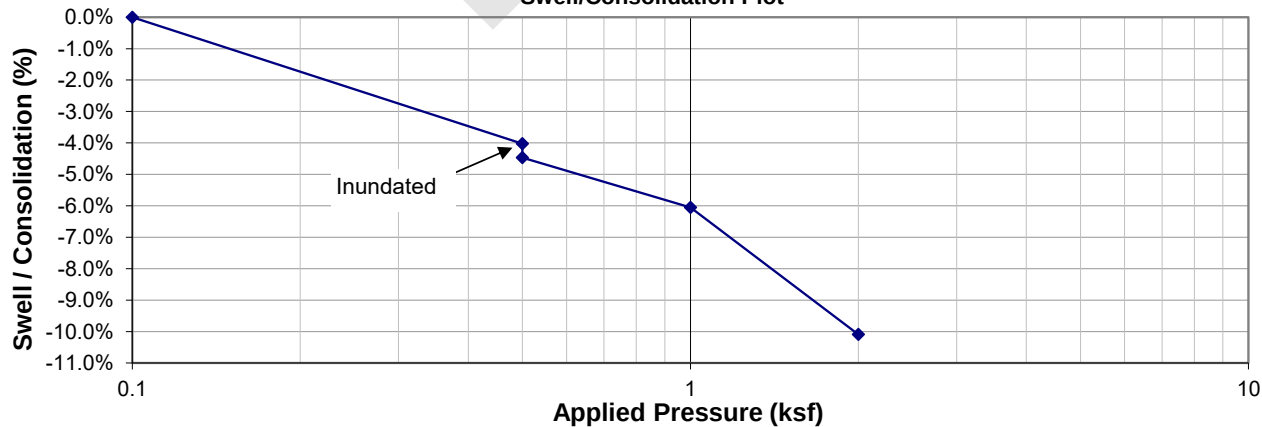
Swell/Consolidation

Load (ksf):	0.1	0.5	Add Water	0.5	1	2			
Correction (x 10-4):	0	37		37	74	110			
Dial Reading (x 10-4):	4580	4241		4208	4052	3713			
Swell/Consolidation %:	0.0%	-4.0%		-4.5%	-6.1%	-10.1%			

Results:

Settlement Upon Wetting @
 500 psf: **-0.4%**
 Swell Pressure (psf): **N/A**

Tested By: R. S. Kay
 Checked By: K. Runner

Swell/Consolidation Plot

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							41	18	23
□							43	17	26
△	0.0	40.4	49.6	10.0		SP-SM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"			100.0
3/4"			81.7
1/2"			73.0
3/8"			67.7
GRAIN SIZE			
D60			4.9551
D30			0.4366
D10			0.0751
COEFFICIENTS			
Cc			0.51
Cu			65.96

SIEVE number size	PERCENT FINER		
	○	□	△
#4			59.6
#10			51.6
#20			42.7
#40			29.5
#60			20.4
#100			15.8
#200	71.4	71.1	10.0

Material Description

○

□

△ poorly graded sand with silt and gravel

REMARKS:

○ Natural Moisture Content: 26.1%

□ Natural Moisture Content: 32.9%

△

○ Location: LE-01 Brass Liner Depth: 5' Sample Number: 11775

□ Location: LE-01 Brass Liner Depth: 7.5' Sample Number: 11776

△ Location: LE-01 Bag Depth: 15' Sample Number: 11778

Martinez Associates

Client: Lithos Engineering
Project: 58th and Tennyson
Lithos Project Number: 22134
Project No.: 23-0029

Figure

The graph displays the cumulative distribution of aggregate particle sizes. The y-axis represents the percentage of material finer than a given grain size, and the x-axis represents the grain size in millimeters on a logarithmic scale. Three distinct aggregate samples are compared, each represented by a different marker and curve.

Grain Size (mm)	Percent Finer (Triangles)	Percent Finer (Circles)	Percent Finer (Squares)
60	100	100	100
30	100	100	100
15	100	100	100
7.5	100	100	100
3.75	100	100	100
1.9	100	100	100
0.85	100	100	100
0.425	100	100	100
0.25	100	100	100
0.15	100	100	100
0.075	100	100	100
0.0475	100	100	100
0.025	100	100	100
0.015	100	100	100
0.0075	100	100	100
0.00475	100	100	100
0.0025	100	100	100
0.0015	100	100	100
0.00075	100	100	100
0.000475	100	100	100
0.00025	100	100	100
0.00015	100	100	100
0.000075	100	100	100
0.0000475	100	100	100
0.000025	100	100	100
0.000015	100	100	100
0.0000075	100	100	100
0.00000475	100	100	100
0.0000025	100	100	100
0.0000015	100	100	100
0.00000075	100	100	100
0.000000475	100	100	100
0.00000025	100	100	100
0.00000015	100	100	100
0.000000075	100	100	100
0.0000000475	100	100	100
0.000000025	100	100	100
0.000000015	100	100	100
0.0000000075	100	100	100
0.00000000475	100	100	100
0.0000000025	100	100	100
0.0000000015	100	100	100
0.00000000075	100	100	100
0.000000000475	100	100	100
0.00000000025	100	100	100
0.00000000015	100	100	100
0.000000000075	100	100	100
0.0000000000475	100	100	100
0.000000000025	100	100	100
0.000000000015	100	100	100
0.0000000000075	100	100	100
0.00000000000475	100	100	100
0.0000000000025	100	100	100
0.0000000000015	100	100	100
0.00000000000075	100	100	100
0.000000000000475	100	100	100
0.00000000000025	100	100	100
0.00000000000015	100	100	100
0.000000000000075	100	100	100
0.0000000000000475	100	100	100
0.000000000000025	100	100	100
0.000000000000015	100	100	100
0.0000000000000075	100	100	100
0.00000000000000475	100	100	100
0.0000000000000025	100	100	100
0.0000000000000015	100	100	100
0.00000000000000075	100	100	100
0.000000000000000475	100	100	100
0.00000000000000025	100	100	100
0.00000000000000015	100	100	100
0.000000000000000075	100	100	100
0.0000000000000000475	100	100	100
0.000000000000000025	100	100	100
0.000000000000000015	100	100	100
0.0000000000000000075	100		

	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	63.6	31.8	4.6		GP			
□							35	15	20
△	0.0	56.1	25.7	18.2		GM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"	100.0		100.0
3/4"	52.1		46.7
1/2"	48.0		
3/8"	43.1		45.6
	GRAIN SIZE		
D ₆₀	20.3722		20.8082
D ₃₀	2.3418		0.3329
D ₁₀	0.2866		
	COEFFICIENTS		
C _c	0.94		
C _u	71.08		

SIEVE number size	PERCENT FINER		
	○	□	△
#4	36.4	53.5	43.9
#10	28.4		42.7
#20	20.8		40.8
#40	13.0		33.0
#60	9.2		27.0
#100	6.6		23.6
#200	4.6		18.2

☐ poorly graded gravel with sand

☐ Δ silty gravel with sand

○ Natural Moisture Content: 2.8%

☐ Natural Moisture Content: 18.1%

△Natural Moisture Content: 12.1%

Sample Number: 11782



Project No.: 23-0029

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	27.1	64.5	8.4					
□							32	17	15
△	0.0	33.8	58.8	7.4					

SIEVE inches size	PERCENT FINER		
	○	□	△
1"	100.0		100.0
3/4"	96.2		94.2
1/2"	88.4		87.2
3/8"	84.0		77.9
GRAIN SIZE			
D ₆₀	1.5091		3.1397
D ₃₀	0.3783		0.6052
D ₁₀	0.0993		0.1334
COEFFICIENTS			
C _c	0.95		0.87
C _u	15.20		23.53

SIEVE number size	PERCENT FINER		
	○	□	△
#4	72.9		66.2
#10	63.5		51.9
#20	50.3		36.3
#40	33.3		23.8
#60	19.6		16.1
#100	12.9		10.8
#200	8.4	53.4	7.4

Material Description
○
□
△

REMARKS:
○
□ Natural Moisture Content: 17.8%
△ Natural Moisture Content: 4.3%

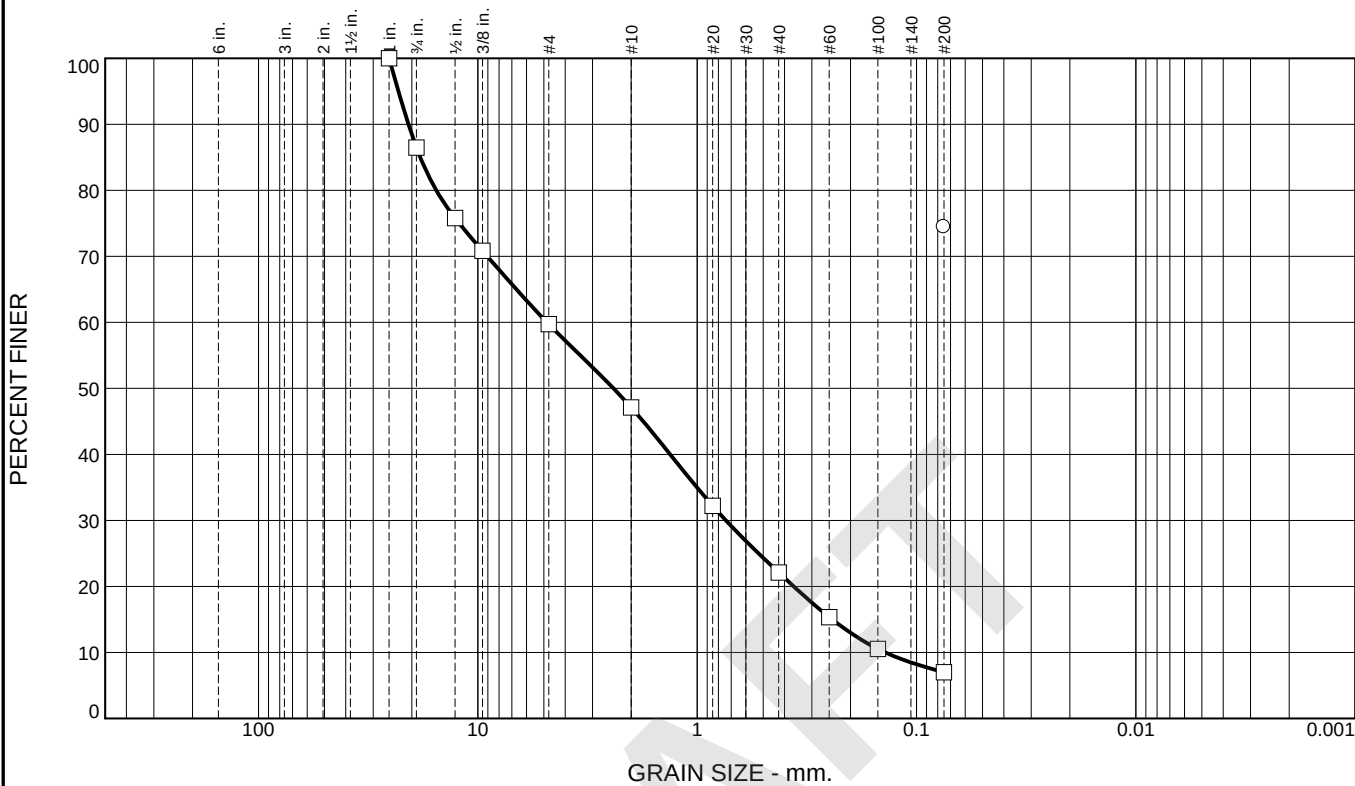
○ Location: LE-02 Bag Depth: 20' Sample Number: 11783
 □ Location: LE-03 Brass Liner Depth: 5' Sample Number: 11784
 △ Location: LE-03 Brass Liner Depth: 7.5' Sample Number: 11785

Martinez
Associates

Client: Lithos Engineering
 Project: 58th and Tennyson
 Lithos Project Number: 22134
 Project No.: 23-0029

Figure

Particle Size Distribution Report



☐	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
☐							NV	NP	NP
☐	0.0	40.3	52.7		7.0				

SIEVE inches size	PERCENT FINER		
	☐	☐	
1"		100.0	
3/4"		86.5	
1/2"		75.8	
3/8"		70.8	
	GRAIN SIZE		
D60		4.8370	
D30		0.7401	
D10		0.1389	
	COEFFICIENTS		
C _c		0.82	
C _u		34.82	

SIEVE number size	PERCENT FINER		
	☐	☐	
#4	74.5		59.7
#10			47.1
#20			32.2
#40			22.1
#60			15.3
#100			10.5
#200			7.0

Material Description

☐

☐

REMARKS:

☐ Natural Moisture Content: 54.6%

☐

☐ Location: LE-04 Brass Liner Depth: 5' Sample Number: 11786
☐ Location: LE-04 Bag Depth: 10' Sample Number: 11787

Analytical Results

TASK NO: 230224063

Report To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Bill To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Task No.: 230224063
Client PO:
Client Project: Dewatering Application

Date Received: 2/24/23
Date Reported: 3/10/23
Matrix: Water - Ground

Customer Sample ID LB-01
Sample Date/Time: 2/24/23 11:45 AM
Lab Number: 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Dissolved</u>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	0.7831 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.015 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<u>Potentially Dissolved</u>						
Chromium - Trivalent	0.01 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Arsenic	0.0032 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0009 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0153 mg/L	EPA 200.8	0.0015 mg/L	2/28/23	QC63218	MBN
Copper	0.0644 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0534 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	1.49 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Nickel	0.0158 mg/L	EPA 200.8	0.0009 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0305 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.138 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<u>Total</u>						
Mercury	0.0002 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<u>Total Recoverable</u>						
Chromium - Trivalent	0.08 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Aluminum	41.9 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

Abbreviations/ References:

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Analytical Results

TASK NO: 230224063

Report To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Bill To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Task No.: 230224063
Client PO:
Client Project: Dewatering Application

Date Received: 2/24/23
Date Reported: 3/10/23
Matrix: Water - Ground

Customer Sample ID LB-01
Sample Date/Time: 2/24/23 11:45 AM
Lab Number: 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Total Recoverable						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0085 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	0.7867 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0021 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0011 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0877 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1621 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0969 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0061 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.0656 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0088 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0007 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0010 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0420 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.351 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	59.5 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

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Date Analyzed = Date Test Completed

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(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Analytical Results

TASK NO: 230224063

Report To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Bill To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Task No.: 230224063
Client PO:
Client Project: Dewatering Application

Date Received: 2/24/23
Date Reported: 3/10/23
Matrix: Water - Ground

Customer Sample ID LB-02

Sample Date/Time: 2/24/23 12:45 PM

Lab Number: 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Dissolved</u>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	8.46 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.030 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<u>Potentially Dissolved</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Arsenic	0.0056 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0028 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0458 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1060 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0856 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	11.3 mg/L	EPA 200.8	0.0080 mg/L	2/28/23	QC63218	MBN
Nickel	0.0480 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0053 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0182 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.216 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<u>Total</u>						
Mercury	0.0003 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<u>Total Recoverable</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Aluminum	68.7 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

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Date Analyzed = Date Test Completed

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(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Analytical Results

TASK NO: 230224063

Report To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Bill To: James Carroll

Company: Lithos Engineering
2750 S Wadsworth Blvd
Suite D-200
Denver CO 80227

Task No.: 230224063
Client PO:
Client Project: Dewatering Application

Date Received: 2/24/23
Date Reported: 3/10/23
Matrix: Water - Ground

Customer Sample ID LB-02

Sample Date/Time: 2/24/23 12:45 PM

Lab Number: 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Total Recoverable</u>						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0153 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	1.58 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0030 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0033 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.1397 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.2837 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.1382 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0107 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.1071 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0023 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0015 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0218 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.602 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	112 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

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ND = Not Detected at Reporting Limit.

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313

Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

Report To: James Carroll
Company: Lithos Engineering

Receive Date: 2/24/23
Project Name: Dewatering Application

Test	QC Batch ID	QC Type	Result	Method
Chromium - Hexavalent	QC63291	Blank	ND	SM 3500-Cr B
Mercury	QC63211	Method Blank	ND	EPA 245.7
Aluminum	QC63218	Method Blank	ND	EPA 200.8
Antimony	QC63218	Method Blank	ND	EPA 200.8
Arsenic	QC63218	Method Blank	ND	EPA 200.8
Barium	QC63218	Method Blank	ND	EPA 200.8
Beryllium	QC63218	Method Blank	ND	EPA 200.8
Cadmium	QC63218	Method Blank	ND	EPA 200.8
Chromium	QC63218	Method Blank	ND	EPA 200.8
Copper	QC63218	Method Blank	ND	EPA 200.8
Lead	QC63218	Method Blank	ND	EPA 200.8
Manganese	QC63218	Method Blank	ND	EPA 200.8
Molybdenum	QC63218	Method Blank	ND	EPA 200.8
Nickel	QC63218	Method Blank	ND	EPA 200.8
Selenium	QC63218	Method Blank	ND	EPA 200.8
Silver	QC63218	Method Blank	ND	EPA 200.8
Thallium	QC63218	Method Blank	ND	EPA 200.8
Uranium	QC63218	Method Blank	ND	EPA 200.8
Zinc	QC63218	Method Blank	ND	EPA 200.8
Iron	QC63200	Method Blank	ND	EPA 200.7

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
Chromium - Hexavalent	QC63291	Duplicate	0 - 20	-	1.7	SM 3500-Cr B
		LCS	90 - 110	103.5	-	
Mercury	QC63211	Duplicate	0 - 20	-	0.0	EPA 245.7
		LCS	90 - 110	105.8	-	
		MS	80 - 120	92.0	-	
Aluminum	QC63218	LCS	90 - 110	102.1	-	EPA 200.8
		MS	70 - 130	99.5	-	
		MSD	0 - 10	-	3.1	
Antimony	QC63218	LCS	90 - 110	99.9	-	EPA 200.8
		MS	70 - 130	103.3	-	
		MSD	0 - 10	-	1.3	
Arsenic	QC63218	LCS	90 - 110	100.6	-	EPA 200.8
		MS	70 - 130	113.8	-	
		MSD	0 - 10	-	3.7	
Barium	QC63218	LCS	90 - 110	96.1	-	EPA 200.8
		MS	70 - 130	91.6	-	
		MSD	0 - 10	-	0.7	
Beryllium	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	97.5	-	

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MSD	0 - 10	-	4.9	
Cadmium	QC63218	LCS	90 - 110	94.0	-	EPA 200.8
		MS	70 - 130	104.5	-	
		MSD	0 - 10	-	2.8	
Chromium	QC63218	LCS	90 - 110	100.7	-	EPA 200.8
		MS	70 - 130	104.4	-	
		MSD	0 - 10	-	0.2	
Copper	QC63218	LCS	90 - 110	96.6	-	EPA 200.8
		MS	70 - 130	86.2	-	
		MSD	0 - 10	-	0.4	
Lead	QC63218	LCS	90 - 110	98.1	-	EPA 200.8
		MS	70 - 130	94.8	-	
		MSD	0 - 10	-	6.8	
Manganese	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	105.2	-	
		MSD	0 - 10	-	0.6	
Molybdenum	QC63218	LCS	90 - 110	95.3	-	EPA 200.8
		MS	70 - 130	97.4	-	
		MSD	0 - 10	-	0.5	
Nickel	QC63218	LCS	90 - 110	101.7	-	EPA 200.8
		MS	70 - 130	100.0	-	
		MSD	0 - 10	-	1.9	
Selenium	QC63218	LCS	90 - 110	94.4	-	EPA 200.8
		MS	70 - 130	110.0	-	
		MSD	0 - 10	-	2.1	
Silver	QC63218	LCS	90 - 110	94.9	-	EPA 200.8
		MS	70 - 130	93.8	-	
		MSD	0 - 10	-	1.0	
Thallium	QC63218	LCS	90 - 110	102.6	-	EPA 200.8
		MS	70 - 130	102.3	-	
		MSD	0 - 10	-	5.5	
Uranium	QC63218	LCS	90 - 110	100.1	-	EPA 200.8
		MS	70 - 130	94.5	-	
		MSD	0 - 10	-	7.1	
Zinc	QC63218	LCS	90 - 110	98.0	-	EPA 200.8
		MS	70 - 130	91.7	-	
		MSD	0 - 10	-	0.3	
Iron	QC63200	Duplicate	0 - 20	-	0.0	EPA 200.7
		LCS	90 - 110	98.4	-	
		MS	75 - 125	102.9	-	

All analyses were performed in accordance with approved methods under the latest revision to 40 CFR Part 136 unless otherwise identified. Based on my inquiry of the person or persons directly responsible for analyzing the wastewater samples and generating the report (s), the analyses, report, and information submitted are, to the best of my knowledge and belief, true, accurate, and complete.



DATA APPROVED FOR RELEASE BY

Abbreviations/ References:

RL = Reporting Limit = Minimum Level
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10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313

Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

Page 6 of 9

230224063

6 / 6

Colorado
Analytical
LABORATORIES, INC.

Report To Information		Bill To Information (If different from report to)		Project Name / Number	
Company Name: <u>Lithos Eng.</u>		Company Name: <u>at</u>			
Contact Name: <u>Mariah Masdel</u> <u>James Carroll</u>		Contact Name: _____			
Address: <u>2750 S Wadsworth Suite D300</u>		Address: _____		Task Number (Lab Use Only)	
City <u>Denver</u> State <u>CO</u> Zip <u>80227</u>		City _____ State _____ Zip _____		CAL Task	
Phone: <u>970 373 3388</u>		Phone: _____		230224063	
Email: <u>James@LithosEng.com</u>		Email: _____		NAB	
Sample Collector: <u>Mariah Masdel</u>					
Sample Collector Phone: <u>406 320 0537</u>		PO No.: _____			

Commerce City Lab
10411 Heinz Way
Commerce City CO 80640

Lakewood Service Center
610 Garrison Street, Unit E
Lakewood CO 80215

Phone: 303-659-2313

www.coloradolab.com

[illegible]



CAL Task
230224063

NAB

Bottle Order Test Detail

Order ID: QBO22090006

Date Created: 9/2/22

Ship To: Kennedy/Jenks Consultants

143 Union Blvd
Suite 600
Lakewood CO 80228
303-985-3636
Emily Hudish

Attention:

Emily Hudish

Shipping Options:

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:
Standard: 2

Customer Needs By: 1/23/23

Ships From: Lakewood

****Verify All Shipping Addresses****

Project:

Dewatering Application

Qty Bottle / Preservative / Test

2 3- VOA HCl / 3-VOA None
624 VOCs - Water - Ground

2 500 ml Amber Unpreserved
625 SOC's - Water - Ground

2 500 ml Cylinder - HNO3
Ag - PD - Water - Ground
Ag - TR - Water - Ground
Al - TR - Water - Ground
As - PD - Water - Ground
As - TR - Water - Ground
Ba - TR - Water - Ground
Be - TR - Water - Ground
Cd - PD - Water - Ground
Cd - TR - Water - Ground
Cr - PD - Water - Ground
Cr - TR - Water - Ground
Cr - Tri - Water - Ground
Cu - PD - Water - Ground
Cu - TR - Water - Ground
Fe - TR - Water - Ground
Hg - Water - Ground

****Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.****

Internal Shipping Instructions:

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

Ship To: Kennedy/Jenks Consultants 143 Union Blvd Suite 600 Lakewood CO 80228 303-985-3636 Emily Hudish Attention:		Ship Via: Customer Pickup Cooler: Yes	
Shipping Options:		Chain of Custody Drinking Water: Standard: 2	
Customer Needs By: 1/23/23 Ships From: Lakewood		Project:	
Verify All Shipping Addresses		Dewatering Application	

Qty.	Bottle / Preservative / Test
2	Mn - PD - Water - Ground Mo - TR - Water - Ground Ni - PD - Water - Ground Ni - TR - Water - Ground Pb - PD - Water - Ground Pb - TR - Water - Ground Sb - TR - Water - Ground Se - PD - Water - Ground Se - TR - Water - Ground Ti - PD - Water - Ground Ti - TR - Water - Ground U - PD - Water - Ground U - TR - Water - Ground Zn - PD - Water - Ground Zn - TR - Water - Ground
2	500 ml Cylinder - Unpreserved Cr - Hex - Water - Ground Fe - Dis - Water - Ground Mn - Dis - Water - Ground

Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.

Internal Shipping Instructions:

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

Exhibit 3

Amendment No. 3

To The “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. For Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58th Project in An Amount Not To Exceed \$86,450.00” For Purposes Of Awarding Contractor Phase II With A Guaranteed Maximum Price Of \$13,258,966.50, Thereby Increasing The Total Contract Amount To An Amount Not To Exceed \$13,703,199.63

Arvada North Trunk Sewer 90% Design

Bid Item	Item	General Description	Method of Payment
1	Permits & General Conditions (LS)	Includes the cost of the Permits & General Conditions. Includes the time allocated to the superintendents, project manager, safety manager, and project coordinator. Also, includes the indirect cost (Port-o-let, dumpster, pre-construction photos), materials/compaction testing, health and safety plan, materials management plan, yard rental. The permits required and will have costs associated with them are the SWMP permit and the dewatering permit.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
2	Pothole Existing Utilities (EACH)	Cost associated with potholing for existing utilities in the area. This includes all the materials, equipment, and labor needed to verify utility/feature depths.	Payment will be based on units completed and accepted.
3	Mobilization (LS)	Includes all costs for mobilization. Mobilization entails the hauling crew of equipment and tools, mobilization crew to unload said equipment and tools, asphalt and flatwork mobilization, and the concrete structures mobilization.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
4	Erosion Control / Stormwater Management (LS)	Includes the cost of erosion control/stormwater management. This entails vehicle tracking control, concrete washouts, silt fence, construction fence, curb socks, inlet protection, erosion control blankets, and monthly inspections. This item also includes the construction and deconstruction of the stabilized staging area which requires the use of one crew and stabilization rock.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
5	Survey (LS)	Includes the cost of surveying and providing as-builts.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.

6	Traffic Control (LS)	Includes the cost associated traffic control devices (traffic arrow boards, signs, drums, barricades and the use of certified flaggers as required. Traffic control will be overseen by the traffic control supervisor.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
7	Dewatering (LS)	Includes the cost of dewatering. Which includes the open cut dewatering & treatment system from vault to bore pit this includes the dewatering & treatment system base cost, generators), crew maintenance, weekly effluent sampling, quarterly influent sampling, ion exchange resin changeout, granular activated carbon vessel changeout, and cation media vessel changeout. Another associated cost is the cost of the meter facility under drain which includes the underdrain, the use of a crew, 8" corrugated pipe, and the use of 3/8" pea gravel. Lastly, the item of dewatering will require the dewatering of the bore pit. The bore pit will require the dewatering & treatment system, generators crew maintenance, weekly effluent sampling, quarterly influent sampling, ion exchange resin changeout, granular activated carbon vessel changeout, and cation media vessel changeout.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
8	Trench Stabilization Rock & Over Excavation (LF)	The item of trench stabilization rock and over excavation have the cost included of an excavation crew and stabilization rock, trucking, disposal fees, and geotextile fabric.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
9	Sanitary Bypass Pumping (LS)	The item of the sanitary bypass will include bypass from the South side of the project at the Meter Vault and continuing, in phases, as construction works to the North end of the project. Includes pumps, generators, suction and discharge pipe and pump watch as required for overnight bypass pumping.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.

10	42" FRP Installation & Removal of Existing 21" In Same Trench (LF)	The item of 42" FRP installation & removal of existing 21" in same trench includes removal of existing 21" pipe, installation of new 42" FRP, pipe testing, import/export of backfill material, disposal fees for trench spoils and pipe removal. This bid item also includes incidental work to abandon existing SS from MH 5.9 at W 60 th to railroad tracks. The 42" pipe installation includes all labor, equipment, shoring, bedding using 57/67 rock, trucking trench spoils, Disposal fee for trench spoils, and pipe material which includes 42" FRP, shipping, detector tape and tracer wire. The item of pipe testing includes CCTV & Jetting and Deflection testing. Importing / exporting backfill material will entail the use of class 1 structural backfill, trucking trench spoils, and the disposal fees of the trench spoils.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
11	Connect to Existing Metro Trunk Line (LS)	The item of connection to existing metro trunk line includes manhole connections, trucking manhole spoils, and the manhole spoils disposal fees. The task of manhole connection includes all labor equipment required for the connection, coring of the existing manhole for the new 42" FRP connection.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
12	72" Diameter Manholes (Changed to 96" Bid Item to (72")) (EACH)	This item will include the cost of manhole installation, manhole materials, bedding material using 57/67 rock, vacuum test 72" manhole, trucking manhole spoils, disposal fees manhole spoils. The task of manhole install will Include all labor, equipment and shoring necessary for completion.	Payment will be based on units completed and accepted.
13	84" Diameter Manholes (EACH)	This item will include the cost of manhole installation, manhole materials, bedding material using 57/67 Rock, vacuum test 84" manhole, trucking manhole spoils, disposal fees manhole spoils. The task of manhole install include all labor material and shoring necessary for completion.	Payment will be based on units completed and accepted.

14	Manhole Lining (EACH)	Manhole lining will be performed by a subcontractor using Spectrashield internal lining.	Payments shall be made based on units completed and accepted.
15	Diversion Vaults (EACH)	This item includes the cost of all labor, equipment, and material to excavate, haul off spoils, bedding, placing a new diversion structure, forming the split flow floor, and internal lining.	Payments shall be made based on units completed and accepted.
16	CIPP Existing Sanitary Line (LS)	This item includes the cost of all labor, equipment, and material to clean the existing sanitary sewer and install a new CIPP liner.	Payments shall be made based on units completed and accepted.
17	Abandon Existing Manhole (SSMH 4-7 & SSMH 4-8) (EACH)	This item will include all labor, equipment and material, including the use of flow-fill, and trucking / disposal fees of the manhole materials or asphalt.	Payments shall be made based on units completed and accepted.
18	8" PVC – Sanitary Lateral & Existing Manhole Modification (LF)	This item includes the tasks pipe installation, modifying the existing manhole, and the importing and exporting of material. The task of pipe installation will include all labor, equipment and shoring for installation, bedding using 57 / 67 rock, trucking, and disposal fees of the trench spoils, and 8" SDR-35 PVC. All backfill material will include exporting backfill material and importing class 1 structural backfill and the trucking and disposal fees of the trench spoils.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
19	Sanitary Service Modification at Existing MH 4-7 (EACH)	This item includes the modifications needed to make the connection with the adjacent lateral into the new CIPP liner, including all labor, equipment, and material needed.	Payments shall be made based on units completed and accepted.

20	21" PVC Sanitary Lateral & Existing Manhole Modification (LF)	This item includes the tasks pipe installation, modifying the existing manhole, and the importing and exporting of material. The task of pipe installation will include all labor, equipment and shoring, bedding using 57 / 67 rock, trucking and disposal fees of the trench spoils and the use of 21" SDR-35 PVC. To modify the manhole the task includes all labor, equipment and shoring, coring of the existing manhole - 21" PVC, pouring new inverts for the existing manhole, CCTV & jetting. Lastly, importing/exporting backfill material will include the cost of exporting all native backfill and importing class 1 structural backfill and the trucking and disposal fees of the trench spoils.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
21	Storm Line Crossings (EACH)	The storm crossing item will include the following tasks of storm line removal and replacement @STA 24+33, storm line removal and replacement @STA 26+36, storm line removal and replacement @STA 33+58, and the trucking and disposal fees of trench spoils. The task of storm line removal and replacement @STA 24+33 and 26+36 and 33+58 includes labor and equipment to remove existing storm lines. STA 24+33 includes 12" RCP, STA 26+36 and 33+58 includes 36" RCP, Class III and 57/67 rock. Lastly, the items of trucking trench spoils and disposal fees will be included and done via subcontractor.	Payment will be based on units completed and accepted.
22	Cut-off Walls (EACH)	The item of Cut-off walls will include all labor, equipment, and material including the use the use of flow-fill, and trucking / disposal fees of the trench spoils.	Payment will be based on units completed and accepted.

23	New Sanitary Meter Vault (Metro Standard) (EACH)	The new sanitary meter vault will require the tasks and inherit the cost of vault excavation and backfill, crew installation (interior pipe, flume, FRP stop logs, FRP grating, 48" x 48" access hatch, auto sampler and vent piping ,exterior damp-proofing, interior vault coating using Spectrashield, bedding, the vault will be backfilled using flow-fill, trucking /disposal fees of vault spoils, bypass piping using 30" FRP, and a 3' x 3.5' box culvert.	Payment will be based on units completed and accepted.
24	Electrical For Meter Vault (LS)	Electrical for the meter vault will be performed by a subcontracted company. The electrical portion of this item was executed under a separate task order. This item only includes the concrete pad for the electrical equipment.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
25	Demo/Abandon Existing Meter Vault (EACH)	The item of the demolition and abandonment of the existing meter vault will include the tasks of excavating the existing vault along with removing and backfilling the area with structural fill; trucking and disposal fees of the vault spoils and materials are included.	Payment will be based on units completed and accepted.
26	Remove Existing 30" Sanitary Line (LF)	Removal of the existing 30" sanitary line bid item will include the 30" removal from STA1+00 to 17+36, removal of 5 existing manholes, and the abandonment of the remaining 30" line from STA 17+36 to STA 21+05 using flowfill.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
27	Trenchless Mobilization and General Conditions (LS)	Trenchless mobilization will include all trucking and labor to mobilize to the site.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.

28	Shafts Construction & Backfill (LS)	The shafts construction and backfill item will include the tasks of excavating launch/receive shaft and water relocation. The excavation of the launch shaft will include all labor and equipment as well as the use of slide rail for shoring. The proposed launch shaft will be 44'x16'x16' shaft in the street. The receive shaft will be 25'X15'X16'. This item also includes the backfill of the shafts. The existing waterline on the east side of the pit will be temporarily relocated to allow it to remain in service during construction.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
29	Engineering Services (LS)	Engineering services will include the following tasks: casing calcs, axial bending and buckling, tunnel work plan, contact grout submittal, backfill grout submittal, and additional engineering services.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
30	Geotechnical Instrumentation (LS)	Geotechnical instrumentation will be required and the task of instrumentation and monitoring at RTD-BNSF-UPRR will be included. The task encompasses geo instrumentation/monitoring, instrumentation installation and breakdown, survey data collection, data review and reporting, sub material cost, additional survey.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
31	Railroad Cost (LS)	The item of Railroad cost includes, railroad permits and ROW agreements, railroad insurance, mobilization/admin fees, railroad construction observer fee, and railroad flaggers.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
32	GBM Auger Bore 30" Casing (LF)	The item GBM Auger Bore includes GBM setup, steel casing install, teardown and load bore equipment, Superintendent supervision, standard bore subcontracts, light plants, and miscellaneous.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.

33	Insituform 30" CIPP Lining (LF)	This item includes the labor, equipment, and material to measure, fabricate, and install a steam cured CIPP liner in the 30" steel casing pipe.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
34	8" C900 Waterline Relocation (LF)	The 8" waterline relocation item will include all labor, equipment and shoring necessary for removing the existing 8" waterline to allow for the installation of the new 42" sanitary main. This item also includes all labor, equipment, shoring and materials for the installation of the new 8" C900 PVC water main and connection to the existing main including detectable tape and tracer wire. The bedding for the watermain will be squeegee, all trench backfill material will be exported and disposed of off-site with imported structural fill to be used as backfill material. The pipeline will be hydrostatically tested and cleared of high chlorine using chlorine tablets.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
35	Waterline Service Reconnect (EACH)	This bid item will include labor, equipment and material to reconnect $\frac{3}{4}$ " water services using $\frac{3}{4}$ " type k copper, 8" x $\frac{3}{4}$ " saddle and a $\frac{3}{4}$ " corp.	Payment will be based on units completed and accepted.
36	8" Lateral – Extend & Reconnect (EACH)	This bid item includes the labor, equipment and material to extend and reconnect two – 8" waterlines. 8" C900 PVC, squeegee bedding, 8" Solid sleeves, 8" x 8" tee, and the export of native backfill material and import of structural fill.	Payment will be based on units completed and accepted.
37	8" Water Relocation @ Approx. STA 32+38.25 (LS)	This bid item includes the labor, equipment, and material to reroute the existing waterline out of the launch shaft and reconnect it.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
38	8" Gate Valve (EACH)	The 8" gate valve includes the material, labor and equipment required for installation.	Payment will be based on units completed and accepted.

39	8" – 45 Degree Bend (EACH)	The 8" 45-degree bends will include all materials, labor and equipment for installation and thrust blocks.	Payment will be based on units completed and accepted.
40	Asphalt Removal and Replacement (SY)	Asphalt removal (T-Patch) will include saw cutting the asphalt, and labor and equipment needed for asphalt removal, trucking and disposal fees. Replacement will be performed by a subcontractor at a depth up to 9".	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.
41	Pavement Markings (LS)	Pavement markings include mobilization, solid white striping, yellow striping, railroad crossing symbols, stop bars and any other required striping.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
42	Temporary Asphalt (50% of Total Trench Length) (SY)	Temporary asphalt will be 2" and will be prepared by a ground preparation crew	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.
43	Staging Area Restoration (LS)	The staging area location has not been formally leased but, this item would cover up to 2 acres of seeding for restoring a staging site if needed.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
44	Trench Maintenance & Citizen Notification (LS)	The item of trench safety will provide the citizens with postcards to update them on the construction process and schedule that may impact them and will provide weekly updates. This item also includes street sweeping as required for maintenance during construction.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.
45	Minor Contract Revisions (LS)	Will be provided as needed.	Payment shall be made based on all work being completed as a percentage of approved work performed and materials furnished.

46	Storm Channel (LF)	The storm channel restoration includes re-grading of the drainage ditch from STA 1+00 to STA 8+62 as required to return the ditch to original conditions. This item also includes erosion control blanket as required and subcontractor to hold power poles as necessary while excavation and re-grading the ditch.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
47	Water Line Lowering (EACH)	The item of water line lowering will include the tasks of 4" water line lowering, 12" water line lowering, 6" hydrant lateral lowering, and 2x 8" waterline lowering. All lowerings include labor, equipment and shoring as needed to complete the waterline lowerings. The 4" lowering includes installation of thrust blocks, 4" – 45 degree bends, 4" C900 PVC, squeegee bedding, and the trucking and the disposal cost of lowering the line. The 12" lowering includes thrust blocks, 12" – 45 degree bends, 12" C-900 PVC, squeegee bedding, and the trucking and disposal fee of the lowering of the water line. The 6" hydrant lateral lowering includes 6" – 45-degree bends, 6" Ductile Iron Pipe, addition of thrust blocks, squeegee bedding, and the trucking and disposal of materials from the 6" hydrant lateral lowering. Both 8" waterline lowerings include 8" – 45-degree bends, 8" C900 PVC, the use of a thrust blocks, squeegee bedding, and trucking/disposal of material related to the lowering of both the 8" pipes.	Payment will be based on units completed and accepted.
48	Sanitary Lowering or Raising – STA 15+90 (EACH)	The item of sanitary raising or lowering will involve the movement of the existing 6" sanitary pipe that conflicts with the new sanitary main being installed. The item includes all labor, equipment and shoring for the relocation of the existing line, 57/67 rock, and bypass pumping required and, 6" SDR-35 PVC, and the trucking / disposal of the related work.	Payment will be based on units completed and accepted.

49	1.5 " Force Main R&R (LF)	The item of 1.5" force main R&R includes all labor, equipment and shoring for the installment of 1.5" PVC, and modifications to the existing manhole	Payments shall be made based on the linear foot of approved work performed and materials furnished.
50	2" Mill Overlay – Adams County (SY)	The 2" mill overlay will be done via subcontractor but will incur cost of trucking and disposal fees. The full width mill & overlay is only included in the Adams County portion of the project.	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.
51	Sidewalk Removal & Replacement (SF)	The item of sidewalk removal and replacement include all labor and equipment necessary, sawcutting the sidewalk, sidewalk replacement, concrete blanketing, and the trucking/disposal fees associated with the sidewalk removal and replacement.	Payment shall be made based on the area measurement per square foot of approved work performed and materials furnished.
52	Curb & Gutter Removal & Replacement (LF)	Curb and gutter removal and replacement will include the removal and replacement of a 6" curb and gutter. The task includes all labor equipment, sawcutting the gutter, and will include the cost of trucking and disposal fee of the removal and replacement.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
53	ADA Ramp R&R (EACH)	ADA ramp removal and replacement will include all labor and equipment necessary. The work will include the sawcut of ADA ramps, the installation of new ADA ramps, and the trucking and disposal fees of the removal and replacement.	Payment will be based on units completed and accepted.
54	Concrete Pavement Replacement (SY)	Concrete paving replacement will require the concrete paving of 3 private drives. The task includes sawcut of the concrete and all labor and equipment necessary for removal and replacement as well as the trucking and disposal fees from the task.	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.

55	Concrete Cross Pan Replacement (SY)	Concrete pan replacement will include saw cut concrete gutter, removal of the existing concrete and the trucking and disposal fees of the material from the task. This task also includes the subcontract work to replace the existing concrete cross-pan.	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.
56	Gravel Surface Restoration – 3” Depth (SY)	Gravel surface restoration will be performed by a crew and will require the use of class 6 road base.	Payment shall be made based on the area measurement per square yard of approved work performed and materials furnished.
57	24” RCP Replacement (LF)	The replacement of 24” RCP includes labor, equipment, shoring, Class III RCP, bedding and trucking / disposal fees for trench spoils and existing RCP that cannot be re-used. This item is as required for driveway crossings.	Payments shall be made based on the linear foot of approved work performed and materials furnished.
58	Headwall Removal & Replacement (EACH)	Headwall removal and replacement, removal and disposal of existing headwall and cast-in-place new headwall.	Payment will be based on units completed and accepted.

Exhibit 4-Part 1

Amendment No. 3

To The “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. For Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58th Project in An Amount Not To Exceed \$86,450.00” For Purposes Of Awarding Contractor Phase II With A Guaranteed Maximum Price Of \$13,258,966.50, Thereby Increasing The Total Contract Amount To An Amount Not To Exceed \$13,703,199.63

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LOCATION MAP
SCALE: NTS



VICINITY MAP
SCALE: NTS

CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS



DRAWING INDEX

SHEET NO	DRAWING NO	SHEET TITLE
GENERAL:		
1	G-001	COVER, LOCATION AND VICINITY MAPS, AND DRAWING INDEX
2	G-002	GENERAL NOTES AND LEGEND
3	G-003	GENERAL PROCESS SYMBOLS
4	G-004	SURVEY CONTROL DIAGRAM
CIVIL:		
5	C-001	CIVIL NOTES AND ABBREVIATIONS
6	C-002	CIVIL LEGEND
7	C-003	CIVIL DETAILS - I
8	C-004	CIVIL DETAILS - II
9	C-005	TUNNELING DETAILS - I
10	C-006	TUNNELING DETAILS - II
11	C-007	TUNNELING DETAILS - III
12	C-350	PLAN AND PROFILE STA 1+00 TO 6+00
13	C-351	PLAN AND PROFILE STA 6+00 TO 11+00
14	C-352	PLAN AND PROFILE STA 11+00 TO 16+00
15	C-353	PLAN AND PROFILE STA 16+00 TO 20+50
16	C-354	PLAN AND PROFILE STA 20+50 TO 25+50
17	C-355	PLAN AND PROFILE STA 25+50 TO 30+50
18	C-356	PLAN AND PROFILE STA 30+50 TO 35+50
19	C-357	PLAN AND PROFILE STA 35+50 TO 37+00
20	C-450	SITE RESTORATION STA 1+00 TO 11+00
21	C-451	SITE RESTORATION STA 11+00 TO 20+50
22	C-452	SITE RESTORATION STA 20+50 TO 30+50
23	C-453	SITE RESTORATION STA 30+50 TO 37+00
STRUCTURAL:		
24	S-001	STRUCTURAL GENERAL NOTES AND SPECIAL INSPECTIONS
25	S-002	STRUCTURAL PLANS
26	S-003	STRUCTURAL SECTIONS
27	S-004	STRUCTURAL DETAILS - I
MECHANICAL:		
28	M-001	METERING VAULT PLAN
29	M-002	METERING VAULT SECTIONS AND DETAILS

DRAWING INDEX - CONTINUED

SHEET NO	DRAWING NO	SHEET TITLE
ELECTRICAL:		
30	E-001	ELECTRICAL ABBREVIATIONS AND NOTES
31	E-002	ELECTRICAL LEGEND - I
32	E-003	ELECTRICAL LEGEND - II
33	E-004	ELECTRICAL TYPICAL DETAILS - I
34	DE-010	OVERALL DEMOLITION SITE PLAN
35	E-010	ELECTRICAL OVERALL SITE PLAN
36	E-011	ELECTRICAL METER VAULT DETAILS
37	E-020	ELECTRICAL ONE LINE DIAGRAM AND SCHEDULES
38	E-030	ELECTRICAL CONDUIT AND CABLE SCHEDULE
39	E-040	ELECTRICAL CONDUIT ROUTING BLOCK DIAGRAM
INSTRUMENTATION:		
40	I-001	INSTRUMENTATION LEGEND AND NOTES
41	I-002	INSTRUMENTATION STANDARD DETAILS
42	I-011	PARSHALL FLUME PROCESS AND INSTRUMENTATION DIAGRAM
EROSION CONTROL:		
43	EC-601	EROSION CONTROL NOTES
44	EC-602	EROSION CONTROL DETAILS - I
45	EC-603	EROSION CONTROL DETAILS - II
46	EC-650	GRADING, EROSION, AND SEDIMENT CONTROL STA 1+00 TO 11+00
47	EC-651	GRADING, EROSION, AND SEDIMENT CONTROL STA 11+00 TO 20+50
48	EC-652	GRADING, EROSION, AND SEDIMENT CONTROL STA 20+50 TO 30+50
49	EC-653	GRADING, EROSION, AND SEDIMENT CONTROL STA 30+50 TO 37+00

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GEI CONSULTANTS 350 INDIANA ST, SUITE 750 GOLDEN, CO 80401	AUSTIN WILKES AWILKES@GEICONSULTANTS.COM 770-862-7425
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CRESTVIEW WATER AND SANITATION DISTRICT 7145 MARIPOSA ST #7200 DENVER, CO 80221	MITCHELL TERRY MANAGER@CRESTVIEWWATER.COM 303-429-1881
BERKELEY WATER AND SANITATION DISTRICT	CONTACT DENVER WATER



APPROVED City of Arvada, Colorado			
CITY ENGINEER	DATE	JOB NUMBER	
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.			
SEP 2024 - 90% DESIGN			
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.			
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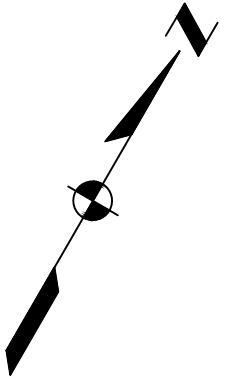
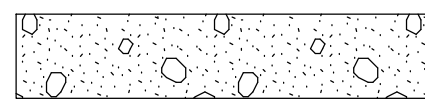
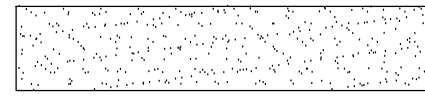
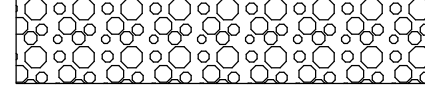
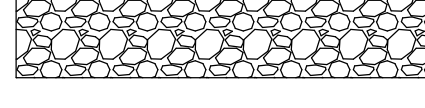
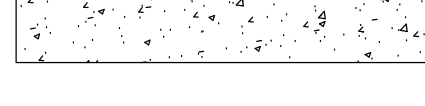
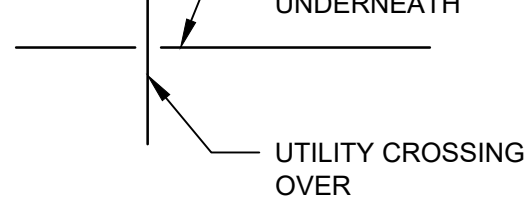
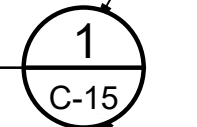
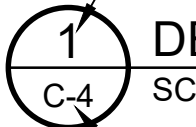
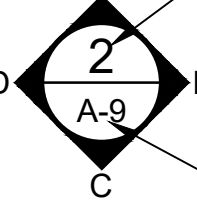
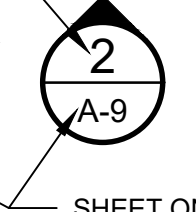
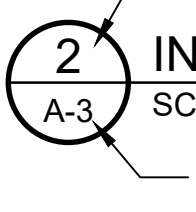
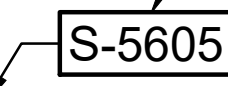
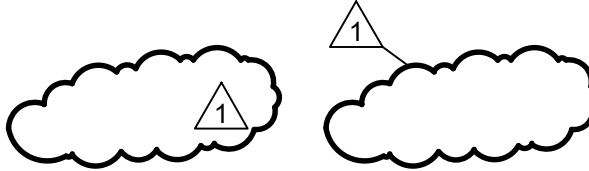
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COVER, LOCATION AND VICINITY MAPS,
AND DRAWING INDEX

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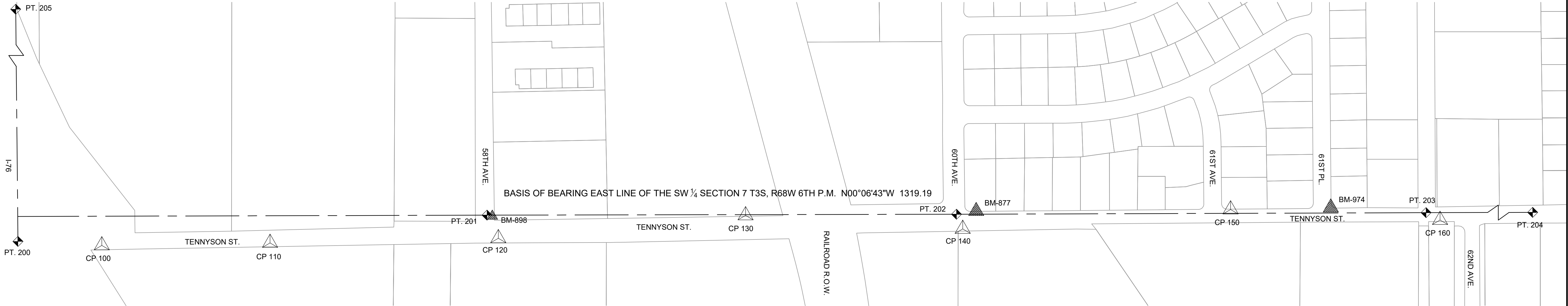
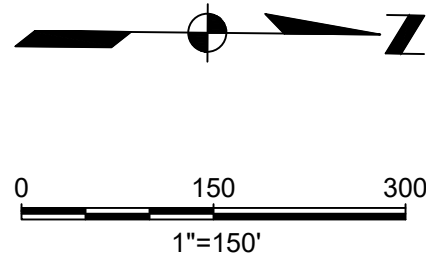
NOTES				NOTES (CONTINUED)				SYMBOLLOGY				CROSS-REFERENCING SYMBOLS			
GENERAL 1. THIS PROJECT IS WITHIN CITY OF ARVADA AND ADAMS COUNTY RIGHT OF WAY. CONTRACTOR SHALL CONFORM TO CITY OF ARVADA AND ADAMS COUNTY PERMITS AND REQUIREMENTS. 2. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH CITY OF ARVADA STANDARDS, ADAMS COUNTY STANDARDS, AND APPLICABLE AWWA STANDARDS. 3. PRE-EXISTING SITE CONDITION PHOTOS SHALL BE PROVIDED BY THE CONTRACTOR AND SHALL SHOW EXISTING CONDITIONS OF ALL CONCRETE, ASPHALT, LANDSCAPED AREAS, ETC. SURROUNDING THE CONSTRUCTION AREAS. PHOTOS SHALL BE SUBMITTED TO THE OWNER PRIOR TO BREAKING GROUND. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT EXISTING IMPROVEMENTS WHICH ARE TO REMAIN IN PLACE FROM DAMAGE. ALL IMPROVEMENTS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED AT THE CONTRACTOR'S EXPENSE WITHOUT ADDITIONAL COMPENSATION. 4. CONTRACTOR SHALL RESTORE ALL SURVEY MONUMENTS THAT ARE DAMAGED OR DESTROYED DURING CONSTRUCTION. 5. OBSERVATIONS OF WORK IN PROGRESS DURING SITE VISITS SHALL NOT ALTER THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. UTILITIES 1. LOCATIONS OF UNDERGROUND UTILITIES SHOWN ON THE DRAWINGS WERE OBTAINED FROM AVAILABLE RECORDS AND ARE SHOWN IN THEIR APPROXIMATE LOCATION. THERE IS NO GUARANTEE THAT ALL EXISTING PIPELINES AND OBSTRUCTIONS ARE SHOWN OR THAT LOCATIONS INDICATED ARE ACCURATE. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL POTHOLE TO DETERMINE ACTUAL LOCATION AND ELEVATION OF ALL EXISTING UTILITIES IN AND AROUND THE AREAS OF NEW CONSTRUCTION. 2. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT ALL REMAINING EXISTING UTILITIES WHETHER SHOWN OR NOT SHOWN. 3. PRIOR TO ANY CONNECTION TO AN EXISTING UTILITY, THE CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER. 4. PRIOR TO ANY EXCAVATION IN THE VICINITY OF ANY EXISTING UNDERGROUND FACILITIES, INCLUDING ALL WATER, SEWER, STORM DRAIN, GAS, PETROLEUM PRODUCTS, OR OTHER PIPELINES; ALL BURIED ELECTRIC POWER, COMMUNICATIONS, OR TELEVISION CABLES; ALL TRAFFIC SIGNAL AND STREET LIGHTING FACILITIES; AND ALL ROADWAY, STATE HIGHWAY, AND RAILROAD RIGHTS-OF-WAY, THE CONTRACTOR SHALL NOTIFY THE RESPECTIVE AUTHORITIES REPRESENTING THE OWNERS OR AGENCIES RESPONSIBLE FOR SUCH FACILITIES TO FACILITATE A TIMELY MANNER OF WORK SO THAT A REPRESENTATIVE OF SAID OWNERS OR AGENCIES CAN BE PRESENT DURING SUCH WORK IF THEY SO DESIRE. IN THE CASE OF THE UNDERGROUND UTILITY SERVICE ALERT CENTER, THIS NOTICE WILL GIVE THEM TIME TO MARK THE LOCATION OF THE UTILITIES. THE CONTRACTOR SHALL ALSO NOTIFY UNDERGROUND SERVICES ALERT (USA) AT (811) IN ACCORDANCE WITH THE SPECIFICATIONS TO FACILITATE A TIMELY MANNER OF WORK, PRIOR TO SUCH EXCAVATION. SUE QUALITY LEVEL 1. EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL B STANDARDS, UNLESS NOTED OTHERWISE. 2. SUBSURFACE, GAS, ELECTRIC, WATER, STORM SEWER, AND FIBER OPTIC MAINLINE CROSSINGS OF THE PROPOSED SANITARY PIPE, WITHIN THE EXPECTED LIMITS OF EXCAVATION, WERE LOCATED TO ASCE QUALITY LEVEL A STANDARDS. SANITARY SEWER LINE DEPTHS ARE DERIVED FROM SURVEYED INVERT INFORMATION PROVIDED BY THE OWNER SHOWING A LINEAR PIPE SLOPE FROM INVERT TO INVERT. POTHOLE INFORMATION FOR EXISTING UTILITIES AND CROSSINGS IS PROVIDED ON SHEET C-357. ALL OTHER EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL C STANDARDS. INDIVIDUAL SERVICE LINES FOR SUBSURFACE UTILITIES ARE LOCATED TO QUALITY LEVEL C, EXCEPT THOSE SERVICES AS IDENTIFIED ON SHEET C-357. 3. ALL SANITARY AND STORM INFORMATION FOR INSTANCES NOT CROSSING THE PROPOSED SANITARY PIPE IS QUALITY LEVEL C. 4. THE CONTRACTOR SHALL REQUEST LOCATE INFORMATION FOR THE PROJECT PRIOR TO ANY EXCAVATION. KENNEDY/JENKS DOES NOT GUARANTEE THE LOCATIONS OF THE UTILITIES SHOWN OR THAT THE UTILITIES SHOWN INCLUDE ALL UTILITIES IN THE AREA. RELIANCE UPON THESE DATA DOES NOT RELIEVE THE CONTRACTOR FROM FOLLOWING ALL THE APPLICABLE UTILITY DAMAGE PREVENTION STATUTES, POLICIES, AND/OR PROCEDURES DURING EXCAVATION. IT IS IMPORTANT THAT THE CONTRACTOR INVESTIGATES AND UNDERSTANDS THE SCOPE OF WORK BETWEEN THE PROJECT OWNER AND THEIR ENGINEER REGARDING THE SCOPE AND LIMITS OF THE UTILITY INVESTIGATIONS LEADING TO THESE UTILITY DEPICTIONS. CONTRACTOR SHALL MEET				ALL REQUIREMENTS OF COLORADO SENATE BILL 18-167 AS PART OF THIS PROJECT. QUALITY LEVEL - A: (3D INFORMATION) USE OF APPROPRIATE NONDESTRUCTIVE DIGGING EQUIPMENT AT DISCREET, CRITICAL POINTS TO DETERMINE THE PRECISE HORIZONTAL AND VERTICAL POSITION OF UNDERGROUND UTILITIES, AS WELL AS THE TYPE, SIZE, CONDITION, MATERIAL, AND OTHER CHARACTERISTICS. QLA IS THE HIGHEST QUALITY LEVEL PRESENTLY AVAILABLE. QUALITY LEVEL - B: (2D INFORMATION) USE OF APPROPRIATE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND HORIZONTAL POSITION OF VIRTUALLY ALL SUBSURFACE UTILITIES. 1). UTILITY QUALITY LEVEL B (QLB) IS VALUE ASSIGNED TO A UTILITY SEGMENT OR SUBSURFACE UTILITY FEATURE WHOSE EXISTENCE AND POSITION ARE BASED UPON GEOPHYSICAL METHODS COMBINED WITH PROFESSIONAL JUDGEMENT AND WHOSE LOCATION IS TIED TO THE PROJECT SURVEY DATUM. QLB IS MORE UNCERTAIN THAN QLA, AND LESS UNCERTAIN THAN QLC OR QLD. 2). APPROXIMATE HORIZONTAL LOCATION OF UTILITY. QUALITY LEVEL - C: SURVEYING VISIBLE ABOVE GROUND UTILITY FACILITIES.				 NORTH ARROW  NEW  (E) CIPP LINED  EXISTING; SCREENED TEXT LABELS FOR SCREENED ELEMENTS IMPLY THE ELEMENT IS EXISTING  FUTURE  EXISTING LINEAR ELEMENTS TO BE REMOVED OR DEMOLISHED  EXISTING NON-LINEAR ELEMENTS TO BE REMOVED, DEMOLISHED, OR ABANDONED  CENTERLINE  MATCHLINE CONTINUED ON SHEET  MATCHLINE  BREAK LINE  NATIVE EARTH (IN SECTION)  ENGINEERED FILL (IN SECTION)  LANDSCAPE FILL (IN PLAN AND SECTION)  SAND OR GROUT (IN PLAN AND SECTION)  GRAVEL (IN PLAN AND SECTION)  AGGREGATE BASE (IN PLAN AND SECTION)  CRUSHED ROCK (IN PLAN AND SECTION)  CONCRETE (IN PLAN AND SECTION)  GRATING (IN PLAN)  CHECKER PLATE (IN PLAN)  MASONRY (IN SECTION)  STEEL (IN SECTION)  CROSSING UTILITIES				FOUND ON DRAWING WHERE DETAIL, SECTION, OR ELEVATION IS CALLED OUT  DETAIL NUMBER SHEET ON WHICH DETAIL IS DRAWN, "-" IF ON SAME SHEET FOUND ON DRAWING WHERE DETAIL, SECTION, OR ELEVATION IS DRAWN  DETAIL NUMBER DETAIL TITLE SCALE SHEET ON WHICH DETAIL IS CALLED OUT, "-" IF ON SAME SHEET  SECTION LETTER SHEET ON WHICH SECTION IS DRAWN, "-" IF ON SAME SHEET  SECTION LETTER SECTION TITLE SCALE SHEET ON WHICH SECTION IS CUT, "-" IF ON SAME SHEET  LETTERS USED WHEN MORE THAN ONE ELEVATION IS DRAWN WITHIN A SINGLE ROOM ELEVATION NUMBER  OR SHEET ON WHICH ELEVATION IS DRAWN, "-" IF ON SAME SHEET  ELEVATION NUMBER INTERIOR ELEVATION A SCALE SHEET ON WHICH ELEVATION IS CALLED OUT, "-" IF ON SAME SHEET  STANDARD DETAIL NUMBER STANDARD DETAIL TITLE SUB-TITLE SCALE: #/#" = 1'-0" REV 00 NOTE STANDARD DETAILS ARE LOCATED WITHIN THEIR RESPECTIVE DISCIPLINE, IMMEDIATELY FOLLOWING THE GENERAL ABBREVIATIONS, NOTES, AND LEGEND SHEETS.			
APPROVED City of Arvada, Colorado CITY ENGINEER _____ DATE _____ JOB NUMBER _____ REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.				REVISION SYMBOLS  CLOUDED AREA INDICATES CHANGED INFORMATION; NUMBER IN TRIANGLE INDICATES THE DRAWING VERSION AND MATCHES WITH REVISION INFORMATION IN THE REVISION BLOCK WITHIN THE DRAWING BORDER				DESIGNED TS DRAWN WAS CHECKED LS CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 Kennedy Jenks				GENERAL NOTES AND LEGEND SCALE NTS JOB NO 2246059*00 DATE SEP 2024 SHEET 2 OF 49 G-002			
SEP 2024 - 90% DESIGN NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.				NO REVISION DATE BY				SCALES 0 1" 0 25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.							

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PIPING - SINGLE LINE				VALVES AND GATES				PRIMARY INLINE ELEMENTS				EQUIPMENT				PIPING ACCESSORIES AND FITTINGS			
NEW WORK (NOT SCREENED) EXISTING (SCREENED) FUTURE (LONG DASH, SHORT DASH) PROCESS - PRIMARY PROCESS - SECONDARY PROCESS - DRAIN PROCESS - HEAT TRACED OR CONNECTED NOT CONNECTED				* FC = FAIL CLOSED FO = FAIL OPEN FL = FAIL LOCKED IN LAST GATE VALVE (NORMALLY OPEN, NORMALLY CLOSED) GLOBE VALVE (NORMALLY OPEN, NORMALLY CLOSED) PLUG VALVE (NORMALLY OPEN, NORMALLY CLOSED) CHECK VALVE ANGLED CHECK VALVE DUCKBILL CHECK VALVE BALL CHECK VALVE BACKFLOW PREVENTER (DOUBLE CHECK ASSEMBLY) BACKFLOW PREVENTER (REDUCED PRESSURE PRINCIPLE) PINCH VALVE DIAPHRAGM VALVE BUTTERFLY VALVE BALL VALVE (NORMALLY OPEN, NORMALLY CLOSED) NEEDLE VALVE PRESSURE REDUCING VALVE, SELF-CONTAINED PRESSURE REDUCING VALVE WITH EXTERNAL PRESSURE TAP PRESSURE SUSTAINING VALVE, SELF-CONTAINED PRESSURE SUSTAINING VALVE WITH EXTERNAL PRESSURE TAP DIFFERENTIAL PRESSURE REGULATING VALVE, SELF-CONTAINED DIFFERENTIAL PRESSURE REGULATING VALVE WITH EXTERNAL PRESSURE TAP 3-WAY VALVE 4-WAY VALVE SHADING INDICATES PORT TO BE CLOSED DURING NORMAL OPERATION. DOT INDICATES PORT TO BE CLOSED DURING ALTERNATE OPERATION. ANGLE VALVE FOOT VALVE VACUUM RELIEF/AIR INLET VALVE (AV) PRESSURE RELIEF VALVE (PREL) AIR RELEASE/VACUUM RELIEF VALVE (ARVR) COMBINATION AIR/VACUUM VALVE (CA) AIR RELEASE VALVE (AR) GATE - NORMALLY CLOSED GATE - NORMALLY OPEN FLAP GATE				ORIFICE PLATE MAGNETIC FLOW TUBE SINGLE PORT PITOT TUBE OR PITOT-VENTURI TUBE VENTURI TUBE AVERAGING PITOT TUBE FLUME WEIR TURBINE OR PROPELLER-TYPE PRIMARY ELEMENT THERMAL MASS FLOWMETER POSITIVE DISPLACEMENT TYPE FLOW TOTALIZING INDICATOR VORTEX SENSOR TARGET TYPE SENSOR CORIOLIS EFFECT SENSOR				MISCELLANEOUS DU DRIVE UNIT M MOTOR CENTRIFUGAL PUMPS M HORIZONTAL M SUBMERSIBLE M VERTICAL TURBINE PUMP HEAD M VERTICAL TURBINE PUMP T-HEAD VERTICAL TURBINE PUMP CAN VERTICAL TURBINE PUMP INTAKE POSITIVE DISPLACEMENT PUMPS M METERING PUMP S METERING SOLENOID M PERISTALTIC/ HOSE PUMP M ROTARY PUMP M PROGRESSIVE CAVITY PUMP BLOWERS, FANS AND COMPRESSORS M BLOWER M FAN M CENTRIFUGAL COMPRESSOR M RECIPROCATING COMPRESSOR MIXERS M VERTICAL M SUBMERSIBLE CONVEYORS HORIZONTAL SCREW INCLINED SCREW THICKENERS AND GRINDERS BELT FILTER PRESS GRAVITY BELT THICKENER CENTRIFUGE SLUDGE GRINDER				FLANGE UNION TEE Y STRAINER FLOW STRAIGHTENING VANE SCREWED CAP WELDED CAP BLIND FLANGE QUICK DISCONNECT REDUCER (CONCENTRIC) REDUCER (ECCENTRIC) HOSE BIBB CONNECTION CHEMICAL PIPING FLEXIBLE CONNECTION/ FLEXIBLE HOSE FLEXIBLE TANK CONNECTION BRAIDED METAL HOSE METAL BELLOWS EXPANSION JOINT FLEXIBLE COUPLING FLANGED COUPLING ADAPTER DISASSEMBLING JOINT DRAIN SPRAY NOZZLE THERMOWELL CALIBRATION CYLINDER PULSATION DAMPER DIAPHRAGM SEAL ANNULAR SEAL RUPTURE DISK, PRESSURE RUPTURE DISK, VACUUM PURGE			
TANKS AND VESSELS				MISCELLANEOUS				MISCELLANEOUS				MISCELLANEOUS				MISCELLANEOUS			
TANK WITH CONICAL ROOF TANK WITH DOMED ROOF TANK WITH FLAT ROOF OPEN TOP TANK TANK WITH FLOATING COVER PRESSURE VESSEL - VERTICAL PRESSURE VESSEL - HORIZONTAL HOPPER, VESSEL, OR BIN FILTER VESSEL STORAGE DRUM MANHOLE																			
APPROVED City of Arvada, Colorado CITY ENGINEER DATE JOB NUMBER REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.				0 1" 0 25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.				DESIGNED TS DRAWN CLL CHECKED LS				CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 KJ Kennedy Jenks		GENERAL PROCESS SYMBOLS		SCALE NTS JOB NO 2246059*00 DATE SEP 2024 SHEET 3 OF 49 G-003			

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NORTH TRUNK SEWER IMPROVEMENTS
TENNYSON STREET SURVEY CONTROL DIAGRAM
61ST PL. TO HIGHWAY 76



PROJECT BENCHMARK INFORMATION

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION
	NORTHING	EASTING		NORTHING	EASTING		
BM-877	1718690.601	3128077.474	5248.35	719098.501	128819.867	5245.90	2" BRASS CAP TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER 60TH AVE. & TENNYSON ST.

PROJECT COORDINATE TABLE

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION OF MONUMENT
	NORTHING	EASTING		NORTHING	EASTING		
100	1716235.485	3128174.019	5242.33	716642.802	128916.435	5239.93	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 100, .10' BELOW GRAVEL SHOULDER SURFACE
110	1716707.689	3128166.503	5242.42	717115.118	128908.916	5240.07	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 110, FLUSH WITH GROUND
120	1717348.954	3128153.540	5243.76	717756.535	128895.951	5241.40	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 120, FLUSH WITH GROUND
130	1718043.519	3128089.233	5246.66	718451.266	128831.628	5244.10	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 130, FLUSH WITH GROUND
140	1718653.577	3128127.307	5248.86	719061.468	128869.711	5246.50	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 140, FLUSH WITH GROUND
150	1719406.089	3128072.783	5269.56	719814.159	128815.174	5267.09	FOUND CHISELED TRIANGLE WITH PUNCH MARK ON 5' TYPE R INLET AT NW CORNER 61ST AVE. & TENNYSON ST.
160	1719994.598	3128102.218	5278.84	720402.808	128844.617	5276.41	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 160, FLUSH WITH GROUND
200	1715999.301	3128162.299		716406.563	128904.713		70' W.C. EAST OF THE S ¼ SEC. 7 FOUND A 3 ¼" CAP IN RANGE BOX ILLEGIBLE
201	1717317.224	3128088.588		717724.799	128830.985		C-S ⅙ SEC. 7 FOUND A 2 ½ " ALUM. CAP IN RANGE BOX STAMPED: S 7 C-S ⅙ 2005 LS 16837
202	1718636.102	3128086.014		719043.989	128828.409		C ¼ SEC. 7 3 ¼" ALUM. CAP ON 2" STEEL PIPE IN RANGE BOX STAMPED: ERNEST KNIGHT LS 7276 T3S, R68W S7 C ¼ 1988 ADAMS COUNTY
203	1719955.381	3128081.771		720363.582	128824.166		C-N ⅙ SEC. 7 3 ¼" ALUM. CAP ON #6 REBAR IN RANGE BOX STAMPED: GREENHORNE & OMARA N ⅙ S7 1986 PLS 20696
204	1721275.134	3128077.632		721683.648 C.O.A. CALC.	128820.025 C.O.A. CALC.		N ¼ SEC. 7 1" AXLE 1.2' BELOW ASPHALT SURFACE IN RANGE BOX @ 64TH & TENNYSON ST.
205	1715973.927	3125529.897		716381.183 C.O.A. CALC.	126271.685 C.O.A. CALC.		SW CORNER SEC. 7 3 ¼" ALUM. CAP IN CONCRETE ON BRIDGE IN RANGE BOX STAMPED: LANE ENG. SRV INC T3S R69W R68W 13-7 2006 LS 16837 @ 56TH & SHERIDAN BLVD.

GENERAL NOTES:

- THIS PROJECT CONTROL DIAGRAM IS FOR THE EXCLUSIVE USE OF THE CITY OF ARVADA, FOR THE DESIGN AND CONSTRUCTION OF THE TENNYSON AND 58TH NORTH TRUNK SEWER PROJECT. IT IS NOT A MONUMENTED LAND SURVEY OR LAND SURVEY PLAT. IT IS INTENDED ONLY TO DEPICT THE CONTROL INFORMATION AND MONUMENTATION SHOWN HEREON, AND IS SUBJECT TO CHANGE. CONTACT THE CITY OF ARVADA FOR THE MOST RECENT DIAGRAM.
- PUBLISHED UNITS FOR COORDINATES AND ELEVATIONS ARE IN US SURVEY FEET.
- SURVEY CONTROL DIAGRAM WAS PROVIDED BY THE CITY OF ARVADA DATED SEPTEMBER 22ND, 2022.
- DESIGN SURVEY WAS PERFORMED BY THE CITY OF ARVADA DATED AUGUST, 2023. ADDITIONAL DESIGN SURVEY WAS PERFORMED BY THE CITY DATED JULY 2024.
- CONTRACTOR SHALL PROTECT IN PLACE THE ALIQUOT SECTION CORNER MONUMENTS WITHIN THE AREA OF WORK. IF MONUMENTS ARE TO BE DISTURBED DURING CONSTRUCTION, THEY SHALL BE REFERENCED IN PLACE PRIOR TO DISTURBANCE AND REESTABLISHED IN PLACE AFTER CONSTRUCTION COMMENCES BY A PLS REGISTERED IN THE STATE OF COLORADO.

BASIS OF BEARINGS:

ASSUMES THE LINE BETWEEN POINT 201 AND POINT 202 BEARS N 00° 06' 43" W A DISTANCE OF 1313.19 FEET. POINT 201 IS THE S ⅙ AT 58TH AND TENNYSON ST. AND 202 IS THE C ¼ AT 60TH AND TENNYSON

BASIS OF ELEVATIONS:

THE VERTICAL CONTROL IS BASED ON EXCLUSIVE CITY OF ARVADA DATUM AND IS NOT RELATED TO NGVD29 OR NAVD88. A LEVEL LOOP WAS RAN THROUGH EACH CONTROL POINT FROM BM-877 USING A LEICA DNA 10 (DIGITAL LEVEL) FROM BENCHMARK #877 WHICH IS A 2" BRASS CAP AT TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER OF 60TH AND TENNYSON ST.

COORDINATE DATUM:

STATE PLANE COORDINATES ARE COLORADO CENTRAL ZONE (0502) NAD83 GEOID 18 BASED ON FAST STATIC GPS SURVEY. PROJECT COORDINATES ARE MODIFIED COLORADO STATE PLANE CENTRAL ZONE COORDINATES. PROJECT COORDINATES ARE DERIVED FROM STATE PLANE COORDINATES USING THE FOLLOWING FORMULAS.

PROJECT NORTHING = (STATE PLANE NORTHING * 1.000237332) - 1000000.00
PROJECT EASTING = (STATE PLANE EASTING * 1.000237332) - 3000000.00

CONVERSION OF PROJECT COORDINATES TO COLORADO STATE PLANE CENTRAL ZONE:

ADD 1,000,000 FEET TO THE PROJECT NORTHING AND 3,000,000 FEET TO PROJECT EASTING AND MULTIPLY EACH BY THE COMBINED SCALE FACTOR OF 0.999762724.

APPROVED

City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

LEGEND:

- = SECTION, QUARTER & SIXTEENTH CORNERS
- = CONTROL POINT SET BY THE CITY OF ARVADA
- = CITY OF ARVADA BENCH MARK

SEP 2024 - 90% DESIGN

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NO

REVISION

DATE

BY

SCALES

0 1" = 150'
0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED
TS

DRAWN
WAS

CHECKED
LS



NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SURVEY CONTROL DIAGRAM

SCALE

1" = 150'

JOB NO
2246059'00

DATE
SEP 2024

SHEET 4 OF 49
G-004

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User: GEOVANNY CISNEROS

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CIVIL NOTES

GENERAL

1. OBTAIN PERMITS NECESSARY TO COMPLETE FEATURES WITHIN EASEMENTS, DEDICATIONS, AND PUBLIC RIGHT-OF-WAY.

2. COORDINATES ARE PROVIDED AS FOLLOWS UNLESS OTHERWISE NOTED ON DRAWINGS:

2.1. FACE OF WALL

2.2. FACE OF CURB

2.3. CORNER OF EQUIPMENT PADS AND VAULTS

3. ORIENT SURFACE FEATURES PARALLEL TO CURB/GUTTER OR WALLS UNLESS OTHERWISE NOTED.

4. PROTECT ALL SURVEY MONUMENTS.

5. SHOULD THE CONTRACTOR DISCOVER ANY DISCREPANCIES BETWEEN THE CONDITIONS EXISTING IN THE FIELD AND THE INFORMATION SHOWN ON THESE DRAWINGS, CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION.

6. THE CONTRACTOR SHALL MAINTAIN A COPY OF AN APPROVED SET OF PLANS ON THE CONSTRUCTION SITE AT ALL TIMES.

7. "LIMITS OF EXCAVATION" INDICATES THE MINIMUM MATERIAL REMOVAL REQUIRED DUE TO GEOTECHNICAL RECOMMENDATIONS AND THE NATURE OF THE WORK. TAKE CARE NOT TO EXCAVATE BEYOND THE LIMITS INDICATED IN THE CONTRACT DOCUMENTS.

8. "LIMITS OF WORK" INDICATES THE TOTAL AREA OF DISTURBANCE DUE TO THE NATURE AND SCOPE OF THE WORK. THE TERM MAY ALSO BE USED TO INDICATE AREAS WHERE ACCESS IS LIMITED OR RESTRICTED.

9. PROVIDE TEMPORARY TRAFFIC SIGNAGE IN ACCORDANCE WITH STATE AND LOCAL AGENCIES DURING THE COURSE OF CONSTRUCTION.

10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL WITHIN THE PUBLIC RIGHT OF WAY IN ACCORDANCE WITH LOCAL ORDINANCES. NO WORK SHALL COMMENCE UNTIL ALL REQUIRED TRAFFIC CONTROL MEASURES ARE IN PLACE.

11. FOR WORK ASSOCIATED WITH METRO WATER RECOVERY: METRO MAY REQUIRE PRE- AND POST-VIDEO INSPECTIONS OF THE EXISTING METRO TRANSMISSION MAINLINE DURING CONSTRUCTION TO ENSURE NO DAMAGE IS DONE TO THE EXISTING SANITARY LINE. COORDINATE WITH THE METRO FIELD INSPECTOR FOR REQUIREMENTS:

a. NOTIFY TYLER HOPKINS 2-WEEKS PRIOR TO CONSTRUCTION STARTING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.

b. NOTIFY AND INVITE METRO TO THE PRECONSTRUCTION MEETING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.

12. ALL PROPOSED WORK FROM SSMH 4-7 SOUTH TO THE SOUTHERN MOST EXTENTS OF CONSTRUCTION LIMITS ARE LOCATED WITHIN THE 100-YEAR FLOODPLAIN AND/OR FLOODWAY. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL NECESSARY PERMITS FOR WORK WITHIN THE ADAMS COUNTY AND CITY OF ARVADA RIGHT OF WAY INCLUDING ANY NECESSARY PERMITS REQUIRED RELATED TO WORK WITHIN THE FLOODPLAIN AND/OR FLOODWAY.

13. THE OWNER, OWNER'S REPRESENTATIVE, AND/OR THE ENGINEER, IS NOT A GUARANTOR OF THE CONSTRUCTION CONTRACTORS' OBLIGATIONS AND PERFORMANCE OF CONTRACT.

14. OBSERVATIONS OF WORK IN PROGRESS AND ON-SITE VISITS ARE NOT TO BE CONSTRUED AS A GUARANTEE BY THE CITY OR ENGINEER OF THE CONTRACTORS' PERFORMANCE.

15. THE OWNER OR ENGINEER, IS NOT RESPONSIBLE FOR SAFETY IN, ON, OR ABOUT THE PROJECT SITE, NOR FOR COMPLIANCE BY THE APPROPRIATE PARTY OF ANY REGULATIONS RELATING THERETO.

16. THE OWNER OR ENGINEER, EXERCISES NO CONTROL OF THE SAFETY OR ADEQUACY OF ANY EQUIPMENT, BUILDING COMPONENTS, SCAFFOLDING, FORMS, OR ANY OTHER WORK AIDS USED IN OR ABOUT THE PROJECT, OR IN THE SUPERINTENDING OF THE SAME.

17. WORK WITHIN ADAMS COUNTY R/W SHALL MILL/OVERLAY ENTIRE LANE TO THE CENTERLINE OF THE ROAD. IF WORK EXTENDS PAST THE CENTERLINE, CONTRACTOR SHALL MILL/OVERLAY THE ENTIRETY OF THE ROAD EXTENTS.

GRADING

1. ADJUST VALVE BOXES, PULL BOXES, VAULTS, AND MAINTENANCE HOLES TO FINISHED GRADES AND SLOPES SHOWN ON CIVIL GRADING DRAWINGS UNLESS OTHERWISE SHOWN OR SPECIFIED. MAINTENANCE HOLES IN OPEN FIELDS SHALL BE SET ONE FOOT ABOVE GRADE. APPROXIMATE RIM ELEVATIONS ARE SHOWN ON DRAWINGS.

2. GRADES SHOWN ARE TO TOP OF THE FINISHED SURFACE UNLESS OTHERWISE NOTED.

DEMOLITION

1. DEMOLITION EXTENTS INDICATED IN DRAWINGS ARE THE MINIMUM REQUIRED TO COMPLETE THE WORK. CONTRACTOR SHALL DETERMINE FULL DEMOLITION EXTENTS DURING FIELD RECONNAISSANCE PRIOR TO CONSTRUCTION.

2. PROVIDE COORDINATES OF ABANDONED UTILITIES IN THE RECORD DRAWINGS.

3. EXISTING METERING VAULT SHALL BE REMOVED. REMOVE VAULT BASE AS NEEDED TO PERFORM THE PIPELINE BEDDING, TRENCHING, AND BACKFILLING REQUIREMENTS OUTLINED IN THE PROJECT SPECIFICATIONS. BACKFILL REMAINING AREAS TO GRADE.

PIPING

1. THESE NOTES ARE GENERIC IN NATURE. PROJECT SPECIFIC NOTES ON FOLLOWING DRAWINGS TAKE PRECEDENCE.

2. THE CONTRACTOR SHALL COMPLY WITH THE STATE DEPARTMENT OF HEALTH SERVICES CRITERIA FOR THE SEPARATION BETWEEN WATER MAINS, NON-POTABLE WATER UTILITIES, AND SEWER.

3. INSTALL WATER, STORM, AND SEWER PIPELINES WITH A MINIMUM OF 48 INCHES OF COVER, UNLESS OTHERWISE NOTED OR SHOWN ON THE DRAWINGS.

4. PRIOR TO SUBMITTAL OF PIPE SHOP DRAWINGS, VERIFY THE INVERT ELEVATIONS, ALIGNMENT, OUTSIDE DIAMETER, LOCATION, AND MATERIAL OF ALL EXISTING PIPELINES TO WHICH NEW PIPELINES WILL BE CONNECTED.

5. PIPE STATIONING REPRESENTS THE HORIZONTAL PROJECTION OF THE PIPE CENTERLINE BETWEEN MAINTENANCE HOLES, POINTS OF INFLECTION, AND/OR CENTER OF FITTINGS.

6. RESTRAIN ALL WATER PIPE AND FITTINGS AT UTILITY CROSSINGS PER CITY OF ARVADA LENGTH OF RESTRAINED PIPE DETAIL.

7. LOCATION OF EXISTING UTILITIES ARE APPROXIMATE. CONTRACTOR SHALL EXPOSE EXISTING PIPE(S) OR STRUCTURE(S) TO WHICH NEW PIPE(S) IS/ARE CONNECTING. VERIFY EXACT LOCATION, SIZE, MATERIALS, AND INVERT ELEVATIONS PRIOR TO SUBMITTING PIPE DRAWINGS.

8. PROTECT EXISTING UTILITIES UNLESS OTHERWISE NOTED.

9. USE CAUTION WHEN WORKING IN PROXIMITY TO GAS. NOTIFY UTILITY COMPANY WHEN WORKING WITHIN THE VICINITY AND FOLLOW UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.

10. USE CAUTION WHEN WORKING IN PROXIMITY TO OVERHEAD ELECTRICAL LINES. FOLLOW ELECTRICAL UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.

11. CROSSING PIPELINES SHOWN IN PROFILE REPRESENT OUTSIDE DIAMETER UNLESS OTHERWISE NOTED.

12. ORIENT ECCENTRIC MAINTENANCE HOLE(S) SUCH THAT THE LID IS OUTSIDE OF WHEEL PATH.

13. COORDINATES LOCATING MAINTENANCE HOLES ARE TO THE CENTER OF THE STRUCTURE.

14. SIZE OF FITTING SHOWN ON THE DRAWINGS CORRESPONDS TO THE ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED. MATCH TYPE OF JOINT AND FITTING MATERIAL TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED.

15. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS ARE APPROXIMATE. PROVIDE UNIONS AS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.

16. COORDINATE AND PERFORM CONNECTIONS TO THE WORK OF OTHER CONTRACTORS, IF APPLICABLE.

17. MINIMUM HORIZONTAL CLEARANCE FOR UTILITIES IS 10 FEET FROM EDGE OF SANITARY SEWER PIPE. MINIMUM VERTICAL CLEARANCE FOR UTILITIES IS 18 INCHES FROM EDGE OF SANITARY SEWER PIPE. IF MINIMUM HORIZONTAL AND VERTICAL UTILITY CLEARANCES CANNOT BE MET DUE TO FIELD CONDITIONS, SANITARY PIPING DESIGN CONSISTS OF PRESSURE RATED MATERIALS WITH LEAK TIGHT JOINTS. CONTRACTOR SHALL WORK WITH UTILITY OWNERS TO ACCOMMODATE REQUIRED CLEARANCES WHEN POSSIBLE.

18. WHEN CROSSING UNDERNEATH POTABLE WATER WITH LESS THAN 18-INCHES OF CLEARANCE, THE CONTRACTOR SHALL NOTIFY THE ENGINEER. THE CONTRACTOR SHALL CROSS THE UTILITY WITH NO PIPE JOINTS WITHIN 9-FEET OF EITHER SIDE OF THE CROSSING.

WATER

1. WATER MAIN ABANDONMENT, CITY OF ARVADA: CITY OF ARVADA WATER MAINS TO BE ABANDONED MUST BE REMOVED AND DISPOSED OF OFF SITE.

2. MINIMUM BURY DEPTH FOR ALL WATERLINES IS 4-FEET DEEP TO TOP OF PIPE UNLESS OTHERWISE NOTED ON THE PLANS.

3. NEW WATER MAIN SHOULD BE TESTED IN SECTIONS AS TO MINIMIZE THE AMOUNT OF POTENTIAL DOWNTIME OF WATER SERVICE TO CUSTOMERS. CONTRACTOR SHALL NOTIFY CUSTOMER A MINIMUM 48 HOURS IN ADVANCE OF UPCOMING UTILITY DISRUPTIONS. FOR DOWNTIMES RESULTING IN 4 HOURS OR MORE, CONTRACTOR SHALL PROVIDE TEMPORARY WATER SERVICE TO CUSTOMERS.

4. CONTRACTOR SHALL COORDINATE WITH THE CITY OF ARVADA WATER DEPARTMENT BEFORE, AND DURING, THE WATERLINE REPLACEMENT WORK. COORDINATION WILL INCLUDE CONSTRUCTION SEQUENCING, WATER SERVICE DISRUPTIONS, INSTALLATION OF TEMPORARY BLOWOFFS, AND OPERATION OF EXISTING VALVES. CONTRACTOR IS NOT PERMITTED TO OPERATE EXISTING ARVADA WATER DEPARTMENT VALVES. VALVES WILL OPERATED BY ARVADA PERSONNEL ONLY.

5. A POTENTIAL WATERLINE CONSTRUCTION SEQUENCE IS PROVIDED ON SHEETS C-355 THROUGH C-357. THIS IS NOT A REQUIRED SEQUENCE AS THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE MEANS AND METHODS OF WATERLINE CONSTRUCTION SEQUENCING IN THE FIELD TO MINIMIZE UTILITY DISRUPTIONS.

6. CITY RECORDS INDICATE AN ABANDONED 6" CI WATER LINE IS LOCATED IN THE VICINITY OF THE PROPOSED WATER MAIN ALONG TENNYSON STREET. CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING WATER LINE IF ENCOUNTERED IN THE FIELD DURING CONSTRUCTION.

7. FOR WATERLINE RAISINGS AND LOWERINGS, CONTRACTOR SHALL WORK WITH THE UTILITY OWNER TO DETERMINE THE APPROPRIATE METHOD FOR MAINTAINING VERTICAL CLEARANCES AND ON WHETHER A PERMANENT BLOWOFF ASSEMBLY IS REQUIRED.

SANITARY SEWER

1. ALL SANITARY SEWER SYSTEM PLANS AND CONSTRUCTION SHALL CONFORM TO THE CURRENT CITY OF ARVADA ENGINEERING STANDARDS AND SPECIFICATIONS AND SHALL BE SUBJECT TO CONSTRUCTION OBSERVATION BY CITY PERSONNEL OR REPRESENTATIVES. THE ENGINEER OR CONTRACTOR SHALL SCHEDULE A PRE-CONSTRUCTION MEETING WITH THE OWNER AT LEAST 48-HOURS PRIOR TO START OF CONSTRUCTION. NO CONSTRUCTION WILL BE PERMITTED UNTIL ALL EASEMENTS ARE SIGNED AND RECORDED, AS APPLICABLE, AND THE PRE-CONSTRUCTION MEETING HAS BEEN HELD.

2. PROBATIONARY ACCEPTANCE OF THE NEW SANITARY SEWER MAINS WILL NOT BE CONSIDERED UNTIL ALL REQUIREMENTS FOR ACCEPTANCE HAVE BEEN MET, INCLUDING:

a. SANITARY SEWER TRENCH COMPACTION TEST RESULTS

b. SANITARY SEWER PIPE LEAK TESTING RESULTS

c. CCTV FOOTAGE OF THE NEWLY INSTALLED PIPELINE

d. RECORD DRAWINGS

3. MAINTENANCE HOLE RIMS SHALL BE SET AT AN ELEVATION RELATIVE TO THE PAVEMENT, IN ACCORDANCE WITH THE APPROPRIATE CITY, COUNTY, OR STATE HIGHWAY DEPARTMENT STANDARDS. WHETHER OR NOT THE MAINTENANCE HOLE IS IN A PAVED OR UNPAVED AREA, A MINIMUM OF 4-INCHES OF CONCRETE RISER RINGS SHALL BE USED TO ADJUST RIM ELEVATIONS TO FINAL GRADE. THE MAXIMUM ACCEPTABLE VERTICAL ADJUSTMENT UTILIZING RISER RINGS IS 12-INCHES.

4. THE CONTRACTOR SHALL VERIFY EXISTING MAINTENANCE HOLE INVERTS AT PROPOSED POINTS OF CONNECTION, PRIOR TO CONSTRUCTION STAKING.

5. THE CONTRACTOR SHALL TAKE CARE TO PROPERLY SHAPE ALL MAINTENANCE HOLE INVERTS AND BENCHES IN ACCORDANCE WITH CITY ENGINEERING STANDARDS AND SPECIFICATIONS. MAINTENANCE HOLE INVERTS SHALL BE CONSTRUCTED WITH A SMOOTH TROWEL FINISH, AND BENCHES FINISHED WITH A LIGHT BROOM, NON-SKID FINISH.

6. ALL NEW MAINS MUST BE JETTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.

7. ALL NEW MAINS SHALL BE VIDEO-INSPECTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.

8. THE INVERT ELEVATIONS OF ALL EXISTING PIPES WHERE CONNECTIONS ARE TO BE MADE MUST BE FIELD VERIFIED PRIOR TO CONSTRUCTION.

9. SANITARY SEWER ABANDONMENT, CITY OF ARVADA R/W: EXISTING SANITARY SEWER TRUNKLINE SHALL BE REMOVED AS PART OF CONSTRUCTION UNLESS OTHERWISE DENOTED WITH DEMO HATCHING. IF DEMO HATCHING IS SHOWN, CONTRACTOR CAN ABANDON IN PLACE. SANITARY SEWER MAINS TO BE ABANDONED IN PLACE SHALL BE FILLED WITH CONCRETE OR FLOW FILL. WHERE A PIPE IS ABANDONED AT A MAINTENANCE HOLE, THE PIPE SHALL BE PLUGGED AT THE MAINTENANCE HOLE AND REMOVED FOR A MINIMUM OF 2-FEET. PRIOR TO FILLING WITH CONCRETE OR FLOW FILL, ANY PIPE TO BE ABANDONED IN PLACE SHALL BE FLUSHED WITH CLEAN WATER TO REMOVE DEBRIS. THE FLUSHING WATER SHALL BE PROPERLY CAPTURED AND TREATED AND NOT RELEASED TO THE STORM WATER SYSTEM OR NATURAL CHANNEL. FLUSHING WATER AND DEBRIS SHALL NOT BE DISCHARGED TO DOWNSTREAM SANITARY SEWER PIPING.

10. SANITARY SEWER ABANDONMENT, ADAMS COUNTY R/W: THE EXISTING SANITARY SEWER MAINS WITHIN ADAMS COUNTY R/W MUST BE REMOVED AND DISPOSED OF OFF SITE.

11. MAINTENANCE HOLE ABANDONMENT: MAINTENANCE HOLES SHALL HAVE THE TOP CONE REMOVED AND THE REMAINING MAINTENANCE HOLE VOID SPACE SHALL BE FILLED WITH FLOWABLE FILL WITH COMPRESSIBLE STRENGTH OF LESS THAN 200 PSI SO THAT IT CAN BE EXCAVATED IN THE FUTURE AS NEEDED.

12. CONTRACTOR SHALL ROTATE ECCENTRIC MAINTENANCE HOLE RIMS AND COVERS TO AVOID DRAINAGE AREAS SUCH AS GUTTERS, SURFACE STORMWATER FLOWLINES, AND DRAINAGE PANS. ROTATE RIMS AND COVERS OUT OF THE LIKELY WHEEL PATH OF VEHICLES WITHIN THE RIGHT-OF-WAY. ROTATE RIMS AND COVERS SO THAT THEY ARE LOCATED OUTSIDE OF THE CURB AND SIDEWALK WHERE POSSIBLE.

13. ALL MAINTENANCE HOLE RIMS AND COVERS SOUTH OF AND INCLUDING SSMH 4-7 SHALL BE WATER TIGHT, SEE SECTION 02080 FOR REQUIREMENTS.

14. FOR CONNECTING PIPELINES LESS THAN OR EQUAL TO 30-INCHES IN DIAMETER, 5'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED. FOR CONNECTING PIPELINES GREATER THAN 30-INCHES IN DIAMETER, 6'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED.

15. 6'-0" DIAMETER MAINTENANCE HOLES SHALL BE INSTALLED WITH 30" RINGS AND COVERS. 5'-0" DIAMETER MAINTENANCE HOLES SHALL BE INSTALLED WITH 24" RINGS AND COVERS. SEE SECTION 02080 FOR DETAILS.

16. ALL MAINTENANCE HOLES SHALL INCLUDE EXTERNAL SEALING BANDS ON THE OUTSIDE OF THE STRUCTURE AT ALL JOINTS TO PREVENT GROUNDWATER INTRUSION. COAL TAR EPOXY COAT THE EXTERIOR OF THE MAINTENANCE HOLE. LINE THE INSIDE OF THE MAINTENANCE HOLE WITH AN H2S RESISTANT COATING. SEE SECTION 02080 FOR REQUIREMENTS.

17. ALL MAINTENANCE HOLES AND PIPING SOUTH OF THE METER VAULT SHALL BE DESIGNED AND CONSTRUCTED TO METRO WATER RECOVERY STANDARD DETAILS AND SPECIFICATIONS. THIS INCLUDES THE 30" BYPASS PIPING AROUND THE METER VAULT.

18. SANITARY SEWER OWNERSHIP TRANSITIONS FROM THE CITY OF ARVADA TO METRO DOWNSTREAM OF SSMH M-3. ALL SANITARY RELATED INFRASTRUCTURE DOWNSTREAM OF THIS LOCATION, INCLUDING BYPASS INFRASTRUCTURE AND ELECTRICAL INFRASTRUCTURE, WILL BECOME THE PROPERTY OF METRO ONCE CONSTRUCTION IS ACCEPTED BY METRO.

PIPE SCHEDULE

LINE	SYSTEM	SIZE	SERVICE	FLOW	PIPE TYPE	SPECIFICATION
SS	SANITARY	21" - 42"	BURIED	GRAVITY	FRP, SN 46	SEE SPEC 02530
SS	SANITARY	< 21"	BURIED	GRAVITY	PVC, SDR 35	SEE SPEC 02530
SS-RR	SANITARY SEWER RAILROAD	30"	BURIED	GRAVITY	CIPP*	SEE SPEC 02550
SSFM	SANITARY FORCE MAIN	≤ 4"	BURIED	PRESSURE	PVC, DR 21	SEE SPEC 02531
W	WATER MAIN	≥ 6"	BURIED	PRESSURE	PVC, C909	SEE SPEC 02510
W	FIRE HYDRANT LATERAL	6"	BURIED	PRESSURE	PVC, C909	SEE SPEC 02510
W	WATER SERVICE	≤ 2"	BURIED	PRESSURE	CUP	SEE SPEC 02510
-	CASING PIPE	30"	BURIED	-	STEEL	SEE SPEC 02450

*CIPP APPLICATION TO BE UTILIZED FOR EXISTING 30" VCP/RCP AS WELL AS FOR LINING THE NEW 30" STEEL CASING PIPE

PIPING DESIGNATIONS

NEW PIPING

CENTERLINE ELEVATION (UNLESS OTHERWISE NOTED)

XXX.X

6"-RW

XXX.X

PROCESS CODE, SEE PIPE SCHEDULE

NOMINAL PIPE DIAMETER

EXISTING PIPING

6"-RW

6"-RW

FUTURE PIPING

6"-RW

6"-RW

ABBREVIATIONS

'	FOOT, FEET	G	GAS
"	INCH, INCHES	HDPE	HIGH DENSITY POLYETHYLENE
#	POUND, NUMBER	ID	INSIDE DIAMETER
%	PERCENT	IJTS	INSULATING JOINT TEST STATION
&	AND	INV	INVERT
@	AT	LF	LINEAR FEET
±	APPROXIMATELY	MAX	MAXIMUM
ℓ	CENTERLINE	MIN	MINIMUM
<	LESS THAN	MJ	MECHANICAL JOINT
=	LESS THAN OR EQUAL TO	MW	MONITORING WELL
≅	EQUALS	(N)	NEW
>	GREATER THAN	NAD	NORTH AMERICAN DATUM
>	GREATER THAN OR EQUAL TO	NAVD	NORTH AMERICAN VERTICAL DATUM
Δ	DEFLECTION	NGVD	NATIONAL GEODETIC VERTICAL DATUM
∠	ANGLE	OD	OUTSIDE DIAMETER
°	DEGREE(-S) (ANGULAR)	OHE	OVERHEAD ELECTRICAL
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS	OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
ALUM	ALUMINUM	PE	POLYETHYLENE
APPROX	APPROXIMATE(-LY)	P/L	PROPERTY LINE
ASCE	AMERICAN SOCIETY OF CIVIL ENGINEERS	PH	POTHOLE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS	PVC	POLYVINYL CHLORIDE
AR/AV	AIR RELEASE/AIR VACUUM	QLA	QUALITY LEVEL A
BMP	BEST MANAGEMENT PRACTICE	QLB	QUALITY LEVEL B
CATS	CASING TEST STATION	QLC	QUALITY LEVEL C
CCTV	CLOSED CIRCUIT TELEVISION	QLD	QUALITY LEVEL D
CDOT	COLORADO DEPARTMENT OF TRANSPORTATION	R/R	REMOVE AND REPLACE
CDPHE	COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT	R/W	RIGHT OF WAY
CI	CAST IRON	RCP	REINFORCED CONCRETE PIPE
CIP	CAST IRON PIPE	RTD	REGIONAL TRANSPORTATION DISTRICT
CIPP	CURED IN PLACE PIPE	SD	STORM DRAIN
CM	CONTROL MEASURE	SDMH	STORM DRAIN MAINTENANCE HOLE
CSTS	CURRENT SPAN TEST STATION	SQ	SQUARE
CTS	CORROSION TEST STATION	SS	SANITARY SEWER, STAINLESS STEEL
CUP	COPPER PIPE	SSA	STABILIZED STAGING AREA
CWA	CONCRETE WASHOUT AREA	SSFM	SANITARY SEWER, FORCE MAIN
DIA	DIAMETER	SSMH	SANITARY SEWER MAINTENANCE HOLE
DIP	DUCTILE IRON PIPE	STA	STATION
DNF	DID NOT FIND	SUE	SUBSURFACE UTILITY ENGINEERING
(E)	EXISTING	SW	STEEL WELD
EC	EROSION CONTROL	SWMP	STORMWATER MANAGEMENT PLAN
ESCP	EROSION AND SEDIMENT CONTROL PLAN	TP	TEST PIT
ESMT	EASEMENT	TYP	TYPICAL
ETS	ELECTROLYSIS TEST STATION	VCP	VITRIFIED CLAY PIPE
FOC	FIBER OPTIC CABLE	VTC	VEHICLE TRACKING CONTROL
FPTS	FOREIGN PIPELINE TEST STATION		
FRP	FIBERGLASS REINFORCED PLASTIC		
FT	FEET		

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

CIVIL NOTES AND ABBREVIATIONS

SCALE

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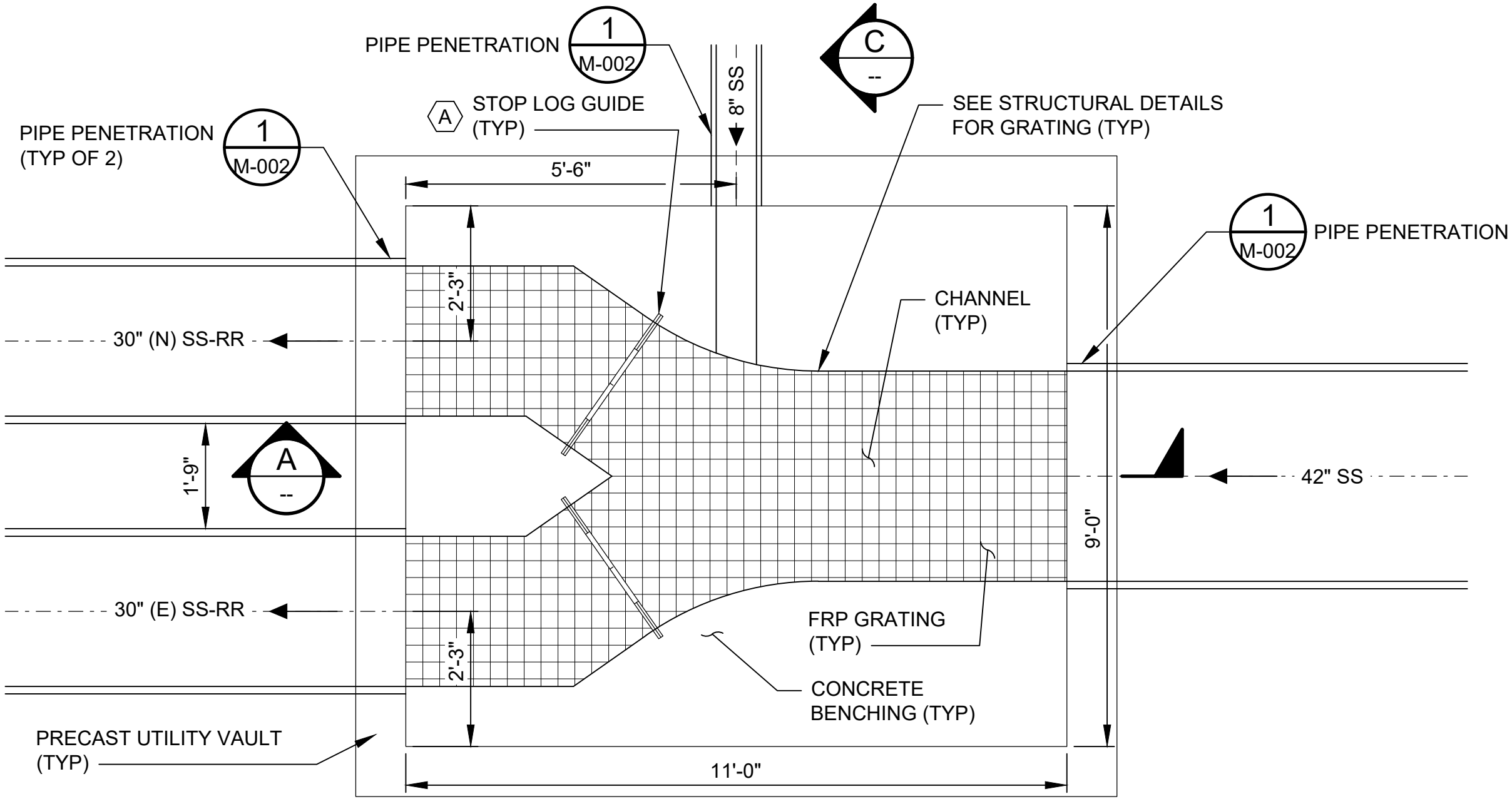
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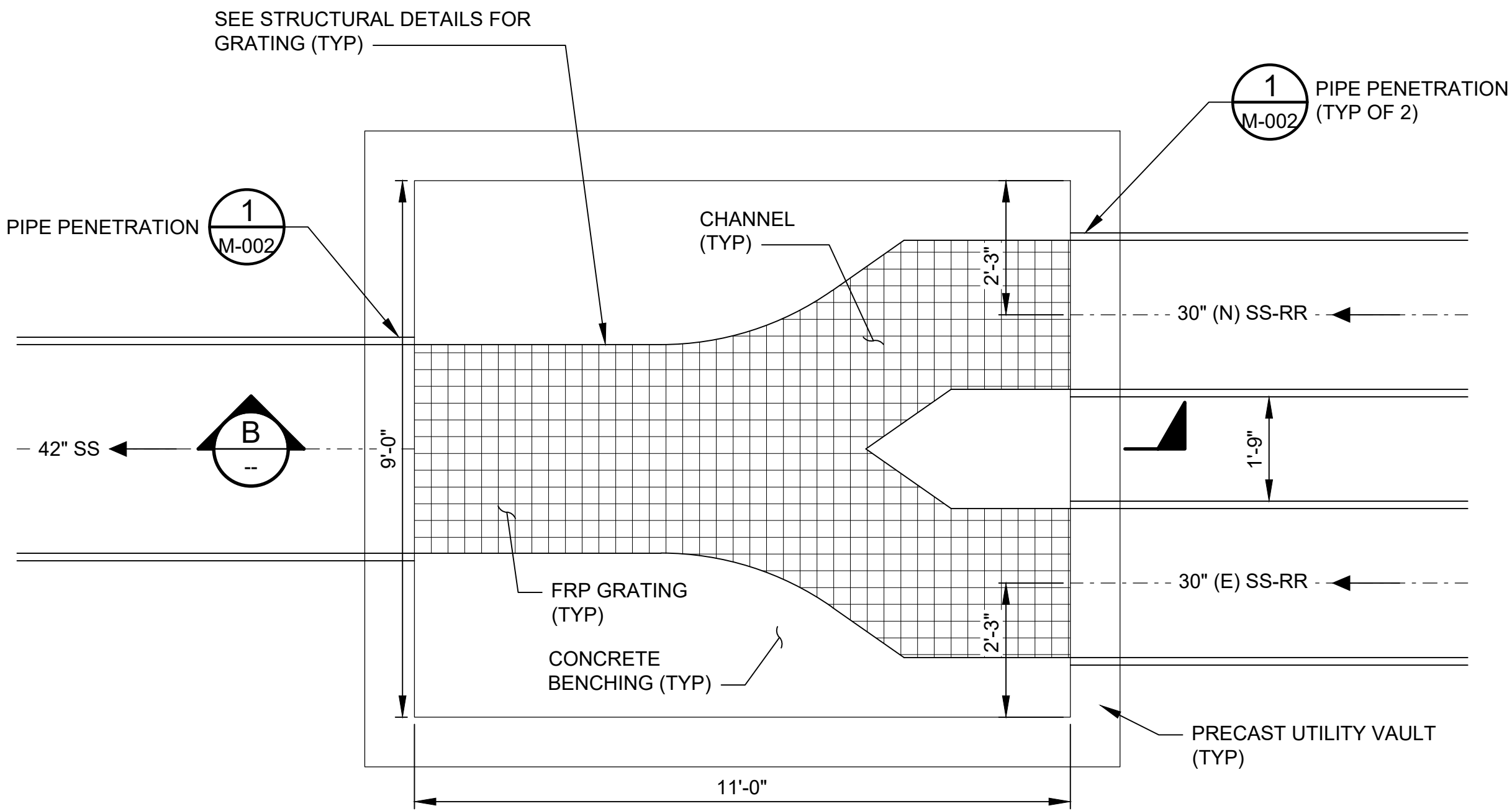
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GEOTECHNICAL SYMBOLS		TOPOGRAPHY AND MAPPING SYMBOLS		EXISTING FEATURES		PIPING AND UTILITIES		ROADWORK AND PAVING	
PH-# TP-# MW UTILITY MONITORING POINT POTHOLE LOCATION TEST PIT LOCATION MONITORING WELL UTILITY MONITORING POINT		125 124 TOP OF SLOPE TOE OF SLOPE P/L P/L PROPERTY LINE R/W R/W RIGHT-OF-WAY LINE GRADE BREAK R RIDGE LINE ESMT EASEMENT LINE ESMT TEMPORARY TEMPORARY EASEMENT LINE TRAIL OR DIRT ROAD FLOW LINE FLOOD HAZARD AREA EDGE OF WETLANDS RAILROAD SITE OR RETAINING WALL GUARDRAIL (PERMANENT) LIMITS OF GRADING LIMITS OF EXCAVATION		VEGETATION TREE (SIZE AND TYPE) WELL POWER POLE GUY LINE AND ANCHOR MAILBOX TRAFFIC SIGNAL BOX OR POLE SIGN TELEPHONE BOX COMMUNICATION/CATV BOX HOSE BIBB HOSE RACK WATER BOX/METER BACKFLOW PREVENTER MAINTENANCE HOLE OR VAULT FIRE HYDRANT					

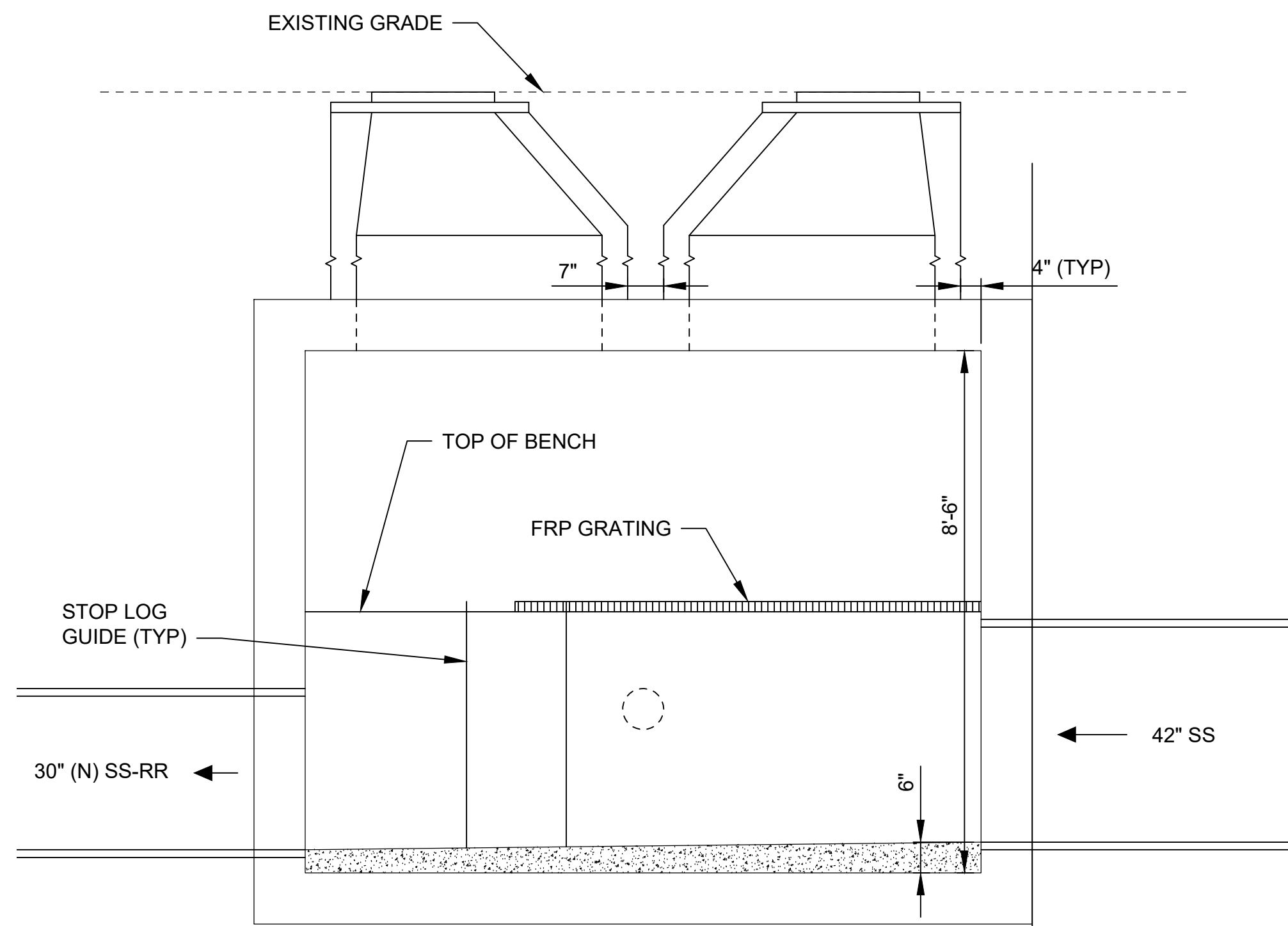
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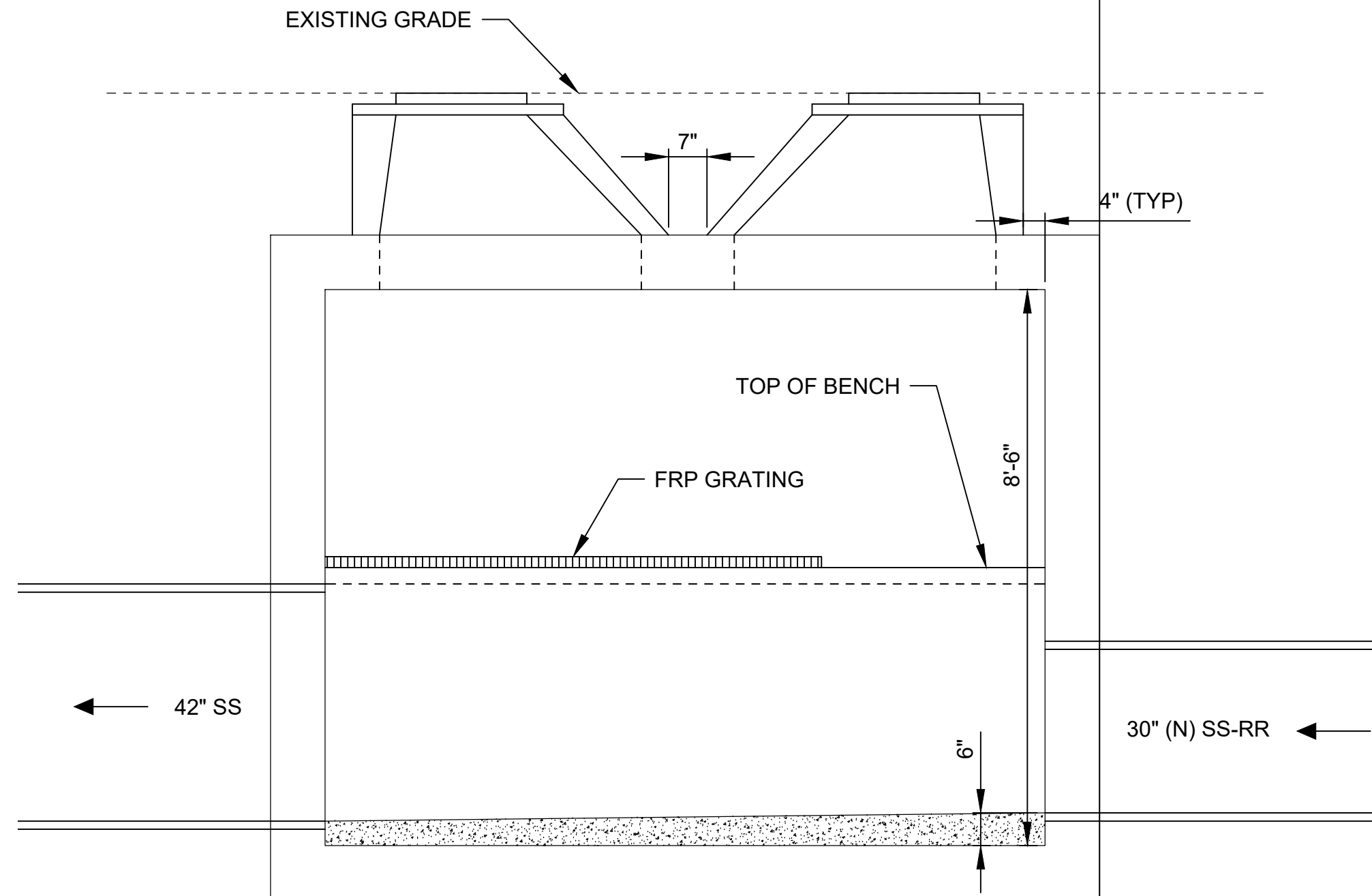
FLOW DIVERSION VAULT CHANNEL PLAN - SSMH-8
SCALE: 1/2"=1'-0"



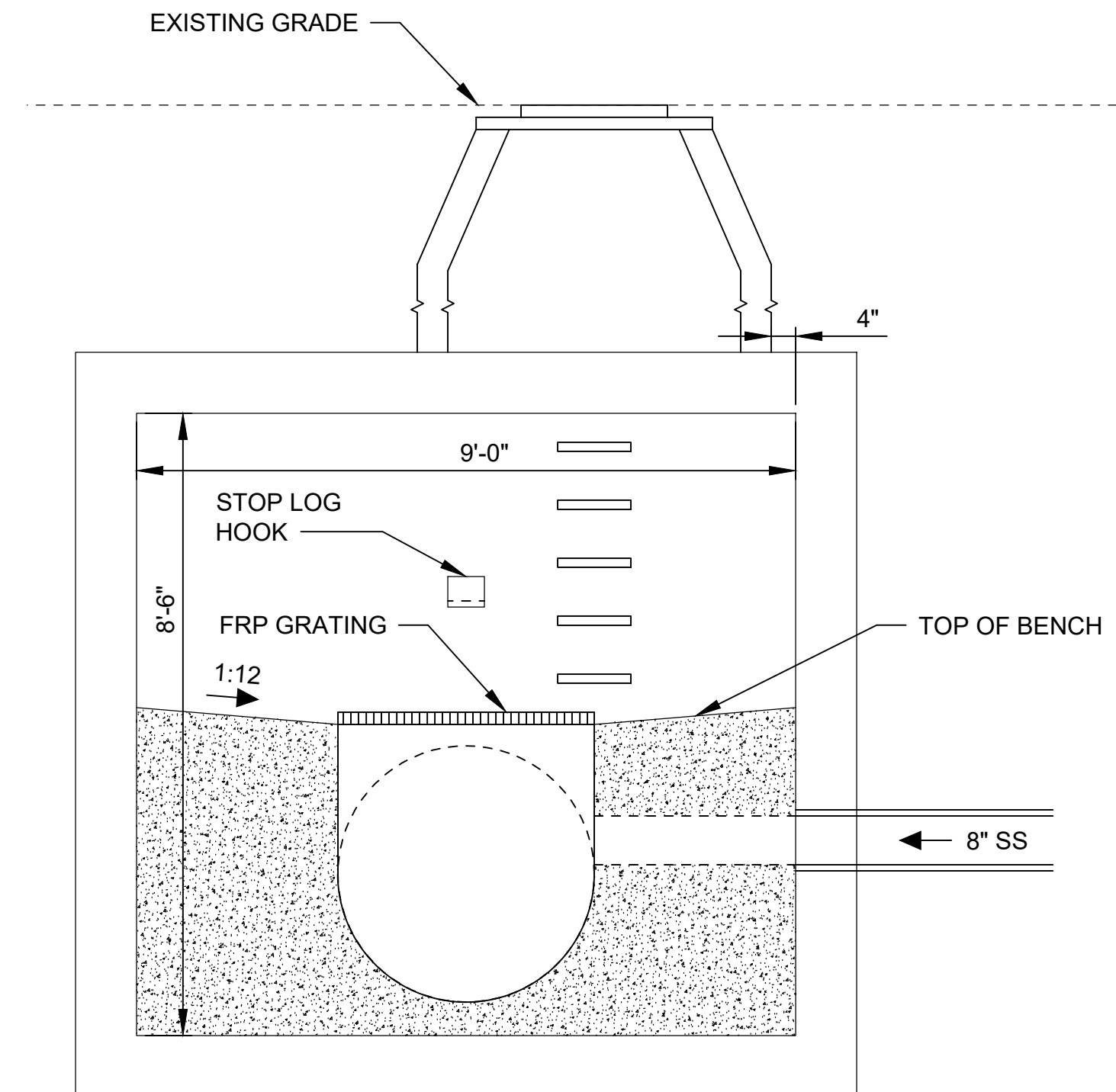
FLOW DIVERSION VAULT CHANNEL PLAN - SSMH-7
SCALE: 1/2"=1'-0"



A SECTION
SCALE: 1/2"=1'-0"



B SECTION
SCALE: 1/2"=1'-0"



C SECTION
SCALE: 1/2"=1'-0"

GENERAL SHEET NOTES

- CHANNELIZATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL EITHER PROVIDE PRECAST CHANNELS OR FIELD FORM CHANNELS. INVERTS INTO AND OUT OF THE STRUCTURE SHALL MATCH THOSE SHOWN ON SHEET C-354. CARE SHALL BE TAKEN TO AVOID UNEVEN SURFACES THAT COULD POTENTIALLY CAUSE A HYDRAULIC JUMP WHEN FLOWING WASTEWATER IS PRESENT. CONTRACTOR SHALL TAKE CARE TO ACCOMMODATE THE STOP LOG CHANNEL GUIDES SO THAT STOP LOGS CAN BE INSERTED/REMOVED WITH EASE AFTER INSTALLATION.
- CONTRACTOR SHALL COORDINATE VAULT DEPTHS, CHANNEL INVERTS, PIPE PENETRATIONS, DOWELING LOCATIONS, AND ADDITIONAL REQUIREMENTS WITH THE PRECAST VAULT MANUFACTURER. VAULTS SHALL BE SUBMITTED AS A COMPLETE PACKAGE FOR FAVORABLE REVIEW BY THE ENGINEER PRIOR TO DELIVERY.
- FLOW DIVERSION VAULTS ARE CONSIDERED A CLASS 1, DIVISION 1 CLASSIFIED SPACE SIMILAR TO MAINTENANCE HOLES.
- BENCHES SHALL EXTEND 3" ABOVE THE SOFFIT OF THE LARGEST PIPE. SLOPE OF BENCH IS 1:12.
- "COLD JOINTS" ARE NOT ALLOWED.
- SEE SHEET C-354 FOR PIPE INVERT INFORMATION.

SHEET KEYNOTES

- A. PROVIDE A LEAK TIGHT CONNECTION BETWEEN THE STOP LOGS AND CHANNEL GUIDES. PROPOSED MATERIALS SHALL BE SUITABLE FOR MUNICIPAL WASTEWATER SERVICE. SEE METRO STANDARD DETAIL 40 05 59.1.

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

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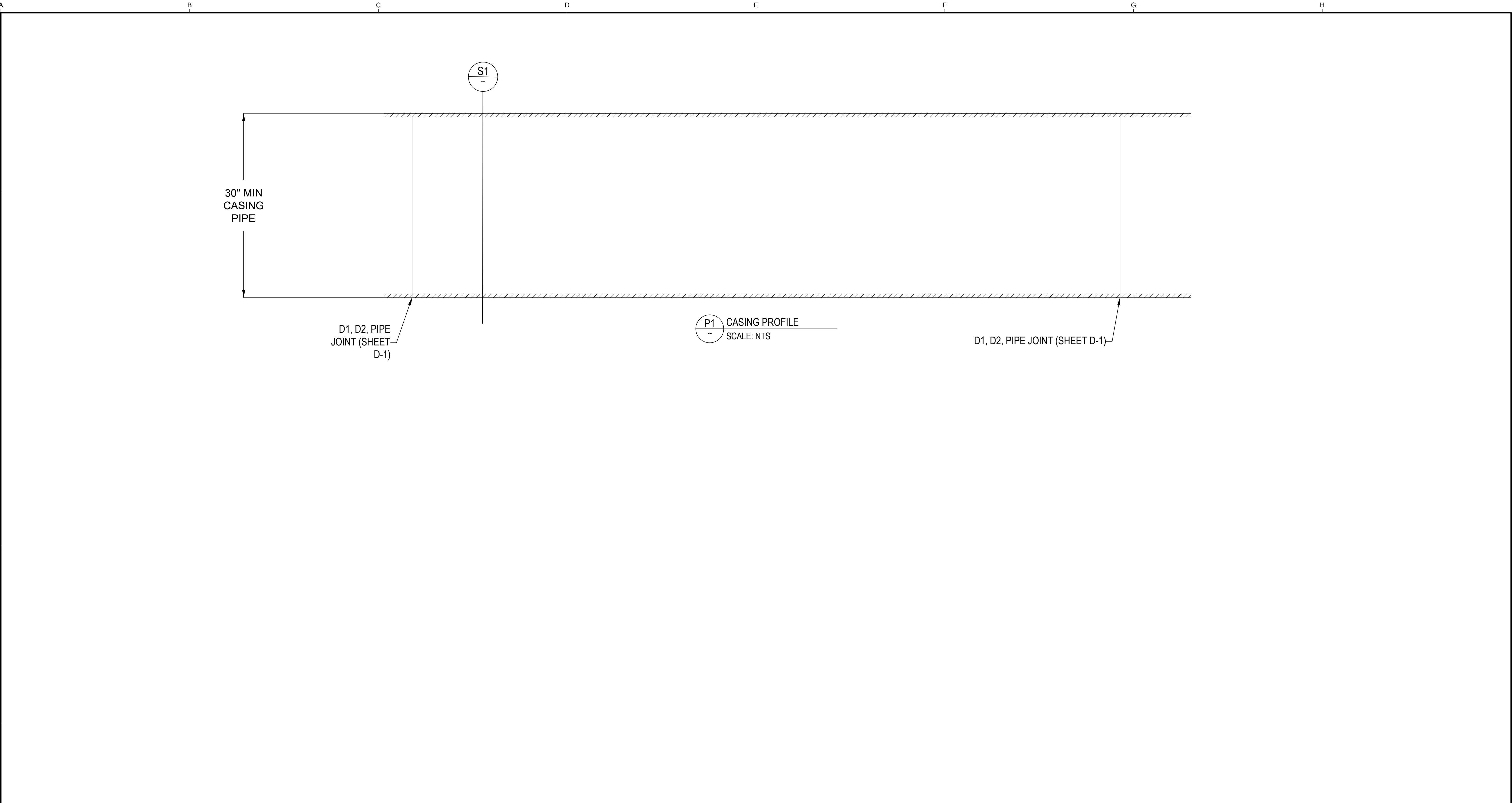
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CITY OF ARVADA
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
Kennedy Jenks

CIVIL DETAILS - II

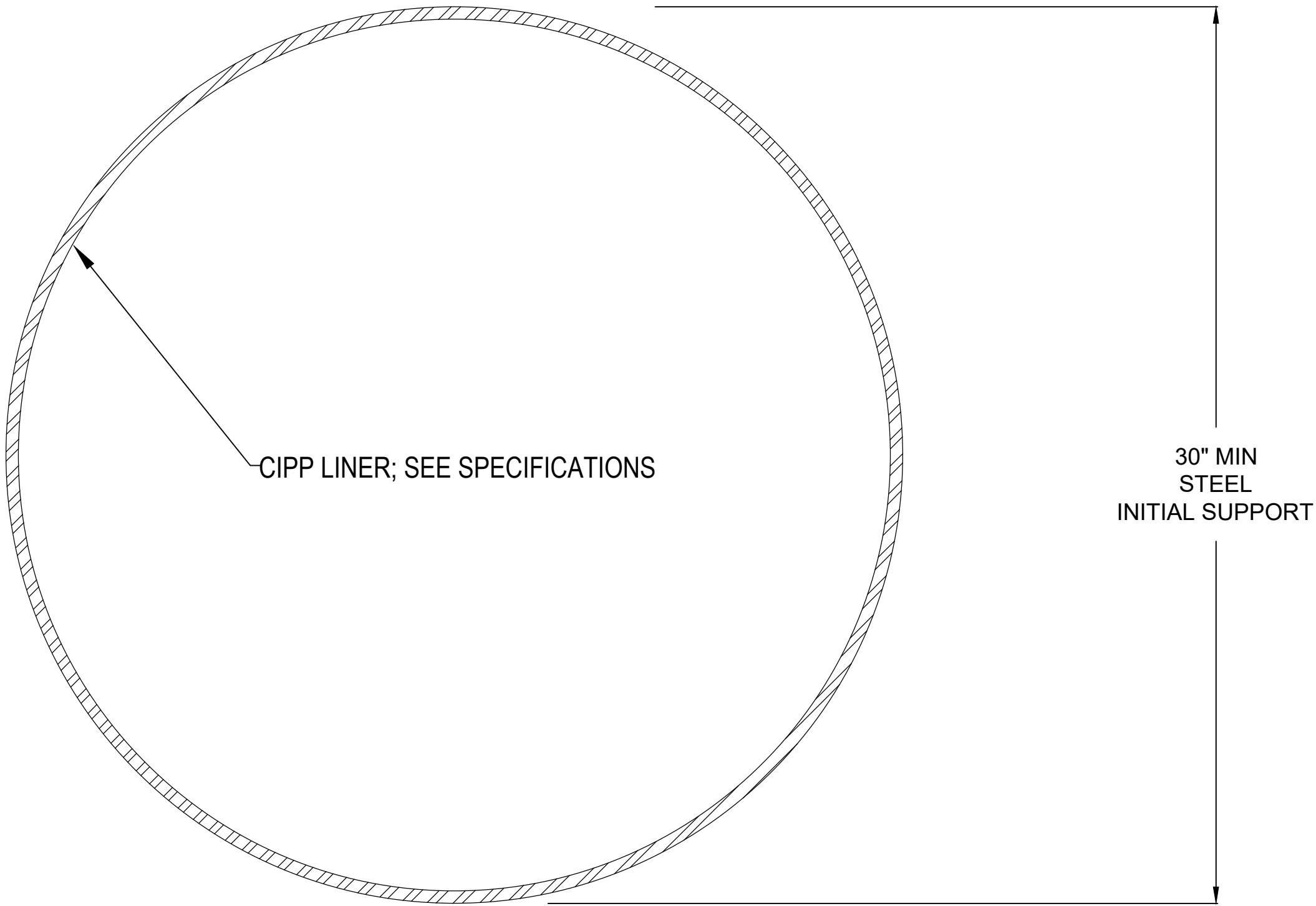
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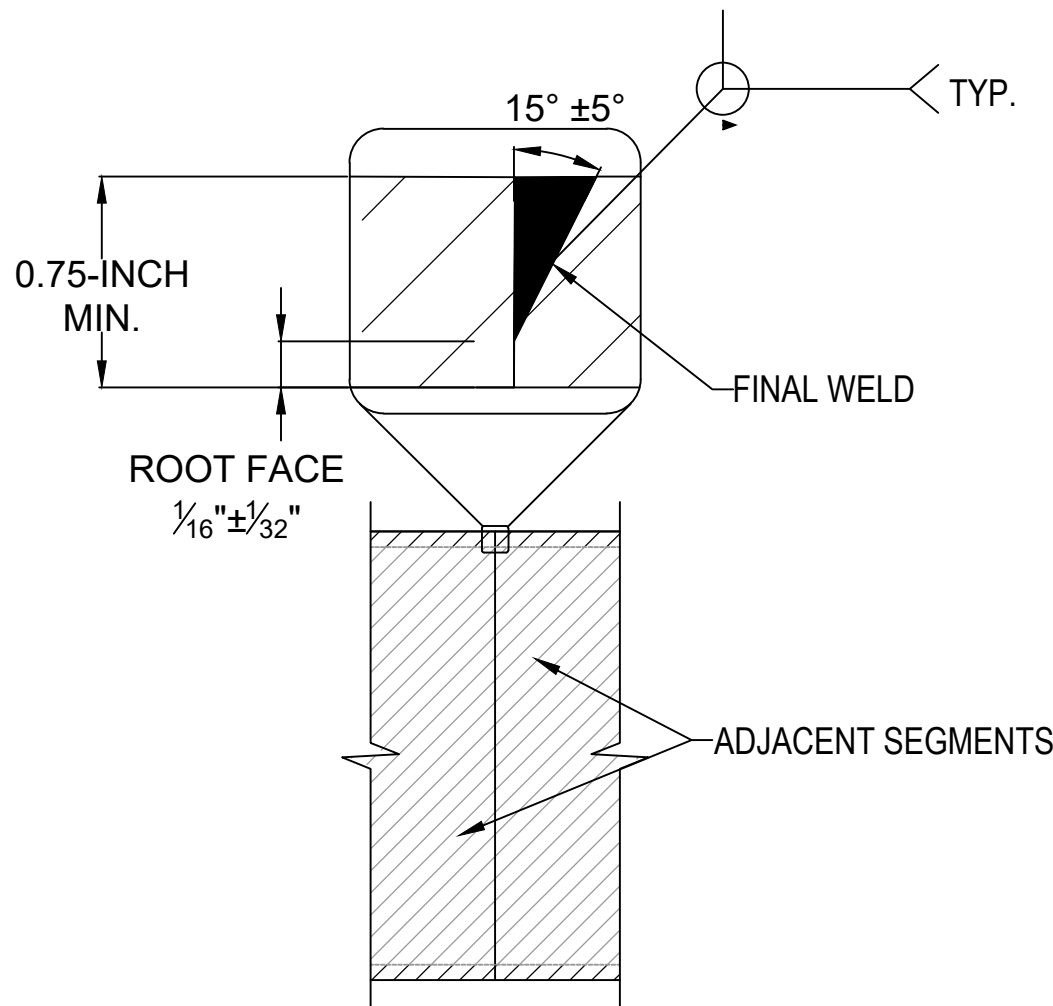


APPROVED City of Arvada, Colorado CITY ENGINEER DATE JOB NUMBER REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.									
SEP 2024 - 90% DESIGN					SCALES 0 1" 0 25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.	DESIGNED JC	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	TUNNELING DETAILS - I	SCALE NTS
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.						DRAWN AM			
						CHECKED RD	GEI Consultants		DATE SEP 2024
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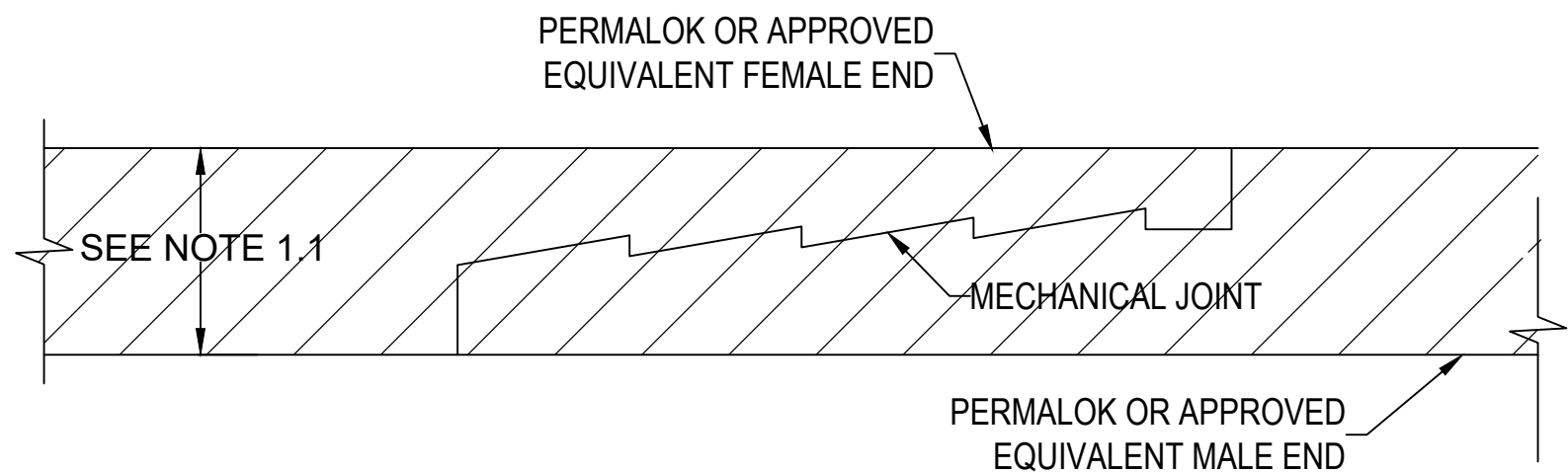
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S-1 30" CASING AND CIPP CROSS SECTION
SCALE: NTS



D-1 WELDED JOINT DETAIL
SCALE: NTS



D-2 MECHANICAL JOINT DETAIL - JACKED INSTALLATION
SCALE: NTS

GENERAL NOTES:

- TUNNEL EXCAVATION & INITIAL SUPPORT
 - THE TUNNEL EXCAVATION AND INITIAL SUPPORT SPECIFICATION PROVIDES THE ACCEPTABLE TUNNELING TECHNIQUES, THE MINIMUM SPECIFIED INITIAL SUPPORT THICKNESS, AND INSTALLATION TOLERANCES.

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City of Arvada, Colorado

CITY ENGINEER

DATE

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DESIGNED

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CITY OF

ARVADA

NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

GEI

Consultants

TUNNELING DETAILS - II

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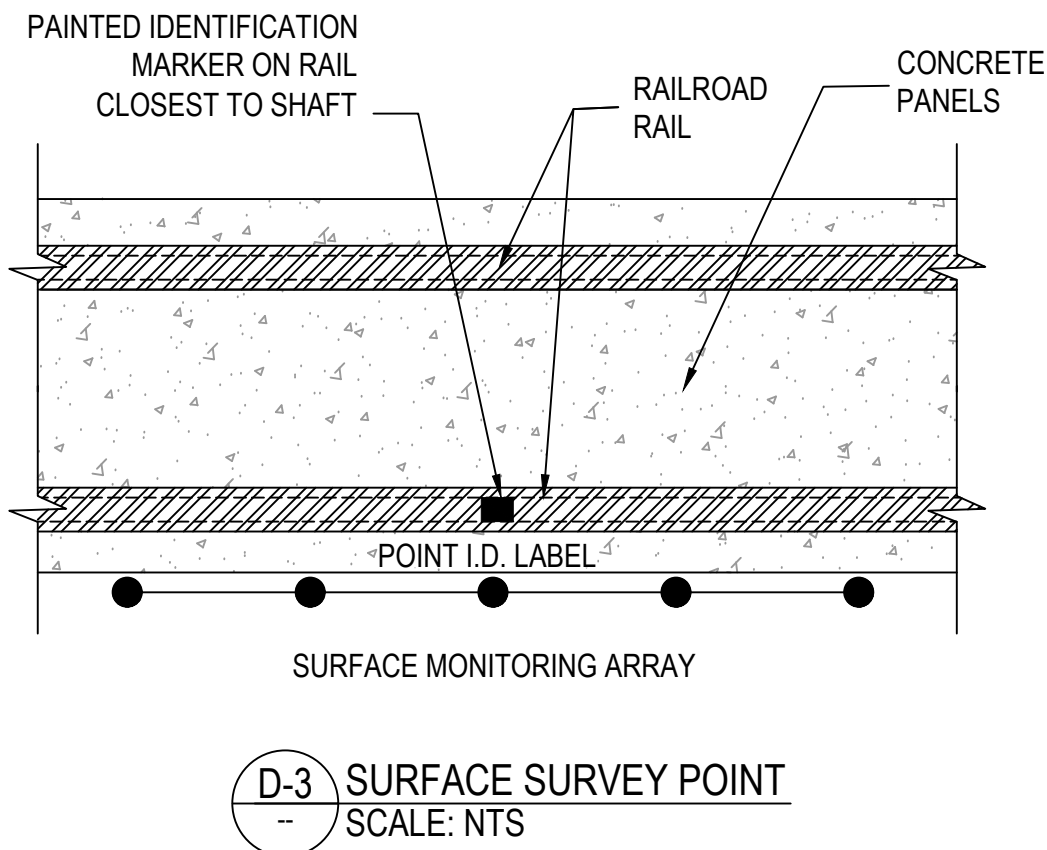
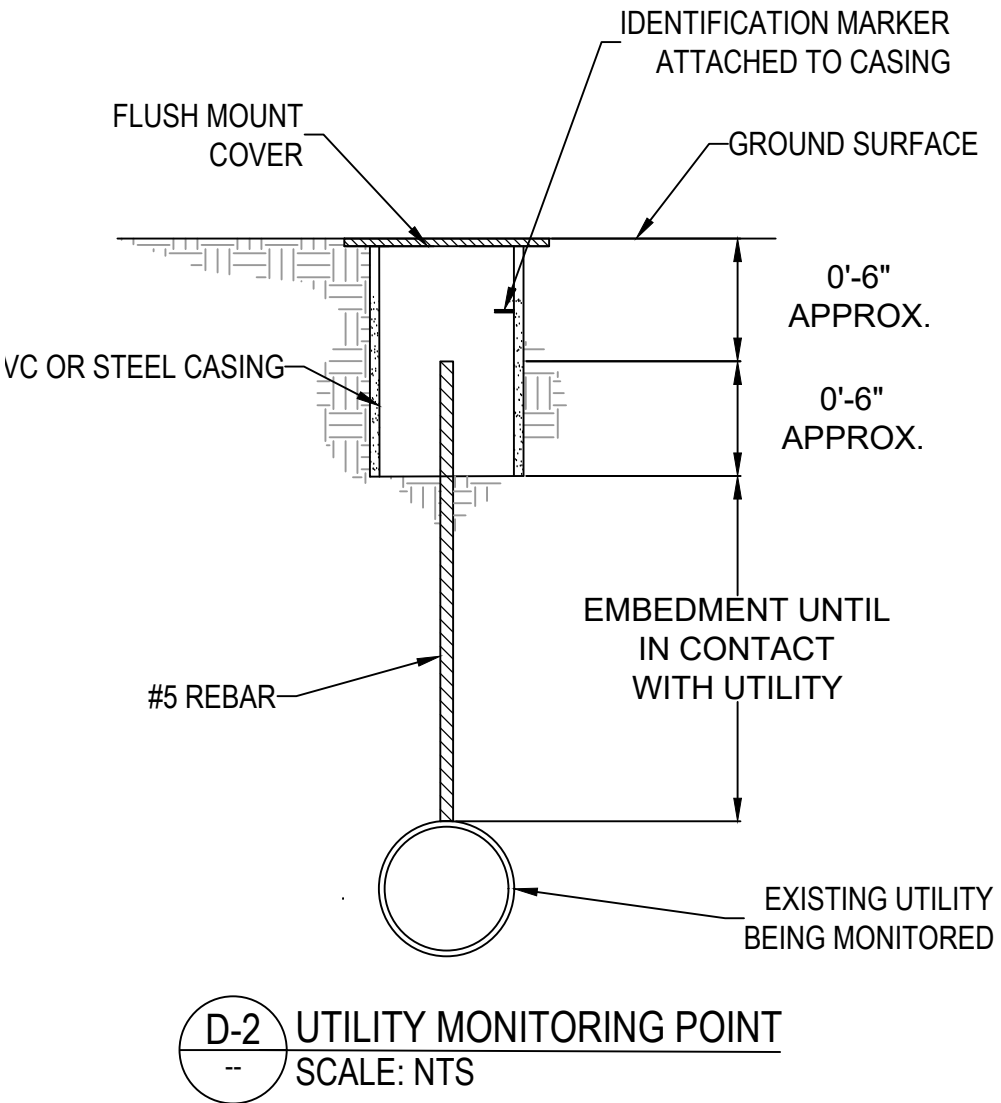
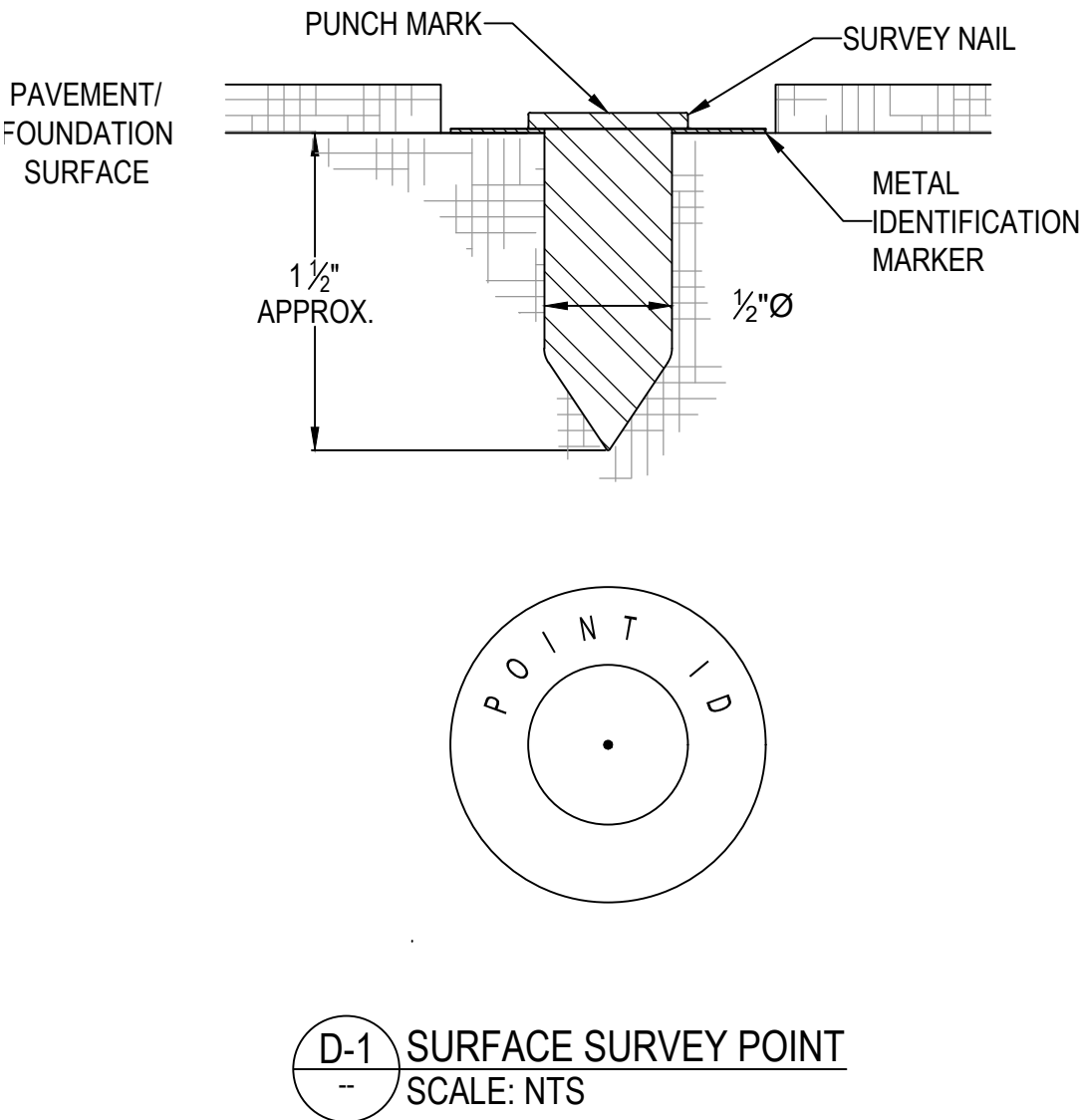
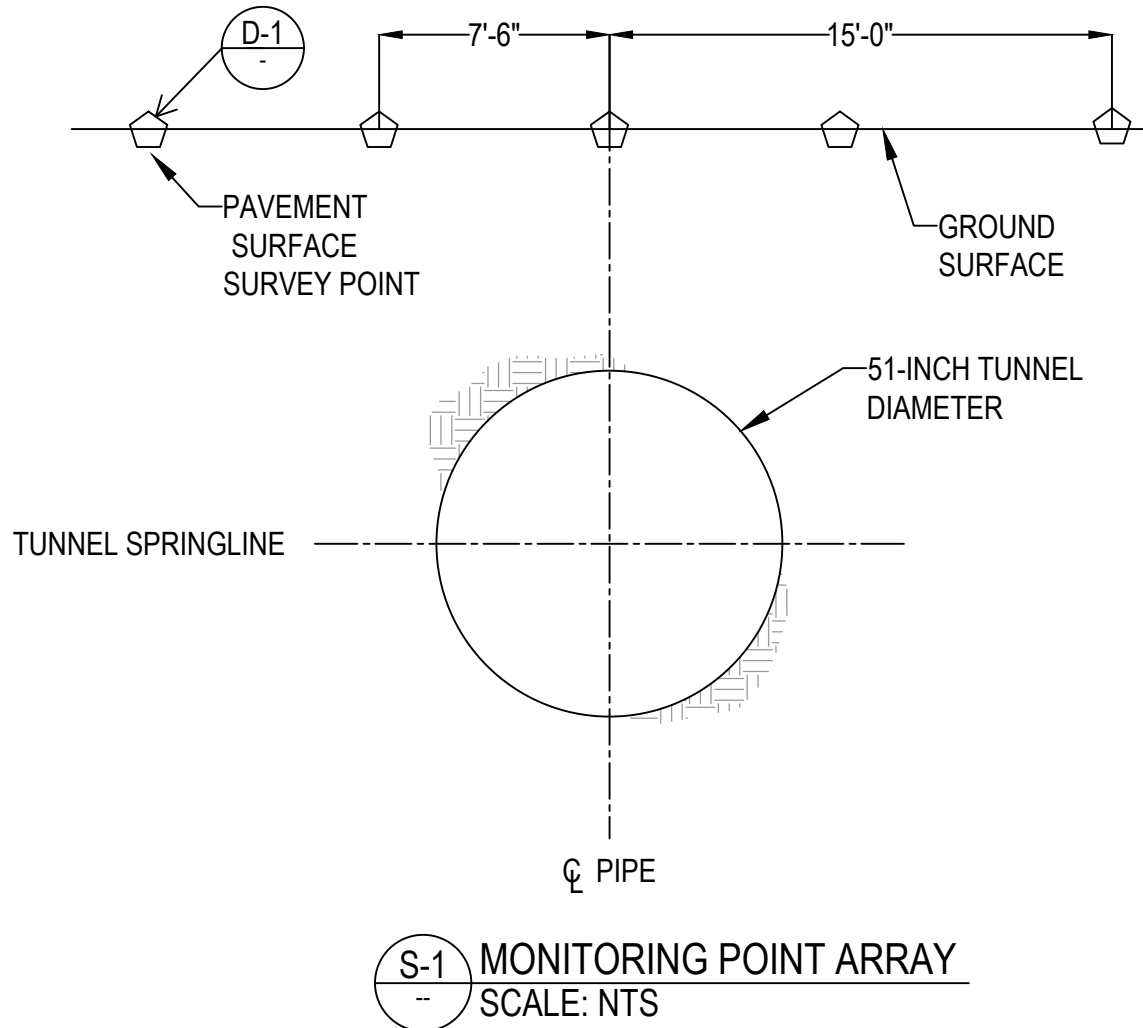
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NOTES:

1. SITE SAFETY INCLUDING SURVEY READINGS CONDUCTED WITHIN RAILROAD RIGHT OF WAY AND ROADWAY SHOULDER SHALL BE AT THE INSTRUMENTATION SPECIALIST'S DISCRETION. RAILROAD FLAGGERS AND TRAFFIC CONTROL SHALL BE PROVIDED BY THE INSTRUMENTATION SPECIALIST AS NECESSARY TO MEET UPRR, BNSF, AND RTD REQUIREMENTS AND CONDUCT SURVEY READINGS IN THE RIGHT OF WAY.
2. THE SURFACE MONITORING ARRAYS SHALL CONSIST OF EVENLY SPACED SURFACE SURVEY POINTS, AS SHOWN IN SECTION S-1, INSTALLED AS CLOSE TO THE RAILROAD TRACKS AS POSSIBLE WITH PAINTED IDENTIFICATION MARKERS PLACED ON THE RAILROAD TRACKS CORRESPONDING TO THE MONITORING ARRAY (DETAIL D-3).
3. SURFACE MONITORING POINTS, UTILITY MONITORING POINTS, AND MONITORING POINT ARRAYS SHALL HAVE MEASUREMENT READ TWICE WEEKLY DURING SHAFT CONSTRUCTION, ONCE DAILY DURING TUNNELING, AND WEEKLY AFTER COMPLETION OF THE TUNNEL UNTIL MOVEMENT BETWEEN SUCCESSIVE MEASUREMENTS IS NEGLIGIBLE AS DETERMINED BY THE ENGINEER.
4. RESPONSE VALUES FOR COLLECTED SURVEY DATA ARE AS SHOWN IN THE TABLE BELOW:

INSTRUMENTATION RESPONSE VALUES		
INSTRUMENTATION TYPE	THRESHOLD VALUE	SHUTDOWN VALUE
UTILITY MONITORING POINTS	0.04 FEET IN Z	0.08 FEET IN Z
SURFACE MONITORING POINTS	0.01 FEET IN Z	0.02 FEET IN Z
	0.2 FEET IN ANY OF X OR Y	0.4 FEET IN ANY OF X OR Y

- 4.1. IF A THRESHOLD VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND/OR RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST. THE CONTRACTOR SHALL MEET WITH THE OWNER, OWNER'S REPRESENTATIVE, ENGINEER, UPRR, BNSF, AND/OR RTD TO REVIEW COLLECTED DATA AND DETERMINE WHETHER ANY CHANGES TO THE CONSTRUCTION PROCEDURES ARE NECESSARY TO ENSURE THE SAFE COMPLETION OF THE WORK.
- 4.2. IF A SHUTDOWN VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST AND THE CONTRACTOR SHALL STOP TUNNEL WORK UNTIL MEETING WITH THE OWNER, ENGINEER, UPRR, BNSF, RTD, AND/OR ANY OTHER AFFECTED THIRD PARTIES OCCURS. A SEPARATE PLAN OF ACTION DIFFERING FROM THE MEANS AND METHODS UTILIZED CAUSING EXCESSIVE MOVEMENT SHALL BE ADOPTED TO HELP MITIGATE FUTURE GROUND MOVEMENT. IF THE OWNER AND ENGINEER DEEM EXCESSIVE MOVEMENT HAS OCCURRED, MITIGATION TO CORRECT THE DISPLACED SURFACE SHALL BE COMPLETED FOR THE AFFECTED STRUCTURES AT THE CONTRACTORS EXPENSE.
5. ALL MONITORING INSTRUMENTATION SHALL BE REMOVED AND RESTORED IN ACCORDANCE WITH THE OWNER'S REPRESENTATIVE'S PERMIT REQUIREMENTS AFTER THE ENGINEER HAS DETERMINED THAT ADDITIONAL SURVEY DATA IS NO LONGER REQUIRED.



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City of Arvada, Colorado

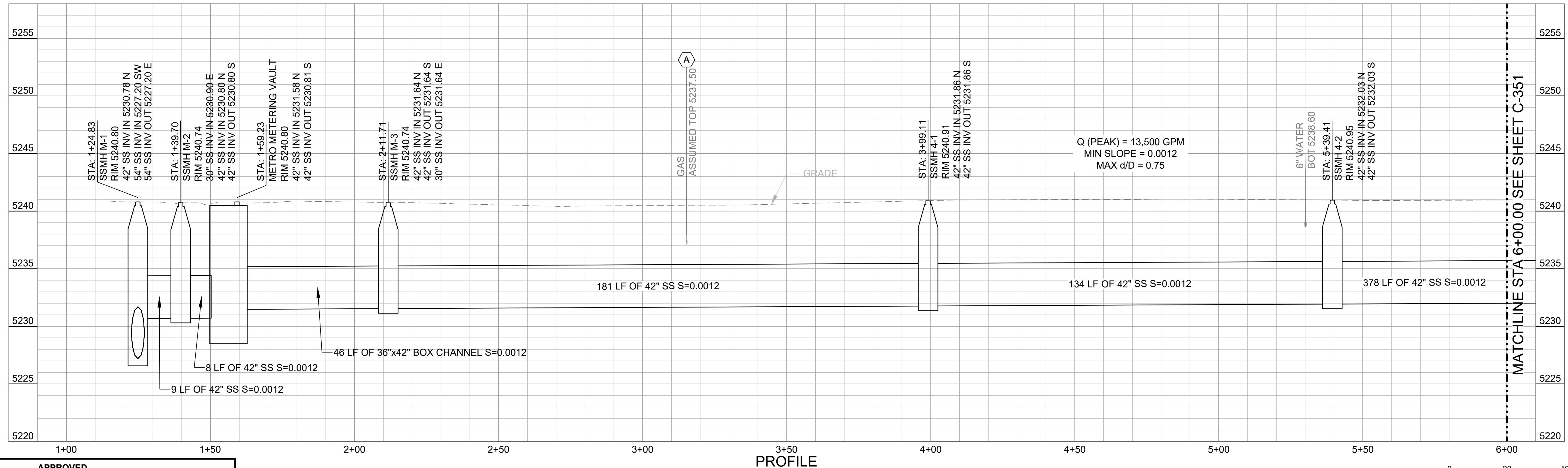
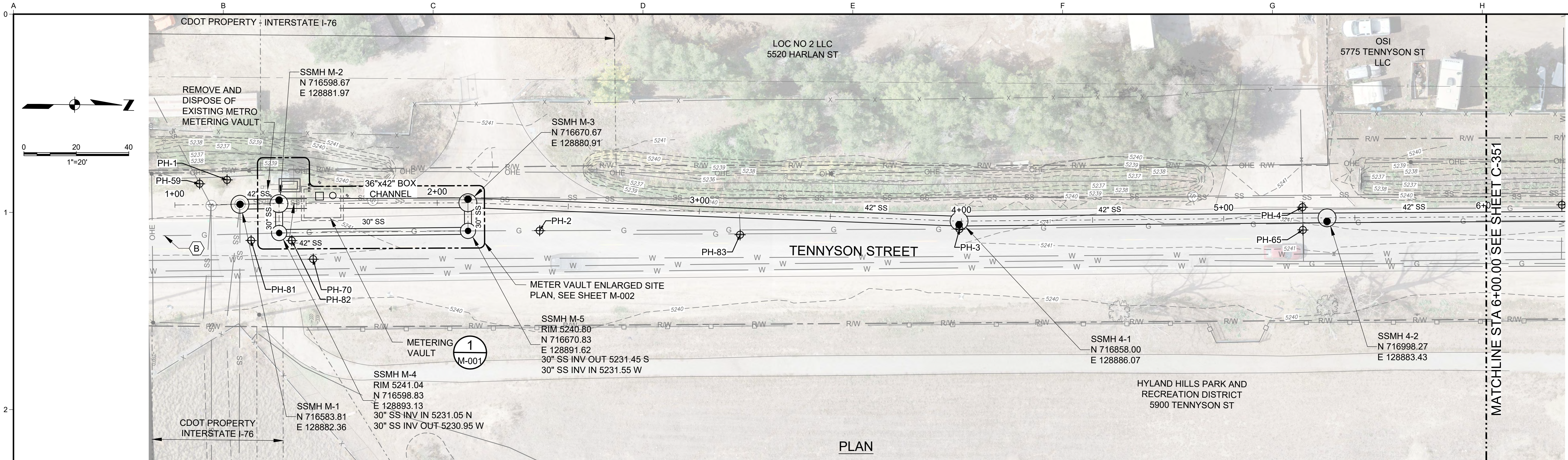
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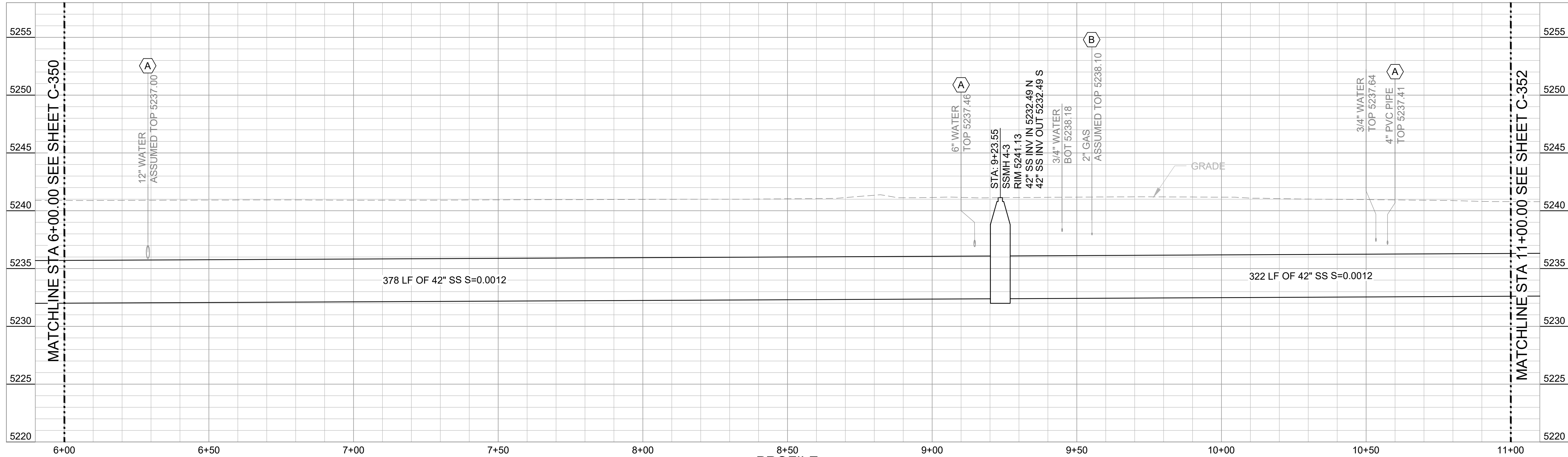
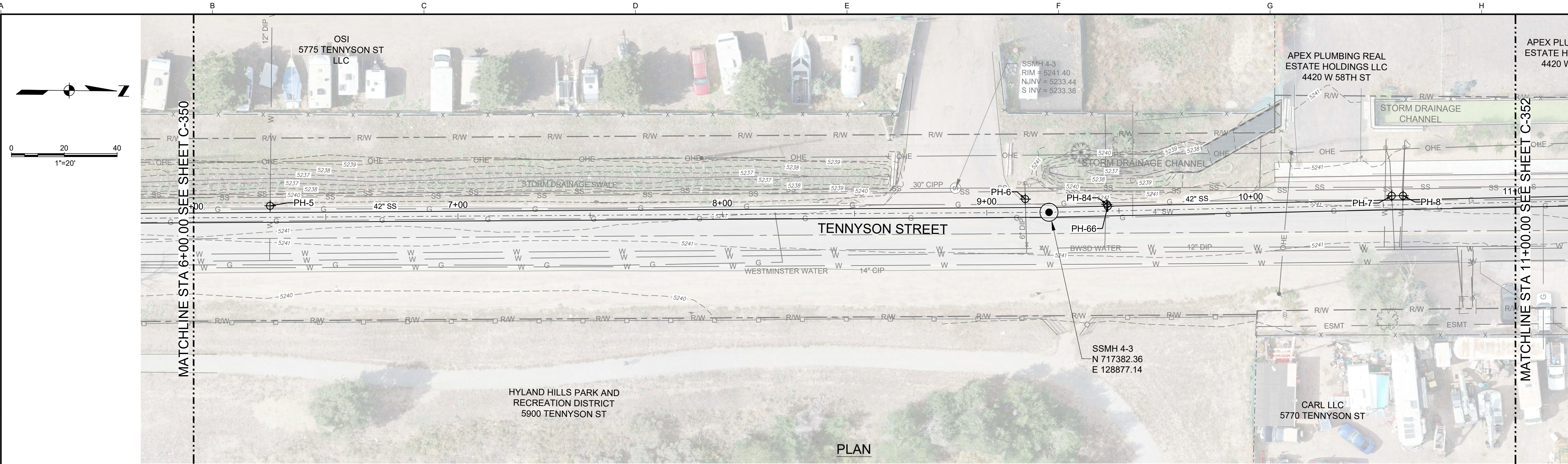


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 SHEET KEYNOTES	 SHEET KEYNOTES (CONT.)
A. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.	B. START XCEL GAS REALIGNMENT.

SEP 2024 - 90% DESIGN				SCALES 0 1" 0 25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.				DESIGNED		 CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11		PLAN AND PROFILE STA 1+00 TO 6+00				SCALE 1" = 20'	
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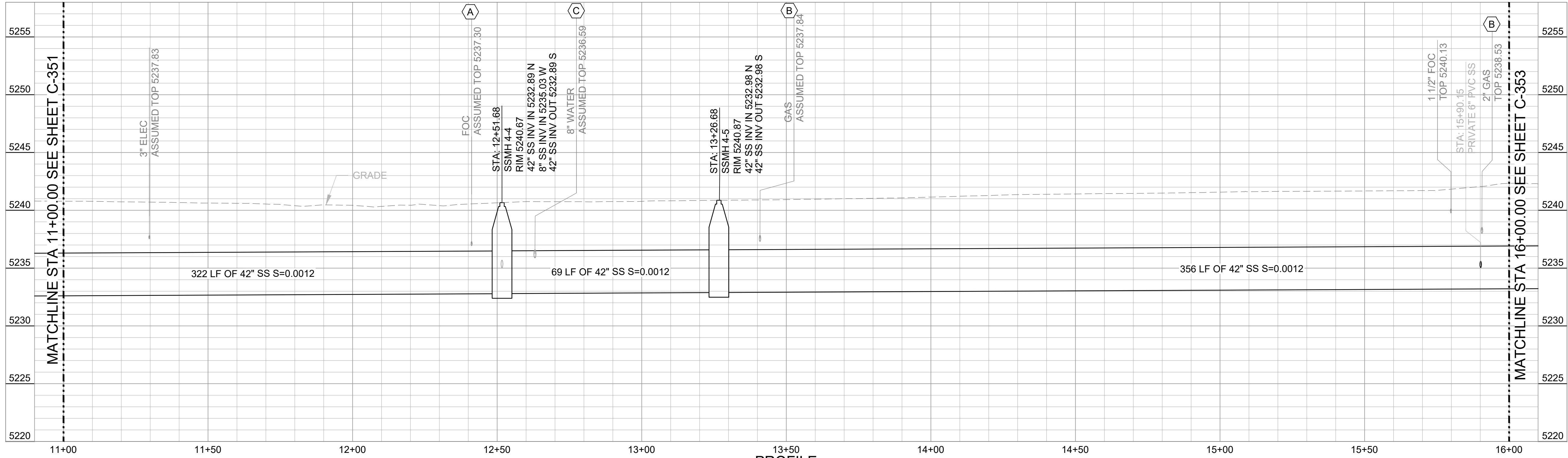
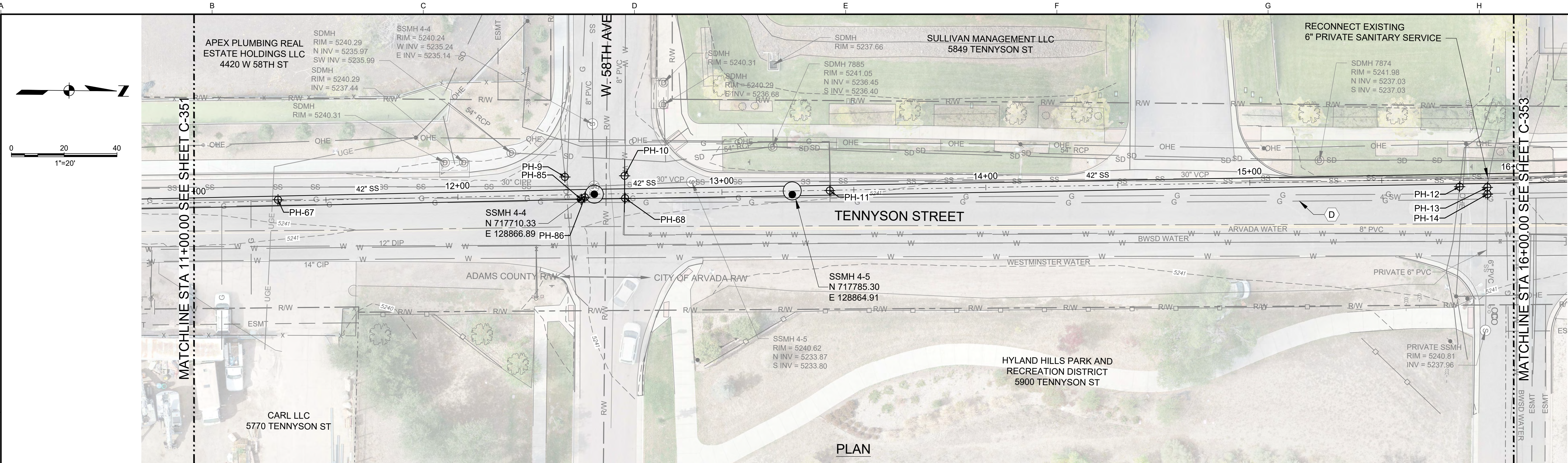


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SHEET KEYNOTES	SHEET KEYNOTES (CONT.)
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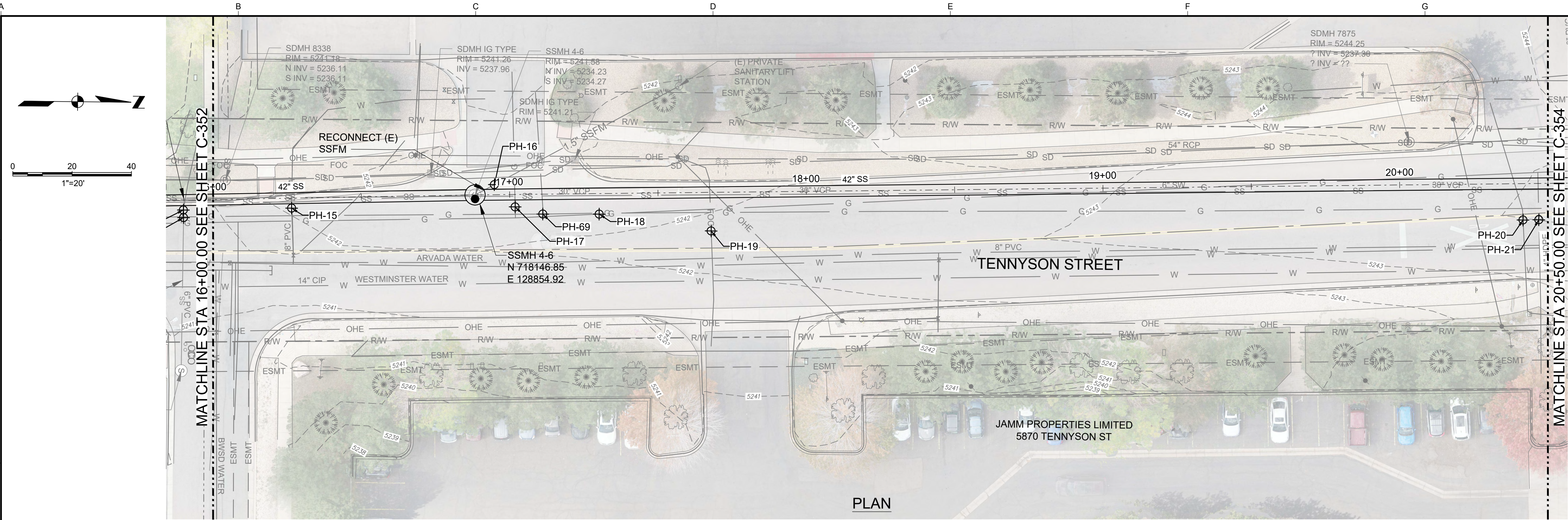
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APPROVED City of Arvada, Colorado		SHEET KEYNOTES		SHEET KEYNOTES (CONT.)		SHEET KEYNOTES (CONT.)		SHEET KEYNOTES (CONT.)	
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SEP 2024 - 90% DESIGN			NO		REVISION	DATE	BY	DESIGNED TS	
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.								DRAWN WAS	
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								CITY OF ARVADA	
								NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	
								Kennedy Jenks	
								PLAN AND PROFILE STA 11+00 TO 16+00	
								SCALE 1" = 20'	
								JOB NO 2246059'00	
								DATE SEP 2024	
								SHEET 14 OF 49 C-352	

Plot Date: 8/30/2024 11:52 PM
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PLAN



PROFILE

APPROVED City of Arvada, Colorado		
CITY ENGINEER	DATE	JOB NUMBER
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.		

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NO	REVISION	DATE	BY		

SCALES
0 1" 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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CHECKED	LS

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

PLAN AND PROFILE STA 16+00 TO 20+50	
SCALE 1" = 20'	
JOB NO 2246059.00	
DATE SEP 2024	
SHEET 15 OF 49	
C-353	

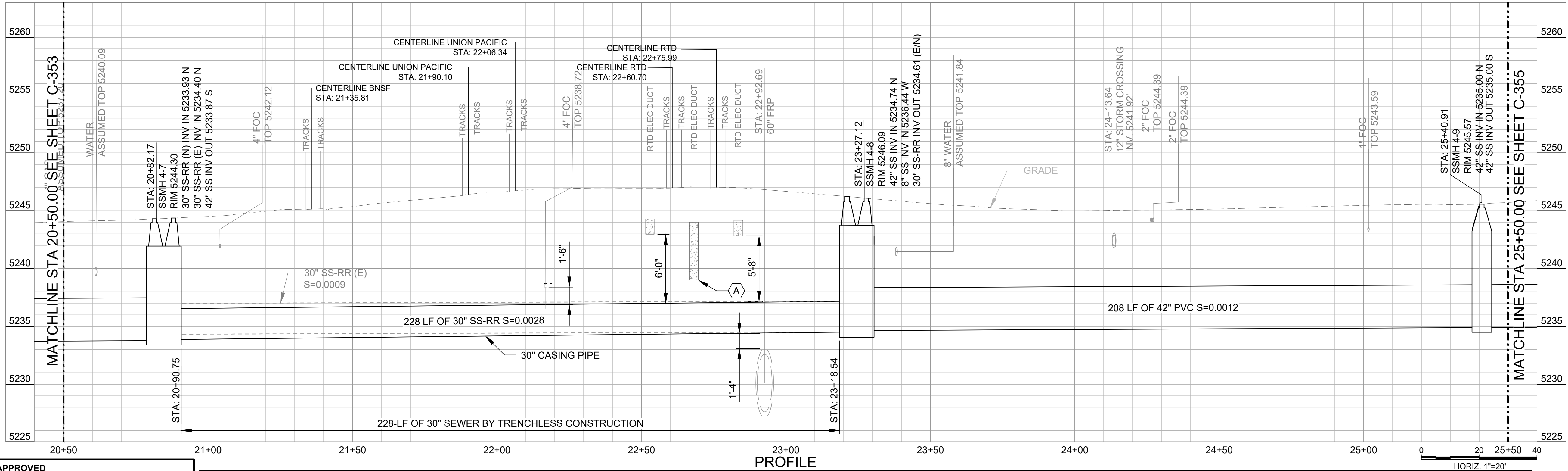
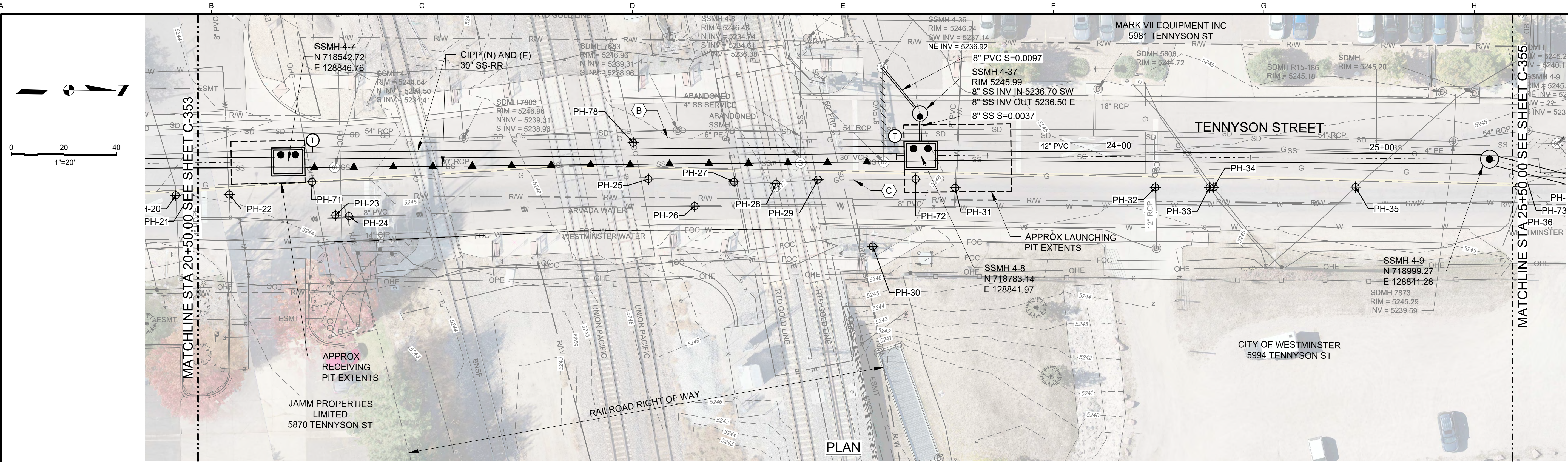
- SHEET KEYNOTES
- A.

POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASEMENT AS NEEDED FOR VERTICAL CROSSINGS.
- B.

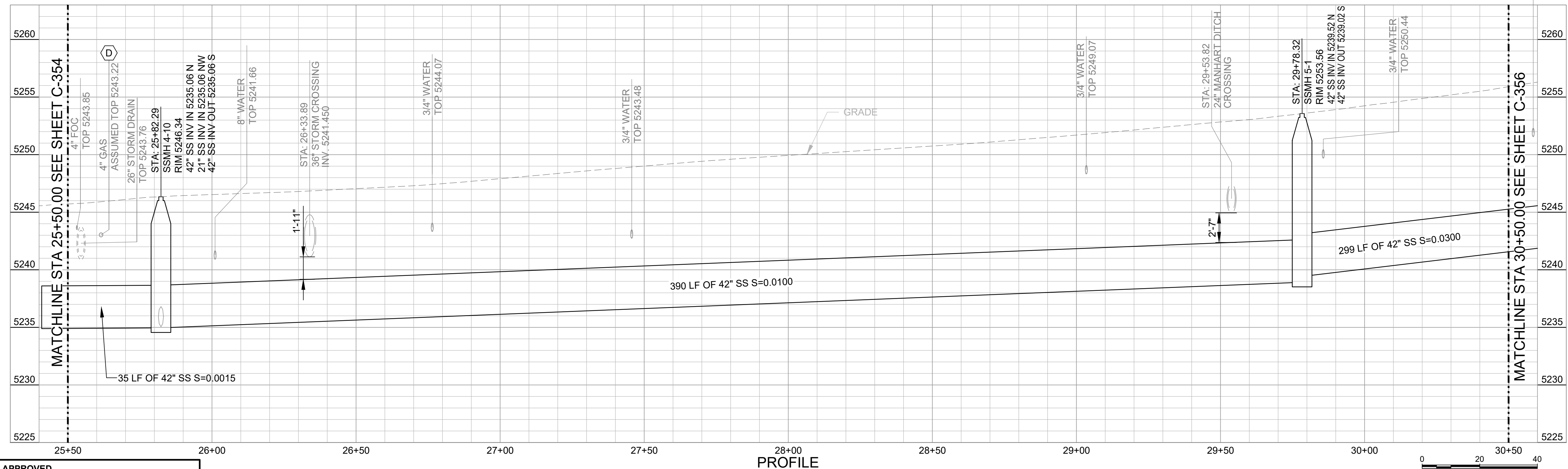
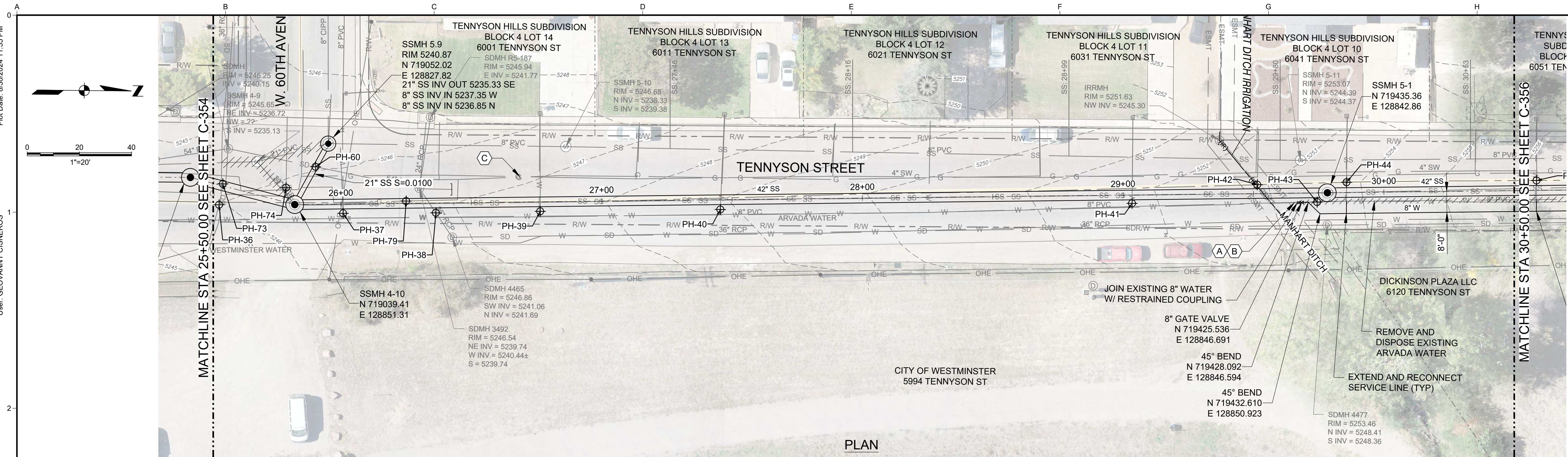
FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.
- C.

LOWER 8" WATER MAIN AT SEWER CROSSING TO RELOCATE UNDER PROPOSED SEWER AT A MINIMUM OF 18" CLEARANCE. RELOCATE WATER MAIN PER CITY OF ARVADA CROSSING STORM AND SANITARY SEWERS AND OPEN CUT CROSSING BENEATH CONDUITS DETAILS ON C-003.

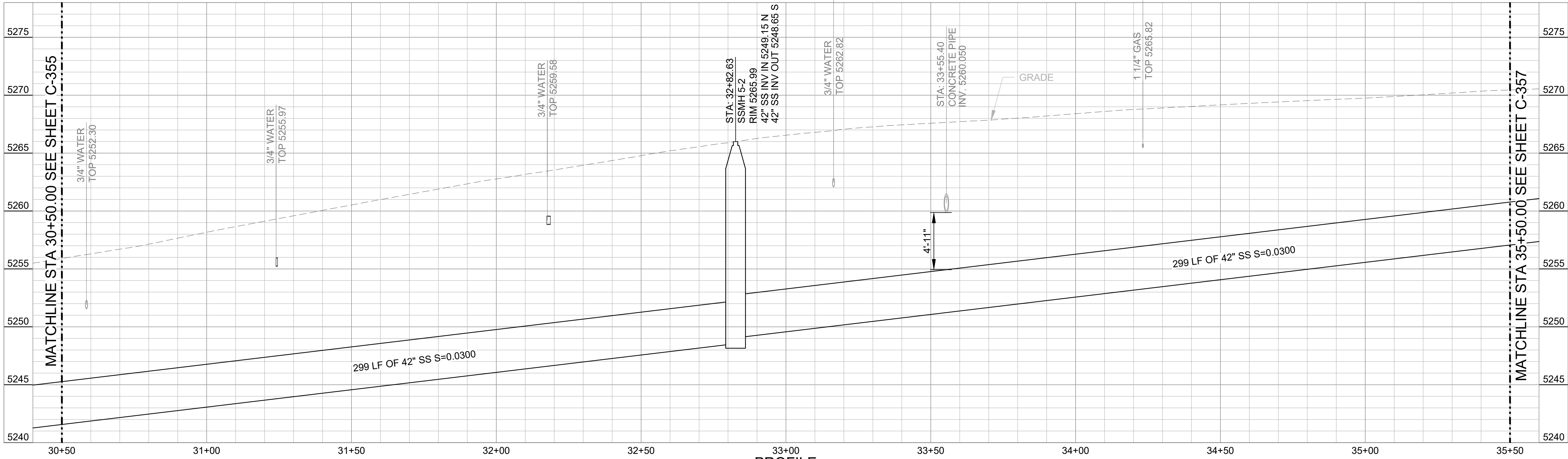
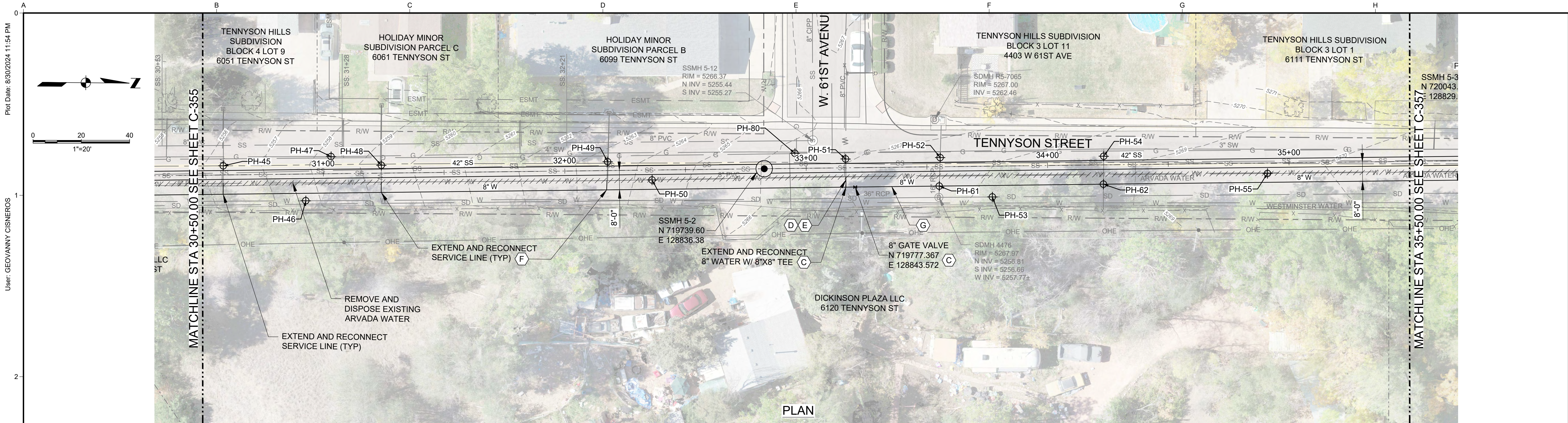
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APPROVED City of Arvada, Colorado			PROFILE										HORIZ. 1"=20'																						
			GENERAL SHEET NOTES			GENERAL SHEET NOTES (CONT.)				SHEET KEYNOTES			SHEET KEYNOTES (CONT.)																						
CITY ENGINEER			DATE			JOB NUMBER			1. CONTRACTOR TO VERIFY WITH SURVEY THAT MAINTENANCE HOLES AND TEST STATIONS WILL BE LOCATED OUTSIDE OF RAILROAD R/W.			2. CONTRACTOR SHALL PLAN FOR ACTIVE BYPASSING OF THE EXISTING SANITARY PIPE FROM EXISTING SSMH 4-9 TO EXISTING SSMH 4-6 AT A MINIMUM SO THAT CIPP LINING OF THE EXISTING SANITARY PIPE WITHIN THE RAILROAD CORRIDOR CAN PROCEED AHEAD OF TUNNELING WORK. CONTRACTOR TO COORDINATE WITH THE CITY OF ARVADA UTILITIES DEPARTMENT FOR ACCESS TO THE ADJACENT STORMWATER INFRASTRUCTURE FOR ACTIVE BYPASSING PRIOR TO CONSTRUCTION.				A. POTHOLING ACTIVITIES WERE UNABLE TO UNCOVER THE BOTTOM DEPTH OF THE MIDDLE RTD DUCT BANK IN MULTIPLE LOCATIONS. GIVEN THE DEPTHS OF THE EXISTING UTILITIES THAT CROSS THIS DUCT BANK (54" STORM, 30" SANITARY, 14" WATER, 8" WATER, AND 6" GAS), IT IS PRESUMED TO BE OF IDENTICAL SIZE OF THE OTHER TWO DUCT BANKS AND IS THUS NOT A CONFLICT WITH THE PROPOSED DESIGN.			B. GAS LINE IN THIS LOCATION WAS NOT FOUND AND DETERMINED BY XCEL TO HAVE BEEN ABANDONED. CONTRACTOR TO VERIFY EXISTING CASING PIPE WAS REMOVED PRIOR TO TUNNELING WORK.			C. START XCEL GAS REALIGNMENT													
SEP 2024 - 90% DESIGN			NOT FOR CONSTRUCTION			NO			REVISION			DATE			BY			DESIGNED TS			DRAWN WAS			CHECKED LS			NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11			PLAN AND PROFILE STA 20+50 TO 25+50			SCALE 1" = 20'		
																																	JOB NO 2246059*00		
																																	DATE SEP 2024		
																																	SHEET 16 OF 49		
																																	C-354		



APPROVED City of Arvada, Colorado CITY ENGINEER DATE JOB NUMBER REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS". LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.					GENERAL SHEET NOTES 1. ALL PORTIONS OF MANHART DITCH BOTTOMS, SIDES, BANKS, FACILITIES, AND ALL AFFECTED PORTIONS OF MANHART'S PROPERTY OR EASEMENTS WHICH ARE DISTURBED SHALL BE RESTORED TO THEIR ORIGINAL CONDITION SO THAT THE FLOW OF WATER IN THE DITCH RUNS AT THE ORIGINAL AMOUNT AND					GENERAL SHEET NOTES (CONT.) VELOCITY. ANY AND ALL FENCING AND OTHER FACILITIES APPURTENANT TO MANHART'S PROPERTY OR EASEMENTS SHALL BE REPLACED IN A CONDITION AT LEAST EQUAL TO THE CONSTITUTION OF SUCH FACILITIES AND APPURTENANCES PRIOR TO CONSTRUCTION.					WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES A. INITIATE WATERLINE SHUT DOWN. ISOLATE AND CUT EXISTING 8" WATERLINE TO THE SOUTH. B. CONNECT NEW WATERLINE TO EXISTING WATERLINE AND START SEGMENT 1 INSTALL. INSTALL GATE VALVE AND ENOUGH LINE SEGMENT TO RECHARGE EXISTING WATERLINE TO THE SOUTH.					SHEET KEYNOTES C. END XCEL GAS REALIGNMENT D. XCEL TO EXTEND GAS MAIN ALONG 60TH TO NEW ALIGNMENT. MAINTAIN A MINIMUM OF 18" COVER ABOVE PROPOSED SANITARY PIPE.					0 20 40 HORIZ. 1"=20'									
SEP 2024 - 90% DESIGN NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.					NO REVISION DATE BY					SCALES 0" = 1" 0" = 25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.					DESIGNED TS DRAWN WAS CHECKED LS					CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 KJ Kennedy Jenks					PLAN AND PROFILE STA 25+50 TO 30+50					SCALE 1" = 20' JOB NO 2246059*00 DATE SEP 2024 SHEET 17 OF 49 C-355				

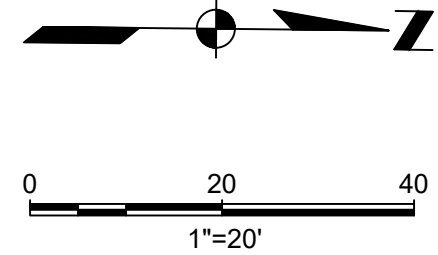


APPROVED City of Arvada, Colorado			PROFILE WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) C. INSTALL TEMPORARY PLUG ON THE WEST SIDE OF THE NEW TEE. INSTALL SEGMENT 1 THROUGH THE GATE VALVE NORTH OF THE TEE. D. ISOLATE, CUT, AND DRAIN 8" WATERLINE LATERAL TO THE WEST. WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) E. REMOVE TEMPORARY PLUG FROM TEE, EXTEND NEW WATERLINE WEST, AND CONNECT TO 8" WATERLINE LATERAL FOR W. 61ST AVE. F. DISINFECT AND TEST SEGMENT 1. UPON COMPLETION, SERVICE LINE RECONNECTIONS AND EXTENSIONS CAN BE COMPLETED. WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) G. RECHARGE SEGMENT 1 AND WEST LATERAL AND BEGIN INSTALL OF SEGMENT 2.				02040 HORIZ. 1"=20'															
CITY ENGINEER DATE JOB NUMBER																						
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NO			SCALES 01" 025mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.										DESIGNED TS		CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11			PLAN AND PROFILE STA 30+50 TO 35+50			SCALE 1" = 20'	
													DRAWN WAS		KJ Kennedy Jenks			JOB NO 2246059*00				
													CHECKED LS					DATE SEP 2024				
																		SHEET 18 OF 49				
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Plot Date: 9/3/2024 12:01 PM

User: GEOVANNY CISNEROS

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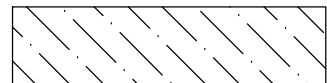


SITE RESTORATION LEGEND

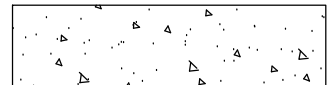
APPROX ASPHALT
PATCHING, CONCRETE
REPAIR, AND TRENCH
RESTORATION EXTENTS
(LIMITS OF WORK)



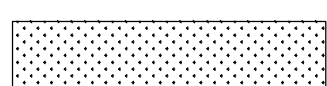
ASPHALT RESTORATION



CONCRETE RESTORATION



DRAINAGE SWALE
RESTORATION



CURB AND GUTTER
RESTORATION



LANDSCAPE/GRAVEL
RESTORATION



ADA RAMP REPLACEMENT



SHEET KEYNOTES

- A. CONTRACTOR SHALL PROTECT STORMWATER HEADWALLS, CULVERTS, AND SWALE IN PLACE. IF EXISTING INFRASTRUCTURE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REPLACE IN KIND.

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE | ADAMS COUNTY

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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NO	REVISION	DATE	BY

SCALES

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IF THIS BAR IS NOT
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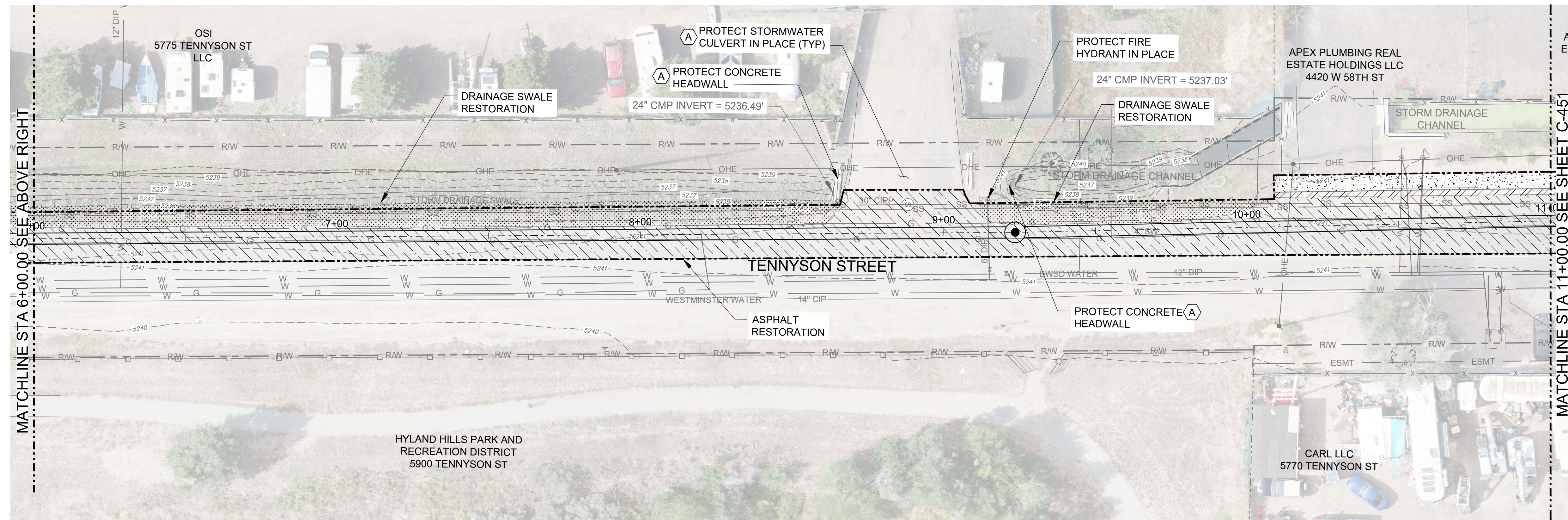
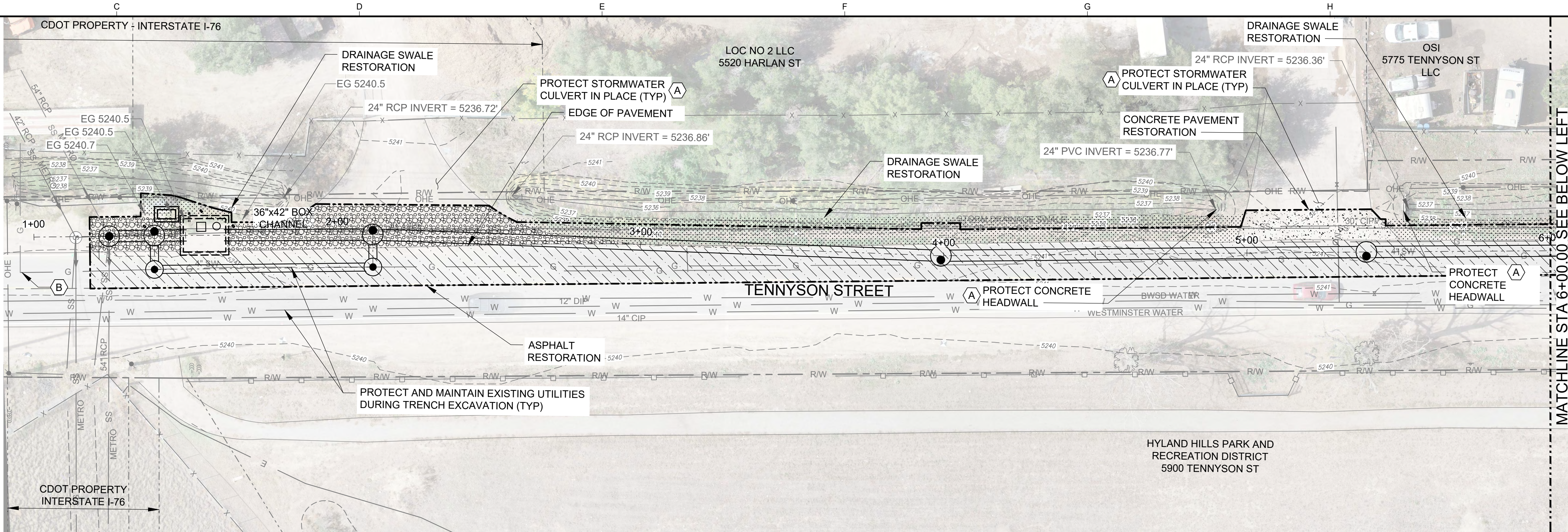


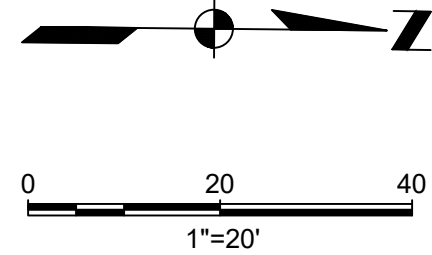
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SITE RESTORATION
STA 1+00 TO 11+00

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JOB NO
2246059-00
DATE
SEP 2024
SHEET 20 OF 49
C-450



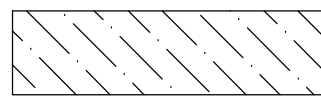


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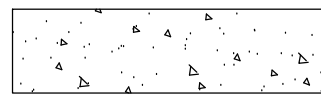
APPROX ASPHALT
PATCHING, CONCRETE
REPAIR, AND TRENCH
RESTORATION EXTENTS
(LIMITS OF WORK)



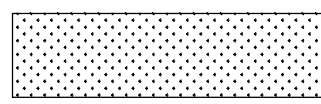
ASPHALT RESTORATION



CONCRETE RESTORATION



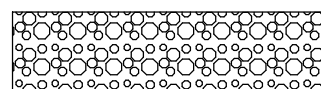
DRAINAGE SWALE
RESTORATION



CURB AND GUTTER
RESTORATION



LANDSCAPE/GRAVEL
RESTORATION



ADA RAMP REPLACEMENT



SHEET KEYNOTES

- A. CONTRACTOR SHALL PROTECT STORMWATER INLETS IN PLACE. IF EXISTING INFRASTRUCTURE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REPLACE IN KIND.

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE I ADAMS COUNTY

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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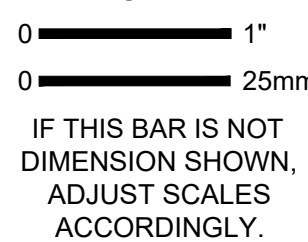
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NO REVISION DATE BY

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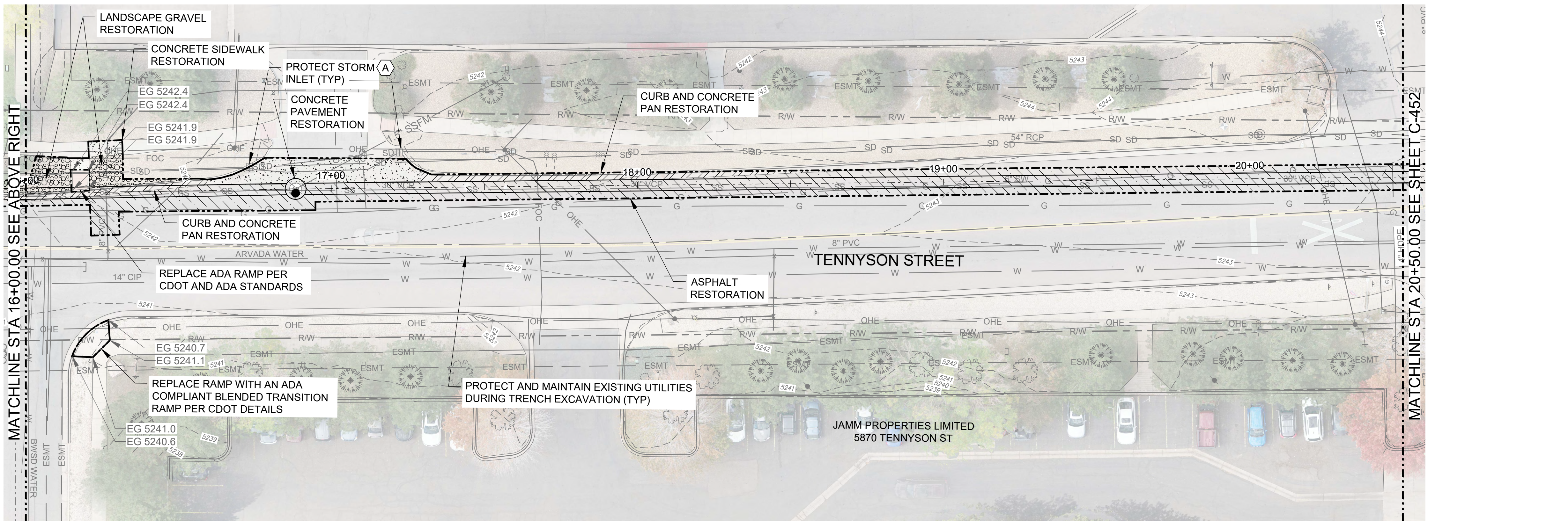
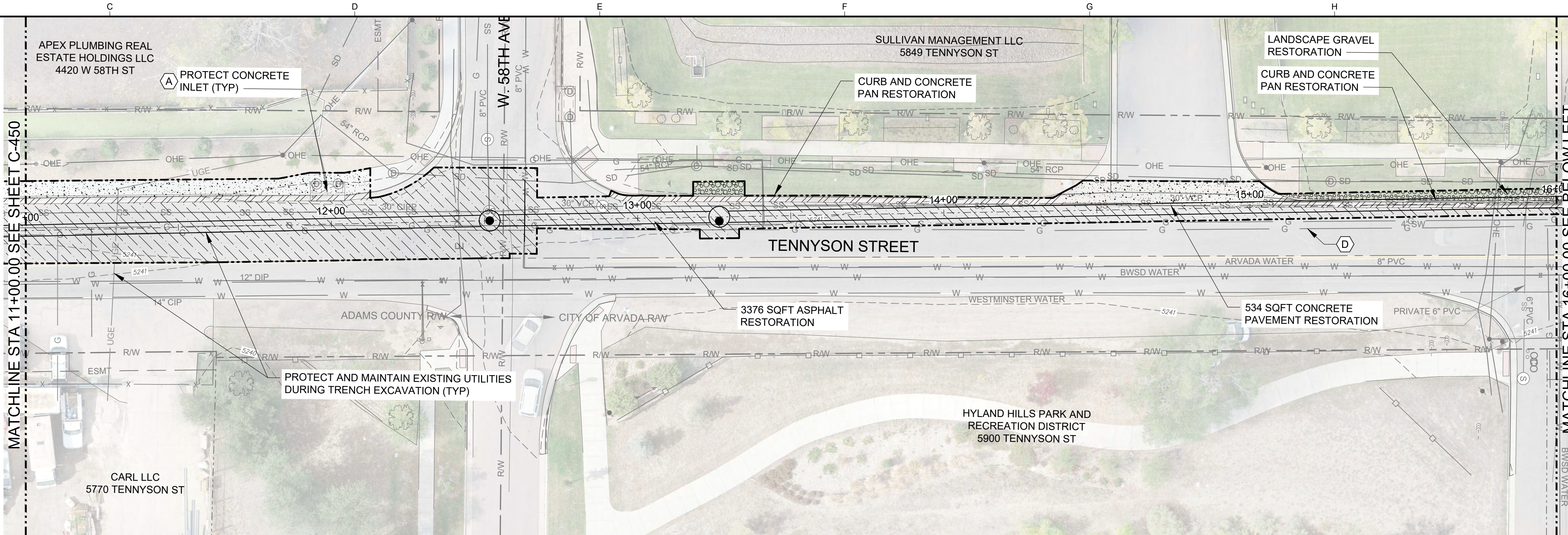


NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SITE RESTORATION
STA 11+00 TO 20+50

SCALE
1" = 20'
JOB NO
2246059.00
DATE
SEP 2024
SHEET 21 OF 49
C-451



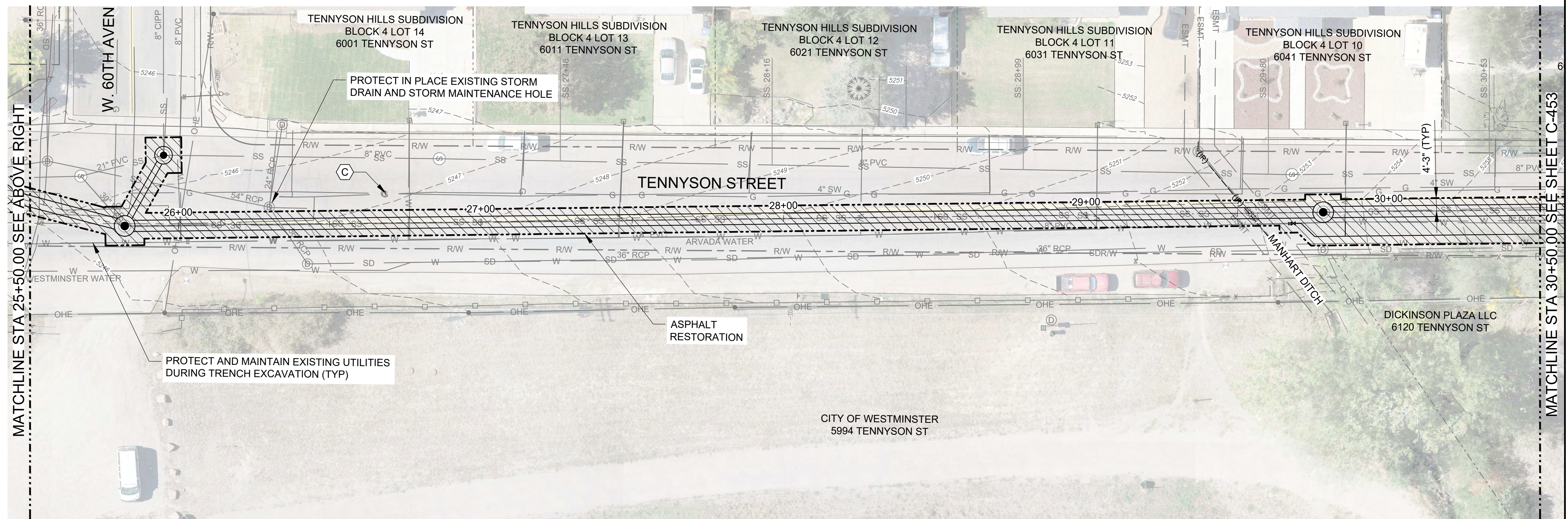
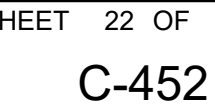


Exhibit 4-Part 2

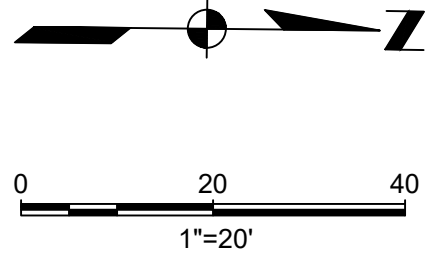
Amendment No. 3

To The “Construction Management/General Contractor Agreement Between Arvada and BT Construction, Inc. For Pre-Construction Services for North Trunk Sewer Improvements – Tennyson & 58th Project in An Amount Not To Exceed \$86,450.00” For Purposes Of Awarding Contractor Phase II With A Guaranteed Maximum Price Of \$13,258,966.50, Thereby Increasing The Total Contract Amount To An Amount Not To Exceed \$13,703,199.63

Plot Date: 9/3/2024 12:32 PM

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SITE RESTORATION LEGEND

- APPROX ASPHALT PATCHING, CONCRETE REPAIR, AND TRENCH RESTORATION EXTENTS (LIMITS OF WORK)
- ASPHALT RESTORATION
- CONCRETE RESTORATION
- DRAINAGE SWALE RESTORATION
- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE | ADAMS COUNTY

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NO

REVISION

DATE

BY

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IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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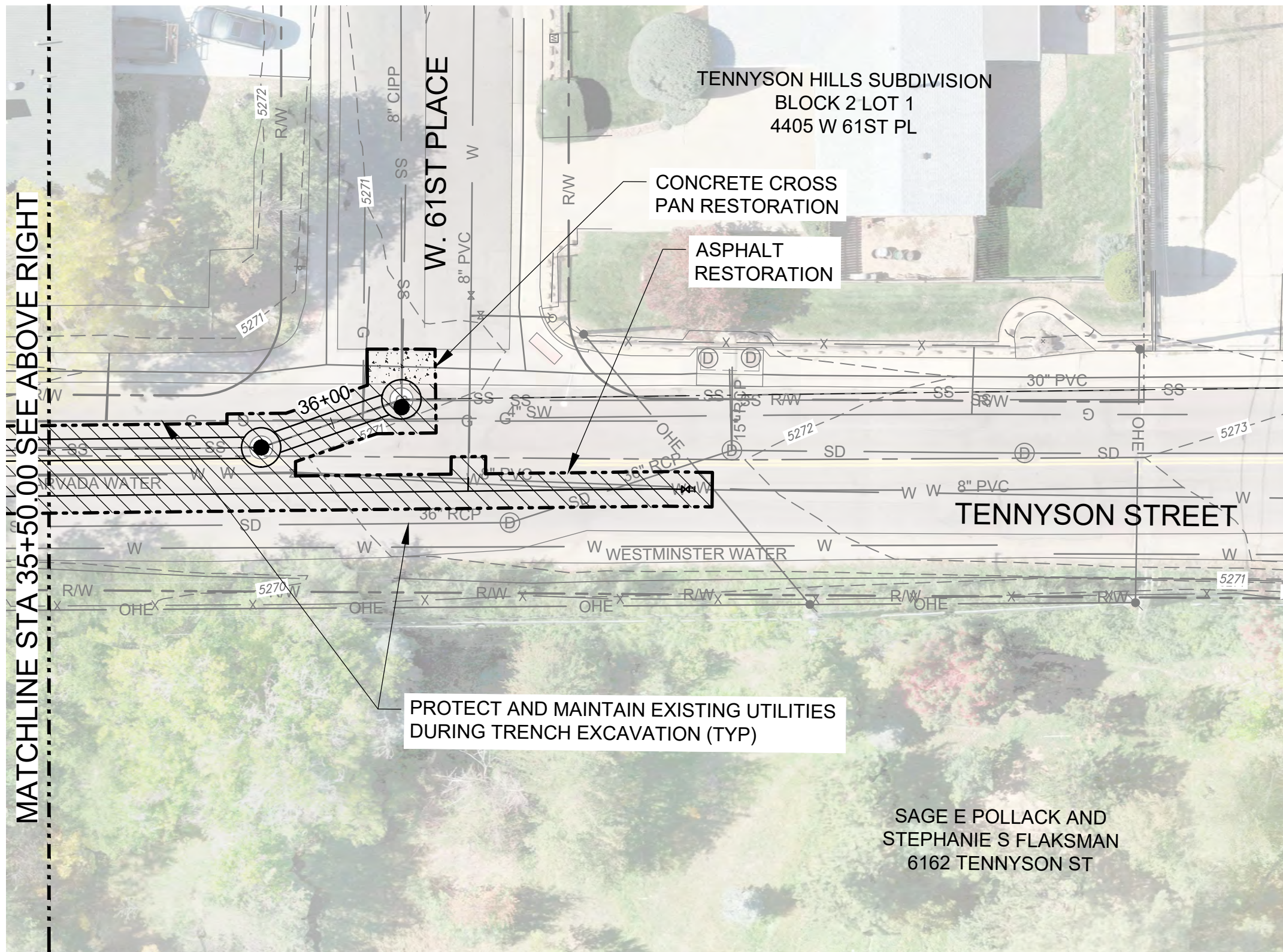
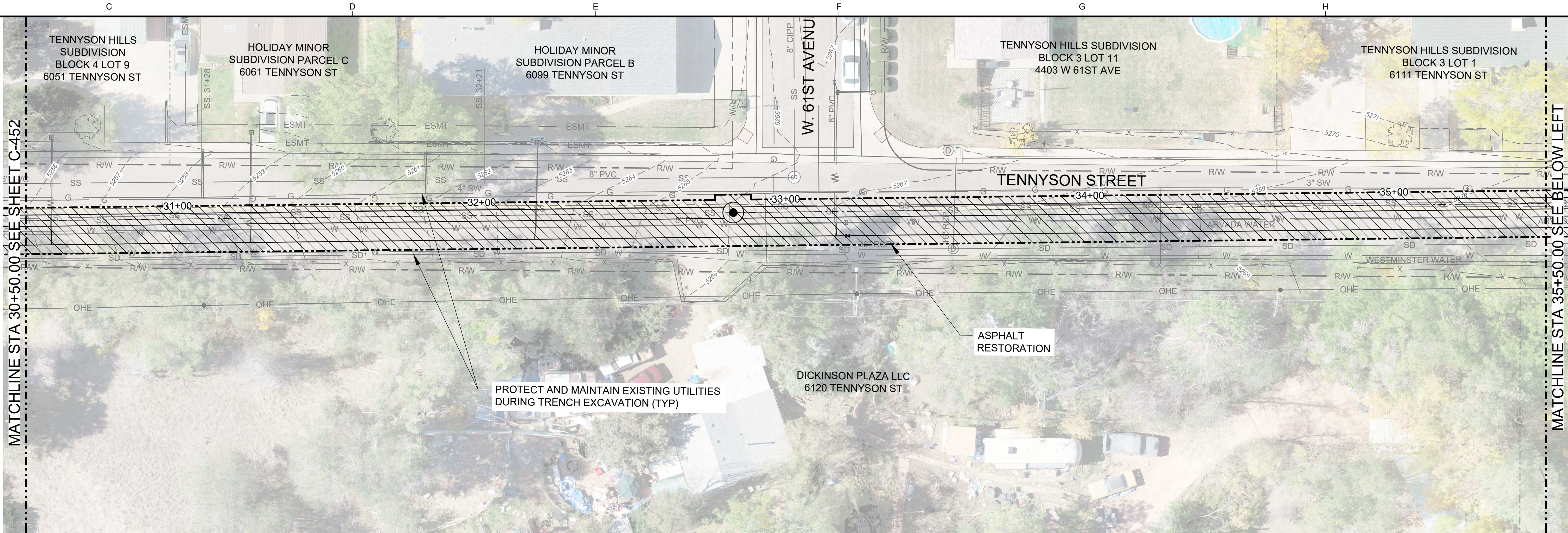


NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



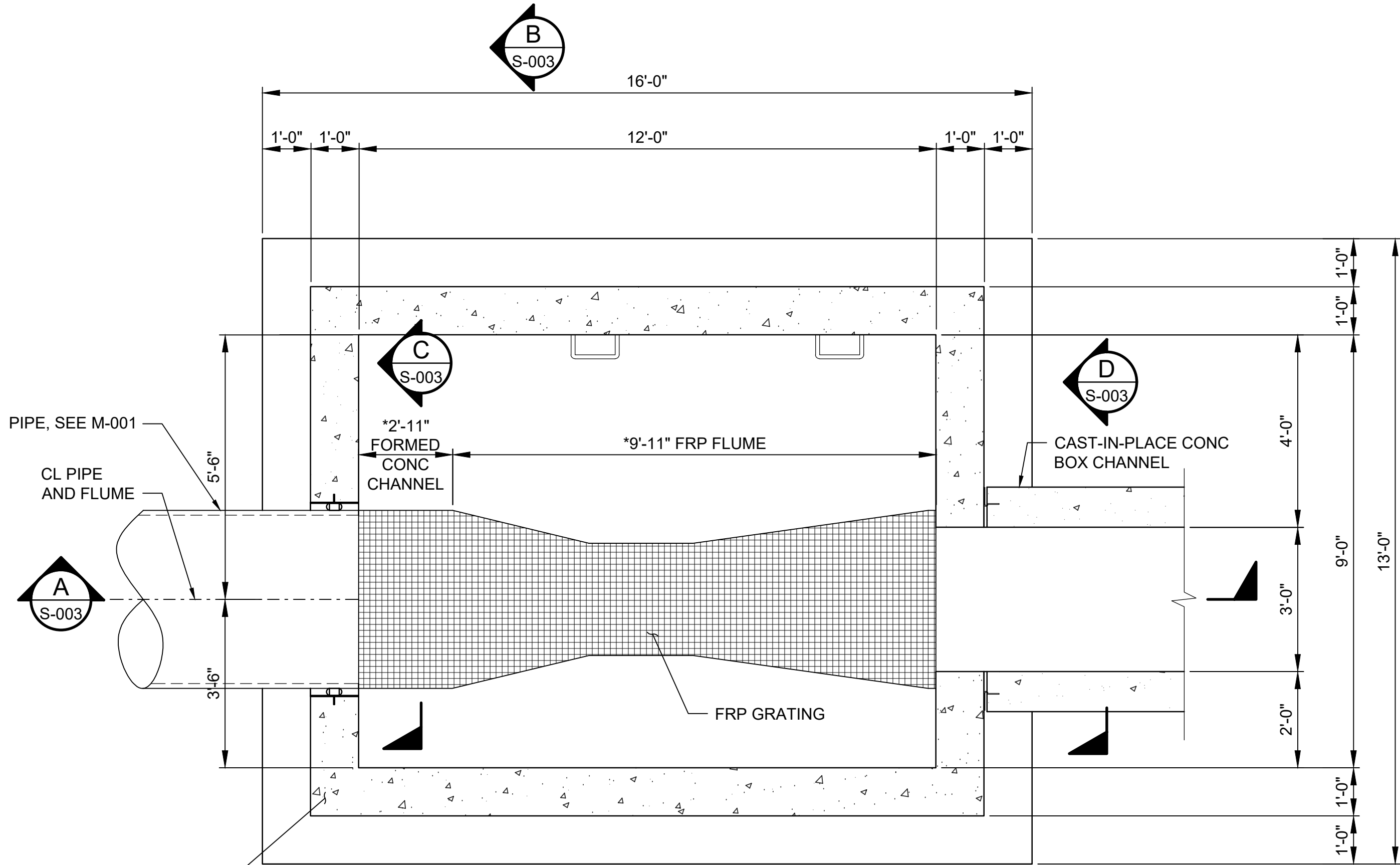
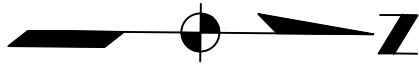
SITE RESTORATION
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JOB NO
2246059'00
DATE
SEP 2024
SHEET 23 OF 49
C-453

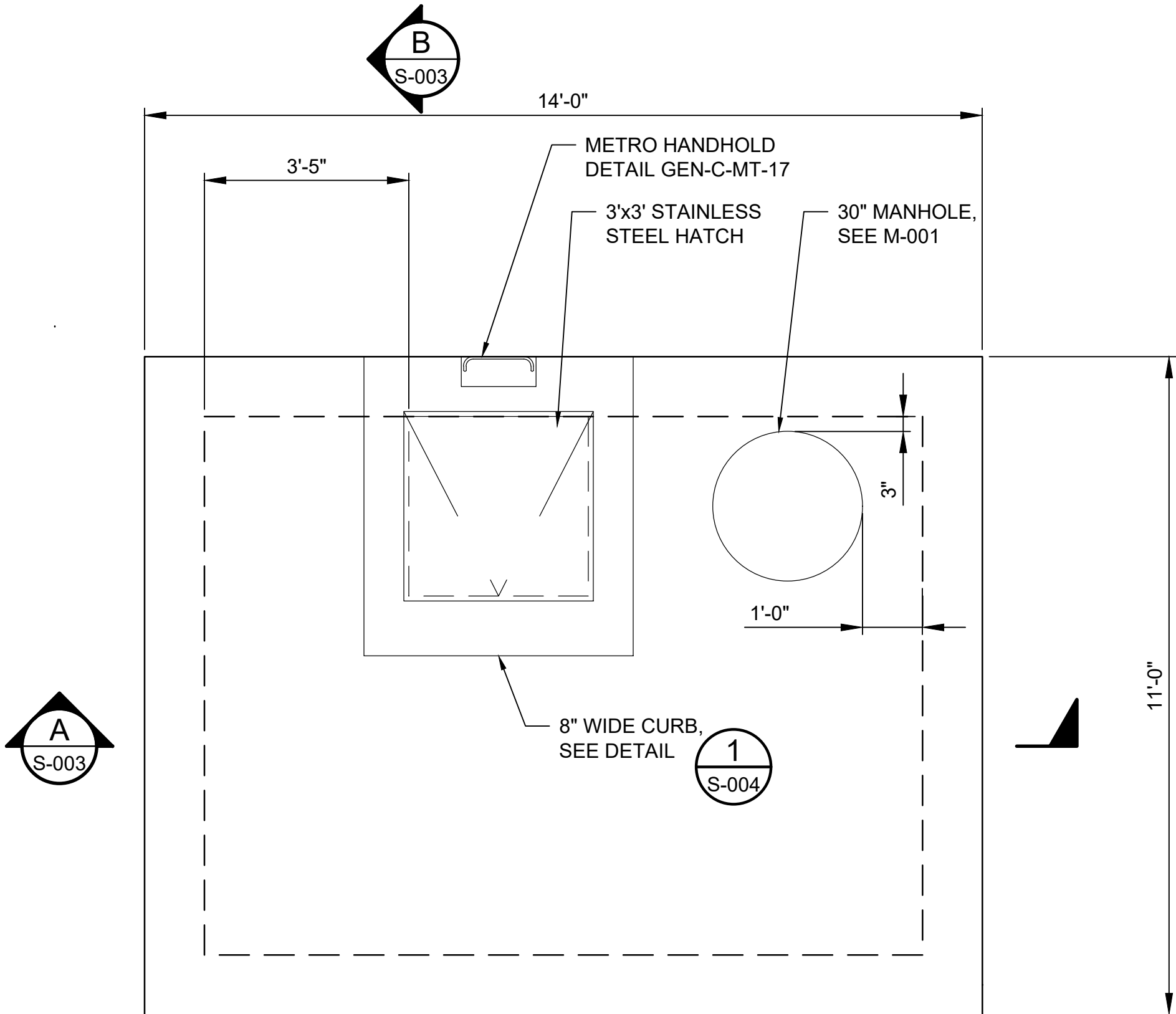


QUANTITIES TABLE				
#	ITEM	DESCRIPTION	QUANTITY	UNIT
1	TRENCH RESTORATION - ASPHALT	ASPHALT ROAD	39,990	SF
2	TRENCH RESTORATION - CONCRETE	CONCRETE ROAD/DRIVE	960	SF
3	TRENCH RESTORATION - SWALE	GRASS DRAINAGE SWALE	5,506	SF
4	TRENCH RESTORATION - SIDEWALK	CONCRETE SIDEWALK	1,255	SF
5	TRENCH RESTORATION - CURB	CONCRETE CURB	304	LF
6	TRENCH RESTORATION - PAN	CONCRETE PAN	653	SF
7	TRENCH RESTORATION - ADA RAMP	CITY OF ARVADA ADA RAMP	2	EA
8	TRENCH RESTORATION - GRAVEL	LANDSCAPE GRAVEL	2,524	SF
9	UTILITY - WATER	8" PVC WATER MAIN	733	LF
10	UTILITY - WATER	8" GATE VALVE	5	EA
11	UTILITY - WATER	8" 45° BEND	2	EA
12	UTILITY - WATER	8" RESTRAINED COUPLING	2	EA
13	UTILITY - WATER	SERVICE LINE EXTEND AND RECONNECT	4	EA
14	UTILITY - WATER	8" X 8" TEE	2	EA
15	UTILITY - SANITARY	42" GRAVITY PIPE	3,096	LF
16	UTILITY - SANITARY	30" GRAVITY PIPE	239	LF
16	UTILITY - SANITARY	21" GRAVITY PIPE	24	LF
17	UTILITY - SANITARY	8" GRAVITY PIPE	50	LF
18	UTILITY - SANITARY	RECONNECT 1.5" FORCE MAIN	1	EA
19	UTILITY - SANITARY	5' DIA MAINTENANCE HOLE	4	EA
20	UTILITY - SANITARY	6' DIA MAINTENANCE HOLE	16	EA
21	UTILITY - WATER RELOCATION	WATER SERVICE RELOCATION	1	EA
22	UTILITY - WATER RELOCATION	6" WATER RELOCATION	1	EA
23	UTILITY - WATER RELOCATION	8" WATER RELOCATION	2	EA
24	UTILITY - WATER RELOCATION	12" WATER RELOCATION	1	EA
25	UTILITY - GAS RELOCATION	2" GAS RELOCATION	4	EA
26	UTILITY - GAS RELOCATION	6" GAS RELOCATION	1	EA
27	UTILITY - FIBER/ELEC RELOCATION	FIBER/ELEC RELOCATION	1	EA

Plot Date: 8/30/2024 7:35 PM
User: ROBERT INOPEA
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FOUNDATION PLAN
SCALE: 1/2"=1'-0"



TOP PLAN
SCALE: 1/2"=1'-0"

GENERAL SHEET NOTES

- SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
- OPENINGS IN GRATING NOT SHOWN FOR CLARITY. COORDINATE GRATING LAYOUT WITH FAVORABLY REVIEWED EQUIPMENT SHOP DRAWINGS.
- COATING SYSTEMS NOT SHOWN. SEE MECHANICAL DRAWINGS AND PROJECT SPECIFICATIONS FOR COATING REQUIREMENTS.
- PROVIDE CONSTRUCTION JOINT IN SLAB, WALLS, AND TOP SLAB AT CENTER POINT ALONG THE LENGTH OF CAST-IN-PLACE BOX CHANNEL
- PROVIDE ADDITIONAL REINFORCEMENT AT ALL OPENINGS PER DETAIL S-3421.

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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NO REVISION DATE BY

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IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

PRELIMINARY
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CONSTRUCTION

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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



STRUCTURAL PLANS

SCALE
JOB NO
2246059'00
DATE
SEP 2024
SHEET 25 OF 49
S-002

Plot Date: 8/30/2024 7:36 PM

User: ROBERT INOPEA

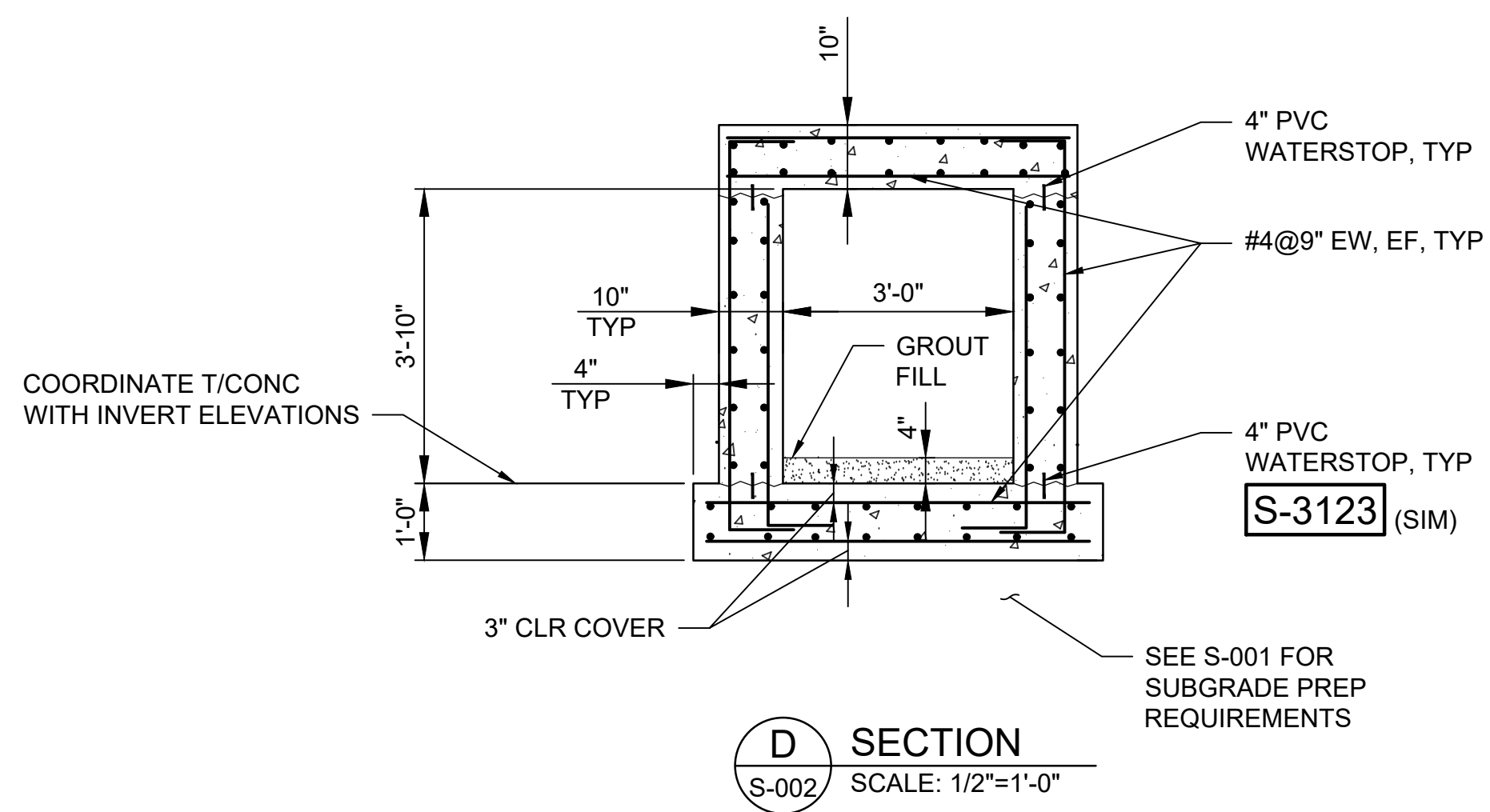
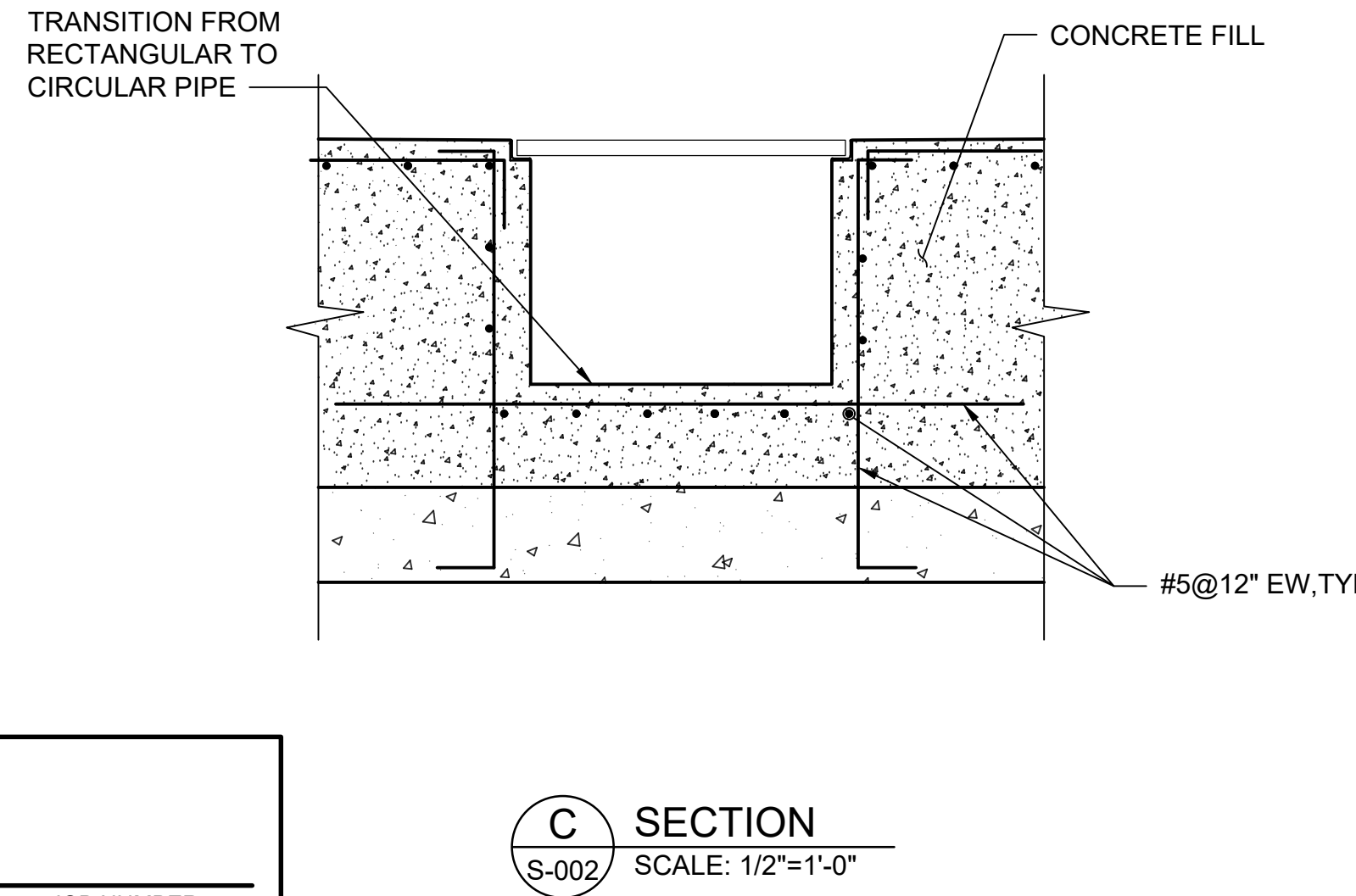
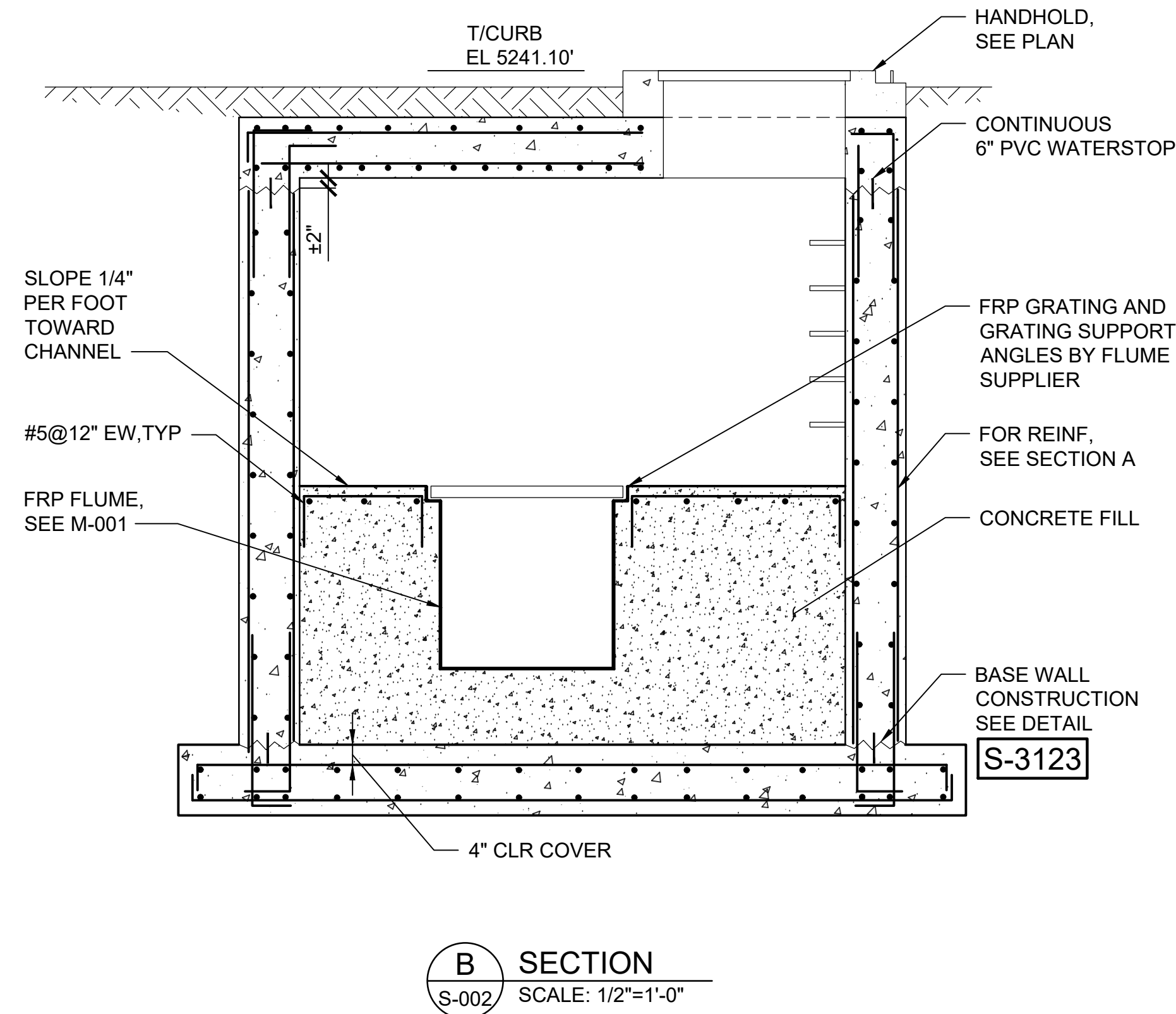
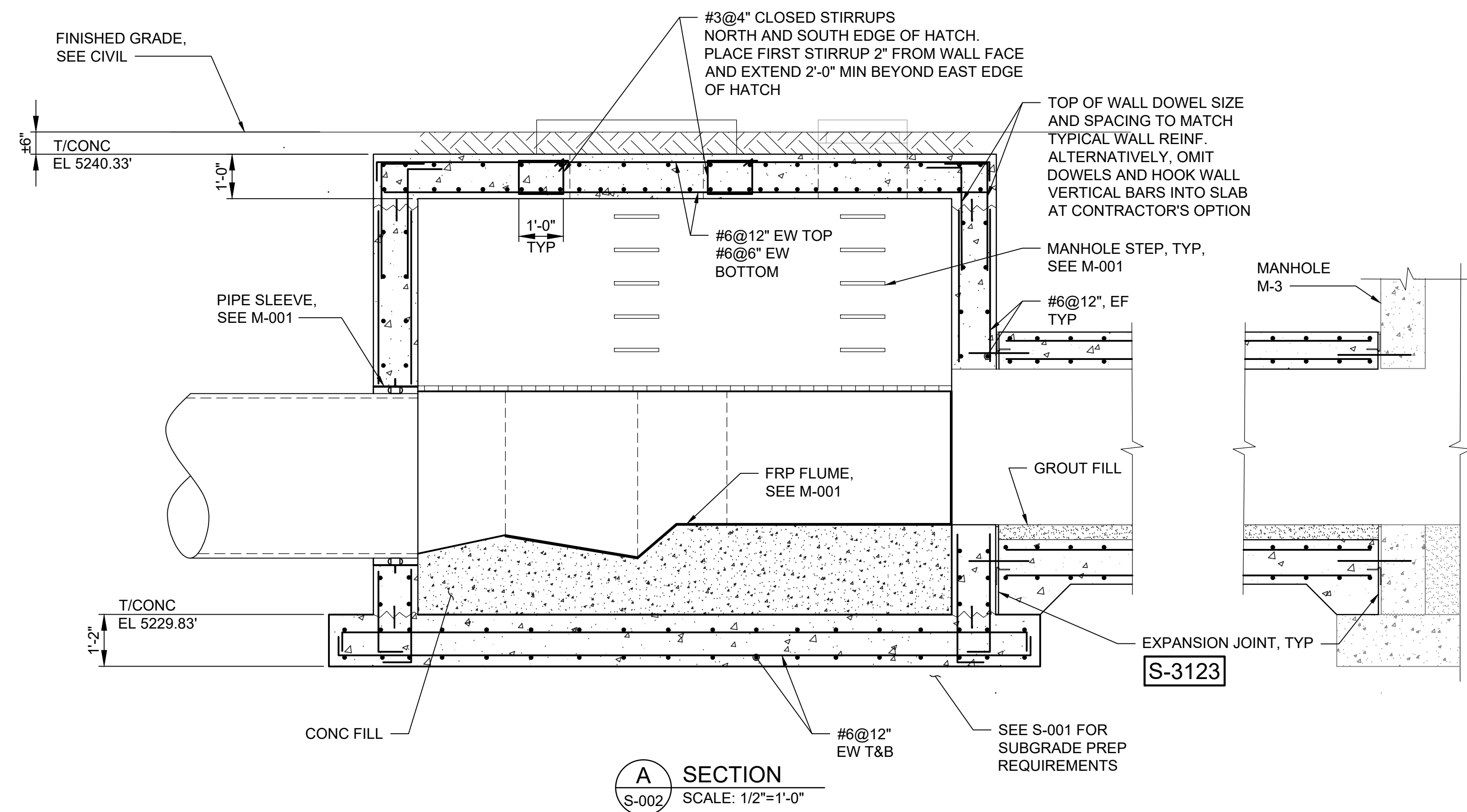
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- GENERAL SHEET NOTES
1.

SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
2.

PLACEMENT OF CONCRETE FILL SHALL FOLLOW ACI 301 TEMPERATURE LIMITATIONS. SUBMIT THERMAL CONTROL PLAN FOR REVIEW.
3.

ROUGHEN SURFACES IN CONTACT WITH CONCRETE FILL AND GROUT FILL TO 1/4" AMPLITUDE.



APPROVED

City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

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IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

STRUCTURAL SECTIONS

SCALE

JOB NO 2246059'00

DATE SEP 2024

SHEET 26 OF 49

S-003

Plot Date: 8/30/2024 7:38 PM

User: ROBERT INOPEA

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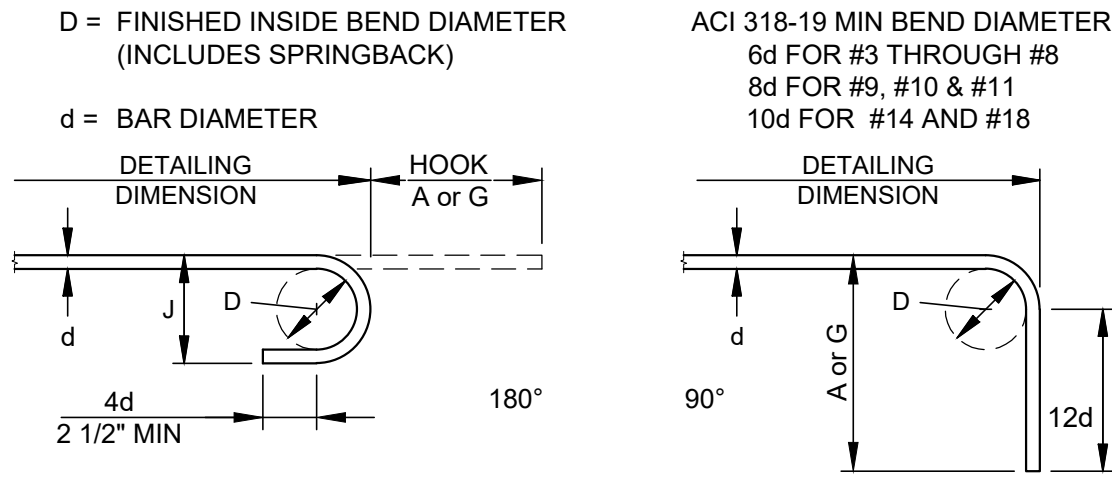
LAP SPLICE LENGTH FOR REINFORCING BARS IN WALLS, SLABS & FTNGS (INCHES)						
CONCRETE COMPRESSIVE STRENGTH, $f_c \geq 3,000$ PSI						
BAR SIZE	COVER=1.00 IN.		COVER=1.50 IN.		COVER=2.00 IN.	
IMPERIAL [SOFT METRIC]	TOP ⁴	OTHER	TOP ⁴	OTHER	TOP ⁴	OTHER
#3 [#10]	17	13	17	13	17	13
#4 [#13]	23	17	23	17	23	17
#5 [#16]	33	26	28	22	28	22
#6 [#19]	46	35	34	26	34	26
#7 [#22]	74	57	55	43	49	38
#8 [#25]	93	72	70	54	56	43
#9 [#29]	113	87	86	66	69	53
#10 [#32]	137	106	105	81	85	66
#11 [#36]	162	125	125	97	102	79

- NOTES:
- THE SPLICE LENGTH TABLE IS SPECIFIC TO TENSION DEVELOPMENT AND TENSION LAP SPLICE LENGTHS FOR WALLS, SLABS AND FOOTINGS DETERMINED IN ACCORDANCE WITH ACI 318-19, CHAPTER 25, ACI 350-06 CHAPTER 12, AND THE CRITERIA IN THIS DETAIL. CONTACT THE EOR FOR ANY DISCREPANCIES TO THE CRITERIA IN THIS DETAIL.
 - LAP SPLICE LENGTHS ARE CLASS B LAPS, IN INCHES, FOR GRADE 60 REINF IN NORMAL-WEIGHT CONC WITH $f_c \geq 3,000$ PSI.
 - OC SPACING OF REINF SHALL BE > 2 TIMES THE CONC COVER PLUS ONE BAR DIA.
 - TOP BARS ARE HORIZ BARS WITH $> 12"$ OF CONC CAST BELOW BARS.
 - FOR EPOXY-COATED REINF OR LIGHTWEIGHT CONC, CONTACT THE EOR FOR LAP SPLICE LENGTHS.
 - FOR BARS OF DIFFERENT SIZES, THE LAP SPLICE LENGTHS OF THE SMALLER BAR SHALL BE USED.
 - STAGGER LAPS A DISTANCE OF ONE-HALF THE SPLICE LENGTH, UON.
 - DO NOT LOCATE LAP SPLICE IN CONSTRUCTION JOINTS (CJ), EXPANSION JOINTS (EJ), OR CONTRACTION JOINTS (CNJ). LOCATE LAPS AT LEAST $4'$ PAST JOINT UON, TYP.

CONCRETE REBAR LAP SPLICE

S-3010

SCALE: NTS
REV 00



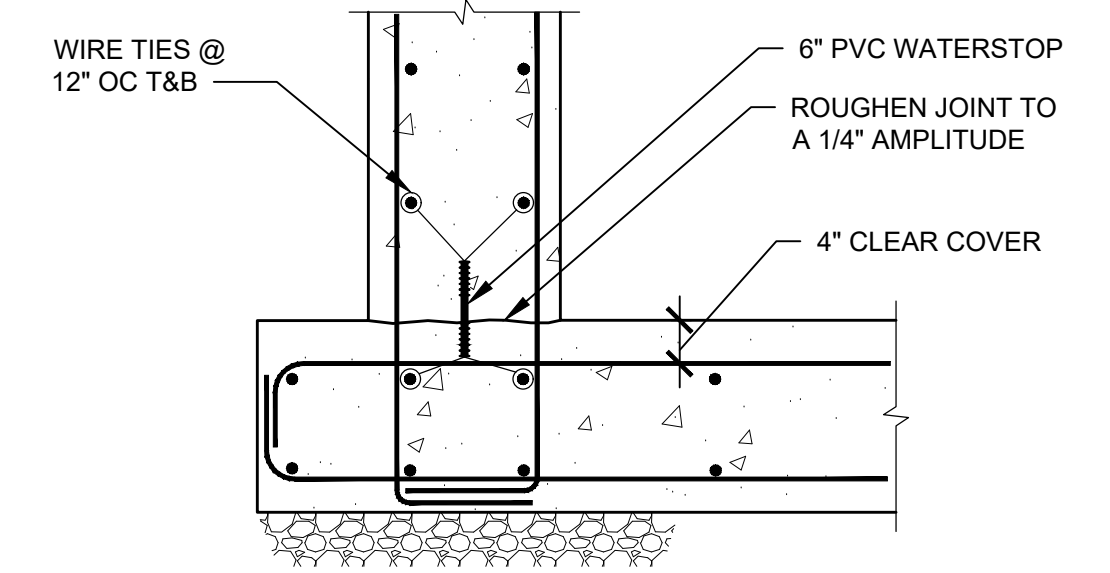
RECOMMENDED END HOOK DIMENSIONS				
BAR SIZE	D	180 ° HOOKS		90 ° HOOKS
		A or G	J	A or G
#3	0'-2 1/4"	0'-5"	0'-3"	0'-6"
#4	0'-3"	0'-6"	0'-4"	0'-8"
#5	0'-3 3/4"	0'-7"	0'-5"	0'-10"
#6	0'-4 1/2"	0'-8"	0'-6"	1'-0"
#7	0'-5 1/4"	0'-10"	0'-7"	1'-2"
#8	0'-6"	0'-11"	0'-8"	1'-4"
#9	0'-9 1/2"	1'-3"	0'-11 3/4"	1'-7"
#10	0'-10 3/4"	1'-5"	1'-1 1/4"	1'-10"
#11	1'-0"	1'-7"	1'-2 3/4"	2'-0"

REINFORCING HOOKS

S-3020

SCALE: NTS
REV 00

- NOTES:
- LOCATE WATERSTOP WITH WIRE TIES BETWEEN TWO CURTAINS OF REINFORCING.
 - AT INTERSECTIONS OF CONST JOINTS, CONNECT WATERSTOP WITH FACTORY MITERED ELLS AND TEES TO FORM CONTINUOUS WATER BARRIER. REFER TO SPECS FOR INSTALLATION & DETAILED PRODUCT REQ'S.
 - EXTEND BAR HOOKED ENDS TO BOTTOM OF SLAB.

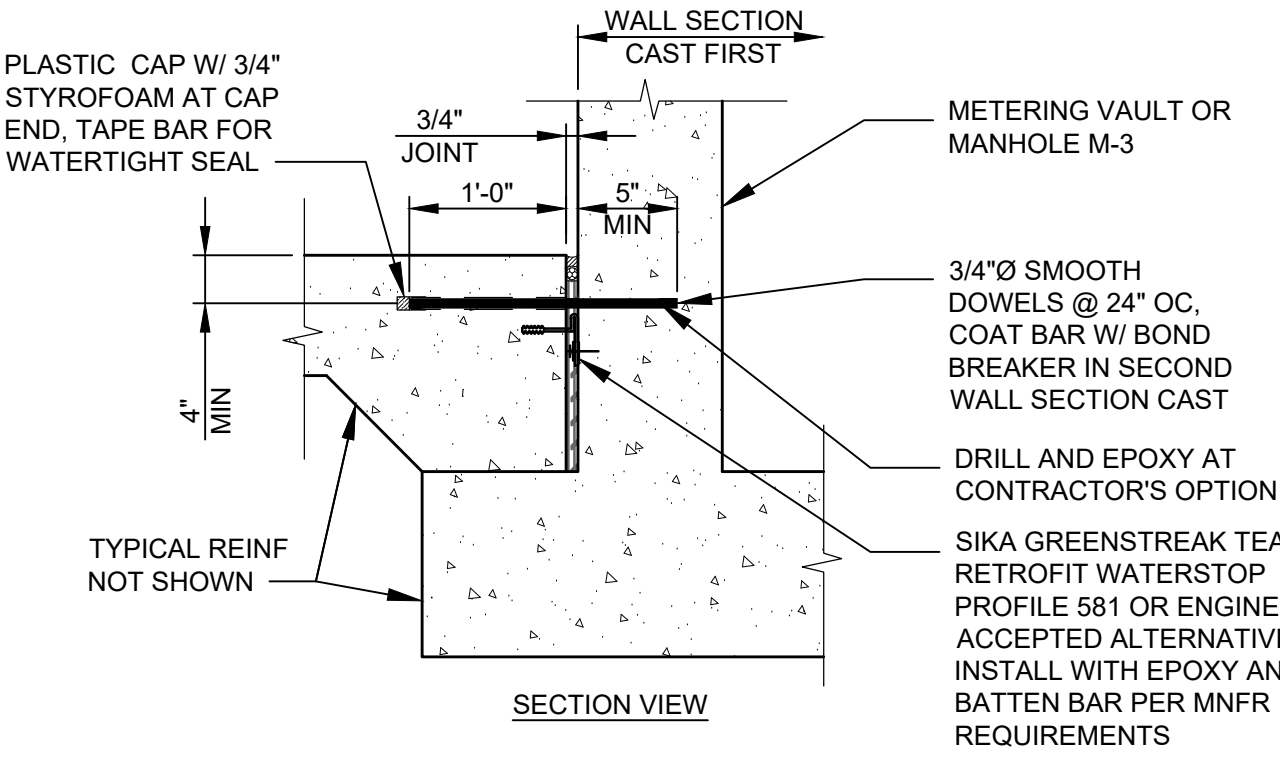


WALL-TO-SLAB JOINT

S-3123

INVERTED KEY
SCALE: NTS
REV 01

- NOTES:
- WATERSTOP SHALL BE CONTINUOUS. PROVIDE SHOP FABRICATED BENDS AS REQUIRED.
 - SCAN FOR EXISTING REINF. PRIOR TO POST INSTALLING BARS AND ANCHORS. NO EXISTING REINF. SHALL BE DAMAGED.

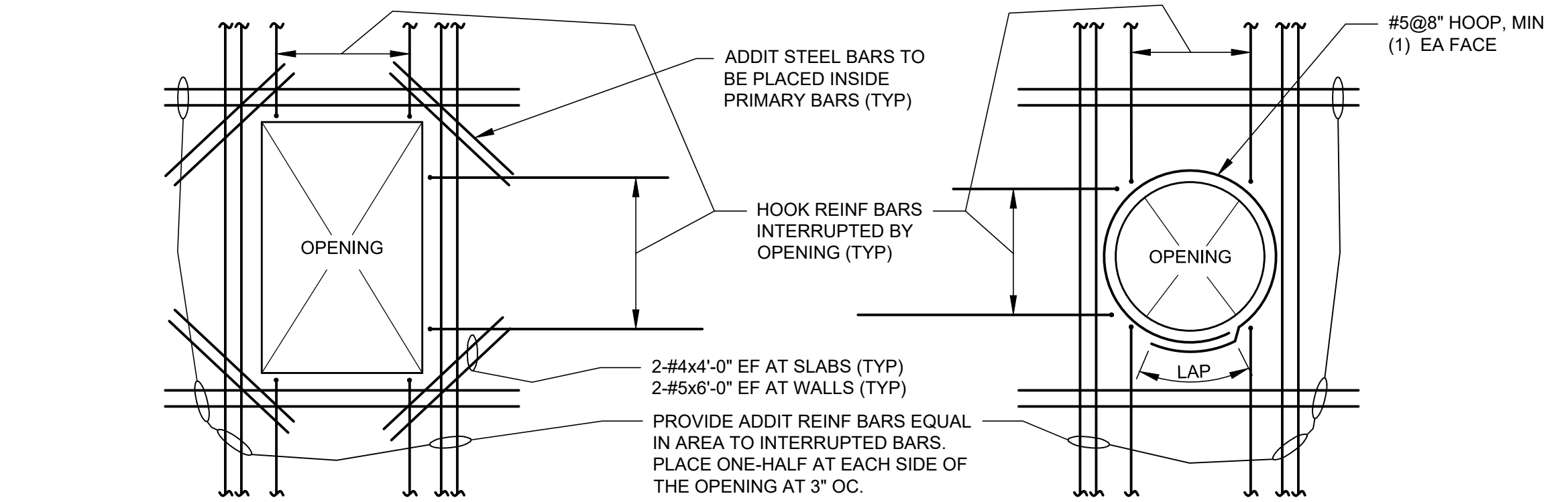


EXPANSION JOINT

S-3164

SCALE: NTS
REV 00

- NOTES:
- PROVIDE ADDITIONAL VERTICAL REINF EQUAL IN LENGTH TO THE UNINTERRUPTED BARS.
 - EXTEND ADDITIONAL HORIZONTAL REINF $5'-0"$ MIN BEYOND EITHER SIDE OF OPENING (HOOK BARS IF $5'-0"$ NOT AVAILABLE).
 - THIS DETAIL APPLIES TO ALL WALLS AND SLABS USED FOR RETAINING LIQUIDS AND SOIL.

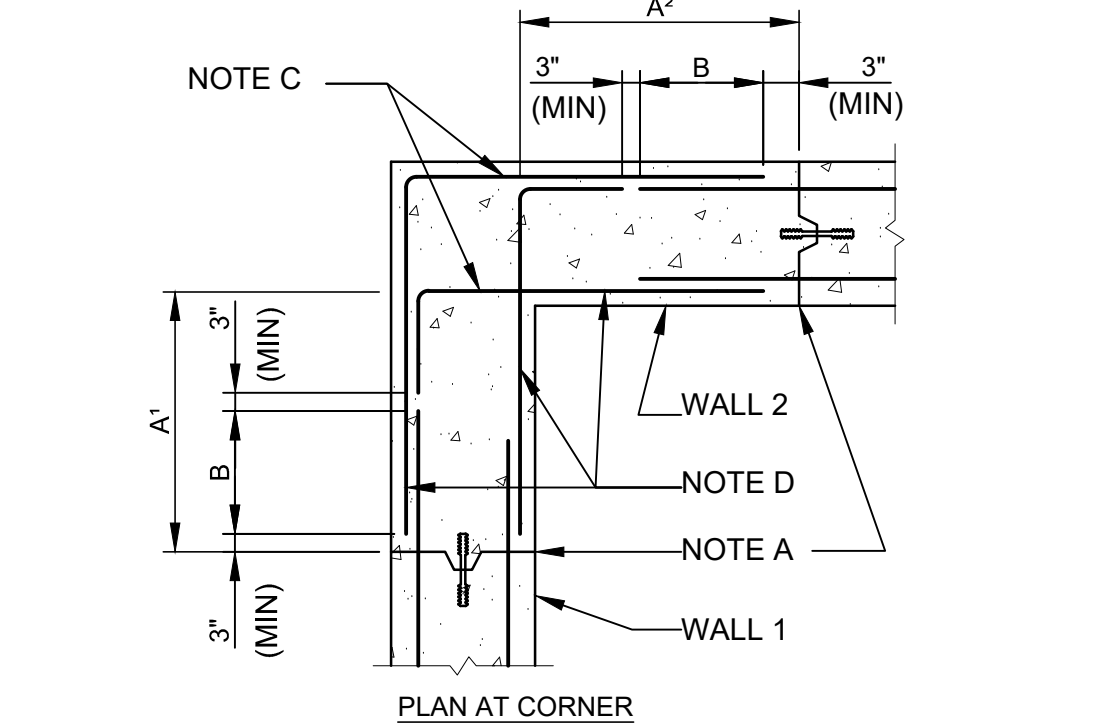


ADDIT REINF AT OPENINGS

S-3421

PRESSURE WALLS AND SLABS
SCALE: 1" = 1'-0"
REV 00

- NOTES:
- VERTICAL REINFORCING NOT SHOWN.
 - THESE DETAILS SHALL BE APPLICABLE TO ALL WALL CORNERS UNLESS NOTED OTHERWISE ON THE PLANS.
 - ALL SPLICES ARE IN THE VERTICAL PLANE.

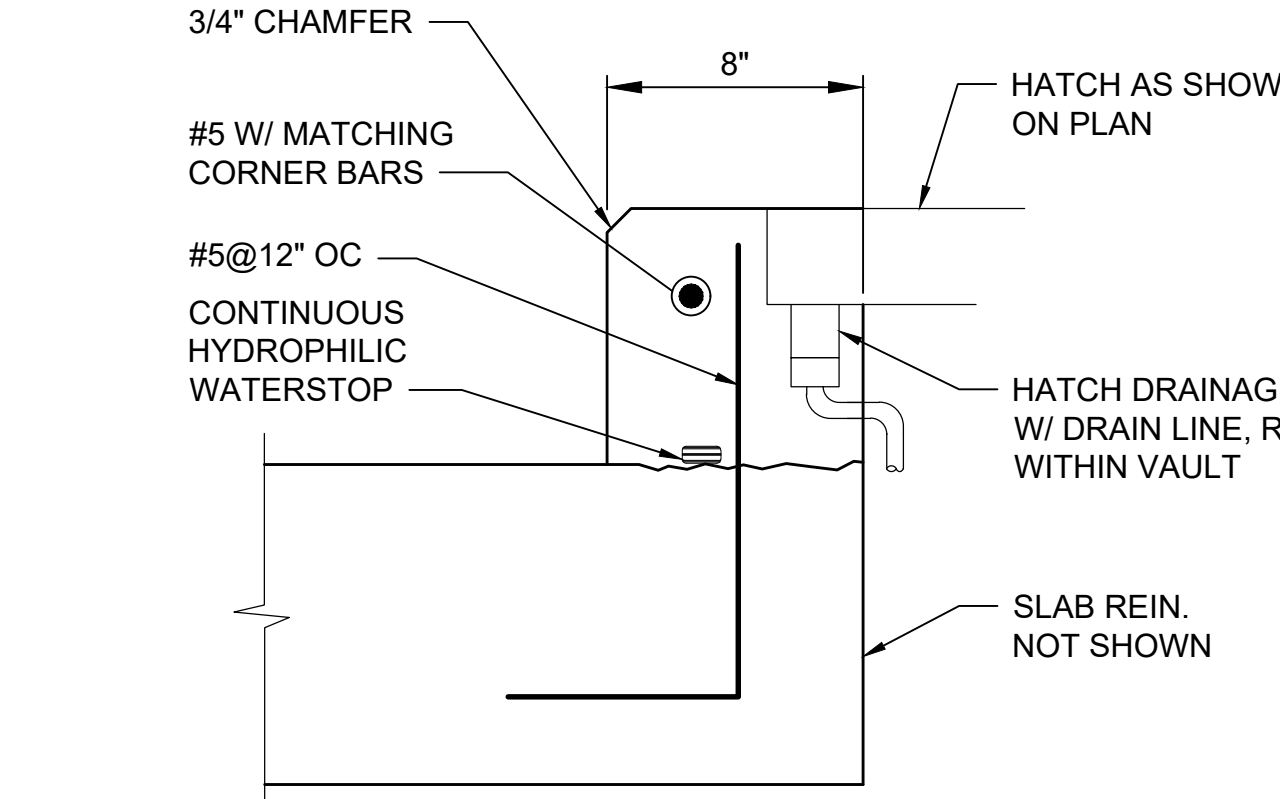


- A = VERTICAL CONSTRUCTION JOINT NEAREST TO WALL CORNER. WITH WATERSTOP AT CONTAINMENT STRUCTURES ONLY WHERE SHOWN IN PLAN.
- A* = DISTANCE FROM INSIDE CORNER FACE TO NEAREST VERTICAL CONSTRUCTION JOINT IN SIMILARLY NUMBERED WALL. "A" SHALL NOT BE LESS THAN DIMENSIONS INDICATED BY THESE DETAILS; NOR GREATER THAN INDICATED ON PLAN DRAWINGS; BUT IN ANY CASE THE SUM OF TWO ADJACENT "A" DIMENSIONS SHALL NOT EXCEED 30 FEET.
- B = STANDARD LAP SPLICE LENGTH. USE SPLICE LENGTH FOR THE SMALLER OF THE TWO BARS BEING SPLICED.
- C = STANDARD HOOK
- D = TYPICAL CORNER REINFORCEMENT. SIZE SHALL MATCH LARGEST ADJACENT WALL HORIZONTAL REINFORCEMENT; SPACING SHALL MATCH MINIMUM ADJACENT WALL HORIZONTAL REINFORCEMENT SPACING.

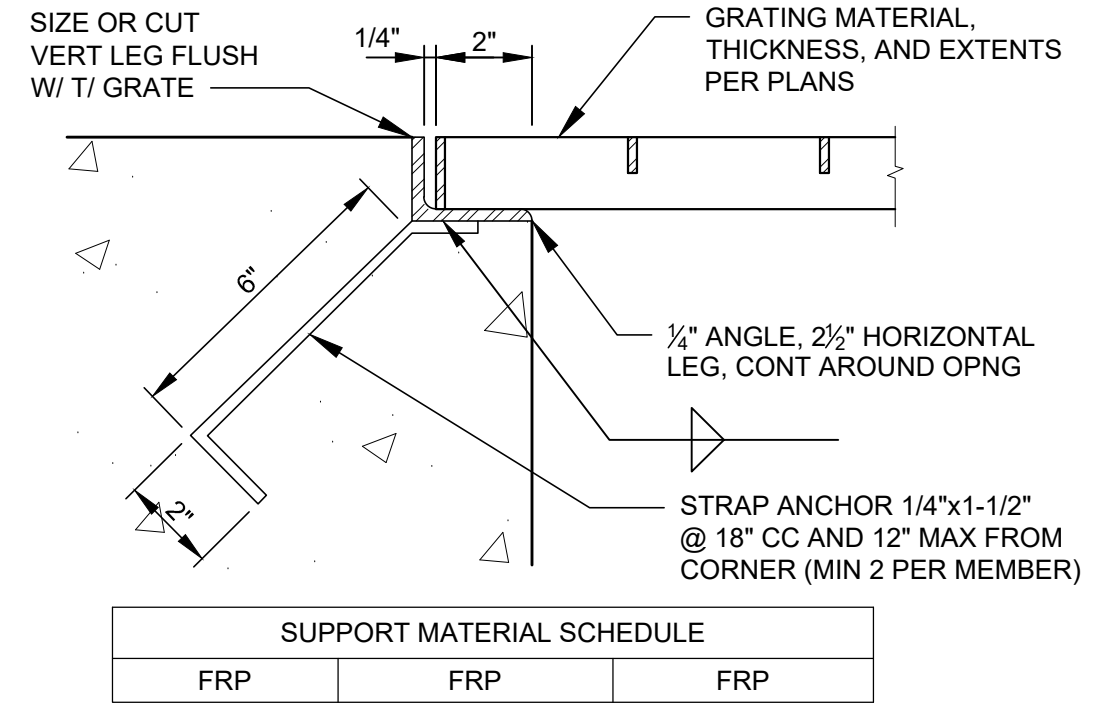
WALL CORNER REINFORCING

S-3412

DOUBLE MAT
SCALE: 3/8" = 1'-0"
REV 00



1 HATCH CURB DETAIL
S-002 SCALE: NTS



GRATING SUPPORT

S-3560

EMBEDDED ANGLE
SCALE: 3" = 1'-0"
REV 00

DESIGNED: MW
DRAWN: MS
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CONSTRUCTION

CITY OF ARVADA

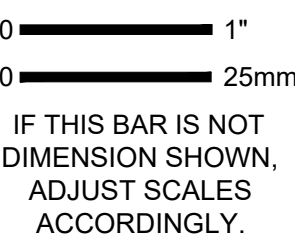
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

STRUCTURAL DETAILS - I

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DATE SEP 2024
SHEET 27 OF 49 S-004

SCALES



SEP 2024 - 90% DESIGN

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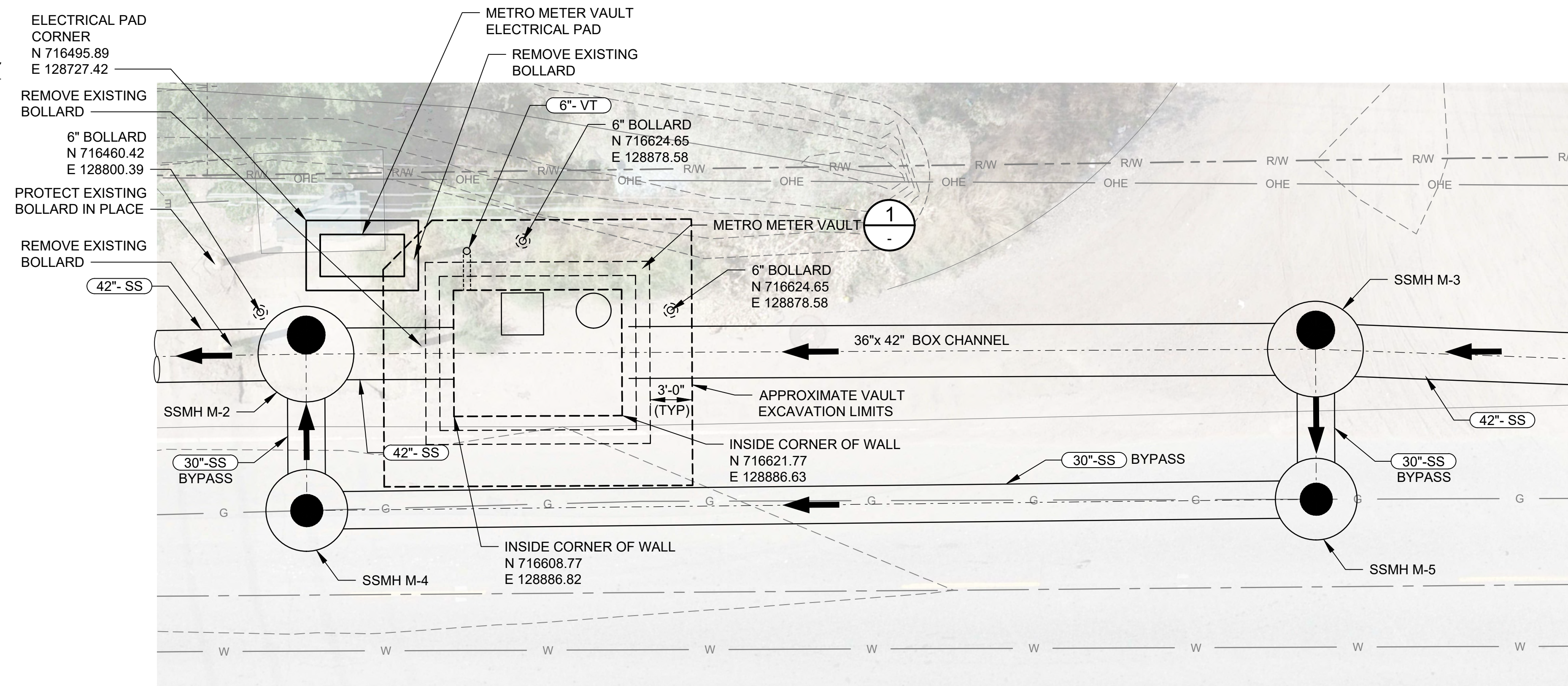
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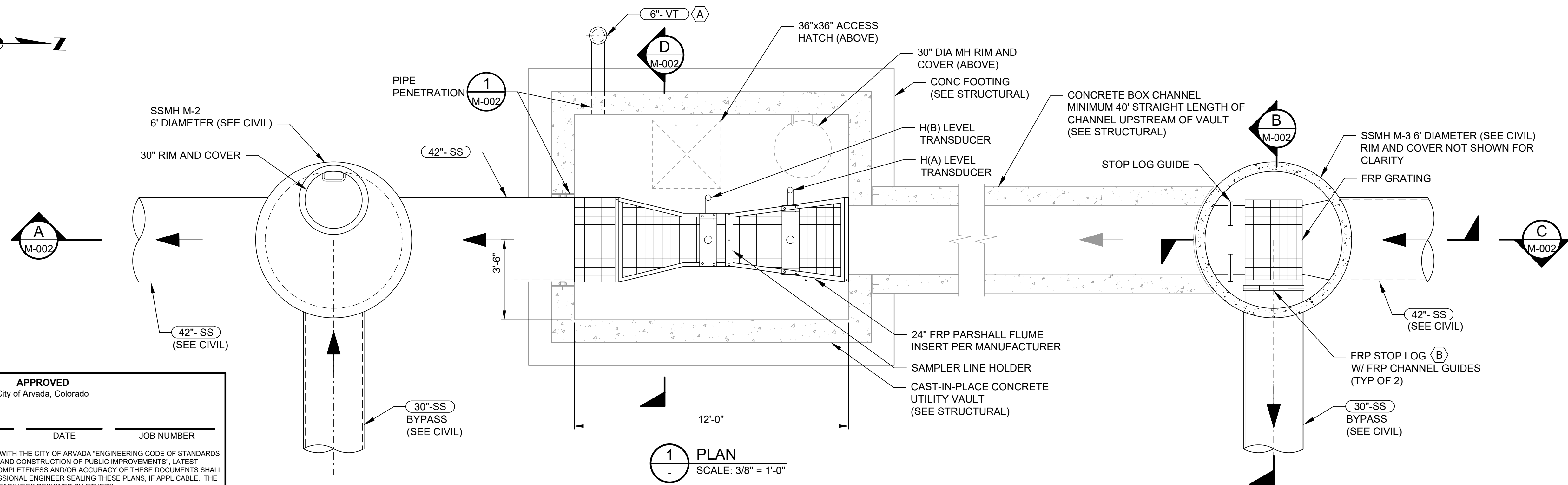
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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METERING VAULT ENLARGED SITE PLAN
SCALE: 3/16"=1'-0"



1 PLAN
- SCALE: 3/8" = 1'-0"

APPROVED

Mayor of Arvada, Colorado

CITY ENGINEER _____ DATE _____ JOB NUMBER _____

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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



METERING VAULT PLAN

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2246059*00

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SEP 2024

SCALE	AS SHOWN
JOB NO	2246059*00
DATE	SEP 2024
SHEET	29 OF 49
M-002	

Plot Date: 8/29/2024 2:27 PM	ABBREVIATIONS										ELECTRICAL NOTES										ELECTRICAL DEMOLITION NOTES																	
	'	FOOT, FEET	ETM	ELAPSED TIME METER	MFR	MANUFACTURER	T	TIME(-R)	1. THIS IS A GENERALIZED LEGEND SHEET. THIS CONTRACT MAY NOT USE ALL INFORMATION SHOWN. 2. THE INSTALLATION OF ALL EQUIPMENT, RACEWAYS, CONDUCTORS, AND CABLES SHOWN ON THESE DRAWINGS OR DESCRIBED IN THE SPECIFICATIONS SHALL CONFORM TO THE REQUIREMENTS SET FORTH IN THE LATEST EDITIONS OF THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE LOCAL CODES AND UTILITY COMPANY STANDARDS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTACT THE UTILITY COMPANY AND VERIFY THEIR REQUIREMENTS. 3. ELECTRICAL CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING THE PROJECT TO VERIFY THE SCOPE OF WORK WITH FIELD CONDITIONS. PARTICULAR ATTENTION SHOULD BE GIVEN TO NEW CONDUIT RUNS IN EXISTING BUILDINGS. 4. NOTIFY THE ENGINEER IMMEDIATELY IN WRITING IF CONFLICTS IN EQUIPMENT LOCATIONS ARE DISCOVERED OR IF PROBLEMS ARISE DUE TO FIELD CONDITIONS, LACK OF INFORMATION OR ANY OTHER REASON. NO PAYMENT WILL BE MADE FOR CHANGES WHICH HAVE NOT BEEN FAVORABLY REVIEWED BY THE ENGINEER. 5. CONDUIT ROUTING SHOWN ON PLAN DRAWINGS IS DIAGRAMMATIC ONLY. RACEWAYS SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT OR STRUCTURAL CONDITIONS. EXPOSED RACEWAYS SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO BEAMS AND WALLS. REFER ALSO TO THE CONTRACT SPECIFICATIONS. 6. VERIFY THE EXACT LOCATION OF TERMINAL BOXES AND CONDUIT ENTRANCES TO ALL EQUIPMENT AGAINST APPROVED SHOP DRAWINGS BEFORE STUBBING UP CONDUITS. CONDUIT STUB-UPS SHALL NOT BE MORE THAN 6 INCHES FROM THE CENTERLINE OF TERMINAL BOXES. 7. CONNECTIONS BETWEEN RIGID CONDUIT AND MOTOR TERMINAL BOXES OR SIMILAR EQUIPMENT SUBJECT TO VIBRATION SHALL BE FLEXIBLE LIQUID-TIGHT CONDUIT. 8. CONDUITS SHALL BE TERMINATED SO AS TO PERMIT NEAT CONNECTION TO MOTORS AND OTHER EQUIPMENT. 9. CONDUITS FOR FUTURE EQUIPMENT OR EXTENSIONS SHALL BE TERMINATED AS SHOWN IN THE DETAILS OR AS SPECIFIED. 10. LOCATIONS OF PULLBOXES ARE APPROXIMATE. COORDINATE EXACT LOCATION IN THE FIELD TO ENSURE 6 INCHES (MINIMUM) CLEARANCE FROM MECHANICAL PIPING FLOW LINES. 11. ONLY MAJOR PULLBOXES ARE SHOWN. PROVIDE ADDITIONAL PULLBOXES WHERE REQUIRED TO MAKE A WORKABLE INSTALLATION. 12. PERFORM WORK IN ACCORDANCE WITH THE DETAILS WHETHER OR NOT THEY ARE REFERENCED ON THE DRAWINGS. 13. VERIFY ALL COLOR REQUIREMENTS BEFORE ORDERING MATERIALS. 14. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUIT REPRESENT A SUGGESTED ARRANGEMENT BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS ACCEPTABLE TO THE ENGINEER MAY BE MADE BY THE CONTRACTOR TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED. THE BASIC SEQUENCE AND METHOD OF CONTROL MUST BE MAINTAINED AS INDICATED ON THE DRAWINGS AND/OR SPECIFICATIONS. 15. REFER TO THE MECHANICAL DRAWINGS FOR CERTAIN CONTROL DIAGRAMS, EXACT LOCATIONS OF MECHANICAL EQUIPMENT, AND FOR CERTAIN CONNECTIONS TO BE MADE TO ELECTRICAL CIRCUITS. 16. CONDUIT SIZE AND FILL SHALL BE AS INDICATED ON THE CONDUIT AND CABLE SCHEDULES. WHERE NO SIZE IS SHOWN, THE CONDUIT SHALL BE SIZED IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE ADOPTED BY THE AUTHORITY HAVING JURISDICTION. MINIMUM CONDUIT SIZE IS 3/4 INCH, EXCEPT WHERE ENCASED OR BURIED. MINIMUM ENCASED OR BURIED CONDUIT SIZE IS 1 INCH. 17. PROVIDE EXPANSION OR EXPANSION AND DEFLECTION FITTINGS FOR ALL CONDUIT RUNS CROSSING EXPANSION JOINTS. REFER TO THE STRUCTURAL DRAWINGS FOR LOCATIONS OF EXPANSION JOINTS. 18. PROVIDE 3/16 INCH NYLON PULL ROPE IN EACH EMPTY CONDUIT. 19. FOR LIGHTING AND RECEPTACLE SYSTEMS, ONLY CIRCUIT NUMBERS ARE SHOWN. PROVIDE ALL NECESSARY CONDUITS, WIRES, FITTINGS, JUNCTION BOXES AND NECESSARY COMPONENTS SHOWN OR NOT SHOWN ON THE DRAWINGS, TO MAKE THE ELECTRICAL INSTALLATION COMPLETE AND OPERATIONAL. SIZE CONDUITS AND WIRING IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. ALL CONDUIT RUNS SHALL BE CONCEALED UNLESS INDICATED OTHERWISE. CIRCUIT LOADING SHALL BE AS INDICATED IN THE PANEL SCHEDULES. ALL LIGHTING AND RECEPTACLE CIRCUITS SHALL INCLUDE GROUND WIRE. 20. MOUNT LUMINAIRES ACCORDING TO THE MOUNTING HEIGHT GIVEN ON THE DRAWINGS, WITH THE DISTANCE BEING MEASURED FROM THE BOTTOM OF THE LUMINAIRE TO THE FINISHED FLOOR. PROVIDE APPROPRIATE BRACKETS AND HARDWARE FOR MOUNTING. 21. ALL RECEPTACLES IN OUTDOOR AND ANTICIPATED WET AREAS SHALL BE GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLES WITH WEATHERPROOF WHILE IN-USE COVERS. 22. ALL FREE STANDING ELECTRICAL EQUIPMENT AND CONTROL PANELS SHALL BE SET ON CONCRETE HOUSEKEEPING PADS WITH LEVELING CHANNELS EMBEDDED IN THE PAD. 23. ALL PANELBOARDS SHALL BE MOUNTED SO THAT THE DISTANCE FROM THE CENTERLINE OF THE TOP CIRCUIT BREAKER OPERATING HANDLE IN THE UPPERMOST POSITION TO THE FINISHED FLOOR SHALL NOT EXCEED 6'-7". 24. ALL SURFACE MOUNTED PANELS AND PANELBOARDS ON THE INTERIOR OF EXTERIOR WALLS ABOVE GRADE OR IN OTHER LOCATIONS CONSIDERED DAMP OR WET SHALL BE MOUNTED SO AS TO MAINTAIN A 1/4 INCH (MINIMUM) AIR SPACE BETWEEN THE ENCLOSURE AND THE WALL. 25. PROVIDE LOCKOUTS IN STRICT ACCORDANCE WITH OWNER'S REQUIREMENTS. 26. REFER TO THE SINGLE LINE DIAGRAMS, EQUIPMENT ELEVATIONS, PANELBOARD SCHEDULES, AND COMPONENT/DEVICE LABELS IN THE CONTROL SCHEMATICS FOR NAMEPLATE INFORMATION. SEE THE CONTRACT SPECIFICATIONS FOR NAMEPLATE SIZE, COLOR, MATERIAL, AND PLACEMENT REQUIREMENTS. 27. "NORMAL" STATUS OF SWITCHES OR CONTACTS SHOWN IN CONTROL SCHEMATICS IS THE SHELF POSITION.										1. BIDDING CONTRACTORS SHALL VISIT THE SITE TO ASSESS THE SCOPE OF DEMOLITION, REMOVAL AND MODIFICATION WORK.	2. ELECTRICAL CONTRACTOR AND THE OWNER SHALL DE-ENERGIZE ALL WIRING PRIOR TO REMOVAL OF EQUIPMENT, DEVICES, MOTORS INSTRUMENTATION, CONTROL PANELS, ETC. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE OWNER.	3. EXPOSED RACEWAYS: REMOVE CONDUIT, WIRES, AND BOXES. PATCH TO MATCH EXISTING. FINISH ALL OPENINGS LEFT IN WALLS AND FLOORS.	4. CONCEALED CONDUITS IN THE SLAB: REMOVE EXISTING WIRES TO THE EXTENT POSSIBLE AND ABANDON CONDUITS IN THE SLAB. CUT CONDUIT FLUSH AND PATCH THE FLOOR TO MATCH EXISTING.	5. CONTROL PANELS: ELECTRICAL CONTRACTOR SHALL DE-ENERGIZE AND REMOVE ALL CONDUIT AND WIRE AS DESCRIBED IN NOTES 3 AND 4. CONTRACTOR SHALL REMOVE PANELS AS NOTED ON THE CONTRACT DRAWINGS.	6. MOTOR CONTROL CENTERS: DISCONNECT AND REMOVE ALL CONDUITS AND WIRING TO EXISTING STARTERS AND/OR BREAKERS, PANELBOARDS, BRANCH CIRCUITS, INTERLOCKS AND STATUS WIRING WITHIN MCC.	7. REFER TO THE CONTRACT SPECIFICATIONS FOR ADDITIONAL ELECTRICAL DEMOLITION AND REMOVAL REQUIREMENTS.													
	#	INCH, INCHES	EUSERC	ELECTRIC UTILITY SERVICE EQUIPMENT	MH	MANHOLE	TB	TERMINAL BLOCK																														
	%	PERCENT	EXIST	EXISTING	MIL(-S)	ONE-THOUSANDTH OF AN INCH	TC	TRAY CABLE																														
	&	AND	EXP	EXPANSION	MIN	MINIMUM, MINUTE(-S)	TEFC	TOTALLY ENCLOSED FAN COOLED																														
	@	AT	EXT	EXTERNAL	MISC	MISCELLANEOUS	TEL	TELEPHONE																														
	+	APPROXIMATELY			MLO	MAIN LUGS ONLY	TEMP	TEMPERATURE, TEMPORARY																														
	<	LESS THAN	FA	FIRE ALARM	MM	MULTIMODE	TENV	TOTALLY ENCLOSED NON-VENTILATED																														
	=	EQUALS	FACIL	FACILITY(-Y, -IES)	MOC	MAXIMUM OVERCURRENT PROTECTION	THRU	THROUGH																														
	>	GREATER THAN	FDR	FEEDER	MOD(-S)	MODIF(-Y, -ICATIONS)	TOT	TOTAL, TOTALIZE(R)																														
A	AMPERE(-S)	FIG	FIGURE	MOV	MOTOR OPERATED VALVE	TSTAT	THERMOSTAT																															
A/C	AIR CONDITIONING	FLA	FULL LOAD AMPERES	MT(-D, -G)	MOUNT(-ED, -ING)	TYP	TYPICAL																															
A/D	ANALOG TO DIGITAL	FLEX	FLEXIBLE	MTR	MOTOR	UG	UNDERGROUND																															
A/M	AUTO/MANUAL	FO	FIBER OPTIC	MTS	MOTOR TRANSFER SWITCH	UL	UNDERWRITERS LABORATORIES																															
ABAN(-D)	ABANDON(-ED)	FREQ	FREQUENCY	MV	MEDIUM VOLTAGE	UNKN	UNKNOWN																															
AC	ALTERNATING CURRENT	FT	FOOT, FEET			UPS	UNINTERRUPTIBLE POWER SUPPLY																															
AF	AMPERE FRAME	FUT	FUTURE			UTP	UNSHIELDED TWISTED PAIR																															
AFCI	ARC-FAULT CIRCUIT INTERRUPTER	FUSE	FUSE			UV	ULTRAVIOLET																															
AFF	ABOVE FINISHED FLOOR	FVNR	FULL VOLTAGE, NON REVERSING	N	NORTH, NEUTRAL	V	VOLTS																															
AFG	ABOVE FINISHED GRADE	FVNR	FULL VOLTAGE, REVERSING	NAOCL	SODIUM HYPOCHLORITE	V/S	VARIABLE SPEED																															
AI	ANALOG INPUT	FWD	FORWARD	NAOH	SODIUM HYDROXIDE	VA	VOLT-AMPERES																															
AIC	AMPERES INTERRUPTING CAPACITY			NC	NORMALLY CLOSED	VAR	VARIES, VARIABLE, VOLT-AMPERES REACTIVE																															
ANN	ANNUNCIATOR	G	GROUND (ELECTRICAL)	NEC	NATIONAL ELECTRICAL CODE (NFPA 70)																																	
ANT	ANTENNA	GAC	GRANULAR ACTIVATED CARBON	NECA	NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION																																	
AO	ANALOG OUTPUT	GAL	GALLON(-S)																																			
APPROX	APPROXIMATE(-LY)	GFCI	GROUND-FAULT CIRCUIT INTERRUPTER	NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION																																	
ARCH	ARCHITECT(-URAL)	GND	GROUND			VCP	VENDOR CONTROL PANEL																															
AS	AMMETER SWITCH	GRS	GALVANIZED RIGID STEEL			VFD	VARIABLE FREQUENCY DRIVE (AC)																															
ASD	ADJUSTABLE SPEED DRIVE (DC)			NETA	INTERNATIONAL ELECTRICAL TESTING ASSOCIATION	VFI	VACUUM FAULT INTERRUPTER																															
AT	AMPERE TRIP			NFC	NOT FOR CONSTRUCTION	VS	VOLTMETER SWITCH																															
ATS	AUTOMATIC TRANSFER SWITCH	H	HIGH, HEIGHT	NFPA	NATIONAL FIRE PROTECTION ASSOCIATION	W	WIDE, WIDTH, WIRE, WATTS, WEST																															
AUTO	AUTOMATIC	HD	HEAT DETECTOR			W/	WITH																															
AUX	AUXILIARY	HDP	HIGH DENSITY POLYETHYLENE	NH3	AMMONIA	W/O	WITHOUT																															
AWG	AMERICAN WIRE GAGE	HGR	HANGER	NIC	NOT IN CONTRACT	WAN	WIDE AREA NETWORK																															
		HH	HANDHOLE	NO	NORMALLY OPEN, NUMBER	WDM	WATT-HOUR DEMAND METER																															
		HMI	HUMAN MACHINE INTERFACE	NORM	NORMAL	WHM	WATT-HOUR METER																															
		HOA	HAND-OFF-AUTOMATIC	NTS	NOT TO SCALE	WP	WEATHERPROOF, WEATHER PROTECTED																															
BATT	BATTERY	HOR	HAND-OFF-REMOTE			WR	WEATHER RESISTANT																															
BC	BARE COPPER	HP	HORSEPOWER			WTP	WATER TREATMENT PLANT																															
BKR	BREAKER	HTR(S)	HOUR(-S)	O/C	OPEN/CLOSE	WTR	WATER																															
		HTR	HEATER	O3	OZONE	WW	WASTEWATER																															
		HVAC	HEATING, VENTILATING, AND AIR CONDITIONING	ODP	OPEN DRIP PROOF	WWTP	WASTEWATER TREATMENT PLANT																															
C	CONDUCTOR, CONTACT	HZ	HERTZ (CYCLES PER SECOND)	OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED																																	
C/S	CONSTANT SPEED			OIT	OPERATOR INTERFACE TERMINAL	XFMR	TRANSFORMER																															
CAB	CABINET	I&C	INSTRUMENTATION AND CONTROL	OL	THERMAL OVERLOAD RELAY	XP	EXPLOSION PROOF																															
CALC(S)	CALCULATION(S)	I/O	INPUT/OUTPUT	ORIG	ORIGINAL																																	
CAT	CATEGORY	IEEE	INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS	OSC	OPEN/STOP/CLOSE																																	
CB	CATCH BASIN			OT	OVER TEMPERATURE																																	
CCTV	CLOSED-CIRCUIT TELEVISION	IL	INDICATING LIGHT	P	POLE																																	
CHEM	CHEMI(-CAL, -STRY)	IN	INCH(-ES)	PA	PUBLIC ADDRESS																																	
CID1	CLASSIFICATION I, DIVISION 1	INST	INSTANTANEOUS	PB	PULLBOX, PUSHBUTTON																																	
CID2	CLASSIFICATION I, DIVISION 2	INSTR	INSTRUMENT(-ATION)	PC(-S)	PIECE(-S), PHOTOCCELL																																	
CKT	CIRCUIT	IP	INTERNET PROTOCOL	PCC	POINT OF COMMON COUPLING																																	
CLR	CLEAR(-ANCE)	IR	INFRARED	PE	PHOTOELECTRIC																																	
CLSM	CONTROLLED LOW STRENGTH MATERIAL	IS	INTRINSICALLY SAFE	PF	POWER FACTOR																																	
CO	CONDUIT ONLY	ISA	INTERNATIONAL SOCIETY OF AUTOMATION	PFR	POWER FACTOR RELAY																																	
COAX	COAXIAL	ISO	ISOLATE(-E, -ION)	PH	PHASE																																	
COM	COMMON	ISR	INTRINSICALLY SAFE RELAY	PLC	PROGRAMMABLE LOGIC CONTROLLER																																	
COMM	COMMUNICATION	JB	JUNCTION BOX	PM	POWER MONITOR																																	
COND	CONDUIT			PNL	PANEL																																	
CPT	CONTROL POWER TRANSFORMER			PNLBD	PANELBOARD																																	
CR	CONTROL RELAY	KA	KILOAMPERE(-S)	POE	POWER OVER ETHERNET																																	
CT	CURRENT TRANSFORMER	KCMIL	THOUSANDS OF CIRCULAR MILS	PP	POWER POLE																																	
CTRL	CONTROL	KHZ	KILOHERTZ	PRI	PRIMARY																																	
CU IN	CUBIC INCH(-ES)	KV	KILOVOLT(-S)	PRV	PRESSURE RELIEF VALVE, PRESSURE REDUCING VALVE																																	
		KVA	KILOVOLT-AMPERE(-S)																																			
		KVAR	KILOVOLT-AMPERE(-S) REACTIVE	PS	POWER SUPPLY																																	
		KVARH	KILOVOLT-AMPERE REACTIVE HOUR(-S)	PT(-S)	POTENTIAL TRANSFORMER																																	
		KW	KILOWATT(-S)	PVC	POLYVINYL CHLORIDE																																	
		KWH	KILOWATT HOUR(-S)	PWR	POWER																																	
				R, RAD	RADIUS																																	
		L	LENGTH, LINE	RCPT	RECEPTACLE																																	
		LA	LIGHTNING ARRESTER	RCT	REPEAT CYCLE TIMER																																	
		LAN	LOCAL AREA NETWORK	RIO	REMOTE INPUT/OUTPUT																																	
		LB(-S)	POUND(-S)	RM	ROOM																																	
		LCP	LOCAL CONTROL PANEL	RMT	REMOTE																																	
		LCS	LOCAL CONTROL STATION	RPM	REVOLUTIONS PER MINUTE																																	
		LEL	LOWER EXPLOSIVE LIMIT	RST	RESET																																	
		LOC	LOCATION	RT	RESET TIMER																																	
		LOR	LOCAL-OFF-REMOTE	RTU	REMOTE TELEMETRY UNIT																																	
		LOTO	LOCK-OUT, TAG-OUT	RVSS	REDUCED VOLTAGE, SOLID STATE																																	
		LP	LIGHTING PANELBOARD																																			
		L-R	LOCAL-REMOTE																																			
		LS	LIMIT SWITCH	S/S	START/STOP																																	
		LT	LIGHT	SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION																																	
		LTG	LIGHTING																																			
		LV	LOW VOLTAGE	SCR	SILICON CONTROLLED RECTIFIER																																	
				SD	SMOKE DETECTOR																																	
		mA	MILLIAMPERE(-S)	SEC	SECONDARY																																	
		MAX	MAXIMUM	SER	SERVICE ENTRANCE RATED																																	
		MCB	MAIN CIRCUIT BREAKER	SGNL	SIGNAL																																	
		MCC	MOTOR CONTROL CENTER	(SH)	SHIELDED																																	
		MCP	MOTOR CIRCUIT PROTECTOR	SHT	SHEET																																	
		MECH	MECHANICAL	SM	SINGLEMODE																																	
				SP	SET POINT																																	
				SPD	SURGE PROTECTIVE DEVICE																																	
				SPDT	SINGLE POLE, DOUBLE THROW																																	
				SPEC(-S)	SPECIFICATION(-S)																																	
				SS	STAINLESS STEEL, SOLID STATE																																	
				STB	SHORTING TERMINAL BLOCK																																	
				STD(-S)	STANDARD(-S)																																	
				STL	STEEL																																	
				STP	SHIELDED TWISTED PAIR																																	
				STRC	STRUCTUR(-E, -AL)																																	
				SWBD	SWITCHBOARD																																	
				SWGR	SWITCHGEAR																																	
				SYNC	SYNCHRONIZING																																	

User: TIMOTHY KELLY	APPROVED										DESIGNED										ELECTRICAL NOTES										ELECTRICAL DEMOLITION NOTES									
	City of Arvada, Colorado										ZLP										CITY OF ARVADA										ABBREVIATIONS AND NOTES									
	CITY ENGINEER										DATE										VZ										NORTH TRUNK SEWER IMPROVEMENTS									
	JOB NUMBER										ZCD										NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11										SEP 2024									
	REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.																				Kennedy Jenks										E-001									

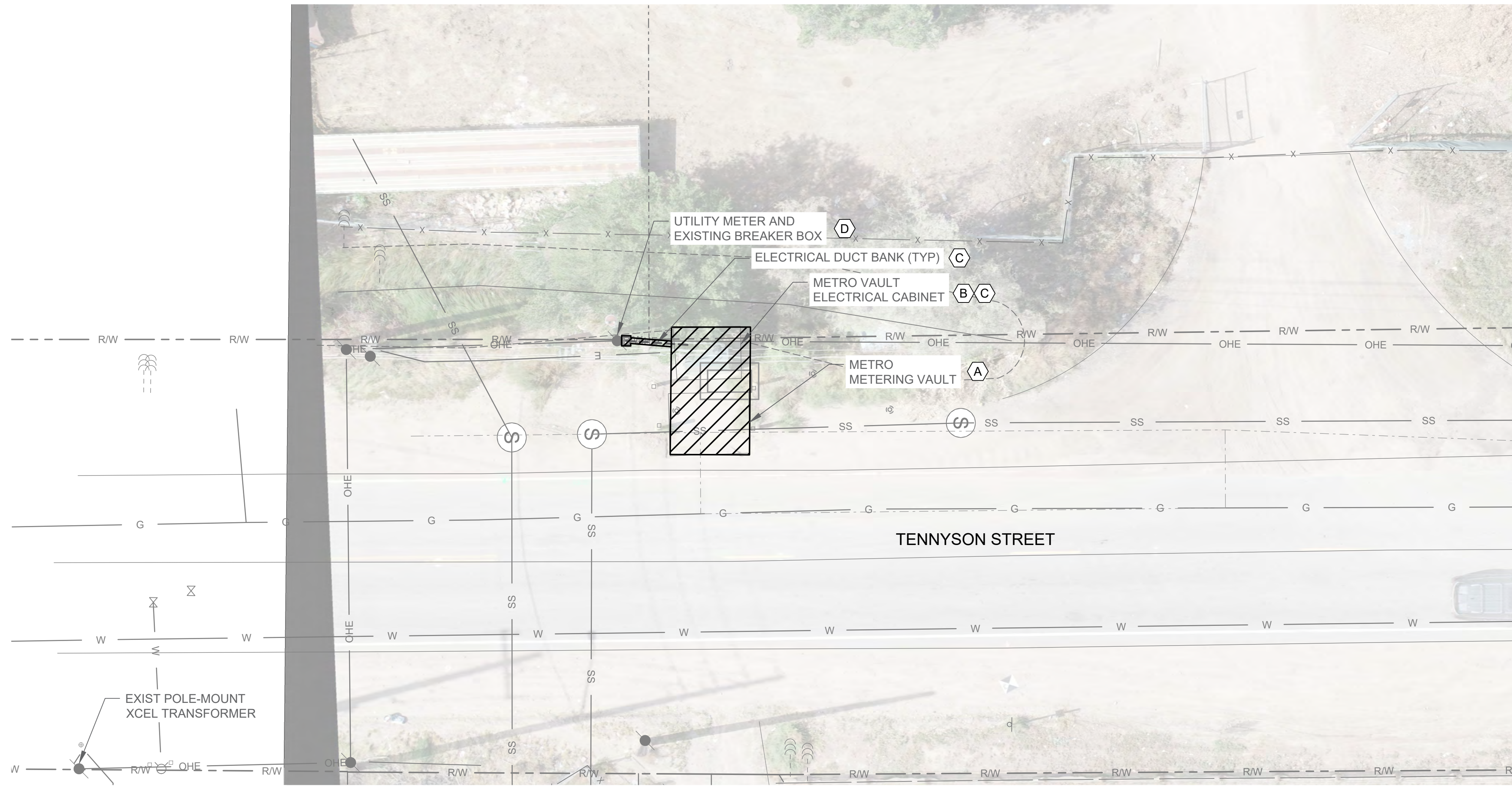
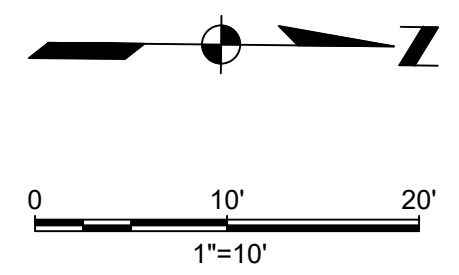
SEP 2024 - 90% DESIGN					SCALES					DESIGNED					DRAWN					CHECKED					ZCD				
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NO					REVISION					DATE					BY														

Plot Date: 8/29/2024 2:27 PM User: TIMOTHY KELLY	PLAN SYMBOLS														
	CONDUIT AND RACEWAYS					LIGHTING					SECURITY AND COMMUNICATION				
	<														

Plot Date: 8/29/2024 2:28 PM

User: TIMOTHY KELLY

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- GENERAL SHEET NOTES
1.

REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF DEMOLITION.
2.

COORDINATE WITH THE ELECTRIC UTILITY, ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES
- A.

EXISTING METRO METERING VAULT TO BE DEMOLISHED. DIFFERENTIAL LEVEL INSTRUMENTATION ELEMENTS AND ASSOCIATED EQUIPMENT SHALL BE REMOVED FROM VAULT, PROTECTED IN STORAGE, AND REINSTALLED IN NEW VAULT. REFER TO THE REST OF THE ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
- B.

EXISTING METRO VAULT ELECTRICAL CABINET SHALL BE REMOVED, PROTECTED IN STORAGE, AND REINSTALLED IN LOCATION ADJACENT TO EXISTING AS SHOWN.
- C.

EXISTING CONCRETE HOUSEKEEPING PAD, EXISTING ELECTRICAL DUCTBANK, AND EXISTING CONDUIT STUB-UPS SHALL BE DEMOLISHED
- D.

EXISTING BREAKER BOX SHALL BE DEMOLISHED.

APPROVED

City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

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NO	REVISION	DATE	BY

SCALES

0 1" 0 25mm

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DESIGNED

ZLP

DRAWN

ZLP

CHECKED

ZCD

CITY OF ARVADA

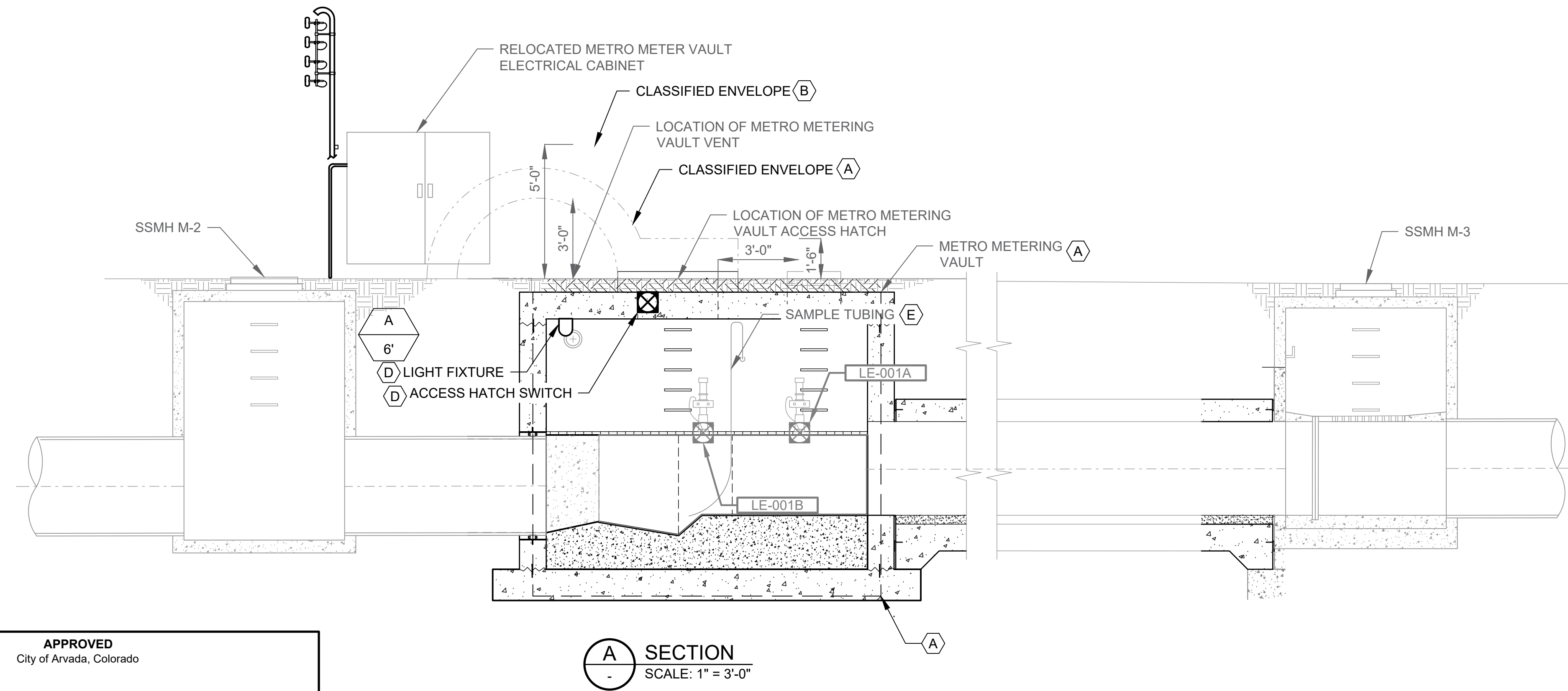
NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

OVERALL DEMOLITION SITE PLAN

SCALE	1" = 10'
JOB NO	2246059*00
DATE	SEP 2024
SHEET	34 OF 49
	DE-010



SHEET KEYNOTES

A. THE ENTIRE SPACE OF THE METRO METERING VAULT AS WELL AS THE SPACE AROUND THE VENT EXTENDING FOR A 3' RADIUS IS A NEC CLASS I, GROUP D, DIVISION 1 HAZARDOUS LOCATION PER NFPA 820.

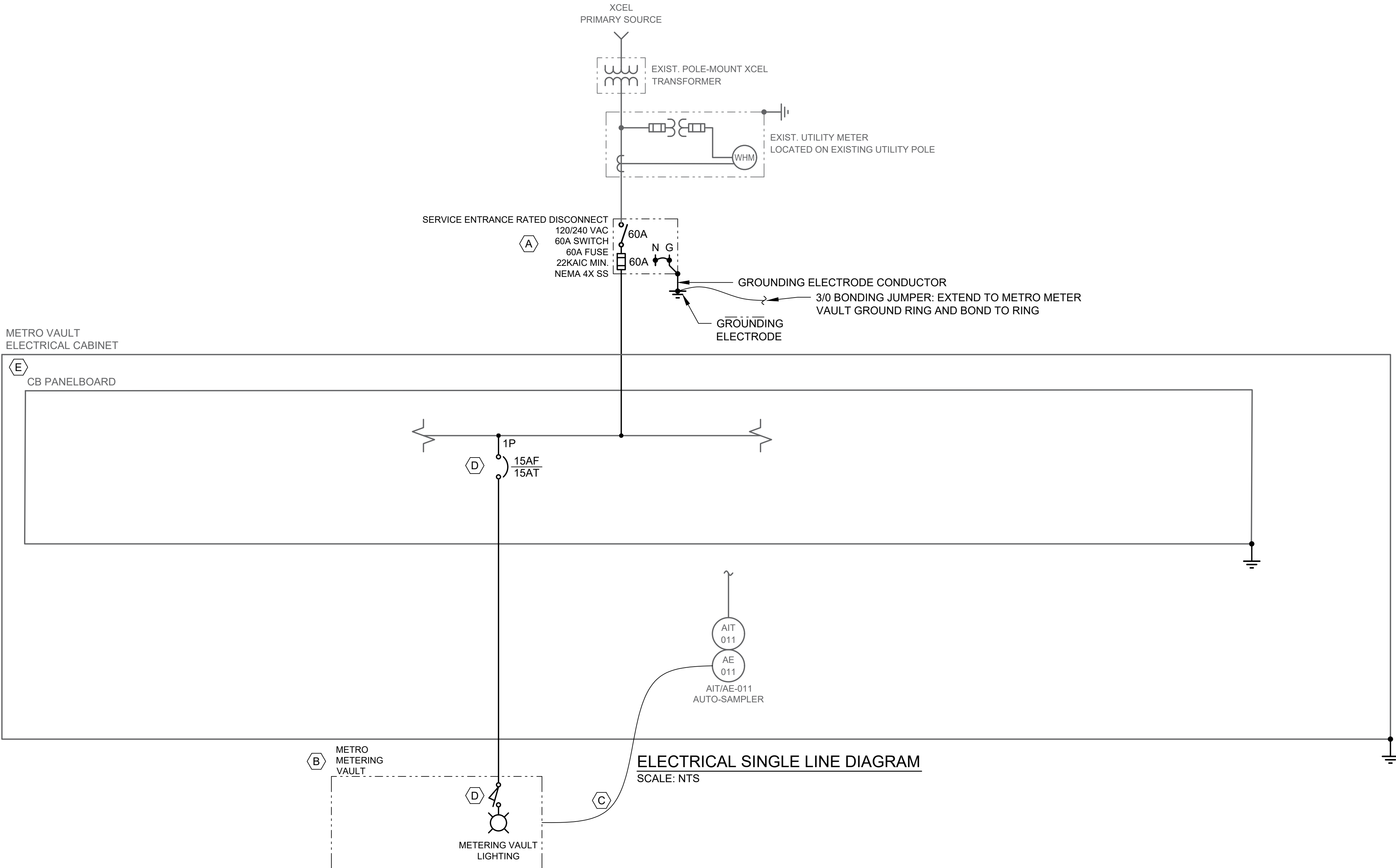
B. THE SPACE AROUND THE VENT STARTING FROM A 3' RADIUS TO A 5' RADIUS FROM THE VENT AS WELL AS THE SPACE AROUND THE HATCH OPENING EXTENDING 18" AFG AND 3' HORIZONTALLY IN ALL DIRECTIONS IS A NEC CLASS I, GROUP D, DIVISION 2 HAZARDOUS LOCATION PER NFPA 820.

SCALE	1" = 3'	
JOB NO	2246059*00	
DATE	SEP 2024	
SHEET	36 OF	49
E-011		

Plot Date: 8/29/2024 2:35 PM

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ELECTRICAL SINGLE LINE DIAGRAM
SCALE: NTS

LUMINAIRE SCHEDULE					
TYPE	DESCRIPTION	LAMPS	WATTS /FIXTURE	MANUFACTURER CATALOG NUMBER	MOUNTING
A	CLASS I, DIVISION I, GROUP D LED FLOOLIGHT, WALL MOUNT, YOKE MOUNT KIT	LED	40	HOLOPHANE, HEXF1 P2 MV 4K T2M CL OR EQUAL	WALL MOUNT, YOKE MOUNT KIT

LUMINAIRE SCHEDULE
SCALE: NTS

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City of Arvada, Colorado

CITY ENGINEER

DATE

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NO

REVISION

DATE

BY

SCALES

0 1"

0 25mm

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DESIGNED

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VZ

CHECKED

ZCD

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

ONE-LINE DIAGRAM AND SCHEDULES

SCALE

NTS

JOB NO

2246059*00

DATE

SEP 2024

SHEET

37 OF 49

E-020

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0

1

2

3

4

A

B

C

D

E

F

G

H

CONDUIT AND CABLE SCHEDULE									
NUMBER	FROM	TO	SIZE (")	POWER	CONTROL	SIGNAL	COMMENTS		
P-001	EXISTING UTILITY METER	SERVICE ENTRANCE RATED DISCONNECT	1"	3-#6, #8 GND.			RE-USE EXISTING CONDUIT		
P-002	SERVICE ENTRANCE RATED DISCONNECT	CB PANELBOARD (WITHIN METRO VAULT ELECTRICAL CABINET)	1"	3-#6, #8 GND.					
P-010	CB PANELBOARD	METERING VAULT LIGHTING	1"	2-#12, #12GND.			IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)		
S-005	LIT-001	LE-001A, LE-001B	1"			2-MFR CABLE	IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)		
M-001	AUTOSAMPLER AIT-011	PARSHALL FLUME SAMPLING POINT	2"				CONTAINS 3/8" PVC SA SAMPLE TUBING IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)		

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NO

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DATE

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SCALES

0 1"

0 25mm

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DESIGNED

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 CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

 Kennedy Jenks

CONDUIT AND CABLE SCHEDULE

SCALE

NTS

JOB NO

2246059*00

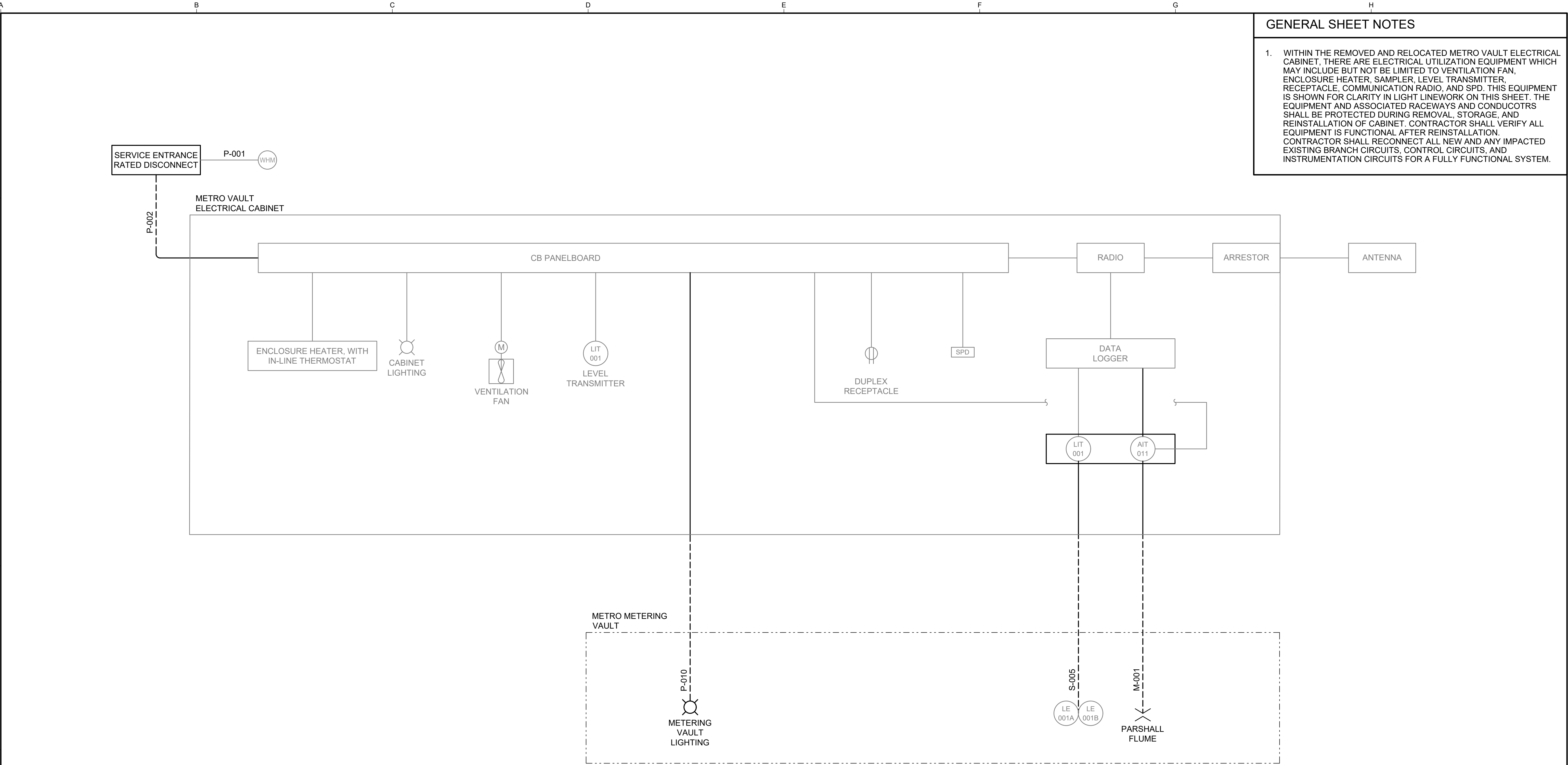
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SHEET 38 OF 49

E-030

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APPROVED City of Arvada, Colorado			
CITY ENGINEER	DATE	JOB NUMBER	
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NO	REVISION	DATE	BY

SCALES
0 1"
0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED ZLP	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 Kennedy Jenks
DRAWN VZ	
CHECKED ZCD	

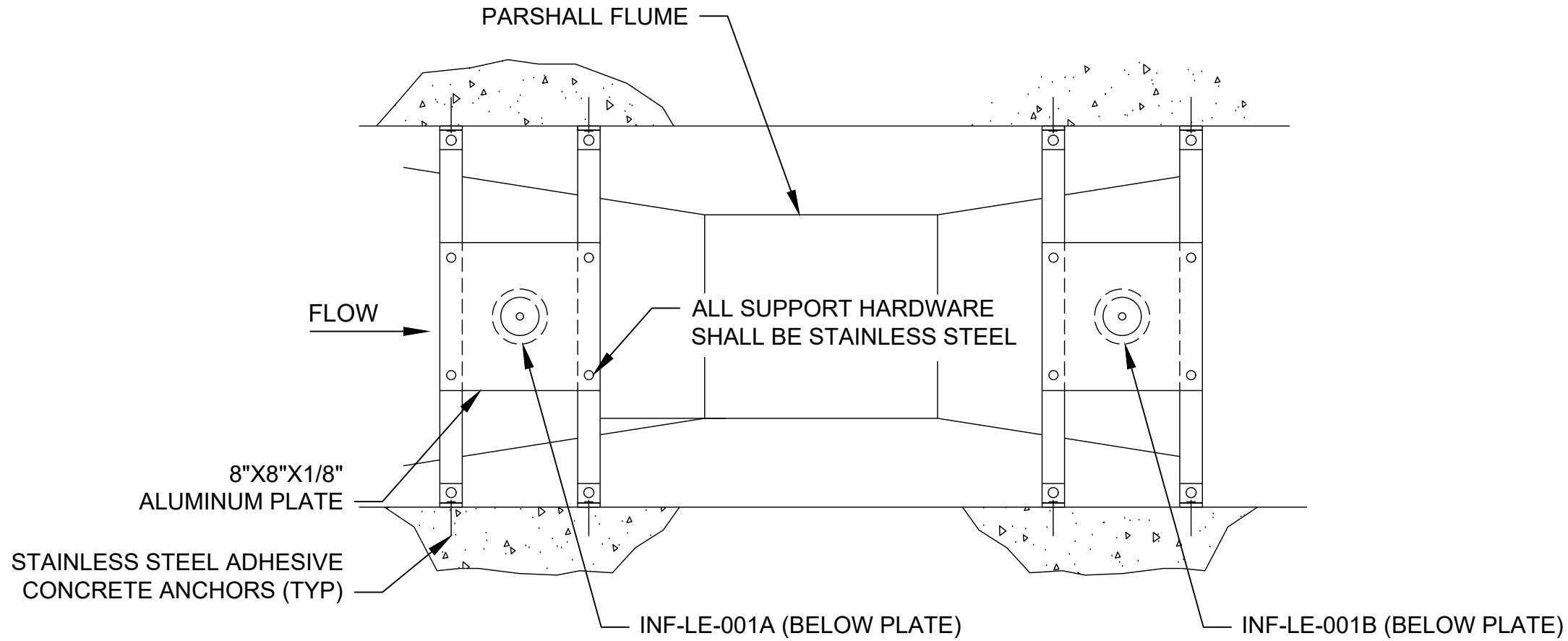
CONDUIT BLOCK ROUTING DIAGRAM

SCALE NTS
JOB NO 2246059*00
DATE SEP 2024
SHEET 39 OF 49 E-040

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GENERAL SHEET NOTES

1. ALL DETAILS SHOWN ARE TYPICAL. DETAILS SHALL BE USED THROUGHOUT THE PROJECT AS APPLICABLE.



PARSHALL FLUME TRANSMITTER MOUNTING DETAIL

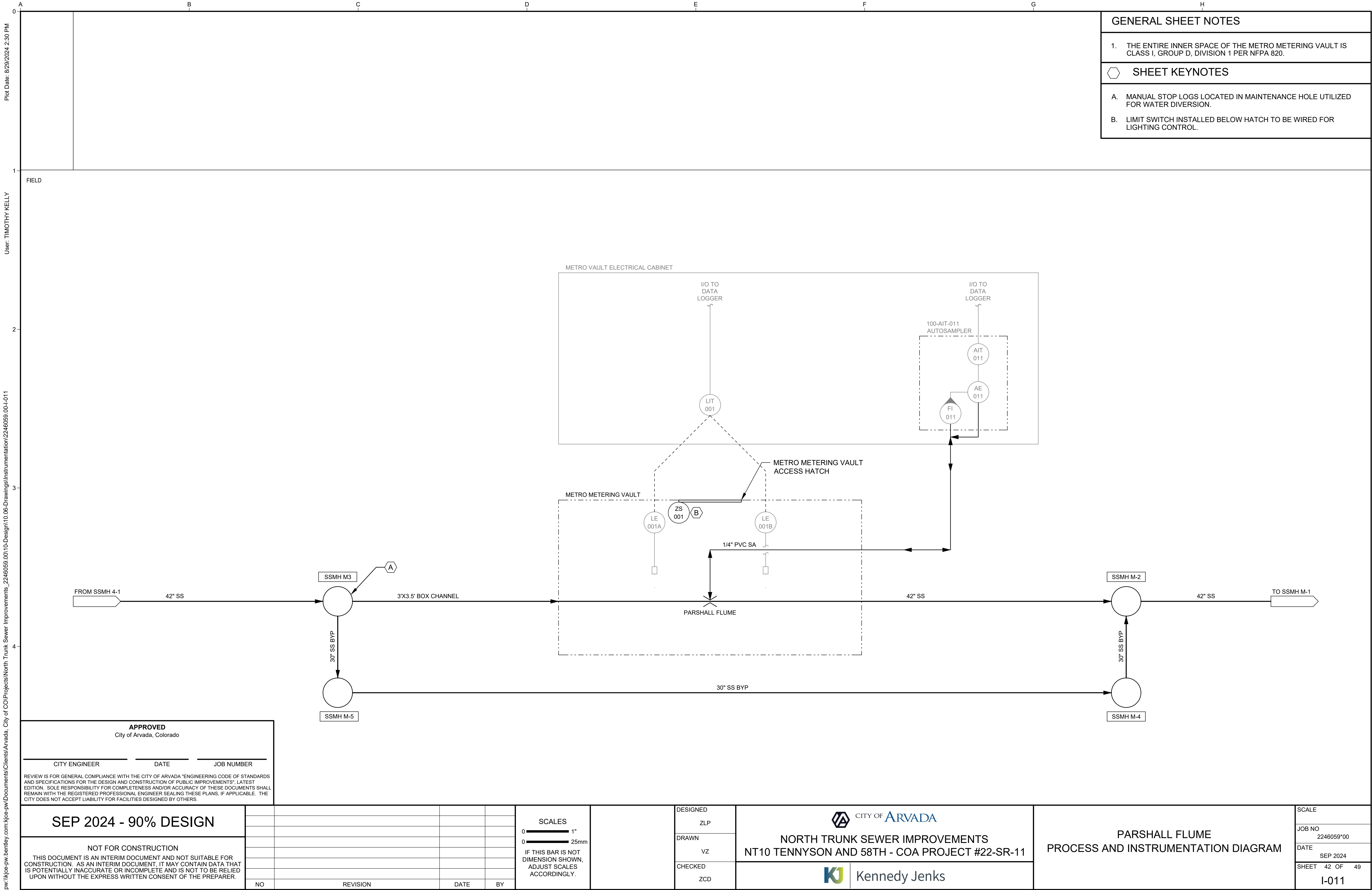
I-0001
SCALE: NTS
REV 00

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City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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SEP 2024 - 90% DESIGN								SCALES 01"25mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.		DESIGNED	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 KJ Kennedy Jenks	STANDARD DETAILS	SCALE	NTS
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									VZ	DATE			SEP 2024	
									CHECKED	SHEET			41 OF	49
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CITY OF ARVADA EROSION CONTROL NOTES

1.

AT ANYTIME THE CITY DETERMINES THE PROJECT TO BE OUT OF COMPLIANCE WITH EROSION AND SEDIMENT CONTROL/GOOD HOUSEKEEPING REQUIREMENTS, THEY HAVE THE AUTHORITY TO IMMEDIATELY STOP WORK ON THE PROJECT UNTIL THE DETERMINATION HAS BEEN MADE BY THE CITY STAFF THAT THE SITE HAS REGAINED COMPLIANCE WITH REQUIREMENTS.

2.

THE CONTRACTOR SHALL ENSURE STORMWATER QUALITY BEST MANAGEMENT PRACTICES SHALL BE IMPLEMENTED TO MINIMIZE SOIL EROSION, SEDIMENTATION, INCREASED POLLUTANT LOADS, AND CHANGED WATER FLOW CHARACTERISTICS RESULTING FROM LAND DISTURBING ACTIVITY TO THE MAXIMUM EXTENT PRACTICAL, SO AS TO MINIMIZE POLLUTION TO THE MS4 OR RECEIVING WATERS.

3.

CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REQUIRED STATE OR LOCAL PERMITS. STANDARD FEES FOR THE CITY PERMIT SHALL BE WAIVED BY THE CITY. THE CITY RESERVES THE RIGHT TO WITHHOLD RETAINAGE ON A PROJECT AS NECESSARY FOR PERFORMANCE OF MAINTENANCE ON BMP'S DUE TO CONTRACTOR'S FAILURE TO COMPLY OR PERFORM EROSION CONTROL MEASURES IN ACCORDANCE WITH THIS PLAN.

4.

AT A MINIMUM ALL BEST MANAGEMENT PRACTICES (BMP'S) AS GENERALLY OUTLINED IN STANDARD DRAWINGS, IN ACCORDANCE WITH THE CITY OF ARVADA SITE DEVELOPMENT PERMIT REQUIREMENTS AND IN ACCORDANCE WITH APPROVED INSTALLATION AND MAINTENANCE DETAILS, SHALL BE CORRECTLY INSTALLED AND FUNCTIONING AS DESIGNED AT ALL TIMES.

5.

CONTRACTOR SHALL DESIGNATE AN EROSION CONTROL REPRESENTATIVE AVAILABLE ON-CALL AT ALL TIMES. REPRESENTATIVE SHALL PERFORM ROUTINE AND POST-STORM INSPECTIONS OF ALL BMP'S PER CITY SITE DEVELOPMENT PERMIT REQUIREMENTS.

6.

ALL BMP'S IDENTIFIED BY THE CITY AS DEFICIENT SHALL BE MAINTAINED, REPAIRED, OR INSTALLED BY CONTRACTOR AS SOON AS POSSIBLE, IN MOST CASES IMMEDIATELY.

7.

CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION AND SEDIMENT CONTROL MEASURES AT ALL TIMES BEFORE, DURING AND AFTER LAND DISTURBING ACTIVITIES. SUCH MEASURES SHALL BE PLACED AS CONSTRUCTION SEQUENCING AND ACCESS DICTATES. CONTRACTOR SHALL REMOVE ALL SEDIMENT FROM EROSION CONTROL MEASURES AFTER EACH EROSION EVENT, AS NEEDED AND AT THE DIRECTION OF THE CITY.

8.

THE CITY MAY REQUEST THE MODIFICATION OF THE EROSION AND SEDIMENT CONTROLS AS FIELD CONDITIONS WARRANT.

9.

SEE ARVADA DETAILS FOR BMP INSTALLATION AND MAINTENANCE STANDARDS FOR THE FOLLOWING BMP'S: ROCK SOCKS, INLET PROTECTION, SILT FENCE, SEDIMENT CONTROL LOGS, CONCRETE WASHOUT AREA, EROSION CONTROL BLANKET, STABILIZED STAGING AREA AND VEHICLE TRACKING CONTROL. OTHER APPROVED BMP INSTALLATION/MAINTENANCE DETAILS CAN BE FOUND IN THE UDFCD VOLUME III CRITERIA MANUAL.

10.

SURFACE DRAINAGE PASSING THROUGH OR ORIGINATING FROM EACH SITE SHALL BE TREATED/CAPTURED BY ONE OR MORE BMP'S DEPENDENT ON AREA OF DISTURBANCE.

11.

SOIL STABILIZATION MEASURES SHALL BE IMPLEMENTED WITHIN 14 DAYS TO ALL DISTURBED AREAS THAT MAY OR MAY NOT BE AT FINAL GRADE BUT WILL REMAIN UNDISTURBED FOR PERIODS LONGER THAN 30 CALENDAR DAYS OR FOR AN INDETERMINATE LENGTH OF TIME.

12.

ALL TEMPORARY EROSION AND SEDIMENT CONTROL BMP'S MUST BE REMOVED UPON FINAL STABILIZATION.

13.

ALL CONSTRUCTION WASTES, FUEL, LUBRICANTS, CHEMICAL WASTES, TRASH OR DEBRIS SHALL BE CONTAINED WHEN STORED ON-SITE AND PROTECTED FROM CONTACT WITH RAIN/SNOWFALL OR SURFACE RUNOFF. PROPER DISPOSAL OF SUCH WASTES SHALL BE IMMEDIATE AND THE RESPONSIBILITY OF THE CONTRACTOR.

14.

ROUTINE VEHICLE MAINTENANCE SHALL NOT BE PERFORMED ON-SITE. IF EQUIPMENT MAINTENANCE/REPAIR BECOMES NECESSARY, APPROPRIATE BMP'S SHALL BE IMPLEMENTED SUCH AS DRIP PANS, SPILL MATERIALS, ETC. ON-SITE FUELING SHOULD BE PERFORMED BY DELIVERY VEHICLES WITH ADEQUATE SPILL PREVENTION AND RESPONSE CAPABILITY.

15.

CONCRETE WASHOUT ACTIVITIES MUST BE CONDUCTED IN A MANNER THAT DOES NOT CONTRIBUTE POLLUTANTS TO SURFACE WATERS OR STORMWATER RUNOFF. CONCRETE WASHOUT SHALL BE PERFORMED IN A DESIGNATED CONCRETE WASHOUT AREA OR OFF-SITE WASHOUT. PORTABLE UNITS ARE ACCEPTABLE WITH A MANUFACTURERS SPECIFICATION.

16.

CONTRACTOR IS RESPONSIBLE FOR CONTROLLING DUST EMISSIONS. A WATER TRUCK SHALL BE USED WITHIN TWENTY-FOUR (24) HOURS OF REQUEST BY CITY.

17.

CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL OF TRACKED MATERIALS ON STREETS, SIDEWALKS, DRIVEWAYS OR PARKING LOTS. TRACKED MATERIAL SHALL BE REMOVED IMMEDIATELY BY SCRAPING AND SWEEPING. FLUSHING MATERIALS FROM HARD SURFACE WITH WATER IS PROHIBITED. CONTRACTOR SHALL HAVE ACCESS TO MEANS OF MECHANICAL SWEEPING AT ALL TIMES.

18.

AREAS TO BE RESEEDD AT THE COMPLETION OF UTILITY INSTALLATION OR GRADING ACTIVITIES SHALL BE IN ACCORDANCE WITH UDFCD VOL III SEED/MULCH SPECIFICATIONS.

19.

NECESSARY EROSION CONTROL MEASURES MUST REMAIN IN PLACE AND FUNCTIONING AS DESIGNED UNTIL A VIABLE VEGETATIVE COVER HAS BEEN ESTABLISHED OR ROAD RESURFACED.

20.

IN HIGH TRAFFIC AREAS WHERE LANE CLOSURES ARE OPENED AT THE END OF THE WORK DAY, BMP'S MAY BE REMOVED AT THE END OF THE DAY AND REINSTALLED AT THE BEGINNING OF THE NEXT WORK DAY PROVIDED ALL DIRT AND MATERIALS ARE REMOVED FROM THE AREA AND AT THE DISCRETION OF THE CITY OF ARVADA INSPECTOR.

APPROVED

City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

ADAMS COUNTY EROSION CONTROL NOTES

GENERAL:

1.

ALL CONSTRUCTION PROJECTS, REGARDLESS OF THE SIZE, SHALL INSTALL, MAINTAIN AND REPAIR STORMWATER POLLUTION CONTROL MEASURES (CM'S) TO EFFECTIVELY MINIMIZE EROSION, SEDIMENT TRANSPORT, AND THE RELEASE OF POLLUTANTS RELATED TO CONSTRUCTION ACTIVITY. CM'S EXAMPLE INCLUDE: SEDIMENT CONTROL LOGS (SCL), SILT FENCE (SF), DIKES/SWALES, SEDIMENT TRAPS (ST), INLET PROTECTION (IP), OUTLET PROTECTION (OP), CHECK DAMS (CD), SEDIMENT BASINS (SB), TEMPORARY/PERMANENT SEEDING AND MULCHING (MU), SOIL ROUGHENING, MAINTAINING EXISTING VEGETATION AND PROTECTION OF TREES. CM'S MUST BE SELECTED, DESIGNED, ADEQUATELY SIZED, INSTALLED AND MAINTAINED IN ACCORDANCE WITH GOOD ENGINEERING, HYDROLOGIC AND POLLUTION CONTROL PRACTICES. CM'S/BMP'S INSTALLATION AND MAINTENANCE DETAILS SHALL CONFORM TO URBAN DRAINAGE FLOOD CONTROL CRITERIA MANUAL VOLUME 3, OR THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) ITEM CODE BOOK. CM'S MUST FILTER, SETTLE, CONTAIN OR STRAIN POLLUTANTS FROM STORMWATER FLOWS IN ORDER TO PREVENT BYPASS OF FLOWS WITHOUT TREATMENT. CM'S MUST BE APPROPRIATE TO TREAT THE RUNOFF FROM THE AMOUNT OF DISTURBED AREA, THE EXPECTED FLOW RATE, DURATION, AND FLOW CONDITIONS (I.E. SHEET OR CONCENTRATED FLOW). CM'S/BMP'S SHALL BE SPECIFIED IN THE SWMP (IF APPLICABLE), AND THE LOCATIONS SHOWN ON THE EC PLAN.

1)

PRIOR TO CONSTRUCTION, PROJECTS DISTURBING 1 OR MORE ACRES OF LAND, OR ANY PROJECT BELONGING TO A COMMON PLAN OF DEVELOPMENT DISTURB 1 OR MORE ACRES, MUST OBTAIN:

- A GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES, FROM THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, AND
- AN ADAMS COUNTY STORMWATER QUALITY PERMIT WITHIN THE UNINCORPORATED ADAMS COUNTY MS4 AREA.

2)

PERMITTED PROJECTS SHALL DEVELOP A STORMWATER MANAGEMENT PLAN (SWMP), AKA EROSION AND SEDIMENT CONTROL PLAN (ESCP), IN COMPLIANCE WITH CDPHE MINIMUM REQUIREMENTS. THE APPROVED SWMP, INCLUDING EROSION CONTROL (EC) PLAN (SITE MAP), SHALL BE KEPT ON-SITE AND UPDATED AT ALL TIMES. THE QUALIFIED STORMWATER MANAGER IS RESPONSIBLE FOR IMPLEMENTING THE SWMP AND CM's (AKA BMP's) DURING CONSTRUCTION.

3)

PERMITTED PROJECTS SHALL PERFORM REGULAR STORMWATER INSPECTIONS EVERY 7 CALENDAR DAYS, OR EVERY 14 CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY PRECIPITATION OR SNOWMELT EVENT THAT CAUSES SURFACE EROSION. INSPECTION FREQUENCY CAN BE REDUCED FOR POST-STORM EVENT INSPECTIONS AT TEMPORARILY IDLE SITES AND ALSO FOR STORMWATER INSPECTIONS AT COMPLETED SITES WAITING FOR FINAL STABILIZATION. INSPECTION REPORTS MUST IDENTIFY ANY INCIDENTS OF NON-COMPLIANCE.

4)

TRACKING OF DIRT ONTO PAVED PUBLIC OR PRIVATE PAVED ROADS IS NOT ALLOWED. THE USE OF DIRT RAMPS TO ENTER/EXIT FROM AN UNPAVED INTO A PAVED AREA IS PROHIBITED. VEHICLE TRACKING CONTROLS SHALL BE IMPLEMENTED, OTHERWISE ENTRANCE AREA MUST DRAIN THRU A CM TOWARDS THE PRIVATE SITE.

5)

TRUCK LOADS OF FILL MATERIAL IMPORTED TO OR CUT MATERIAL EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORTATION ON PUBLIC RW. HAUL ROUTES MUST BE PERMITTED BY THE COUNTY. NO MATERIAL SHALL BE TRANSPORTED TO ANOTHER SITE WITHOUT APPLICABLE PERMITS.

6)

CONTROL MEASURES DESIGNED FOR CONCRETE WASHOUT WASTE MUST BE IMPLEMENTED. THIS INCLUDES WASHOUT WASTE DISCHARGED TO THE GROUND AND WASHOUT WASTE FROM CONCRETE TRUCKS AND MASONRY OPERATIONS.

7)

TEMPORARY CM'S/BMP'S SHALL BE REMOVED AFTER THE SITE HAS REACHED FINAL STABILIZATION.

8)

DEWATERING OPERATIONS DISCHARGING OFF-SITE INTO ANY WATERS CONVEYANCE SYSTEMS INCLUDING WETLANDS, IRRIGATION DITCHES, CANALS, RIVERS, STREAMS, OR STORM SEWER SYSTEMS, REQUIRE A STATE CONSTRUCTION DEWATERING PERMIT.

9)

PERMITTED PROJECTS SHALL KEEP THE CDPHE'S STORMWATER DISCHARGE PERMIT, STORMWATER MANAGEMENT PLAN (SWMP) AND INSPECTION LOGS AVAILABLE ON-SITE THROUGHOUT THE DURATION OF THE PROJECT, AND FOR AN ADDITIONAL 3 YEARS AFTER PERMIT CLOSE-OUT.

10)

PERMITTED LANDOWNER AND/OR CONTRACTOR SHALL CLOSE THE STATE AND CITY/COUNTY PERMIT ONCE FINAL STABILIZATION IS REACHED. STORMWATER INSPECTIONS SHALL CONTINUE UNTIL INACTIVATION NOTICE IS FILED WITH CDPHE.

ADAMS COUNTY EROSION CONTROL NOTES (CONT)

PERFORMANCE STANDARD:

1.

STORMWATER RUNOFF FROM DISTURBED AREAS MUST FLOW TO AT LEAST ONE (1) CM TO MINIMIZE SEDIMENT IN THE DISCHARGE. DO NOT ALLOW SEDIMENT TO LEAVE THE SITE. THE BEST WAY TO PREVENT SEDIMENT OR POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM IS TO STABILIZE THE SITE AS QUICKLY AS POSSIBLE, PREVENTING EROSION AND STOPPING SEDIMENT RUN-OFF AT ITS SOURCE.

2.

PHASE CONSTRUCTION TO MINIMIZE DISTURBED AREAS, INCLUDING DISTURBANCE OF STEEP SLOPES (I.E. THE ENTIRE PROJECT SITE SHOULD NOT BE DISTURBED IF CONSTRUCTION WILL ONLY BE OCCURRING IN ONE PARTICULAR SECTION OF THE SITE). LIMIT SOIL EXPOSURE TO THE SHORTEST POSSIBLE PERIOD OF TIME. PROTECT NATURAL FEATURES AND EXISTING VEGETATION WHENEVER POSSIBLE. REMOVAL OF EXISTING VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATIONS. MAINTAIN PRE-EXISTING VEGETATION (OR EQUIVALENT CM'S) FOR AREAS WITHIN 50 HORIZONTAL FEET OF RECEIVING WATERS.

3.

SOIL COMPACTION MUST BE MINIMIZED FOR AREAS WHERE INFILTRATION CM'S WILL OCCUR OR WHERE FINAL STABILIZATION WILL BE ACHIEVED THROUGH A VEGETATIVE COVER.

4.

ALL SOIL IMPORTED TO OR EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT THE LOSS OF MATERIAL DURING TRANSPORT.

5.

DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES OR WIND SHALL BE CONTROLLED.

6.

INSTALL CONSTRUCTION FENCE (ORANGE) TO PROTECT WETLANDS AND OTHER SENSITIVE AREAS AND THE PREVENT ACCESS, AND TO DELINEATE THE LIMITS OF CONSTRUCTION. DO NOT USE SILT FENCE TO PROTECT WETLANDS SINCE TRENCHING MAY IMPACT THESE AREAS.

7.

CM'S INTENDED TO CAPTURE OVERLAND, LOW VELOCITY SHEET FLOW AT A FAIRLY LEVEL GRADE SHALL ONLY BE INSTALLED ALONG CONTOURS.

8.

INSTALL CM'S, SUCH AS CHECK DAMS, PERPENDICULAR TO THE CONCENTRATED FLOWS TO REDUCE FLOW VELOCITY.

9.

STORM DRAIN INLETS WITHIN AND ADJACENT TO THE CONSTRUCTION SITE MUST BE PROTECTED. ANY PONDING OF STORMWATER AROUND INLET PROTECTION MUST NOT CAUSE EXCESSIVE FLOODING OR DAMAGE ADJACENT AREAS OR STRUCTURES.

10.

INSTALL VEHICLE TRACKING CONTROL (VTC) TO ENTER/EXIT UNPAVED AREA. DO NOT USE RECYCLED CRUSHED CONCRETE OR ASPHALT MILLINGS FOR VEHICLE TRACKING PADS.

11.

STRAW BALES SHALL NOT BE USED FOR PRIMARY EROSION OR SEDIMENT CONTROL (I.E. STRAW BALES MAY BE USED FOR REINFORCEMENT BEHIND ANOTHER BMP SUCH AS A SILT FENCE.

12.

OUTLETS SYSTEMS (SUCH AS SKIMMER OR PERFORATED RISER PIPE) SHALL BE INSTALLED TO WITHDRAW WATER FROM OR NEAR THE SURFACE LEVEL WHEN DISCHARGING FROM BASINS. WATER CANNOT DRAIN FROM THE BOTTOM OF THE POND.

13.

TEMPORARY STABILIZATION MUST BE IMPLEMENTED FOR EARTH DISTURBING ACTIVITIES ON ANY PORTION OF THE SITE WHERE LAND DISTURBING ACTIVITIES HAVE PERMANENTLY OR TEMPORARILY CEASED (FOR MORE THAN 14 CALENDAR DAYS). TEMPORARY STABILIZATION METHODS EXAMPLES: TARPS, SOIL TACKIFIER, AND HYDROSEED. TEMPORARY STABILIZATION REQUIREMENT MAY EXCEED THE 14-DAY SCHEDULE WHEN EITHER THE FUNCTION OF THE SPECIFIC AREA REQUIRES IT TO REMAIN DISTURBED, OR PHYSICAL CHARACTERISTICS OF THE TERRAIN AND CLIMATE PREVENT STABILIZATION AS LONG AS THE CONSTRAINTS AND ALTERNATIVE SCHEDULE IS DOCUMENTED ON THE SWMP, AND LOCATIONS ARE IDENTIFIED ON THE EC PLAN (SITE MAP).

14.

RUNOFF FROM STOCKPILE AREA MUST BE CONTROLLED. SOILS THAT WILL BE STOCKPILED FOR MORE THAN 30 DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION. INSTALL CM'S/BMP'S 5 FEET AWAY FROM THE TOE OF THE STOCKPILE'S SLOPE.

15.

WATER USED TO CLEAN CONCRETE TRUCKS SHALL BE DISCHARGED INTO A CONCRETE WASHOUT AREA (CWA). THE PREDEFINED CONTAINMENT AREA MUST BE IDENTIFIED WITH A SIGN, AND SHALL ALLOW THE LIQUIDS TO EVAPORATE OR DRY OUT. CWA DISCHARGES THAT MAY REACH GROUNDWATER MUST FLOW THROUGH SOIL THAT HAS BUFFERING CAPACITY PRIOR TO REACHING GROUNDWATER. THE CONCRETE WASHOUT LOCATION SHALL NOT BE LOCATED IN AN AREA WHERE SHALLOW GROUNDWATER MAY BE PRESENT AND WOULD RESULT IN BUFFERING CAPACITY NOT BEING ADEQUATE, SUCH AS NEAR NATURAL DRAINAGES, SPRINGS, OR WETLANDS. IN THIS CASE, A LINER UNDERNEATH IS NEEDED FOR AREAS WITH HIGH GROUNDWATER LEVELS. CWA SHALL NOT BE PLACED IN LOW AREAS, DITCHES OR ADJACENT TO STATE WATERS. PLACE CWA 50 FEET AWAY FROM STATE WATERS.

16.

WASTE, SUCH AS BUILDING MATERIALS, WORKERS TRASH AND CONSTRUCTION DEBRIS, MUST BE PROPERLY MANAGED TO PREVENT STORMWATER POLLUTION.

17.

INSTALL STABILIZED STAGING AREAS (SSA) TO STORE MATERIALS, CONSTRUCTION TRAILER, ETC.

18.

IF CONDITIONS IN THE FIELD WARRANT ADDITIONAL CM'S/BMP'S TO THE ONES ORIGINALLY APPROVED ON THE SWMP OR EC PLAN (CIVIL DRAWING), THE LANDOWNER OR CONTRACTOR SHALL IMPLEMENT MEASURES DETERMINED NECESSARY, AS DIRECTED BY THE COUNTY.

19.

PERMANENT CM'S/BMP'S FOR SLOPES, CHANNELS, DITCHES, OR DISTURBED LAND AREA SHALL BE PERFORMED IMMEDIATELY AFTER FINAL GRADING. CONSIDER THE USE OF EROSION CONTROL BLANKETS ON SLOPES 3:1 OR STEEPER AND AREAS WITH CONCENTRATED FLOWS SUCH AS SWALES, LONG CHANNELS AND ROADSIDE DITCHES.

20.

THE DISCHARGE OF SANITARY WASTE INTO THE STORM SEWER SYSTEM IS PROHIBITED. PORTABLE TOILETS MUST BE PROVIDED, SECURED AND PLACED ON PERMEABLE SURFACES, AWAY FROM THE CURBSIDE, STORM INLETS AND/OR DRAINAGE WAYS.

21.

REMOVE TEMPORARY CM'S/BMP'S ONCE FINAL STABILIZATION IS REACHED, UNLESS OTHERWISE AUTHORIZED.

22.

FINAL STABILIZATION MUST BE IMPLEMENTED. FINAL STABILIZATION IS REACHED WHEN ALL SOIL DISTURBING ACTIVITIES HAVE BEEN COMPLETED, AND EITHER A UNIFORM VEGETATIVE COVER HAS BEEN ESTABLISHED WITH AN INDIVIDUAL PLANT DENSITY OF AT LEAST 70% OF PRE-DISTURBED LEVELS, OR EQUIVALENT PERMANENT ALTERNATIVE METHOD HAS BEEN IMPLEMENTED.

ADAMS COUNTY EROSION CONTROL NOTES (CONT)

PERFORMANCE STANDARD (CONT):

23.

PROVIDE SPILL PROTECTION AND CONTAINMENT MEASURES FOR CONSTRUCTION MATERIALS, WASTE AND FUEL STORAGE AREAS. BULK STORAGE (55 GALLONS OR GREATER) OF PETROLEUM PRODUCTS AND LIQUID CHEMICALS MUST HAVE SECONDARY CONTAINMENT, OR EQUIVALENT PROTECTION, IN ORDER TO CONTAIN SPILLS AND TO PREVENT SPILLED MATERIAL FROM ENTERING STATE WATERS.

24.

REPORT SPILLS OR RELEASES OF CHEMICAL, OIL, PETROLEUM PRODUCT, SEWAGE, ETC., WHICH MAY REACH THE STORM SEWER OR ENTER STATE WATERS WITHIN 24-HOURS FROM TIME OF DISCOVERY. GUIDANCE AVAILABLE AT WWW.CDPHE.STATE.CO.US/EMP/SPILLSANDRELEASED.HTML; STATE OF COLORADO SPILL-LINE: 877-518-5608; ADAMS COUNTY STORMWATER HOTLINE: 720-523-6400; PUBLIC WORKS: 303-453-8787; AND THE TRI-COUNTY HEALTH DEPARTMENT AT 303-220-9200.

MAINTENANCE STANDARD:

1.

MAINTAIN AND REPAIR CM'S ACCORDING TO APPROVED EROSION CONTROL PLAN (CIVIL DRAWING) TO ASSURE THEY CONTINUE PERFORMING AS ORIGINALLY INTENDED.

2.

CM'S/BMP'S REQUIRING MAINTENANCE OR ADJUSTMENT SHALL BE REPAIRED IMMEDIATELY AFTER OBSERVATION OF THE FAILING BMP.

3.

CM'S SHALL BE CLEANED WHEN SEDIMENT LEVELS ACCUMULATE TO HALF THE DESIGN UNLESS OTHERWISE SPECIFIED.

4.

SWMP AND EC PLAN SHALL BE CONTINUOUSLY UPDATED TO REFLECT NEW OR REVISED CM'S/BMP'S DUE TO CHANGES IN DESIGN, CONSTRUCTION, OPERATION, OR MAINTENANCE, TO ACCURATELY REFLECT THE ACTUAL FIELD CONDITIONS. A NOTATION SHALL BE MADE IN THE SWMP, INCLUDING DATE OF CHANGES IN THE FIELD, IDENTIFICATION OF THE CM'S REMOVED, MODIFIED OR ADDED, AND THE LOCATIONS OF THOSE CM's. UPDATES MUST BE MADE WITHIN 72-HOURS FOLLOWING THE CHANGE.

5.

MAINTAIN VEHICLE TRACKING CONTROL (VTC), IF SEDIMENT TRACKING OCCURS, CLEAN-UP IMMEDIATELY. SWEEP BY HAND OR USE STREET SWEEPERS (WITH VACUUM SYSTEM). FLUSHING OFF PAVED SURFACES WITH WATER IS PROHIBITED.

6.

CWA MUST BE CLEANED ONCE WASTE ACCUMULATION REACHES 2/3 OF THE WET STORAGE CAPACITY OF THE STRUCTURE. LEGALLY DISPOSE OF CONCRETE WASTE. DO NOT BURY ON-SITE.

7.

CLEAN-UP SPILLS IMMEDIATELY AFTER DISCOVERY, OR CONTAIN UNTIL APPROPRIATE CLEANUP METHODS CAN BE EMPLOYED. FOLLOW MANUFACTURER'S RECOMMENDED METHODS FOR SPILL CLEANUP, ALONG WITH PROPER DISPOSAL METHODS. RECORDS OF SPILLS, LEAKS, OR OVERFLOWS THAT RESULT IN DISCHARGE OF POLLUTANTS MUST BE DOCUMENTED AND MAINTAINED.

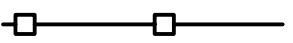
8.

REMOVE SEDIMENT FROM STORM SEWER INFRASTRUCTURE (PONDS, STORM PIPES, OUTLETS, INLETS, ROADSIDE DITCHES, ETC.), AND RESTORE VOLUME CAPACITY UPON COMPLETION OF PROJECT OR PRIOR TO INITIAL ACCEPTANCE OF PUBLIC IMPROVEMENTS (IF APPLICABLE). DO NOT FLUSH SEDIMENT OFF-SITE, CAPTURE ON-SITE AND DISPOSE OF AT AN APPROVED LOCATION.

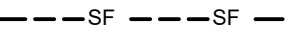
THESE NOTES ARE NOT INTENDED TO BE ALL-INCLUSIVE, BUT TO HIGHLIGHT THE BASIC STORMWATER POLLUTION PREVENTION REQUIREMENTS FOR CONSTRUCTION ACTIVITIES TO COMPLY WITH CDP'S STORMWATER CONSTRUCTION PERMIT AND BE IN CONFORMANCE WITH COUNTY STANDARDS.

LEGEND

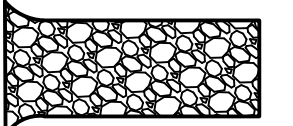
CONSTRUCTION FENCE

 (CF)

SILT FENCE

 (SF)

VEHICLE TRACKING CONTROL

 (VTC)

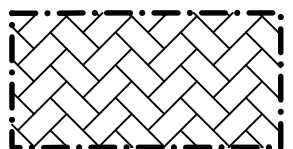
LIMITS OF CONSTRUCTION

 (LOC)

EROSION CONTROL BLANKET

 (ECB)

STABILIZED STAGING AREA*

 (SSA)

SEDIMENT CONTROL LOG

 (SCL)

INLET PROTECTION

 (IP)

CURB SOCK

 (CS)

CONCRETE WASHOUT

 (CWA)

DRAINAGE FLOW DIRECTION



* STABILIZED STAGING AREA LOCATIONS TO BE DETERMINED BY THE CONTRACTOR AND APPROVED BY THE PARCEL OWNER AND CITY PRIOR TO MOBILIZATION.

SEP 2024 - 90% DESIGN

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NO

REVISION

DATE

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 CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

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NTS

JOB NO

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DATE

SEP 2024

SHEET

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EROSION CONTROL NOTES

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SC-5

Rock Sock (RS)

Rock Sock (RS)

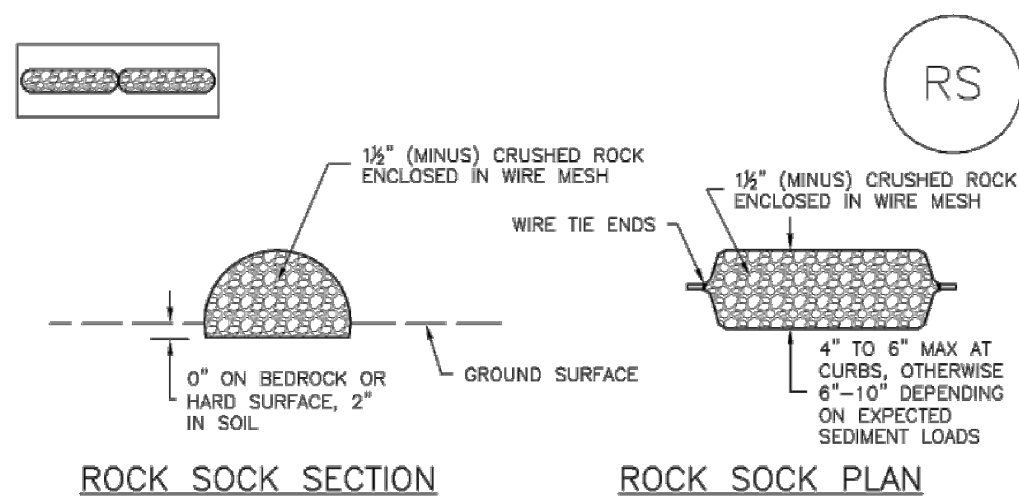
SC-5

Concrete Washout Area (CWA)

MM-1

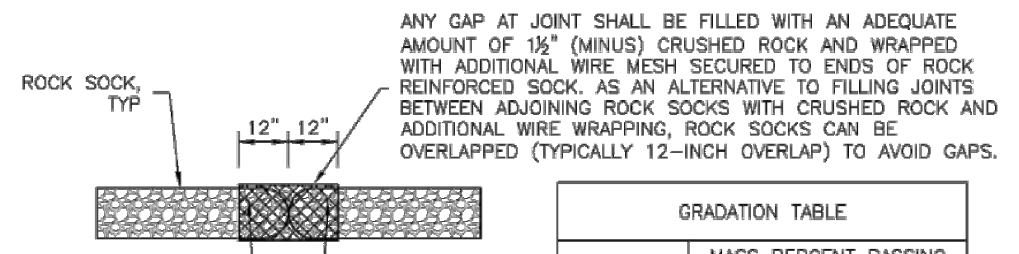
MM-1

Concrete Washout Area (CWA)



ROCK SOCK SECTION

ROCK SOCK PLAN



ROCK SOCK JOINTING

ROCK SOCK INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-LOCATION(S) OF ROCK SOCKS.
- CRUSHED ROCK SHALL BE 1/2" (MINUS) IN SIZE WITH A FRACTURED FACE (ALL SIDES) AND SHALL COMPLY WITH GRADATION SHOWN ON THIS SHEET (1/2" MINUS).
- WIRE MESH SHALL BE FABRICATED OF 10 GAGE POULTRY MESH, OR EQUIVALENT, WITH A MAXIMUM OPENING OF 1/4", RECOMMENDED MINIMUM ROLL WIDTH OF 48"
- WIRE MESH SHALL BE SECURED USING "HOG RINGS" OR WIRE TIES AT 6" CENTERS ALONG ALL JOINTS AND AT 2" CENTERS ON ENDS OF SOCKS.
- SOME MUNICIPALITIES MAY ALLOW THE USE OF FILTER FABRIC AS AN ALTERNATIVE TO WIRE MESH FOR THE ROCK ENCLOSURE.

RS-1. ROCK SOCK PERIMETER CONTROL

GRADATION TABLE	
SIEVE SIZE	MASS PERCENT PASSING SQUARE MESH SIEVES
NO. 4	
2"	100
1 1/2"	90 - 100
1"	20 - 55
3/4"	0 - 15
3/8"	0 - 5

MATCHES SPECIFICATIONS FOR NO. 4 COARSE AGGREGATE FOR CONCRETE PER AASHTO M4.3. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES.

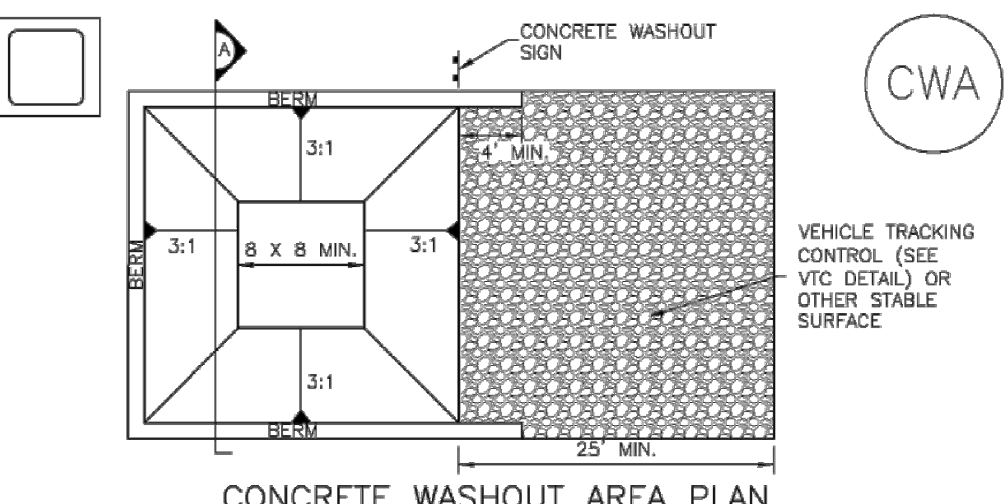
ROCK SOCK MAINTENANCE NOTES

- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
- FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
- WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
- ROCK SOCKS SHALL BE REPLACED IF THEY BECOME HEAVILY SOILED, OR DAMAGED BEYOND REPAIR.
- SEDIMENT ACCUMULATED UPSTREAM OF ROCK SOCKS SHALL BE REMOVED AS NEEDED TO MAINTAIN FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY 1/2 OF THE HEIGHT OF THE ROCK SOCK.
- ROCK SOCKS ARE TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND APPROVED BY THE LOCAL JURISDICTION.
- WHEN ROCK SOCKS ARE REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED AS APPROVED BY LOCAL JURISDICTION.

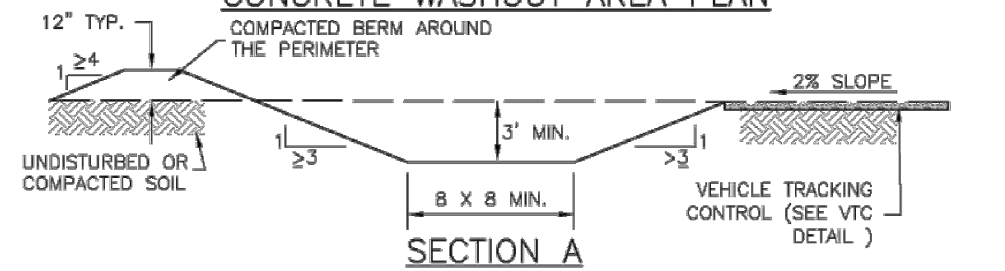
(DETAIL ADAPTED FROM TOWN OF PARKER, COLORADO AND CITY OF AURORA, COLORADO, NOT AVAILABLE IN AUTOCAD)

NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

NOTE: THE DETAILS INCLUDED WITH THIS FACT SHEET SHOW COMMONLY USED, CONVENTIONAL METHODS OF ROCK SOCK INSTALLATION IN THE DENVER METROPOLITAN AREA. THERE ARE MANY OTHER SIMILAR PROPRIETARY PRODUCTS ON THE MARKET. UDFCD NEITHER INDORSES NOR DISCOURAGES USE OF PROPRIETARY PROTECTION PRODUCTS; HOWEVER, IN THE EVENT PROPRIETARY METHODS ARE USED, THE APPROPRIATE DETAIL FROM THE MANUFACTURER MUST BE INCLUDED IN THE SWMP AND THE BMP MUST BE INSTALLED AND MAINTAINED AS SHOWN IN THE MANUFACTURER'S DETAILS.



CONCRETE WASHOUT AREA PLAN



CWA-1. CONCRETE WASHOUT AREA

CWA INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-CWA INSTALLATION LOCATION.
- DO NOT LOCATE AN UNLINED CWA WITHIN 400' OF ANY NATURAL DRAINAGE PATHWAY OR WATERBODY. DO NOT LOCATE WITHIN 1,000' OF ANY WELLS OR DRINKING WATER SOURCES. IF SITE CONSTRAINTS MAKE THIS INFEASIBLE, OR IF HIGHLY PERMEABLE SOILS EXIST ON SITE, THE CWA MUST BE INSTALLED WITH AN IMPERMEABLE LINER (18 MIL MIN. THICKNESS) OR SURFACE STORAGE ALTERNATIVES USING PREFABRICATED CONCRETE WASHOUT DEVICES OR A LINED ABOVE GROUND STORAGE ARE SHOULD BE USED.
- THE CWA SHALL BE INSTALLED PRIOR TO CONCRETE PLACEMENT ON SITE.
- CWA SHALL INCLUDE A FLAT SUBSURFACE PIT THAT IS AT LEAST 8' BY 8' SLOPES LEADING OUT OF THE SUBSURFACE PIT SHALL BE 3:1 OR FLATTER. THE PIT SHALL BE AT LEAST 3' DEEP.
- BERM SURROUNDING SIDES AND BACK OF THE CWA SHALL HAVE MINIMUM HEIGHT OF 1'.
- VEHICLE TRACKING PAD SHALL BE SLOPED 2% TOWARDS THE CWA.
- SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE CWA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CWA TO OPERATORS OF CONCRETE TRUCKS AND PUMP TRUCKS.
- USE EXCAVATED MATERIAL FOR PERIMETER BERM CONSTRUCTION.

CONCRETE WASHOUT AREA

RS-2

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RS-3

Silt Fence (SF)

SC-1

SC-1

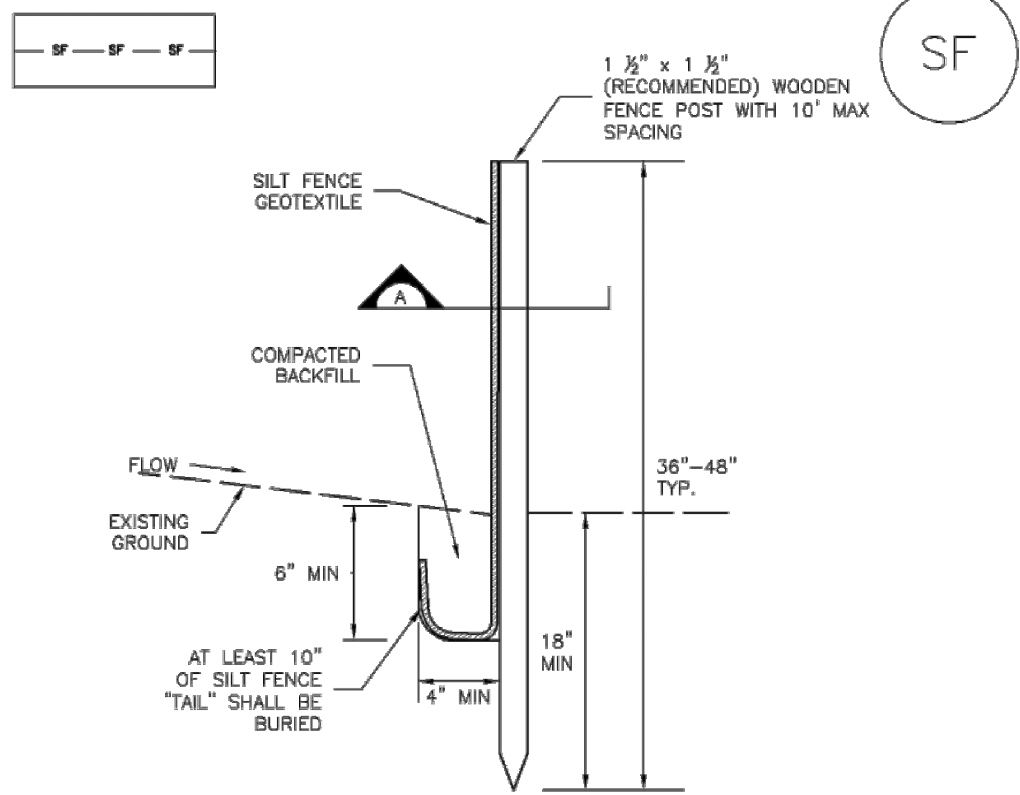
Silt Fence (SF)

Stabilized Staging Area (SSA)

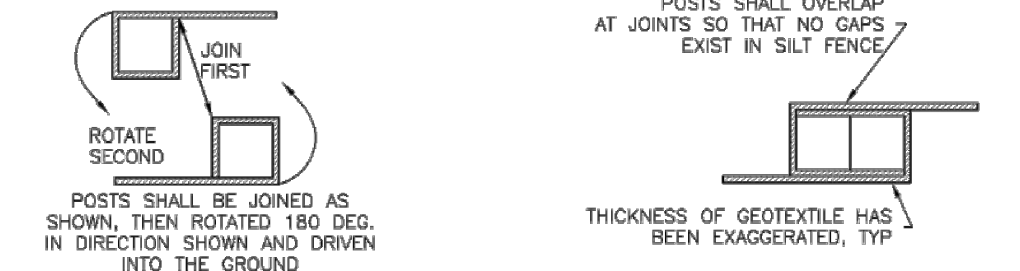
SM-6

SM-6

Stabilized Staging Area (SSA)



SILT FENCE



SECTION A

SF-1. SILT FENCE

SILT FENCE INSTALLATION NOTES

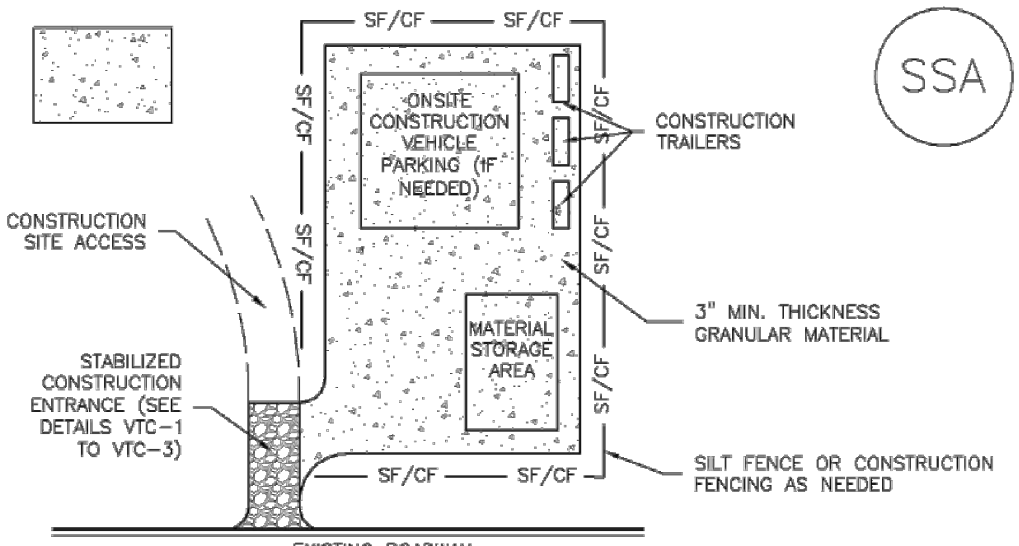
- SILT FENCE MUST BE PLACED AWAY FROM THE TOE OF THE SLOPE TO ALLOW FOR WATER PONDING. SILT FENCE AT THE TOE OF A SLOPE SHOULD BE INSTALLED IN A FLAT LOCATION AT LEAST SEVERAL FEET (2-5 FT) FROM THE TOE OF THE SLOPE TO ALLOW ROOM FOR PONDING AND DEPOSITION.
- A UNIFORM 6" X 4" ANCHOR TRENCH SHALL BE EXCAVATED USING TRENCHER OR SILT FENCE INSTALLATION DEVICE. NO ROAD GRADERS, BACKHOES, OR SIMILAR EQUIPMENT SHALL BE USED.
- COMPACT ANCHOR TRENCH BY HAND WITH A "JUMPING JACK" OR BY WHEEL ROLLING. COMPACTION SHALL BE SUCH THAT SILT FENCE RESISTS BEING PULLED OUT OF ANCHOR TRENCH BY HAND.
- SILT FENCE SHALL BE PULLED TIGHT AS IT IS ANCHORED TO THE STAKES. THERE SHOULD BE NO NOTICEABLE SAG BETWEEN STAKES AFTER IT HAS BEEN ANCHORED TO THE STAKES.
- SILT FENCE FABRIC SHALL BE ANCHORED TO THE STAKES USING 1" HEAVY DUTY STAPLES OR NAILS WITH 1" HEADS. STAPLES AND NAILS SHOULD BE PLACED 3" ALONG THE FABRIC DOWN THE STAKE.
- AT THE END OF A RUN OF SILT FENCE ALONG A CONTOUR, THE SILT FENCE SHOULD BE TURNED PERPENDICULAR TO THE CONTOUR TO CREATE A "U-HOOK". THE "U-HOOK" EXTENDING PERPENDICULAR TO THE CONTOUR SHOULD BE OF SUFFICIENT LENGTH TO KEEP RUNOFF FROM FLOWING AROUND THE END OF THE SILT FENCE (TYPICALLY 10' - 20').
- SILT FENCE SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.

SILT FENCE MAINTENANCE NOTES

- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
- FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
- WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
- SEDIMENT ACCUMULATED UPSTREAM OF THE SILT FENCE SHALL BE REMOVED AS NEEDED TO MAINTAIN THE FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY 6".
- REPAIR OR REPLACE SILT FENCE WHEN THERE ARE SIGNS OF WEAR, SUCH AS SAGGING, TEARING, OR COLLAPSE.
- SILT FENCE IS TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND APPROVED BY THE LOCAL JURISDICTION, OR IS REPLACED BY AN EQUIVALENT PERIMETER SEDIMENT CONTROL BMP.
- WHEN SILT FENCE IS REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED AS APPROVED BY LOCAL JURISDICTION.

(DETAIL ADAPTED FROM TOWN OF PARKER, COLORADO AND CITY OF AURORA, NOT AVAILABLE IN AUTOCAD)

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SSA-1. STABILIZED STAGING AREA

STABILIZED STAGING AREA INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-LOCATION OF STAGING AREA(S).
-CONTRACTOR MAY ADJUST LOCATION AND SIZE OF STAGING AREA WITH APPROVAL FROM THE LOCAL JURISDICTION.
- STABILIZED STAGING AREA SHOULD BE APPROPRIATE FOR THE NEEDS OF THE SITE. OVERSIZING RESULTS IN A LARGER AREA TO STABILIZE FOLLOWING CONSTRUCTION.
- STAGING AREA SHALL BE STABILIZED PRIOR TO OTHER OPERATIONS ON THE SITE.
- THE STABILIZED STAGING AREA SHALL CONSIST OF A MINIMUM 3" THICK GRANULAR MATERIAL.
- UNLESS OTHERWISE SPECIFIED BY LOCAL JURISDICTION, ROCK SHALL CONSIST OF DOT SECT. #703, AASHTO #3 COARSE AGGREGATE OR 6" (MINUS) ROCK.
- ADDITIONAL PERIMETER BMPs MAY BE REQUIRED INCLUDING BUT NOT LIMITED TO SILT FENCE AND CONSTRUCTION FENCING.

STABILIZED STAGING AREA MAINTENANCE NOTES

- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
- FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
- WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
- ROCK SHALL BE REAPPLIED OR REGRADED AS NECESSARY IF RUTTING OCCURS OR UNDERLYING SUBGRADE BECOMES EXPOSED.

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

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Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

SF-3

SF-4

Urban Drainage and Flood Control District
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SSA-3

SSA-4

Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

November 2010

SILT FENCE

STABILIZED STAGING AREA

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

EROSION AND SEDIMENT
CONTROL DETAILS - I

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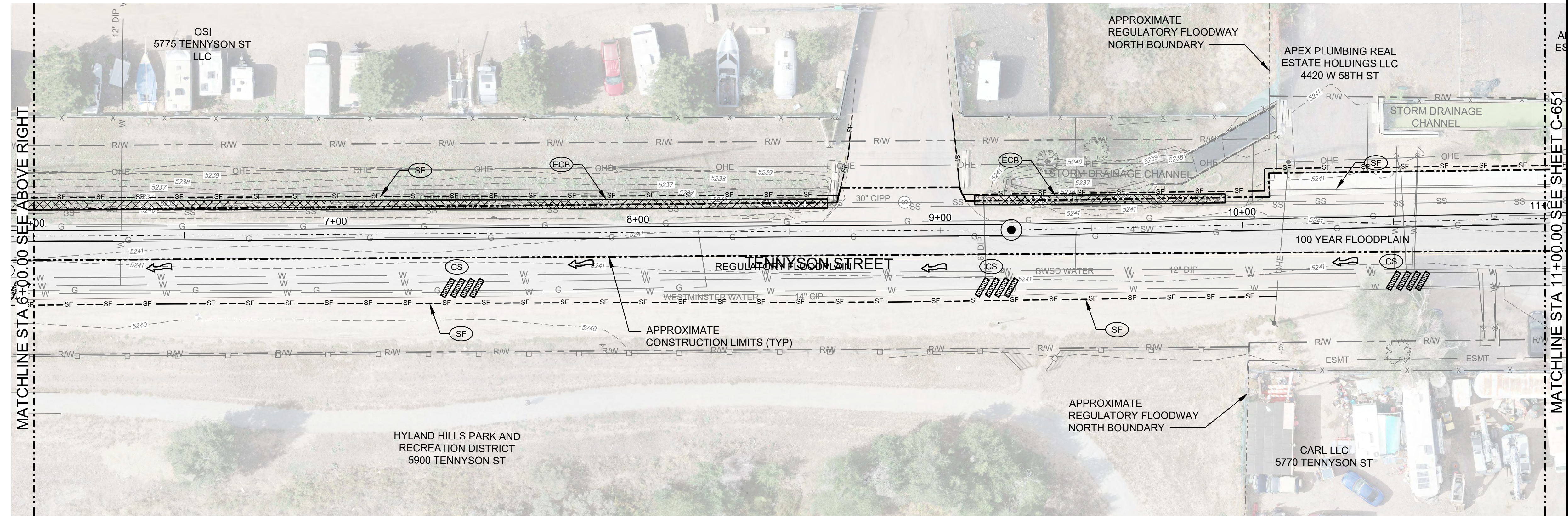
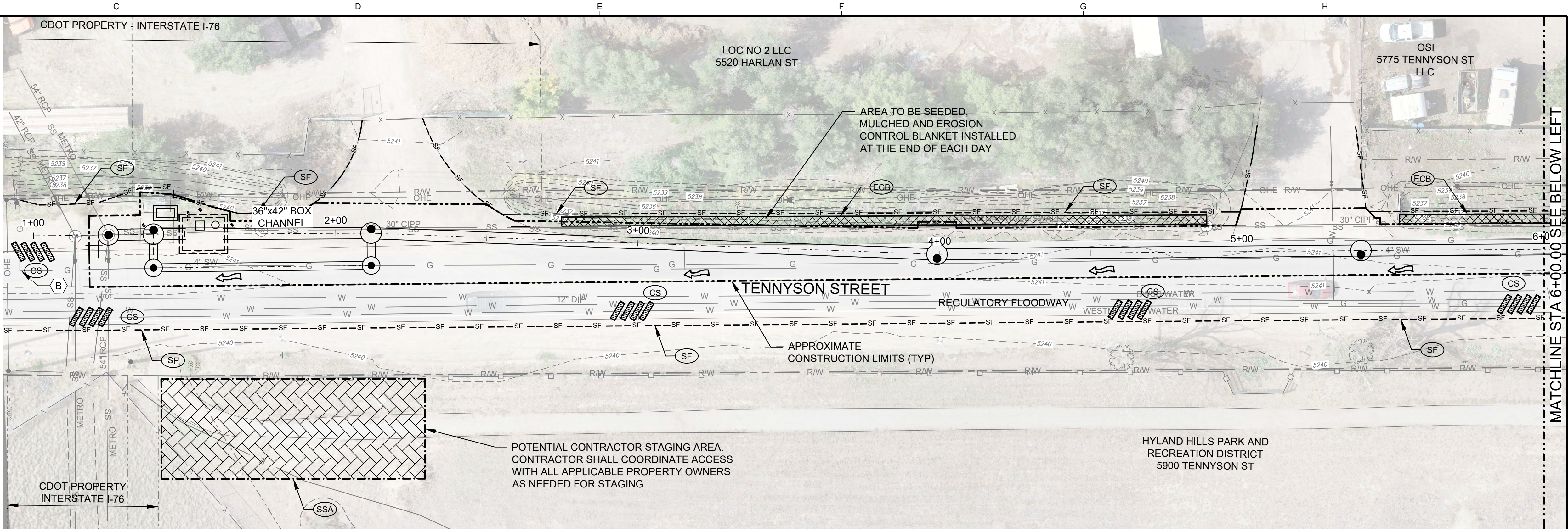
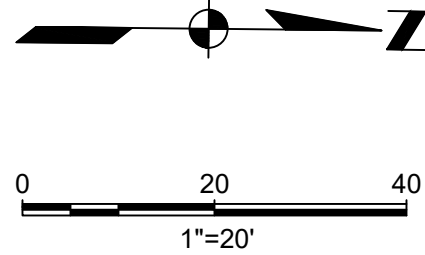
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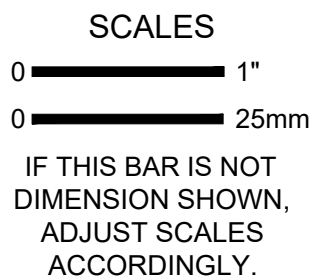
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APPROVED City of Arvada, Colorado			
CITY ENGINEER	DATE	JOB NUMBER	
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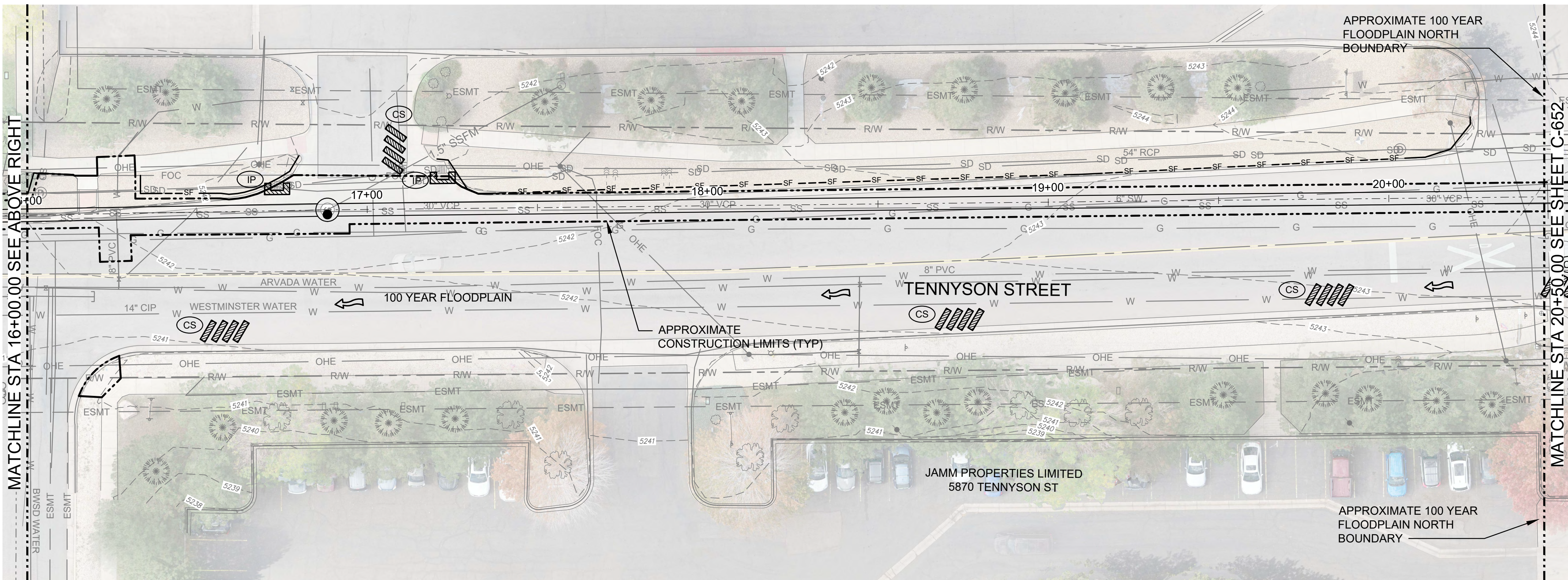
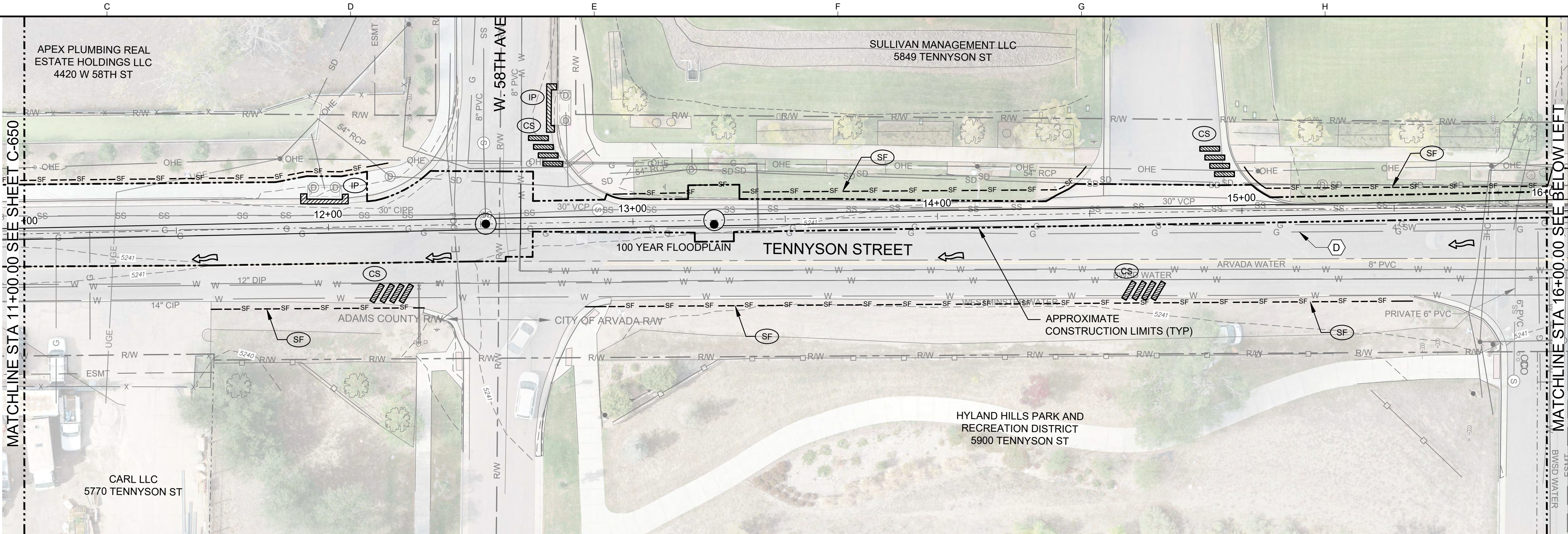
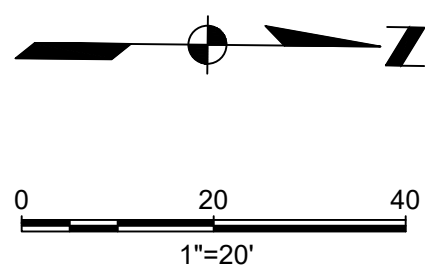
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CITY OF ARVADA
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
 Kennedy Jenks

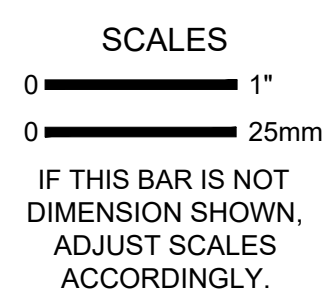
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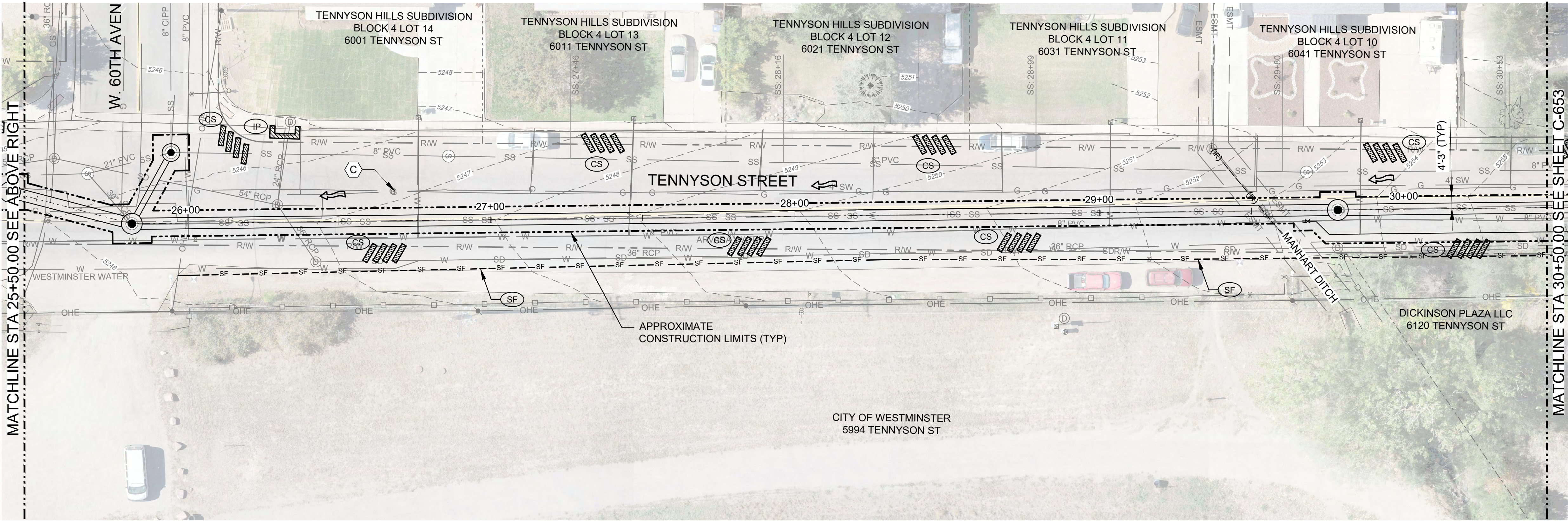
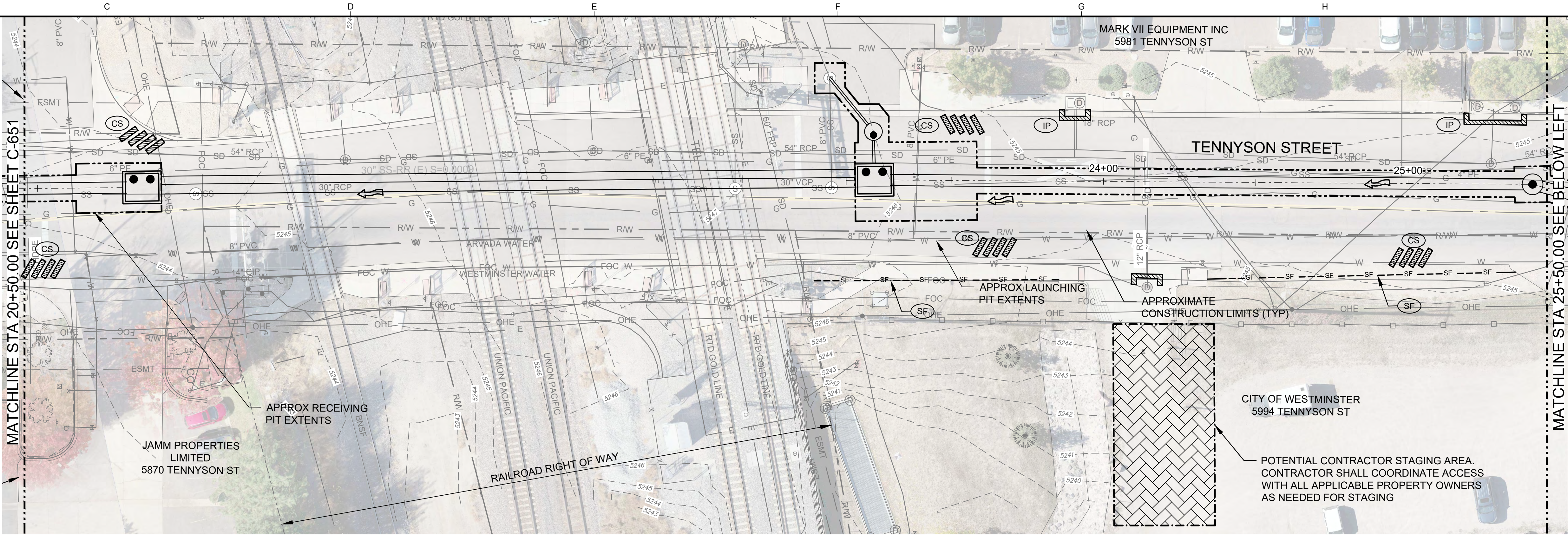
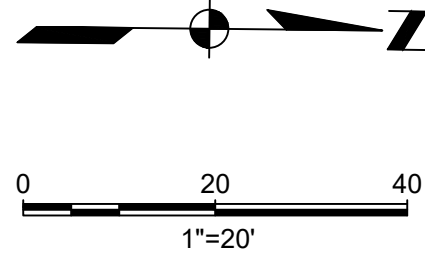


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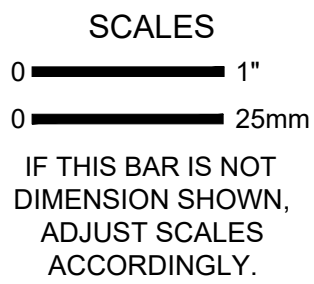
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CITY OF ARVADA
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
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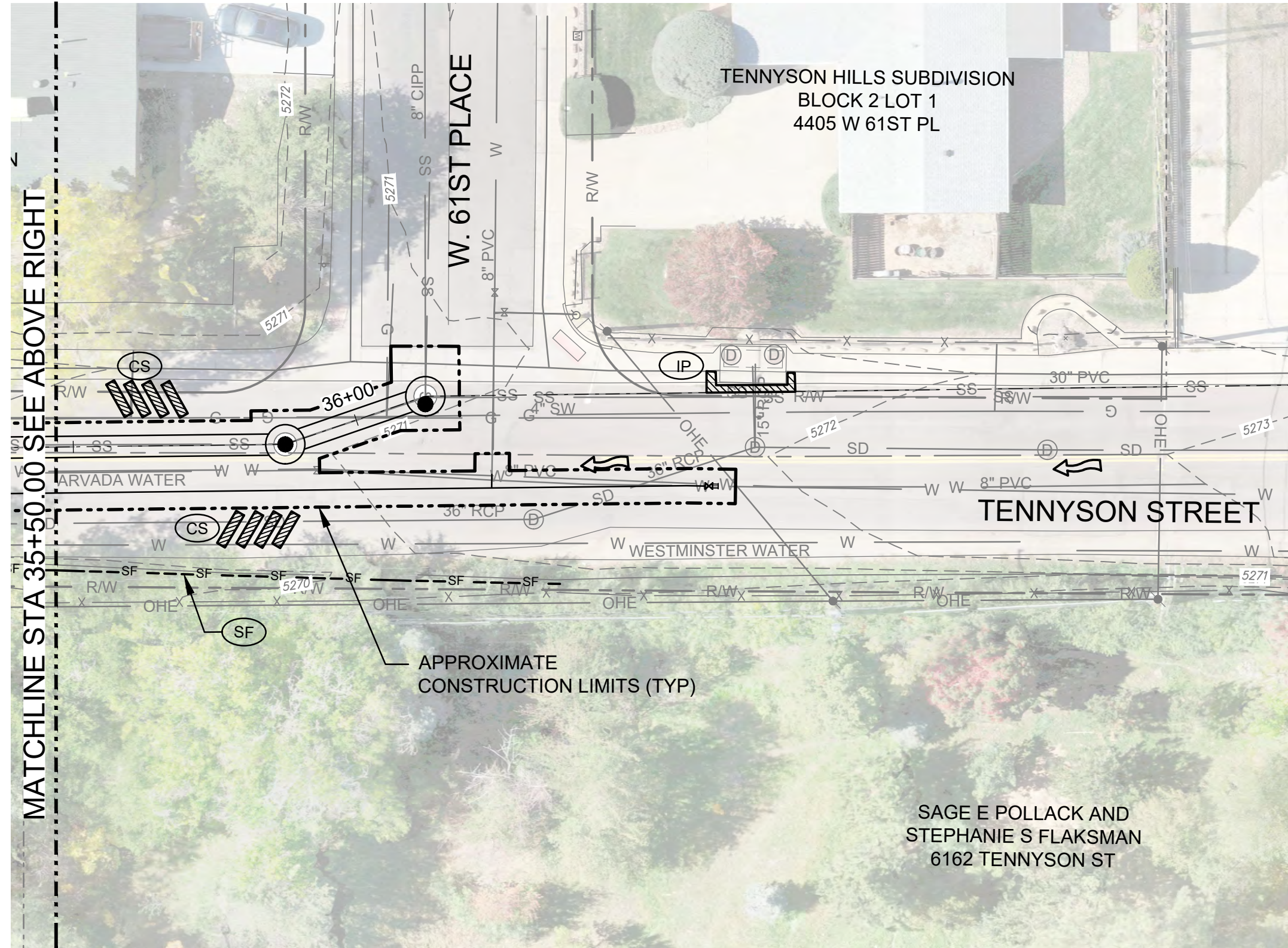
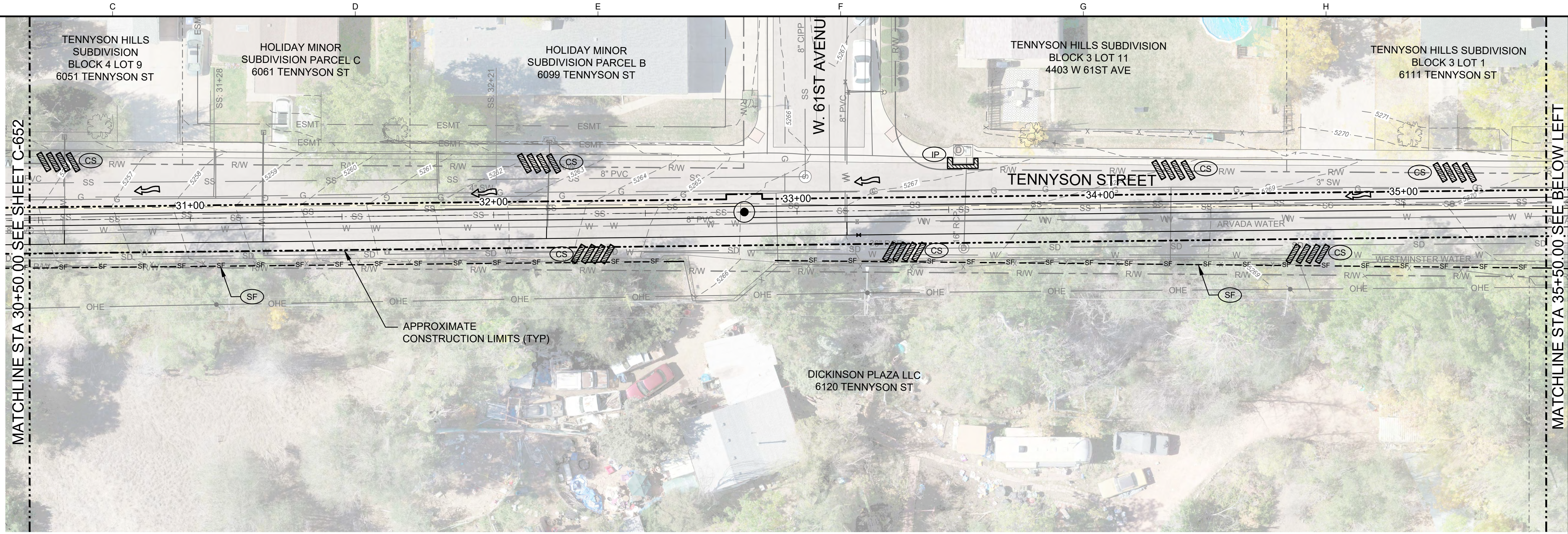
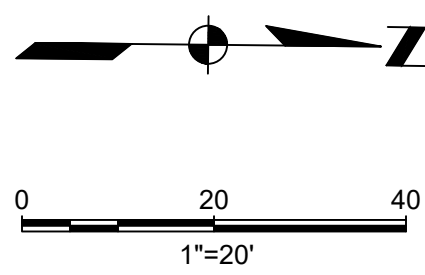
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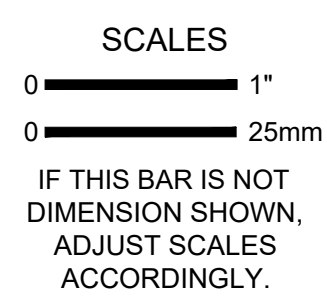
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- GENERAL SHEET NOTES**
- TOTAL AREA OF SITE DISTURBANCE IS APPROXIMATELY 1 ACRE, ALL PHASES.
 - CONTRACTOR RESPONSIBLE FOR COORDINATING ALL NECESSARY SWMP AND STATE STORMWATER PERMIT CERTIFICATIONS. THIS IS TO INCLUDE PROVIDING THE POST-CONSTRUCTION WATER QUALITY EXCEPTION TO THE REQUIRED AGENCIES AS WELL AS A COPY TO THE OWNER.

APPROVED City of Arvada, Colorado			
CITY ENGINEER	DATE	JOB NUMBER	
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CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 Kennedy Jenks	

GRADING, EROSION, AND SEDIMENT CONTROL STA 30+50 TO 37+00	
SCALE	1" = 20'
JOB NO	2246059*00
DATE	SEP 2024
SHEET	49 OF 49
EC-653	



REPORT TO CITY COUNCIL RESOLUTION

AGENDA ITEM
8.A.2.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66

Report in Brief

Amendment No. 1 to the Construction Management/General Contractor services contract between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave. project will increase the existing contract amount by \$20,107,055.66 to a new contract total of \$20,299,577.66.

The Arvada team recommends that the City Council approve R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66.

Financial Impact

CIP Project: 23-SR-03 NTL7 Sheridan and 76th

Financial Impact: \$20,107,055.66

This is a one-time request for Project Construction costs.

Funding Source: UT Wastewater Bond Projects (42)

CIP Account Number: 98552

Workday Account: PRJ23098552

Background

In 2022, the City of Arvada completed a Sanitary Sewer Master Plan that provided the hydraulic modeling results of the existing sanitary sewer infrastructure servicing northern Arvada. This report highlighted several areas of capacity concerns under existing and build-out conditions. NTL7 was identified as one of the four priority areas and one of the most time-sensitive portions. The Arvada team contracted with Garney Companies Inc. to provide construction management/general contractor services for the sewer improvements in Sheridan from W 68th Ave. to W 76th Ave.

Discussion

A Construction Management/General Contractor (CM/GC) alternative delivery method was selected for the project to mitigate construction risks due to the project being located in Sheridan Boulevard. The risk categories include being located within the City of Westminster, being in right of way owned by the Colorado Department of Transportation and numerous underground

SUBJECT: R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66

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utilities. Garney Companies, Inc. was originally selected to be the project CM/GC in March 2024 following City procurement rules. Garney was contracted for an amount of \$192,522.00 for pre-construction phase services. Garney has demonstrated their professionalism and construction knowledge throughout the pre-construction phase of this project and has successfully negotiated a fair guaranteed maximum price for all work necessary to construct the project. Amendment 1 will increase the total contract value to \$20,299,577.66 and includes all construction time and materials costs for the project.

Original Contract: \$192,522.00

Amendment 1: \$20,107,055.66 for construction of the project

Public Contact

Posting of the City Council agenda.

Commission Recommendation

N/A

Strategic Alignment

The recommended action aligns with the Infrastructure Priority Area within the City Council Strategic Plan. Specifically, the recommended action is consistent with the following work system service included in the Infrastructure Priority Area:

Provides the community with a safe, reliable high quality water supply, drainage system, and wastewater disposal services for full city build-out, as defined in the Comprehensive Plan. This includes maintaining utility rates at the lowest practical levels with accurate billing that supports replacement of aging infrastructure in order to maintain robust utility systems.

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66.

Suggested Motion:

I move that R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66, be (approved) (rejected).

Prepared by:

Matthew Amidei, Civil Engineer III

SUBJECT: R24-124, A Resolution Authorizing Amendment No. 1 to "A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount from \$192,522.00 to an Amount Not to Exceed \$20,299,577.66

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Reviewed by:

Approved by:

Mary Stahl, Senior Civil Engineer	11/12/2024
Chris Lisberg, Assistant City Engineer	11/13/2024
Jacqueline Rhoades, Public Works Director	11/14/2024
Bryan Archer, Director of Finance	11/14/2024
Tammy Hedlund, Legal Specialist	11/15/2024
Jessica Morales, Assistant City Attorney	11/15/2024
Don Wick, Deputy City Manager	11/15/2024
Rachel Morris, City Attorney	11/19/2024
Linda Haley, Acting City Manager	11/20/2024

Enclosure, exhibits & attachments required to support the report

RESOLUTION NO. R24-124

A RESOLUTION AUTHORIZING AMENDMENT NO. 1 TO "A CONSTRUCTION MANAGEMENT/GENERAL CONTRACTOR (CM/GC) AGREEMENT BY AND BETWEEN THE CITY OF ARVADA AND GARNEY COMPANIES, INC. FOR THE NORTH TRUNK SEWER IMPROVEMENTS AT SHERIDAN BLVD. AND 76TH AVE.," FOR PURPOSES OF AWARDED PHASE II, AT A GUARANTEED MAXIMUM PRICE OF \$20,107,055.66, THEREBY INCREASING THE CONTRACT AMOUNT FROM \$192,522.00 TO AN AMOUNT NOT TO EXCEED \$20,299,577.66

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The Mayor or Mayor Pro Tem is authorized to sign and the City Clerk to attest, in form approved by the City Attorney, an Agreement that is in substantially the same form as that attached hereto.

Section 2. This resolution shall be effective upon its approval by the City Council.

APPROVED AND ADOPTED this 2nd day of December, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney:

BY: _____

AMENDMENT NO. 1
TO “A CONSTRUCTION MANAGEMENT/GENERAL CONTRACTOR
(CM/GC) AGREEMENT BY AND BETWEEN THE CITY OF ARVADA AND
GARNEY COMPANIES, INC. FOR THE NORTH TRUNK SEWER
IMPROVEMENTS AT SHERIDAN BLVD. AND 76TH AVE.,” FOR PURPOSES
OF AWARDED PHASE II, AT A GUARANTEED MAXIMUM PRICE OF
\$20,107,055.66, THEREBY INCREASING THE CONTRACT AMOUNT FROM
\$192,522.00 TO AN AMOUNT NOT TO EXCEED \$20,299,577.66

This Amendment No. 1, made this ____ day of _____, 2024, by and between the CITY OF ARVADA, a home rule municipal corporation (“Arvada” and/or “City”) and GARNEY COMPANIES, INC., a Missouri Corporation, (“Contractor”). Arvada and Contractor may be referred to individually as a “Party” and collectively as the “Parties”.

WITNESSETH: That upon Contractor acceptance and City Approval, the Work and Contract Documents for City of Arvada, Project No. 23-SR-03, entitled North Trunk Sewer Improvements - Sheridan Blvd. and 76th Ave., shall be adjusted as provided herein:

1. RECITALS AND PURPOSE.

- 1.1. On or about March 27, 2024, Arvada and Contractor entered into A Construction Management/General Contractor (CM/GC) Agreement By and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave., Awarding Phase I Services Only, In an Amount Not to Exceed \$192,522.00 (“Original Agreement”).
- 1.2. Due to the voluminous nature of the Original Agreement, the Original Agreement is not attached hereto but is incorporated herein by reference.
- 1.3. The Original Agreement provides Contractor an opportunity to be the General Contractor during the Phase II portion of the Project.
- 1.4. Section 2.5 of the Original Agreement specifies that award of the Phase II portion of the Project is not guaranteed and is dependent on a successful negotiation of a guaranteed maximum price (“GMP”) for all the Work necessary to complete the Project, approval by the Arvada City Council, and execution of an Amendment to the Original Agreement.
- 1.5. The purpose of this Amendment No. 1 is to award Contractor Phase II of the Project, with a GMP of **\$20,107,055.66**, for a revised contract total in an amount not to exceed **\$20,299,577.66** for all Work.

- 2. CONTRACT DOCUMENTS AND EXHIBITS.** The Contract Documents shall consist of the Original Agreement and this Amendment No. 1, together with the following:

Exhibit 1: Contractor's GMP for Phase II;

Exhibit 2: Contractor's Project Schedule;

Exhibit 3: Geotechnical Investigation Report;

Exhibit 4: Subsurface Utility Inspection;

Exhibit 5: 95% Documents (Volume 1); and

Exhibit 6: 95% Documents (Volume 2).

All exhibits referred to in this Amendment No. 1 are attached hereto and are by reference incorporated herein for all purposes. In the event any matter, term, provision, or condition that is the subject of the Agreement, requires clarification or is in dispute, or is the subject of a difference of opinion, the purpose and intent of the Agreement shall be ascertained by reference to the Contract Documents in their entirety. In the event of any dispute or differences between the respective documents that constitute the Contract Documents, then Contractor shall secure the written instructions from Arvada before proceeding with the performance of the services affected by such conflicts, omissions, or discrepancies.

3. AWARD OF PHASE II AND COMPENSATION.

- 3.1. In accordance with Section 2.5 of the Original Agreement, Contractor is hereby awarded Phase II at a GMP of **\$20,107,055.66**, for a revised contract total in an amount not to exceed **\$20,299,577.66** for all Work.
- 3.2. Contractor shall perform the Work in accordance with the Original Agreement and this Amendment No. 1.

4. TERMS AND CONDITIONS.

- 4.1. If any other provision of this Amendment No. 1 is held invalid or unenforceable, no other provision shall be affected by such holding, and all of the remaining provisions of this Agreement shall continue in full force and effect.
- 4.2. Contractor represents and affirms that the signature page hereof accurately states the full legal name of Contractor (whether as a corporation, partnership, limited liability company, sole proprietorship, or other), contains all requisite signature(s) on behalf of Contractor, in accordance with all applicable statutes, regulations, resolutions, rules, bylaws, agreements, or similar sources of authority or limitation. This Amendment No. 1 may be executed in counterpart(s), each of which shall be

deemed to be an original, and all of which, taken together, shall constitute one instrument.

- 5. FULL FORCE AND EFFECT.** All other terms and conditions shall be as set forth in the Original Agreement.

CITY OF ARVADA, COLORADO

Lauren Simpson
Mayor
8101 Ralston Road
Arvada, Colorado 80002

ATTEST/WITNESS:

City Clerk

APPROVED AS TO FORM:
For Rachel Morris, City Attorney

By: _____

GARNEY COMPANIES, INC, a
Missouri Corporation

Keith Lemaster, DBIA
Director of West Pipe
7911 Shaffer Pkwy
Littleton, CO 80127
klemaster@garney.com

Exhibit 1

Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66

CITY OF ARVADA - NORTH TRUNK LINE 7 (NTL7)
Schedule of Values

BID ITEM #	SIZE	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXTENSION
1		General				
1.1		Mobilization and Demobilization	1.0	LS	\$ 597,922.98	\$ 597,922.98
1.2		Site Preparation	1.0	LS	\$ 41,011.75	\$ 41,011.75
1.3		Erosion Control	1.0	LS	\$ 93,434.14	\$ 93,434.14
1.4		Survey	1.0	LS	\$ 25,226.91	\$ 25,226.91
1.5		Potholing	1.0	LS	\$ 78,400.00	\$ 78,400.00
1.6		Dewatering	1.0	LS	\$ 191,763.92	\$ 191,763.92
1.7		Bypass Pumping	1.0	LS	\$ 737,843.81	\$ 737,843.81
1.8		Traffic Control	1.0	LS	\$ 938,841.60	\$ 938,841.60
2		Material Procurement				
2.1	42"	42" FRPM Pipe Procurement	4,778.0	LF	\$ 277.98	\$ 1,328,190.00
2.2	36"	36" FRPM Pipe Procurement	782.0	LF	\$ 246.80	\$ 193,000.00
2.3	30"	30" FRPM Pipe Procurement	2,347.0	LF	\$ 197.03	\$ 462,420.00
2.4	72"	6' Diameter Precast Maintenance Hole 0'-9'	7.0	EA	\$ 9,745.00	\$ 68,215.00
2.5	72"	6' Diameter Precast Maintenance Hole 9'-18'	13.0	EA	\$ 11,904.00	\$ 154,752.00
2.6	6'x 8'	6' x 8' Precast Combo Box Vault	2.0	EA	\$ 18,364.50	\$ 36,729.00
3		Open Cut Pipe Installation				
3.1	42"	Reach 1 - 42" FRPM - South Tie In to Vault 2 - (STA 174+08.25 to 168+27.12)	561.0	LF	\$ 683.91	\$ 383,674.35
3.2	30"	Reach 2 - Dual 30" FRPM - Vault 2 to Vault 1 (STA 168+27.12 to 163+32.27)	489.0	LF	\$ 675.84	\$ 330,486.34
3.3	30"	Reach 3 - 30" FRPM - Vault 1 to SSMH#15 (STA 163+32.27 to STA 149+75.47)	1,337.0	LF	\$ 454.93	\$ 608,235.73
3.4	42"	Reach 4 - 42" FRPM - SSMH#15 to S. 72nd Bore (STA 149+75.47 to STA 145+21.49)	448.0	LF	\$ 1,154.77	\$ 517,336.34
3.5	42"	Reach 5 - 42" FRPM - N. 72nd Bore to SSMH#8 (STA 143+21.49 to STA 123+32.96)	1,955.0	LF	\$ 809.95	\$ 1,583,451.49
3.6	42"	Reach 6 - 42" FRPM - SSMH#8 to SSMH#4 (STA 123+33.10 to STA 116+50.71)	652.0	LF	\$ 821.69	\$ 535,740.75
3.7	42"	Reach 7 - 42" FRPM - SSMH#4 to SSMH#2 (STA 116+50.71 to STA 107+81.57)	856.0	LF	\$ 445.93	\$ 381,718.02
3.8	36"	Reach 8 - 36" FRPM - SSMH#2 to North Tie In (STA 107+81.57 to STA 100+00.00)	768.0	LF	\$ 308.65	\$ 237,043.99
4		Maintenance Holes and Vaults				
4.1	72"	6' Diameter Precast Maintenance Hole 0'->9'	7.0	EA	\$ 20,692.39	\$ 144,846.76
4.2	72"	6' Diameter Precast Maintenance Hole 9'-18'	13.0	EA	\$ 35,343.15	\$ 459,460.96
4.3	6'x9'	6' x 9' Precast Combo Vault Box	2.0	EA	\$ 42,261.07	\$ 84,522.14
5		Connections				
5.1	42"	South Tie In Connection	1.0	EA	\$ 115,082.96	\$ 115,082.96
5.2	8"	8" PVC Lateral Connection SSMH #17	1.0	EA	\$ 35,795.27	\$ 35,795.27
5.3	18"	18" FRPM Lateral Connection Vault 1	1.0	EA	\$ 42,778.99	\$ 42,778.99
5.4	42"	SSMH # 6 Connection at Existing System	1.0	EA	\$ 131,062.17	\$ 131,062.17
5.5	36"	North Tie in Connection	1.0	EA	\$ 108,399.74	\$ 108,399.74
6		Trenchless				
6.1		72nd Bore Launch Pit	1.0	EA	\$ 146,224.00	\$ 146,224.00
6.2		72nd Ave 60" Casing and 42" FRPM Carrier Pipe Installation	200.0	LF	\$ 3,244.85	\$ 648,970.52
6.3		72nd Bore Receiving Pit	1.0	EA	\$ 34,117.00	\$ 34,117.00
7		Utility Relocations				
7.1	16"	16" Waterline Conflict STA 123+25 (Westminster)	1.0	LS	\$ 69,392.42	\$ 69,392.42
7.2	8"	8" Waterline Conflict STA 124+50 (Westminster)	1.0	LS	\$ 45,529.44	\$ 45,529.44
7.3	12"	12" Waterline Conflict STA 156+75 (Arvada)	1.0	LS	\$ 47,977.68	\$ 47,977.68
7.4	30"	30" Strom Conflict STA 168+08 (Arvada)	1.0	LS	\$ 82,940.14	\$ 82,940.14

7.5	36"	36" RCP Storm Conflict STA 170+43 (Arvada)	1.0	LS	\$ 135,976.49	\$ 135,976.49
7.6	24"	24" Waterline Conflict STA 170+34 (Arvada)	1.0	LS	\$ 90,272.79	\$ 90,272.79
8		Surface Removals and Restoration				
8.1		12" Thick Asphalt Removal	6,036.0	SY	\$ 37.96	\$ 229,118.00
8.2		Asphalt Trench Patching	3,125.0	TON	\$ 227.92	\$ 712,245.95
8.3		2" Mill and Overlay	19,771.0	SY	\$ 27.05	\$ 534,869.93
8.4		4" Temporary Paving and Removal	1,613.0	SY	\$ 37.09	\$ 59,825.99
8.5		Striping	1.0	LS	\$ 134,343.52	\$ 134,343.52
8.6		Concrete Sidewalk Removal and Replacement	1,073.0	SF	\$ 18.72	\$ 20,091.05
8.6		8' Concrete Trail Removal and Replacement	9,256.0	SF	\$ 17.73	\$ 164,082.63
8.7		Concrete Curb and Cutter Removal and Replacement	1,122.0	LF	\$ 56.95	\$ 63,897.56
8.9		Stamped and Colored Concrete Removal and Replacement	2,722.0	SF	\$ 36.83	\$ 100,255.70
8.1		ADA Ramps	3.0	EA	\$ 3,000.00	\$ 9,000.00
8.11		Wood Split Rail Fence Removal and Replacement	150.0	LF	\$ 44.01	\$ 6,602.00
8.12		Sod	4,550.0	SF	\$ 2.36	\$ 10,740.20
8.13		Seeding	5.0	AC	\$ 3,360.00	\$ 16,800.00
8.14		Irrigation Repairs	1.0	LS	\$ 5,500.00	\$ 5,500.00
9		Pipe/Below Ground Structure Removals, Abandonment & Replacement				
9.1		Remove and Dispose of Existing Manhole Structures	4.0	EA	\$ 6,933.11	\$ 27,732.43
9.2		Abandonment of Existing Sanitary Sewer Pipe	7,120.0	LF	\$ 39.14	\$ 278,692.93
9.3		Abandonment of Existing Sanitary Sewer Structures	16.0	EA	\$ 3,428.59	\$ 54,857.39
9.4		Removal and Disposal of Existing Pipe	507.0	LF	\$ 15.97	\$ 8,096.23
9.5		Remove and Replace 14' x 6' Dual Barrel Box Culvert	1.0	LS	\$ 178,907.66	\$ 178,907.66
10		Above Grade Removals and Replacement				
10.1		Wood Creek Sign Removal and Replacement	1.0	LS	\$ 50,000.00	\$ 50,000.00
11		Testing				
11.1		Sewer Pipe and Manhole Testing	1.0	LS	\$ 76,076.00	\$ 76,076.00
12		General Conditions				
12.1		General Conditions	1.0	LS	\$ 752,975.55	\$ 752,975.55

SOV Total:	\$ 15,443,498.30
2.36% Bonds & Insurance:	\$ 364,466.56
Total:	\$ 15,807,964.86
12% Fee:	\$ 1,896,955.78
Project Total:	\$ 17,704,920.65

13		Owner Controlled Items				
13.1		Additional CDOT Trench Paving	972.0	TON	\$ 198.33	\$ 192,774.60
13.2		Additional CDOT Mill and Overlay Paving and Striping	7,254.0	SY	\$ 31.87	\$ 231,208.41
13.3	8"	8" AC Waterline Lowering's (Westminster)	2.0	EA	\$ 27,335.57	\$ 54,671.14
13.4		1' Over Excavation and Trench Stabilization	500.0	LF	\$ 59.72	\$ 29,858.96
13.5		Dewatering Treatment	1.0	LS	\$ 1,362,455.79	\$ 1,362,455.79
13.7		76th Ave Traffic Signal Removal and Replacement	2.0	EA	\$ 106,590.00	\$ 213,180.00

SOV Total:	\$ 2,084,148.91
2.36% Bonds & Insurance:	\$ 49,185.91
Total:	\$ 2,133,334.82
5% General Conditions:	\$ 106,666.74
Total:	\$ 2,240,001.56
12% Fee:	\$ 268,800.19
Allowance Total:	\$ 2,402,135.01

Project Total (GMP):	\$ 20,107,055.66
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ARVADA NTL7 - ESTIMATE

BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
1					General									
1.1	Mobilization and Demobilization							1		LS		\$ 597,142.16		\$ 597,142.16
1.1	Garney		Crew		CMAR - Pipe Crew	1.0	Shifts	1.00	1.00	Shifts		\$ 26,172.29	\$ 26,212.43	
1.1	Garney		Crew		CMAR- Support Crew	10.0	Shifts	1.00	10.00	Shifts		\$ 6,818.56	\$ 68,453.97	
1.1	Garney		Crew		CMAR - PM Job Set Up/ Close Out	22.0	Shifts	1.00	22.00	Shifts		\$ 3,939.70	\$ 86,673.40	
1.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		2.00	2.00	Lump Sum		\$ -	\$ 2,859.63	
1.1	Fencing		Material		Chain Link Safety Fence/Posts/Stand (440LF)	1		1.00	1.00	LS	X	\$ 9,224.29	\$ 9,958.54	
1.1	Specialty Shoring	Wylaco	Material		Trench Box Rental (27x10 & 27x8)	9	Months	1.00	9.00	MONTH	X	\$ 5,000.00	\$ 48,582.00	
1.1	Specialty Shoring	Wylaco	Material		Spreader Rentals	9	Months	2.00	18.00	EA	X	\$ 680.00	\$ 13,214.30	
1.1	Specialty Shoring	Wylaco	Material		Mizer Box	9	Months	2.00	18.00	EA	X	\$ 1,450.00	\$ 28,177.56	
1.1	Specialty Shoring	Wylaco	Material		G3 Shoring	1		1.00	1.00	LS	X	Included	Included	
1.1	Specialty Shoring	Wylaco	Material		Street Plates	7	Months	4.00	28.00	EA	X	\$ 785.00	\$ 23,729.61	
1.1	Specialty Shoring	Wylaco	Material		Street Plates (Additional North Open Space)	2	Months	8.00	16.00	EA	X	\$ 785.00	\$ 13,559.78	
1.1	Construction Water		Material		Construction Water	5	Months	264,000.00	1,320.00	GAL/TH		\$ 10.00	\$ 13,200.00	
1.1	Teeth & Tires		Material		Tiger Teeth	2		1.00	2.00	LS	X	\$ 1,500.00	\$ 3,238.80	
1.1	One Time Office Costs		Material		One Time Office Costs	1		10.00	10.00	EA		\$ 750.00	\$ 7,500.00	
1.1	Monthly Office Costs		Material		Monthly Office Costs	1		10.00	10.00	EA		\$ 2,500.00	\$ 25,000.00	
1.1	Monthly Office Costs		Material		Port-a-Jons	9		2.00	18.00	EA		\$ 185.00	\$ 3,330.00	
1.1	Monthly Office Costs		Material		Dumpsters	9		1.00	9.00	EA		\$ 850.00	\$ 7,650.00	
1.1	Safety		Material		Safety - % of Labor (excluding fringe)	3%		1.00	3,902,061.80	Lump Sum		\$ 1.00	\$ 117,061.85	
1.1	Permits		Other		Westminster Permits	1		1.00	1.00	EA		\$ 2,000.00	\$ 2,000.00	
1.1	Permits		Other		CDPHE Permits	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
1.1	Permits		Other		CDOT Permits	1		1.00	1.00	EA		\$ 2,000.00	\$ 2,000.00	
1.1	Permits	CMS	Other		CMS Permit Applications	1		4.00	4.00	EA		\$ 200.00	\$ 800.00	
1.1	Permits	CMS	Other		CMS CDPHE Application	2		1.00	2.00	EA		\$ 300.00	\$ 600.00	
1.1	Permits	CMS	Other		CMS Stormwater Management	1		8.00	8.00	MONTHS		\$ 650.00	\$ 5,200.00	
1.1	Survey		Subcontract		GPS Equipment	1		1.00	1.00	LS	X	\$ 12,403.00	\$ 13,390.28	
1.1	Lowboys		Subcontract		Lowboys	1		1.00	1.00	LS		\$ 32,250.00	\$ 32,250.00	
1.1	Pre-Construction Video and Pho	TWEIZ	Subcontract		Photo/Video	1		1.00	1.00	LS		\$ 6,500.00	\$ 6,500.00	
1.1	Seed & Sod		Subcontract		Tree Replacement	1		4.00	4.00	EA		\$ 3,000.00	\$ 12,000.00	
1.1	Traffic Control Sub		Subcontract		Special Signs (Businnes Access)	1		1.00	1.00	LS		\$ 2,000.00	\$ 2,000.00	
1.1	One Time Office Costs		Subcontract		Project Sign (Skid Mount)	1		1.00	1.00	LS		\$ 1,000.00	\$ 1,000.00	
1.1	One Time Office Costs		Subcontract		Procore	1		1.00	1.00	LS		\$ 18,000.00	\$ 18,000.00	
1.2	Site Preparation							1		LS		\$ 41,011.75		\$ 41,011.75
1.2	Garney		Crew		CMAR- Support Crew	3.0	Shifts	1.00	3.00	Shifts		\$ 6,818.56	\$ 20,536.19	
1.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		3.00	3.00	Lump Sum		\$ -	\$ -	
1.2	Crushed Stone	Burnco	Material		Road Base for Laydown Area	207.41		1.00	207.41	TONS		\$ 26.40	\$ 5,475.56	
1.2	Fencing		Material		Chain Link Fence Yard	1		1.00	1.00	LS		\$ 10,000.00	\$ 10,000.00	
1.2	Clearing		Subcontract		Tree Removal 76th Ave	1		1.00	1.00	LS		\$ 5,000.00	\$ 5,000.00	
1.3	Erosion Control							1		LS		\$ 93,434.14		\$ 93,434.14
1.3	Garney		Crew		CMAR- Support Crew	0.5	Shifts Per Unit	9.14	4.57	Shifts		\$ 6,818.56	\$ 31,294.02	
1.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		4.00	4.00	Lump Sum		\$ -	\$ -	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
1.3	Erosion Control		Material		Big Reds (Stock Pile Management)	1		15.00	15.00	EA	X	\$ 160.00	\$ 2,591.04	
1.3	Erosion Control	Blue Tec	Material		FODS	8		1.00	8.00	EA	X	\$ 3,100.00	\$ 26,774.08	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Street Sweeping	7		4.00	28.00	WK		\$ 350.00	\$ 9,800.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Eco Pan	8		1.00	8.00	MONTH		\$ 750.00	\$ 6,000.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Silt Fence	1		2,000.00	2,000.00	LF		\$ 1.25	\$ 2,500.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Inlet Protection	1		13.00	13.00	EA		\$ 450.00	\$ 5,850.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Rock Socks	1		260.00	260.00	LF		\$ 15.50	\$ 4,030.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Silt Fence Removal	1		2,000.00	2,000.00	LF		\$ 0.75	\$ 1,500.00	
1.3	Erosion Control Sub	Blue Tec	Subcontract		Damaged/Replacement Erosion Control	0.25		1.00	0.25	LS		\$ 12,380.00	\$ 3,095.00	
1.4					Survey	1				LS		\$ 25,226.91		\$ 25,226.91
1.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		5.00	5.00	Lump Sum		\$ -	\$ -	
1.4	Survey	Ranger	Subcontract		Survey Model	1		7,555.00	7,555.00	LS		\$ 0.27	\$ 2,039.85	
1.4	Survey	Majestic	Subcontract		Survey	1		1.00	1.00	LS		\$ 21,060.00	\$ 21,060.00	
1.4	Survey	Majestic	Subcontract		Survey (Re-Staking)	1		1.00	1.00	LS		\$ 2,127.06	\$ 2,127.06	
1.5					Potholing	1				LS		\$ 78,400.00		\$ 78,400.00
1.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		6.00	6.00	Lump Sum		\$ -	\$ -	
1.5	Vac Truck	Badger	Subcontract		Core Holes	1		80.00	80.00	Each		\$ 200.00	\$ 16,000.00	
1.5	Vac Truck	Badger	Subcontract		Potholes (Crossings)	1		60.00	60.00	Each		\$ 600.00	\$ 36,000.00	
1.5	Vac Truck	Badger	Subcontract		Potholes (Parallel Utilities)	1		36.00	36.00	Each		\$ 600.00	\$ 21,600.00	
1.5	Vac Truck	Badger	Subcontract		Potholes (Unknown)	0.1	Percent	80.00	8.00	Each		\$ 600.00	\$ 4,800.00	
1.6					0 Dewatering	1				LS		\$ 191,763.02		\$ 191,763.02
1.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		7.00	7.00	Lump Sum		\$ -	\$ 53,162.02	
1.6	Specialty Tools / Hoses	Rain for Rent	Material		Frac Tank	1		5.00	5.00	LS		\$ 1,000.00	\$ 5,000.00	
1.6	Specialty Tools / Hoses	Rain for Rent	Material		Delivery/Pick Up	1		1.00	1.00	LS		\$ 916.00	\$ 916.00	
1.6	Specialty Tools / Hoses	Rain for Rent	Material		Submersible Pumps 7.5HP	2		5.00	10.00	MONTH		\$ 1,800.00	\$ 18,000.00	
1.6	Fuel		Material		Generator Fuel	141	Gal/Day	135.00	19,035.00	GAL		\$ 5.00	\$ 95,175.00	
1.6	Permits	CMS	Other		CMS Dewatering Plan	1		1.00	1.00	EA		\$ 1,200.00	\$ 1,200.00	
1.6	Permits	CMS	Other		CMS Dewatering Sampling (Weekly)	3		5.00	15.00	EA		\$ 450.00	\$ 6,750.00	
1.6	Permits	CMS	Other		CMS Dewatering Sampling (Monthly)	1		5.00	5.00	EA		\$ 600.00	\$ 3,000.00	
1.6	Permits	CMS	Other		CMS DMR's	1		9.00	8.00	MONTH		\$ 195.00	\$ 1,560.00	
1.6	Vac Truck	Badger	Subcontract		Tank Cleaning	1		2.00	2.00	EA		\$ 3,500.00	\$ 7,000.00	
1.7					0 Bypass Pumping	1				LS		\$ 737,843.81		\$ 737,843.81
1.7	Garney		Crew		CMAR- Support Crew	10.0	Shifts	1.00	10.00	Shifts		\$ 6,818.56	\$ 68,453.97	
1.7	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		8.00	8.00	Lump Sum		\$ -	\$ -	
1.7	Precast Concrete	Copeland	Material		Additional Cone Material (To Prime Pumps)	1		1.00	1.00	LS		\$ 5,000.00	\$ 5,000.00	
1.7	Precast Concrete	Copeland	Material		Manhole Repair Material	1		1.00	1.00	LS		\$ 5,000.00	\$ 5,000.00	
1.7	Bypass Pumping	United Rentals	Material		Purchase Plugs	1		2.00	2.00	EA		\$ 5,000.00	\$ 10,000.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Box Culvert Ditch and Storm Water Bypassing	1		1.00	1.00	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Installation and Removal	1		1.00	1.00	MONTH		\$ 2,000.00	\$ 2,000.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass Pump Rental	1		1.00	1.00	DAY		\$ 6,967.22	\$ 6,967.22	
1.7	Fuel	United Rentals	Material		Fuel for Dri Prime Pump	42		30.00	1,260.00	GAL		\$ 5.00	\$ 6,300.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass #1			1.00	-	LS		Included	Included	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Installation and Removal	1		1.00	1.00	LS		\$ 81,756.00	\$ 81,756.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass System Rental	1		10.00	10.00	DAY		\$ 3,065.10	\$ 30,651.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Fuel	120		10.00	1,200.00	GAL		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass #2				-	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Installation and Removal	1		1.00	1.00	LS		\$ 36,146.25	\$ 36,146.25	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass System Rental	1		14.00	14.00	LS		\$ 1,036.57	\$ 14,511.98	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Fuel	120		14.00	1,680.00	GAL		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass #3				-	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		3.1 Installation and Removal	1		1.00	1.00	LS		\$ 26,823.00	\$ 26,823.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		3.2 Installation and Removal	1		1.00	1.00	LS		\$ 16,421.00	\$ 16,421.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		3.1 Bypass System Rental	1		1.00	1.00	LS		\$ 2,355.00	\$ 2,355.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		3.2 Bypass System Rental	1		1.00	1.00	LS		\$ 1,251.00	\$ 1,251.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Fuel	12		2.00	24.00	GAL		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass #4				-	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		4.1 Installation and Removal	1		1.00	1.00	LS		\$ 36,146.25	\$ 36,146.25	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		4.2 Installation and Removal	1		1.00	1.00	LS		\$ 16,041.00	\$ 16,041.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		4.1 Bypass System Rental	1		35.00	35.00	LS		\$ 699.80	\$ 24,493.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		4.2 Bypass System Rental	1		7.00	7.00	LS		\$ 398.86	\$ 2,792.02	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Fuel	120		42.00	5,040.00	GAL		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Bypass #5				-	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Installation and Removal	1		1.00	1.00	LS		\$ 54,337.00	\$ 54,337.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Standby Bypass System Rental	1		21.00	21.00	LS		\$ 833.24	\$ 17,498.04	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Additional Bypassing Requirements				-	LS		Included	Included	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		24/7 Pump Watch for One 8 MGD System	1		30.00	30.00	LS		\$ 3,570.00	\$ 107,100.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		24/7 Pump Watch for Two 8 MGD Systems	1		16.00	16.00	LS		\$ 5,950.00	\$ 95,200.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Night Pump Watch Bypass 3.1 & 3.2	1		2.00	2.00	LS		\$ 1,190.00	\$ 2,380.00	
1.7	Bypass Pumping Sub	United Rentals	Subcontract		Pump Fuel	1		7,944.00	7,944.00	LS		\$ 6.07	\$ 48,220.08	
1.7	Asphalt Paving	CPS	Subcontract		Temp Asphalt - Direct Bury Bypass Pipes	1		1.00	1.00	LS		\$ 20,000.00	\$ 20,000.00	
1.8				0	Traffic Control			1		LS		\$ 938,841.60	\$ 938,841.60	
1.8	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		9.00	9.00	Lump Sum		\$ -	\$ -	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Pothole Additional Traffic Control	1		10.00	10.00	DAY		\$ 1,500.00	\$ 15,000.00	
1.8	Specialty Tools / Hoses		Material		Purchase Barrier Picker	1		1.00	1.00	LS		\$ 6,000.00	\$ 6,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Traffic Control Devices	1		1.00	1.00	LS		\$ 65,000.00	\$ 65,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Traffic Control Mobilization	1		1.00	1.00	LS		\$ 18,000.00	\$ 18,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Message Boards	1		4.00	4.00	EA		\$ 12,500.00	\$ 50,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Safe Hit - Glue Down Channelizer	2		200.00	400.00	EA		\$ 85.00	\$ 34,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		TCS	9	MONTH	22.00	198.00	DAY		\$ 795.00	\$ 157,410.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Traffic Control Inspection	9	MONTH	8.00	72.00	DAY		\$ 425.00	\$ 30,600.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		TCS - Night	15		1.00	15.00	DAY		\$ 1,200.00	\$ 18,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Flagging Night	15		20.00	300.00	HR		\$ 60.00	\$ 18,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Flagger (Full Time)	10	HR/DAY	198.00	1,980.00	HR		\$ 44.00	\$ 87,120.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Flagger (Additional)	20	HR/DAY	99.00	1,980.00	HR		\$ 44.00	\$ 87,120.00	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Flagger OT	10	OT/WK	39.60	396.00	LS		\$ 70.00	\$ 27,720.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Mill and Overlay Traffic Control	1		10.00	10.00	DAY		INCLUDED	Included	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Striping Traffic Control	1		4.00	4.00	DAY		INCLUDED	Included	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Signal Trailers Phase 1	3	MONTHS	2.00	6.00	EA	x	\$ 3,500.00	\$ 22,671.60	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Signal Trailers Phase 2-8	6	MONTHS	3.00	18.00	EA		\$ 3,500.00	\$ 63,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Signal Delivery/Pick Up	2		3.00	6.00	EA		\$ 700.00	\$ 4,200.00	
1.8	Traffic Control Sub	Sturgeon	Subcontract		Existing Signal Head and Camera Shifts	2		5.00	10.00	EA		\$ 2,300.00	\$ 23,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Jersey Barrier Phase 1 & 2	3	Month	1,400.00	4,200.00	LF		\$ 11.00	\$ 46,200.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Jersey Barrier Remaing Phases	6	Month	800.00	4,800.00	LF		\$ 11.00	\$ 52,800.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Jersey Barrier Delivery	2		14.00	28.00	LOADS		\$ 1,000.00	\$ 28,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Jersey Barrier Moves	1		10.00	10.00	EA		\$ 5,000.00	\$ 50,000.00	
1.8	Traffic Control Sub	Burnt Mountain	Subcontract		Impact Attenuator	1		2.00	2.00	EA		\$ 17,500.00	\$ 35,000.00	
2					Material Procurement									
2.1	42"			42"	42" FRPM Pipe Procurement	4,778			LF	\$ 277.98			\$ 1,328,190.00	
2.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		11.00	11.00	Lump Sum		\$ -	\$ -	
2.1	Fiberglass Pipe	HOBAS	Pipe		42" FRPM	1		4,780.00	4,780.00	LF		\$ 255.00	\$ 1,218,900.00	
2.1	Fiberglass Pipe	HOBAS	Pipe		42" Closure Couplings	1		6.00	6.00	EA		\$ 1,415.00	\$ 8,490.00	
2.1	Fiberglass Pipe	HOBAS	Pipe		Freight	160	LF/TRUCK	4,778.00	28.00	LOADS		\$ 3,600.00	\$ 100,800.00	
2.2	36"			36"	36" FRPM Pipe Procurement	782			LF	\$ 246.80			\$ 193,000.00	
2.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		12.00	12.00	Lump Sum		\$ -	\$ -	
2.2	Fiberglass Pipe	HOBAS	Pipe		36" FRPM	1		800.00	800.00	LF		\$ 212.00	\$ 169,600.00	
2.2	Fiberglass Pipe	HOBAS	Pipe		36" Closure Coupling	1		4.00	4.00	EA		\$ 1,350.00	\$ 5,400.00	
2.2	Fiberglass Pipe	HOBAS	Pipe		Freight	160	LF/TRUCK	800.00	5.00	LOADS		\$ 3,600.00	\$ 18,000.00	
2.3	30"			30"	30" FRPM Pipe Procurement	2,347			LF	\$ 197.03			\$ 462,420.00	
2.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		13.00	13.00	Lump Sum		\$ -	\$ -	
2.3	Fiberglass Pipe	HOBAS	Pipe		30" FRPM	1		2,360.00	2,360.00	LF		\$ 171.00	\$ 403,560.00	
2.3	Fiberglass Pipe	HOBAS	Pipe		30" Closure Coupling	1		4.00	4.00	EA		\$ 1,215.00	\$ 4,860.00	
2.3	Fiberglass Pipe	HOBAS	Pipe		Freight	160		2,360.00	15.00	LOADS		\$ 3,600.00	\$ 54,000.00	
2.4	72"			72"	6' Diameter Precast Maintenance Hole 0'-9'	7			EA	\$ 9,745.00			\$ 68,215.00	
2.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		14.00	14.00	Lump Sum		\$ -	\$ -	
2.4	Precast Concrete	Copeland	Material		6' Diameter Precast Manhole 0'-9'	1		7.00	7.00	EA		\$ 6,350.00	\$ 44,450.00	
2.4	Precast Concrete	Copeland	Material		Bench	1		7.00	7.00	EA		\$ 2,500.00	\$ 17,500.00	
2.4	Precast Concrete	Copeland	Material		Custom Arvada 30" R&C	1		7.00	7.00	EA		\$ 895.00	\$ 6,265.00	
2.5	72"			72"	6' Diameter Precast Maintenance Hole 9'-18'	13			EA	\$ 11,904.00			\$ 154,752.00	
2.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		15.00	15.00	Lump Sum		\$ -	\$ -	
2.5	Precast Concrete	Copeland	Material		6' Diameter Precast Manhole 9'-18'	1		13.00	13.00	EA		\$ 8,509.00	\$ 110,617.00	
2.5	Precast Concrete	Copeland	Material		Bench	1		13.00	13.00	EA		\$ 2,500.00	\$ 32,500.00	
2.5	Precast Concrete	Copeland	Material		Custom Arvada 30" R&C	1		13.00	13.00	EA		\$ 895.00	\$ 11,635.00	
2.6	6'x 8'			6'x 8'	6' x 8' Precast Combo Vault Box	2			EA	\$ 18,364.50			\$ 36,729.00	
2.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		16.00	16.00	Lump Sum		\$ -	\$ -	
2.6	Precast Concrete	Copeland	Material		Vault #1	1		1.00	1.00	EA		\$ 17,603.00	\$ 17,603.00	
2.6	Precast Concrete	Copeland	Material		Vault #2	1		1.00	1.00	EA		\$ 15,336.00	\$ 15,336.00	
2.6	Precast Concrete	Copeland	Material		Engineering	1		2.00	2.00	EA		\$ 1,000.00	\$ 2,000.00	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
2.6	Precast Concrete	Copeland	Material		Custom Arvada 30" R&C	1		2.00	2.00	EA		\$ 895.00	\$ 1,790.00	
3					Open Cut Pipe Installation									
3.1				42"	Reach 1 - 42" FRPM - South Tie In to Vault 2 - (STA 174+08.1 to 174+08.1)			561		LF		\$ 683.91		\$ 383,674.35
3.1	Garney	Install	Crew		CMAR - Pipe Crew	80.0	Units Per Shift	561.00	7.01	Shifts		\$ 26,172.29	\$ 183,814.69	
3.1	Garney	Utilities	Crew		CMAR - Pipe Crew	0.2	Shifts Per Unit	8.00	1.60	Shifts		\$ 26,172.29	\$ 41,939.89	
3.1	Garney	Delay/Phasing & Paving	Crew		CMAR - Pipe Crew	2.5	Shifts	561.00	2.50	Shifts		\$ 26,172.29	\$ 65,531.08	
3.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		19.00	19.00	Lump Sum		\$ -	\$ -	
3.1	Bedding	Burnco	Material		Bedding	1.83		561.00	1,026.08	TN		\$ 35.33	\$ 36,251.37	
3.1	Supply House	Ferguson	Material		Marking Tape - Detectable	1		561.00	561.00	LF		\$ 0.07	\$ 39.27	
3.1	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	3		24.00	72.00	CY		\$ 178.00	\$ 12,816.00	
3.1	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.54		561.00	865.74	CY		\$ 23.00	\$ 19,912.04	
3.1	Trucking	Tin Cup	Subcontract		On Site Trucking	30		7.09	212.70	HR		\$ 100.00	\$ 21,270.00	
3.1	Electrical	Sturgeon	Subcontract		Light Post - Remove and Reset	1		1.00	1.00	LS		\$ 2,100.00	\$ 2,100.00	
3.2				30"	Reach 2 - Dual 30" FRPM - Vault 2 to Vault 1 (STA 168+27.1 to 168+27.1)			489		LF		\$ 675.84		\$ 330,486.34
3.2	Garney	Install	Crew		CMAR - Pipe Crew	80.0	Units Per Shift	489.00	6.11	Shifts		\$ 26,172.29	\$ 160,223.50	
3.2	Garney	Utilities	Crew		CMAR - Pipe Crew	0.2	Shifts Per Unit	3.00	0.60	Shifts		\$ 26,172.29	\$ 15,727.46	
3.2	Garney	Delay/Phasing & Paving	Crew		CMAR - Pipe Crew	2.5	Shifts	489.00	2.50	Shifts		\$ 26,172.29	\$ 65,531.08	
3.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		20.00	20.00	Lump Sum		\$ -	\$ -	
3.2	Bedding	Burnco	Material		Bedding	2.05		489.00	1,004.42	TN		\$ 35.33	\$ 35,486.20	
3.2	Supply House	Ferguson	Material		Marking Tape - Detectable	2		489.00	978.00	LF		\$ 0.07	\$ 68.46	
3.2	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	2		30.00	60.00	CY		\$ 178.00	\$ 10,680.00	
3.2	Concrete	Holcim	Material		Concrete Encasement - Under Box Culvert	2		15.00	30.00	CY		\$ 178.00	\$ 5,340.00	
3.2	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.70		489.00	830.09	CY		\$ 23.00	\$ 19,092.13	
3.2	Trucking	Tin Cup	Subcontract		On Site Trucking	30		6.11	183.38	HR		\$ 100.00	\$ 18,337.50	
3.3				30"	Reach 3 - 30" FRPM - Vault 1 to SSMH#15 (STA 163+32.27 to 163+32.27)			1,337		LF		\$ 454.93		\$ 608,235.73
3.3	Garney	Install	Crew		CMAR - Pipe Crew	100.0	Units Per Shift	1,337.00	13.37	Shifts		\$ 26,172.29	\$ 350,460.24	
3.3	Garney	Utilities	Crew		CMAR - Pipe Crew	0.20	Shifts Per Unit	6.00	1.20	Shifts		\$ 26,172.29	\$ 31,454.92	
3.3	Garney	Delay/Phasing & Paving	Crew		CMAR - Pipe Crew	2.50	Shifts	1,337.00	2.50	Shifts		\$ 26,172.29	\$ 65,531.08	
3.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		21.00	21.00	Lump Sum		\$ -	\$ -	
3.3	Bedding	Burnco	Material		Bedding	1.40		1,337.00	1,868.31	TN		\$ 35.33	\$ 66,007.22	
3.3	Supply House	Ferguson	Material		Marking Tape - Detectable	1		1,337.00	1,337.00	LF		\$ 0.07	\$ 93.59	
3.3	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	5		24.00	120.00	CY		\$ 178.00	\$ 21,360.00	
3.3	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.08		1,337.00	1,444.29	CY		\$ 23.00	\$ 33,218.67	
3.3	Trucking	Tin Cup	Subcontract		On Site Trucking	30		13.37	401.10	HR		\$ 100.00	\$ 40,110.00	
3.4				42"	Reach 4 - 42" FRPM - SSMH#15 to S. 72nd Bore (STA 149+75.1 to 149+75.1)			448		LF		\$ 1,154.77		\$ 517,336.34
3.4	Garney	Install	Crew		CMAR - Pipe Crew	40.0	Units Per Shift	448.00	11.20	Shifts		\$ 26,172.29	\$ 293,579.26	
3.4	Garney	Delay/Phasing & Paving	Crew		CMAR - Pipe Crew	2.5	Shifts	448.00	2.50	Shifts		\$ 26,172.29	\$ 65,531.08	
3.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		22.00	22.00	Lump Sum		\$ -	\$ -	
3.4	Bedding	Burnco	Material		Bedding	1.83		448.00	819.40	TN		\$ 35.33	\$ 28,949.40	
3.4	Supply House	Ferguson	Material		Marking Tape - Detectable	1		448.00	448.00	LF		\$ 0.07	\$ 31.36	
3.4	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	1		448.00	448.00	LF		\$ 178.00	\$ 79,744.00	
3.4	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.54		448.00	691.36	CY		\$ 23.00	\$ 15,901.23	
3.4	Trucking	Tin Cup	Subcontract		On Site Trucking	30		11.20	336.00	HR		\$ 100.00	\$ 33,600.00	

ARVADA NTL7 - ESTIMATE

BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
3.5				42"	Reach 5 - 42" FRPM - N. 72nd Bore to SSMH#8 (STA 143+21			1,955		LF		\$ 809.95		\$ 1,583,451.49
3.5	Garney	Install	Crew		CMAR - Pipe Crew	50.0	Units Per Shift	1,955.00	39.10	Shifts		\$ 26,172.29	\$ 1,024,906.17	
3.5	Garney	Utilities	Crew		CMAR - Pipe Crew	0.20	Shifts Per Unit	13.00	2.60	Shifts		\$ 26,172.29	\$ 68,152.33	
3.5	Garney	Delay/Phasing & Pavin	Crew		CMAR - Pipe Crew	5.0	Shifts	1,955.00	5.00	Shifts		\$ 26,172.29	\$ 131,062.17	
3.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		23.00	23.00	Lump Sum		\$ -	\$ -	
3.5	Bedding	Burnco	Material		Bedding	1.83		1,955.00	3,575.73	TN		\$ 35.33	\$ 126,330.54	
3.5	Supply House	Ferguson	Material		Marking Tape - Detectable	1		1,955.00	1,955.00	LF		\$ 0.07	\$ 136.85	
3.5	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	8		30.75	246.00	CY		\$ 178.00	\$ 43,788.00	
3.5	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.54		1,955.00	3,016.98	CY		\$ 23.00	\$ 69,390.43	
3.5	Trucking	Tin Cup	Subcontract		On Site Trucking	30		39.90	1,196.85	HR		\$ 100.00	\$ 119,685.00	
3.6				42"	Reach 6 - 42" FRPM - SSMH#8 to SSMH#4 (STA 123+33.10 to			652		LF		\$ 821.69		\$ 535,740.75
3.6	Garney	Install	Crew		CMAR - Pipe Crew	60.0	Units Per Shift	652.00	10.87	Shifts		\$ 26,172.29	\$ 284,841.78	
3.6	Garney	Utilities	Crew		CMAR - Pipe Crew	0.20	Shifts Per Unit	3.00	0.60	Shifts		\$ 26,172.29	\$ 15,727.46	
3.6	Garney	Delay/Phasing & Pavin	Crew		CMAR - Pipe Crew	5.0	Shifts	652.00	5.00	Shifts		\$ 26,172.29	\$ 131,062.17	
3.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		24.00	24.00	Lump Sum		\$ -	\$ -	
3.6	Bedding	Burnco	Material		Bedding	1.83		652.00	1,192.52	TN		\$ 35.33	\$ 42,131.72	
3.6	Supply House	Ferguson	Material		Marking Tape - Detectable	1		652.00	652.00	LF		\$ 0.07	\$ 45.64	
3.6	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	1		30.00	30.00	CY		\$ 178.00	\$ 5,340.00	
3.6	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.54		652.00	1,006.17	CY		\$ 23.00	\$ 23,141.98	
3.6	Trucking	Tin Cup	Subcontract		On Site Trucking	30		11.15	334.50	HR		\$ 100.00	\$ 33,450.00	
3.7				42"	Reach 7 - 42" FRPM - SSMH#4 to SSMH#2 (STA 116+50.71 to			856		LF		\$ 445.93		\$ 381,718.02
3.7	Garney	Install	Crew		CMAR - Pipe Crew	140.0	Units Per Shift	856.00	6.11	Shifts		\$ 26,172.29	\$ 160,270.31	
3.7	Garney	Utilities	Crew		CMAR - Pipe Crew	0.20	Shifts Per Unit	1.00	0.20	Shifts		\$ 26,172.29	\$ 5,242.49	
3.7	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		25.00	25.00	Lump Sum		\$ -	\$ -	
3.7	Bedding	Burnco	Material		Bedding	1.83		856.00	1,565.64	TN		\$ 35.33	\$ 55,314.04	
3.7	Supply House	Ferguson	Material		Marking Tape - Detectable	1		856.00	856.00	LF		\$ 0.07	\$ 59.92	
3.7	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	5		24.00	120.00	CY		\$ 178.00	\$ 21,360.00	
3.7	Flowable Fill	Holcim	Material		CLSM - Sheet Pile Penetration	1		10.00	10.00	CY		\$ 156.00	\$ 1,560.00	
3.7	Crushed Stone	Burnco	Material		24" Rip Rap	1		50.00	50.00	TN		\$ 81.25	\$ 4,062.50	
3.7	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.54		856.00	1,320.99	CY		\$ 100.00	\$ 132,098.77	
3.7	Welding	Mountain Man	Subcontract		Sheet Pile Penetration Hole	1		1.00	1.00	LS		\$ 1,750.00	\$ 1,750.00	
3.8				36"	Reach 8 - 36" FRPM - SSMH#2 to North Tie In (STA 107+81.5			768		LF		\$ 308.65		\$ 237,043.99
3.8	Garney	Install	Crew		CMAR - Pipe Crew	140.0	Units Per Shift	768.00	5.49	Shifts		\$ 26,172.29	\$ 143,793.92	
3.8	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		26.00	26.00	Lump Sum		\$ -	\$ -	
3.8	Bedding	Burnco	Material		Bedding	1.75		768.00	1,344.02	TN		\$ 35.33	\$ 47,484.17	
3.8	Supply House	Ferguson	Material		Marking Tape - Detectable	1		768.00	768.00	LF		\$ 0.07	\$ 53.76	
3.8	Concrete	Holcim	Material		Concrete Encasement - Utility Crossings	1		24.00	24.00	CY		\$ 178.00	\$ 4,272.00	
3.8	Flowable Fill	Holcim	Material		CLSM - Sheet Pile Penetration	1		10.00	10.00	CY		\$ 156.00	\$ 1,560.00	
3.8	Crushed Stone	Burnco	Material		24" Rip Rap	1		44.00	44.00	TN		\$ 81.25	\$ 3,575.00	
3.8	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.39		768.00	1,067.61	CY		\$ 23.00	\$ 24,555.14	
3.8	Welding	Mountain Man	Subcontract		Sheet Pile Penetration Hole	1		1.00	1.00	EA		\$ 1,750.00	\$ 1,750.00	
3.8	CIPP		Subcontract		Concrete Storm Ditch Removal/Replacement	1		1.00	1.00	LS		\$ 10,000.00	\$ 10,000.00	
					Maintenance Holes and Vaults									

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
4.1				72"	6' Diameter Precast Maintenance Hole 0'->9'				7	EA		\$ 20,692.39		\$ 144,846.76
4.1	Garney		Crew		CMAR - Pipe Crew	0.75	Shifts Per Unit	7.00	5.25	Shifts		\$ 26,172.29	\$ 137,615.28	
4.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		28.00	28.00	Lump Sum		\$ -	\$ -	
4.1	Supply House	Ferguson	Material		Marker Posts	1		4.00	4.00	EA		\$ 60.00	\$ 240.00	
4.1	Crushed Stone	Burnco	Material		67 Stone	8		7.00	56.00	TN		\$ 35.33	\$ 1,978.48	
4.1	Flowable Fill	Holcim	Material		CLSM (Backill Around Manholes in Pavement)	1		14.00	14.00	CY		\$ 156.00	\$ 2,184.00	
4.1		Tin Cup	Subcontract		Haul Off - Spoils	1		123.00	123.00	CY		\$ 23.00	\$ 2,829.00	
4.2				72"	6' Diameter Precast Maintenance Hole 9'-18'				13	EA		\$ 35,343.15		\$ 459,460.96
4.2	Garney		Crew		CMAR - Pipe Crew	1.0	Shifts Per Unit	13.00	13.00	Shifts		\$ 26,172.29	\$ 340,761.64	
4.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		29.00	29.00	Lump Sum		\$ -	\$ -	
4.2	Crushed Stone	Burnco	Material		67 Stone	8		13.00	104.00	TN		\$ 35.33	\$ 3,674.32	
4.2	Flowable Fill	Holcim	Material		CLSM (Backill Around Maholes in Pavement)	1		502.00	502.00	CY		\$ 156.00	\$ 78,312.00	
4.2	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1		738.00	738.00	CY		\$ 23.00	\$ 16,974.00	
4.2	Tunnel	UIT	Subcontract		Install MH#14	1		1.00	1.00	EA		\$ 19,739.00	\$ 19,739.00	
4.3				6'x9'	6' x 9' Precast Combo Vault Box				2	EA		\$ 42,261.07		\$ 84,522.14
4.3	Garney		Crew		CMAR - Pipe Crew	1.0	Shifts Per Unit	2.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
4.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		30.00	30.00	Lump Sum		\$ -	\$ -	
4.3	Crushed Stone	Burnco	Material		67 Stone	9		2.00	18.00	TN		\$ 35.33	\$ 635.94	
4.3	Flowable Fill	Holcim	Material		CLSM (Backill Around Maholes in Pavement)	2		26.00	52.00	CY		\$ 156.00	\$ 8,112.00	
4.3	Structural Concrete	Holcim	Subcontract		Invert Fill	1		2.00	2.00	EA		\$ 8,000.00	\$ 16,000.00	
4.3	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	2		29.33	58.67	CY		\$ 23.00	\$ 1,349.33	
4.3	Crane	Duffy	Subcontract		Crane	1		2.00	2.00	EA		\$ 3,000.00	\$ 6,000.00	
5				0	Connections									
5.1				0	South Tie In Connection				1	EA		\$ 115,082.96		\$ 115,082.96
5.1	Garney		Crew		CMAR - Pipe Crew	4.0	Shifts	1.00	4.00	Shifts		\$ 26,172.29	\$ 104,849.74	
5.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		32.00	32.00	Lump Sum		\$ -	\$ -	
5.1	Supply House	Ferguson	Material	12"	SDR 35	1		28.00	28.00	LF		\$ 22.50	\$ 630.00	
5.1	Supply House	Ferguson	Material	12"	PVC to VCP Coupling	1		1.00	1.00	EA		\$ 150.00	\$ 150.00	
5.1	Supply House	Ferguson	Material	30"	SDR 35	1		28.00	28.00	LF		\$ 135.00	\$ 3,780.00	
5.1	Supply House	Ferguson	Material	30"	PVC to VCP Coupling	1		1.00	1.00	EA		\$ 1,550.00	\$ 1,550.00	
5.1	Bedding	Burnco	Material	12"	Bedding	0.55		20.00	10.92	TN		\$ 35.33	\$ 385.84	
5.1	Bedding	Burnco	Material	30"	Bedding	1.40		14.00	19.56	TN		\$ 35.33	\$ 691.18	
5.1	Crushed Stone	Burnco	Material		Road Base for Shoe Fly	1.00		20.00	20.00	TN		\$ 26.40	\$ 528.00	
5.1	Asphalt Paving	CPS	Subcontract		Asphalt Ramps for Shoe Fly	1.00		2.00	2.00	EA		\$ 1,000.00	\$ 2,000.00	
5.1	Trucking	Tin Cup	Subcontract		Haul Off - 12" Spoils	0.37		20.00	7.41	CY		\$ 23.00	\$ 170.37	
5.1	Trucking	Tin Cup	Subcontract		Haul Off - 30" Spoils	1.08		14.00	15.12	CY		\$ 23.00	\$ 347.84	
5.2				0	8" PVC Lateral Connection SSMH #17				1	EA		\$ 35,795.27		\$ 35,795.27
5.2	Garney		Crew		CMAR - Pipe Crew	1.0	Shifts	1.00	1.00	Shifts		\$ 26,172.29	\$ 26,212.43	
5.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		33.00	33.00	Lump Sum		\$ -	\$ -	
5.2	Supply House	Ferguson	Material	8"	SDR 35	1		42.00	42.00	LF		\$ 10.15	\$ 426.30	
5.2	Supply House	Ferguson	Material	8"	Coupling	1		1.00	1.00	EA		\$ 100.00	\$ 100.00	
5.2	Bedding	Ferguson	Material		Bedding	0.45		34.00	15.30	TN		\$ 35.33	\$ 540.55	
5.2	Flowable Fill	Flashfill Services	Material		Flashfill (Expedite Night Work)	52.89		1.00	52.89	CY		\$ 127.00	\$ 6,716.89	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
5.2	Flowable Fill	Flashfill Services	Material		Flashfill Night Work Fee	1.00		1.00	1.00	EA		\$ 350.00	\$ 350.00	
5.2	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	0.29		34.00	10.00	CY		\$ 23.00	\$ 230.09	
5.2	Trucking	Tin Cup	Subcontract		Haul Off - Spoils (Flashfill)	1		53.00	53.00	CY		\$ 23.00	\$ 1,219.00	
5.3				0	18" FRPM Lateral Connection Vault 1			1		EA		\$ 42,778.99		\$ 42,778.99
5.3	Garney		Crew		CMAR - Pipe Crew	1.0	Shifts	1.00	1.00	Shifts		\$ 26,172.29	\$ 26,212.43	
5.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		34.00	34.00	Lump Sum		\$ -	\$ -	
5.3	Fiberglass Pipe	HOBAS	Pipe	18"	18" FRPM	1		60.00	60.00	LF		\$ 95.00	\$ 5,700.00	
5.3	Supply House	Ferguson	Material	18"	18" VCP to FRPM Coupling	1		1.00	1.00	EA		\$ 495.00	\$ 495.00	
5.3	Bedding	Burnco	Material		Bedding	0.70		41.00	28.51	LF		\$ 35.33	\$ 1,007.11	
5.3	Flowable Fill	Flashfill Services	Material		Flashfill (Expedite Night Work)	56.94		1.00	56.94	CY		\$ 127.00	\$ 7,231.94	
5.3	Flowable Fill	Flashfill Services	Material		Flashfill Night Work Fee	1.00		1.00	1.00	EA		\$ 350.00	\$ 350.00	
5.3	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	0.50		41.00	20.50	EA		\$ 23.00	\$ 471.50	
5.3	Trucking	Tin Cup	Subcontract		Haul Off - Spoils (Flashfill)	57		1.00	57.00	CY		\$ 23.00	\$ 1,311.00	
5.4				0	SSMH # 6 Connection at Existing System			1		EA		\$ 131,062.17		\$ 131,062.17
5.4	Garney		Crew		CMAR - Pipe Crew	5.0	Shifts	1.00	5.00	Shifts		\$ 26,172.29	\$ 131,062.17	
5.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		35.00	35.00	Lump Sum		\$ -	\$ -	
5.5				0	North Tie in Connection			1		EA		\$ 108,399.74		\$ 108,399.74
5.5	Garney		Crew		CMAR - Pipe Crew	4.0	Shifts	1.00	4.00	Shifts		\$ 26,172.29	\$ 104,849.74	
5.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		36.00	36.00	Lump Sum		\$ -	\$ -	
5.5	Small Tools	Home Depot	Material		Grout	1		1.00	1.00	EA		\$ 50.00	\$ 50.00	
5.5	Cutting & Coring	DeAndrea	Subcontract		36" Core Hole - MH8411	1		1.00	1.00	EA		\$ 3,500.00	\$ 3,500.00	
6					Trenchless									
6.1					72nd Bore Launch Pit			1		EA		\$ 146,224.00		\$ 146,224.00
6.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		38.00	38.00	Lump Sum		\$ -	\$ -	
6.1	Tunnel	UIT	Subcontract		72nd Launch Pit	1		1.00	1.00	EA		\$ 85,378.00	\$ 85,378.00	
6.1	Tunnel	UIT	Subcontract		Mobilization	1		1.00	1.00	EA		\$ 36,846.00	\$ 36,846.00	
6.1	Tunnel	UIT	Subcontract		Box Rental (Additional Week)	1		2.00	2.00	EA		\$ 2,400.00	\$ 4,800.00	
6.1	Tunnel	UIT	Subcontract		I&M	1		1.00	1.00	LS		\$ 19,200.00	\$ 19,200.00	
6.2					72nd Ave 60" Casing and 42" FRPM Carrier Pipe Installation			200		LF		\$ 3,244.85		\$ 648,970.52
6.2	Garney		Crew		CMAR - Pipe Crew	2.0	Shifts	200.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
6.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		39.00	39.00	Lump Sum		\$ -	\$ -	
6.2	Tunnel	UIT	Subcontract		72nd Bore	1		200.00	200.00	LF		\$ 2,966.00	\$ 593,200.00	
6.2	Trucking	Tin Cup	Subcontract		Haul Off Spoils	1		145.46	145.46	CY		\$ 23.00	\$ 3,345.65	
6.3					72nd Bore Receiving Pit			1		EA		\$ 34,117.00		\$ 34,117.00
6.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		40.00	40.00	Lump Sum		\$ -	\$ -	
6.3	Tunnel	UIT	Subcontract		72nd Receiving Shaft	1		1.00	1.00	EA		\$ 26,917.00	\$ 26,917.00	
6.3	Tunnel	UIT	Subcontract		Box Rental (Additional Week)	1		3.00	3.00	WK		\$ 2,400.00	\$ 7,200.00	
7					Utility Relocations									
7.1				16"	16" Waterline Conflict STA 123+25 (Westminster)			1		LS		\$ 69,392.42		\$ 69,392.42
7.1	Garney		Crew		CMAR - Pipe Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
7.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		42.00	42.00	Lump Sum		\$ -	\$ -	
7.1	Supply House	Ferguson	Material	16"	Solid Sleeves	2		1.00	2.00	EA		\$ 1,015.00	\$ 2,030.00	
7.1	Supply House	Ferguson	Material	16"	C900	40		1.00	40.00	LF		\$ 72.50	\$ 2,900.00	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
7.1	Supply House	Ferguson	Material	16"	45 Degree Bends	4		1.00	4.00	EA		\$ 1,125.00	\$ 4,500.00	
7.1	Supply House	Ferguson	Material	16"	Mega Lugs	12		1.00	12.00	EA		\$ 305.00	\$ 3,660.00	
7.1	Supply House	Ferguson	Material	16"	BNG Kit	12		1.00	12.00	EA		\$ 65.00	\$ 780.00	
7.1	Supply House	Ferguson	Material		Sacrificial ZN Cap	120		1.00	120.00	EA		\$ 4.00	\$ 480.00	
7.1	Supply House	Ferguson	Material	16"	Joint Restraints	1		1.00	1.00	EA		\$ 595.00	\$ 595.00	
7.1	Supply House	Ferguson	Material		Tracer Wire	40		1.00	40.00	LF		\$ 1.50	\$ 60.00	
7.1	Supply House	Ferguson	Material		Splice Kits	2		1.00	2.00	EA		\$ 20.00	\$ 40.00	
7.1	Concrete	Holcim	Material		Thrust Blocks	4		1.00	4.00	LS		\$ 100.00	\$ 400.00	
7.1	Concrete	Home Depot	Material		Rebar	1		1.00	1.00	LS		\$ 50.00	\$ 50.00	
7.1	Bedding	Burnco	Material		Bedding	0.70		40.00	27.81	TN		\$ 35.33	\$ 982.55	
7.1	Supply House	Ferguson	Material		Chlorine Tablets	1		1.00	1.00	LS		\$ 30.00	\$ 30.00	
7.1	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	0.50		40.00	20.00	CY		\$ 23.00	\$ 460.00	
7.2				8"	8" Waterline Conflict STA 124+50 (Westminster)				1	LS		\$ 45,529.44		\$ 45,529.44
7.2	Garney		Crew		CMAR - Pipe Crew	1.5	Shifts	1.00	1.50	Shifts		\$ 26,172.29	\$ 39,318.65	
7.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		43.00	43.00	Lump Sum		\$ -	\$ -	
7.2	Supply House	Ferguson	Material	8"	Solid Sleeves	2		1.00	2.00	EA		\$ 335.00	\$ 670.00	
7.2	Supply House	Ferguson	Material	8"	C900	40		1.00	40.00	LF		\$ 26.50	\$ 1,060.00	
7.2	Supply House	Ferguson	Material	8"	45 Degree Bends	4		1.00	4.00	EA		\$ 270.00	\$ 1,080.00	
7.2	Supply House	Ferguson	Material	8"	Mega Lugs	12		1.00	12.00	EA		\$ 70.00	\$ 840.00	
7.2	Supply House	Ferguson	Material	8"	BNG Kit	12		1.00	12.00	EA		\$ 28.00	\$ 336.00	
7.2	Supply House	Ferguson	Material	8"	Joint Restraints	1		1.00	1.00	EA		\$ 258.02	\$ 258.02	
7.2	Supply House	Ferguson	Material		Sacrificial ZN Cap	120		1.00	120.00	EA		\$ 4.00	\$ 480.00	
7.2	Supply House	Ferguson	Material		Tracer Wire	40		1.00	40.00	LF		\$ 1.50	\$ 60.00	
7.2	Supply House	Ferguson	Material		Splice Kits	2		1.00	2.00	EA		\$ 20.00	\$ 40.00	
7.2	Concrete	Holcim	Material		Thrust Blocks	4		1.00	4.00	EA		\$ 100.00	\$ 400.00	
7.2	Concrete	Home Depot	Material		Rebar	1		1.00	1.00	LS		\$ 50.00	\$ 50.00	
7.2	Bedding	Burnco	Material		Bedding	0.45		40.00	18.00	TN		\$ 35.33	\$ 636.07	
7.2	Supply House	Ferguson	Material		Chlorine Tablets	1		1.00	1.00	LS		\$ 30.00	\$ 30.00	
7.2	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	0.29		40.00	11.77	CY		\$ 23.00	\$ 270.70	
7.3				12"	12" Waterline Conflict STA 156+75 (Arvada)				1	LS		\$ 47,977.68		\$ 47,977.68
7.3	Garney		Crew		CMAR - Pipe Crew	1.5	Shifts	1.00	1.50	Shifts		\$ 26,172.29	\$ 39,318.65	
7.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		44.00	44.00	Lump Sum		\$ -	\$ -	
7.3	Supply House	Ferguson	Material	12"	Solid Sleeves	2		1.00	2.00	EA		\$ 515.00	\$ 1,030.00	
7.3	Supply House	Ferguson	Material	12"	C900	40		1.00	40.00	LF		\$ 61.00	\$ 2,440.00	
7.3	Supply House	Ferguson	Material	12"	45 Degree Bends	4		1.00	4.00	EA		\$ 575.00	\$ 2,300.00	
7.3	Supply House	Ferguson	Material	12"	Mega Lugs	8		1.00	8.00	EA		\$ 135.00	\$ 1,080.00	
7.3	Supply House	Ferguson	Material	12"	BNG Kit	8		1.00	8.00	EA		\$ 38.00	\$ 304.00	
7.3	Supply House	Ferguson	Material	12"	Sacrificial ZN Cap	80		1.00	80.00	EA		\$ 4.00	\$ 320.00	
7.3	Supply House	Ferguson	Material	12"	Joint Restraints	1		1.00	1.00	EA		\$ 245.00	\$ 245.00	
7.3	Supply House	Ferguson	Material		Tracer Wire	40		1.00	40.00	LF		\$ 1.50	\$ 60.00	
7.3	Supply House	Ferguson	Material		Splice Kits	2		1.00	2.00	EA		\$ 20.00	\$ 40.00	
7.3	Concrete	Holcim	Material		Thrust Blocks	4		1.00	4.00	EA		\$ 100.00	\$ 400.00	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
7.3	Concrete	Home Depot	Material		Rebar	1		1.00	1.00	LS		\$ 50.00	\$ 50.00	
7.3	Bedding	Burnco	Material		Bedding	0.55		1.00	0.55	TN		\$ 35.33	\$ 19.29	
7.3	Supply House	Ferguson	Material		Chlorine Tablets	1		1.00	1.00	LS		\$ 30.00	\$ 30.00	
7.3	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	0.37		40.00	14.81	CY		\$ 23.00	\$ 340.74	
7.4				30"	30" Strom Conflict STA 168+08 (Arvada)			1		LS		\$ 82,940.14		\$ 82,940.14
7.4	Garney		Crew		CMAR - Pipe Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
7.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		45.00	45.00	Lump Sum		\$ -	\$ -	
7.4	Supply House	Ferguson	Material	30"	SDR 35	1		84.00	84.00	LF		\$ 135.00	\$ 11,340.00	
7.4	Crushed Stone	Burnco	Material		67 Stone	1.40		74.00	103.41	LF		\$ 35.33	\$ 3,653.35	
7.4	Small Tools	Home Depot	Material		Grout	1		1.00	1.00	LS		\$ 50.00	\$ 50.00	
7.4	Flowable Fill	Flashfill Services	Material		Flashfill	32.89	CY	1.00	32.89	CY		\$ 127.00	\$ 4,176.89	
7.4	Flowable Fill	Flashfill Services	Material		Flashfill (Night Work Charge)	1		2.00	2.00	EA		\$ 350.00	\$ 700.00	
7.4	Asphalt Paving	CMS	Subcontract		Paving Mobilizatoin (Night)	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
7.4	Cutting & Coring	DeAndrea	Subcontract		Core Holes	1		2.00	2.00	EA		\$ 2,500.00	\$ 5,000.00	
7.4	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.08		74.00	79.94	LF		\$ 23.00	\$ 1,838.58	
7.4	Trucking	Tin Cup	Subcontract		Haul Off - Flashfill	1		32.89	32.89	LF		\$ 23.00	\$ 756.44	
7.5				36"	36" RCP Storm Conflict STA 170+43 (Arvada)			1		LS		\$ 135,976.49		\$ 135,976.49
7.5	Garney		Crew		CMAR - Pipe Crew	2.5	Shifts	1.00	2.50	Shifts		\$ 26,172.29	\$ 65,531.08	
7.5	Garney		Crew		CMAR- Support Crew	0.5	Shifts	1.00	0.50	Shifts		\$ 6,818.56	\$ 3,422.70	
7.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		80.00	80.00	Lump Sum		\$ -	\$ -	
7.5	Supply House		Material		SDR 35	1		112.00	112.00	LF		\$ 355.00	\$ 39,760.00	
7.5	Crushed Stone		Material		67 Stone	1.29		109.00	140.68	LF		\$ 35.33	\$ 4,970.21	
7.5	Concrete		Material		Grout	1		1.00	1.00	LS		\$ 200.00	\$ 200.00	
7.5	Flowable Fill		Material		Flashfill	103		1.00	103.00	CY		\$ 127.00	\$ 13,081.00	
7.5	Flowable Fill		Material		Flashfill (Night Work Charge)	1		2.00	2.00	EA		\$ 350.00	\$ 700.00	
7.5	Asphalt Paving		Subcontract		Paving Mobilization (Night)	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
7.5	Cutting & Coring		Subcontract		Core Holes	1		1.00	1.00	LS		\$ 2,000.00	\$ 2,000.00	
7.5	Trucking		Subcontract		Haul Off - Spoils	1.31		109.00	142.98	CY		\$ 23.00	\$ 3,288.50	
7.5	Trucking		Subcontract		Haul Off - Flashfill	1		1.00	1.00	CY		\$ 23.00	\$ 23.00	
7.6				24"	24" Waterline Conflict STA 170+34 (Arvada)			1		LS		\$ 90,272.79		\$ 90,272.79
7.6	Garney		Crew		CMAR - Pipe Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
7.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		46.00	46.00	Lump Sum		\$ -	\$ -	
7.6	Supply House		Material	24"	Solid Sleeves	2		1.00	2.00	EA		\$ 2,100.00	\$ 4,200.00	
7.6	Supply House		Material	24"	C900	60		1.00	60.00	LF		\$ 72.50	\$ 4,350.00	
7.6	Supply House	Ferguson	Material	24"	45 Degree Bends	4		1.00	4.00	EA		\$ 1,125.00	\$ 4,500.00	
7.6	Supply House	Ferguson	Material	24"	Mega Lugs	8		1.00	8.00	EA		\$ 305.00	\$ 2,440.00	
7.6	Supply House	Ferguson	Material	24"	BNG Kit	8		1.00	8.00	EA		\$ 65.00	\$ 520.00	
7.6	Supply House	Ferguson	Material	24"	Sacrificial ZN Cap	120		1.00	120.00	EA		\$ 4.00	\$ 480.00	
7.6	Supply House	Ferguson	Material	24"	Joint Restraints	1		1.00	1.00	EA		\$ 595.00	\$ 595.00	
7.6	Supply House	Ferguson	Material		Tracer Wire	60		1.00	60.00	LF		\$ 1.50	\$ 90.00	
7.6	Supply House	Ferguson	Material		Splice Kits	2		1.00	2.00	EA		\$ 20.00	\$ 40.00	
7.6	Concrete	Ferguson	Material		Thrust Blocks	4		1.00	4.00	EA		\$ 100.00	\$ 400.00	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
7.6	Concrete	Home Depot	Material		Rebar	1		1.00	1.00	LS		\$ 50.00	\$ 50.00	
7.6	Bedding	Burnco	Material		Bedding	1.40		60.00	83.84	TN		\$ 35.33	\$ 2,962.18	
7.6	Supply House	Ferguson	Material		Chlorine Tablets	1		1.00	1.00	LS		\$ 30.00	\$ 30.00	
7.6	Flowable Fill	Flashfill Services	Material		Flashfill	80.00	CY	1.00	80.00	CY		\$ 127.00	\$ 10,160.00	
7.6	Flowable Fill	Flashfill Services	Material		Flashfill (Night Work Charge)	1		2.00	2.00	EA		\$ 350.00	\$ 700.00	
7.6	Asphalt Paving	CPS	Subcontract		Paving Mobilizatoin (Night)	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
7.6	Trucking	Tin Cup	Subcontract		Haul Off - Spoils	1.08		60.00	64.81	CY		\$ 23.00	\$ 1,490.74	
7.6	Trucking	Tin Cup	Subcontract		Haul Off - Flashfill	1		80.00	80.00	CY		\$ 23.00	\$ 1,840.00	
8					Surface Removals and Restoration									
8.1					0	12" Thick Asphalt Removal			6,036		SY		\$ 37.96	\$ 229,118.00
8.1	Garney		Crew		CMAR- Support Crew	5.0	Shifts	6,036.00	5.00	Shifts		\$ 6,818.56	\$ 34,226.99	
8.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		157.00	157.00	Lump Sum		\$ -	\$ -	
8.1	Asphalt Paving	CPS	Subcontract		Milling Mobilizations	1		5.00	5.00	EA		\$ 1,800.00	\$ 9,000.00	
8.1	Asphalt Paving	CPS	Subcontract		Trench Milling (In Place)	1		6,036.00	6,036.00	SY		\$ 7.74	\$ 46,718.64	
8.1	Trucking	CPS	Subcontract		Millings Haul Off (12")	49992	SQ FT	1.00	1,851.56	CY		\$ 23.00	\$ 42,585.78	
8.1	Trucking	CPS	Subcontract		Road Base Import Haul Off (12")	53530	SQ FT	1.00	1,982.59	CY		\$ 23.00	\$ 45,599.63	
8.1	Trucking	CPS	Subcontract		Asphalt Haul Off (Laterals/Lowerings)	3537	SQ FT	1.00	131.00	CY		\$ 10.00	\$ 1,310.00	
8.1	Cutting & Coring	CPS	Subcontract		Saw Cutting (Trench Patching)	2		5,400.00	10,800.00	LF		\$ 4.00	\$ 43,200.00	
8.1	Cutting & Coring	CPS	Subcontract		Saw Cutting (Laterals/Lowerings/Abdondonments/Bore/Box C.)	1.1		1,472.00	1,619.20	LF		\$ 4.00	\$ 6,476.96	
8.2					0	Asphalt Trench Patching			3,125		TON		\$ 227.92	\$ 712,245.95
8.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		48.00	48.00	Lump Sum		\$ -	\$ -	
8.2	Asphalt Paving	CPS	Subcontract		Mobilizations	1		10.00	10.00	EA		\$ 1,500.00	\$ 15,000.00	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (Mainline)	1.05		2,719.00	2,854.95	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (16" PVC Waterline Lowering Sta 123+25)	1		17.00	17.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Tench Patching (8" PVC Waterine Lowering STA 124+50)	1		17.00	17.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Tench Patching (12" PVC Waterline Raising STA 156+75)	1		17.00	17.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Tench Patching (30" Storm Raising STA 168+08)	1		33.00	33.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Tench Patching (24" PVC Waterline Lowering STA 170+34)	1		17.00	17.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Tench Patching (36" RCP Stom Line Raising STA 170+43)	1		102.00	102.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (MH Abondonment)	12		8.00	96.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (8" Connection MH 18)	1		8.00	8.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (18" Connection Vault 2)	1		14.00	14.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching (Box Culvert)	1		72.00	72.00	TON		Included	Included	
8.2	Asphalt Paving	CPS	Subcontract		Trench Patching	1		3,125.00	3,125.00	TON		\$ 151.03	\$ 471,968.75	
8.2	Asphalt Paving	CPS	Subcontract		Road Base Installation & Prep (12")	1		6,135.00	6,135.00	SY		\$ 36.72	\$ 225,277.20	
8.3					0	2" Mill and Overlay			19,771		SY		\$ 27.05	
8.3	Garney		Crew		CMAR- Support Crew	5.0	Shifts	19,771.00	5.00	Shifts		\$ 6,818.56	\$ 34,226.99	
8.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		49.00	49.00	Lump Sum		\$ -	\$ -	
8.3	Asphalt Paving	CPS	Subcontract		Mobilizations	1		2.00	2.00	EA		\$ 1,800.00	\$ 3,600.00	
8.3	Asphalt Paving	CPS	Subcontract		Mill and Overlay	1		19,771.00	19,771.00	SY		\$ 25.14	\$ 497,042.94	
8.4					0	4" Temporary Paving and Removal			1,613		SY		\$ 37.09	\$ 59,825.99
8.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		78.00	78.00	Lump Sum		\$ -	\$ -	
8.4	Asphalt Paving	CPS	Subcontract		Temp Paving and Removal	1		1,613.00	1,613.00	SY		\$ 35.23	\$ 56,825.99	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
8.4	Asphalt Paving	CPS	Subcontract		Mobilizations	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
8.5				0	Striping				1	LS		\$ 134,343.52		\$ 134,343.52
8.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		50.00	50.00	Lump Sum		\$ -	\$ -	
8.5	Striping	Riders	Subcontract		Stiping (Red Area)	1		1.00	1.00	LS		\$ 83,948.65	\$ 83,948.65	
8.5	Striping	Riders	Subcontract		Overrun	0.1		1.00	0.10	LS		\$ 83,948.65	\$ 8,394.87	
8.5	Striping	Riders	Subcontract		Mill and Overlay Stiping (Removal)	1		5.00	5.00	EA		\$ 4,200.00	\$ 21,000.00	
8.5	Striping	Riders	Subcontract		Mill and Overlay Striping (Final Temp)	1		5.00	5.00	EA		\$ 4,200.00	\$ 21,000.00	
8.6				0	Concrete Sidewalk Removal and Replacement				1,073	SF		\$ 18.72		\$ 20,091.05
8.6	Garney	Removal	Crew		CMAR - Pipe Crew	0.2	Shifts	1,073.00	0.15	Shifts		\$ 26,172.29	\$ 3,931.87	
8.6	Garney	Prep	Crew		CMAR- Support Crew	2,500.0	Units Per Shift	1,073.00	0.43	Shifts		\$ 6,818.56	\$ 2,938.04	
8.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		51.00	51.00	Lump Sum		\$ -	\$ -	
8.6	Crushed Stone	CCS	Material		Road Base	1		30.00	30.00	TN		\$ 26.40	\$ 792.00	
8.6	Concrete Flatwork	CCS	Subcontract		Sidewalk Replacement	1		1,073.00	1,073.00	SF		\$ 9.71	\$ 10,418.83	
8.6	Concrete Flatwork	CCS	Subcontract		Mobilizations	1		1.00	1.00	EA		\$ 1,500.00	\$ 1,500.00	
8.6	Cutting & Coring	CCS	Subcontract		Saw Cutting	6		12.00	72.00	LF		\$ 3.50	\$ 252.00	
8.6	Trucking	Tin Cup	Subcontract		Haul Off	1		25.83	25.83	CY		\$ 10.00	\$ 258.31	
8.6	Trucking		Subcontract		Concrete Dump Fee	1		3.00	3.00	LD		Included	Included	
8.6				0	8' Concrete Trail Removal and Replacement				9,256	SF		\$ 17.73		\$ 164,082.63
8.6	Garney		Crew		CMAR - Pipe Crew	1.30	Shifts	9,256.00	1.30	Shifts		\$ 26,172.29	\$ 34,076.16	
8.6	Garney		Crew		CMAR- Support Crew	2,500.0	Units Per Shift	9,256.00	3.70	Shifts		\$ 6,818.56	\$ 25,344.40	
8.6	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		52.00	52.00	Lump Sum		\$ -	\$ -	
8.6	Crushed Stone	Burnco	Material		Road Base	1		342.81	342.81	TN		\$ 26.40	\$ 9,050.31	
8.6	Concrete Flatwork	CCS	Subcontract		8' Wide Trail Replacement	1		9,256.00	9,256.00	SF		\$ 9.71	\$ 89,875.76	
8.6	Concrete Flatwork	CCS	Subcontract		Mobilizations	1		2.00	2.00	EA		\$ 1,500.00	\$ 3,000.00	
8.6	Cutting & Coring	DeAndrea	Subcontract		Saw Cutting	8		12.00	96.00	LF		\$ 3.50	\$ 336.00	
8.6	Trucking	Tin Cup	Subcontract		Haul Off	1		240.00	240.00	CY		\$ 10.00	\$ 2,400.00	
8.6	Trucking		Subcontract		Concrete Dump Fee	1		24.00	24.00	LD		Included	Included	
8.7				0	Concrete Curb and Cutter Removal and Replacement				1,122	LF		\$ 56.95		\$ 63,897.56
8.7	Garney		Crew		CMAR - Pipe Crew	0.6	Shifts	1,122.00	0.60	Shifts		\$ 26,172.29	\$ 15,727.46	
8.7	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		53.00	53.00	Lump Sum		\$ -	\$ -	
8.7	Concrete Flatwork	CCS	Subcontract		Curb and Gutter	1		518.00	518.00	LF		\$ 37.05	\$ 19,191.90	
8.7	Concrete Flatwork	CCS	Subcontract		Curb and Gutter (Median Removal for Traffic)	1		604.00	604.00	LF		\$ 37.05	\$ 22,378.20	
8.7	Concrete Flatwork	CCS	Subcontract		Mobilizations	1		4.00	4.00	EA		\$ 1,500.00	\$ 6,000.00	
8.7	Trucking	Tin Cup	Subcontract		Haul Off	1		6.00	6.00	LD		\$ 100.00	\$ 600.00	
8.7	Trucking		Subcontract		Concrete Dump Fee	1		6.00	6.00	EA		Included	Included	
8.9				0	Stamped and Colored Concrete Removal and Replacement				2,722	SF		\$ 36.83		\$ 100,255.70
8.9	Garney	Removal	Crew		CMAR- Support Crew	1,985.0	Units Per Shift	2,722.00	1.37	Shifts		\$ 6,818.56	\$ 9,386.99	
8.9	Garney	Prep	Crew		CMAR- Support Crew	1,250.0	Units Per Shift	2,722.00	2.18	Shifts		\$ 6,818.56	\$ 14,906.54	
8.9	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		54.00	54.00	Lump Sum		\$ -	\$ -	
8.9	Crushed Stone	Burnco	Material		Road Base	1		51.00	51.00	TON		\$ 26.40	\$ 1,346.40	
8.9	Concrete Flatwork	CCS	Subcontract		Stamped and Colored Concrete	1		807.00	807.00	SF		\$ 27.10	\$ 21,869.70	
8.9		CCS	Subcontract		Stamped and Colored Concrete (Median Removal Traffic Control)	1		1,915.00	1,915.00	SF		\$ 27.10	\$ 51,896.50	
8.9	Trucking	Tin Cup	Subcontract		Haul Off	1		84.96	84.96	CY		\$ 10.00	\$ 849.57	

ARVADA NTL7 - ESTIMATE

BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
8.9	Trucking		Subcontract		Dump Fee	1		2,722.00	2,722.00	SF		Included	Included	
8.1				0	ADA Ramps				3	EA		\$ 3,000.00		\$ 9,000.00
8.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		55.00	55.00	Lump Sum		\$ -	\$ -	
8.1	Concrete Flatwork	CCS	Subcontract		ADA Ramps	1		3.00	3.00	EA		\$ 3,000.00	\$ 9,000.00	
8.11				0	Wood Split Rail Fence Removal and Replacement				150	LF		\$ 44.01		\$ 6,602.00
8.11	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		56.00	56.00	Lump Sum		\$ -	\$ -	
8.11	Fencing Sub	Town and Country	Subcontract		Split Rail Fence Replacement	1		1.00	1.00	LS		\$ 6,602.00	\$ 6,602.00	
8.12					Sod				4,550	SF		\$ 2.36		\$ 10,740.20
8.12	Garney		Crew		CMAR- Support Crew	0.5	Shifts	4,550.00	0.50	Shifts		\$ 6,818.56	\$ 3,422.70	
8.12	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		57.00	57.00	Lump Sum		\$ -	\$ -	
8.12	Seed & Sod	Modern Golf	Subcontract		Top Soil	1		37.00	37.00	TN		\$ 65.00	\$ 2,405.00	
8.12	Seed & Sod	Modern Golf	Subcontract		Sod Mobilization	1		2.00	2.00	EA		\$ 750.00	\$ 1,500.00	
8.12	Seed & Sod	Modern Golf	Subcontract		Sod Installation	1		4,550.00	4,550.00	SF		\$ 0.75	\$ 3,412.50	
8.13					Seeding				5	AC		\$ 3,360.00		\$ 16,800.00
8.13	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		58.00	58.00	Lump Sum		\$ -	\$ -	
8.13	Seed & Sod	Blue Tec	Subcontract		Seeding and Mulch	1.2		5.00	6.00	AC		\$ 1,550.00	\$ 9,300.00	
8.13	Seed & Sod	Blue Tec	Subcontract		Mobilization	1		5.00	5.00	AC		\$ 1,000.00	\$ 5,000.00	
8.13	Seed & Sod	Blue Tec	Subcontract		Landscaping 76th Ave Corner	1		1.00	1.00	LS		\$ 2,500.00	\$ 2,500.00	
8.14					Irrigation Repairs				1	LS		\$ 5,500.00		\$ 5,500.00
8.14	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		59.00	59.00	Lump Sum		\$ -	\$ -	
8.14	Landscaping	Modern Golf	Subcontract		Temp Irrigation System Capping	1		1.00	1.00	LS		\$ 1,500.00	\$ 1,500.00	
8.14	Landscaping	Modern Golf	Subcontract		Irrigation Repairs	1		1.00	1.00	LS		\$ 4,000.00	\$ 4,000.00	
9					Pipe/Below Ground Structure Removals, Abandonment & Replacement									
9.1					Remove and Dispose of Existing Manhole Structures				4	EA		\$ 6,933.11		\$ 27,732.43
9.1	Garney		Crew		CMAR - Pipe Crew	0.25	Shifts Per Unit	4.00	1.00	Shifts		\$ 26,172.29	\$ 26,212.43	
9.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		61.00	61.00	Lump Sum		\$ -	\$ -	
9.1	Trucking	Tin Cup	Subcontract		Haul Off	10		4.00	40.00	CY		\$ 23.00	\$ 920.00	
9.1	Trucking		Subcontract		Concrete Dump Fee	1		4.00	4.00	EA		\$ 150.00	\$ 600.00	
9.2					Abandonment of Existing Sanitary Sewer Pipe				7,120	LF		\$ 39.14		\$ 278,692.93
9.2	Garney		Crew		CMAR- Support Crew	6.0	Shifts	7,120.00	6.00	Shifts		\$ 6,818.56	\$ 41,072.38	
9.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		62.00	62.00	Lump Sum		\$ -	\$ -	
9.2	Flowable Fill	Home Depot	Material		Sand Bags	1		1.00	1.00	LS		\$ 500.00	\$ 500.00	
9.2	Flowable Fill	United Rentals	Material		Water Truck	1		2.00	2.00	WK		\$ 2,176.00	\$ 4,352.00	
9.2	Abandonment Grouting	Flashfill Services	Subcontract		Cellular Concrete 24"	0.12		371.00	43.17	LF		\$ 153.00	\$ 6,605.53	
9.2	Abandonment Grouting	Flashfill Services	Subcontract		Cellular Concrete 27"	0.15		212.00	31.22	LF		\$ 153.00	\$ 4,777.21	
9.2	Abandonment Grouting	Flashfill Services	Subcontract		Cellular Concrete 30"	0.18		6,538.00	1,188.80	LF		\$ 153.00	\$ 181,885.80	
9.2	Abandonment Grouting	Flashfill Services	Subcontract		Concrete Pumping	10		10.00	100.00	HR		\$ 360.00	\$ 36,000.00	
9.2	Abandonment Grouting	Flashfill Services	Subcontract		Flashfill (Night Work Charge)	1		10.00	10.00	EA		\$ 350.00	\$ 3,500.00	
9.3					Abandonment of Existing Sanitary Sewer Structures				16	EA		\$ 3,428.59		\$ 54,857.39
9.3	Garney		Crew		CMAR- Support Crew	5.0	Shifts	16.00	5.00	Shifts		\$ 6,818.56	\$ 34,226.99	
9.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		63.00	63.00	Lump Sum		\$ -	\$ -	
9.3	Abandonment Grouting	Flashfill Services	Subcontract		Flashfill	7.2		16.00	115.20	CY		\$ 127.00	\$ 14,630.40	
9.3	Trucking	Tin Cup	Subcontract		Haul Off	10		6.00	60.00	HR		\$ 100.00	\$ 6,000.00	

ARVADA NTL7 - ESTIMATE

BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
9.4					Removal and Disposal of Existing Pipe	507			LF			\$ 15.97		\$ 8,096.23
9.4	Garney		Crew		CMAR - Pipe Crew	0.25	Shifts	507.00	0.25	Shifts		\$ 26,172.29	\$ 6,553.11	
9.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		64.00	64.00	Lump Sum		\$ -	\$ -	
9.4	Trucking	Tin Cup	Subcontract		Haul Off	0.08		507.00	41.01	CY		\$ 23.00	\$ 943.12	
9.4	Trucking		Subcontract		Landfill Fee	1		4.00	4.00	LD		\$ 150.00	\$ 600.00	
9.5					Remove and Replace 14' x 6' Dual Barrel Box Culvert	1			LS			\$ 178,907.66		\$ 178,907.66
9.5	Garney		Crew		CMAR - Pipe Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 26,172.29	\$ 52,424.87	
9.5	Garney		Crew		CMAR- Support Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 6,818.56	\$ 13,690.79	
9.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		65.00	65.00	Lump Sum		\$ -	\$ -	
9.5	Specialty Shoring	United Rentals	Material		Sheet Piles	1		1.00	1.00	MONTH		\$ 11,197.00	\$ 11,197.00	
9.5	Supply House	Home Depot	Material		Sand Bags	1		1.00	1.00	LS		\$ 500.00	\$ 500.00	
9.5	Structural Concrete	HEI	Subcontract		Demo and Pour Back Box Culvert	1		1.00	1.00	LS		\$ 101,095.00	\$ 101,095.00	
10					Above Grade Removals and Replacement									
10.1					Wood Creek Sign Removal and Replacement	1			LS			\$ 50,000.00		\$ 50,000.00
10.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		67.00	67.00	Lump Sum		\$ -	\$ -	
10.1	CIPP		Subcontract		Wood Creek Sign Removal and Replacement	1		1.00	1.00	LS		\$ 50,000.00	\$ 50,000.00	
11					Testing									
11.1					Sewer Pipe and Manhole Testing	1			LS			\$ 76,076.00		\$ 76,076.00
11.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		70.00	70.00	Lump Sum		\$ -	\$ -	
11.1	Testing & Disinfection	High Country	Subcontract		Mobilizations - Travel Time	1		30.00	30.00	LS		\$ 185.00	\$ 5,550.00	
11.1	Testing & Disinfection	High Country	Subcontract		Manhole Testing - 42" Main	1		20.00	20.00	LS		\$ 798.00	\$ 15,960.00	
11.1	Testing & Disinfection	High Country	Subcontract		Manhole Testing - 30" Main	1		2.00	2.00	LS		\$ 570.00	\$ 1,140.00	
11.1	Testing & Disinfection	High Country	Subcontract		30" Sewer Pipe Testing	1		2,347.00	2,347.00	LS		\$ 5.00	\$ 11,735.00	
11.1	Testing & Disinfection	High Country	Subcontract		36" Sewer Pipe Testing	1		768.00	768.00	LS		\$ 5.00	\$ 3,840.00	
11.1	Testing & Disinfection	High Country	Subcontract		42" Sewer Pipe - Joint Testing	1		230.00	230.00	LS		\$ 55.00	\$ 12,650.00	
11.1	Testing & Disinfection	High Country	Subcontract		CCTV	1		7,907.00	7,907.00	LS		\$ 1.00	\$ 7,907.00	
11.1	Testing & Disinfection	High Country	Subcontract		Jetting/Cleaning	1		7,907.00	7,907.00	LS		\$ 1.00	\$ 7,907.00	
11.1	Testing & Disinfection	High Country	Subcontract		30" Mandrel Testing	1		2,347.00	2,347.00	LS		\$ 3.00	\$ 7,041.00	
11.1	Testing & Disinfection	High Country	Subcontract		36" Mandrel Testing	1		782.00	782.00	LS		\$ 3.00	\$ 2,346.00	
11.1	Testing & Disinfection	High Country	Subcontract		42" Mandrel Testing	1		4,778.00	4,778.00	LS		Included	Included	
13					Allowance Items									
13.1					Additional CDOT Trench Paving	972			TON			\$ 198.33		\$ 192,774.60
13.1	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		74.00	74.00	Lump Sum		\$ -	\$ -	
13.1	Asphalt Paving	CPS	Subcontract		Additional CDOT Trench Paving	1		972.00	972.00	TON		\$ 151.03	\$ 146,801.16	
13.1	Asphalt Paving	CPS	Subcontract		Additional Road Base Installation	1		1,252.00	1,252.00	TON		\$ 36.72	\$ 45,973.44	
13.2					Additional CDOT Mill and Overlay Paving and Striping	7,254			SY			\$ 31.87		\$ 231,208.41
13.2	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		75.00	75.00	Lump Sum		\$ -	\$ -	
13.2	Asphalt Paving	CPS	Subcontract		Additional CDOT Mill and Overlay Paving	1		7,254.00	7,254.00	SY		\$ 25.14	\$ 182,365.56	
13.2	Asphalt Paving	Riders	Subcontract		Additional Striping	1		1.00	1.00	LS		\$ 48,842.85	\$ 48,842.85	
13.3					8" AC Waterline Lowering's (Westminster)	2			EA			\$ 27,335.57		\$ 54,671.14
13.3	Garney	Install	Crew		CMAR - Pipe Crew	0.5	Shifts Per Unit	2.00	1.00	Shifts		\$ 26,172.29	\$ 26,212.43	
13.3	Garney	Testing	Crew		CMAR- Support Crew	0.5	Shifts Per Unit	2.00	1.00	Shifts		\$ 6,818.56	\$ 6,845.40	
13.3	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		76.00	76.00	Lump Sum		\$ -	\$ -	

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BID ITEM	DESCRIPTION	VENDOR	TYPE	SIZE	DESCRIPTION	QUANTITY PER INSTALL	INSTALL MEASURE	BID ITEM INSTALLS	TOTAL BID ITEM INSTALLS	UNIT	TAX	UNIT COST	LINE ITEM TOTAL	BID ITEM TOTAL
13.3	Supply House	Ferguson	Material	8"	Transition Couplings AC to PVC	2		2.00	4.00	EA		\$ 600.00	\$ 2,400.00	
13.3	Supply House	Ferguson	Material	8"	C900	60		2.00	120.00	LF		\$ 30.96	\$ 3,715.20	
13.3	Supply House	Ferguson	Material	8"	45 Degree Bends	4		2.00	8.00	EA		\$ 310.39	\$ 2,483.12	
13.3	Supply House	Ferguson	Material	8"	Mega Lugs	8		2.00	16.00	EA		\$ 65.26	\$ 1,044.16	
13.3	Supply House	Ferguson	Material	8"	BNG Kit	8		2.00	16.00	EA		\$ 32.92	\$ 526.72	
13.3	Supply House	Ferguson	Material	8"	Sacrificial ZN Cap	92		2.00	184.00	EA		\$ 8.00	\$ 1,472.00	
13.3	Supply House	Ferguson	Material	8"	Joint Restraints	1		2.00	2.00	EA		\$ 258.02	\$ 516.04	
13.3	Supply House	Ferguson	Material		Tracer Wire	2		60.00	120.00	LF		\$ 1.50	\$ 180.00	
13.3	Supply House	Ferguson	Material		Splice Kits	4		2.00	8.00	EA		\$ 20.00	\$ 160.00	
13.3	Concrete	Holcim	Material		Thrust Blocks	4		2.00	8.00	EA		\$ 50.00	\$ 400.00	
13.3	Concrete	Home Depot	Material		Rebar	2		2.00	4.00	EA		\$ 20.00	\$ 80.00	
13.3	Bedding	Burnco	Material		Bedding	0.45		40.00	18.00	TN		\$ 35.33	\$ 636.07	
13.3	Abatement		Subcontract		AC Cutting and Disposal	1		2.00	2.00	EA		\$ 4,000.00	\$ 8,000.00	
13.4			0		1' Over Excavation and Trench Stabilization			500		LF		\$ 59.72		\$ 29,858.96
13.4	Garney		Crew		CMAR - Pipe Crew	0.75	Shifts	500.00	0.75	Shifts		\$ 26,172.29	\$ 19,659.33	
13.4	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		77.00	77.00	Lump Sum		\$ -	\$ -	
13.4	Supply House	Ferguson	Material		Mirifi	1		500.00	500.00	LF		\$ 1.48	\$ 740.00	
13.4	Crushed Stone	Burnco	Material		1.5" Crushed Rock	1		165.28	165.28	TN		\$ 35.33	\$ 5,839.26	
13.4	Trucking	Tin Cup	Subcontract		Haul Off	1		157.41	157.41	CY		\$ 23.00	\$ 3,620.37	
13.5			0		Dewatering Treatment			1		LS		\$ 1,362,455.79		\$ 1,362,455.79
13.5	Garney	Set Up	Crew		CMAR- Support Crew	2.0	Shifts	1.00	2.00	Shifts		\$ 6,818.56	\$ 13,690.79	
13.5	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		79.00	79.00	Lump Sum		\$ -	\$ -	
13.5	X	United Rentals	Material		Generator Rental 3X Shift	1		9.00	9.00	MONTH		\$ 2,500.00	\$ 22,500.00	
13.5	X	United Rentals	Material		Generator Service	720		9.00	6,480.00	HR		\$ 1.00	\$ 6,480.00	
13.5	Dewatering	RK Water	Subcontract		Groundwater Treatment System (Set Up & 1 Month Operation)	1		1.00	1.00	LS		\$ 225,092.00	\$ 225,092.00	
13.5	Dewatering	RK Water	Subcontract		Additional Months of System	8		1.00	8.00	MONTH		\$ 66,987.00	\$ 535,896.00	
13.5	Dewatering	RK Water	Subcontract		Sampling	1		3.00	3.00	EA		\$ 1,600.00	\$ 4,800.00	
13.5	Dewatering	RK Water	Subcontract		Ion Exchange	1		4.00	4.00	EA		\$ 8,200.00	\$ 32,800.00	
13.5	Dewatering	RK Water	Subcontract		Carbon Changeout	1		4.00	4.00	EA		\$ 12,100.00	\$ 48,400.00	
13.5	Dewatering	RK Water	Subcontract		Fuel	72		270.00	19,440.00	GAL		\$ 5.00	\$ 97,200.00	
13.5	Dewatering	RK Water	Subcontract		System Move	1		1.00	1.00	EA		\$ 9,000.00	\$ 9,000.00	
13.5	Dewatering	RK Water	Subcontract		24/7 Additional Labor	1		4.50	4.50	MONTHS		\$ 81,466.00	\$ 366,597.00	
13.7			0		76th Ave Traffic Signal Removal and Replacement			2		EA		\$ 106,590.00		\$ 213,180.00
13.7	Rental		Rental		Total Rental Costs from Rental Tab for this Bid Item	1.0		81.00	81.00	Lump Sum		\$ -	\$ -	
13.7	Electrical	Sturgen	Subcontract		Traffic Signal Removal and Replacement	1		1.00	1.00	EA		\$ 193,800.00	\$ 193,800.00	
13.7	Electrical	Sturgen	Subcontract		Treffic Signal Unknowns (No Design)	0.1		1.00	0.10	EA		\$ 193,800.00	\$ 19,380.00	
12				0	General Conditions									
12.1			0		General Conditions			1		LS		\$ 752,975.55		\$ 752,975.55
12.1	GC		Material		General Conditions	1.0		1.00	1.00	Lump Sum		\$ 752,975.55	\$ 752,975.55	

Exhibit 2

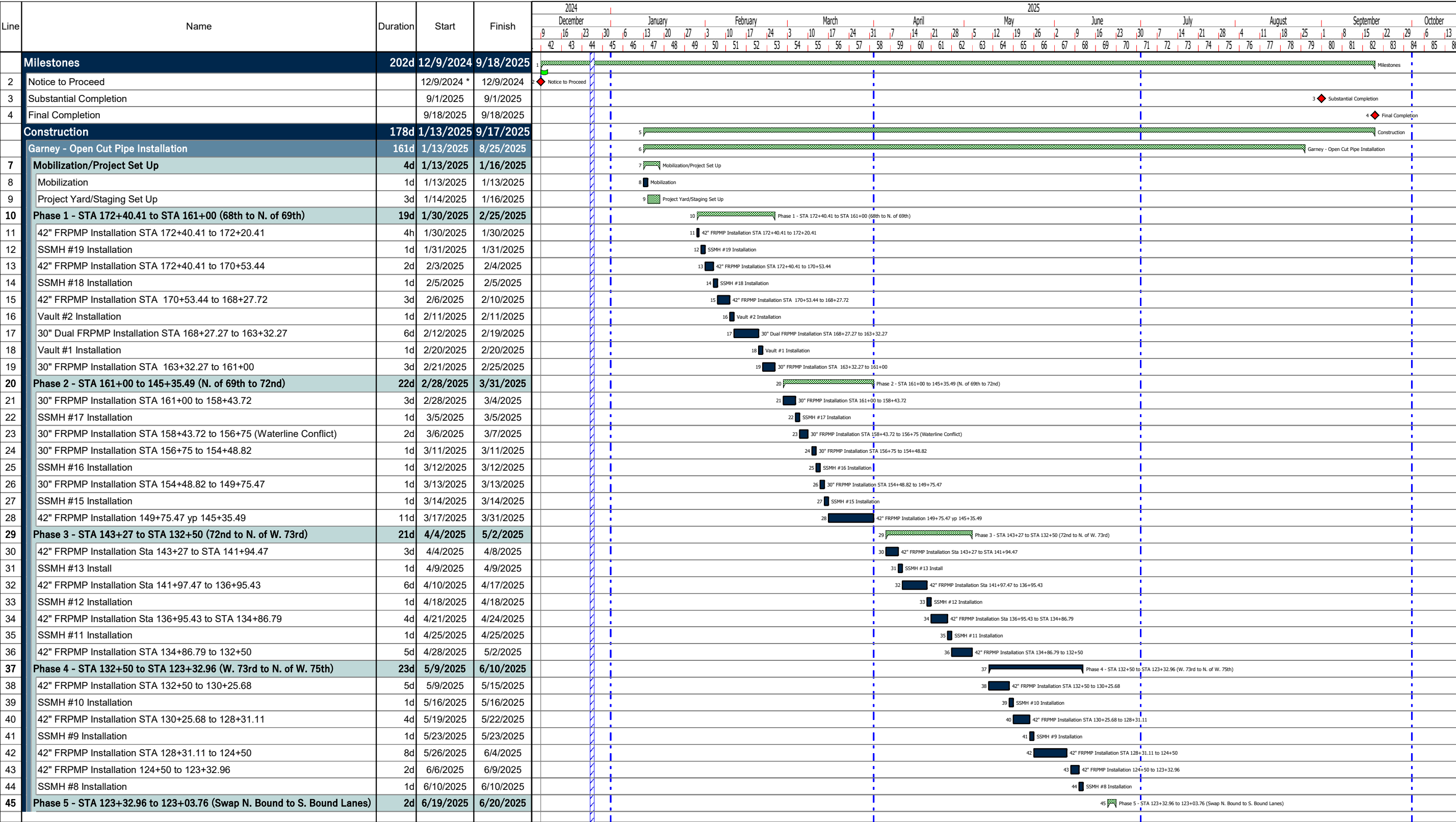
Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66



ADVANCING WATER

CITY OF ARVADA - NORTH TRUNK LINE 7 PROJECT (NTL7)





CITY OF
ARVADA

Page 2 of 3



CITY OF
ARVADA



Responsibility

Garney Traffic Control Asphalt Bypass Trenchless Restoration Milestone Box Culvert

Milestone Appearances

Diamond

Exhibit 3

Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66

GEOTECHNICAL INVESTIGATION REPORT

***NORTH TRUNK SEWER IMPROVEMENTS (NTL7) – SHERIDAN
AND 76TH***

ARVADA, COLORADO

October 2024



10/16/2024
2305969

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Carollo Engineers, Inc.
890 Interlocken Crescent Suite 800
Broomfield, CO 80021

Attention: Kim Zulliger, PE
Associate Vice President

Regarding: Geotechnical Investigation Report
North Trunk Sewer Improvement (NTL7) – Sheridan and 76th
Arvada, Colorado

Ms. Zulliger,

Submitted herewith is the Geotechnical Investigation Report for the North Trunk Sewer Improvements (NTL7) – Sheridan and 76th project. This study was conducted in accordance with our contract between Lithos Engineering and Carollo dated October 23, 2023. This report contains the results of our findings, a geotechnical engineering interpretation with respect to the available project characteristics, and recommendations to aid design and construction of geotechnical components of this project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,
Lithos Engineering

Adam Malsam, EI
Staff Engineer

Austin Wilkes, PE
Project Manager

Nate Soule, PE
Senior Engineer



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1 INTRODUCTION & PROJECT BACKGROUND

The City of Arvada (Owner) has identified several areas where the existing sanitary trunk sewer is unable to meet the current required capacity. In total, approximately 8,000 feet of sanitary sewer is scheduled to be replaced with new 30- to 42-inch diameter mains. The replacement alignment includes a section along Sheridan Blvd between W 80th Ave and W 64th Ave, which is the focus of this report.

Carollo Engineers, Inc. (Carollo) is designing the new pipeline which will be delivered with coordination from Garney Construction using a Construction Manager at Risk (CMAR) approach. Carollo retained Lithos Engineering (Lithos) as the project's geotechnical engineer. The purpose of this report is to provide the results of the geotechnical investigation and provide geotechnical recommendations for design and construction.

2 GEOLOGIC SETTING

2.1 Regional Geology

Geologic mapping performed by Lindvall, R.M. (1979) indicates the project site and surrounding vicinity consist of Holocene and Pleistocene eolian (wind-blown) loess deposits, Holocene age Piney Creek Alluvium, artificial fill where the roadways have been built up, and underlying Denver and Arapahoe Formation bedrock. Lindvall (1979) describes these units as the following:

- Eolian loess is yellowish brown to light grayish brown sandy silt. May contain some clay or silty clay and is slightly calcareous. Unit thickness generally less than 10 feet but may be as much as 20 to 25 feet.
- Piney Creek Alluvium consists of brown, light brown, and light to dark gray interbedded sand, silt, and clay found within drainages. The upper part of the formation is generally finer grained than the lower part with interbedded gravels being common in the lower part. Commonly five to ten feet thick.
- Artificial fill consists of clay, silt, sand, gravel, and artificial debris consisting of concrete, brick, wood, metal, plastic, glass, etc. Generally found in building, roadway, and railroad foundations as well as within small embankment dams within the project vicinity.
- Denver and Arapahoe Formations consist of brown, yellowish-brown, gray, and blue-gray interbedded claystone, siltstone and sandstone with cross-bedded and lenticular units common throughout the formation. Claystone bedrock within the formation generally swells when wetted. The thickness of the unit is reported as 781 feet in the Westminster area.

3 GEOTECHNICAL INVESTIGATION

Lithos conducted a geotechnical investigation at the project site in three phases. The first phase took place on December 4th and 5th, 2023 in which borings LE-01, LE-02, LE-04, LE-05, LE-07, and LE-08 were drilled. Due to weather and permitting challenges, borings LE-03 and LE-06 were drilled during a second phase on January 30th, 2024. As the project developed, a tunnel crossing beneath 72nd Ave was evaluated as being a potential alternative to open cut excavation across the intersection of Sheridan Blvd and 72nd Ave. Accordingly, two additional borings, B-9 and B-10, were drilled on July 2, 2024 to provide geotechnical data for a potential tunnel crossing.

Geotechnical borings were advanced to depths between 15 feet and 30 feet below the existing ground surface (bgs). Lithos subcontracted Vine Laboratories to drill the borings utilizing a truck-mounted CME 550X-1 drilling rig. Drilling and sampling procedures were conducted in general accordance with ASTM D1586 – *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, ASTM D3550 – *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils*, and ASTM D1587 – *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes*. Continuous-flight, solid-stem augers were used to advance eight of the ten borings below the existing ground surface through soil and into the bedrock. Hollow stem augers were used to drill LE-01 and LE-04 to facilitate the installation of temporary monitoring wells at these locations. During auger advance, Modified California samples (2.0-inch inner diameter) and split spoon samples (1.4-inch inner diameter) were generally obtained at 5-foot intervals. Within potential tunnel zones (i.e. five feet above a potential tunnel crown to five feet below a potential tunnel invert) samples were collected at 2.5-foot intervals. The number of blows by a 140-pound hammer falling 30-inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs.

Select samples collected from these investigations were then submitted to a laboratory for geotechnical testing. A site vicinity map showing boring locations is included as Figure 1. Boring logs are included in Appendix A.

3.1 Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by Lithos and conducted by Martinez Associates on representative samples collected during the subsurface investigation. A laboratory summary table and graphical testing results are provided in Appendix B. Laboratory tests conducted in general accordance with associated ASTM standards are presented in the table below.

Geotechnical Laboratory Testing	
Test	Standard
Grain Size Distribution	ASTM D422/ASTM C136
#200 Sieve Wash	ASTM D1140
Swell / Consolidation	ASTM D4546
Atterberg Limits	ASTM D4318
Moisture Content & Dry Density	ASTM D2216 & D2937
Unconfined Compressive Strength (UCS)	ASTM D2166

If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

3.2 Corrosion Potential Testing

In addition to the above geotechnical laboratory tests, samples were also tested for their corrosion properties. Corrosion laboratory tests were conducted by Project X Corrosion Engineering in general accordance with associated ASTM and Standard Methods standards. The table below lists the corrosion tests performed and their respective standards.

Corrosion Testing	
Test	Standard
Soil Resistivity	ASTM G187
pH	ASTM G51
Sulfate	ASTM D4327
Redox Potential	ASTM G200
Sulfide	SM 4500-S2
Ammonia	ASTM D4327
Nitrate	ASTM D4327
Fluoride	SM 2320B
Phosphate	ASTM D4327
Lithium	ASTM D4327
Sodium	ASTM D4327
Potassium	ASTM D4327
Magnesium	ASTM D4327
Calcium	ASTM D4327
Bicarbonate	SM 2320B

4 SUBSURFACE CONDITIONS

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil and rock descriptions noted on the boring logs and below are in general accordance with ASTM D2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and ASTM D2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

4.1 Subsurface Materials

Primary materials encountered during the subsurface investigation include fill, eolian deposits, fine and coarse alluvium deposits, and claystone and sandstone bedrock of the Denver Formation. Boring logs and a supplementary boring log key explaining boring log details are provided in Appendix A.

4.1.1 Fill

Fill was encountered in seven of the ten borings, all of which were along Sheridan Boulevard. Fill was found to extend from the surface down to a depth of four to 10 feet bgs. Encountered artificial fill deposits were described as the following in accordance with the Unified Soil Classification System (USCS):

- Lean clay (CL)
- Lean clay with sand CL)
- Sandy lean clay (CL)
- Clayey sand with gravel (SC)
- Sandy silty clay (CL-ML)
- Poorly graded sand (SP)

Artificial fill deposits were primarily comprised of mixtures of sand and clay. Artificial fill was distinguished based on local topography and the presence of artificial debris within the soil. Artificial debris included

fragments of asphalt, plastic, bricks, and glass. Blow counts for coarse alluvium ranged from seven to 15 blows per foot (bpf), indicating a consistency of medium stiff to stiff or a relative density of loose to medium dense.

4.1.2 Eolian Deposits

Eolian deposits were encountered in two of the ten borings. Generally, eolian deposits can be found at the ground surface or beneath up to ten feet of artificial fill and extended to depths of 15 feet bgs. Encountered eolian deposits were described as the following in accordance with the Unified Soil Classification System (USCS):

- Lean clay (CL)
- Lean clay with sand (CL)
- Sandy lean clay (CL)

Eolian deposits were primarily comprised of clay with varying proportions of sand and blow counts from seven to 20 blows per foot (bpf), indicating a consistency of medium stiff to very stiff.

4.1.3 Fine Alluvium

Fine alluvium deposits were encountered in four of the ten borings. Fine alluvium deposits were found near local drainages, including Little Dry Creek and the area immediately west of Hidden Lake. Fine alluvium deposits were found at depths ranging from 0 to 30 feet bgs. Encountered fine alluvium deposits were described as the following in accordance with the Unified Soil Classification System (USCS):

- Lean clay (CL)
- Lean clay with sand (CL)
- Sandy lean clay (CL)

Fine alluvium deposits were primarily comprised of clay with varying proportions of sand and silt and blow counts from six to 29 blows per foot (bpf), indicating a consistency of medium stiff to very stiff. Fine alluvium was distinguished from eolian deposits by their proximity to local drainages and based on the contacts drawn between the two deposits by Lindvall (1979). Fine alluvium deposits were differentiated from coarse alluvium by their fines percentage, where fine alluvium has greater than 50% fines and coarse alluvium has less than 50% fines. Swell testing performed on one sample of fine alluvium resulted in a 0.3% expansion at 500 psf confining pressure and a swell pressure of 1,049 psf.

4.1.4 Coarse Alluvium

Coarse alluvium deposits were encountered in two of the ten borings, both of which were located immediately next to Little Dry Creek. Coarse alluvium deposits were found below a layer of fine alluvium at depths ranging from five to 15 feet bgs. Encountered coarse alluvium deposits were described as the following in accordance with the Unified Soil Classification System (USCS):

- Clayey sand (SC)
- Clayey gravel (GC)
- Poorly graded gravel with clay (GP-GC)

Coarse alluvium deposits were primarily comprised of sand and gravel with less than 50% fines content. Cobbles were not sampled but inferred to be infrequently present within this unit based on drilling

behavior. Blow counts for coarse alluvium ranged from eight to 25 blows per foot (bpf), indicating a relative density of loose to medium dense.

4.1.5 Denver Formation Bedrock

The Denver Formation bedrock may be further subdivided into two separate categories. The first of these is residuum, which indicates bedrock that has been completely weathered to soil but still retains rock structure. Residual Denver Formation was encountered at depths ranging from 10 to 21.5 feet bgs and was described as the following in accordance with the Unified Soil Classification System (USCS):

- Silty sand (SM)
- Poorly graded sand with silt (SP)
- Sandy silt, (ML)
- Lean clay with sand (CL)

Residuum exhibited blow counts ranging from 12 blows per foot (stiff / medium dense) to 75 blows for nine inches (hard / very dense).

The second category is highly to moderately weathered bedrock that has not been completely weathered to soil. Denver Formation bedrock was encountered at depths ranging from eight to 31.5 feet bgs and consisted of moderate to highly weathered claystone, sandstone, and silty sandstone. Blow counts for Denver Formation bedrock ranged from 24 blows per foot to 84 blows for 11 inches. Swell testing performed on one sample of claystone bedrock resulted in no swell potential.

4.2 Groundwater

Groundwater was encountered during the subsurface investigation in all borings. Temporary monitoring wells were installed in borings LE-01 and LE-04 for future monitoring and to allow for water sampling. Fluctuations in the groundwater level may occur due to variations in rainfall, temperature, site development, and other factors not evident at the time that these measurements were made. The table below presents initial groundwater levels measured in the borings.

Boring Number	LE-01	LE-02	LE-03	LE-04	LE-05	LE-06	LE-07	LE-08	B-09	B-10
Groundwater Depth (ft bgs)	13	8	14	14.2	17	11	8	23	24	23
Date Recorded	12/04/23	12/04/23	1/30/24	12/04/23	12/05/23	1/30/24	12/05/23	12/05/23	07/02/24	07/02/24

5 GEOTECHNICAL DESIGN RECOMMENDATIONS

The following sections are included primarily for the engineer performing design. If additional geotechnical design recommendations are necessary, Lithos should be contacted to provide the required information.

5.1 Lateral Earth Pressures

Lateral earth pressures presented below should be considered during the structural design process for foundation elements extending below grade. Lateral earth pressure values are a function of the properties

and the geometry of the retained fill, soil, and/or bedrock and anticipated magnitude of lateral deflection. In addition, the presence of groundwater and saturated materials will increase the total horizontal stress, resulting in higher lateral earth pressures in comparison to retained materials above a groundwater table.

Lateral Earth Pressures											
Backfill Material Type	Unit Weight (pcf)	Friction Angle (degrees)	Static Earth Pressure Coefficients			Static Equivalent Fluid Pressure (pcf)					
						Active		At-Rest		Passive (2)	
			Active	At-Rest	Passive	Above GWT ¹	Below GWT ¹	Above GWT ¹	Below GWT ¹	Above GWT ¹	Below GWT ¹
Imported CDOT Class 1 Structure Backfill	130	34	0.28	0.44	3.54	37	82	57	92	460	302
Processed In-Situ Material (CDOT Class 2)	125	28	0.36	0.53	2.77	45	85	66	96	346	234

¹ GWT = Ground Water Table

² Values shown are half of theoretical calculated value due to large strains required to mobilize passive earth pressure.

For the lateral earth pressures presented above to remain applicable, backfill material placement adjacent to below-grade walls should be in accordance with procedures outlined in this report. In addition, backfilled material must be placed within a 1 horizontal to 1 vertical (1H:1V) backfill geometry, up and away from the base of the structure. If the excavation is steeper than 1:1, the more conservative values outlined above should be used. Consideration has not been given to vertical loads applied to the backfill surfaces during or after construction as a result of traffic and/or other surcharge loads.

5.2 Geotechnical Parameters for Counteracting Buoyancy

Structures which extend below the highwater elevation, including manholes, should be evaluated for buoyancy. Where the structure loads are not sufficient to counteract buoyancy, additional resistance to uplift can be achieved by extending the foundation outside the vertical walls and engaging the weight of an additional wedge of soil. For design purposes, the wedge of soil providing resistance on the extended foundation can be defined by including the soil within a 12-degree slope (measured from vertical) up and away from the bottom exterior edge of the extended footing to the ground surface. A saturated unit weight of 125 pcf may be used for the soil wedge if the buoyant force on the structure includes the weight of water displaced by the soil wedge. If the buoyant force on the structure does not include the weight of water displaced by the soil wedge, i.e., only the volume of water that is displaced by the structure itself, then a soil unit weight of 63 pcf should be used.

5.3 Surface and Subsurface Drainage

Construction details should ensure that surface water does not penetrate utility trenches to the extent reasonable, and any inflow is appropriately managed locally with sumps without allowing saturation of the subsurface and placed backfill materials during construction.

5.4 Seismic Site Classification

Based on the International Building Code and the American Society of Civil Engineers Minimum Design Loads for Buildings and other Structures 7-22, our subsurface investigation, and our experience and knowledge of seismic conditions in the area, a Site Classification of C is recommended for seismic design.

5.5 Pavement Recommendations

The majority of the proposed pipeline will be installed beneath Sheridan Boulevard. Pavement which is removed during the installation of the pipeline should be replaced in accordance with the appropriate governing body. For Sheridan Boulevard, CDOT standards shall be adhered to when replacing the roadway. If sections of local (i.e. non-CDOT) roads require repairs or replacement because of construction, then either Arvada or Westminster standards shall be adhered to respectively.

5.6 Corrosion

Pipe installation trenches are anticipated to be backfilled with properly compacted granular pipe bedding material. Depending on the specific pipe type and accessories selected, the corrosion potential of soils and water surrounding trench backfill should be assessed. The designer should evaluate the need to account for the corrosive soil conditions when selecting pipe materials based on collected data presented at the back of Appendix C.

Water soluble sulfate testing was conducted as part of a larger corrosion testing suite on one sample of sandy claystone. The test results indicated a sulfates weight percentage of 0.0037% which would characterize the concrete risk as “Not Applicable” as shown in the table below. These results should be considered when specifying the allowable cement types and concrete mixes.

American Concrete Institute Code 318-19 Water Soluble Sulfates		
Cement Type	Water-Soluble Sulfate in Soil SO ₄ , Percent by Weight	Risk
--	SO ₄ < 0.10	Not Applicable
II, IP (MS), IS(MS), I(PM)(MS), I(SM)(MS)	0.10 < SO ₄ < 0.20	Moderate
V	0.20 < SO ₄ < 2.00	Severe
V plus pozzolan	SO ₄ > 2.00	Very Severe

5.7 Pipeline Recommendations

5.7.1 Differential Movement

Pipelines excavated through various soils and bedrock will be susceptible to differential movements up to 2 inches. Pipe penetrations into structures should be designed to tolerate a total of 2 inches of upward or downward relative movement. Existing and proposed structures are expected to function as relatively rigid structures, therefore, flexible joints and/or connections between lines and structures are recommended. Allowance for differential movement should be expected and planned for where pipelines penetrate structures. GEI recommends CLSM backfill be used in pipe trenches within 10 ft of

structures, in lieu of traditional pipe bedding and pipe trench backfill to mitigate the migration of groundwater which could lead to soil movement. GEI recommends pipe couplings at structure penetrations are capable of tolerating in-service dynamic movements.

5.7.2 Thrust Restraint

Buried, pressurized pipes experience thrust forces at various pipe configurations including tees, reducers, dead ends, valves, bends, and wyes. In order to balance internal transient pressures, thrust blocks or restrained joints are recommended for pipe restraint. For thrust block design, an allowable lateral bearing pressure of 1,500 psf is recommended. A minimum of 1 foot of cover over thrust blocks is recommended and thrust blocks should be oriented such that the passive pressure influence zones do not overlap for adjacent blocks and do not impact other subsurface utilities. If restrained joints are selected, then a coefficient of friction of 0.25 shall be used for plastic pipe against anticipated trench backfill material.

5.7.3 Modulus of Soil Reaction (E')

The modulus of soil reaction (E') is an empirically derived coefficient which is related to the stiffness of the native soils and the nature and degree of compaction of the pipe bedding and backfill material. Various design guidelines specific to pipe material provide recommended values for E' . For full embedment of PVC pipe in compacted granular pipe bedding, where the trench is excavated in soils that are loose/medium stiff or better (stiffer or denser, typically with blow counts greater than 4 blows per foot), and where the trench width measured at the pipe elevation (B_d) is at least 2 times the pipe diameter (D), an E' value of 2000 psi should be used.

6 CONSTRUCTION CONSIDERATIONS

The following sections are intended for the Engineer producing specifications and the contractor constructing the proposed project. Construction considerations include temporary excavations, preparation of excavated surfaces for foundations, backfill materials, fill placement and compaction, bedrock or oversize material excavation, and construction dewatering.

6.1 Temporary Excavations

General site safety including temporary excavations are the sole responsibility of the contractor performing construction. Lithos is providing temporary excavation information strictly as an informational benefit to the project team, specifically the general contractor. An Occupational Safety and Health Administration (OSHA) defined competent person should be identified by the contractor to be in charge of temporary excavations. In general, the contractor's competent person should have experience or training in determining soil types, benching and shoring, and have the ability to detect potential temporary slope stability and protective system issues.

OSHA defines an excavation as a man-made cut, trench, or depression formed by the removal of earth. A trench is a specific type of narrow excavation with a geometry including a greater depth than width and a width of 15 feet or less. Trenches 5 feet deep or greater should be sloped, retained with shoring, or shielded appropriately. Shielding most commonly includes trench boxes. In general, shoring can include inclined, horizontal, or vertical systems depending on the excavation geometry and availability of retention alternatives. Sloping and benching should be in accordance with OSHA recommendations.

Benching should include a maximum 4-foot vertical face for each bench and the overall excavation geometry less than or equal to the OSHA defined slope.

Deep excavations are anticipated on the project. A registered professional engineer is required to approve the contractor's approach for trenches greater than or equal to 20 feet in depth. In addition, shoring for trench excavations is required to be designed by a professional engineer or be based on tabulated data prepared or approved by a registered professional engineer in accordance with OSHA 1926.652(b) and (c).

Lithos has evaluated observed soil conditions likely to be penetrated by the proposed construction. Based on the OSHA determined soil Types, the following table presents maximum recommended temporary excavation slopes to be utilized during construction.

OSHA Temporary Excavation Slopes		
Backfill Material Type	OSHA Classification	Maximum Recommended Slope (H:V) ^{1,2}
Soils (sand)	Type C	1½:1
Soils (clay and silt)	Type B	1:1
Residuum	Type B	1:1
Bedrock	Type A	0.75:1

¹ H:V is an abbreviation for Horizontal:Vertical

² Valid for trench excavations less than 20 feet in depth

During construction, heavy equipment or excavated material stockpiles should be kept away from excavation edges to the extent possible. It is recommended that heavy equipment or excavated material stockpiles be kept at least 10 feet from the edges of excavations. Underground utilities should be fully understood and documented prior to initiating excavations. Finally, the contractor's competent person should inspect trenches and excavations routinely for signs of instability including sliding, toppling, subsidence and bulging, heaving or squeezing, boiling, and/or other visual concerns.

6.1.1 Shored Temporary Excavations

The contractor may elect to use a temporary shoring system to limit excavation extents, particularly if other site infrastructure may be impacted. For excavations greater than 20 feet deep, the contractor will be required to submit a design prepared by a professional engineer registered in the state of Colorado to demonstrate that the shoring system maintains both local and global slope stability for the duration of the open excavation.

Typically trench boxes are used to support lateral loads during excavation and construction in soils that have sufficient standup time to excavate the trench, install the trench box, complete installation and remove the trench box without full contact of the soils. Tight shoring typically involves full contact of the soils with the shoring system. Typical tight shoring systems include sheet pile walls, soldier pile and lagging walls, secant pile walls, soil nail walls and slide rail systems.

6.2 Site Grading and Earthwork

Appropriate site preparation, material placement and compaction, and backfill selection can reduce the risk of post-construction settlement and potential issues related to lateral earth pressures. General site preparation and backfill type and placement considerations are presented in the following sections.

6.2.1 Site Preparation

Areas supporting backfill and pipe bedding should be properly prepared. Once the rough grade has been established in excavated areas, and prior to placement of backfill, the exposed subgrade should be carefully inspected via probing and testing, as determined necessary by the geotechnical engineer. If the subgrade is evaluated to be unsuitable, then the project geotechnical engineer, project inspector, and/or project engineer may require the removal of the unsuitable material and replacement with stabilization material. If the bottom of the trench is wet then sump pumps located a minimum of two inches below the bottom of the trench excavation shall be used for dewatering at the geotechnical engineer's discretion (Arvada, 2023). At the time of such observation, it may be necessary to make hand auger borings and/or use a hand penetration device in the base of the foundation excavation to confirm that the soils below the base are satisfactory for foundation support. The necessary depth of penetration will be established during observation. Frozen, wet, soft, or loose soil, as well as any other undesirable material should be removed. Once suitable soil conditions are achieved, the subgrade should be scarified and compacted prior to fill placement. The suitable exposed soil materials should be scarified and moistened or dried, as necessary, to a minimum depth of 8 inches below the proposed construction. Scarified material should be compacted to the minimum specifications defined in the following sections.

6.2.2 Structure and Trench Backfill Material

Backfill is anticipated within pipeline trenches and around manholes. Material recommendations are provided below:

- CDOT Class 2 (processed on-site material) is recommended for backfill above the pipe bedding zone. Processing onsite material shall include removing expansive materials, frozen chunks, wood, trash, organic material, and cobbles and boulders larger than 3 inches in diameter. Additionally, bedrock should not be repurposed for on-site CDOT Class 2 backfill.
- Import CDOT Class 1 Structure Backfill may be considered for backfill. CDOT Class 1 Structure Backfill must have a maximum PI of 6 and maximum LL of 35 and gradation is as shown in the table below:

CDOT Class 1 Structure Backfill	
Sieve Size	Percentage Passing
2 inch	100
#4	30-100
#50	10-60
#200	5-20

- Pipe shall be laid in a zone of pipe bedding which extends from 12 inches above the crown of the pipe to six inches below the pipe's invert. The City of Arvada specifies that pipe bedding for all

PVC, HDPE, CPP, PP, and DIP shall consist of well-graded sand or squeegee sand which complies to the following (Arvada, 2023):

Pipe Bedding – Well Graded Sand	
Sieve Size	Percentage Passing
3/8"	100
#4	70-100
#8	36-93
#16	20-80
#30	8-65
#50	2-30
#100	1-10
#200	0-3
Pipe Bedding – Squeegee	
3/8"	100
#200	0-5

The Owner has stated a preference for using #67 stone as pipe bedding material. #67 stone has a gradation in accordance with that shown in the table below (FHWA, 2015). #67 stone falls outside of the City of Arvada's standard specification for PVC, HDPE, CPP, PP, and DIP pipe bedding, but is evaluated to be suitable for use in this project.

Pipe Bedding – #67 Stone	
Sieve Size	Percentage Passing
1"	100
3/4"	90-100
3/8"	20-55
#4	0-10
#8	0-5

If another material is preferred for any of the presented applications, Lithos should be contacted to review submitted particle size distribution and plasticity testing results.

6.2.3 Fill Placement and Compaction

The City of Arvada states that trench backfill shall be placed in maximum 8-inch loose lifts when heavy equipment is used. Trench backfill should be conducted in maximum 6-inch loose lifts when hand compaction equipment (i.e. jumping jack, plate compactor) is used (Arvada, 2023). Fill beneath precast manholes is to consist of 12 inches of 1 ½-inch crushed rock. If manholes are cast in place, then the concrete should be poured directly over undisturbed soil (Arvada, 2023). Lift thickness for pipe bedding should not exceed 6 inches. Minimum recommended compaction specifications are outlined in the following table.

Soil Compaction Recommendations			
Backfill Material Type	Moisture and Compaction Specifications		
	Moisture Content ¹	Dry Density ²	Relative Density ³
Pipe Bedding			≥ 65%
Reprocessed On-Site Material	-2% to +2%	≥ 95%	
Imported Structural Backfill	-2% to +2%	≥ 95%	

¹ Moisture content relative to the optimum moisture content as determined by ASTM D698

² Dry density relative to the maximum dry density as determined by ASTM D698

³ As determined by ASTM D4263 and D4254. Need for relative density testing can be reviewed by Lithos with submitted pipe bedding material gradation

Mechanical compaction is required for all materials placed as backfill during construction. Compaction of cohesive materials is best accomplished with equipment such as a jumping jack or padfoot roller. Non-cohesive soils are best compacted with a vibratory plate or vibratory smooth-drum roller. Compaction utilizing any flooding type technique should not be allowed. Care should be taken when compacting fill adjacent to structures. Generally, we recommend operating only light-weight compaction equipment such as jumping jacks and vibratory plates immediately adjacent to pipelines.

Quality assurance of backfill material and backfill placement will be necessary to reduce potential for long-term differential settlements. Inspection of subgrade materials prior to placing pipelines is also critical to project success. Lithos recommends a qualified testing agency is retained to provide quality assurance services during the backfill process.

6.3 Bedrock or Oversized Material Excavation

Based on the subsurface investigation, bedrock at the site was classified as claystone/siltstone/sandstone and bedrock excavation is anticipated in limited areas near the southern end of the pipeline alignment and near the intersection of Sheridan Blvd and 72nd Ave during proposed construction activities. Based on the relative softness of encountered bedrock during the subsurface investigation, the use of standard equipment is anticipated to be sufficient to excavate bedrock layers. It is likely excavations may be performed using a standard sized bucket with teeth.

6.4 Construction Dewatering

Groundwater was encountered during the subsurface investigation at depths as shallow as 8 feet. Temporary construction dewatering should be anticipated for the proposed construction at locations where excavations extend below groundwater. Given the anticipated lower permeability of onsite soils and the limited anticipated depths trenches will penetrate bedrock, sump pumps to control minor groundwater seepage should be anticipated. Construction dewatering must adhere to the Colorado Department of Public Health and Environment (CDPHE) regulations and discharge permit requirements. Lithos is available to assist with dewatering design if required. Dewatering should be carefully evaluated and accounted for in the construction estimate to avoid construction cost and time increases.

Anticipated groundwater pumping rates are dependent on the aquifer soil type. Two distinct soil types with differing hydraulic conductivities are identified along the project alignment. The following table

outlines these soil types, where they are anticipated, and an estimated groundwater pumping rate. Groundwater flow through bedrock is assumed to be negligible.

Estimated Dewatering Pumping Rates			
Location	Soil Type (USCS)	Estimated Hydraulic Conductivity (ft/sec)	Estimated Dewatering Flow Rate (gpm)
Along Little Dry Creek	SC, GC, GP-GC	1×10^{-5}	6
Along Sheridan Blvd	CL	1×10^{-7}	0.2

6.5 Unstable Subgrade Conditions

If soft/loose pockets or undesirable materials are encountered in the excavations, the proposed excavations may be re-established by backfilling after the material has been removed. The backfill should consist of CDOT Class 5 or 6 base course. If the base of the overexcavation is still soft and further overexcavation is not practical, a stabilization product meeting the minimum requirements of Tensar Biaxial Geogrid BX1200 or Mirafi Woven Geotextile HP270 should be placed in the base of the overexcavation per the manufacturer's recommendations. The backfill should be placed and compacted according to specifications outlined in this report. Field observations by a geotechnical engineer and testing of the open excavations should be performed prior to concrete placement to verify the subgrade conditions and/or to make corrective recommendations, as necessary.

6.6 Trench Plugs

Trench plugs should be constructed from impervious material and should be keyed into the in situ soils or bedrock along the trench bottom and sidewalls, extending at least 6 inches to 12 inches above the top of the bedding elevations. Trench plugs are recommended to be installed at a spacing not to exceed 1,000 feet. Trench plugs may be constructed from compacted clay soils with an USCS classification of CL or with at least 60 percent fines and a plasticity index of 15 or greater. Trench plugs may also be constructed from lean concrete, CLSM (flowable fill), or sandy site soils amended with bentonite. Trench plugs should have a minimum thickness of 2 feet as measured parallel to the pipe.

7 CONSTRUCTION OBSERVATION AND QUALITY ASSURANCE

We understand the primary geotechnical components of construction will include trenching, pipeline placement, and trench backfill. Quality assurance of backfill material and backfill placement in accordance with recommendations provided in this report will be necessary to reduce potential for long term settlements and pipeline performance. Lithos recommends a qualified testing agency be retained to provide quality assurance services during the subgrade preparation and backfill processes.

8 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings, geotechnical laboratory testing, information provided by the client, engineering judgement, and our experience with similar subsurface conditions and projects. The boring logs presented in this report only depict the subsurface conditions at the actual boring locations. Subsurface conditions are typically

variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types and bedrock presented in this report are approximate and, in some cases, may be more abrupt or gradational than described herein. Groundwater levels may vary with time, adjacent surface water levels, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

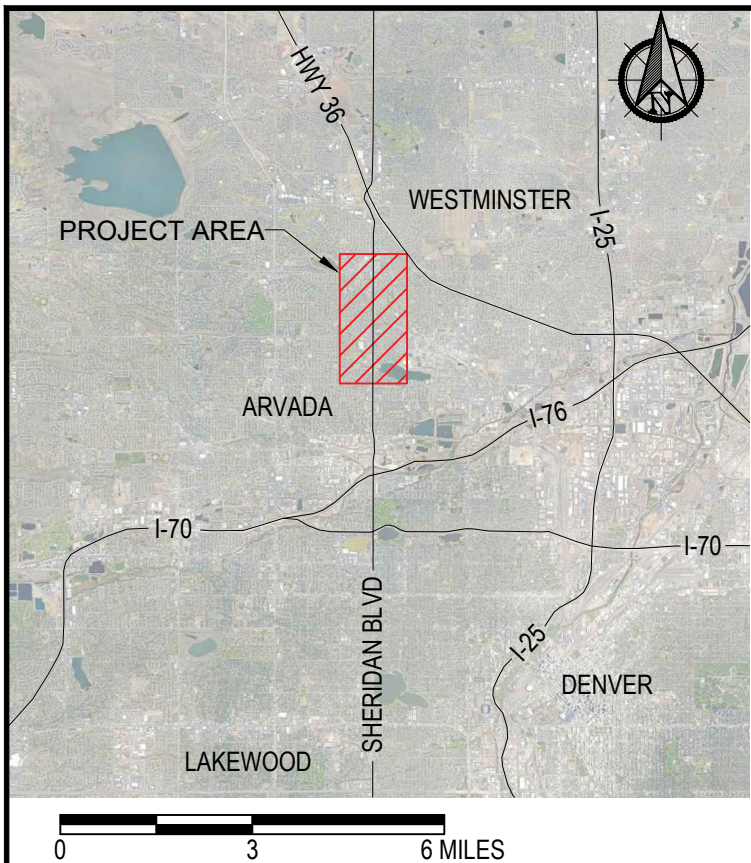
This report has been prepared exclusively for our client for design purposes for the subject project. Lithos Engineering is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects. If differing site conditions are encountered during further evaluation of the subsurface conditions by others or during construction, Lithos Engineering should be notified immediately to determine if any changes to our recommendations presented in this report are warranted.

The recommendations presented in this report are only intended for the proposed design and construction as understood by Lithos Engineering at the time of issuing this report. If the proposed design and construction changes, Lithos Engineering should be notified immediately and given the opportunity to review the proposed changes and if necessary, modify our recommendations presented herein.

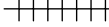
An environmental assessment was not included in Lithos Engineering scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos Engineering recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

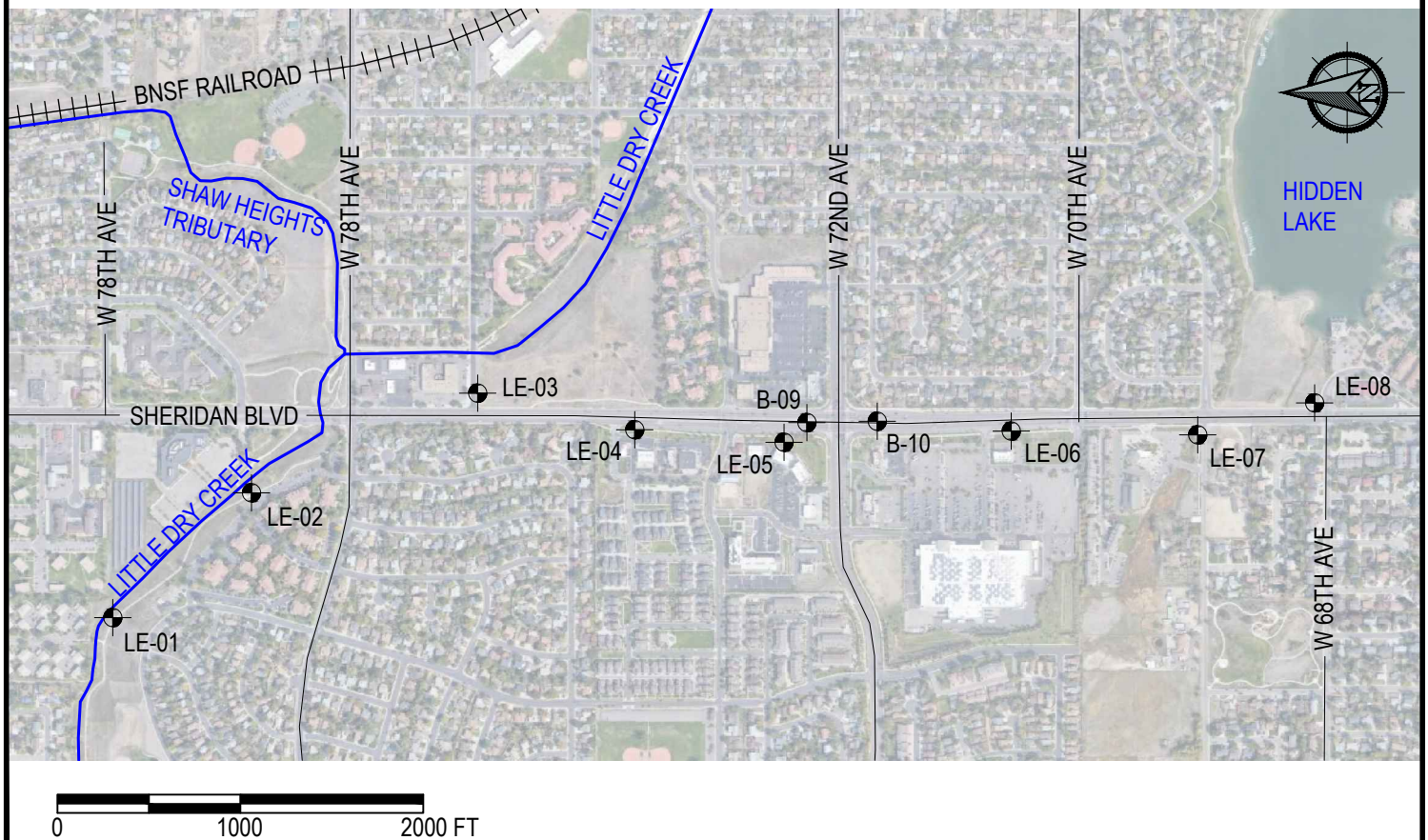
REFERENCES

- ASCE 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ASTM Standards, ASTM International, West Conshohocken, PA (2012).
- City of Arvada, Engineering Code of Standards and Specifications, 2023.
- Federal Highway Administration, Strength Characterization of Open-Graded Aggregates for Structural Backfills (FHWA-HRT-15-034), June 2015.
- Knodel, P.C., 1992, Characteristics and Problems of Collapsible Soils, *US Bureau of Reclamation*, Report No. R-92-02
- Lindvall, R.M. 1979. Geologic map of the Arvada quadrangle, Adams, Denver, and Jefferson Counties, Colorado, *US Geological Survey*, Geological Quadrangle Map GQ-1453



LEGEND:

-  APPROXIMATE BORING LOCATION
-  ROADWAYS
-  RIVERS AND CREEKS
-  RAILROAD TRACKS



  350 INDIANA STREET, SUITE 750 GOLDEN, COLORADO 80401	PROJECT TITLE NORTH TRUNK SEWER IMPROVEMENTS SHERIDAN AND 76TH	OWNER 	CLIENT 	FIGURE NUMBER 1
	DRAWING TITLE SITE VICINITY AND BORING LOCATIONS MAP	PROJECT NO.: 23119 LOCATION: ARVADA, CO DATE: 07/24/24	DRAWN BY: AM DESIGNED BY: AW CHECKED BY: LH	



APPENDIX A

BORING LOG KEY

STANDARD GEOTECHNICAL DRILLING

Soil Classifications:

Clear Square Sieve Openings				U.S. Standard Series Sieve Sizes			
12"	3"	3/4"	4	10	40	200	
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm	

Gradation Estimates by Field Observation	
Description	Quantity (%)
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		Cohesive Soils	
Classification	Blows per 12 in	Classification	Blows per 12 in
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

Color: Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Plasticity	
Description	Criteria
Nonplastic	A $\frac{1}{8}$ " diameter thread cannot be rolled
Low	A $\frac{1}{8}$ " in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{1}{8}$ " in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{1}{8}$ " in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Description of Odor	
Description	Criteria
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

Rock Descriptions:

Weathering	
Description	Criteria
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	Criteria
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$ " diameter
Medium Grained	Grain diameter between $\frac{1}{16}$ " and $\frac{3}{16}$ "
Coarse Grained	Grains diameter between $\frac{3}{16}$ " and $\frac{1}{4}$ "
Very Coarse Grained	Grains larger than $\frac{1}{4}$ " in diameter

Field Hardness	
Description	Criteria
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$ " deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

Geologic Interpretation:

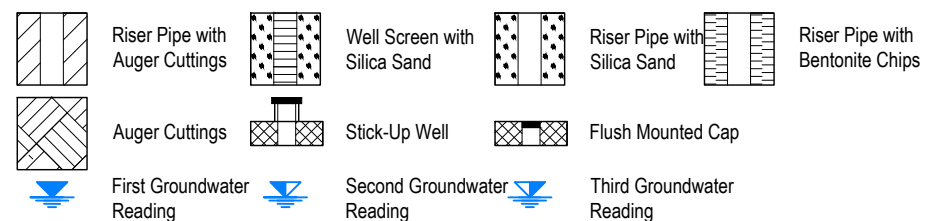
A **Geologic Interpretation** of encountered soil and bedrock units is provided for each specific **Visual Material Description**. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

Sample Graphics and Descriptions:

-  California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.
-  Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.
-  Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.
-  Bulk Sample: Bulk or bagged sample taken from auger cuttings.

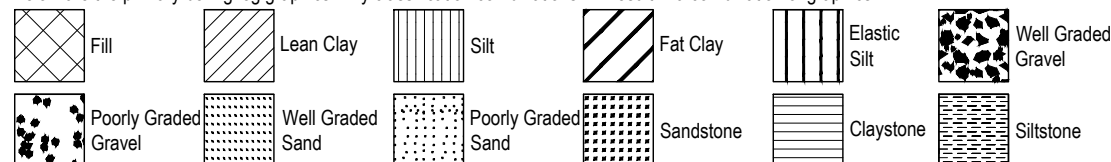
 Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

Groundwater Monitoring Well Graphics:



Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.



BORING: LE-01Project Name: NTL7 - Sheridan and 76thProject Number: 23119Client's Name: CarolloOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesGEI Representative: Adam MalsamDate(s) of Drilling: 12/04/23**Drilling and Sampling Methods**Drill Make and Model: Truck Mounted CME 55Drilling Method: Hollow Stem AugerBit Type: Auger Cutting HeadCasing Description: Hollow Stem AugerHammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.Sampler Type(s): Split Spoon / Mod CalSampler Diameter(s): 1.4" / 2.0"Boring Location: 39.8381, -105.0572Boring Elevation: 5333 ftNotes: Approx. location from Google Maps,
approx. elevation from USGS 3DEP**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States			INDEX DATA					Strength & Compressibility		
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							FINE ALLUVIUM LEAN CLAY (CL), few fine sand, olive brown, moist, roots, organics LEAN CLAY (CL), trace fine sand, medium stiff, olive gray, moist													
5328			3 3 5	6																
6			3 5	8			Clayey SAND (SC), mostly fine to medium sand, some clay, loose, olive gray, moist		18.5	110.9				45	29	15				
5322			8 10 13	18			COARSE ALLUVIUM Clayey SAND (SC), mostly fine to coarse sand, some clay, few gravel up to 2", medium dense, olive, moist Auger chatter noted. Indicative of gravels and/or cobbles in subsurface.	10.0 ft.				8	65	27						
5316			14 9 7	16			Clayey GRAVEL (GC), mostly fine to coarse gravel up to 2", some fine to coarse sand, little clay, medium dense, pale olive, wet, transitions to SC in bottom 6" of sample	16.5 ft.												
18							END OF EXPLORATION													
5310																				
24																				
5304																				
30																				
5298																				
36																				

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
12/04/12	0-hr	13 ft

BORING: LE-02			Drilling and Sampling Methods															
Project Name: NTL7 - Sheridan and 76th			Drill Make and Model: Truck Mounted CME 55			Boring Location: 39.8360, -105.0548												
Project Number: 23119			Drilling Method: Solid Stem Auger			Boring Elevation: 5328 ft												
Client's Name: Carollo			Bit Type: Auger Cutting Head			Notes: Approx. location from Google Maps,												
Owner's Name: City of Arvada			Casing Description: N/A			approx. elevation from USGS 3DEP												
Drilling Subcontractor: Vine Laboratories			Hammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.															
GEI Representative: Adam Malsam			Sampler Type(s): Split Spoon / Mod Cal															
Date(s) of Drilling: 12/04/23			Sampler Diameter(s): 1.4" / 2.0"															
Sampling Data			Visual Material Description			Laboratory Testing Results												
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil:		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA				Strength & Compressibility		
							-GEOLOGIC INTERPRETATION-			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)
0	5328						USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions		 (8.0 ft.)									
							Rock:											
							-GEOLOGIC INTERPRETATION-											
							Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions											
							FINE ALLUVIUM LEAN CLAY (CL), few fine sand, dark brown, moist, roots, organics LEAN CLAY (CL), few fine to medium sand, stiff, olive gray, moist, few roots											
6	5322		5 6 7	14			As above except medium stiff, dark brown with light brownish gray mottling			21.9	97.6			72				
			4 3	7														
12	5316		2 8 12	16			Sandy LEAN CLAY (CL), some fine to coarse sand, few gravel in bottom 3" of sample up to 2" in diameter, very stiff, olive, wet											
			7 12 13	14			COARSE ALLUVIUM Poorly graded GRAVEL with clay (GP-GC), mostly gravel up to 1", few clay, some fine to coarse sand, pale olive wet											
18	5310						DENVER FORMATION BEDROCK CLAYSTONE, very soft, highly weathered, bluish gray with yellowish brown staining, very fine grained											
							END OF EXLORATION											
24	5304																	
30	5298																	
36	5292																	
General Notes: 1) Soil classificaitons are in general accordance with ASTM D2487 2) The maximum particle size identified in the material description is dependent on sampler dimensions. 3) Additional information is provided on the Boring Log Key. 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.										Groundwater Data: Date: 12/04/12 Elapsed Time: 0-hr Depth to Groundwater: 8 ft								

BORING: LE-03 Project Name: NTL7 - Sheridan and 76th Project Number: 23119 Client's Name: Carollo Owner's Name: City of Arvada Drilling Subcontractor: Vine Laboratories GEI Representative: Rob Johanson Date(s) of Drilling: 01/30/24			Drilling and Sampling Methods Drill Make and Model: Truck Mounted CME 55 Drilling Method: Solid Stem Auger Bit Type: Auger Cutting Head Casing Description: N/A Hammer Weight (lbs)/Fall (in): 140 lbs. / 30 in. Sampler Type(s): Split Spoon / Mod Cal Sampler Diameter(s): 1.4" / 2.0"			GEI Consultants Boring Location: 39.8332, -105.0534 Boring Elevation: 5326 ft Notes: Approx. location from Google Maps, approx. elevation from USGS 3DEP																																																																																																																																																																																																						
Sampling Data <table><tr><td>Depth (ft)</td><td>Elevation (ft)</td><td>Sample Identification</td><td>Blow Count/6 in</td><td>Recovery (in) / RQD (%)</td><td>Drilling Rate (min./ft.)</td><td>Geologic Graphic</td></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>13 16</td><td>12</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>13 16</td><td>12</td><td></td><td></td><td></td></tr><tr><td>5322</td><td></td><td>6 7</td><td>11</td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>3 5</td><td>12</td><td></td><td></td><td></td></tr><tr><td>5316</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>12</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>4 8</td><td>12</td><td></td><td></td><td></td></tr><tr><td>5310</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>18</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5304</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>24</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5298</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>30</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5292</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>36</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>			Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	0									13 16	12						13 16	12				5322		6 7	11				6									3 5	12				5316							12									4 8	12				5310							18														5304							24														5298							30														5292							36							Visual Material Description Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions ASPHALT - 8 INCHES 0.7 ft. EOLIAN DEPOSIT LEAN CLAY with sand (CL), little fine sand, yellowish brown, moist Sandy LEAN CLAY (CL), some fine sand, few gravel, very stiff, olive yellow, moist As above except some fine to medium sand, stiff As above except some fine sand, medium stiff, yellowish brown, gypsum veins present DENVER FORMATION RESIDUUM 14.0 ft. LEAN CLAY with sand (CL), mostly clay, little fine sand, stiff, greenish-pale olive, moist, rock fabric present 15.0 ft. END OF EXPLORATION			Groundwater Depth / Monitoring Well Configuration (8.0 ft.)			Laboratory Testing Results <table><tr><td colspan="3">In-Situ States</td><td colspan="4">INDEX DATA</td><td colspan="3">Strength & Compressibility</td></tr><tr><td>Moisture Content (%)</td><td>Dry Unit Weight (pcf)</td><td>Water Soluble Sulfates (%)</td><td>Gravel Content (%)</td><td>Sand Content (%)</td><td>Fines Content (%)</td><td>Liquid Limit (%)</td><td>Plasticity Index (%)</td><td>UCS (psf)</td><td>Swell Pressure (psf)</td><td>Swell Percent (%)</td></tr><tr><td>14.1</td><td>111.6</td><td></td><td>10.0</td><td>35.0</td><td>55.0</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>22</td><td>98</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>N/A</td><td>-0.1</td></tr></table>						In-Situ States			INDEX DATA				Strength & Compressibility			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)	14.1	111.6		10.0	35.0	55.0						22	98								N/A	-0.1
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BORING: LE-04Project Name: NLT7 - Sheridan and 76thProject Number: 23119Client's Name: CarolloOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesGEI Representative: Adam MalsamDate(s) of Drilling: 12/04/23**Drilling and Sampling Methods**Drill Make and Model: Truck Mounted CME 55Drilling Method: Hollow Stem AugerBit Type: Auger Cutting HeadCasing Description: Hollow Stem AugerHammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.Sampler Type(s): Split Spoon / Mod CalSampler Diameter(s): 1.4" / 2.0"Boring Location: 39.8303, -105.0535Boring Elevation: 5332 FTNotes: Approx. location from Google Maps,
approx. elevation from USGS 3DEP**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions	Groundwater Depth / Monitoring Well Configuration	In-Situ States								INDEX DATA			Strength & Compressibility		
									Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)			
0							FILL LEAN CLAY (CL), trace sand, olive with light brownish gray mottling, moist, roots As above except stiff, no roots															
5328		3 4 7		13																		
6		3 5		6			As above except some sand, olive gray with pale olive mottling, brick, asphalt, plastic fragments							68.0								
5322		11 17 30		18			DENVER FORMATION RESIDUUM Sandy SILT (ML), mostly silt, some fine to medium sand, dense, olive yellow, moist	10.0 ft.				0.0	45.0	55.0	29	4						
5316		18 50/3"		10			As above except very dense, wet	15.8 ft.														
18							DENVER FORMATION BEDROCK Silty SANDSTONE, very soft, moderately weathered, gray, fine to medium grained, micaceous, poorly cemented	16.0 ft.														
							END OF EXPLORATION															
5310																						
24																						
5304																						
30																						
5298																						
36																						

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date: 12/04/12 Elapsed Time: 0-hr Depth to Groundwater: 14.2 FT

BORING: LE-05 Project Name: <u>NLT7 - Sheridan and 76th</u> Project Number: <u>23119</u> Client's Name: <u>Carollo</u> Owner's Name: <u>City of Arvada</u> Drilling Subcontractor: <u>Vine Laboratories</u> GEI Representative: <u>Adam Malsam</u> Date(s) of Drilling: <u>12/05/23</u>						Drilling and Sampling Methods Drill Make and Model: <u>Truck Mounted CME 55</u> Drilling Method: <u>Solid Stem Auger</u> Bit Type: <u>Auger Cutting Head</u> Casing Description: <u>N/A</u> Hammer Weight (lbs)/Fall (in): <u>140 lbs. / 30 in.</u> Sampler Type(s): <u>Split Spoon / Mod Cal</u> Sampler Diameter(s): <u>1.4" / 2.0"</u>						GEI Consultants Boring Location: <u>39.8281, -105.0538</u> Boring Elevation: <u>5335 ft</u> Notes: <u>Approx. location from Google Maps,</u> <u>approx. elevation from USGS 3DEP</u>					
Sampling Data						Visual Material Description						Laboratory Testing Results					
						Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions						In-Situ States INDEX DATA Strength & Compressibility					
Depth (ft) Elevation (ft) Sample Identification Blow Count/6 in Recovery (in) / RQD (%) Drilling Rate (min./ft.) Geologic Graphic						Groundwater Depth / Monitoring Well Configuration						Moisture Content (%) Dry Unit Weight (pcf) Water Soluble Sulfates (%) Gravel Content (%) Sand Content (%) Fines Content (%) Liquid Limit (%) Plasticity Index (%) UCS (psf) Swell Pressure (psf) Swell Percent (%)					
0 5334 4 6 7 14 6 5 6 6 5328 3 3 3 16 5322 25 50/3" 12 5316 23 40 46 17 24 5310 30 5304 36 5298						FILL LEAN CLAY (CL), little fine to medium sand, olive gray, moist, roots As above except stiff As above except with trace gravel up to 0.5", no roots 10.0 ft.- EOLIAN DEPOSIT Sandy LEAN CLAY (CL), some fine to coarse sand, medium stiff, pale olive, moist 15.0 ft.- DENVER FORMATION RESIDUUM Poorly graded SAND with silt (SP-SM), mostly fine to medium sand, few silt, very dense, yellowish brown, moist, mica crystals As above except wet 21.5 ft.- END OF EXPLORATION						(17.0 ft.)					
General Notes: 1) Soil classificaitons are in general accordance with ASTM D2487 2) The maximum particle size identified in the material description is dependent on sampler dimensions. 3) Additional information is provided on the Boring Log Key. 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.												Groundwater Data: Date: <u>12/05/23</u> Elapsed Time: <u>0-hr</u> Depth to Groundwater: <u>17 ft</u>					

BORING: LE-06Project Name: NLT7 - Sheridan and 76thProject Number: 23119Client's Name: CarolloOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesGEI Representative: Rob JohansonDate(s) of Drilling: 01/30/24**Drilling and Sampling Methods**Drill Make and Model: Truck Mounted CME 55Drilling Method: Solid Stem AugerBit Type: Auger Cutting HeadCasing Description: N/AHammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.Sampler Type(s): Split Spoon / Mod CalSampler Diameter(s): 1.4" / 2.0"Boring Location: 39.8249 , -105.0536Boring Elevation: 5320 ftNotes: Approx. location from Google Maps,
approx. elevation from USGS 3DEP**Sampling Data****Visual Material Description****Laboratory Testing Results**

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description		Groundwater Depth / Monitoring Well Configuration	In-Situ States			INDEX DATA				Strength & Compressibility		
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)
0							ASPHALT - 12 INCHES	1.0 ft.											
							FILL Sandy LEAN CLAY (CL), some fine sand, pale olive to olive, moist												
5316			5 8	12			Sandy SILTY CLAY (CL-ML), some fine sand, stiff, pale olive to yellowish brown, dry-moist calcite nodules present	4.0 ft.		23.2					32	7			
6			3 10	12			DENVER FORMATION RESIDUUM Silty SAND (SM), mostly fine sand, some silt, stiff, greenish gray-yellowish brown, moist, rock fabric present, iron oxide staining present	8.0 ft.	(8.0 ft.)										
5310			18 35	12			DENVER FORMATION SILTSTONE, very soft, highly weathered, yellowish brown-olive yellow, very fine grained, dry			19.4	98.9			50.0					
12			34 50/5"	12			SANDSTONE, very soft, moderately weathered, olive yellow, fine grained, wet	14.9 ft.											
5304							END OF EXPLORATION												
18																			
5298																			
24																			
5292																			
30																			
5286																			
36																			

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
12/04/12	0-hr	8 ft

BORING: LE-07Project Name: NTL7 - Sheridan and 76thProject Number: 23119Client's Name: CarolloOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesGEI Representative: Adam MalsamDate(s) of Drilling: 12/05/23**Drilling and Sampling Methods**Drill Make and Model: Truck Mounted CME 55Drilling Method: Solid Stem AugerBit Type: Auger Cutting HeadCasing Description: N/AHammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.Sampler Type(s): Split Spoon / Mod CalSampler Diameter(s): 1.4" / 2.0"Boring Location: -39.8220, -105.0536Boring Elevation: 5295 ftNotes: Approx. location from Google Maps,
approx. elevation from USGS 3DEP**Sampling Data****Visual Material Description****Laboratory Testing Results**

Visual Material Description							Groundwater Depth / Monitoring Well Configuration	In-Situ States			INDEX DATA				Strength & Compressibility			
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0																		
5292			4 4	7			FILL Landscaping gravel, 3 inches thick, landscaping fabric at base											
			3 3 4	13			Clayey SAND with gravel (SC), little sand, few gravel, medium stiff, olive gray with reddish brown and pale olive mottling, moist, asphalt, glass, and plastic fragments As above except with little gravel up to 1.5"				22	37	41					
6							7.5 ft. 											
5286			4 5 5	18			FINE ALLUVIUM LEAN CLAY with sand (CL), few sand, stiff, greenish black, wet, sulphur odor from organic decomposition											
12			10 18	8			DENVER FORMATION BEDROCK CLAYSTONE, very soft, highly weathered, gray with reddish yellow staining, very fine grained, sulphur odor											
5280							15.0 ft.											
							16.0 ft.											
18							END OF EXPLORATION											
5274																		
24																		
5268																		
30																		
5262																		
36																		

General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
12/05/23	0-hr	8 ft

BORING: LE-08Project Name: NTL7 - Sheridan and 76thProject Number: 23119Client's Name: CarolloOwner's Name: City of ArvadaDrilling Subcontractor: Vine LaboratoriesGEI Representative: Adam MalsamDate(s) of Drilling: 12/04/2023**Drilling and Sampling Methods**Drill Make and Model: Truck Mounted CME 55Drilling Method: Solid Stem AugerBit Type: Auger Cutting HeadCasing Description: N/AHammer Weight (lbs)/Fall (in): 140 lbs. / 30 in.Sampler Type(s): Split Spoon / Mod CalSampler Diameter(s): 1.4" / 2.0"Boring Location: 39.8202, -105.0530Boring Elevation: 5293 ftNotes: Approx. location from Google Maps,
approx. elevation from USGS 3DEP**Sampling Data****Visual Material Description****Laboratory Testing Results**

Visual Material Description								Groundwater Depth / Monitoring Well Configuration	In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0	5292		6 7 8	12			FILL LEAN CLAY (CL), little fine to medium sand, olive, dry, asphalt fragments, roots As above except stiff, with trace gravel												
6	5286		5 4	6			As above except trace sand, no gravel, no roots, moist												
12	5280		3 4 4	18			FINE ALLUVIUM LEAN CLAY (CL), few sand, medium stiff, greenish black with gray calcite stringers, moist						77						
18	5274		4 5	10			LEAN CLAY (CL), trace sand, stiff, greenish black, calcite stringers, moist												
24	5268		4 5 6	14			As above excapt olive brown												
30	5262		5 6	12			As above except wet, calcite crystals	17.2					47	24			1049.0	0.3	
36	5256		8 10 14	18			DENVER FORMATION BEDROCK CLAYSTONE, very soft, highly weathered, gray with yellowish brown staining, very fine grained END OF EXPLORATION												

General Notes:

- Soil classifications are in general accordance with ASTM D2487
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
12/04/23	0-hr	23 ft

BORING: B-9 Project Name: <u>NLT7 - Sheridan and 76th</u> Project Number: <u>23119</u> Client's Name: <u>Carollo</u> Owner's Name: <u>City of Arvada</u> Drilling Subcontractor: <u>Vine Laboratories</u> GEI Representative: <u>Adam M.</u> Date(s) of Drilling: <u>07/02/2024</u>					Drilling and Sampling Methods Drill Make and Model: <u>CME 75 Truck Mounted</u> Drilling Method: <u>Soild Stem Auger</u> Bit Type: <u>Auger drill bit</u> Casing Description: <u>N/A</u> Hammer Weight (lbs)/Fall (in): <u>140 lbs. / 30 in.</u> Sampler Type(s): <u>Split Spoon / Mod Cal</u> Sampler Diameter(s): <u>1.4" / 2.0"</u>					GEI Consultants Boring Location: <u>39.8276, -105.0534</u> Boring Elevation: <u>5331 ft</u> Notes: <u>Approx. location from Google Maps,</u> <u>approx. elevation from USGS 3DEP</u>																																																																																																																																																																																																	
Sampling Data <table><tr><td>Depth (ft)</td><td>Elevation (ft)</td><td>Sample Identification</td><td>Blow Count/6 in</td><td>Recovery (in) / RQD (%)</td><td>Drilling Rate (min./ft.)</td><td>Geologic Graphic</td></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5328</td><td></td><td></td><td>4</td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td>4</td><td></td><td>17</td><td></td></tr><tr><td></td><td></td><td></td><td>7</td><td></td><td></td><td></td></tr><tr><td>5322</td><td></td><td></td><td>7</td><td></td><td>7</td><td></td></tr><tr><td></td><td></td><td></td><td>11</td><td></td><td></td><td></td></tr><tr><td>12</td><td></td><td></td><td>7</td><td></td><td>18</td><td></td></tr><tr><td></td><td></td><td></td><td>12</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td>14</td><td></td><td></td><td></td></tr><tr><td>5316</td><td></td><td></td><td>11</td><td></td><td>12</td><td></td></tr><tr><td></td><td></td><td></td><td>25</td><td></td><td></td><td></td></tr><tr><td>18</td><td></td><td></td><td>14</td><td></td><td>18</td><td></td></tr><tr><td></td><td></td><td></td><td>21</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td>25</td><td></td><td></td><td></td></tr><tr><td>5310</td><td></td><td></td><td>19</td><td></td><td>10</td><td></td></tr><tr><td></td><td></td><td></td><td>29</td><td></td><td></td><td></td></tr><tr><td>24</td><td></td><td></td><td>16</td><td></td><td>18</td><td></td></tr><tr><td></td><td></td><td></td><td>30</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td>50/3"</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td>50/6"</td><td></td><td>8</td><td></td></tr><tr><td>5304</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>30</td><td></td><td></td><td>20</td><td></td><td>18</td><td></td></tr><tr><td></td><td></td><td></td><td>28</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td>41</td><td></td><td></td><td></td></tr><tr><td>5298</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>36</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>					Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	0							5328			4				6			4		17					7				5322			7		7					11				12			7		18					12							14				5316			11		12					25				18			14		18					21							25				5310			19		10					29				24			16		18					30							50/3"							50/6"		8		5304							30			20		18					28							41				5298							36							Visual Material Description Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions					Groundwater Depth / Monitoring Well Configuration Moisture Content (%) Dry Unit Weight (pcf) Water Soluble Sulfates (%) Gravel Content (%) Sand Content (%) Fines Content (%) Liquid Limit (%) Plasticity Index (%) UCS (psf) Swell Pressure (psf) Swell Percent (%)				
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic																																																																																																																																																																																																					
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ASPHALT 1.5 ft. FILL Sandy LEAN CLAY (CL), some fine to medium sand, stiff, mottled gray, light brownish gray, and olive brown, moist, numerous roots and organics. 8.0 ft. DENVER FORMATION CLAYSTONE, very soft, highly weathered, mottled pale olive to bluish gray with yellowish brown staining, very fine grained, calcite stringers. As above Silty SANDSTONE, very soft, highly weathered, pale olive to yellowish brown, very fine to fine grained, extremely thin bedding, mica crystals. Sandy CLAYSTONE, very soft, highly weathered, mottled pale olive to light bluish gray with yellowish brown staining, very fine to fine grained. SILTSTONE, very soft, highly weathered, pale olive to yellowish brown, very fine to fine grained, extremely thin bedding, mica crystals. As above except bottom two inches is wet. As above except with reddish brown staining. Silty SANDSTONE, very soft, moderately weathered, pale olive to yellowish brown, very fine to fine grained, extremely close bedding 31.5 ft. END OF EXPLORATION							24.0 ft. 18.1 94.9 NA -0.5																																																																																																																																																																																																				
General Notes: 1) Soil classificaitons are in general accordance with ASTM D2487 2) The maximum particle size identified in the material description is dependent on sampler dimensions. 3) Additional information is provided on the Boring Log Key. 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.							Groundwater Data: Date: <u>07/02/24</u> Elapsed Time: <u>0-hr</u> Depth to Groundwater: <u>24 ft</u>																																																																																																																																																																																																				

BORING: B-10 Project Name: <u>N7L7 - Sheridan and 76th</u> Project Number: <u>23119</u> Client's Name: <u>Carollo</u> Owner's Name: <u>City of Arvada</u> Drilling Subcontractor: <u>Vine Laboratories</u> GEI Representative: <u>Adam M.</u> Date(s) of Drilling: <u>07/02/2024</u>					Drilling and Sampling Methods Drill Make and Model: <u>CME 75 Truck Mounted</u> Drilling Method: <u>Soild Stem Auger</u> Bit Type: <u>Auger drill bit</u> Casing Description: <u>N/A</u> Hammer Weight (lbs)/Fall (in): <u>140 lbs. / 30 in.</u> Sampler Type(s): <u>Split Spoon / Mod Cal</u> Sampler Diameter(s): <u>1.4" / 2.0"</u>					GEI Consultants Boring Location: <u>39.8269, -105.0534</u> Boring Elevation: <u>5331 ft</u> Notes: <u>Approx. location from Google Maps,</u> <u>approx. elevation from USGS 3DEP</u>							
Sampling Data					Visual Material Description					Laboratory Testing Results							
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil:		Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA				Strength & Compressibility	
							-GEOLOGIC INTERPRETATION-			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)
0							-GEOLOGIC INTERPRETATION-		(23.0 ft.)								
							USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions										
							Rock:										
							-GEOLOGIC INTERPRETATION-										
							Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions										
							ASPHALT										
							FILL										
							Poorly graded SAND (SP), trace clay, mostly fine to coarse sand, loose, light brownish gray to gray, dry, grains angular to subangular.										
							DENVER FORMATION										
							Sandy SILTSTONE, very soft, highly to completely weathered, gray to light brownish gray, very fine to fine grained, minor lignite coal.										
6	5328	5 7	6				As above except for some well cemented, medium hard, white rock within the sample.		14.9	105.6					4069		
12	5322	5 11 36	18				As above except highly weathered, light brownish gray with olive yellow stains, extremely thin bedding planes noticable in 1/4 of the sample.						58	29	5		
18	5316	17 40 42	18				As above.		16	101.5							
24	5310	18 33 50/3"	18				As above except extremely fine bedding planes throughout the sample.						70	31	6		
		25 40	12				As above except sample is moist to wet.		17.4	106.9							
		21 30 50/2"	16				As above except for some dark gray layers of lignite coal.										
30	5304	18 31	8				As above except sand grains range from fine to coarse.		14.6	113.5					955		
	5298						END OF EXPLORATION										
36																	

General Notes:

1) Soil classifaitions are in general accordance with ASTM D2487

2) The maximum particle size identified in the material description is dependent on sampler dimensions.

3) Additional information is provided on the Boring Log Key.

4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date: 07/02/24

Elapsed Time: 0-hr

Depth to Groundwater: 23 ft



APPENDIX B

North Trunk Sewer Improvements (NTL7) - Sheridan and 76th

GEOTECHNICAL LABORATORY TESTING RESULTS

Sample Identification		In-Place States		Material Classification and Index Testing					Swell and Compressability		Unconfined Compression Strength (psi)	USCS Classification ^{1, 2}	Description ¹
Boring/ Test Pit	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Particle Size Distribution (%)			Atterberg Limits		Swell Pressure (psf)	Swell Percent (%)			
LE-01	5	19	111			45	29	15				SC	Clayey Sand
LE-01	10			8	65	27						SC	Clayey Sand
LE-02	5	22	98			72						CL	Lean Clay with Sand
LE-03	4	14	112	10	35	55						CL	Sandy Lean Clay
LE-03	14	22	98						N/A	-0.1		CL	Lean Clay with Sand
LE-04	5					68						CL	Lean Clay with Sand
LE-04	10			0	45	55	29	4				ML	Sandy Silt
LE-05	10					62	44	28				CL	Sandy Lean Clay
LE-06	4	23					32	7				SM	Silty Sand
LE-06	9	19	99			50						-	Silty Sandstone
LE-07	5			22	37	41						SC	Clayey Sand with Gravel
LE-07	10	19					36	22				CL	Lean Clay with Sand
LE-08	10					77						CL	Lean Clay
LE-08	25	17					47	24	1,049.0	0.3		CL	Lean Clay
B-9	10	18	95			96	42	21	N/A	-0.5		-	Claystone
B-9	14					93						-	Claystone
B-9	16	18	108									-	Silty Sandstone
B-9	21	17	117			82	30	7			42	-	Siltstone
B-9	24					75	30	6				-	Siltstone
B-9	26	17	111								55	-	Silty Sandstone
B-9	31					44	28	4				-	Silty Sandstone

¹Where Atterberg Limits and Fines Content testing was not performed, USCS classifications visually/manually determined in the field during the subsurface investigation

²Hyphens are used in place of bedrock where encountered.

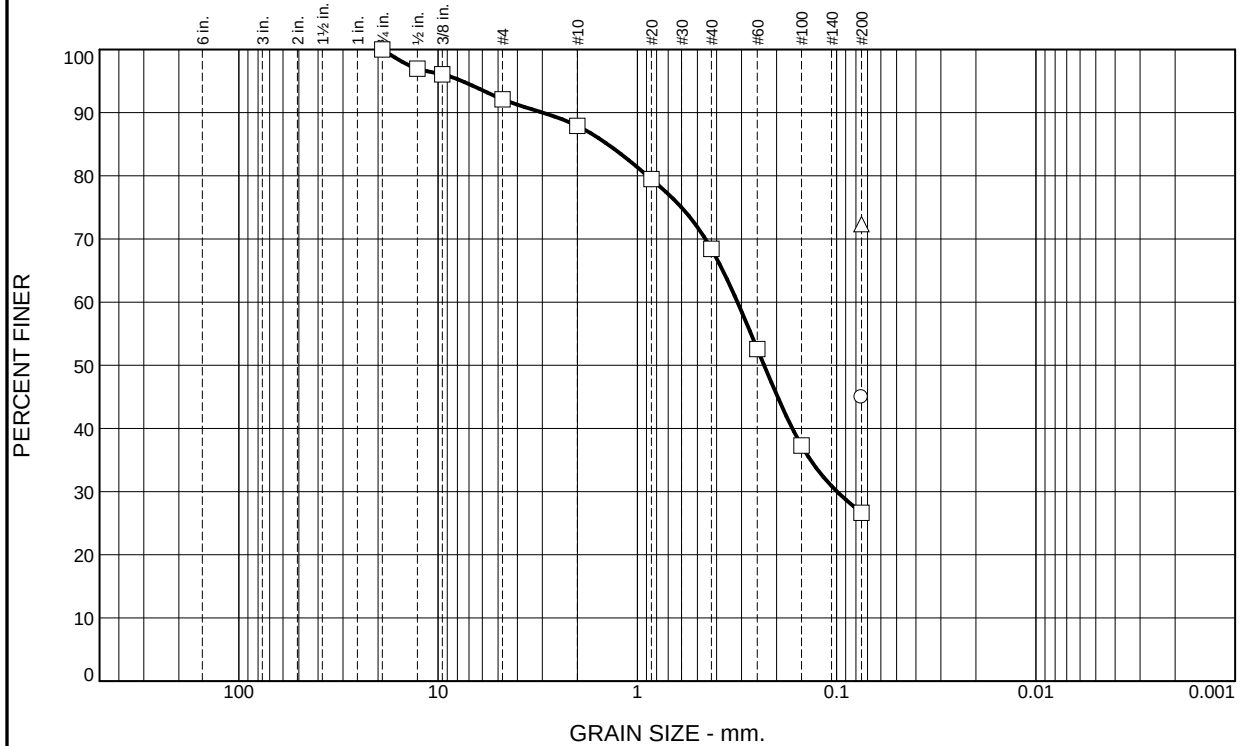
North Trunk Sewer Improvements (NTL7) - Sheridan and 76th

[illegible]

¹Where Atterberg Limits and Fines Content testing was not performed, USCS classifications visually/manually determined in the field during the subsurface investigation

²Hyphens are used in place of bedrock where encountered.

Particle Size Distribution Report



+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
0	8	65	27			29.0	14.0	15.0

SIEVE inches size	PERCENT FINER		
	○	□	△
3/4"		100	
1/2"		97	
3/8"		96	
GRAIN SIZE			
D ₆₀		0.3145	
D ₃₀		0.0995	
D ₁₀			
COEFFICIENTS			
C _c			
C _u			

SIEVE number size	PERCENT FINER		
	○	□	△
#4		92	
#10		88	
#20		79	
#40		68	
#60		53	
#100		37	
#200	45	27	72

Material Description
○
□
△
REMARKS:
○ Moisture content: 18.5% Dry Density: 110.9 pcf
□
△ Moisture content: 21.9% Dry density: 97.6 pcf

○ Location: LE-01; C2 Depth: 5-6
 □ Location: LE-01; S3 Depth: 10-11.5
 △ Location: LE-02; C2 Depth: 5-6

Sample Number: 12715
 Sample Number: 12716
 Sample Number: 12717

Martinez
Associates

Client: Lithos Engineering
 Project: North Trunk Sewer #7 (LE 23119)
 Project No.: 24-0017

Figure

Tested By: A. Dudney

Checked By: K. Runner

PERCENT FINER

GRAIN SIZE - mm.

Grain Size (mm)	Percent Finer (%) - Circles	Percent Finer (%) - Triangles	Notes
6 in.	100	-	
3 in.	100	-	
2 in.	100	100	
1 1/2 in.	100	100	
1 in.	92	100	
3/4 in.	91	100	
3/8 in.	91	100	
3/16 in.	90	100	
1/4 in.	89	100	
1/8 in.	86	100	
3/32 in.	82	100	
1/16 in.	75	100	
1/32 in.	67	82	
1/64 in.	55	55	
0.075 mm	-	-	68% (Square)

	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0	10	35	55					
◻									
△	0	0	45	55		ML	28.6	24.2	4.4

SIEVE inches size	PERCENT FINER		
	○	□	△
1 1/2"	100		
1"	91		
	GRAIN SIZE		
D ₆₀	0.1003		0.0855
D ₃₀			
D ₁₀			
	COEFFICIENTS		
C _c			
C _u			

SIEVE number size	PERCENT FINER		
	○	□	△
#4	90		100
#10	88		100
#20	86		100
#40	81		100
#60	75		95
#100	66		82
#200	55	68	55

Sample Number: 12721

Figure

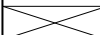
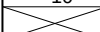
GEI Consultants

6 in. 3 in. 2 in. 1 1/2 in. 1 in. 3/4 in. 1/2 in. 3/8 in. #4 #10 #20 #30 #40 #60 #100 #140 #200

PERCENT FINER

GRAIN SIZE - mm.

	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							44.2	16.7	27.5
◻									
△	0	22	37	41					

SIEVE inches size	PERCENT FINER		
	○	□	△
1 1/2"			100
1"			83
3/4"			83
1/2"			81
3/8"			80
	GRAIN SIZE		
D ₆₀			0.2640
D ₃₀			
D ₁₀			
	COEFFICIENTS		
C _c			
C _u			

SIEVE number size	PERCENT FINER		
	○	□	△
#4			78
#10			75
#20			72
#40			66
#60			59
#100			51
#200	62	50	41

Material Description
○
□
△

<u>REMARKS:</u> ○ ☐ Moisture content: 19.4% Dry Density: 98.9 pcf △	
--	--

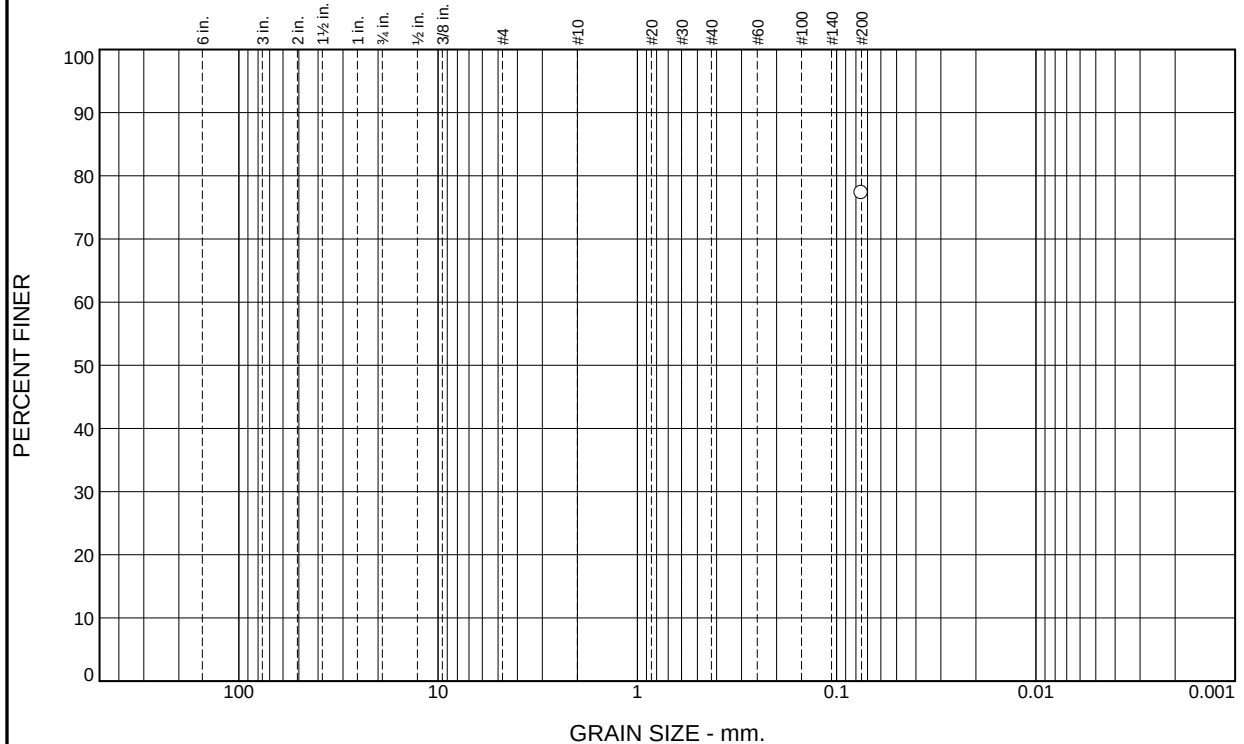
○ Location: LE-05; S3	Depth: 10-11.5	Sample Number: 12722
□ Location: LE-06; C4	Depth: 9	Sample Number: 12724
△ Location: LE-07; S2	Depth: 5-6.5	Sample Number: 12725

	Client: Lithos Engineering Project: North Trunk Sewer #7 (LE 23119)	Figure
---	--	--------

LITHOS
ENGINEERING
A GEI Company



Particle Size Distribution Report



+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○								

SIEVE inches size	PERCENT FINER		
	○		

	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							42	21	21
□									
△							30	23	7

SIEVE inches size	PERCENT FINER		
	○	□	△
X	GRAIN SIZE		
D ₆₀			
D ₃₀			
D ₁₀			
X	COEFFICIENTS		
C _c			
C _u			

SIEVE number size	PERCENT FINER		
	○	□	△
#200	96	93	82

Material Description
○
□
△

REMARKS:
○
□
△

○	Location: B-9; C-2	Depth: 10
□	Location: B-9; S-3	Depth: 14
△	Location: B-9; C-6	Depth: 21

Sample Number: 13047
Sample Number: 13048
Sample Number: 13050

Martinez
Associates

Client: GEI Consultants
Project: North Trunk Line #7 (GEI 2305969)
Project No.: 24-0017

Figure

Checked By: K. Runner

	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							30	24	6
□							28	24	4
△							29	24	5

SIEVE inches size	PERCENT FINER		
	○	□	△
	GRAIN SIZE		
D ₆₀			
D ₃₀			
D ₁₀			
	COEFFICIENTS		
C _c			
C _u			

SIEVE number size	PERCENT FINER		
			
#200	75	44	58

Material	Description
○	
□	
△	

REMARKS:
○
□
△

○ Location: B-9; S-7	Depth: 24
□ Location: B-9; S-9	Depth: 31
△ Location: B-10; S-4	Depth: 16

Sample Number: 13051
Sample Number: 13053
Sample Number: 13055

	Client: GEI Consultants Project: North Trunk Line #7 (GEI 2305969)	Figure
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Tested By: A. Dudney **Checked By:** K. Runner

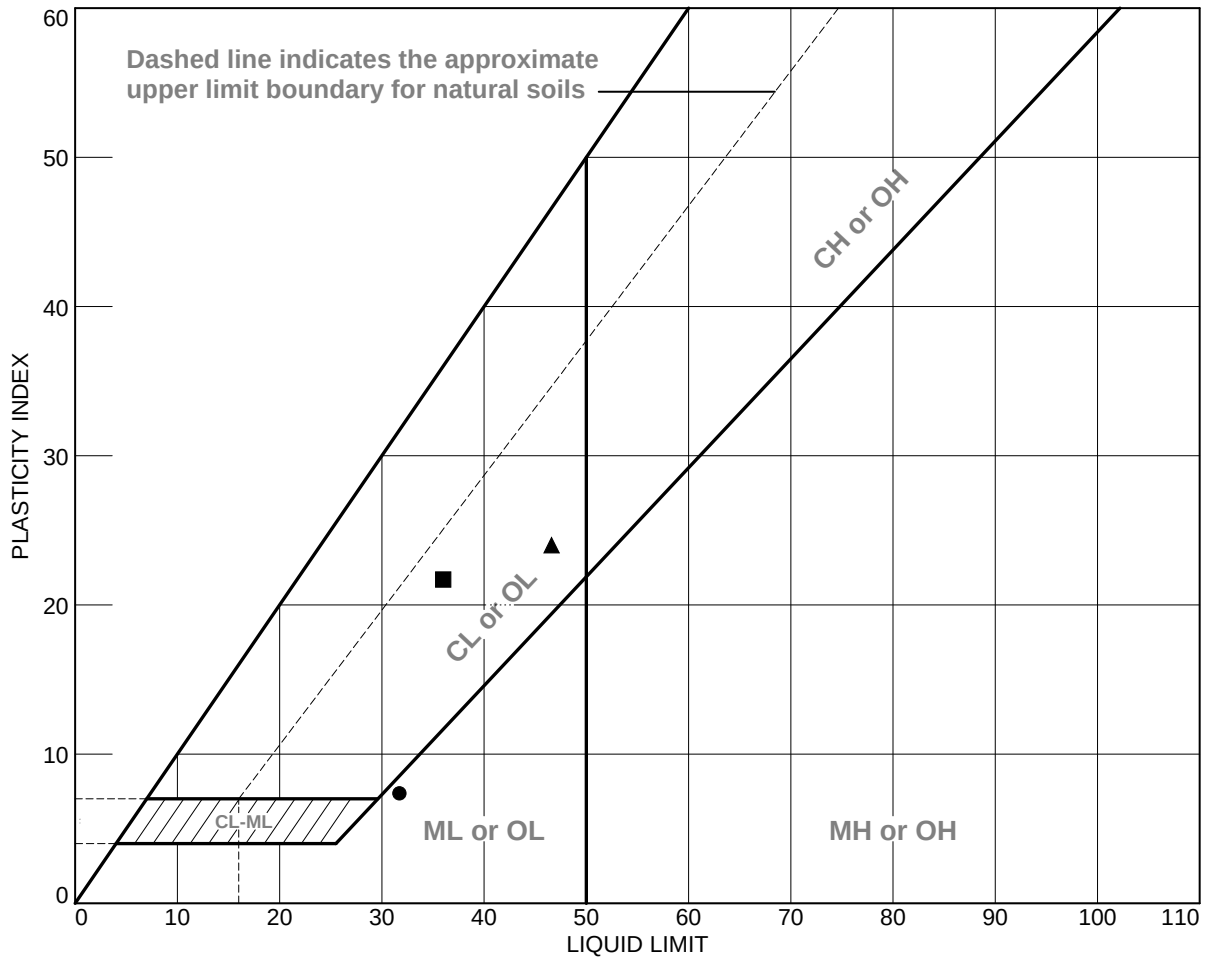
[illegible][illegible]

Sample Number: 13057

Figure

Checked By: K. Runner

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	LE-06; C3	12723	4	23.2	24.5	31.8	7.3	
■	LE-07; S3	12726	10-11.5	19.4	14.3	36.0	21.7	
▲	LE-08; C6	12728	25-26	17.2	22.6	46.6	24.0	

Martinez
Associates

Client: Lithos Engineering
Project: North Trunk Sewer #7 (LE 23119)
Project No.: 24-0017

Figure

Tested By: A. Dudney **Checked By:** K. Runner

MOISTURE CONTENT & DENSITY DETERMINATION

PROJECT: North Trunk Line #7 JOB NO. 24-0017

TESTED BY A. Dudney DATE 7/29/2024 CLIENT JOB NO.: 2305969

LAB NO.	13049	13056	13058
Boring No.	B-9; C-4	B-10; C-5	B-10; C-7
Depth, ft.	16.0	14.0	23.0
Diameter, in.	1.928	1.916	1.938
Length, in.	4.030	4.114	4.068
Wet Soil + Tare, gm.	403.2	374.8	403.8
Tare, gm.	8.2	8.1	8.1
Wet Soil, gm.	395.0	366.7	395.7
Volume, cu. ft.	0.006809	0.006864	0.006944
Wet Density, pcf	127.8	117.7	125.5
Cup No.	5	CBS	42
Cup Weight, gm	8.2	8.1	8.1
Wet Soil + Cup, gm.	403.2	374.8	403.8
Dry Soil + Cup, gm.	342.2	324.3	345.1
Water, gm.	61.0	50.5	58.7
Dry Soil, gm.	334.0	316.2	337.0
Moisture Content, %	18.3	16.0	17.4
Dry Density, pcf	108.1	101.5	106.9

Martinez Associates

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One Dimensional Swell/Consolidation (ASTM D 4546)

(Denver Area Swell/Consolidation Test)

Project Name: North Trunk Sewer #7 File No.: 24-0017 Client Project 23119Lab ID No.: 12719 Sample Date: - Sampled By: Lithos Reviewed By: K. RunnerSample Location: LE-03; C5 @ 14' USCS: **Sample Data:**

Ring No:	C	Dish No:	Why
Ring Mass (g):	276.5	Dish Mass (g):	6.8
Sample Height (in):	0.75	Swell Machine #:	3

Pre-test Sample

Ring + Sample (g):	345.9
Dish wt:	6.8
Wet wt (g):	322.1
Dry wt (g):	265.9

Post-test Sample

Ring + Sample (g):	347.6
Dish wt:	6.9
Wet wt (g):	77.4
Dry wt (g):	63.5

Results:**Pre-test Sample**

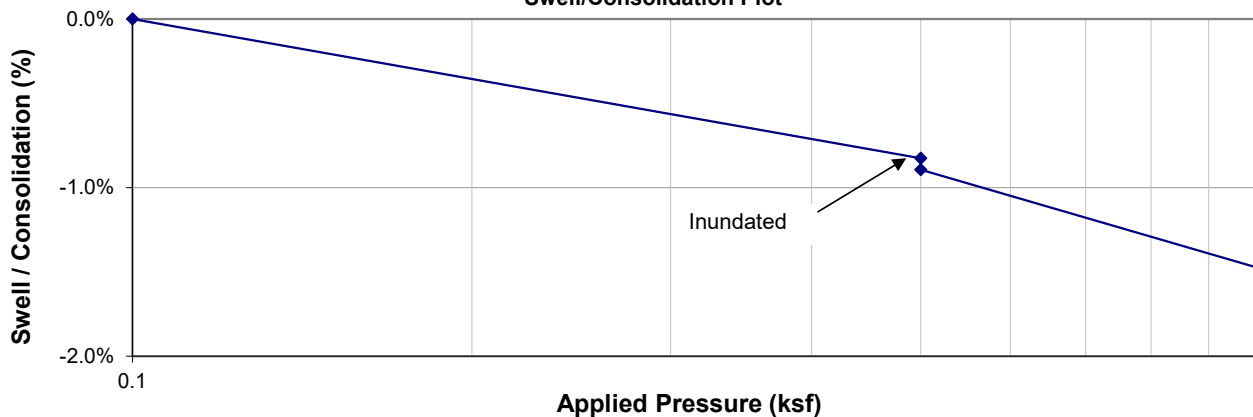
Moisture Content:	21.7%
Wet Density (pcf):	119.8
Dry Density (pcf):	98.4

Post-test Sample

Moisture Content:	24.6%
Wet Density (pcf):	124.5
Dry Density (pcf):	100.0

Swell/Consolidation

Load (ksf):	0.1	0.5	Add Water	0.5	1				
Correction (x 10-4):	0	33		33	51				
Dial Reading (x 10-4):	5190	5095		5090	5028				
Swell/Consolidation %:	0.0%	-0.8%		-0.9%	-1.5%				

Results:Settlement Upon Wetting @
500 psf: **-0.1%**Swell Pressure (psf): **NA**Tested By: A. DudneyChecked By: K. Runner**Swell/Consolidation Plot**

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Martinez
 Associates

One Dimensional Swell/Consolidation (ASTM D 4546)**(Denver Area Swell/Consolidation Test)**

Project Name: North Trunk Sewer #7 File No.: 24-0017 Client Project No: 23119

Lab ID No.: 12728 Sample Date: - Sampled By: Lithos Reviewed By: K. Runner

Sample Location: LE-08; C6 @ 25-26' USCS:

Sample Data:

Ring No:	E	Dish No:	Sometimes
Ring Mass (g):	236.8	Dish Mass (g):	6.9
Sample Height (in):	0.75	Swell Machine #:	5
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	307.0	Ring + Sample (g):	308.9
Dish wt:	6.9	Dish wt:	6.8
Wet wt (g):	344.2	Wet wt (g):	78.5
Dry wt (g):	294.8	Dry wt (g):	63.8

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	17.2%	Moisture Content:	25.8%
Wet Density (pcf):	121.1	Wet Density (pcf):	129.2
Dry Density (pcf):	103.4	Dry Density (pcf):	102.7

Swell/Consolidation

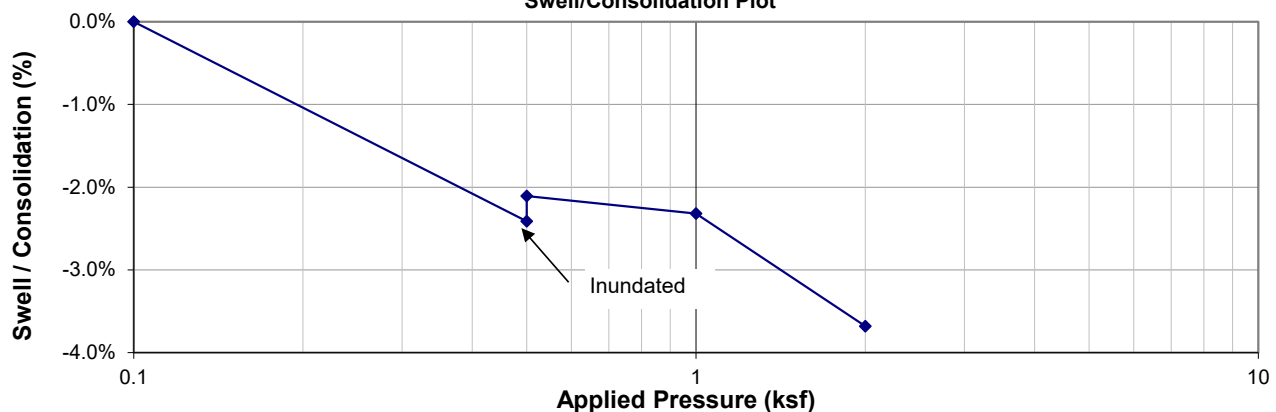
Load (ksf):	0.1	0.5	Add Water	0.5	1	2			
Correction (x 10-4):	0	17		17	46	74			
Dial Reading (x 10-4):	2330	2132		2155	2110	1980			
Swell/Consolidation %:	0.0%	-2.4%		-2.1%	-2.3%	-3.7%			

Results:

Swell Upon Wetting @
 500 psf: **0.3%**

Swell Pressure (psf): **1,049**

Tested By: A. Dudney
 Checked By: K. Runner

Swell/Consolidation Plot

Martinez Associates

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 Fax: (303) 482-2230

Martinez
 Associates

One Dimensional Swell/Consolidation (ASTM D 4546)

(Denver Area Swell/Consolidation Test)

Project Name: North Trunk Line #7 File No.: 24-0017 Client Project: 2305969

Lab ID No.: 13047 Sample Date: _____ Sampled By: GEI Reviewed By: K. Runner

Sample Location: B-9; C-2 @ 10' USCS: _____

Sample Data:

Ring No:	C	Dish No:	1
Ring Mass (g):	276.5	Dish Mass (g):	464.5
Sample Height (in):	0.75	Swell Machine #:	3
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	341.2	Ring + Sample (g):	345.0
Dish wt: (g):	464.5	Dish wt: (g):	8.2
Wet wt (g):	763.6	Wet wt (g):	76.1
Dry wt (g):	717.7	Dry wt (g):	61.4

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	18.1%	Moisture Content:	27.6%
Wet Density (pcf):	111.6	Wet Density (pcf):	121.2
Dry Density (pcf):	94.5	Dry Density (pcf):	94.9

Swell/Consolidation

Load (ksf):	0.1	0.5	Add Water	0.5	1				
Correction (x 10-4):	0	33		33	51				
Dial Reading (x 10-4):	5190	5080		5040	4955				
Swell/Consolidation %	0.0%	-1.0%		-1.6%	-2.5%				

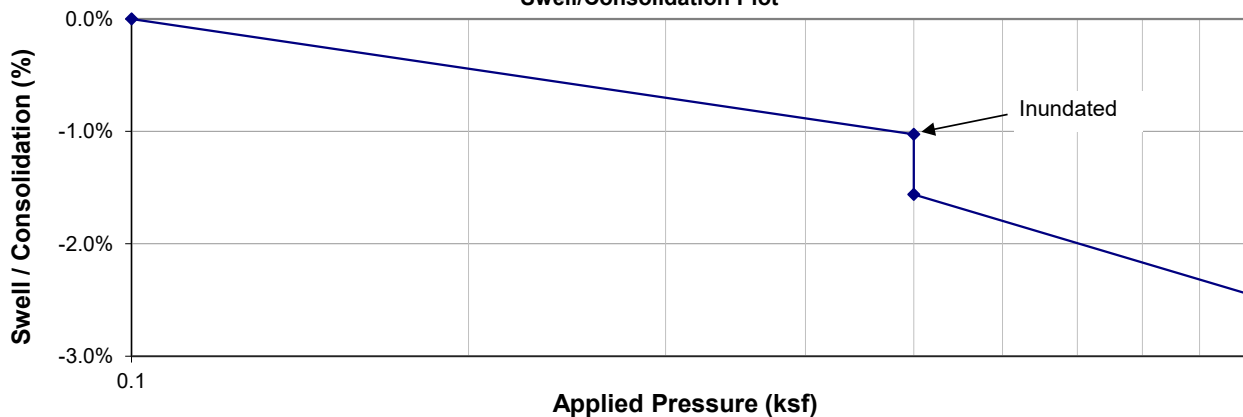
Results:

Settlement Upon Wetting @
 500 psf: -0.5%

Swell Pressure (psf): NA

Tested By: A. Dudney

Checked By: K. Runner

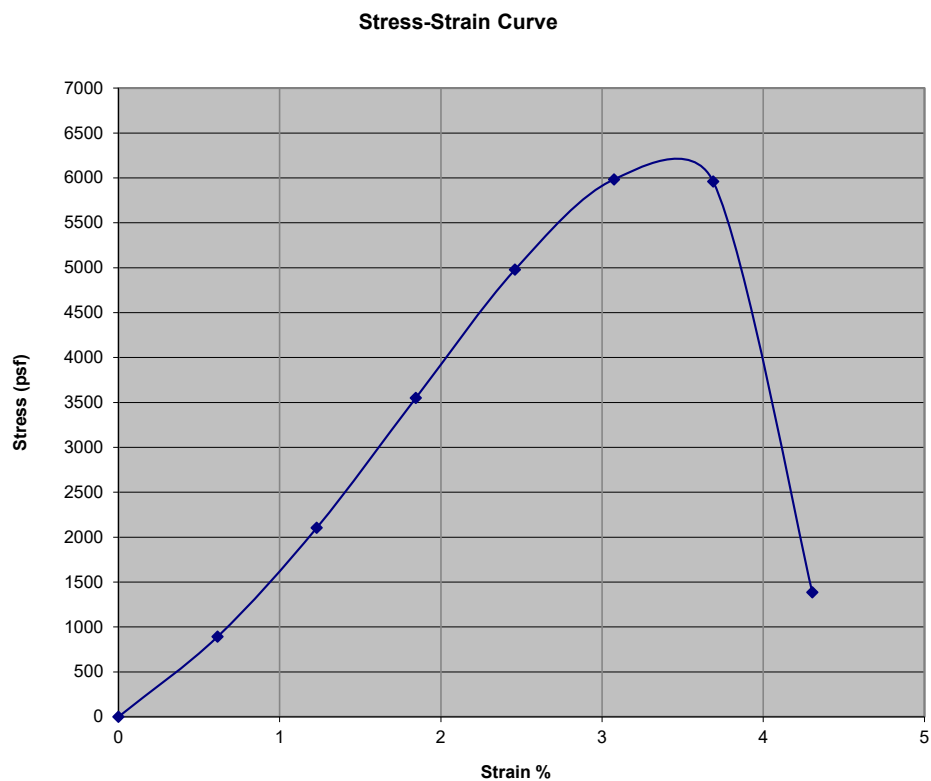
Swell/Consolidation Plot

Sample Location: B-9; C-6 @ 21' USCS: _____

Project Name: North Trunk Line #7 File No. 24-0017 Client Project No. 2305969

Sample Location: B-9; C-6 @ 21' USCS: _____

Stress (psf)



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 Associates

Unconfined Compressive Strength of Cohesive Soil (ASTM 2166)

Project Name: North Trunk Line #7 File No. 24-0017 Client Project No. 2305969

Lab ID Number: 13052 Sample Date: _____ Sampled By: GEI Reviewed By: K. Runner

Sample Location: B-9; C-8 @ 26' USCS: _____

Sample Data:

Diameter:	1.929 inches	Length:	3.973 inches
Diameter:	1.929 inches	Length:	3.999 inches
Diameter:	1.933 inches	Length:	3.979 inches
Avg. Dia.:	1.93 inches	Avg. Length:	3.98 inches
Aspect Ratio (L/Dia):	2.06	Axial Strain Rate:	0.08 in./minute

L/Dia. Ratio Criteria: between 2:1 & 2.5:1 Specimen Conforms?: YES Final Dial, in. 0.225
 Initial Avg. Cross-Sectional Area (sf): 0.020 Time of Test, min 3

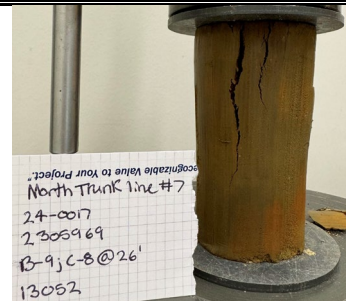
Test Results:

Elapsed Time (min)	Dial (in.)	Axial Strain (%)	Axial Load (lb)	Axial Stress (psf)	Elapsed Time (min)	Dial (in.)	Axial Strain (%)	Axial Load (lb)	Axial Stress (psf)
	0.000	0.0	0.0	0					
	0.025	0.6	16.5	807					
	0.050	1.3	47.0	2284					
	0.075	1.9	84.1	4060					
	0.100	2.5	123.6	5929					
	0.125	3.1	154.4	7359					
	0.150	3.8	167.9	7950					
	0.175	4.4	162.7	7654					
	0.200	5.0	80.9	3781					
	0.225	5.6	52.7	2447					

Unconfined Compressive Strength (q_u): 7,950 psf

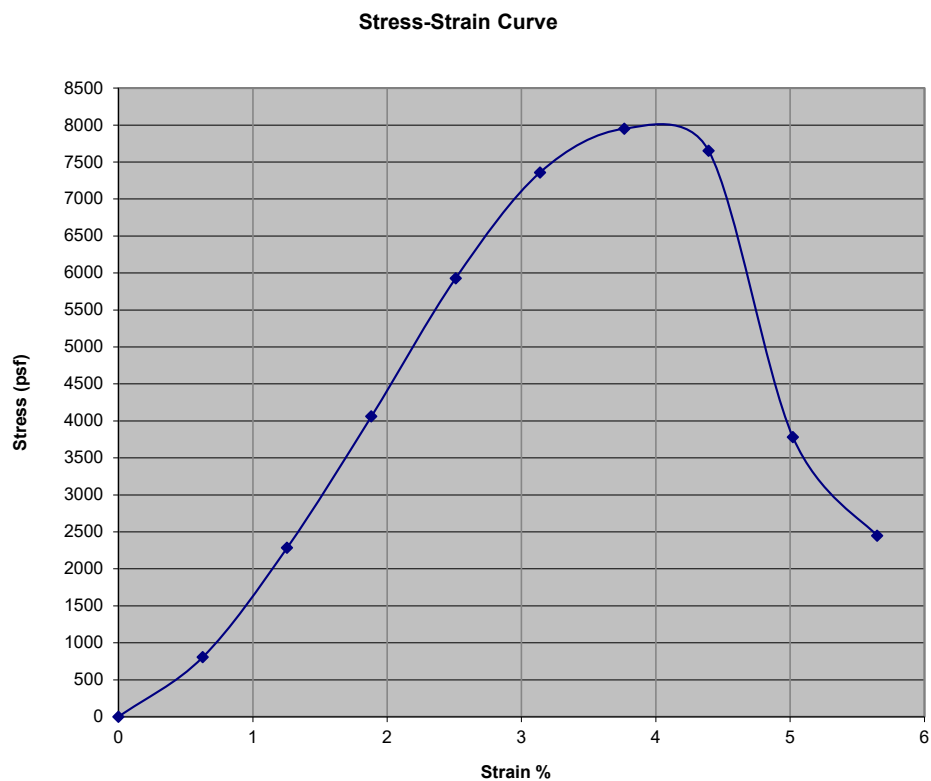
Moisture Content & Density

Pan ID	26
Pan Mass:	8
Wet soil+ pan (g)	405
Dry soil+ pan (g)	348.7
Moisture Content (%):	16.5%
Sample Mass (g)	397
Dry sample mass (g)	340.7
Wet density (pcf)	129.7
In-Situ Dry Density (pcf)	111.3



Sample Location: B-9; C-8 @ 26' USCS: _____

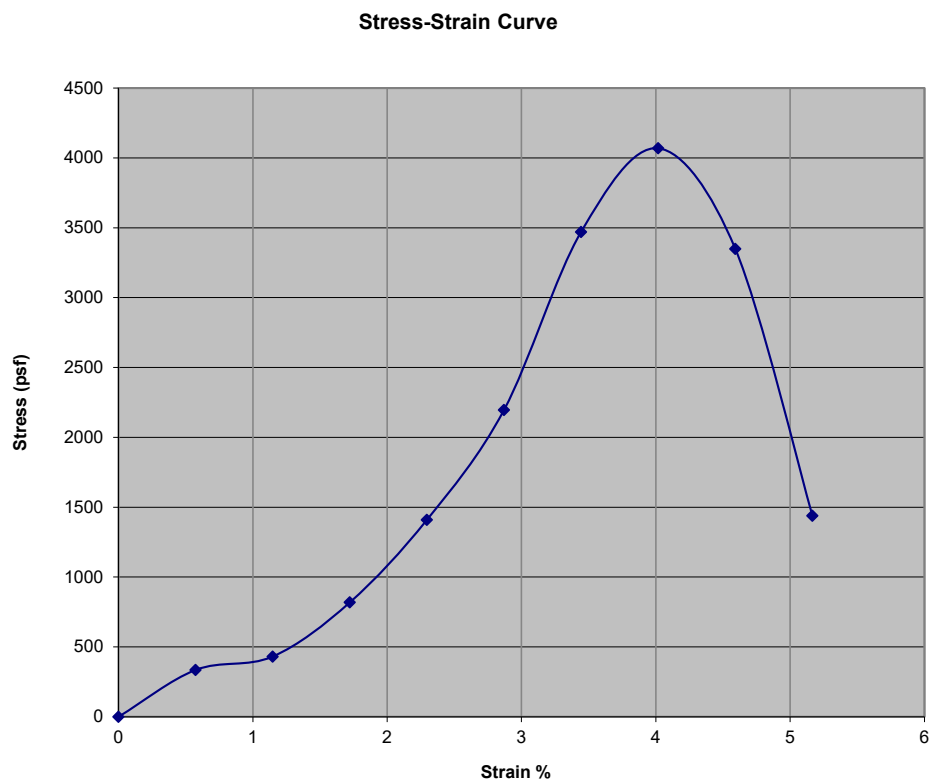
Unconfined Compressive Strength (q_u): 7,950 psf

[illegible]

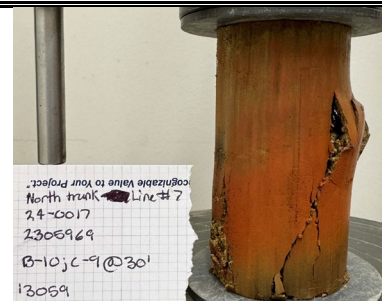
Sample Location: B-10; C-3 @ 11' USCS: _____

Sample Location: B-10; C-3 @ 11' USCS: _____

Unconfined Compressive Strength (q_u): 4,069 psf

[illegible]

Sample Location: B-10; C-9 @ 30' USCS:





Results Only Soil Testing for Northern Trunk Line #7

July 23, 2024

Prepared for:

**Austin Wilkes
GEI
350 Indiana Street, Suite 750
Golden, CO 80401
awilkes@geiconsultants.com**

**Project X Job#: S240722K
Client Job or PO#: 2305969 (formerly: 23119)**

Prepared by:
N. Rabatin

Respectfully Submitted,

Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com





Soil Analysis Lab Results

Client: GEI

Job Name: Northern Trunk Line #7

Client Job Number: 2305969 (formerly: 23119)

Project X Job Number: S240722K

July 23, 2024

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51	ASTM G200	SM 4500-D	ASTM D4327	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D4327	ASTM D4327
Bore# / Description	Depth	Sulfates SO ₄ ²⁻		Chlorides Cl ⁻		Resistivity As Rec'd Minimum		pH	Redox	Sulfide S ²⁻	Nitrate NO ₃ ⁻	Ammonium NH ₄ ⁺	Lithium Li ⁺	Sodium Na ⁺	Potassium K ⁺	Magnesium Mg ²⁺	Calcium Ca ²⁺	Fluoride F ₂ ²⁻	Phosphate PO ₄ ³⁻
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ω-cm)	(Ω-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
S-5, B-9 Sandy Claystone	19.0	37.2	0.0037	17.0	0.0017	1,876	737	7.7	159	ND	9.1	5.1	ND	20.0	10.8	27.4	82.6	4.3	2.0

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography

mg/kg = milligrams per kilogram (parts per million) of dry soil weight

ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown

Chemical Analysis performed on 1:3 Soil-To-Water extract

PPM = mg/kg (soil) = mg/L (Liquid)

Note: Sometimes a bad sulfate hit is a contaminated spot. Typical fertilizers are Potassium chloride, ammonium sulfate or ammonium sulfate nitrate (ASN). So this is another reason why testing full corrosion series is good because we then have the data to see if those other ingredients are present meaning the soil sample is just fertilizer-contaminated soil. This can happen often when the soil samples collected are simply surface scoops. This is why it's best to dig in a foot, throw away the top and test the deeper stuff. Dairy farms are also notorious for these items.

If one sample pops up much more corrosive than all others, we would recommend collecting more samples surrounding the problem sample location to determine if the peak is isolated to it. This allows us to conclude it was a contaminated sample and able to declare it an outlier.

Try out our new online forms: [SOIL CORROSIVITY & THERMAL RESISTIVITY LAB REQUEST FORM](#) & [IN-SITU WENNER 4 PIN QUOTE REQUEST FORM](#)

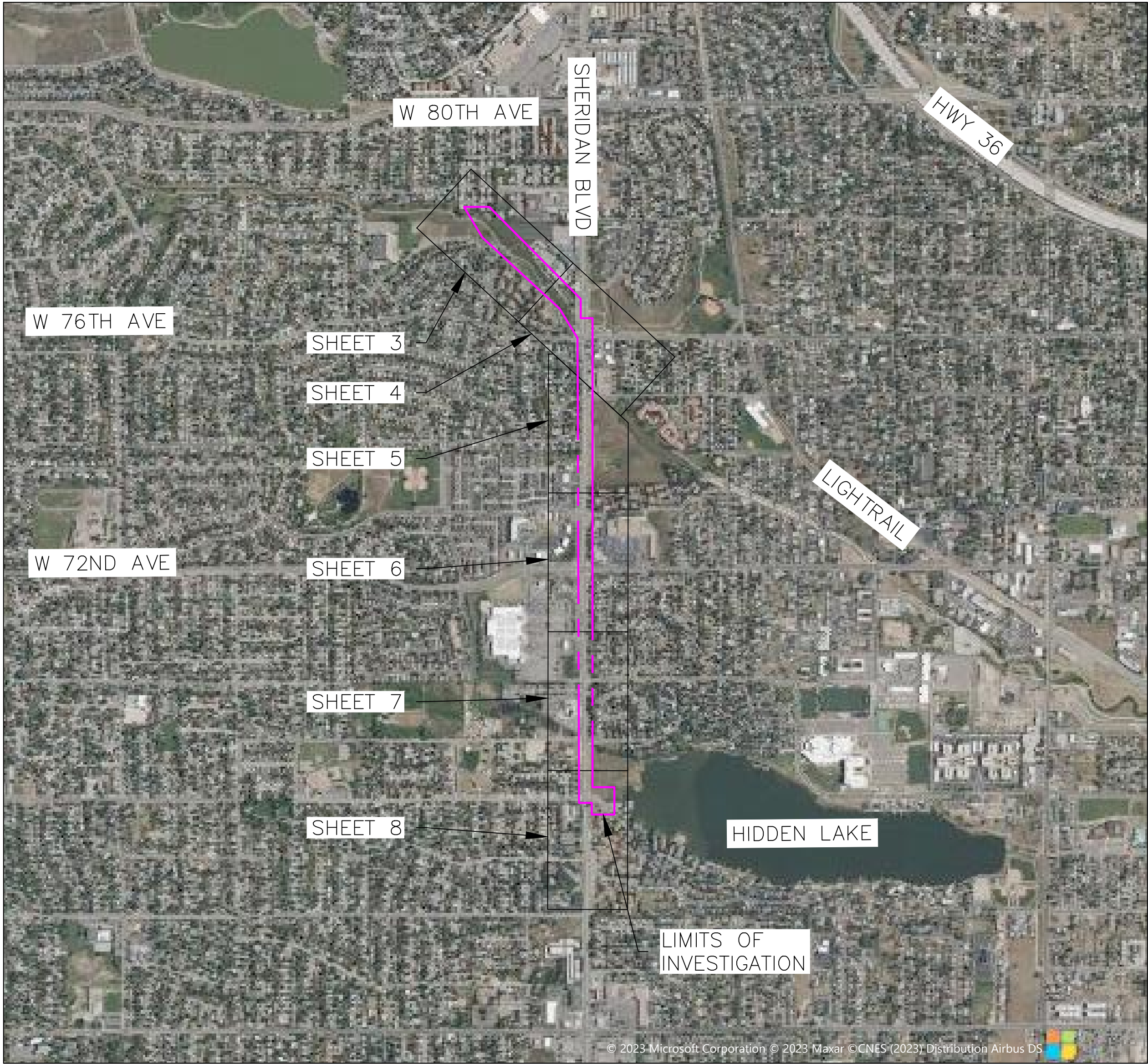
Exhibit 4

Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66

SHEET INDEX	
SHEET NO.	TITLE
1	COVER SHEET
2	GENERAL NOTES AND LEGEND
3-8	PLAN SHEETS
9-10	TEST HOLE SUMMARY

SUBSURFACE UTILITY INVESTIGATION
81204 - ARVADA NTL7
WESTMINSTER, JEFFERSON COUNTY, CO



LAYOUT MAP
SCALE: 1"=1000'



VICINITY MAP
SCALE: 1"=5000'

I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE
DRAWINGS IS IN ACCORDANCE WITH CII/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY: _____

1	UPDATED INVERT TABLES FOR SHEETS 3 THROUGH 8	JPE	01/19/24	PROJECT: CAROLLO
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	06/16/24	ARVADA NTL7
				JOB NUMBER: 1023081204
				DATE: 07/18/2024
				SCALE: N.T.S
				ENGINEER: T. SULLIVAN
				TECHNICIAN: R. EMBORSKY
				DRAWING: J. ENGELE
				TRACT ID:
				PARTYCHIEF:
				FIELDBOOKS:
NO.	REVISIONS	BY	DATE	



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Email: info@sam.biz

COVER SHEET

SHEET 1
OF 10

GENERAL NOTES:

1.

PURPOSE: TO SEARCH, INTERPRET, AND DEPICT SPECIFIC EXISTING UNDERGROUND UTILITIES AS PER THE SCOPE OF WORK NEGOTIATED BETWEEN SAM AND THE CLIENT, WITHIN CLIENT SPECIFIC CORRIDORS.
2.

THE SUBSURFACE UTILITIES SHOWN ON THE SUBSURFACE UTILITY INVESTIGATION WERE IDENTIFIED USING APPROPRIATE INDUSTRY STANDARD DETECTION METHODOLOGIES IN ACCORDANCE WITH THE AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE) STANDARD GUIDELINE FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA. QUALITY LEVELS AND DEFINITIONS PER CII/ASCE STANDARD NO. 38-02
3.

QUALITY LEVEL "D" - QL-D - DEPICTED ACCORDING TO UTILITY RECORD INFORMATION AND IN-FIELD VISUAL INSPECTION. NO ELECTRONIC DESIGNATING INFORMATION WAS OBTAINED. UTILITIES WITH A QL-D LABEL ARE DEPICTED ON THE PLANS USING PROFESSIONAL JUDGMENT IN INTERPRETING THIRD-PARTY RECORDS OR OTHER INFORMATION.
4.

QUALITY LEVEL "C" - QL-C - EXISTING UTILITY STRUCTURES HAVE BEEN FIELD LOCATED AND SURVEYED TO ASSIST IN THE DEPICTING OF THE UTILITIES SHOWN ON THE RECORDS. NO ELECTRONIC DESIGNATING INFORMATION WAS OBTAINED. UTILITIES WITH A QL-C LABEL ARE DEPICTED ON THE PLANS USING PROFESSIONAL JUDGMENT IN INTERPRETING AND CORRELATING THE SURVEYED UTILITY APPURTENANCES, THIRD-PARTY RECORDS INFORMATION.
5.

QUALITY LEVEL "B" - QL-B - INFORMATION WAS OBTAINED THROUGH THE APPLICATION OF APPROPRIATE SURFACE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND APPROXIMATE HORIZONTAL POSITION OF THE SUBSURFACE UTILITIES. QL-B DATA SHOULD BE REPRODUCIBLE BY SURFACE GEOPHYSICS AT ANY POINT OF THEIR DEPICTION. UTILITIES WITH A QL-B LABEL ARE DEPICTED ON THE PLANS USING PROFESSIONAL JUDGMENT IN SELECTING AND INTERPRETING APPROPRIATE GEOPHYSICAL DATA, SURVEYING TO APPROPRIATE PROJECT ACCURACIES, AND USING PROFESSIONAL JUDGMENT TO CORRELATE THIRD-PARTY RECORDS OR OTHER INFORMATION, IF AVAILABLE, TO THESE QL-B DEPICTIONS.
6.

QUALITY LEVEL "A" - QL-A - OBTAIN PRECISE HORIZONTAL AND VERTICAL POSITION OF THE UTILITY LINE BY EXCAVATING A TEST HOLE. THE TEST HOLE SHALL BE DONE USING VACUUM EXCAVATION OR COMPARABLE NON-DESTRUCTIVE EQUIPMENT IN A MANNER AS TO CAUSE NO DAMAGE TO UTILITY LINE. UNLESS OTHERWISE NOTED, ALL SIZES OF QL-A PIPES AND CONDUITS WILL BE PROVIDED AS OUTER DIAMETER (O.D.) RATHER THAN NOMINAL SIZE OR INSIDE DIAMETER.
7.

RELIANCE UPON THIS DATA FOR RISK MANAGEMENT PURPOSES DURING BIDDING DOES NOT RELIEVE THE EXCAVATOR OR UTILITY OWNER FROM FOLLOWING ALL APPLICABLE UTILITY DAMAGE PREVENTION STATUTES, POLICIES, AND/OR PROCEDURES DURING EXCAVATION.
8.

IT IS IMPORTANT THAT THE CONTRACTOR INVESTIGATES AND UNDERSTANDS THE SCOPE OF WORK BETWEEN THE PROJECT OWNER AND THEIR ENGINEER REGARDING THE SCOPE AND LIMITS OF THE UTILITY INVESTIGATIONS LEADING TO THESE UTILITY DEPICTIONS.
9.

EDGES OF DUCT BANK SHOWN ARE APPARENT BASED ON INTERPRETATION OF ELECTROMAGNETIC READINGS. ACTUAL DUCT BANK MAY BE LARGER DUE TO POSSIBLE CONCRETE ENCASEMENT NOT ABLE TO BE DETECTED BY ELECTROMAGNETIC METHODS. TEST HOLES REQUIRED FOR POSITIVE VERIFICATION OF ACTUAL EDGES.
10.

UTILITIES SHOWN OUTSIDE OF PROJECT LIMITS ARE FOR REFERENCE ONLY. THESE UTILITIES ARE SHOWN FOR GENERAL INFORMATION USE DURING UTILITY COORDINATION, BUT THEY HAVE NOT BEEN VERIFIED AS BEING COMPLETE OR ACCURATE.
11.

UTILITY SIZE AND TYPE ARE DETERMINED THROUGH AVAILABLE UTILITY OWNER INFORMATION OR FIELD OBSERVATIONS; UTILITIES LABELED AS UNKNOWN HAVE NO CORRELATED RECORDS OR VISIBLE APPURTENANCES TO DETERMINE FUNCTION OR TYPE.
12.

UTILITY MAPPING WAS COMPLETED IN THE FIELD 12/01/2023. UTILITIES MAY HAVE BEEN CHANGED OR ADDED AFTER THIS DATE.
13.

"END OF INFORMATION" (EOI) SIGNIFIES GEOPHYSICAL EQUIPMENT LOST THE SIGNAL OF THE TARGET UTILITY AND THE LINE WAS UNABLE TO BE DESIGNATED ANY FURTHER. LINES SHOWING AN EOI SYMBOL CONTINUE ON OR MAY STOP. POSITIVE VERIFICATION BY EXCAVATION IS REQUIRED TO CONFIRM PRESENCE BEYOND END OF SIGNAL.
14.

HORIZONTAL COORDINATE SYSTEM

NAD83 COLORADO STATE PLANES, CENTRAL ZONE, US SURVEY FOOT
15.

SAM, LLC. SUBMITTED THE FOLLOWING SUBSURFACE UTILITY ENGINEERING NOTIFICATION TICKETS:
B329001479-00B, B329002628-00B, B329002726-00B, AND B329002785-00B
16.

UNLESS OTHERWISE NOTED THE FOLLOWING UTILITIES ARE OWNED AS SHOWN:

Contact Sheet & Record Collection Status

81204 - Arvada NTL7

Utility Type	Utility Owner	Contact	Phone	E-mail
All possible types	CITY OF WESTMINSTER	Cheyney Henricks	(303) 658-2572	chenrick@westminsterco.gov
Sewer, Water, and Stormwater	CITY OF ARVADA	Alec Henderson	(262) 488-1482	ahenderson@arvada.org
CATV and Fiber	COMCAST	Artjahmel Davis	(303) 603-2682	Artjahmel.Davis@cable.comcast.com
Electric and Fiber	CDOT DIV. OF TRANSPRT DEVELOP	Wendy Pettit	(719) 546-5748	wendy.pettit@state.co.us
Electric and Fiber	ZAYO BANDWIDTH	James R. Black	(719) 216-8508	jamesr.black@zayo.com
Fiber	MCI	Lane Grady	(303) 827-9756	lane.grady@verizon.com
Fiber and Telecommunication	CENTURYLINK	Tammy Williams	(303) 332-4379	tammy.williams@centurylink.com
Gas and Electric	XCEL ENERGY	Gary Motsinger	(303) 571-3186	gary.d.motsinger@xcelenergy.com

QUALITY LEVEL "B"

	E(B)	ELECTRIC
	SL(B)	STREET LIGHTING
	TC(B)	TRAFFIC CONTROL
	T(B)	TELEPHONE
	FO(B)	FIBER OPTIC
	TV(B)	CABLE TV
	G(B)	GAS
	W(B)	WATER
	SS(B)	SANITARY SEWER
	STM(B)	STORM DRAIN
	UNK(B)	UNKNOWN

QUALITY LEVEL "C"

	E(C)	ELECTRIC
	SL(C)	STREET LIGHTING
	TC(C)	TRAFFIC CONTROL
	T(C)	TELEPHONE
	FO(C)	FIBER OPTIC
	TV(C)	CABLE TV
	G(C)	GAS
	W(C)	WATER
	SS(C)	SANITARY SEWER
	STM(C)	STORM DRAIN
	UNK(C)	UNKNOWN

QUALITY LEVEL "D"

	E(D)	ELECTRIC
	SL(D)	STREET LIGHTING
	TC(D)	TRAFFIC CONTROL
	T(D)	TELEPHONE
	FO(D)	FIBER OPTIC
	TV(D)	CABLE TV
	G(D)	GAS
	W(D)	WATER
	SS(D)	SANITARY SEWER
	STM(D)	STORM DRAIN
	UNK(D)	UNKNOWN

LEGEND

	LIMITS OF INVESTIGATION
	CONCRETE WALL/CURB
	END OF INFORMATION (EOI)
	CABLE TV MANHOLE
	CABLE TV PEDESTAL
	CABLE TV VAULT
	TELEPHONE MANHOLE
	TELEPHONE PEDESTAL
	TELEPHONE VAULT
	TELEPHONE BOX
	ELECTRIC BOX
	ELECTRIC METER
	ELECTRIC OUTLET
	POWER POLE
	ELECTRIC TRANSFORMER
	ELECTRIC VAULT
	ELECTRIC PEDESTAL
	ELECTRIC MANHOLE
	GAS METER
	GAS MANHOLE
	GAS VALVE
	GAS VAULT
	STORM DRAIN INLET
	STORM DRAIN MANHOLE
	STORM DRAIN CLEANOUT
	SANITARY SEWER MANHOLE
	SANITARY STRUCTURE IDENTIFIER
	STORM STRUCTURE IDENTIFIER
	TEST HOLE

	FIRE HYDRANT
	WATER METER
	WATER MANHOLE
	WATER VALVE
	WATER VAULT
	WATER WELL
	TRAFFIC SIGNAL BOX
	TRAFFIC SIGNAL POLE
	FIBER OPTIC BOX
	FIBER OPTIC MANHOLE
	ELECTRIC MISCELLANEOUS
	GAS MISCELLANEOUS
	WATER MISCELLANEOUS
	TRAFFIC CONTROL MISCELLANEOUS
	TELEPHONE MISCELLANEOUS
	CABLE TV MISCELLANEOUS
	FIBER OPTIC MISCELLANEOUS
	SANITARY SEWER MISCELLANEOUS
	STORM DRAIN MISCELLANEOUS
	TRAFFIC CROSSWALK SIGNAL
	LIGHT POLE
	SANITARY SEWER CLEANOUT

I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH CII/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY: _____

2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24	PROJECT: CAROLLO ARVADA NTL7
				JOB NUMBER: 1023081204
				DATE: 07/18/2024
				SCALE: N.T.S
				ENGINEER: T. SULLIVAN
				TECHNICIAN: R. EMBORSKY
				DRAWING: J. ENGEL
				TRACT ID:
				PARTYCHIEF:
				FIELDBOOKS:
NO.	REVISIONS	BY	DATE	



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NOTES AND LEGEND

PATH:\SAM\CD\EN\PROJECTS\1023081204\04DELIVERY\PRELIM\20240812\81204 - ARVADA NTL7 TEST HOLES.DWG

PATH:\SAVINGDEN\PROJECTS\1023081204\04DELIVERY\PRELIM\20240912\81204 ARVADA NTL7_TEST_HOLES.DWG



I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH C/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY: _____

1	UPDATED INVERT TABLE	JPE	01/19/24
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24
NO.	REVISIONS	BY	DATE

PROJECT: CAROLLO
ARVADA NTL7
JOB NUMBER: 1023081204
DATE: 07/18/2024
SCALE: 1"=50'
ENGINEER: T. SULLIVAN
TECHNICIAN: R. EMBORSKY
DRAWING: J. ENGELE
TRACT ID:
PARTYCHIEF:
FIELDBOOKS:



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NOTES AND LEGEND

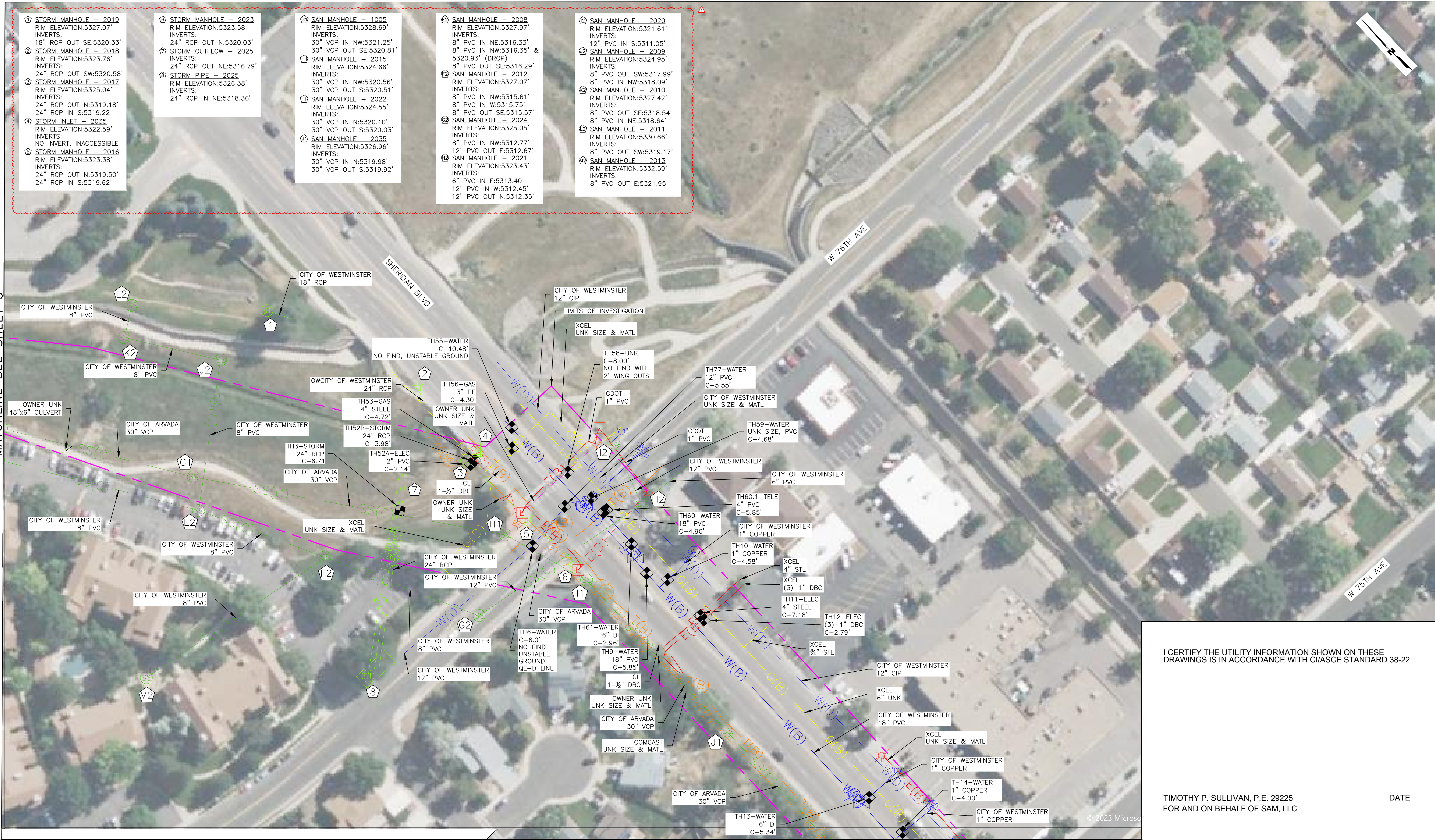
SHEET 3
OF 10

MATCHLINE SEE SHEET 4

MATCHLINE SEE SHEET 4

PATH:\SAM\CDN\PROJECTS\1023081204\04DELIVERY\PRELIM\20240912\81204 ARVADA NTL TEST HOLES.DWG

MATCHLINE SEE SHEET 3



MATCHLINE SEE SHEET 5

I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH C/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY:

1. UPDATED INVERT TABLE
2. TEST HOLE DATA ADDED TO ALL SHEETS

JPE 01/19/24
JPE 08/16/24

PROJECT: CAROLLO
JOB NUMBER: 1023081204
DATE: 07/18/2024
SCALE: 1"=50'
ENGINEER: T. SULLIVAN
TECHNICIAN: R. EMBORSKY
DRAWING: J. ENGELE
TRACT ID:
PARTYCHIEF:
FIELDBOOKS:

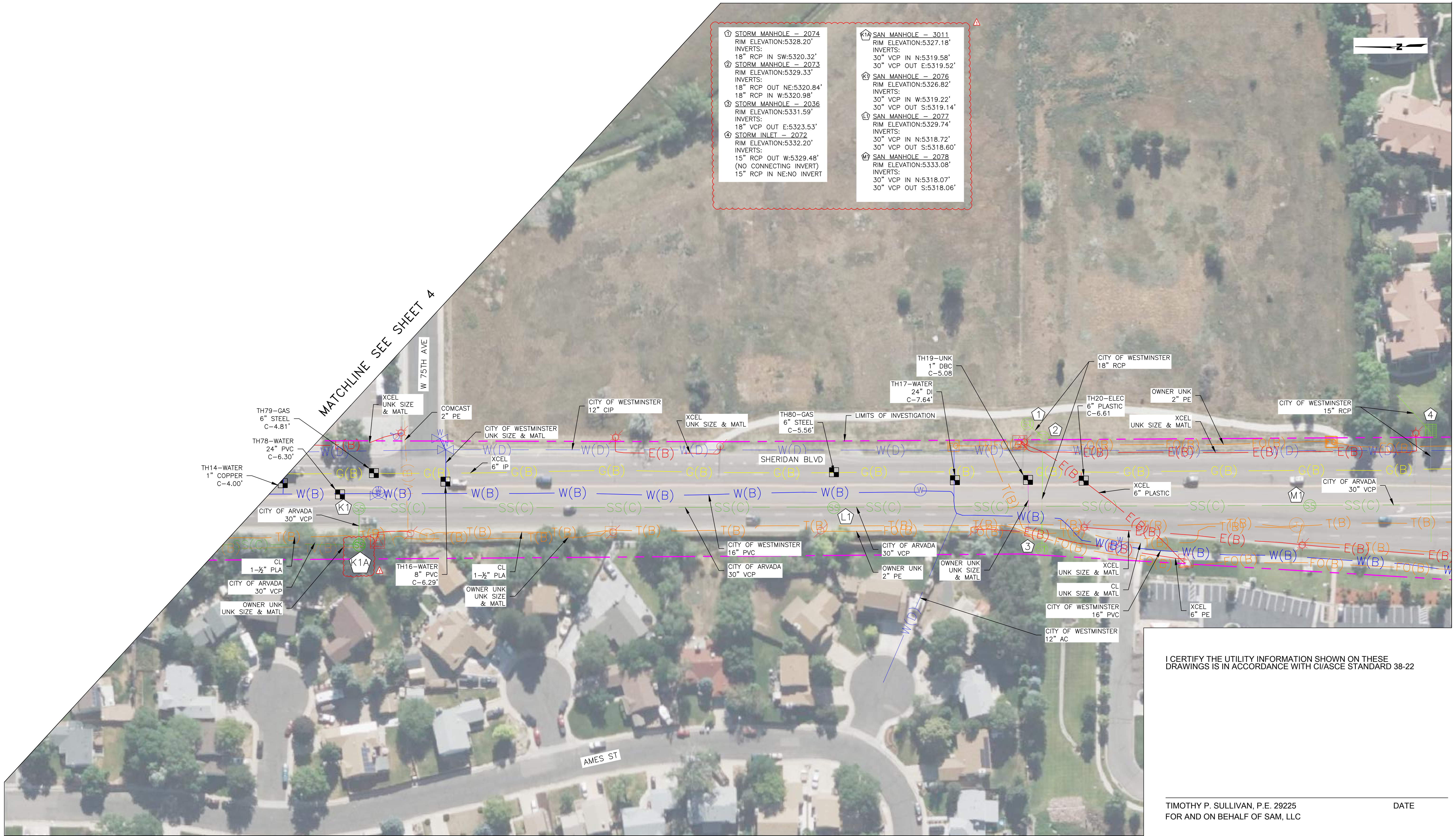


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NOTES AND LEGEND

SHEET 4
OF 10

PATH:\SAVING\DEN PROJECTS\1023081204\04DELIVERY\PRELIM\20240912\81204 ARVADA NTL7_TEST_HOLES.DWG



- ① STORM MANHOLE — 2074
RIM ELEVATION:5328.20'
INVERTS:
18" RCP IN SW:5320.32'
② STORM MANHOLE — 2073
RIM ELEVATION:5329.33'
INVERTS:
18" RCP OUT NE:5320.84'
18" RCP IN W:5320.98'
③ STORM MANHOLE — 2036
RIM ELEVATION:5331.59'
INVERTS:
18" VCP OUT E:5323.53'
④ STORM INLET — 2072
RIM ELEVATION:5332.20'
INVERTS:
15" RCP OUT W:5329.48'
(NO CONNECTING INVERT)
15" RCP IN NE:NO INVERT
- K1A SAN MANHOLE — 3011
RIM ELEVATION:5327.18'
INVERTS:
30" VCP IN N:5319.58'
30" VCP OUT E:5319.52'
K2 SAN MANHOLE — 2076
RIM ELEVATION:5326.82'
INVERTS:
30" VCP IN W:5319.22'
30" VCP OUT S:5319.14'
K3 SAN MANHOLE — 2077
RIM ELEVATION:5329.74'
INVERTS:
30" VCP IN N:5318.72'
30" VCP OUT S:5318.60'
K4 SAN MANHOLE — 2078
RIM ELEVATION:5333.08'
INVERTS:
30" VCP IN N:5318.07'
30" VCP OUT S:5318.06'

I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH C/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

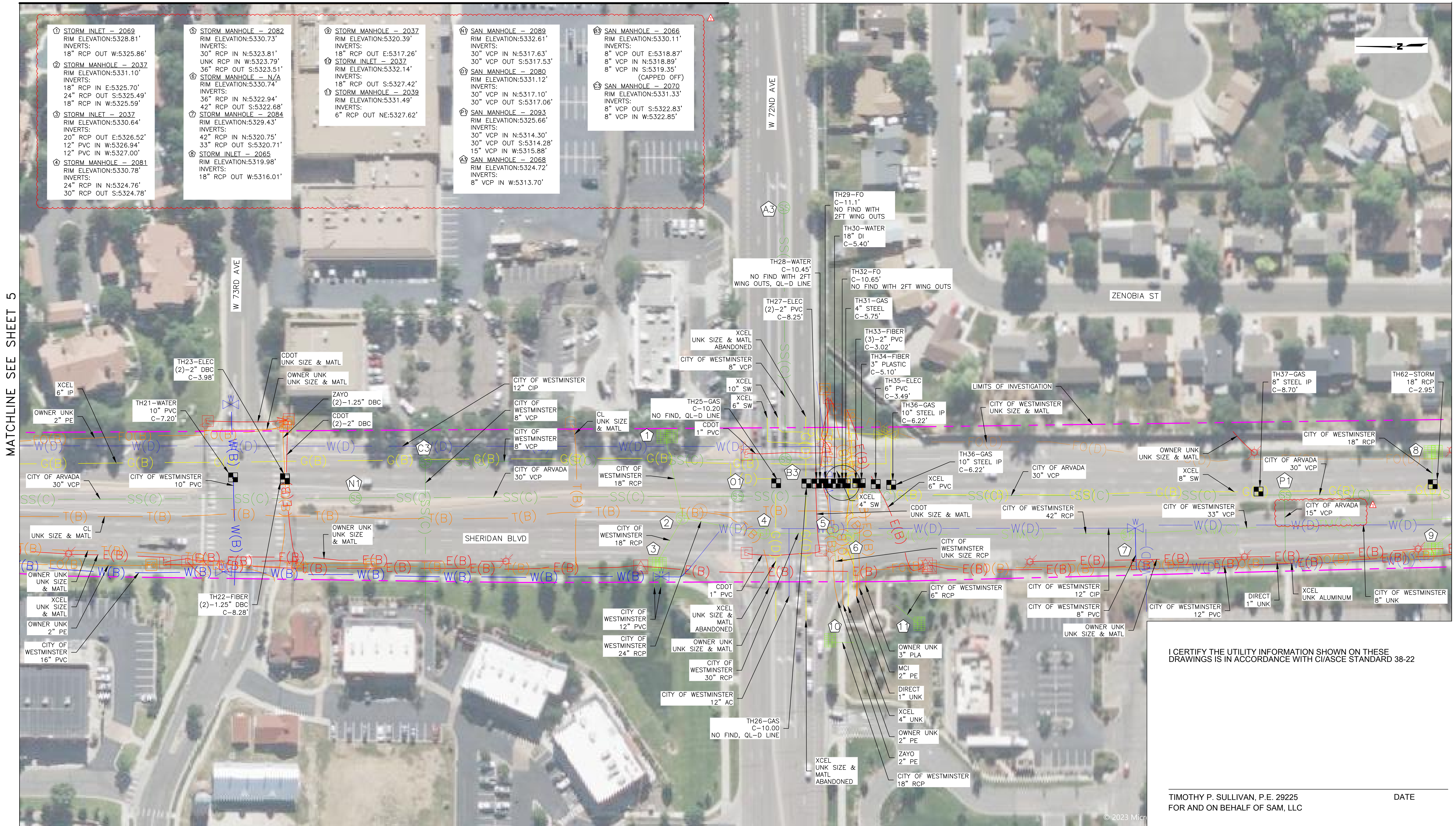
DATE

REVIEWED BY: _____			
1	IADD ADDITION MH, UPDATE INVERT TABLE	JPE	01/19/24
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24
PROJECT: CAROLLO ARVADA NTL7			
JOB NUMBER: 1023081204			
DATE: 07/18/2024			
SCALE: 1"=50'			
ENGINEER: T. SULLIVAN			
TECHNICIAN: R. EMBORSKY			
DRAWING: J. ENGELE			
TRACT ID:			
PARTYCHIEF:			
FIELDBOOKS:			
NO.	REVISIONS	BY	DATE

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NOTES AND LEGEND	SHEET 5 OF 10
------------------	------------------

MATCHLINE SEE SHEET 6



I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE
DRAWINGS IS IN ACCORDANCE WITH CI/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE _____

REVIEWED BY: _____			
1	UPDATED CALLOUT SIZE, UPDATED INVERT TABLE	JPE	01/19/24
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24
NO.	REVISIONS	BY	DATE

PROJECT:	CAROLLO ARVADA NTL7
JOB NUMBER:	1023081204
DATE:	07/18/2024
SCALE:	1"=50'
ENGINEER:	T. SULLIVAN
TECHNICIAN:	R. EMBORSKY
DRAWING:	J. ENGELE
TRACT ID:	
PARTYCHIEF:	
FIFI DROOKS:	



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NOTES AND LEGEND

SHEET 6
OF 10

PATH:\SAVING\DEN PROJECTS\1023081204\04-DELIVERY\PRELIM\20240912\81204 ARVADA NTL7_TEST_HOLES.DWG

MATCHLINE SEE SHEET 6



I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH CI/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY: _____

1	UPDATED INVERT TABLE	JPE	01/19/24	PROJECT: CAROLLO
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24	ARVADA NTL7
				JOB NUMBER: 1023081204
				DATE: 07/18/2024
				SCALE: 1"=50'
				ENGINEER: T. SULLIVAN
				TECHNICIAN: R. EMBORSKY
				DRAWING: J. ENGELE
				TRACT ID:
				PARTYCHIEF:
				FIELDBOOKS:
NO.	REVISIONS	BY	DATE	



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NOTES AND LEGEND

SHEET 7
OF 10

MATCHLINE SEE SHEET 8



I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE
DRAWINGS IS IN ACCORDANCE WITH CI/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE _____

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REVIEWED BY: _____

1	ADDITIONAL INVERTS, SIZE & MATL CHANGES TO LINES, UPDATED INVERT TABLE	JPE	01/19/24	PROJECT: CAROLLO ARVADA NTL7 JOB NUMBER: 1023081204 DATE: 07/18/2024 SCALE: 1"=50' ENGINEER: T. SULLIVAN TECHNICIAN: R. EMBORSKY DRAWING: J. ENGELE TRACT ID: PARTY CHIEF: FIELDBOOKS:
2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24	
NO.	REVISIONS	BY	DATE	



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NOTES AND LEGEND

SHEET 8
OF 10



SURVEYING AND MAPPING LLC
8300 E. Maplewood Ave., Suite 300
Greenwood Village, CO 80111
PH. 303-988-5852

Test Hole Summary

Project: NTL7 Arvada

SAM, LLC Project # 1023081204

Prepared By: Tim Sullivan

Client: Carollo Engineers

Checked By: Jon Engle

STATE: COLORADO City: Arvada

TH#	Utility Expected	Utility Found	Utility Owner	Pavement Thickness / Depth of Roadbase	Northing	Easting	Elev. Existing Ground	Elev. Top of Utility	Depth of Cover	NOTES
1	Water	None	Westminster	N/A	730477.348	125477.306	5328.782	5320.78	8.00'	Went down on stake point location. Ran into ground water at 4ft that was flooding hole. Probed down to 11ft but couldn't get hose to suck more than 8ft of water and mud out. No find on water. Ground water floods hole instantly after 4ft deep (QL-D Marks).
2	Water	None	Westminster	N/A	730179.497	125713.189	5328.345	5317.35	11.00'	Went down on stake point location and ran into flooding amounts of ground water at 5' deep. Cleared hole down 11 feet and didn't find utility. Ground water floods hole immediately after pulling hose out of ground. Got grade rod down 11ft. (QL-D Marks)
3	Storm Water	24" RCP	Westminster	N/A	729705.495	126039.455	5326.269	5319.56	6.71'	Went down on stake point location and found 24" rcp line at 6.71'. Found additional duct like structure or concrete cap at 4.18' while trying to get to storm. Duct structure is testhole 3a
3A	Unknown	Concrete Cap	Unknown	N/A	729705.495	126039.455	5326.269	5322.09	4.18'	Went down to find storm sewer and found concrete cap structure at 4.18'. Think it's a sanitary line but cannot be sure. Hit some ground water as we got deeper
4				N/A				0.00		Maintenance of building wwould not let us drive over new grass and we do not have a long enough hose.
6	Water	None	Westminster	7" / None	729577.142	126120.74	5324.581	5318.58	6.00'	Went down on premark and ran into squeegee almost immediately. Got hole down to 6' before squeegee started caving in all around the hole. Too much to suck out without risking a cave in on road so we stopped. Also believe water line is in a different area approx 6' to the north. Fresh pavement and excavation in area. (QL-D Marks)
9	Water	18" PVC	Westminster	10" / 20"	729469.12	126193.228	5324.93	5319.08	5.85'	
10	Water	1" Copper	Westminster	7" / 18"	729448.525	126205.628	5324.775	5320.20	4.58'	
11	Electric	4" Steel	XCEL	7" / 18"	729394.817	126204.998	5324.976	5317.80	7.18'	
12	Electric	3 - 1" DBC	XCEL	7" / 18"	729388.266	126205.012	5324.941	5322.15	2.79'	
13	Water	6" DI	Westminster	10" / 15"	729120.096	126206.006	5325.919	5320.58	5.34'	
14	Water	1" Copper	Westminster	7" / 20"	729066.78	126207.133	5326.27	5322.27	4.00'	
16	Water	8" PVC	Westminster	11" / 15"	728888.328	126208.564	5327.399	5321.11	6.29'	
17	Water	24" DI	Westminster	8" / 20"	728329.148	126209.265	5330.41	5322.77	7.64'	
19	Unknown	1" DBC	Unknown	7" / 18"	728248.99	126209.431	5330.956	5325.88	5.08'	
20	Electrical	6" PLASTIC	XCEL	8" / 18"	728187.798	126208.639	5331.204	5324.59	6.61'	
21	Water	10" PVC	Westminster	10" / 15"	727547.212	126205.625	5332.736	5325.54	7.20'	
22	Fiber	2 - 1.25" DBC	Zayo	9" / 18"	727489.78	126204.64	5332.639	5324.36	8.28'	
23	Electric	2 - 2" DBC	Unknown	9" / 18"	727489.088	126204.629	5332.618	5328.64	3.98'	
25	Gas	None	XCEL	11" / 22"	726944.886	126198.167	5330.624	5320.42	10.20'	Went down on stake out point and cleared hole 10.20' deep with 2ft wing outs and didn't find any utilities in hole. 11" core. 22" road base. (QL-D Marks)
26	Gas	None	XCEL	11" / 22"	726911.353	126197.927	5330.679	5320.68	10.00'	Went down on stake out point for xcel gas and cleared down 10' with 2' wing outs. Ran into hard clay around 8' down. Didn't find any utilities within hole. (QL-D Marks)
27	Electric	2 - 2" PVC	Arvada	12" / 21"	726899.69	126197.822	5330.742	5322.49	8.25'	Went back into testhole 27 and did more thorough wing out and found traffic electric in the wall of hole at 8.25'. 2' conduit x2.
28	Water	None	Westminster	11" / 21"	726892.334	126198.048	5330.755	5320.31	10.45'	Dug down on premark for QLD water and found nothing. Cleared 10.45' with 2' wing outs. (QL-D Marks)
29	Fiber	None	Zayo	12" / 22"	726887.417	126197.847	5330.713	5319.61	11.10'	Dug down on premark for Zayo fiber. Cleared hole down 11.1' with 2' wing outs and couldn't find fiber. Believe Zayo bored line in super deep through intersection.
30	Water	18" DI	Westminster	10" / 22"	726878.826	126197.717	5330.744	5325.34	5.40'	Dug down to find QLD gas and found 18" black ductile iron water line at 5.40'. Did not find any gas. 10" core and 22" road base.
31	Gas	4" Steel	XCEL	10" / 23"	726867.667	126197.856	5330.703	5324.95	5.75'	Combined holes 31 and 32. Found 4" steel gas main at 5.75'. Couldn't find fiber after digging down 10 ft and winging out. Attempted to replicate locate and couldn't achieve the same thing. Believe this fiber locate is bleed off onto steel gas.
32	Communication	None	Comcast	10" / 22"	726871.546	126198.205	5330.606	5319.96	10.65'	Went down on relocated fiber line and cleared down 10.65' with 2' wing outs and didn't find utility.
33	Communication	3 - 2" PVC	MCI	11" / 24"	726854.883	126198.139	5330.78	5327.76	3.02'	Fiber
34	Communication	3" PLA	CenturyLink	12" / 24"	726851.062	126198.202	5330.66	5325.56	5.10'	
35	Electrical	6" PVC	XCEL	12" / 22"	726834.455	126197.077	5330.684	5327.19	3.49'	Dug down in premark and found 6" gray electric conduit. Mislabeled hole as 34 when it is actually 35.
36	Gas	10" Steel	XCEL	36.23" / 18"	726817.304	126196.286	5330.597	5324.38	6.22'	Got 8-9' of asphalt out of ground and ran into second layer of asphalt that's a bit more rocky and harder to core on. Got core drill maxed out to its capability over 15" and still couldn't get through second layer of asphalt.
37	Gas	8" Steel	XCEL	16" / 22"	726409.909	126188.215	5326.574	5317.87	8.70'	
39	Sewer	None	Arvada	6" /	724684.23	126186.481	5293.05	5286.95	6.10'	Cleared down in hole 6 feet and did wing out approx. 12 inches in each direction. Popped manhole to east and recorded depth of 4.95 on pipe in manhole. No flow coming out of line, probed down with wand approx. 7 feet and couldn't find sanitary line

*Note MATL=PIPE MATERIAL
Unit of Measurement is US FOOT
See General Notes for Coordinate Information
DI = Ductile Iron
DBC = Direct Buried Cable
RCP = Ridge Concrete Pipe

I CERTIFY THE UTILITY INFORMATION SHOWN ON THESE DRAWINGS IS IN ACCORDANCE WITH C/ASCE STANDARD 38-22

TIMOTHY P. SULLIVAN, P.E. 29225
FOR AND ON BEHALF OF SAM, LLC

DATE

REVIEWED BY: _____

2	TEST HOLE DATA ADDED TO ALL SHEETS	JPE	08/16/24
NO.	REVISIONS	BY	DATE

PROJECT: CAROLLO
ARVADA NTL7
JOB NUMBER: 1023081204
DATE: 07/18/2024
SCALE: N.T.S
ENGINEER: T. SULLIVAN
TECHNICIAN: R. EMBORSKY
DRAWING: J. ENGELE
TRACT ID:
PARTYCHIEF:
FIELDBOOKS:



8300 E. Mapplewood Ave.
Suite 300
Greenwood Village, CO 80111
Ofc: 303.988.5852
Fax: 844.273.6169
Email: info@sam.biz

TEST HOLE SUMMARY



SURVEYING AND MAPPING LLC
8300 E. Maplewood Ave., Suite 300
Greenwood Village, CO 80111
PH. 303-988-5852

Test Hole Summary

Project: NTL7 Arvada
SAM, LLC Project # 1023081204
Client: Carollo Engineers
Prepared By: Tim Sullivan
Checked By: Jon Engele

STATE: COLORADO City: Arvada

TH#	Utility Expected	Utility Found	Utility Owner	Pavement Thickness / Depth of Roadbase	Northing	Easting	Elev. Existing Ground	Elev. Top of Utility	Depth of Cover	NOTES
48	Gas	3" PE	XCEL /	9" / ??	724138.438	126474.501	5294.137	5291.06	3.08'	Found 3 utils in th 48. Electric gas and telephone. Gas measured at 3.08, electric at 3.38, and telephone at 2.48. Found all utils
49								0.00		
50								0.00		
51								0.00		
52-A	Electric	2" PVC	Unknown	None	729689.992	126131.735	5324.915	5322.78	2.14'	Dug down looking for storm sewer and found 2" gray electrical conduit at 2.14' in west wall of TH 52.
52-B	Storm Water	24" RCP	Westminster	None	729690.193	126132.206	5324.834	5320.85	3.98'	
53	Gas	4" Steel	XCEL	None	729690.485	126138.046	5324.36	5319.64	4.72'	
55	Water	None	Westminster	6" / 20"	729689.257	126192.825	5324.61	5324.61		Cleared down 10.48' with 2' wing outs. No find on water line. Believe line dives under creek. 6" core with 20" road base. No find on utility
56	Gas	3" PE	XCEL	6" / 20"	729672.319	126177.586	5324.376	5320.08	4.30'	No Photos
58	Unknown	None	Unknown	7' / 20"	729610.919	126205.026	5324.447	5316.45	8.00'	Went down on premark and went through flow fill after getting through road base. Got down 8' with 2' wing outs and didn't find anything.
59	Water	Water Elbow, PVC	Westminster	8" / 20"	729572.383	126204.436	5324.596	5319.92	4.68'	Dug down on premark and found a pit of flow fill and asphalt, ended up finding an H2O elbow at 4.68'. Couldn't get size because pipe was encased with flow fill, concrete with chunks of asphalt. Pipe was wrapped in plastic. Believe elbow goes east down 76th.
60	Water	18" PVC Water	Westminster	11" / 14"	729551.568	126204.162	5324.575	5319.68	4.90'	Dug down on premark for what I thought was a hole for telephone and came down directly on top of a 18" pvc water line at 4.9'. Hole took a lot of water due to flow fill
60.1	Communication	4" PVC	CenturyLink	7" / 20"	729551.406	126208.192	5324.548	5318.70	5.85'	Moved hole over to the east approx 3 feet to avoid water. Found utility right on SAM locate at 5.85'
61	Water	6" DI	Westminster	11" / 20"	729504.6	126202.85	5324.846	5321.89	2.96'	
62	Storm Water	18" RCP	Westminster	19" / None	726197.007	126196.019	5320.866	5317.92	2.95'	
63	Sewer	None	Arvada	16" / 20"	725859.819	126213.312	5317.626	5301.63	16.00'	Crew cleared down to 16 ft and ran into large rocks and boulders we could not move. 12" wing outs. No find. 20" road base
64	Storm Water	18" RCP	Westminster	15" / No road base	725719.521	126219.598	5317.019	5314.84	2.18'	
66	Water	None	Westminster	No Information	725649.82	126219.03	5316.52	5306.12	10.40'	Cleared down 10.4 ft and did 2 ft wing outs to north and south. No find on line (QL-D)
68	Gas	6" Steel	XCEL	?? / 20"	725626.722	126220.825	5316.323	5312.57	3.75'	
69	Electric	3 - 1" DBC	XCEL	14" / 7"	725377.352	126220.762	5310.137	5306.38	3.76'	
70	Storm Water	None	Westminster	-	-	-	-	-	-	It was determined that this line does not cross the design sewer line. It 45's and runs south into the box culvert
71	Storm Water	14' X 6' Box culvert	Westminster	7" / 4"	724964.243	126226.987	5296.067	5287.73	8.34'	Lots of ground water, difficult to get accurate measurement
72	Storm Water	14' X 6' Box culvert	Westminster	7" / 4"	724946.679	126227.863	5295.907	5287.56	8.35'	Went back into hole to get further towards bottom of culvert. Get to 7.15' before running into concrete spoils and chunks of asphalt and cannot dig any further.
73	Unknown	None	Unknown	7" /	724884.937	126227.284	5295.446	5290.45	5.00'	Dry hole. Crew dug to 5 feet, expanded both sides of hole. No utility found. Signal found with sweep was unreliable and needed gain super high. Crew believes there is no util running here.
74	Storm Water	24" RCP	Westminster	7" /	724521.192	126229.509	5292.959	5290.36	2.60'	
75	Water	24" PVC	Arvada	No Information	724299.346	126230.89	5295.181	5288.90	6.28'	Went back into hole that was already dug on. Got down to 6.28 where we found the water line. Water line was 24" and material was hard to tell. Print shows a 12" pvc
76	Storm Water	36" RCP	Arvada	7" /	724289.507	126229.697	5295.444	5292.37	3.07"	
77	Water	12 " PVC	Westminster	9" / 11" concrete	729585.387	126176.608	5324.481	5318.93	5.55'	
78	Water	24" PVC	Westminster	10" / 20"	729004.026	126194.77	5326.967	5320.67	6.30'	
79	Gas	6" Steel	XCEL	8" / 21"	728966.785	126218.019	5326.771	5321.96	4.81'	
80	Gas	6" Steel	XCEL	6" / 15"	728461.883	126218.245	5329.525	5323.97	5.56'	
								0.00		
								0.00		

*Note MATL=PIPE MATERIAL
Unit of Measurement is US FOOT
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TEST HOLE SUMMARY

Exhibit 5

Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66



CITY OF ARVADA, COLORADO

**NORTH TRUNK LINE SEWER
SHERIDAN, 76th AVENUE to 68th AVENUE (NTL7)**

CITY OF ARVADA PROJECT NO. 24-SR-03

TECHNICAL SPECIFICATIONS

95% SUBMITTAL

VOLUME 1 OF 2

DIVISIONS 01-33

OCTOBER 2024

NOT FOR CONSTRUCTION

These Draft Documents are released for the purpose of information exchange review and planning only under the authority of James J. Kriss, October 17, 2024, Colorado License No. 33808. They are not to be used for bidding or construction purposes.



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CITY OF ARVADA, COLORADO

**NORTH TRUNK LINE SEWER
SHERIDAN, 76th AVENUE to 68th AVENUE (NTL7)**

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SECTION 01_11_00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Detailed description of the Work.

1.02 THE WORK

- A. The Work consists of, but is not limited to, the construction of sanitary sewer interceptor piping and manholes, including connections to existing manholes, abandoning in place existing sanitary sewer interceptor piping and manholes, and any repair and reconstruction of existing improvements, including road, sidewalk, curb and gutter, and medians, affected by the Work.

1.03 LOCATION OF PROJECT

- A. The Work is located in the City of Arvada and City of Westminster along Sheridan Boulevard and Little Dry Creek, approximately between W. 78th Avenue to the north and W. 68th Avenue to the south.

1.04 GEOTECHNICAL REPORT

- A. The following is a geotechnical report of explorations and tests of subsurface conditions at or adjacent to the Site, and is included in an appendix to these specifications:
 - 1. Geotechnical Investigation Report, North trunk Sewer Improvements (NTL7) – Sheridan and 76th, Arvada, Colorado, September 2024 – Lithos Engineering, a GEI Company.

1.05 SUBSURFACE UTILITY INVESTIGATION REPORT

- A. The following is a report containing subsurface utility investigation, including pictures and information of potholing operations for utilities within the proposed interceptor sewer alignment, and is included in an appendix to these specifications:
 - 1. Subsurface Utility Investigation 81204 – Arvada NTL7, Westminster, Jefferson County, CO, September 2024 – Survey and Mapping, LLC.

1.06 PERMITS

- A. The Contractor shall obtain required permits for the execution of the Work in accordance with the Contract Documents. Furnish copies of all permits obtained by the Contractor to the Owner and Engineer. Materials submitted to the Owner and Engineer include, but are not limited to, completed application materials, the permit, written correspondence between the Contractor and the regulatory agency issuing the permit and any information required to be submitted to demonstrate compliance with permit terms and conditions (e.g., inspection reports).

- B. Comply with all conditions of the permits.
- C. Contractor shall verify and pay actual fees.
- D. Completeness of the permit list is not guaranteed by Owner. The absence of information does not relieve Contractor of responsibility for determining and verifying the extent of permits required and of obtaining all permits.
- E. Certain permit applications have been obtained during design and are provided herein for Contractor's convenience. Owner does not guarantee the accuracy or completeness of the permit applications, requirements, and /or fees. Contractor shall be responsible for verification of all permit application forms, fees, and requirements.
- F. Contractor shall be responsible for incorporating all permit requirements, permit lead times, submittal review periods and re-submittals into the Contractor's Schedule. Contractor is responsible for confirming lead and review timeframes associated with permit submittal and approval.

1.07 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

- A. The following permits shall be obtained by Contractor. Contractor shall coordinate permit applications and submittals directly with the Owner and Engineer
- B. Contractor shall be responsible for incorporating all permit requirements, permit lead times, submittal review periods and re-submittals into the Contractor's CPM Schedule.
- C. Local permits obtained shall be for use within applicable local jurisdictions as indicated and as regulated by agencies having jurisdiction. State-issued permits shall be for use within the entire Site unless the location is otherwise specifically indicated.
- D. Known Permits to be Obtained by Contractor:

Permitting Authority	Permit Name	Notes	Permittee
CDOT	CDOT Utility/ Special Use Permit Application	Coordinate directly with CDOT during final design.	Contractor
Colorado Department of Public Health and Environment (CDPHE)	Stormwater Discharge for General Construction Activities	May not be needed if covered by Westminster SWMP.	Contractor
CDPHE	Discharges from Short-term (<2 years) Construction Dewatering Activities	Remediation permit required per CDPHE.	Contractor
CDPHE	General Air Emission Notice (APEN)	General permit required for overall project.	Contractor
CDPHE	Regulation 22 Self-Certification Letter		Arvada and Engineer
City of Westminster	ROW Permit	Online application.	Contractor

Permitting Authority	Permit Name	Notes	Permittee
City of Westminster	Floodplain Permit	Zone A special flood hazard area along Little Dry Creek and at 69th Avenue Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) No. 08059C0208F.	Engineer
City of Arvada	Stormwater Management Plan (SWMP)	Engineer will prepare supporting documents. Contractor will obtain permit.	Contractor
City of Arvada	CIP Permit	City owns it in coordination with Contractor.	Contractor
City of Arvada	Floodplain Development Permit	Zone A special flood hazard area at 69th Avenue FEMA FIRM No. 08059C0208F.	Engineer
Jefferson County	N/A	Potential referral agency.	N/A
Mile High Flood District	N/A	Potential referral agency.	N/A
United States Army Corps of Engineers	N/A	Potential referral agency.	N/A
United States Fish and Wildlife Service	N/A	Potential referral agency.	N/A

- E. No additional compensation or additional Contract Times will be granted to Contractor because of delays by Owner in obtaining any permit unless Contractor is unable to proceed and complete Work and such delays are clearly demonstrated by the Contractor's Progress schedule.
- F. Should the Contractor need to construct borehole structures (e.g. monitoring and observation holes, test holes, and dewatering wells), the Contractor shall submit a Notice of Intent to the state Division of Water Resources. A Notice of Intent shall be filed with the state Division of Water Resources at least three days prior to construction of the structure. Contractor shall have confirmation from the state Division of Water Resources that the Notice has been filed prior to initiating construction of the structure. The structure must be constructed within ninety days of the date of the Notice of Intent. Closure requirements will be borehole structure specific.

1.08 OWNER USE OF PROJECT SITE

- A. Owner may utilize all or part of the existing Site and existing facilities during the entire period of construction for the conduct of Owner's normal operations, observation of the Work, and for other Owner projects. Cooperate and coordinate with the Owner to facilitate Owner's operations and projects and to minimize interference with Contractor's operations at the same time. In any event, Owner shall be allowed safe access to all portions of the Site during the period of construction of the Project.

1.09 NOTICES TO OWNERS OF ADJACENT PROPERTIES AND UTILITIES

- A. Maintain access to all public and private properties at all times through the use of detours or alternate routes or entrances unless written permission is obtained from the property owner or tenant prior to closing such access.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_14_00
WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

- A. Baseline Schedule with MOP tasks.
- B. Method of Procedure (MOP) Form.
- C. Method of Procedure (MOP) Log.
- D. Progress Schedule with MOP tasks.

1.03 METHOD OF PROCEDURE (MOP)

- A. Comply with MOP Instructions as specified in Attachment A - Method of Procedure (MOP).
- B. Prepare MOP for the following conditions:
 - 1. Shutdowns, diversions, and tie-ins to the existing infrastructure.
 - 2. Process start-up activities.
 - 3. Power interruption and tie-ins.
 - 4. Switch over between temporary and permanent infrastructure and piping systems.
- C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.
- D. Submit Baseline Schedule, as specified in Section 01_32_21 - Schedules and Reports with proposed MOPs.
- E. Submit MOP Log at construction progress meetings.
- F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the sanitary sewer system.

1.04 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK

- A. The construction is within three jurisdictions City of Arvada, City of Westminster, and Colorado Department of Transportation (CDOT) right-of-way, in which the majority of it is within CDOT jurisdiction. All construction within CDOT jurisdiction shall conform to CDOT permitting and inspection requirements. Contractor shall use a CDOT certified inspector and surveyor that will be responsible for providing as-built and inspection documentation that meet CDOT requirements.
- B. Traffic control shall meet CDOT requirements and approval.
- C. Bypass pumping will be required for construction of the sanitary sewer interceptor piping.
- D. The City of Westminster typically requires a bond to cover restoration costs of disturbed Open Space but will waive this as a courtesy and execute a Memorandum of Understanding with the City of Arvada regarding the restoration.
- E. The City of Westminster Open Space restoration timeframe spans three growing seasons to ensure the establishment of the desired vegetation and final landform.
- F. A tree preservation plan may be required for work within the City of Westminster limits. Tree damage or removals resulting from the project require mitigation at the discretion of the City of Westminster Forester.
- G. A pedestrian detour plan may be required for the City of Westminster Open Space and will need their approval.
- H. Sidewalks will need to be replaced in-kind for the City of Westminster Open Space. Coordinate with the City of Westminster for their approval.

1.05 UTILITIES

- A. Provide advance notice to and utilize services of Underground Services Alert (U.S.A.) for location and marking of underground utilities operated by utility agencies other than the Owner.
- B. Additional utility exploration will be required. The provided SUE QL-A plans indicate information for the utilities that were found but additional utilities exist that information was unable to be obtained that will require further exploration.
- C. Services crossed or located near the new sanitary sewer may require relocation and possible shutdowns.

1.06 WORK BY OTHERS

- A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

1.07 SHUTDOWN CONSTRAINTS

A. General shutdown constraints:

1. Execute the Work while the existing sewer interceptor is in operation.
2. Organize work to be completed in a minimum number of shutdowns.
3. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
4. Owner maintains the ability to abort on the day of the scheduled shutdown.
5. Unplanned shutdowns due to emergencies are not specified in this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_20_20

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Procedures for measurement and payment of Work under this Contract for lump sum items and unit prices.
- B. Refer to the City of Arvada Specifications for the measurement and payment requirements for the project except as detailed in this specification.

1.01 LUMP SUM ITEMS

- A. Item 1: Dewatering.
 - 1. Measurement:
 - a. Includes work for dewatering and other appurtenant work and materials.
 - b. All other related and necessary materials, work, and equipment necessary to satisfactorily complete this item, complete in accordance with the Contract Documents.
 - c. Measurement for payment shall be based on each.
 - 2. Payment:
 - a. Lump sum.
- B. Item 2: Potholes.
 - 1. Measurement:
 - a. Includes work for the potholes required to determine the location of existing utilities along the alignment.
 - b. All other related and necessary materials, work, and equipment necessary to satisfactorily complete this item, complete in accordance with the Contract Documents.
 - 2. Payment:
 - a. Lump sum.
- C. Item 3: Survey.
 - 1. Measurement:
 - a. Includes work for survey to determine the location of the new pipeline and manhole locations.
 - b. The work shall also include any survey necessary for compiling as-built information for the project.
 - c. All other related and necessary materials, work, and equipment necessary to satisfactorily complete this item, complete in accordance with the Contract Documents.
 - 1. Payment:
 - a. Lump sum.

- D. Item 6: Sanitary Sewer Bypass Pumping.
1. Measurement:
 - a. Includes work required for management including but not limited to temporary piping, protection of temporary piping, temporary power, temporary pumps, secondary containment, monitoring of bypass pumps, and notification to private residences for service interruptions and other requirements as specified in Section 33_05_11- Temporary Bypass Pumping, and all other related and necessary materials, work and equipment necessary to satisfactorily complete this item, complete in accordance with the Contract Documents.
 2. Payment:
 - a. Lump sum.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_29_77

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Procedures for preparation and submittal of Applications for Payment.
- B. See City of Arvada Standards and Specifications Section 1122.03. Retainage shall be per City of Arvada requirements.

1.02 FORMAT

- A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule.
 - 1. Submit payment requests and attach spreadsheet with cost data related to Progress Schedule.
- B. Fill in information required on form.
- C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
 - 1. Identify change order by number and description.
 - 2. Provide cost of change order in appropriate column.
- D. After completing, submit Application for Payment.
- E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.
- F. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

- A. Provide Substantiating Data identifying:
 - 1. Project.
 - 2. Application number and date.
 - 3. Cost flow summary.
 - 4. Updated schedule of values.
 - 5. Progress schedule.
 - 6. Detailed list of enclosures.
 - 7. Stored products log.
 - 8. Equipment log.
 - 9. Submit "certified" payroll, if applicable.
 - 10. Record (as-built) documents.

11. Photos and videos from current pay period.
12. Applicable unconditional waiver and release on progress payment for previous payment made by Owner.

1.04 SUBMITTALS

- A. Submit Application for Payment and Substantiating Data with cover letter.

1.05 PAYMENT REQUESTS

- A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.
- B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.
- C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.
- D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.
- E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.
- F. Payment period:
 1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
 2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
 3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

1.06 COST SUMMARIES

- A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.
- B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_19

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
 - a. Qualifications of Meeting Participants.
 - b. Basic Meeting Requirements.
 - c. Pre-construction Conference.
 - d. Web Based Construction Document Management Software Training.
 - e. Progress Meetings.
 - f. Schedule Update Meetings.
 - g. Quality Control Meetings.
 - h. Pre-Installation Meetings.
 - i. Maintenance of Plant Operations (MOPO) Meetings.
 - j. Commissioning Coordination Meetings.
 - k. Close-out Meeting.
 - l. Post Construction Meeting.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

- A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of the entity each represents.

1.03 BASIC MEETING REQUIREMENTS

- A. Attendees:
 - 1. Meeting leader shall require attendance of parties directly affecting, or affected by, Work being discussed at the meeting.
- B. Location:
 - 1. In location convenient for most invitees.
- C. Notification:
 - 1. Meeting leader shall notify attendees of meeting, including an agenda, a minimum of 7 days prior to meeting.
- D. Agenda:
 - 1. Meeting leader shall prepare copies of the agenda for participants and distribute at the meeting.
 - 2. Minimum requirements:
 - a. Meeting purpose.
 - b. Review minutes of previous meeting.

- c. Safety and security.
 - d. Discuss issues.
 - e. Action items.
 - f. Next meeting.
- E. Meeting minutes:
- 1. Meeting leader shall prepare draft minutes and send to attendees for comment within 7 days.
 - 2. Meeting leader shall incorporate comments from attendees and submit final meeting minutes to attendees within 7 days of receipt of comments.

1.04 PRE-CONSTRUCTION CONFERENCE

- A. Engineer leads the meeting.
- B. Timing:
- 1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable.
- C. Required attendees:
- 1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to the agenda.
- D. Agenda minimum requirements:
- 1. Meeting purpose:
 - a. To establish working understanding between parties and to discuss Construction Schedule, Shop Drawings and other Submittals, cost breakdown of major lump sum items, processing of Submittals and applications for payment, and other subjects pertinent to execution of the Work.
 - 2. Adequacy of distribution of Contract Documents.
 - 3. Distribution and discussion of list of major subcontractors and suppliers.
 - 4. Proposed progress schedules and critical construction sequencing.
 - 5. Major equipment deliveries and priorities.
 - 6. Project coordination.
 - 7. Designation of responsible personnel.
 - 8. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals - separate meeting.
 - d. Change Orders.
 - e. Request for Information/Interpretations.
 - f. Applications for Payment.
 - g. Record documents.
 - 9. Use of premises:
 - a. Office, construction, and storage areas.
 - b. Owner's requirements.
 - 10. Construction facilities, controls, and construction aids.
 - 11. Temporary utilities.
 - 12. Safety and first aid procedures.
 - 13. Security procedures.

14. Housekeeping procedures.
15. Safety and security.
16. Review proposed photographer Submittal.
17. Action items.
18. Next meeting.

1.05 PRE-CONSTRUCTION SCHEDULING MEETING

- A. Engineer leads the meeting.
- B. Timing:
 1. Within 7 days of Notice to Proceed, or earlier when mutually agreeable.
- C. Required attendees:
 1. Contractor's project manager, superintendent, scheduler, Owner, Engineer, and others necessary to the agenda.
- D. Agenda minimum requirements:
 1. Meeting purpose:
 - a. To establish the format and features of the Construction Schedule.
 2. Schedule preparation.
 3. Reporting requirements.
 4. Updates and revision procedures.
 5. Schedule delay analysis procedures.
 6. Schedule methodology.
 7. Planned sequence of operations.
 8. Cost and labor loading methodology.
 9. Proposed activity coding structure as specified in Section 01_32_21 - Schedules and Reports.
 10. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
 - a. Example 1: 2021_07_30 rev 1 draft baseline schedule.xer.
 - b. Example 2: 2021_09_30 rev 2 sep final update.xer.
 11. Action items.
 12. Next meeting.

1.06 WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT SOFTWARE TRAINING

- A. Contractor can submit a written request to the Engineer to waive the training based on staff having sufficient familiarity with the software and its complete usage.
- B. Timing:
 1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable,
 2. Duration minimum: 2 hours.
- C. Agenda minimum requirements:
 1. Meeting purpose:
 - a. Train construction team on the use of the web-based document management system software.
 2. Safety.
 3. General Items.

4. Contractor functions.
5. Owner functions.
6. Engineer functions.
7. Action items.

1.07 PROGRESS MEETINGS

- A. Engineer will lead the meeting.
- B. Timing:
 1. Hold meetings throughout progress of the Work at maximum weekly intervals.
- C. Required attendees:
 1. Owner, Engineer, Contractor, Contractor's project manager, superintendent, quality control manager, project scheduler, major subcontractors, and suppliers as appropriate to the agenda topics for each meeting.
 2. Additional invitees:
 - a. Owner utility companies when the Work affects their interests, and others necessary to the agenda.
- D. Agenda minimum requirements:
 1. Meeting purpose:
 - a. Provide the status of the Work.
 2. Review minutes of previous meeting.
 3. Safety and security.
 4. Construction schedule summary.
 5. Review of 6 weeks schedule.
 - a. Contractor shall provide printed hard copies for each attendee.
 6. Review of off-site fabrication and delivery schedules.
 7. Review of Submittals schedule and status of Submittals.
 8. Request for information (RFI) status.
 9. MOP's/shutdown coordination.
 10. Change order management status.
 11. Maintenance of quality standards (QA/QC).
 12. Field observations, problems, and conflicts.
 13. Commissioning.
 14. Partnering recognition status (optional).
 15. General items.
 16. Action items.
 17. Next meeting.

1.08 SCHEDULE UPDATE MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 1. Hold meetings throughout progress of the Work at maximum monthly intervals.

- C. Required attendees:
 - 1. Owner, Engineer, Contractor, Contractor's project manager, general superintendent, project scheduler, major subcontractors, and suppliers as appropriate to the agenda topics for each meeting.
 - 2. Additional invitees:
 - a. Owner utility companies when the Work affects their interests and others necessary to the agenda.
- D. Agenda minimum requirements:
 - 1. Meeting purpose:
 - a. Identify and troubleshoot scheduling issues in a collaborative environment.
 - b. Provide further detail on Work status.
 - 2. Review minutes of previous meeting.
 - 3. Review Monthly Schedule, (Actual Progress and Variance).
 - a. "Activities Started/Completed" this period.
 - b. "Activities Started/Completed" "Variance" Baseline vs. current.
 - c. "Added/Deleted Activities".
 - d. "Revised Activity Descriptions".
 - e. Any significant Proposed Logic Changes.
 - 4. Review milestone "Substantial Completion" Schedule:
 - a. "Critical" Activities - "Critical Area, Float and Vital Statistics".
 - 5. Review "Cumulative and Monthly Costs" graph.
 - 6. Review "Budgeted Cost" indicating the Current Project Budgeted Cost.
 - 7. Safety and security.
 - 8. Action items.
 - 9. Next meeting.

1.09 PRE-INSTALLATION MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 - 1. When specified in Technical Sections or requested by Engineer, before commencing Work of specific section.
- C. Required attendees:
 - 1. Owner, Engineer, Contractor, Contractor's project manager, general superintendent, project scheduler, major subcontractors including electrical instrumentation, and suppliers as appropriate to the agenda topics for each meeting.
 - 2. Additional invitees:
 - a. Owner utility companies when the Work affects their interests and others necessary to the agenda.
- D. Agenda minimum requirements:
 - 1. Meeting purpose:
 - a. Review conditions of installation, preparation, and installation procedures.
 - b. Review coordination with related work.
 - 2. Review minutes of previous meeting.

3. Safety and security.
4. Action items.
5. Next meeting.

1.10 PRE-SHUTDOWN MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 1. Short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP require a pre-shutdown meeting at Project site at least 3 working days prior to commencing shutdown for tie-in or modification of specific plant systems.
- C. Required attendees:
 1. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner's construction, operations, and maintenance staff.
- D. Agenda minimum requirements:
 1. Meeting purpose:
 - a. Review conditions of installation, preparation, and installation procedures.
 - b. Review coordination with related work.
 2. Review minutes of previous meeting.
 3. Review accepted Construction Method of Procedure (MOP), as specified in Attachment A of Section 01_14_00 - Work Restrictions, including conditions of shutdown, preparation, and installation procedures.
 4. Review timelines and sequences.
 5. Review responsibilities.
 6. Review dry run plan and schedule, as necessary.
 7. Review coordination with related Work.
 8. Safety and security.
 9. Action items.
 10. Next meeting.

1.11 QUALITY CONTROL MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 1. Hold meetings throughout progress of the Work at maximum weekly intervals.
- C. Required attendees:
 1. Engineer, Construction manager and staff, Contractor's quality control manager, and staff.
- D. Agenda minimum requirements:
 1. Meeting purpose:
 - a. Update Contractor's efforts to comply with quality requirements in the Contract Documents.
 2. Review minutes of previous meeting.

3. Review of Work progress and schedule.
4. Review of out-of-compliance inspection or test results.
5. Field observations, problems, and decisions.
6. Review of offsite fabrication and delivery schedules.
7. Planned progress during succeeding work period.
8. Coordination of required inspections and tests.
9. Review 6-week schedule report with upcoming inspections and special tests.
10. Maintenance of quality and work standards.
11. Other business relating to Work.
12. Safety and security.
13. Action items.
14. Next meeting.

1.12 CLOSE-OUT MEETING

- A. Engineer leads the meeting.
- B. Timing:
 1. After punch list items are completed.
- C. Required attendees:
 1. Owner, Engineer, Contractor, Contractor's project manager, and superintendent.
- D. Agenda minimum requirements:
 1. Meeting purpose:
 - a. Coordinate close-out activities.
 2. Review minutes of previous meeting.
 3. Review punch list completion.
 4. Transfer of record documents.
 5. Finalize payment.
 6. Safety and security.
 7. Action items.
 8. Next meeting.

1.13 POST CONSTRUCTION MEETING

- A. Engineer leads the meeting.
- B. Timing:
 1. About 11 months after date of Substantial Completion.
- C. Location:
 1. Meet in Owner's office or other mutually agreed upon place.
- D. Required attendees:
 1. Engineer, Contractor, appropriate manufacturers, and installers of major units of constructions, affected Subcontractors, and Owner's operations and maintenance staff.

- E. Agenda minimum requirements:
1. Meeting purpose:
 - a. Review Project for compliance with the Contract Documents.
 2. Inspect the Work and draft list of items to be completed or corrected.
 3. Review service and maintenance contracts and take appropriate corrective action when necessary.
 4. Complete or correct defective work and may extend correction period.
 5. Safety and security.
 6. Action items.
 7. Next meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_24

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

- A. Owner, Engineer, and Contractor shall utilize the specified Procore or equal, web-based construction management software, for submission of data and documents.
 - 1. Web-based construction management software and associated licenses shall be purchased by the Contractor at no cost to Owner, and Engineer.
 - 2. Joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
 - 3. Web based construction management software shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

- A. Engineer and Owner shall provide a list of key web based construction management software personnel.
 - 1. Engineer and Owner will be allowed to add additional personnel to the web-based construction management software.
 - 2. Subcontractors and Suppliers will be given access to web-based construction management software by and through the Contractor.
 - 3. Contractor is responsible for adding and removing users from the system after the initial setup.
- B. Contractor will grant initial access to the web-based construction management software by creating user profiles to accepted Engineer and Owner personnel.
 - 1. User profiles will define levels of access into the system; determine assigned function based authorizations and user privileges.

1.04 JOINT OWNERSHIP OF DATA

- A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the web-based construction management software system) by Engineer, Owner, and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

- A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents.
- B. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents.
- C. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

- A. Contractor shall use computer hardware and software that meets the requirements of the web-based construction management software system as recommended by the web-based construction management software to access and utilize the web-based construction management software.
- B. As recommendations are modified by the web-based construction management software, Contractor will upgrade their system(s) to meet or exceed the recommendations.
 - 1. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.
- C. Ensure that connectivity to the web-based construction management software system is accomplished through DSL, cable, T-1 or wireless communications systems.
 - 1. Minimum bandwidth requirements for using the system is 5 Mbps. It is recommended a faster connection be used when uploading pictures and files into the system.
- D. Web-based construction management software supports the current version of Chrome (preferred), Mozilla's Firefox, Microsoft Edge, and Apple's Safari on a rolling basis.
 - 1. Each time a new version of one of these browsers is released, the web-based construction management software will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

- A. Responsible for the validity of their information placed in the web-based construction management software and for the abilities of their personnel.
- B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on the web-based construction management software shall be the responsibility of the Contractor.
- C. Accepted users shall be knowledgeable in the use of computers, including Internet browsers, email programs, CAD drawing applications, and Adobe Portable Document Format (PDF) document distribution program.

- D. Utilize the existing forms in the web-based construction management software to the maximum extent possible. If a form does not exist in the web-based construction management software, Contractor must include a form of their own or provided by the Engineer as an attachment to a Submittal.
- E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of the web-based construction management software (outside what is provided by the Owner) and the other programs indicated above as needed.

1.08 TRAINING

- A. Contractor shall arrange and pay for web-based training on using web-based construction management software for the Owner and Engineer. Training may be provided by Contractor's personnel.
- B. Contractor shall arrange and pay for the software required to facilitate Contractor's training.

PART 2 PRODUCTS

2.01 DESCRIPTION

- A. Web-based construction management software provided by Procore or equal.

PART 3 EXECUTION

3.01 WEB-BASED CONSTRUCTION MANAGEMENT SOFTWARE UTILIZATION

- A. Web-based construction management software shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

- A. Use the web-based construction management software feature for Master Submittals List.
 - 1. Select from the predefined submittals list.
- B. Content: As specified in Section 01_33_00 - Submittal Procedures.
- C. Format: As specified in Section 01_33_00 - Submittal Procedures.
- D. Submit Portable Document Format (PDF) documents to the web-based construction management software submittal workflow process and forms.
 - 1. Consolidate electronic format submittals with multiple pages into a single file.

- E. Samples:
 - 1. Enter Submittal data information into the web-based construction management software.
 - 2. Attach a copy of the submittal form(s) to the sample.
- F. Record and Closeout Submittals:
 - 1. Extra materials, spare parts, etc.

3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)

- A. Use web-based construction management software for RFIs.

3.04 OFFICIAL CORRESPONDENCE

- A. Use web-based construction management software for change proposals or for records of any official correspondence.

END OF SECTION

SECTION 01_32_21
SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Schedules and reports.

1.02 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Baseline schedule: A planned and approved timetable projection that illustrates the project execution strategy, key deliverables, planned activity dates and milestones.
 2. Critical path: The longest sequence of dependent tasks in a project.
 3. Near critical path: The longest path after the critical path.
 4. Weather day: The Contractor being prevented or inhibited from performing at least 4 hours of work on the critical path due to weather conditions.

1.03 SCHEDULING FORMAT

- A. Utilize critical path method (CPM) format.
- B. Provide a cost and labor loaded Schedule.
- C. Engineer approval of the format is required.

1.04 SCHEDULING HARDWARE AND SOFTWARE

- A. Scheduling software and hardware shall be located on-site.
- B. Prepare computerized schedule utilizing the most current version of Oracle Primavera P6 or Asta Powerproject.
- C. Contractor and Engineer must agree on the format.

1.05 SCHEDULE PREPARATION

- A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints.
- B. All costs associated with Schedule requirements are included in the Contract Price.
- C. During preparation of the preliminary Progress Schedule, the Engineer will facilitate Contractor's efforts by answering questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

- D. Prepare Schedule utilizing precedence diagramming method (PDM).
- E. Prepare Schedule utilizing activity durations in terms of working days.
 - 1. Do not exceed a 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
 - 2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
 - 3. Coordinate holidays to be observed with the Owner and incorporate them into the Schedule as non-working days.
- F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
 - 1. Contract requirements are not waived by failure of Contractor to include required Schedule constraints, sequences, or milestones in Schedule.
 - 2. Contract requirements are not waived by Owner's acceptance of the Schedule. In the event of conflict between accepted Schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.
- G. Reference Schedule to working days beginning with Notice to Proceed as Contract Time as Day "1".
- H. Baseline Schedule and project completion:
 - 1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's Schedule completion date.
 - 2. Adjust accordingly any Contract milestone dates.
- I. Imposed dates and hidden logic are prohibited.
- J. Interim milestone dates, operational constraints:
 - 1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on Schedule.
 - 2. Do not use zero total float constraint or mandatory finish date on such Contract requirements.
- K. Contract float is for the mutual benefit of both Owner and Contractor.
 - 1. Changes to the Project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time by utilizing float.
 - 2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.
 - 3. Likewise, Contractor may utilize float to offset delays other than delays caused by the Owner.

4. Mutual use of float can continue until all available float shown by Schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.
 5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, Schedule submittals can be rejected for use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations, or imposed dates.
- L. Resource loading and leveling:
1. Input labor data on each schedule activity.
 2. Manpower data consists of the man-hours estimated to perform each task, categorized by trade.
 3. Provide leveled manpower requirements.
 - a. Availability of the resources drive activity duration.

1.06 SCHEDULER

- A. Designate, in writing within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.
- B. Scheduler shall have the authority to update Schedule on behalf of the Contractor.
- C. Qualifications:
 1. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
 2. Knowledge of critical path method (CPM) scheduling utilizing the specified software.

1.07 SUBMITTAL REQUIREMENTS

- A. Preliminary and Baseline Progress Schedule.
- B. Preliminary and Baseline Schedule of Values.
- C. Preliminary and Baseline Schedule of Submittals.
- D. On a monthly basis, updated Schedules as specified.
- E. Final Schedules update as specified.
- F. Revised Schedules and time impact analyses as specified.
- G. Submit Schedules in the media and number of copies as follows:
 1. PDF format and in other formats specified in this Section.
 2. 2 sets of CPM Schedule data electronic files in a native backed-up file format.

1.08 GANTT CHART

- A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
 - 1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.
- B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.
- C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
 - 1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.
- D. Provide Progress Schedule showing the critical path for the Project.
- E. Provide report of Near Critical Path activities for the Project, when required by the Engineer.
- F. Delineate the specified Contract Times and identify the planned completion of the Work as a milestone.
 - 1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as Project float.
- G. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion dates as milestones.
- H. Include, in addition to construction activities:
 - 1. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
 - 2. Equipment and long-lead material deliveries over 8 weeks.
 - 3. Approvals required by regulatory agencies or other third parties.
- I. Produce electronic network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.
- J. Identify the execution of the following:
 - 1. Mobilization.
 - 2. All required Submittals and Submittal review times showing 30 calendar day duration for such activities and equal amount of time for resubmittal reviews.
 - 3. Equipment and materials procurement/fabrication/delivery.
 - 4. Excavation.
 - 5. Shoring design and submission of detailed shoring submittals. Identify submission as a milestone.
 - 6. Shoring review, shoring materials procurement, shoring installation, and shoring removal.
 - 7. Piles.
 - 8. Backfill and compaction.
 - 9. Dewatering.

10. Grading, subbase, base, paving, and curb and gutters.
11. Fencing and landscaping.
12. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
13. Tests for leakage of concrete structures intended to hold water.
14. Masonry.
15. Metal fastenings, framing, structures, and fabrications.
16. Wood structures, finish carpentry, architectural woodwork, and plastic fabrications.
17. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
18. Doors and windows, including hardware and glazing.
19. Finishes including coating and painting, flooring, ceiling, and wall covering.
20. Building specialties including furnishings, laboratory equipment, and toilet and bath accessories.
21. Process equipment, including identification of ordering lead-time, factory testing, and installation.
22. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
23. Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including identification of ordering lead-time and installation.
24. Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment.
25. Trenching, pipe laying, and trench backfill and compaction.
26. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
27. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
28. Plumbing specialties.
29. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
30. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
31. Instrumentation and controls, including identification of ordering lead-time.
32. Preliminary testing of equipment, instrumentation, and controls.
33. Commissioning phase:
 - a. Source Testing.
 - b. Owner Training.
 - c. Installation Verification.
 - d. Functional Testing.
 - e. Start-up Phase.
 - f. Start-up Period.
34. Instrumentation and Controls Performance Testing.
35. Substantial completion.
36. Punch list work.
37. Demobilization.

1.09 PRELIMINARY SCHEDULE

- A. Procedure:
 - 1. Submit proposed Preliminary Schedule within 14 calendar days after Notice to Proceed.
 - 2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments.
 - 3. Submit revised Preliminary Schedule within 5 calendar days after meeting.
 - 4. Update Preliminary Schedule monthly until the Baseline Schedule is accepted.
- B. Format:
 - 1. Simplified Gantt chart.
- C. Activities:
 - 1. Define activities to be completed in the first 90 calendar days of Work.
 - 2. Actualize activities performed during the first 90 days into the first monthly Schedule update.

1.10 WORK WITHIN THE FIRST 90 DAYS

- A. Proceed with Work after Preliminary Schedule and Preliminary Schedule of Values have been accepted by Owner.
- B. Submittal and acceptance of Preliminary Schedule and Preliminary Schedule of Values is condition precedent to making of progress payments as specified in Section 01_29_77 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.

1.11 SCHEDULE OF SUBMITTALS

- A. Schedule of Submittals shall include Submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and maintenance manuals, Shop Drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.
- B. Preliminary Schedule of Submittals:
 - 1. Due date: After Preliminary Schedule has been submitted and accepted by the Owner.
 - 2. Format:
 - a. Include Submittals anticipated in the first 90 calendar days after award of Contract using early start dates.
 - b. Indicate week and month anticipated for submittal to Engineer.
 - c. Indicate "Priority" Submittals where review time can impact Contractor's schedule.
 - 1) "Priority" indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
 - 2) Engineer will endeavor to provide early review of "Priority" Submittals where possible.
 - 3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of Contract.

- C. Final Schedule of Submittals:
 - 1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
 - 2. Format:
 - a. Include Submittals using early start dates.
 - b. Include all Submittals, including those required in the Preliminary Schedule of Submittals.
 - c. Indicate week and month anticipated for submittal to Engineer.
 - d. Indicate "Priority" submittals where review time can impact Contractor's schedule.
 - 1) "Priority" indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
 - 2) Engineer will endeavor to provide early review of "Priority" Submittals where possible.
 - 3. Submittal of final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.
- D. Provide updated Schedule of Submittals with updated schedules if Schedule revisions change listing and timing of Submittals.

1.12 BASELINE PROGRESS SCHEDULE AND BASELINE SCHEDULE OF VALUES

- A. Due date: No more than 45 calendar days after Notice to Proceed.
- B. Format:
 - 1. Progress Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
 - 2. Schedule of Values: Utilize the bid form to produce Schedule of Values.
- C. Acceptance of the Baseline Progress Schedule and Baseline Schedule of Values by the Owner is a condition precedent to making payments as specified in Section 01_29_77 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

1.13 SUMMARY SCHEDULE

- A. Due date: At weekly progress meetings and after each Schedule update or Schedule revision.
- B. Format:
 - 1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
 - 2. Intended to give an overall indication of the Project Schedule without a large amount of detail.

1.14 COST FLOW SUMMARY

- A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.
- B. Format:
 - 1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
 - 2. Base tabulation on the summation of the cost-loaded activities each month.
 - 3. Show planned amounts.
 - 4. Show actual earned amounts and anticipated remaining earnings.
 - 5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.15 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

- A. Due date: Submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.

1.16 WEEKLY SCHEDULE

- A. Due date: At every weekly progress meeting.
- B. Format:
 - 1. Contractor and Engineer must agree on the format.
 - 2. 6-week Schedule showing the activities completed during the previous week and the Contractor's schedule of activities for the following 5 weeks.
 - 3. Use the logic and conform to the status of the current Progress Schedule when producing a weekly Schedule in CPM schedule or a bar chart format.
 - a. In the event that the weekly Schedule no longer conforms to the current Schedule, Contractor may be required to revise the Schedule as specified in this Section.
 - 4. Activity designations used in the weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule updates.

1.17 LABOR HISTOGRAM

- A. Due date:
 - 1. With progress payments after Baseline Schedule has been submitted and accepted by Owner.
- B. Format:
 - 1. Labor histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
 - 2. Submit in electronic format.

1.18 PRE-CONSTRUCTION SCHEDULING MEETING

- A. As specified in Section 01_31_19 - Project Meetings.

1.19 REVIEW AND ACCEPTANCE OF SCHEDULES

- A. Engineer will review preliminary Schedules, Schedule updates, Schedule revisions, and time impact analyses to ascertain compliance with specified project constraints, compliance with milestone dates, durations and sequence, accurate inter-relationships, and completeness.
- B. Engineer and Owner will issue written comments following completion of review of baseline Schedules within 21 calendar days after receipt.
- C. Written comments on review of Schedule updates and Schedule revisions and time impact analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.
- D. Revise and resubmit Schedules in accordance with Engineer's comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.
- E. If the Engineer requests a meeting, the Contractor and all major subcontractors shall participate.
 - 1. Revise and resubmit Schedule within 7 calendar days after meeting.
- F. Use accepted Schedules for planning, organizing, and directing the Work and for reporting progress.
- G. Engineer's Submittal review response:
 - 1. When Schedules reflects the Owner's and Contractor's agreement of project approach and sequence, Schedules will be accepted by the Owner.
 - 2. Engineer's Submittal review response for Schedule Submittals will be "Receipt Acknowledged - Filed for Record".
 - 3. Acceptance of the Schedules by the Owner is for general conformance with the Contract Documents and for the Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the Contract completion dates.
 - a. Omissions and errors in the accepted Schedules shall not excuse performance less than that required by the Contract Documents.
 - b. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.20 SCHEDULE UPDATES

- A. Any update:
 - 1. Prepare update using most recent accepted version of Schedule including:
 - a. Actual start dates of activities that have been started.
 - b. Actual finish dates of activities that have been completed.
 - c. Percentage of completion of activities that have been started but not finished.
 - d. Actual dates on which milestones were achieved.
 - e. Update activities by inputting percent complete figures with actual dates.
 - f. Use retained logic in preparing Schedule updates.

- g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
 - h. Revisions to the Schedule may be included that have been previously approved as specified.
- B. Monthly updates:
- 1. Submit written narrative report in conjunction with each Schedule update, including descriptions of the following:
 - a. Activities added to or deleted from the Schedule are to adhere to cost and other resource loading requirements.
 - 1) Identify added activities in manner distinctly different from original activity designations.
 - b. Changes in sequence or estimated duration of activities.
 - c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
 - d. Assumptions made and activities affected by incorporating change order work into the Schedule.
 - e. Include a response in writing to each of the Engineer's comments or questions from the previous month's schedule review and number responses consistent with the Engineer's numbering.
 - 2. Submit updated Schedule and materials specified under Submittal of Progress Schedules 5 calendar days before the monthly schedule update meeting.
 - 3. Since monthly Schedule update is the application for progress payment required as specified in Section 01_29_77 - Applications for Payment, submittal and acceptance of the monthly Schedule update is a condition precedent to the making of any progress payments.
- C. Weekly progress meeting:
- 1. Update the Schedule prior to weekly progress meeting.
 - a. Identify overall progress of each major item of work in the summary schedule.
 - b. If there are significant changes to the Schedule, submit a written report at the weekly progress meeting.
 - 2. Should monthly Schedule update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as "Project Float".
 - 3. Should monthly Schedule update show Project completion later than current Contract completion date, prepare and submit a Schedule revision.

1.21 REVISIONS TO SCHEDULES

- A. Submit revised Schedules within 5 days:
- 1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
 - 2. When delays in Submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
 - 3. When the Schedule does not represent the actual progress of activities.

4. When any change to the sequence of activities, the completion date for major portions of the Work, or when changes occur which affect the critical path.
 5. When Contract modification necessitates Schedule revision, submit schedule analysis of Change Order work with cost proposal.
- B. Create a separate Submittal for Schedule revisions.
1. Comply with Schedule updates as specified in this Section.
 2. Do not submit with Schedule updates.
- C. Schedule revisions will not be reflected in the Schedule until after the revision is accepted by the Owner.
1. This includes Schedule revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.22 ADJUSTMENT OF CONTRACT TIME OR PRICE

- A. Contract Time will be adjusted only for causes specified in Contract Documents.
- B. If the Contractor believes that the Owner has impacted its work such that the Project completion date will be delayed, the Contractor must submit proof, in the form of a time impact analysis demonstrating the delay to the critical path.
- C. Time impact analysis:
1. Use the accepted Schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the Schedule by:
 - a. Inserting new activities associated with the delay event into the Schedule.
 - b. Revising activity logic.
 - c. Revising activity durations.
 2. If the Progress Schedule's critical path and completion date are impacted as a result of adding this delay event to the Progress Schedule, a time extension equal to the magnitude of the impact may be warranted.
 3. The time impact analysis Submittal must include the following information:
 - a. A fragment of the portion of the Schedule affected by the delay event.
 - b. A narrative explanation of the delay issue and how it impacted the Schedule.
 - c. A schedule file used to perform the time impact analysis.
- D. When a delay to the Project as a whole can be avoided by revising preferential sequencing or logic and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.
- E. Indicate clearly that the Contractor has used, in full, all project float available for the Work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.
1. Utilize the latest version of the Schedule update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

- F. Adjustment of the Contract Times will be granted only when the Contract float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
 - 1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.
- G. Actual delays in activities which do not affect the Critical Path Work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.
- H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.
- I. Notify Engineer of a request for Contract Time adjustment.
 - 1. Submit request as specified in the Contract Documents.
 - 2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.
- J. Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
 - 1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule update.
 - 2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
 - 3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
 - 4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.23 WEATHER DAY ALLOWANCE

- A. Allowance:
 - 1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Day Allowance."

- B. Actual Weather Day:
1. Insert a weather delay activity in the critical path to reflect actual weather day occurrences when weather days are experienced and accepted by the Engineer.
 2. Reduce duration of Weather Day Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in the Weather Day Allowance at completion of the Project is considered float.
 3. Provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
 - a. A Schedule update will not suffice as a written notice.
 - b. Engineer will determine if the Weather Day constitutes a use of a portion of the Weather Day Allowance.
 - c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.

1.24 FINAL SCHEDULE

- A. The final Schedule update becomes the As-Built Schedule.
1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
 2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.
- B. Retainage will not be released until final Schedule update is provided.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_32_34

PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements for photographs and videos.
- B. The purpose of the photographs and videos is to document the condition of the facilities prior to the Contractor beginning work at the Project site, the progress of the Work, and the Project site after Substantial Completion of the Work.
- C. The scope of the photographic and videographic documentation shall be the sole responsibility of the Contractor but shall be acceptable to the Engineer.

1.02 SUBMITTALS

- A. Photographer qualifications.
- B. Pre-construction photographs and videos: Submit prior to beginning work at the Project site or prior to the Preconstruction Conference specified in Section 01_31_19 - Project Meetings, whichever occurs earlier.
- C. Construction photographs and videos: Submit with each application for payment.
- D. Post-construction photographs and videos: Submit with project closeout documents as specified in Section 01_77_00 - Closeout Procedures.

1.03 PHOTOGRAPHER

- A. Photographer qualified and equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to telephoto.
- B. Submit example work of previous photographs and video recording meeting the requirements of this Section.
 - 1. Provide to Engineer no later than the pre-construction conference.
 - 2. Provide photographs used for site examination.
 - 3. Provide video of site examination.
 - 4. Provide samples that used same camera and lighting equipment proposed for the Work.
 - 5. Engineer will review work examples to determine if the quality of the images is acceptable.
 - 6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
 - 7. Do not commence Work prior to approval of the material by the Engineer.
 - 8. Once accepted, the standard report material shall serve as a standard for the remaining work.

1.04 KEY PLAN

- A. Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph.
- B. Include the same label information as the corresponding set of photographs.

1.05 PHOTOGRAPHS

- A. Provide prints of each photograph for each area of Work.
- B. Provide a digital copy of each photograph for each area of Work.
 - 1. Monthly: Indexed digital flash drive.
 - 2. Project record documents:
 - a. Catalog and index prints in chronological sequence.
 - b. Include typed table of contents.

1.06 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

- A. Provide photographs and video of the condition entire site including each area of Work prior to the start of Work.
 - 1. Areas to be photographed and videoed shall include the site of the Work and all existing facilities, either on or adjoining the Project site, including the interior of existing structures that could be damaged as a result of the Contractor's Work.
 - 2. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.

1.07 CONSTRUCTION PHOTOGRAPHS AND VIDEOS

- A. Provide photographs and videos of construction in each area of Work throughout progress of Work including a key plan designating where each photograph was taken.
- B. Take site and interior photographs and videos from differing directions of building demolition, pre-excavation, footing excavation, soil testing, utility crossings, installation of bypass piping, excavation of access pits, installation of lining system in pipes, rehabilitation of manholes, building modifications, utilities, electrical and instrumentation modifications, and other applicable activities indicating relative progress of the work.
- C. Take photos a maximum of 7 calendar days prior to Submittal.

1.08 POST-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

- A. Provide photographs of the entire site including each area of Work at the completion of Work.
 - 1. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.
 - 2. Take photos and video from same points in same direction as pre-construction examination.
- B. Submittal of photos and videos is a condition of final payment.

PART 2 PRODUCTS

2.01 MEDIA

- A. Digital media:
 - 1. Flash drive compatible with current Microsoft Windows.
 - 2. Provide photos as individual, indexed JPG files with the following characteristics:
 - a. Compression shall be set to preserve quality over file size.
 - b. Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
 - c. JPG image resolution shall be 5 megapixels at 2,400 by 1,800 or higher.
 - d. Images shall have rectangular, clean images. Artistic borders, beveling, drop shadows, etc., are not permitted.
 - 3. Identification: On photograph, provide the following information:
 - a. Name of project.
 - b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
 - c. Description of vantage point, indicating location and direction by compass point.
- B. Videos:
 - 1. Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
 - 2. Digital color video format.
 - 3. Provide audio portion of the composite video sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
 - 4. Identification: On each copy provide a label with the following information:
 - a. Name of project.
 - b. Date video was recorded.
 - 5. Submit 1 copy of each video within 7 days of recording.
 - 6. Display continuous running time.
 - 7. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_33_00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements and procedures for Submittals to confirm compliance with Contract Documents.

1.02 GENERAL INSTRUCTIONS

- A. Contractor shall prepare a proposed list of submittals within 30 days after the Notice to Proceed. Engineer and Owner shall review and Contractor shall modify list of proposed submittals.
- B. Contractor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved Shop Drawings and Contract Document requirements.
- C. Provide Submittals:
 - 1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
 - 2. That demonstrate compliance with the Contract Documents.
- D. Where multiple Submittals are required, provide a separate Submittal for each Specification section.
 - 1. In order to expedite construction, the Contractor may make more than one Submittal per Specification section, but a single Submittal may not cover more than one Specification section:
 - a. The only exception to this requirement is when one Specification section covers the requirements for a component of equipment specified in another section.
 - b. For example, circuit breakers are a component of switchgear. The switchgear Submittal must also contain data for the associated circuit breakers, even though they are covered in a different Specification section.
- E. Prepare Submittals in the English language. Do not include information in other languages.
- F. Present measurements in customary American units (feet, inches, pounds, etc.).
- G. Must be clear and legible, and of sufficient size for presentation of information.
- H. Page size, other than drawings:
 - 1. Minimum: 8-1/2 inches by 11 inches.
 - 2. Maximum: 11 inches by 17 inches.

- I. Drawing sheet size:
 - 1. Maximum: 22 inches by 34 inches.
 - a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
 - b. Minimum font size: 1/8-inch.
 - 2. 11-inch by 17-inch sheet:
 - a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
 - b. Minimum font size: 1/8-inch.
- J. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
- K. Provide Submittal information from only one manufacturer for a specified product. Submittals with multiple manufacturers for one product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

- A. Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.
- B. For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is used.
- C. Bookmarks:
 - 1. Bookmarks shall match the table of contents.
 - 2. Bookmark each section (tab) and heading.
 - 3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
 - 4. At file opening, display all levels of bookmarks as expanded.
- D. Where applicable (i.e., except for Drawings, figures, etc.), Submittal content shall be electronically searchable utilizing the PDF file as submitted.
- E. Thumbnails optimized for fast web viewing.
- F. Sequentially number pages within the tabbed sections:
 - 1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
- G. Attachments:
 - 1. Include with each Submittal a copy of the relevant Specification section.
 - a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).
 - b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
 - 2. Include with each Submittal a copy of the relevant Drawing, including relevant addendum updates.
 - a. Indicate either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).

- b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
 - c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.
- H. Contractor: Prepare Submittal information in sufficient detail to show compliance with specified requirements.
 - 1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
 - 2. Coordinate Submittal with other Submittals and with the requirements of the Contract Documents.
 - 3. Check, verify, and revise Submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.
- I. Contractor: Prepare "Or Equal" Submittal information.
 - 1. Provide standard Submittal requirements.
 - a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
 - 2. Provide reason the specified product is not being provided.
 - 3. Explain the benefits to the Owner for accepting the "Or Equal".
 - 4. Itemized comparison of the proposed "Or Equal" with product specified, including a list of significant variations:
 - a. Design features.
 - b. Design dimensions.
 - c. Installation requirements.
 - d. Operations and maintenance requirements.
 - e. Availability of maintenance services and sources of replacement materials.
 - 5. Reference projects where the product has been successfully used:
 - a. Name and address of project.
 - b. Year of installation.
 - c. Year placed in operation.
 - d. Name of product installed.
 - e. Point of contact: Name and phone number.
 - 6. Define impacts:
 - a. Impacts to other contracts.
 - b. Impacts to other work or products.
 - 7. Contractor represents the following:
 - a. Contractor bears the burden of proof of the equivalency of the proposed "Or Equal".
 - b. Proposed "Or Equal" is equal or superior to the specified product.
 - c. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed "Or Equal", unless the Owner requires a Special Warranty.
 - d. Contractor will coordinate installation of accepted "Or Equal" into the Work and will be responsible for the costs to make changes as required to the Work.
 - e. Contractor waives rights to claim additional costs caused by proposed "Or Equal" which may subsequently become apparent.

- J. Contractor: Prepare substitution Submittal information.
1. Provide standard Submittal requirements.
 - a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
 2. Provide reason the specified product is not being provided.
 3. Explain the benefits to the Owner for accepting the substitution.
 4. Itemized comparison of the proposed substitution with product specified, including a list of significant variations:
 - a. Design features.
 - b. Design dimensions.
 - c. Installation requirements.
 - d. Operations and maintenance requirements.
 - e. Availability of maintenance services and sources of replacement materials.
 5. Reference projects where the product has been successfully used:
 - a. Name and address of project.
 - b. Year of installation.
 - c. Year placed in operation.
 - d. Name of product installed.
 - e. Point of contact: Name and phone number.
 6. Define impacts:
 - a. Impacts to Contract Price.
 - 1) Required license fees or royalties.
 - 2) Do not include costs under separate contracts.
 - 3) Do not include Engineer's costs for redesign or revision of Contract Documents.
 - b. Impacts to Contract Time.
 - c. Impacts to Contract Scope.
 - d. Impacts to other contracts.
 - e. Impacts to other work or products.
 7. Contractor represents the following:
 - a. Contractor shall pay associated costs for the Engineer to evaluate the substitution.
 - b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
 - c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
 - d. Proposed substitution is equal or superior to the specified product.
 - e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless the Owner requires a Special Warranty.
 - f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
 - g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

1.04 SUBMITTAL IDENTIFICATION NUMBERING

A. Number each Submittal using the format defined in the table below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
<i>Example 1 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial Submittal</i>		
	00_30_30	-	0008		
<i>Example 2 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial Submittal</i>		<i>First revision to the 8th initial Submittal</i>
	00_30_30	-	0008	.	1

1.05 SUBMITTALS IN ELECTRONIC MEDIA FORMAT

- A. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
- B. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
- C. Graphics: Provide graphic Submittals (Drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.06 SUBMITTAL PROCEDURE

- A. Engineer: Review Submittal and provide response:
 - 1. Review description:
 - a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular Submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
 - b. Engineer's review of Submittals shall not release the Contractor from the Contractor's responsibility for performance of requirements of Contract Documents. Neither shall the Engineer's review release the Contractor from fulfilling purpose of installation nor from the Contractor's liability to replace defective Work.
 - c. Engineer's review of Shop Drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
 - d. Engineer's review does not extend to:
 - 1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by the Contractor.

- 2) Contractor's means, methods, techniques, sequences, or procedures, except when specified, indicated on the Drawings, or required by Contract Documents.
 - 3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.
- e. Engineer can Approve or Not Approve any exception at their sole discretion.
- 2. Review timeframe:
 - a. Except as may be provided in technical Specifications, a Submittal will be returned within 30 days.
 - b. When a Submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the Submittal, give notice of the date by which that Submittal will be returned.
 - c. Engineer's acceptance of progress schedule containing Submittal review times less than those specified or agreed to in writing by the Engineer will not constitute Engineer's acceptance of review times.
 - d. Critical Submittals:
 - 1) Contractor will notify Engineer in writing that timely review of a Submittal is critical to the progress of Work.
- 3. Schedule delays:
 - a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of Submittals unless all of the following criteria are met:
 - 1) Engineer has failed to review and return first submission within the agreed upon time frame.
 - 2) Contractor demonstrates that delay in progress of Work is directly attributable to the Engineer's failure to return Submittal within time indicated and accepted by the Engineer.
- 4. Review response will be returned to the Contractor with one of the following dispositions:
 - a. Approved:
 - 1) No Exceptions:
 - a) There are no notations or comments on the Submittal and the Contractor may release the equipment for production.
 - 2) Make Corrections Noted - See Comments:
 - a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
 - b) Resubmittal not required.
 - 3) Make Corrections Noted - Confirm:
 - a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
 - b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
 - b. Not Approved:
 - 1) Correct and Resubmit:
 - a) Contractor may not proceed with the Work described in the Submittal.

- b) Contractor assumes responsibility for proceeding without approval.
 - c) Resubmittal of complete Submittal package is required within 30 calendar days of the date of the Engineer's Submittal review response.
 - 2) Rejected - See Remarks:
 - a) Contractor may not proceed with the Work described in the Submittal.
 - b) Submittal does not meet the intent of the Contract Documents. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.
 - c. Receipt Acknowledged:
 - 1) Filed for Record:
 - a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
 - 2) With Comments - Resubmit:
 - a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.
- B. Contractor: Prepare resubmittal, if applicable:
 - 1. Clearly identify each correction or change made. Provide page references to the changed information within the resubmittal.
 - 2. Include a response in writing to each of the Engineer's comments or questions for Submittal packages that are resubmitted in the order that the comments or questions were presented from the first and subsequent Submittals and numbered consistent with the Engineer's numbering.
 - a. Acceptable responses to the Engineer's comments are listed below:
 - 1) "Incorporated" - Engineer's comment or change is accepted and appropriate changes are made.
 - 2) "Response" - Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by the Engineer.
 - b. Reviews and resubmittals:
 - 1) Contractor shall provide resubmittals which include responses to all Submittal review comments separately and at a level of detail commensurate with each comment.
 - 2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment
 - a) Responses such as "acknowledged" or "noted" are not acceptable.
 - 3) Resubmittals which do not comply with this requirement may be rejected and returned without review.

- 4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant Submittals.
 - 5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.
 - c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for revision and resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.
3. Resubmittal timeframe:
 - a. Contractor shall provide resubmittal within 15 days.
 - b. When a resubmittal cannot be returned within the specified period, Contractor shall notify the Engineer in writing.
4. Review costs:
 - a. Costs incurred by the Owner as a result of additional reviews of a particular Submittal after the second time it has been reviewed shall be borne by the Contractor.
 - b. Reimbursement to the Owner will be made by deducting such costs from the Contractor's subsequent progress payments.

1.07 PRODUCT DATA

- A. Edit Submittals so that the Submittal specifically applies to only the product furnished.
- B. Neatly cross out all extraneous text, options, models, etc., that do not apply to the product being furnished so that the information remaining is only applicable to the product being furnished.

1.08 SHOP DRAWINGS

- A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of Shop Drawings.
- B. Indicate project-designated equipment tag numbers for Submittal of devices, equipment, and assemblies.

1.09 SAMPLES

- A. Details:
 1. Submit labeled samples.
 2. Samples will not be returned.
 3. Provide number of sample Submittals as below:
 - a. Total: 2 minimum.
 - 1) Owner: 1.
 - 2) Engineer: 2.
 - 3) Contractor: None.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - CONTRACTOR SUBMITTAL TRANSMITTAL FORM

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	Date:	MM/DD/YYYY
Contractor:	Click here to enter text.	Project No.:	XXXXX.XX
Project Name:	Click here to enter text.	Submittal Number:	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal/Equipment Supplier			
Spec ##:	Spec ##.	Subject:	Click here to enter text.
Authored By:	Click here to enter text.		Date Submitted: XX/XX/XXXX

Submittal Certification	
Check Either (A) or (B):	
☐ (A)	We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings with no exceptions.
☐ (B)	We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings, except for the deviations listed.
Certification Statement: By this Submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved Shop Drawings and all Contract requirements.	
General Contractor's Reviewer's Signature:	
Printed Name:	

PM/CM Office Use	
Date Received GC to PM/CM:	Click here to enter text.
Date Received PM/CM to Reviewer:	Click here to enter text.
Date Received Reviewer to PM/CM:	Click here to enter text.
Date Sent PM/CM to GC:	Click here to enter text.

SECTION 01_45_00

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Quality control and control of installation.
 - 2. Tolerances.
 - 3. References.
 - 4. Mock-up requirements.
 - 5. Authority and duties of Owner's representative or inspector.
 - 6. Sampling and testing.
 - 7. Testing and inspection services.
 - 8. Contractor's responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. When specified, products will be tested and inspected either at point of origin or at Work site:
 - 1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
 - 2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.
- I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

- A. ASTM International (ASTM):
 - 1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.
- B. National Institute of Standards and Technology (NIST).

1.05 PRODUCT REQUIREMENTS

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 MOCK-UP REQUIREMENTS

- A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be comparison standard for remaining Work.
- D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

- A. Owner's Project Representative employed or retained by Owner is authorized to inspect the Work.

- B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.
- C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.
- D. Inspector will not:
 - 1. Alter or waive provisions of Contract Documents.
 - 2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
 - 3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.
- E. Inspector will:
 - 1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
 - 2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.08 SAMPLING AND TESTING

- A. General:
 - 1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
 - 2. When specified in sections where products are specified:
 - a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
 - b. Test materials in accordance with standards of national technical organizations.
- B. Sampling:
 - 1. Furnish specimens of materials when requested.
 - 2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
 - 3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
 - 4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.09 TESTING AND INSPECTION SERVICES

- A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

- B. Engineer will employ and pay for specified services of an independent testing firm certified to perform testing and inspection as required in the technical specifications for various work and materials to confirm Contractor's compliance with Contract Documents.
- C. The Engineer's independent testing firm will perform tests, inspections and other services specified in individual specification sections.
- D. The qualifications of laboratory that will perform the testing, contracted by the Engineer or by the Contractor, shall be as follows:
 - 1. Has authorization to operate in the state where the project is located.
 - 2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
 - 3. Meets requirements of ASTM E329.
 - 4. Laboratory Staff: Maintain full time specialist on staff to review services.
 - 5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to NIST or accepted values of natural physical constants.
 - 6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NIST during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
- E. Testing, inspections, and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.
- F. Contractor shall cooperate with Engineer's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Engineer's independent testing firm 48 hours prior to expected time for operations requiring testing.
 - 2. Make arrangements with Engineer's independent testing firm and pay for additional samples and tests required for Contractor's use.
- G. Limitations of authority of testing Laboratory: Engineer's independent testing firm or Laboratory is not authorized to:
 - 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency or laboratory may not approve or accept any portion of the Work.
 - 3. Agency or laboratory may not assume duties of Contractor.
 - 4. Agency or laboratory has no authority to stop the Work.
- H. Testing and employment of an Engineer's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Engineer's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

- J. The Engineer's independent testing firm responsibilities will include:
 - 1. Test samples of mixes submitted by Contractor.
 - 2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
 - 6. Perform additional tests required by Engineer.
 - 7. Attend preconstruction meetings and progress meetings when requested.
- K. Engineer's independent testing firm individual test reports:
 - 1. After each test, Engineer's independent testing firm will promptly submit electronically report to Engineer and to Contractor.
 - 2. Test reports shall include at least the following information:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in Project.
 - g. Type of inspection or test.
 - h. Date of test.
 - i. Certified test results stamped and signed by a registered Engineer in the state where the project is located.
 - j. Summary of conformance with Contract Documents.
 - k. When requested by Engineer, the Engineer's independent testing firm will provide interpretation of test results.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with Engineer's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.
- B. Secure and deliver to Engineer's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.
- C. Provide to Engineer's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.
- D. Submit product test reports electronically.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to construction to be tested.
 - 2. To obtain and handle samples at Work site or at source of product to be tested.

3. To facilitate inspections and tests.
 4. For storage and curing of test samples.
- F. Notify Engineer's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_17
CONTRACTOR QUALITY CONTROL PLAN

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Contractor Quality Control Plan.

1.02 SUBMITTALS

- A. Qualifications of the Contractor's Quality Control (CQC) Plan Manager.
- B. Contractor's Daily Quality Control Report:
 - 1. Submit to Engineer within 1 day of completion of each inspection using the approved form.
- C. Daily Inspection Report:
 - 1. Submit to Engineer at the end of each working day or no later than prior to the beginning of the next working day using the approved form.

1.03 CONTRACTOR'S INSPECTION OF THE WORK

- A. Work performed by Contractor shall be inspected by the Contractor's CQC Plan Manager. Non-conforming Work and any safety hazards in the Work area shall be noted and promptly corrected.
- B. No materials or equipment shall be used in Work without inspection and acceptance by Contractor's CQC Plan Manager.

1.04 QUALIFICATIONS

- A. Contractor's CQC Plan Manager: Demonstrate having performed similar CQC functions on similar type projects. Submit records of personnel experience, training, and qualifying registrations.
- B. Minimum qualifications: Candidate must have a minimum of 10 years of experience on projects of similar type and size.

1.05 COVERING WORK

- A. Whenever Contractor intends to backfill, bury, cast in concrete, or otherwise cover any Work, notify Engineer not less than 24 hours in advance to request inspection before beginning any such Work of covering. Failure of Contractor to notify Engineer in accordance with this requirement shall be resolved according to Article 14 of the General Conditions.

1.06 CONTRACTOR'S QUALITY CONTROL PROGRAM

- A. General: Establish and execute a Quality Control (CQC) Plan for Work. The plan shall establish adequate measures for verification and conformance to defined requirements by Contractor personnel and lower-tier Subcontractors (including Fabricators, Suppliers, and Subcontractors). This program shall be described in a Plan responsive to this Section.
- B. CQC personnel:
 - 1. Contractor's CQC Plan Manager shall report to a Senior Project Manager of the Contractor and shall have no supervisory or managerial responsibility over the workforce.
 - 2. The Contractor CQC Plan Manager shall be on-site as often as necessary, but not less than the daily working hours specified in the Contract Documents to remedy and demonstrate that Work is being performed properly and to make multiple observations of Work in progress.
 - 3. The Contractor is to furnish personnel with assigned CQC functions reporting to the CQC Manager. Persons performing CQC functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.
- C. CQC Plan:
 - 1. Contractor's CQC Plan shall include a statement by the Senior Project Manager designating the CQC Plan Manager and specifying the authority delegated to the CQC Plan Manager to direct cessation or removal and replacement of defective Work.
 - 2. Describe the CQC program and include procedures, work instructions, and records. Describe methods relating to areas that require special testing and procedures as required by the specifications.
 - 3. Include specific instructions defining procedures for observing Work in process and comparing this Work with the Contract requirements (organized by specifications section).
 - 4. Describe procedures to ensure that equipment or materials that have been accepted at the Site are properly stored, identified, installed, and tested.
 - 5. Include procedures to verify that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier Suppliers and/or Subcontractors.
 - 6. Commissioning quality control: Include procedures to verify that the commissioning requirements of the Contract Documents are integrated into the Contractor's CQC Plan and conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to the Contractor and the lower-tier Suppliers and/or Subcontractors.
 - 7. Include instructions for recording inspections and requirements for demonstrating through the Daily Inspection Reports that Work inspected was in compliance or a deficiency was noted and action to be taken.
 - 8. Procedures to preclude the covering of deficient or rejected Work.
 - 9. Procedures for halting or rejecting Work.

10. Procedures for resolution of differences between the CQC Plan Manager and the production personnel.
 11. Identify contractual hold/inspection points as well as any Contractor-imposed hold/inspection points.
- D. Daily Inspection Report: Include, at a minimum:
1. Inspection of specific work.
 2. Quality characteristics in compliance.
 3. Quality characteristics not in compliance.
 4. Corrective/remedial actions taken.
 5. Statement of certification.
 6. CQC Manager's signature, electronic signature is acceptable.
 7. Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents.
- E. Deficient and Non-conforming Work and Corrective Action: Include procedures for handling deficiencies and non-conforming Work. Deficiencies and non-conforming Work are defined as documentation, drawings, material, equipment, or Work not conforming to the indicated requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent reoccurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documents and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
1. Personnel responsible for identifying deficient and non-complying items within Work.
 2. How and by whom deficient and non-compliant items are documented "in the field."
 3. The personnel and process utilized for logging deficient and non-compliant Work at the end of each day onto a deficiency log.
 4. Tracking processes and tracking documentation for deficient and non-conforming Work.
 5. Personnel responsible for achieving resolution of outstanding deficiencies.
 6. Include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
- F. Audits: The CQC program shall provide for regularly scheduled documented audits to verify that CQC procedures are being fully implemented by Contractor and its Subcontractors. Audit records shall be made available to Engineer upon request.
- G. Documented control/quality records:
1. Establish methods for control of Contract Documents that describe how Drawings and Specifications are received and distributed to ensure the correct issue of the document being used. Describe how record document/drawing data are documented and furnished to Engineer.
 2. Maintain evidence of activities affecting quality. Including operating logs, records of inspection, audit reports, personnel qualification and certification records, procedures, and document review records.

3. Maintain quality records in a manner that provides for timely retrieval and traceability. Protect quality records from deterioration, damage and destruction.
 4. Develop a list of specific records as required by the Contract Documents that will be furnished to Engineer at the completion of activities.
- H. Acceptance of CQC Plan: Engineer's acceptance of the CQC Plan shall not relieve Contractor from any of its obligations for performance of Work. Contractor's CQC staffing is subject to Engineer's review and continued acceptance. Owner, at its sole discretion, and without cause, may direct Contractor to remove and replace the CQC Plan Manager.
1. Acceptance of the CQC Plan by the Engineer is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
 2. After acceptance of the CQC Plan, notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_50_00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

- A. American National Standards Institute (ANSI).
- B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

- A. Temporary electrical power:
 - 1. Arrange with local utility to provide adequate temporary electrical service.
 - 2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
 - 3. Provide, maintain, and pay for electric power for performance of the Work.
- B. Temporary electrical lighting:
 - 1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
 - 2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
 - a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.
- C. Temporary heating, cooling, and ventilating:
 - 1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
 - 2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.
- D. Temporary water:
 - 1. Utilize City of Arvada hydrants for temporary construction water.
 - a. Contractor will obtain a hydrant permit from the City of Arvada.

- b. Contractor will be responsible for paying the hydrant meter deposit, but will not be charged for the water usage.
 - c. Contractor will be required to transport water from City of Arvada hydrant locations to locations throughout the project that are not near a City of Arvada hydrant.
- 2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
- E. Temporary sanitary facilities:
 - 1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
 - 2. Existing facility use is not allowed.
 - 3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.
- F. Temporary fire protection:
 - 1. Provide fire protection required to protect the Work and ancillary facilities.
- G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.
- H. Utilities in existing facilities: As specified in Section 01_14_00 - Work Restrictions.

1.05 CONSTRUCTION AIDS

- A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
- B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.
- C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
 - 1. When requested, submit design calculations by professional registered engineer prior to application of loads.
 - 2. Submitted design calculations are for information and record purposes only.
- D. Accident prevention:
 - 1. Exercise precautions throughout construction for protection of persons and property.
 - 2. Observe safety provisions of applicable Laws and Regulations.
 - 3. Guard machinery and equipment and eliminate other hazards.
 - 4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
 - 5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.
- E. Barricades:
 - 1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
 - 2. Provide barriers with flashing lights after dark.

3. Keep barriers in place until excavations are entirely backfilled and compacted.
 4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.
- F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
1. Provide devices in accordance with minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- G. Hazards in public right-of-way:
1. Comply with local jurisdiction standards and requirements for right-of-way barricades and other safety devices.
 2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
 - a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
 3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
 - a. During hours of darkness, provide warning lights at close intervals.
- H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
- I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.
- K. Fences:
1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence, and vandalism.
 2. Enclose temporary offices and storage areas with fence adequate to protect temporary facilities against acts of theft, violence, and vandalism.
 3. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to Substantial Completion.
 4. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
 - a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.

5. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
6. Fence temporary openings when openings are no longer necessary.

1.06 SECURITY

- A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

- A. General:
 1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
 2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.
- B. Off-site access roads:
 1. Build and maintain graded earth roads.
 2. Build roads only in public right-of-way or easements obtained by Owner.
 3. Obtain rights-of-way or easements when electing to build along other alignment.
- C. On-site access roads:
 1. Maintain access roads to storage areas and other areas to which frequent access is required.
 2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
 3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
 4. Maintain on-site access roads free of mud.
 5. Provide controls to prevent vehicles leaving the site from tracking mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

- A. Dust control:
 1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
 2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.
- B. Noise control:
 1. Comply with noise and work hours regulations by local jurisdiction.
 2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
 3. In residential areas, take special measures to suppress noise during night hours.

- C. Mud control:
 - 1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

- A. Provide and maintain a portable Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 6-foot long, 4 by 4 lumber posts, set on a stable and portable base, with exhibit lettering by professional sign painter using no more than 5 sign colors:
 - 1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
 - 2. Identify Contractor's, Engineer's, names in upper right-hand corner underneath the bid number.
- B. On third and fourth lines of printing, paint appropriate dollar amounts.
- C. Erect Project identification sign where directed by Engineer within 14 days after the issuance of the Notice to Proceed.
- D. Replace or repair the project sign if it is damaged or covered with graffiti within 2 working days of observation or notification of damage or graffiti.

1.10 CONTRACTOR FIELD OFFICES AND SHEDS

- A. If a proper location can be found, maintain on Project Site weather tight space in which to hold progress meetings, keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
 - 1. If a proper location cannot be found, meetings will be held at Arvada City Hall or via video call.

1.11 REMOVAL

- A. Remove temporary facilities and controls before inspection for Substantial Completion or when directed.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.
- D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_55_26

TRAFFIC CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Traffic control shall be per Colorado Department of Transportation (CDOT) Standard Specifications Section 630 - Construction Zone Traffic Control.

1.02 SUBMITTALS

- A. Submit traffic control for CDOT, City of Arvada, and City of Westminster approvals.
- B. Approved and signed copies of:
 - 1. Traffic control plan (TCP) and other CDOT required traffic control permits and measures.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_60_01

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements for products.

1.02 TERMINOLOGY

- A. The words and terms listed below, are not defined terms that require initial capital letters, but, when this Section is referenced in other Specifications, have the indicated meaning.
1. Manufacturer's Certificate of Source Testing:
 - a. Form used to confirm that the applicable source tests have been performed and the results conform to the Contract Documents. Form template is provided at the end of this Section.
 2. Manufacturer's instructions:
 - a. Stipulations, directions, and/or recommendations issued by the manufacturer of the product addressing handling, storage, installation, protection, erection, and/or application of the product.
 3. Product data:
 - a. Information about the product, typically found in the manufacturer's catalogs specifications or other resources, including data sheets, bulletins, and brochures.
 4. Source Quality Control:
 - a. Testing and inspections at the location of fabrication or assembly.
 - 1) Includes factory acceptance testing (FAT), factory testing, and Source Testing.
 - b. Test reports, including the following information:
 - 1) Test description.
 - 2) List of equipment used.
 - 3) Name of the person conducting the test.
 - 4) Date and time the test was conducted.
 - 5) Ambient temperature and weather conditions.
 - 6) Raw data collected.
 - 7) Calculated results.
 - 8) Clear statement if the test passed or failed the requirements stated in the Contract Documents.
 - 9) Signature of the person responsible for the test.
 5. Special tools:
 - a. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.03 QUALITY CONTROL

- A. Manufacturer shall provide a permanent quality control department and laboratory facility capable of performing inspections and testing as required by the Contract Documents.
 - 1. Material testing, inspection procedures, and manufacturing process are subject to inspection by the Engineer.
 - 2. Notify the Engineer in writing of the manufacturing start date, not less than 14 days prior to the start, of the manufacturer of project pipe.
 - 3. Perform manufacturer's tests and inspections required by the referenced standards and as specified in this Section, including the following:
 - a. Calibration within last 12 months for equipment such as scales, measuring devices and calibration tools used in the manufacturing of pipe as required by ISO 9001.
 - 1) Each device used in the manufacturer of pipe is required to have a tag recording date of last calibration.
 - 2) Provide calibration certificate.
 - 3) Devices are subject to inspection by the Engineer.
 - 4. Provide Manufacturer's Certificate of Source Testing.

1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVES

- A. Qualifications of manufacturer's representative include the following:
 - 1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications and installation of respective products with full authority by the product manufacturer to issue the certifications required of the manufacturer.
 - 2. Competent, experienced technical representative of the product manufacturer for installation.
 - 3. Additional qualifications may be specified in the Technical Sections.
 - 4. No substitute representatives will be allowed until written approval by the Owner and Engineer has been obtained.
- B. Completion of manufacturer on-site services: Engineer approval required.
 - 1. Manufacturer's representative will advise aspects of installation, including, but not limited to:
 - a. Handling.
 - b. Storing.
 - c. Cleaning and inspecting.
 - d. Coating and lining repairs.
 - e. Tapping.
 - f. General construction methods.
- C. Manufacturer is responsible for determining the time required to perform the specified services.
 - 1. No additional costs associated with performing the required services will be approved.
 - 2. Manufacturer required to schedule services in accordance with the Contractor's Project schedule, up to and including making multiple trips to the Project Site when there are separate milestones associated with installation of each occurrence of the manufacturer's product.

- D. Manufacturer's on-site services include the following:
 - 1. Assistance during construction.
 - 2. Provide 1 copy of daily manufacturer's representative's field notes and data to the Engineer.
 - 3. Other requirements as specified in the Contract Documents.

1.05 GENERAL TEST REQUIREMENTS

- A. Testing prerequisites:
 - 1. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.
- B. Test Plan requirements:
 - 1. As specified in this Section and the Technical Sections.
 - 2. Prepared by the Contractor as a result of discussions and planning emerging from regularly conducted meetings for test planning.
 - 3. Define the following for each test:
 - a. Purpose of the test.
 - b. Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.
 - c. Description of the pass/fail criteria that will be used.
 - d. Listing of pertinent reference documents (Contract Documents or industry standards applicable to the testing).
 - e. Credentials of test personnel.
 - f. Test equipment:
 - 1) Product data.
 - 2) Appropriate calibration records.
 - 3) Drawings or photographs of test stands and/or test apparatus.
 - g. Duration: Determine test durations with the Owner's input.
 - h. Detailed step-by-step test procedures.
 - 1) Setup.
 - 2) Level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and develop confidence that the tests were being performed as planned.
 - 3) Include all steps in the procedures.
 - 4) Define temporary systems (pumps, piping, etc.), shutdown requirements for existing systems.
 - 5) Furnish labor, power, tools, equipment, instruments, and services required for and incidental to completing testing activities.
 - i. Test forms: Include, but not limited to, the following information:
 - 1) Name of product to be tested.
 - 2) Test date.
 - 3) Names of persons conducting the test.
 - 4) Names of persons witnessing the test, where applicable.
 - 5) Test data.
 - 6) Applicable Project requirements.
 - 7) Check offs for each completed test or test step.
 - 8) Place for signature of person conducting tests and for the witnessing person, as applicable.

- C. Submit Test Plan.
 - 1. Submit forms as specified in the Technical Sections.
 - 2. Submit a copy of the Test Plan at least 21 days before any scheduled test date.
 - 3. Engineer approval of Test Plan required prior to beginning testing.
- D. Request proposed test dates.
 - 1. Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.
- E. Implement approved Test Plans.
 - 1. Demonstrate the product performance meets the requirements stated in the Contract Documents.
 - a. When the product fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.
- F. Submit Test Report.

1.06 SOURCE TESTING

- A. As specified in Section 01_45_00 - Quality Control.
- B. Also referred to as factory testing or factory acceptance testing (FAT).
- C. Source Test Plan:
 - 1. As specified in this Section and other Technical Sections.
 - 2. Purpose: Test products for proper performance at point of manufacture or assembly as specified in the Technical Sections.
 - 3. Source Testing requirements as specified in Technical Sections.
 - a. Non-witnessed:
 - 1) Provide completed Attachment A - Manufacturer's Certificate of Source Testing.
 - b. Witnessed:
 - 1) 2 Owner's representatives and 2 Engineer's representatives present during testing, unless otherwise specified.
 - 2) Provide completed Attachment A - Manufacturer's Certificate of Source Testing.
 - 4. Duration: Define.
 - 5. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.
- D. Contractor is responsible for witness trip costs associated with the Owner's and Engineer's representatives.
 - 1. Include costs for at least the following:
 - a. Transportation:
 - 1) Travel on commercial airline to and from site including related fees.
 - 2) Rental car to and from airport, hotel, and test site, including related fees.

- b. Hotel/meals:
 - 1) Hotel costs at a facility with an American Automobile Association 4-star rating or higher equivalent for single occupancy room per person per day.
 - 2) Meal allowance based on government per diem guidelines per location.
- c. Witness labor costs:
 - 1) The greater of \$200 per hour or \$1,600 per day.
- 2. If the Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with the Contractor responsible for costs associated with the trip, including costs described above.
 - a. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip, including costs described above.
 - b. Contractor is responsible for witnesses' costs associated with retests, including costs described above.

1.07 INSTALLATION VERIFICATION

- A. Installation Verification plan:
 - 1. Confirm piping:
 - a. Has been properly installed, adjusted, and aligned.
 - b. Is free of any stresses imposed by connecting piping or anchor bolts.
 - c. Is able to be operated as necessary for Functional Testing.
 - 2. Field test backfill, welded joints, alignment and grade, and pipeline pressure as specified in the Technical Sections.
 - 3. Duration: Define.
 - 4. Coordinate Installation Verification with restrictions and requirements as specified in Section 01_14_00 - Work Restrictions.

1.08 FUNCTIONAL TESTING

- A. Functional Test Plan:
 - 1. Purpose: Test piping system to verify conformance with the Contract Documents.
 - 2. Perform testing in the presence of the Engineer.
 - 3. Contractor is responsible for providing fuel, chemicals, and other consumables needed.
 - 4. Coordinate Functional Testing with restrictions and requirements as specified in Section 33_05_00.09 – Piping Systems Testing and 01_14_00 - Work Restrictions.

1.09 SHIPMENT

- A. Prepare products for shipment by:
 - 1. Tagging or marking to match the Shop Drawings or Contract Documents.
 - 2. Including complete packing lists and bills of material with each shipment.
 - 3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
 - 4. Securely attach special instructions for proper field handling, storage, and installation before packaging and shipment.

- B. Transport products by methods that avoid product damage.
- C. Deliver products in undamaged condition in the manufacturer's unopened packaging.

1.10 DELIVERY AND HANDLING

- A. Handle products in accordance with the manufacturer's instructions.
- B. Deliver products in undamaged condition in the manufacturer's unopened packaging.
- C. Provide construction equipment and personnel to handle products by methods in accordance with the manufacturer's instructions.
- D. Upon delivery, promptly inspect shipments:
 - 1. Verify compliance with the Contract Documents, correct quantities, and undamaged condition of products.
 - 2. Acceptance of shipment does not constitute final acceptance of products.

1.11 STORAGE

- A. Immediately store and protect products until installed in the Work.
- B. Store products with seals and legible labels intact.
- C. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.
- D. Storage of spare parts, maintenance products, special tools.
 - 1. Immediately store in accordance with the manufacturer's instructions.
 - 2. Store spare parts, maintenance products, and special tools in an enclosed, weather-proof, and lighted facility during the construction period.
 - 3. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
 - 4. Store large items individually:
 - a. Weight: Greater than 50 pounds.
 - b. Size: Greater than 24-inches wide by 18-inches high by 36-inches long.
 - c. Clearly labeled:
 - 1) Equipment tag number.
 - 2) Equipment manufacturer.
 - 3) Subassembly component, if appropriate.
 - 5. Store smaller items in spare parts boxes:
 - a. Weight: Less than 50 pounds.
 - b. Size: Less than 24-inches wide by 18-inches high by 36-inches long.
 - c. Clearly labeled:
 - 1) Equipment tag number.
 - 2) Equipment manufacturer.
 - 3) Subassembly component, if appropriate.
 - 6. Spare parts and special tools box:
 - a. Box material: Waterproof, corrosion resistant.
 - b. Hinged cover with locking hasp:
 - 1) Inventory list taped to underside of cover.

- 2) Clearly labeled:
 - a) "Spare Parts and/or Special Tools".
 - b) Equipment tag number.
 - c) Equipment manufacturer.
 - d) Subassembly component, if appropriate.
- E. Exterior storage of fabricated products:
 - 1. Place on aboveground supports that allow for drainage.
 - 2. Cover products subject to deterioration with impervious sheet covering.
 - 3. Provide ventilation to prevent condensation under covering.
- F. Store moisture sensitive products in watertight enclosures.
- G. Store loose granular materials on solid surfaces in well-drained area.
 - 1. Prevent materials mixing with foreign matter.
 - 2. Provide access for inspection.
- H. When needed and approved by the Engineer, offsite storage location shall be within 20 miles of the Project Site.
 - 1. Provide proof of insurance coverage for products stored offsite.
- I. Payment will not be made for products improperly stored or stored without providing the Engineer with the manufacturer's instructions for storage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide products by the same manufacturer when units are of similar nature, unless otherwise specified.
- B. Provide like parts of duplicate units that are interchangeable.
- C. Provide equipment or products that have not been in service prior to delivery, except as required by tests.
- D. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
 - 1. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- E. Provide products produced by manufacturers regularly engaged in the production of these products.
- F. Provide products that bear approvals and labels as specified such as Factory Mutual (FM), Underwriters Laboratory (UL), or National Sanitation Foundation (NSF International) that are acceptable to the Authority Having Jurisdiction.

2.02 MATERIAL

- A. Dissimilar metals:
 - 1. Separate contacting surfaces with dielectric material.
 - 2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, washers, petrolatum tape, or other materials as specified.
 - 3. Dielectric coatings can be used to separate dissimilar metal couples from surrounding environment if isolation of metals is not possible, with approval of the Engineer.
- B. Edge grinding:
 - 1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence and mitigate any safety hazard.
 - 2. A surface profile will need to be re-established for coating adherence based on coating manufacturer's profile requirements.
- C. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.
- D. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.
- E. Aluminum in contact with concrete or masonry: Apply epoxy mastic.
- F. Pipes:
 - 1. Piping provided from manufacturers/distributors inventory is subject to the following condition:
 - a. Provide proof pipe manufactured more than 6 months prior to delivery was stored properly and the material and/or coating was not subjected to ultraviolet (UV) degradation.
 - 2. Mark each length of pipe in accordance with applicable standards.

2.03 PRODUCT SELECTION

- A. When products are specified without named manufacturers, provide products that meet or exceed the Specifications.
- B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide products by one of the named manufacturers that meet or exceed specifications.
- C. When products are specified with names of manufacturers and model numbers or catalog designations, provide products with model numbers or catalog designations by one of the named manufacturers.
- D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
 - 1. Products specified by brand or trade name, model number, or catalog designation.

2. Products by another named manufacturer proven, in accordance with requirements for an "or equal", including the Engineer's approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
- E. When products are specified with only one manufacturer followed by "or equal," provide:
 1. Products meeting or exceeding specifications by specified manufacturer.
 2. Engineer deemed "or equal" evidenced by an approved Shop Drawing or other written communication.
 - F. When products are specified by naming 2 or more manufacturers with 1 manufacturer as a "Basis of Design":
 1. Any of the named manufacturers can be submitted.
 2. If the product submitted is not by the named "Basis of Design" product and requires a change in the scope (dimensions, configuration, physical properties, etc.), schedule (longer lead time), or budget, the Contractor must submit a substitution request.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Inspect equipment or products prior to installation.
- B. Repaint or recoat damaged painted or coated surfaces after installation.
- C. Use anti-galling compound on stainless steel threads used for field assembly.

3.02 PROTECTION AFTER INSTALLATION

- A. Provide coverings as necessary to protect installed products from damage from due to traffic and subsequent construction operations.
 1. Remove covering when no longer needed.
 2. Replace corroded, damaged, or deteriorated products before acceptance of the Project.

END OF SECTION

ATTACHMENT A - MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

I hereby certify Source Testing has been performed on the above-referenced product as defined in the Contract Documents, and the results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

(Authorized Signature)

If applicable, Witness Name (*print*): _____

(Witness Signature)

SECTION 01_71_23
FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

- A. Field surveying shall be per Colorado Department of Transportation (CDOT) Standard Specification Section 625 - Construction Surveying.
 - 1. Contractor shall use a construction surveyor that is approved by CDOT and shall keep records of survey and as-built drawings as required by CDOT.

1.02 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures and CDOT requirements.
- B. Qualifications of the professional land surveyor or licensed civil engineer with the authority to provide land surveying in Colorado, and has CDOT approval, that will be performing the field engineering.
- C. Submit final road, pipe invert, rim elevation, manhole inverts, and horizontal and vertical coordinates of all surface features survey as-built drawings to the Owner per City of Arvada Standards and Specifications Section 200.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_77_00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

1. Provide project closeout per City of Arvada Standards and Specifications Section 200.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_78_36
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

- A. Provide warranty and bond per Contract Documents and City of Arvada Specification Section 200.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_81_50

DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Project design criteria such as temperature and site elevation.

1.02 PROJECT DESIGN CRITERIA

- A. All equipment and materials for the project are to be suitable for performance in a domestic wastewater environment and under following conditions:
1. Design temperatures are:
 - a. Outdoor temperatures: -15 to 105 degrees Fahrenheit.
 - b. Wastewater Temperatures: 35 to 85 degrees Fahrenheit.
 2. Design groundwater elevation: See project geotechnical report.
 3. Freeze-thaw conditions.
 4. Relative Humidities: 0 to 100 percent.
 5. Site elevation: Approximately 5,157 to 5,194 feet above mean sea level.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 03_21_17

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

- A. American Concrete Institute (ACI).
 - 1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.
- B. American National Standards Institute (ANSI):
 - 1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.
- C. ASTM international (ASTM):
 - 1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- D. Concrete Reinforcing Steel Institute (CRSI).
- E. ICC Evaluation Service, Inc. (ICC-ES):
 - 1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- F. Society for Protective Coatings (SSPC):
 - 1. SP 1 - Solvent Cleaning.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. Evaluation Service Report (ESR): Report prepared by ICC-ES or other testing agency acceptable to the Engineer and to the building official that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES acceptance criteria, and to document its acceptance for use under the building code specified by City of Arvada and City of Westminster requirements.

1.04 SUBMITTALS

- A. Product data: Technical data for adhesives, including:
 - 1. Manufacturer's printed installation instructions (MPII).
 - 2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
 - 3. Handling and storage instructions.
- B. Quality Control Submittals:
 - 1. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of ICC-ES AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
 - 2. Installer qualifications:
 - a. Submit evidence of successful completion of the adhesive manufacturer's installation training program.
 - b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.
- C. Inspection and testing reports:
 - 1. Inspections: Field quality control: Reports of inspections and tests.
 - a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installation requirements:
 - a. Have available at the Site and install anchors in accordance with the adhesive MPII.
 - 2. Installer qualifications:
 - a. Demonstrating successful completion of the adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
 - b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the building official.
 - 1) Organizations/certification programs deemed to be qualified are:
 - a) ACI-CRSI Adhesive Anchor Installer Certification Program.
 - b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the building official.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
 - 1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.

2. Control temperature to maintain storage within the manufacturer's recommended temperature range.
 - a. If products have been stored at temperatures outside the manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

- A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.
- B. Adhesives shall have a current Evaluation Report documenting testing and compliance in accordance with ACI 355.4 and ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the seismic design category specified.
- C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

2.02 EPOXY ADHESIVE

- A. Materials:
 1. In accordance with the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C, depending on Site conditions.
 2. 2-component, 100 percent solids, insensitive to moisture.
 3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.
- B. Packaging:
 1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through the manufacturer's static mixing nozzle.
 - a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into the prepared hole.
 - b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
 2. Container markings: Include the manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

- C. Manufacturers: One of the following or equal:
 - 1. Hilti, Inc., HIT-RE 500-V3.
 - 2. Simpson Strong-Tie Co., Inc., SET-3G.

2.03 ALL THREAD RODS

- A. All thread rods:
 - 1. Carbon steel:
 - a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
 - b. High strength all thread rods: In accordance with ASTM F1554, Grade 55.
 - c. Nuts: ASTM A194.
 - d. Washers: ASTM F436.
 - 2. Galvanized carbon steel:
 - a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
 - b. High strength galvanized all thread rods: In accordance with ASTM F1554, Grade 55, and galvanized in accordance with ASTM F2329.
 - c. Nuts: ASTM A194; hot-dip galvanized in accordance with ASTM A153.
 - d. Washers: ASTM F436; hot-dip galvanized in accordance with ASTM A153.

2.04 REINFORCING BARS

- A. As specified in Section 03_30_01 - Concrete Work.

PART 3 EXECUTION

3.01 GENERAL

- A. Execution of this Work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under the Quality Assurance article and accepted by the Engineer and the building official.
 - 1. Do not install holes or adhesive until training is complete.
- B. Perform Work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.
- C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
 - 1. If embedment depth is not indicated, contact the Engineer for requirements.
 - 2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by the Engineer.

3.02 PREPARATION

- A. Do not begin installation of adhesive bonded anchors until:
 - 1. Concrete has achieved an age of at least 21 days after placement.
 - 2. On-site training in installation of adhesive bonded anchors by the manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.
- B. Review the MPII and "Conditions of Use" stipulated in the Evaluation Report before beginning work.
 - 1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.
- C. Install adhesive bonded anchors in full compliance with the MPII using personnel who have successfully completed the manufacturer's on-site training for products to be used and who hold certifications specified in this Section.
- D. Confirm that adhesive and substrate receiving adhesive are within the manufacturer's recommended range for temperature and moisture conditions and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

- A. Drilling holes:
 - 1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
 - 2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by the Engineer.
- B. Hole-drilling equipment:
 - 1. Electric or pneumatic rotary impact type with medium or light impact.
 - a. Installation of anchors in cored holes is not permitted.
 - b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
 - c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
 - 2. Drill bits: Carbide-tipped in accordance with ANSI B212-15, unless otherwise recommended by the manufacturer or required as a condition of use in the Evaluation Report.
 - a. Hollow drill bits with flushing air systems are preferred. Air supplied to drill bits shall be free of oil, water, or other contaminants that will reduce bond.
- C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.
- D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.

- E. Obstructions in drill path:
1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by the Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
 - a. Obtain the Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
 - b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
 - c. Epoxy grout may be substituted for dry-pack mortar when accepted by the Engineer.
 2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
 3. When existing reinforcing steel is encountered during drilling and when specifically accepted by the Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
 4. Bent bar reinforcing bars: Where edge distances are critical and interference with existing reinforcing steel is likely, if acceptable to the Engineer, drill hole at 10-degree (or less) angle from axis of reinforcing bar or all thread rod being installed.
- F. Cleaning holes:
1. Insert air nozzle to bottom of hole and blow out loose dust.
 - a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
 - b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
 2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
 - a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
 - b. Repeat at least 4 times.
 3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
 4. Leave prepared holes clean and dry.
 5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
 6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

- A. Clean and prepare inserts reinforcing bars and all thread rods:
1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.

2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC-SP 1. Provide an oil and grease free surface for bonding of adhesive to steel.
- B. Fill holes with adhesive:
1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
 2. Fill hole as nozzle is withdrawn without creating air voids.
 3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
 4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.
- C. Installing reinforcing bars and all thread rods.
1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
 2. Insert reinforcing bars and all thread rods into adhesive in accordance with the manufacturer's recommended procedures.
 3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
 4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
 5. Clean excess adhesive from the mouth of the hole.
- D. Curing and loading.
1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
 2. Do not disturb or load bonded embeds until the manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

- A. Do not bend bars or all thread rods after bonding to the concrete, unless accepted in advance by the Engineer.
- B. Attachments to all thread rods:
1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
 2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

- A. Provide field quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.

- B. Do not allow Work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.
- C. Manufacturer's services:
 - 1. Before beginning installation, adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
 - a. Provide notice of scheduled training to the Engineer and to special inspector(s) not less than 10 working days before training occurs. Engineer and special inspector may attend training sessions.
 - 2. Submit record, signed by the manufacturer's technical representative, listing the Contractor's personnel who completed the training. Only qualified personnel who have completed the manufacturer's on-site training shall perform installations.
- D. Field inspections and testing:
 - 1. Hole drilling and preparation.
 - 2. Results: Submit records of inspections and testing to the Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

- A. Provide field quality assurance over the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Special inspections, special tests, and structural observation:
 - 1. Frequency of inspections:
 - a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
 - b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
 - 2. Preparation:
 - a. Review Drawings and Specifications for the Work to be observed.
 - b. Review the adhesive manufacturer's MPII and recommended installation procedures.
 - c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
 - 3. Inspection: Periodic:
 - a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
 - 1) Concrete: Class (minimum specified compressive strength) and thickness.

- 2) Environment: Temperature conditions at the work area and moisture conditions of concrete and drilled hole.
 - 3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MP11, and the "Conditions of Use" listed in the Evaluation Report.
 - 4) Adhesive: Product manufacturer and name, lot number and expiration date, temperature of product at installation, installation procedure. Note initial set times observed during installation.
 - 5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
- b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
- 1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
 - 2) For ongoing installations, the special inspector visits the Site at least once per day during each day of installation to observe the Work for compliance with material requirements and installation procedures.
4. Inspection: Continuous.
- a. Make observations as described under "Inspection - Periodic, Initial Inspection" during drilling, cleaning, and bonding activities for all bars and rods installed.
5. Records of inspections:
- a. Provide a written record of each inspection using forms acceptable to the Engineer and to the building official.
- b. Submit electronic copies of inspection reports to the Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03_30_01

CONCRETE WORK

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PART 1 GENERAL

1.01 SUMMARY

- A. This specification applies to cast-in-place concrete structures only. For sidewalk, curb and gutter, median, and other similar concrete work see Colorado Department of Transportation (CDOT) Standard Specifications sections 608 – Sidewalks, 609 – Curb and Gutter, and 610 – Median.
- B. Section includes:
 - 1. Concrete formwork, concrete accessories, concrete reinforcement, batching and mixing of concrete to be cast-in-place, concrete placement and curing, and tooled concrete finishes.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. CODE-318 - Building Code Requirements for Structural Concrete and Commentary.
 - 2. MNL-66 - ACI Detailing Manual.
 - 3. PRC-305 - Specification for Hot Weather Concreting.
 - 4. PRC-306 - Standard Specification for Cold Weather Concreting.
 - 5. SPEC-117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 6. SPEC-301 - Specifications for Concrete Construction.
- B. ASTM International (ASTM):
 - 1. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - 3. A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 4. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 5. C33 - Standard Specification for Concrete Aggregates.
 - 6. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 7. C94 - Standard Specification for Ready-Mixed Concrete.
 - 8. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 - 9. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 10. C150 - Standard Specification for Portland Cement.
 - 11. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
 - 12. C171 - Standard Specification for Sheet Materials for Curing Concrete.
 - 13. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - 14. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 15. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

16. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
17. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
18. C494 - Standard Specification for Chemical Admixtures for Concrete.
19. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
20. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
21. C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
22. C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
23. C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
24. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
25. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
26. C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
27. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
28. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
29. D2103 - Standard Specification for Polyethylene Film and Sheeting.

C. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice.

1.03 TERMINOLOGY

- A. The words and terms listed below, are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
1. Alkali load: Amount of alkalies contributed by the cement in a concrete mixture, expressed in lb/yd³, and calculated by multiplying the cement content of the concrete in lb/yd³ by the alkali content of the Portland cement; or the Portland cement portion of a blended cement, divided by 100.
 2. Average daily temperature: The average of the highest and lowest temperatures during a 24-hour period from midnight to midnight.
 3. Cementitious materials: Portland cement and supplementary cementitious materials.
 4. Cold weather: A period when, for more than 3 consecutive days, the average daily temperature drops below 40 degrees Fahrenheit.
 - a. When the temperature is above 50 degrees Fahrenheit for more than half of any 24-hour duration, that period need not be regarded as cold weather.

5. Green concrete: Concrete whose current compressive strength is less than 100 percent of the minimum specified compressive strength, f'c.
6. Hand mixed concrete: Concrete mixed at or near the point of placement using shovels, hoes, or other similar manually operated tools.
7. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds promote rapid drying of freshly placed concrete.
8. Neat cement grout: Grout made from a mixture of Portland cement and water.
9. Supplementary cementitious material: Inorganic material such as fly ash, natural pozzolans, silica fume, or slag cement that reacts pozzolanically or hydraulically.

1.04 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 1. Formwork:
 - a. Formwork facing materials. Data on facing materials for concrete exposed to view in the finished work, if different from that specified in this Section.
 - b. Form release agent. Manufacturer's name and catalog data, including materials safety datasheet and documentation of suitability for use in contact with potable water.
 2. Joint materials:
 - a. Preformed expansion joint material: Manufacturer's name and catalog data with documentation of conformance to materials standards specified for each type and thickness of material.
 3. Reinforcement:
 - a. Mill certificates for each heat of steel provided.
 - b. Reinforcement placement drawings:
 - 1) Show anchor bolt locations based on anchor bolt templates for approved equipment.
 - c. Concrete bar supports:
 - 1) Precast concrete bar supports ("dobies"): Manufacturer's product data indicating compression strength of concrete supports and material used for tie wires.
 - 2) Wire chairs and slab bolsters: Manufacturer's product data.
 4. Concrete materials:
 - a. Cement:
 - 1) Mill certificate in accordance with ASTM C150. Include "Type" and results of testing for alkali content measured as equivalent alkalies.
 - b. Supplementary cementitious materials:
 - 1) Fly Ash: Identify source and provide testing results documenting compliance with ASTM C618 and any additional requirements of this Section.
 - c. Aggregates:
 - 1) Type, pit or quarry location, and producer's name.

- 2) Commercial laboratory test reports for samples of each aggregate proposed for use. Tests shall have been made not more than 24 months prior to the date of the Submittal.
 - a) Fine aggregate: Gradation analysis, specific gravity, reactivity, and reports of deleterious materials to document compliance with ASTM C33.
 - b) Coarse aggregate: Gradation analysis, specific gravity, soundness, reactivity, and reports of deleterious materials to document compliance with ASTM C33 for each size used.
- d. Admixtures:
 - 1) Manufacturer's catalog cuts and product data indicating compliance with the standards specified.
5. Concrete mixes: Submit full details, including:
 - a. Mix proportions measured by both weight and volume and concrete properties for each class of concrete proposed for use.
 - 1) Information on correction of batching for varying moisture contents of fine aggregate.
 - b. Data to establish the average compressive strength:
 - 1) If established by field test records, submit:
 - a) Product and test data for the materials used in the mix.
 - b) Actual mix proportions used in the mix producing the record.
 - c) Field test data for slump, air content, and 28-day compressive strength. Include not less than 15 tests in accordance with ACI SPEC-301.
 - 2) If established by testing of trial batches, submit:
 - a) Confirmation that the materials and proportions used in the trial batches are those that will be provided for the mix.
 - b) Mix test data for slump, air content, and 28-day compressive strength.
 - 3) For either method, include calculations for:
 - a) Standard deviation: Calculated in accordance with ACI SPEC-301 requirements.
 - b) Required average compression strength (f'_{cr}) using the standard deviation calculated in accordance with ACI SPEC-301 requirements.
 - c) Statement demonstrating that the average compression strength from field test records or from trial batch testing for each mix ($f'_{c_{avg}}$) exceeds the required average compressive strength (f'_{cr}) for that mix.
 - c. Data to establish alkali load:
 - 1) Determine and include the alkali load of the proposed mix.
 - d. Data to establish chloride content:
 - 1) Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table B of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days after mixing.
6. Concrete finishing and curing materials:
 - a. Manufacturer's name and product datasheets.

- C. Shop Drawings:
 - 1. Reinforcement:
 - a. Submit Drawings showing bending and placement of reinforcement.
 - 1) Drawings shall be in accordance with ACI MNL-66.
 - 2) Clearly show placement, shapes, and dimensions of each bar listed in the bill of materials, including additional reinforcement at corners and openings required by details in the Contract Documents.
 - 3) Show splice locations and bar lengths reflecting the Contractor's intended placement sequence.
- D. Samples:
 - 1. Form ties: If requested by the Engineer.
 - 2. Concrete bar supports: If requested by the Engineer, provide samples of:
 - a. Precast concrete bar supports ("dobies").
 - b. Wire chairs and slab bolsters.
- E. Procedures:
 - 1. Contractor's plans for production, placement, finishing, curing, protection, and temperature monitoring of concrete during the following environmental conditions:
 - a. Hot weather.
 - b. Cold weather.
 - 2. Contractor's proposed sequence of concrete placements.
- F. Project record documents:
 - 1. For the following items, note location of concrete in the structure, and include tag numbers of associated cylinders for compression strength tests.
 - 2. Concrete delivery tickets. Submit copies of concrete delivery tickets within 24 hours after delivery.
 - 3. Field test reports: Results of field-testing for slump, temperature, unit weight, and air entrainment.
 - 4. Testing laboratory reports for compression strength.
- G. Notifications:
 - 1. Modifications to concrete mixes:
 - a. Submit notification of any adjustments to mixture proportions and any changes in materials made during the course of the Work for the Engineer's review.
 - b. Include details of the changes and supporting documentation.
 - 2. Joint locations:
 - a. Where joint locations other than those indicated on the Drawings are requested, submit proposed locations for the Engineer's review.
 - b. Provide Drawings showing proposed joint locations with joint types labeled and joint details referenced.
 - 3. Reinforcement placement: Where necessary to move reinforcement beyond the specified placing tolerances to avoid interference, submit the proposed arrangement for the Engineer's review.
 - 4. Concrete placements: Submit notification of readiness for each concrete placement at least 24 hours in advance.

5. Concrete repairs:
 - a. Where concrete surfaces or sections exhibit defects after removal of forms, submit description of existing conditions and of proposed repair procedures and materials.
 - b. Include photos of existing conditions with Submittal.

1.05 QUALITY ASSURANCE

- A. Tolerances on concrete construction: In accordance with ACI SPEC-117 unless more stringent requirements are specified in the Contract Documents.
- B. Concrete mixtures:
 1. Ensure that concrete produced has the specified characteristics in the freshly mixed state, and that those are maintained during transport and delivery and to the point of final placement.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle concrete materials to prevent damage and inclusion of foreign substances.
- B. Deliver reinforcing steel bundled and tagged with identifying tags marked in a legible manner with waterproof markings showing the same designations as indicated on the submitted Shop Drawings.
 1. Store off the ground and protect from moisture, dirt, oil, and other injurious contaminants.
- C. Protect concrete accessories from weather and direct exposure to sunlight before installation.

1.07 PROJECT CONDITIONS

- A. Environmental requirements:
 1. Hot weather concreting: Construct in accordance with ACI PRC-305 during conditions when the ambient air temperature is above 90 degrees Fahrenheit.
 2. Cold weather concreting: Construct in accordance with ACI PRC-306 when ambient air temperature is below 40 degrees Fahrenheit or is 45 degrees Fahrenheit and falling.
 3. Conditions that promote rapid drying of freshly placed concrete, such as low humidity, high temperature, and wind: Take corrective action to minimize loss of water from the concrete.

1.08 SEQUENCING AND SCHEDULING

- A. Schedule placing of concrete in such a manner that completes any single placing operation to a construction or expansion joint as indicated on the Drawings or accepted by the Engineer in advance of the placement.

PART 2 PRODUCTS

2.01 FORMWORK

A. Forms:

1. Design and performance requirements:
 - a. Design and performance of formwork shall be the responsibility of the Contractor, subject to the requirements of the Contract Documents.
 - b. Design, construct, and brace formwork to:
 - 1) Carry all loads applied or transmitted, including the pressure resulting from placement and vibration of plastic concrete.
 - 2) Remain tight to prevent loss of mortar.
 - 3) Maintain specified tolerances and provide finished surfaces as specified.
 - c. Maximum deflection of facing materials and supporting members on surfaces exposed to view in the finished work: 0.0042 times the clear span (span/240).
 - d. Maximum deviation from alignment (horizontal or vertical): In accordance with ACI SPEC-117.
2. Form facing materials:
 - a. Surfaces exposed to view in the finished work:
 - 1) Facing materials shall produce a smooth, uniform texture on the concrete.
 - 2) Do not use materials with raised grain, tears, worn edges, patches, dents, or other similar defects.
 - 3) Acceptable materials: Plywood with "C" or better face, plastic-faced plywood, tempered concrete form grade hardboard, or steel.
 - b. Surfaces not exposed to view in the finished work:
 - 1) Special form facing material not required.
3. Forms for chamfers and keyways:
 - a. Uniform steel, plastic, or lumber section of dimensions shown or specified.
 - b. Provide adequate stiffness and support to maintain a true line at the concrete surface.
 - c. Treated to eliminate bond with the concrete if required to produce a smooth, uniform, and undamaged finish upon removal.

B. Form ties:

1. General:
 - a. Provide form ties fabricated by recognized manufacturer of concrete forming equipment and suitable for use with the forming system selected.
 - b. Provide ties that accurately tie, lock, and spread forms:
 - 1) Do not use wire ties or wood spreaders.
 - c. Provide form ties manufactured such that, when forms are removed, the tie leaves no metal or other material within 1-1/2 inches of the surface of the concrete.
 - d. Do not allow tie holes through forms for ties to leak during concrete placement.
2. Cone snap ties: Tie with removable plastic cone leaving a tapered depression having a minimum diameter of 1 inch at the surface of the concrete and a depth of 1-1/2 inches below the surface.

- C. Dry-pack mortar for filling cone snap tie holes:
 - 1. Proportioned mix of 1 part of Portland cement to 1 part plaster sand with potable water added to provide a stiff consistency that can be driven into holes and properly compacted.
 - 2. Admixtures or additives to mortar are not permitted.
- D. Form release agent: Commercially manufactured, non-staining formwork release agent that will prevent absorption of water by the formwork and will prevent bond between the formwork and the concrete.
 - 1. Form release agent shall comply with local air quality management regulations.

2.02 JOINT MATERIALS

- A. Synthetic sponge rubber expansion joint material:
 - 1. Elastic sponge rubber compound in accordance with ASTM D1752, Type I.
 - 2. Concrete-gray color unless otherwise noted.
 - 3. Thickness: As indicated on the Drawings.
 - 4. Manufacturers: One of the following or equal:
 - a. Williams Products Inc., Everlastic 1300.
 - b. WR Meadows, Seal Tight Sponge Rubber Expansion Joint.
- B. Bituminous fiber expansion joint material:
 - 1. Thickness: To match joint width indicated on the Drawings.
 - 2. Asphalt-impregnated fiberboard in accordance with ASTM D1751.
 - a. Manufacturers: One of the following or equal:
 - 1) Durajoint.
 - 2) W.R. Meadows, SealTight Fibre Expansion Joint.
- C. Sealants and caulking: As specified in Section 07_92_00 -Joint Sealants.

2.03 REINFORCEMENT

- A. Materials:
 - 1. Deformed bars: In accordance with ASTM A615 Grade 60.
 - 2. Welded wire fabric: Sheets of plain wire in accordance with ASTM A1064.
 - 3. Bar supports:
 - a. Over ground or "mud mat":
 - 1) Precast concrete blocks with cast-in annealed steel tie wires, 16 gauge or heavier.
 - a) Compressive strength of blocks equal to or exceeding the compressive strength of the surrounding concrete.
 - 2) Height as required for minimum 3 inches of clear concrete cover below reinforcement.
 - 3) Minimum block "footprint" of 4 square inches, or as required to supporting load from reinforcement while maintaining the required concrete cover.
 - b. Wire supports: Class 3, bright basic wire with galvanized coating in accordance with CRSI Manual of Standard Practice.
 - 4. Tie wire: Annealed steel.

- B. Fabrication:
 - 1. Cut and cold-bend bars in accordance with provisions of ACI MNL-66 and ACI CODE-318.
 - 2. Fabricate reinforcement to the tolerances in accordance with ACI SPEC-117.
 - 3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

2.04 SOURCE QUALITY CONTROL

- A. Submit documentation that the proposed concrete mixes will conform to the requirements of this Section and will produce concrete having the required proportions and properties specified.
 - 1. Do not place concrete until the design for that mix and the results of any trial batch testing have been accepted by the Engineer.
 - 2. If the Engineer requires changes to the mix design, modify mixes within limits set forth in this Section and submit new mix design for the Engineer's review.
- B. After acceptance, do not change mixes or mix proportions without prior acceptance by the Engineer.
 - 1. Exception: At all times, adjust batching of water to compensate for free moisture content of aggregates. Total water content in the mix shall not exceed that specified.
- C. If there is change in source of cement or aggregate, or if there is a significant change in the characteristics or quality of any constituent material received from a source accepted to supply materials, submit new design mixes for each class of concrete affected.
- D. Testing of materials and mixes before placement to demonstrate that they comply with the requirements of this Section shall be at the Contractor's expense.

2.05 CONCRETE MIXES

- A. Constituent materials:
 - 1. Cement:
 - a. Portland cement: In accordance with ASTM C150, Type I or II:
 - 1) Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished.
 - 2. Supplementary cementitious materials (SCM):
 - a. Fly ash:
 - 1) In accordance with ASTM C618, Class F.
 - 2) Sampling and testing: In accordance with ASTM C311.
 - 3) Loss on ignition: Not to exceed 4 percent.
 - 3. Aggregates:
 - a. General:
 - 1) Provide normal weight concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of the amounts specified.
 - 2) Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, or other construction waste.

- 3) Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operations.
- 4) Alkali-silica reactivity:
 - a) Provide fine and coarse aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 and with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260 and not greater than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
- b. Fine aggregate:
 - 1) Provide fine aggregate consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
 - 2) In accordance with ASTM C33.
- c. Coarse aggregate:
 - 1) Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances; and in accordance with ASTM C33, Class 4S.
 - 2) Grading: Unless otherwise specified or accepted in writing by the Engineer, provide the following:
 - a) Aggregate for Class A and C Concrete: ASTM C33, Size Number 57.
 - b) Aggregate for Class CE Concrete: ASTM C33, Size Number 8.
 - c) Where a combination of 2 or more sizes of coarse aggregate are used, the gradation of the blend shall conform to the grading requirements in accordance with ASTM C33 for the size number specified.
4. Water:
 - a. Water for concrete mixes, for washing aggregate, and for curing concrete: Potable water, clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
 - b. Do not exceed the optional chemical limits of ASTM C1602.
5. Admixtures:
 - a. General:
 - 1) Do not use admixtures, except those specified, unless written authorization has been obtained from the Engineer.
 - 2) Admixtures shall be compatible with concrete and other admixtures. Admixtures (other than fly ash) shall be the products of a single manufacturer to ensure compatibility.
 - 3) Do not use admixtures containing chlorides in excess of 0.5 percent by weight of cement when calculated as chloride ion.
 - b. Air entraining admixture: In accordance with ASTM C260.
 - c. Water reducing admixture:
 - 1) In accordance with ASTM C494, Type A or Type D.
 - 2) Not containing air-entraining agents.
 - d. High range water reducing admixtures/plasticizing admixtures:
 - 1) High-range water reducing admixtures: In accordance with ASTM C494, Type F.
 - 2) Use shall produce non-segregating concrete mixture with little bleeding that remains in a plastic state for not less than 2 hours.

- B. Mix design and proportioning:
1. Proportion mixes to provide compression strength, workability, and durability as specified in this Section.
 2. Submit documentation that the proposed mixes will conform to the requirements of this Section and will produce concrete having the required properties.
 3. Compression strength:
 - a. Proportion each concrete mix to provide the required average compressive strength (f'_{cr}) determined in accordance with the provisions of ACI SPEC-301.
 - b. Determine required average compressive strength (f'_{cr}) for each class of concrete using the specified compressive strength of the mix, f'_c , and the standard deviation determined in accordance with ACI SPEC-301.
 - 1) Establish the standard deviation in accordance with ACI SPEC-301 and based on either field test records or based on trial batches.
 - 2) Documentation of standard deviation based on field test records:
 - a) Calculate standard deviation in accordance with ACI SPEC-301 procedures using test records that:
 - (1) Represent materials, quality control procedures, and conditions similar to those expected for this Work.
 - (2) Do not include provisions for materials and proportions that are more restrictive than the materials proposed for use in this Work.
 - (3) Represent a mix proportioned to provide a specified compressive strength (f'_c) within 1,000 pounds per square inch of that specified for the corresponding mix in this Section.
 - 3) Documentation of standard deviation based on trial batches plus empirical code requirements:
 - a) When records including at least 15 consecutive tests that span a period of at least 45 calendar days are not available, determine required average compressive strength (f'_{cr}) from Table A:

Table A: Required Average Compressive Strength	
Specified Compressive Strength f'_c (pounds per square inch)	Required Average Compressive Strength f'_{cr} (pounds per square inch)
Less than 3,000	$f'_c + 1,000$
3,000 to 5,000	$f'_c + 1,200$

4. Workability:
 - a. Provide concrete with workability and consistency that can be readily worked into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on the surface.
5. Cement content:
 - a. Cementitious materials content: Conform to values specified in Table B of this Section.
 - b. Ratio of water to cementitious materials:
 - 1) Conform to values specified in Table B of this Section.
 - 2) Total water, including that from moisture content of aggregates and admixtures, shall not exceed that specified in Table B of this Section.

6. Supplementary Cementitious Materials:
 - a. Fly ash:
 - 1) Maximum of 15 percent by weight of total weight of cementitious materials (cement plus fly ash). Other supplemental cementitious materials shall not be used without prior acceptance by the Engineer.
7. Aggregates:
 - a. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete classes, with exception of Class CE.
8. Admixtures:
 - a. Use in accordance with manufacturer's instructions.
 - b. Air entraining admixture:
 - 1) Provide concrete with entrained air content indicated in Table B of this Section and consisting of evenly dispersed air bubbles.
 - c. Water reducing admixture:
 - 1) No decrease in cementitious materials content is permitted as a result of use of water-reducing admixture.
 - d. High range water reducing admixture/plasticizing admixture:
 - 1) Proportion for a slump of 2 to 4 inches before the admixture is added, and a maximum slump of 8 inches after the admixture is added.
9. Concrete mix design requirements by class:
 - a. Provide concrete mixes for each "class" specified in this Section and indicated in Table B of this Section.
 - b. Use each class at the locations specified in the following paragraphs or indicated on the Drawings.
 - 1) "Class A" concrete: General use. Use at all locations unless otherwise indicated on the Drawings or listed in the following paragraphs.
 - 2) "Class C" concrete: May be used as fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and elsewhere as indicated on the Drawings.
 - c. Pumped concrete: Provide a separate mix design and substantiation testing for each "class" to be placed by pumping.

Table B: Concrete Classes

Concrete Class	Minimum Specified Compressive Strength at 28 days, f'_c ⁽¹⁾ (pounds per square inch)	Ratio of water to cementitious materials ^(2,3) (minimum - maximum)	Cementitious Materials Content ⁽³⁾ (pounds per cubic yard of concrete by weight)	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Coarse Aggregate Size ⁽⁴⁾	Air Entrainment (percent) (N/R: not required)	Admixtures required ⁽⁵⁾	Slump Range (inches)
A	4,500	0.40 to 0.45	535 to 575	ASTM C150, Type II(MH)	0.15	57	6±1.5	AEA WRA	2 to 4
C	2,500	0.62 max.	423 min.	ASTM C150, Type II(MH)	No limit	57	6±1.5	AEA WRA	3 to 6

Notes:

- (1) At locations where concrete will not be subjected to load from other elements of the structure or from the Contractor's placing operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Contractor's Engineer.
- (2) W/C Ratio = Ratio of water to cementitious materials (Portland cement plus supplemental cementitious material) by weight Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement.
- (3) Provide mix within the range of W/C ratio and cementitious materials content indicated.
- (4) Size number in ASTM C33, Table 2.
- (5) Admixtures are designated as follows:
 AEA: Air entraining admixture.
 CA: Coloring admixture.
 HRWR: High-range water reducing admixture.
 WRA: Water reducing admixture.

2.06 CONCRETE BATCHING AND MIXING EQUIPMENT

- A. Provide equipment and facilities for accurate measurement and control of materials.
- At all times, maintain proportions of concrete mix within specified limits.
 - Control and adjust batch weights to secure maximum yield.
- B. Measuring or weighing equipment:
- Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
 - Devices shall bear the current and valid seal of the Sealer of Weights and Measures in the Authority having jurisdiction.
 - Furnish devices capable of providing successive quantities of individual materials measured to within 2 percent of desired amount of that material.

- C. Mixing equipment:
 - 1. Mixes shall be ready-mix or transit-mixed concrete in accordance with ASTM C94.
 - 2. Provide equipment capable of combining aggregates, cementitious materials, water, and admixtures into a thoroughly mixed and uniform mass during the time periods specified, and capable of discharging the resulting mixture without segregation.
 - 3. Maintain mixing equipment in good working order. Operate at loads and speeds, and for periods of time recommended by the manufacturer or specified in this Section.

2.07 CONCRETE FINISHING AND CURING MATERIALS

- A. Evaporation retardant:
 - 1. Manufacturers: One of the following or equal:
 - a. Euclid Chemical Co., Eucobar.
 - b. Master Builders Solutions/Sika, MasterKure ER 50.
- B. Plastic membrane for curing:
 - 1. White polyethylene film in accordance with ASTM C171:
 - a. Nominal thickness not less than 0.0040 inches when measured in accordance with ASTM D2103, and thickness at any point not less than 0.0030 inches.
 - b. Loss of moisture: Not to exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.
- C. Sprayed membrane curing compound:
 - 1. In accordance with ASTM C309, Type 1D. Clear with fugitive dye.

PART 3 EXECUTION

3.01 GENERAL

- A. Preparation:
 - 1. Use construction methods and sequences that allow time for concrete to reach adequate strength to prevent damage to or overstress of the concrete structure or its elements during construction.
 - 2. Locations of construction and expansion joints are indicated on the Drawings.
 - a. Make no other joints, except as accepted in advance by the Engineer.
 - b. Schedule placing of concrete to complete any single placing operation between designated joints.
 - c. Schedule and sequence placements to allow adequate time for concrete to achieve adequate strength before subsequent placements and loads are applied to the structure.
- B. Verification of conditions:
 - 1. Do not place concrete until:
 - a. Forms have been thoroughly cleaned of dirt and debris, and form release agents have been applied.

- b. Forms have been thoroughly checked for alignment, level, strength, and accurate location of reinforcement, joint accessories, and mechanical and electrical inserts or other embedded items.
 - c. Reinforcement is secure and properly fastened in its correct position.
 - d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
 - e. Forms are aligned and secured, and loose form ties at construction joints have been retightened.
2. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the Work:
 - a. Provide this notification in advance of operations, allowing such time as the Engineer deems necessary to make final observation of preparations at location of the concrete placement.
 - b. Have forms, reinforcement, screeds, anchors, ties, embeds, and inserts in place before notifying the Engineer of readiness for final observations.
 3. Do not place concrete until the Engineer has completed final observations of conditions at the placement and has given acceptance to proceed.

3.02 FORMING

A. General:

1. Do not use earth cuts as forms for vertical or sloped surfaces unless specifically required by or indicated on the Contract Documents.
2. Joints: Locate joints as indicated on the Drawings:
 - a. Submit joint locations other than or differing from those indicated on the Drawings for the Engineer's review before construction.
3. Chamfers:
 - a. Permanently exposed outside corners: Provide 3/4-inch chamfer.
 - b. Re-entrant corners:
 - 1) Chamfer not required.
 - 2) Corner may be left square.
 - c. Edges of formed joints: Chamfer not required except where indicated on the Drawings.
4. Level strips: Install level strips at top of wall concrete placements to maintain true line at horizontal construction joints.

B. Constructing and erecting formwork:

1. Brace and anchor formwork to ensure vertical and lateral stability and to maintain finish tolerances when subjected to uplift pressures and lateral pressures from plastic concrete.
 - a. Ensure that formwork is positioned, braced, and firmly held against previously placed concrete to maintain flush surfaces and to prevent loss or leaking of mortar at construction joints.
 - 1) At joints with flush surfaces exposed to view, lap contact surface of form a maximum of 1 inch over the previously placed concrete.
 - b. Design and construct forms with sufficient strength and stiffness that deflections resulting from loading by plastic concrete will not exceed the surface tolerance limits specified.
 - c. Set forming materials in an orderly and symmetrical arrangement, keeping the number of seams to a practical minimum.

- d. Form ties: Tie forms together using cone snap ties placed at not more than 2-foot centers vertically and horizontally.
 - e. Construct formwork to permit easy removal without damage to formed surfaces.
 - f. Provide temporary openings at the base of column and wall formwork to allow cleaning and inspection immediately before concrete placement.
 - g. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.
 - 2. Where forms are reused, clean surfaces of mortar, grout, and foreign materials before coating with form release agent and setting.
 - 3. Cover formwork surfaces with form release agent to prevent bond with the concrete:
 - a. Do not allow form release agent to puddle in the forms.
 - b. Do not allow form release agent to contact reinforcement, embeds, or previously placed concrete.
 - 4. Provide runways supported directly on the formwork for moving equipment and supplies during preparations for concreting:
 - a. Do not rest such runways on reinforcement.
- C. Embeds, joints, and accessories:
- 1. Position pipes, sleeves, conduits, inserts, anchors, castings, and other embedded items in the forms, and anchor to formwork to prevent displacement.
 - 2. Fill voids in sleeves, pipes, inserts and anchor slots with readily removable material, and seal if required to prevent entry of mortar.
 - 3. For pipe or conduit runs, position embeds to allow at least 3 inches of clear concrete separation between parallel runs of pipes, conduits or any combination of these items with each other or with reinforcement.
- D. Removing formwork:
- 1. Remove forms after the specified time for curing and protection has been provided and when operations will not damage concrete.
 - 2. Immediately after forms are removed, carefully examine concrete surfaces.
 - a. Report any irregularities in surfaces and finishes to the Engineer.
 - b. Where surface repairs are needed, contact the Engineer with description of conditions and description of repair procedures before proceeding with the work.
 - 3. Immediately follow form removal with installation of specified curing materials and procedures.
 - 4. After forms are removed from wall and curing is complete, fill tie holes as follows:
 - a. Remove form ties and cones from surfaces.
 - b. Roughen cone-shaped tie holes by heavy sandblasting before repair.
 - c. Clean and dampen tie holes, maintaining a saturated surface for at least 2 hours before applying dry-pack mortar.
 - d. Dry pack cone-shaped tie holes with dry-pack mortar as specified in this Section.

3.03 PLACING CONCRETE REINFORCEMENT, EMBEDS, AND ACCESSORIES

- A. Preparation:
 - 1. Cut and bend deformed steel reinforcement in the shop and deliver completed bars to the site for installation.
 - a. Do not field-bend deformed reinforcement.
 - 2. Surface preparation:
 - a. Thoroughly clean reinforcing bars from rust scale, loose mill scale, rust coat, dirt, oil, and other coatings that adversely affect bonding capacity when placed in the work.
 - 1) Thin coating of red rust resulting from short exposures will not be considered objectionable.
 - b. Remove concrete or other deleterious coatings on dowels and other reinforcement projecting from previous placements by wire brushing or sandblasting before the reinforcement is embedded in the subsequent placement.
- B. Support of reinforcement and accessories:
 - 1. Provide supports for deformed bars and wire fabric to maintain reinforcement position indicated on the Drawings and to provide specified minimum clear concrete cover around the reinforcement.
 - 2. Use number of supports required to prevent reinforcement from sagging and to support loads during construction, but in no fewer quantities and locations than recommended by ACI MNL-66 and CRSI Manual of Standard Practice.
 - 3. Support wire fabric from reinforcing supports:
 - a. Do not place wire fabric on grade or forms for subsequent lifting into plastic concrete during the concrete placement.
 - b. Take care to maintain specified position of wire fabric in the concrete section and to prevent bending, draping, or kinking of the wires.
 - 4. Do not:
 - a. Use brick, broken concrete masonry units, concrete spalls, rocks, or other such material for supporting reinforcement.
 - b. Support reinforcement on additional reinforcing bars installed with less cover than that required by the Contract Documents ("give away bars").
 - c. Adjust location of reinforcement indicated on the Drawings to increase cover over support bars.
 - 5. Furnish and use templates for placing column and wall dowels.
- C. Placing reinforcement:
 - 1. Locate reinforcement to provide minimum clear concrete cover specified:
 - a. Where cover is not specified, provide cover in accordance with ACI CODE-318.
 - 2. Accurately place reinforcement in accordance with the tolerances of ACI SPEC-117:
 - a. Where reinforcement must be moved beyond the specified placing tolerances to avoid interference with other reinforcement, conduits, or embeds, submit the proposed arrangement for the Engineer's review.
 - 3. Fasten reinforcement securely in place with wire ties:
 - a. After tying, bend ends of wire ties inward towards the center of the concrete to match clear concrete cover provided for reinforcement.
 - 4. Do not weld reinforcing bars or wires.

5. Deformed reinforcing bars:
 - a. Tie slab bars at every intersection around the perimeter of slabs.
 - b. Tie wall bar and slab bar intersections, other than those around the perimeter, at every 4th intersection, but not more than 48 inches on center each way.
 - c. Lap splices:
 - 1) Lap reinforcement at splices as indicated on the Drawings or specified.
 - 2) Unless indicated on the Drawings, install lap splices with bars in contact and fastened together with tie wire.
 - 3) If lap splice length is not indicated on the Drawings, provide lap splice equal to 40 times reinforcing bar diameter.
6. Welded wire fabric reinforcement:
 - a. Bend fabric as indicated on the Drawings or required to fit work.
 - b. Straighten fabric to make reinforcement in each face a flat, planar surface before placing in the Work.
 - c. Extend welded wire fabric across concrete section to provide fabric to within 2 inches of vertical concrete edges.
 - d. Lap splice welded wire fabric as indicated on the Drawings:
 - 1) If no splice details are indicated, lap fabric at least 12 inches, fasten with wire ties spaced not more than 24 inches on center, and lace lap with wire of the same diameter of the fabric.

3.04 BATCHING, MIXING, TRANSPORTING, AND DELIVERING CONCRETE

- A. General:
 1. Measure, batch, mix, transport, and deliver ready-mixed concrete in accordance with ASTM C94.
- B. Measuring and batching:
 1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
 - a. Weigh cementitious materials separately.
 2. Furnish satisfactory means for checking moisture content of aggregates before batching.
 - a. Adjust mix water to compensate for free moisture content of aggregate.
 3. Mixing water:
 - a. Measure by volume or by weight.
 - b. Maximum water-to-cementitious materials ratio for each concrete class shall not exceed that specified in Table B of this Section.
 4. Admixtures:
 - a. Provide admixtures as specified.
 - b. Batch products by means of mechanical batcher capable of accurate measurement, and in accordance with the admixture manufacturer's instructions.
- C. Mixing and transporting:
 1. Mixing:
 - a. Equip each truck mixer with device capable of counting number of drum revolutions and interlocked to prevent discharge of concrete from drum before required number of revolutions is complete.

- b. Once drum revolutions commence, continuously revolve drum until it has completely discharged its batch.
 - c. Do not add water until drum commences revolutions.
 - d. Engineer may require an increase in the designated minimum number of revolutions, or a decrease in the designated maximum number of revolutions if necessary to obtain satisfactory mixing.
 - 1) Incorporate such changes without additional costs to the Owner.
- 2. Do not exceed the following time period for mixing and delivery:
 - a. Total elapsed time from addition of water at batch plant through discharging of mix: Not to exceed the lesser of 90 minutes or 300 revolutions of the mixer drum.
 - b. Total elapsed time for from arrival at the project site to completing discharge of mix: Not to exceed 30 minutes.
 - c. Under conditions contributing to quick setting, the Engineer may reduce total elapsed time permitted.
- D. On-site acceptance of concrete mixes:
 - 1. Concrete shall possess the properties specified in this Section at the point of placement.
 - 2. Do not place concrete:
 - a. Having slump outside the limits indicated in Table B of this Section.
 - b. That does not conform to specifications for entrained air content.
 - c. For which the total elapsed time of mixing or elapsed time at the site exceeds the specified maximums.

3.05 CONVEYING, DEPOSITING, AND CONSOLIDATING CONCRETE

- A. Preparation:
 - 1. General:
 - a. Clean construction joints and forming surfaces of dirt, sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
 - 1) Use vacuum cleaner if required to provide clean surfaces.
 - b. Remove snow, ice, frost, and standing water from surfaces of formwork, reinforcement, and embeds in contact with concrete.
 - c. Secure reinforcement, joint materials, anchors, embeds, and other items in place.
 - d. Obtain the Engineer's observation and acceptance of preparations.
 - e. During conveying, placement, consolidation, and finishing of concrete, protect surrounding construction, including concrete walls and slab surfaces, from concrete splatter.
 - f. Thoroughly clean surrounding construction at the completion of each placement and before splatter sets up.
 - 2. Concrete construction on grade:
 - a. Provide subgrade preparation, base materials, and compaction as required by the Contract Documents.
 - b. Remove loose soils, debris, standing water, snow, or ice from subgrade.

- c. Provide moist subgrade with no standing or free water and no muddy or soft spots.
 - 1) When subgrade is not moist, sprinkle with water not less than 2 or more than 6 hours in advance of placing concrete.
 - 2) If subgrade becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
 - 3. Weather conditions:
 - a. Hot weather: In hot weather conditions, make provisions in advance of placement for windbreaks, shading, fogging, sprinkling, ponding, or wet covering.
 - b. Cold weather: In cold weather conditions, make provisions to maintain the required concrete temperatures without overheating or drying, and without exposing concrete to carbon dioxide from heater exhaust.
 - c. Precipitation:
 - 1) Do not begin placements while rain, sleet, or snow is falling or anticipated, or unless adequate protection is provided.
 - 2) Do not allow precipitation to increase concrete water content or to damage the surface of the concrete.
 - d. Wind:
 - 1) Do not begin placements during wind events that will blow dust or debris into the plastic concrete.
 - 2) Do not allow wind-blown debris to become embedded in or to damage the surface of the concrete.
 - 3) At all times, have sufficient coverings on hand to protect new concrete from excessive drying or blowing debris.
- B. Conveying concrete:
- 1. Convey concrete from mixer to place of final deposit by methods that prevent segregation or loss of materials.
 - 2. Use chutes, pumps, and conveyors of size and design that will ensure continuous flow of concrete at point of delivery without cold joints.
 - 3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from the chute or conveying device.
 - 4. Keep conveying equipment clean by thoroughly washing and scraping upon completion of any placement.
- C. Depositing concrete:
- 1. Do not place concrete under the following conditions:
 - a. After initial set has occurred.
 - b. When re-tempering has occurred.
 - 2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
 - a. Do not use vibrators to move concrete from its point of deposit.
 - b. Use tremies for placing concrete where drop is over 5 feet.
 - 3. Place concrete continuously in approximately horizontal layers not exceeding 24 inches in depth. Bring level up evenly in all parts of forms.
 - a. After placement begins, continue without significant interruption and as a continuous operation until the end of that placement is reached.
 - b. Do not allow "cold joints" to form between adjacent layers or areas of the placement, or initial set to form on "wet edge" of placements.

- c. Take precautions to prevent delays between placement of adjacent layers or areas from exceeding 20 minutes.
 - 1) If more than 20 minutes elapse after the initial surface was placed, spread a layer of neat cement grout, as specified for construction joints before depositing additional concrete.
 - 4. Placing concrete on slopes: Commence placement at bottom of slope and work upward.
 - 5. Placing horizontal concrete monolithically with structures below:
 - a. If concrete for slabs, beams, or walkways is to be cast monolithically with walls or columns below, do not place the horizontal concrete elements until the concrete in walls or columns below has been placed, consolidated, and allowed to achieve initial set.
 - b. Allow set time of not less than 1 hour.
 - c. Maintain a moist surface at the top of the walls or columns during the setting period.
 - 6. Placing a second concrete lift over hardened concrete below:
 - a. Take special precautions in form work at top of old lift and bottom of new lift to prevent:
 - 1) Spreading and vertical or horizontal displacement of forms.
 - 2) Grout "bleeding" onto finished concrete surfaces.
- D. Consolidating concrete:
- 1. Thoroughly consolidate concrete into forms and around reinforcement, pipes, and other embeds using mechanical vibrators.
 - a. Take special care to place concrete solidly against forms, leaving no voids.
 - b. Make concrete solid, dense, compact, and smooth.
 - 2. Provide vibration energy sufficient to cause concrete to flow and readily settle into place, leaving no voids. Vibration should visibly affect concrete over a radius of at least 18 inches without segregation.
 - 3. Vibrators:
 - a. At all times, have sufficient vibrators on hand to consolidate concrete as it is placed.
 - b. In addition to vibrators in use while concrete is being placed, have on hand at least 1 spare vibrator in serviceable condition.
 - c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.

3.06 FINISHING CONCRETE

- A. Provide concrete finishes as specified in Section 03_35_29 - Concrete Finishes.
- B. Liquid evaporation retardant:
 - 1. Apply evaporation retardant when environmental conditions will result in rapid evaporation of moisture from the surface of the fresh concrete during finishing operations. Such conditions include low humidity, high heat, and wind occurring alone or in combination.
 - 2. Immediately after the concrete is screeded, coat the surface of the concrete with a liquid evaporation retardant.
 - 3. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks and crazing at the surface.

3.07 CURING AND PROTECTING CONCRETE

- A. Curing concrete:
 - 1. Cure concrete by methods specified in this Section.
 - 2. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for at least 7 days (cure period) after placement unless the details of a particular method specify a longer period.
 - 3. Make provisions to maintain moisture or curing membrane integrity at edges of slabs, tops of walls, and joint surfaces, and to prevent loss of protection.
 - 4. Schedule of curing methods:
 - a. Concrete surfaces that will receive additional materials that require bond to the initial placement (including concrete; concrete repairs, coatings, paints, sealers; grout; and other materials):
 - 1) Water curing or plastic membrane curing.
 - b. Formed surfaces:
 - 1) If non-absorbent forms are left in place for the duration of the cure period after placement: No additional requirements.
 - 2) For absorbent forms or when forms are removed before the completion of the cure period: Cure by water curing, plastic membrane curing, or sprayed membrane curing.
 - c. Unformed concrete surfaces:
 - 1) Water curing, plastic membrane curing, or sprayed membrane curing.
 - 5. Water curing:
 - a. Keep surfaces of concrete constantly and visibly saturated by ponding, continuous fogging, or continuous sprinkling at all times during curing period.
 - 1) Cover surfaces if required to maintain saturated conditions.
 - 2) For horizontal surfaces, pond the surface with at least 2 inches of water or cover with saturated mats or fabric kept continuously wet.
 - b. Formed surfaces:
 - 1) Each day forms remain in place may be counted as 1 day of water curing.
 - 2) Do not loosen form ties while concrete is being cured by forms left in place.
 - 3) No further credit for curing time will be allowed after contact between the concrete surface and the forms has been broken.
 - 6. Plastic membrane curing:
 - a. Cover concrete with plastic membrane, sealing joints and edges against displacement by wind or site operations and to prevent loss of moisture.
 - b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
 - c. Keep all surfaces of concrete under plastic membrane moist at all times during the curing period.
 - 7. Sprayed membrane curing:
 - a. Application of curing compound:
 - 1) Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
 - a) If more than 1 hour elapses between removal of forms and application of curing compound, provide water curing of affected surfaces for the full curing period.

- 2) Contractor is cautioned that the method of applying curing compound specified in this Section may require more compound than normally suggested by manufacturer of compound, and also more than is customary in the trade.
 - 3) Apply curing compound by mechanical, power-operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
 - 4) Apply compound in at least 2 coats, with each subsequent coat in a direction turned 90 degrees from the preceding coat.
 - 5) Apply curing compound in sufficient quantity that concrete has uniform appearance and that the natural color of the concrete is effectively and completely concealed immediately after spraying.
 - 6) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
 - 7) Apply compound to a film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
 - 8) Take care to apply curing compound to edges of placements and over full surface profile of construction joints.
- b. Removal of curing compound:
- 1) Do not remove curing compound from concrete before the completion of the cure period.
 - 2) Before placing fresh concrete against a surface previously coated with curing compound, remove the curing compound by heavy sandblasting, or alternate method acceptable to the Engineer.
 - 3) Prior to final acceptance of the Work, remove any curing compound on surfaces exposed to view by sandblasting or other acceptable method. After removal, only the natural color of finished concrete shall remain visible, and such color shall be uniform over the entire surface.

B. Protecting concrete:

1. Immediately after placement, protect concrete from hot or cold weather, and mechanical damage.
2. Temperature:
 - a. Cold weather: Protect concrete during the curing period so that the concrete temperature is maintained within the following requirements.
 - 1) Sections less than 12-inches thick: Minimum 55 degrees Fahrenheit.
 - 2) Sections 12- to 36-inches thick: Minimum 50 degrees Fahrenheit.
 - b. Hot weather: Protect concrete during the curing period so that the concrete temperature does not exceed 90 degrees Fahrenheit.
 - c. Remove protection against temperature gradually so that concrete surface temperature does not drop or rise by more than 40 degrees Fahrenheit during any 24-hour period.
3. Maintain forms, shoring, and bracing in place after concrete placement for a period after concrete placement as indicated in the following paragraphs. Forms may be removed after these periods if the concrete has developed sufficient strength and hardness to resist surface or other damage.
 - a. Vertical forms:
 - 1) General: Minimum 24 hours after concrete placement.
 - 2) Sides of footings: Minimum 24 hours after concrete placement.
 - 3) Sides of beams, girders, and similar members: Minimum 48 hours after concrete placement.

- b. Horizontal forms:
 - 1) Slabs, beams, and girders: Until concrete reaches specified compressive strength, $f'c$, or until shoring is installed.
 - c. Shoring for slabs, beams, and girders:
 - 1) Shore until concrete strength reaches specified compressive strength, $f'c$.
 - a) Temporary shoring may be required after the specified compressive strength is reached if construction loads will exceed the designated live load capacity of the structure.
 - d. Wall bracing:
 - 1) Brace until strength of concrete beams and slabs laterally supporting the wall reaches specified compressive strength, $f'c$.
- C. Loads against or on the concrete:
- 1. Loading of green concrete, by backfilling or by placing personnel and equipment on the surface, is not permitted.
 - 2. Backfilling: Do not place backfill against concrete walls until the wall and all elements attached to it, including connecting slabs or beams, are fully braced by the structure, and have achieved their minimum specified compressive strength, $f'c$.

3.08 JOINTS AND JOINT PREPARATION

- A. Joint locations and details:
- 1. Construct concrete work as monolith to the extent practical.
 - 2. Construct joints as indicated on the Drawings and as specified.
 - 3. Locations of construction, expansion, and other joints are indicated on the Drawings or specified in this Section.
 - a. Do not relocate, add, or delete joints without prior approval from the Engineer.
- B. Construction joints:
- 1. Where spacing is not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
 - 2. Construct as indicated on the Drawings.
 - 3. Before placing fresh concrete against the joint: Use heavy sandblast to thoroughly clean joint surfaces and reinforcement crossing the joint of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter.
 - 4. Just before placing concrete against the joint, wash surface with water to saturate joint surface and concrete surfaces within 12 inches of the joint.
 - 5. Horizontal joints:
 - a. Immediately before placing concrete, thoroughly spread bed of neat cement grout over the joint surface. Grout shall be as follows:
 - 1) Use same sand-to-cementitious materials ratio that is used for concrete mix.
 - 2) Use same materials that are used for concrete.
 - 3) Use water-to-cementitious materials ratio that is no more than that specified for concrete.
 - b. Grout thickness: Not less than 1/2 inch, or more than 1 inch.

- C. Expansion joints:
 - 1. Where width is not indicated on the Drawings, provide 3/4-inch wide joint.
 - 2. Construct as indicated on the Drawings.
 - 3. Do not extend reinforcement, conduits, or other items through expansion joints unless details for such crossings are indicated on the Drawings.
 - 4. Preformed expansion joint material:
 - a. Accurately position joint filler in the joint.
 - 1) Fasten to concrete or forms with adhesive.
 - 2) Fastening joint filler using nails, bolts, screws, or similar items is not permitted.
 - b. Tape splices in joint filler to prevent intrusion of mortar.

3.09 COLD WEATHER CONCRETING

- A. Preparation:
 - 1. Remove snow, ice, and frost from surfaces, including soil subgrade, that will receive fresh concrete.
 - 2. Do not place concrete against embedments or reinforcement at a temperature below freezing, where such items are sufficiently massive to cause adjacent concrete to freeze.
- B. Placement during cold weather:
 - 1. Placement temperature:
 - a. Minimum temperature of concrete immediately after placement shall be as specified in Table C of this Section.
 - b. Temperature of concrete as placed shall not exceed the values shown in Table C of this Section by more than 20 degrees Fahrenheit.
 - 2. Protection temperature:
 - a. Unless otherwise specified, the minimum temperature of concrete during the protection period shall be as shown Table C of this Section.
 - b. Temperatures specified to be maintained during the protection period shall be those measured at the concrete surface, whether the surface is in contact with formwork, insulation, or air.
 - c. Measure the temperature with a surface measuring device accurate to 2 degrees Fahrenheit.
 - d. Measure the temperature of concrete in each placement at regular time intervals as specified in the Contract Documents.
 - 3. Termination of protection:
 - a. Maximum decrease in temperature measured at the surface of the concrete in a 24-hour period shall not exceed the values listed in Table C of this Section.
 - b. Do not exceed these limits until the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature of surrounding temperatures.
 - c. When the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature, thermal protection may be removed.

Table C: Concrete Temperature Requirements		
Least dimension of section (inches)	Minimum temperature of concrete as placed and maintained during the protection period (degrees Fahrenheit)	Maximum for gradual decrease in surface temperature during any 24-hour period after end of protection period (degrees Fahrenheit)
Less than 12	55	50
12 to less than 36	50	40
36 to 72	45	30
Greater than 72	40	20

C. Curing of concrete:

1. Prevent concrete from drying during the required curing period. If water curing is used, terminate use at least 24 hours before any anticipated exposure of the concrete to freezing temperatures.

D. Protection of concrete:

1. Combustion heaters: Vent flue gases from combustion heating units to the outside of the enclosures.
2. Overheating and drying: Place and direct heaters and ducts to avoid areas of overheating or drying of the concrete surface.
3. Maximum air temperature: During the protection period, do not expose the concrete surface to air having a temperature more than 20 degrees Fahrenheit above the values shown in Table C of this Section unless higher values are required by an accepted curing method.
4. Protection against freezing:
 - a. Cure and protect concrete against damage from freezing for a minimum of 3 days, unless otherwise specified.
 - 1) Maintain the surface temperature of the concrete as specified in Table C of this Section.
 - b. During periods not defined as cold weather, but when freezing temperatures may occur, protect concrete surfaces against freezing for the first 24 hours after placing.

3.10 TOLERANCES

A. Concrete:

1. Finished concrete: Conform to shapes, lines, grades, and dimensions indicated on the Drawings.
2. In accordance with ACI SPEC-117, except as modified in the following paragraphs:
 - a. Where more restrictive tolerances to accommodate equipment are indicated on the Drawings.
 - b. Slabs where slope is indicated:
 - 1) Uniformly slope to drain.
 - 2) Without depressions that puddle water.

- c. Slabs indicated to be level:
 - 1) Maximum deviation of 1/8 inches in 10 feet without any apparent changes in grade.
 - 2) Without depressions that puddle water.
- B. Embeds:
 - 1. General:
 - a. Sleeves and inserts: Plus or minus 1/8 inch.
 - b. Projected ends of anchor bolts: Plus 1/4 inch; minus 0 inches.
 - c. Anchor bolt position: Plus or minus 1/16 inch.
 - 2. Equipment: Set inserts to tolerances required for proper installation and operation of equipment or systems to which insert pertains.

3.11 FIELD QUALITY CONTROL BY CONTRACTOR

- A. Provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Field tests:
 - 1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
 - 2. Sampling and testing shall be performed by the Contractor's testing laboratory. Requirements as specified in Section 01_45_00 - Quality Control.
 - a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
 - b. Provide full access for the Engineer to observe concrete sampling and testing at any time.
 - c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
 - d. Provide firmly braced, insulated, heated, closed wooden curing boxes. Include cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication through receipt at the Contractor's testing laboratory.
 - 3. Testing shall include:
 - a. Sampling of concrete in accordance with ASTM C172.
 - b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.
 - c. Slump of concrete using slump cone in accordance with the requirements of ASTM C143. Test slump at the following intervals:
 - 1) Test slump at the beginning of each placement.
 - 2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
 - 3) When requested to do so by the Engineer.
 - 4) Observe concrete during slump test for signs of segregation:
 - a) Observe concrete for mortar or moisture flow from slumped concrete.
 - b) Reject concrete if mortar or moisture flows out of the mix.
 - d. Unit weight of concrete in accordance with ASTM C138.

- e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
 - 1) At the beginning of each placement.
 - 2) As often as necessary to keep entrained air within the specified range, but not less than every 6th truck.
 - 3) When requested to do so by the Engineer.
- f. Compressive strength, f'_c , in accordance with ASTM C39. Required number of cylinders:
 - 1) Not less than 4 cylinder specimens, 4-inch diameter by 8-inches long, will be tested for each 150 cubic yards of each class of concrete; not less than 4 specimens for each half day of placement.
 - 2) One cylinder will be broken at 7 days and 3 cylinders will be broken at 28 days.
- 4. Furnish concrete for test specimens and provide manual assistance to testing lab in preparing said specimens.
- 5. Assume responsibility for providing care and on-site curing and protection for test specimens in accordance with ASTM C31.

3.12 FIELD QUALITY CONTROL BY OWNER

- A. As specified in Section 01_45_00 - Quality Control.
- B. Special tests and inspections: As required by City of Westminster and City of Arvada requirements.
- C. Field inspections:
 - 1. Observe construction for conformance to the Contract Documents and the accepted Submittals.
 - 2. Records of inspections:
 - a. Provide a record of each inspection.
 - b. Submit copies to the Contractor upon request.
- D. Field tests:
 - 1. Engineer may request, at any time, additional testing to confirm materials being delivered and placed conform to the requirements of the Specifications.
 - a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the cost of these tests.
 - b. If such additional testing shows that the materials do conform to the specified requirements, the Engineer shall pay the cost of these tests.

3.13 NON-CONFORMING WORK

- A. Do not place concrete that does not conform to the requirements of these Specifications. Remove non-conforming materials from the site.
- B. Strength requirements:
 - 1. Concrete is expected to reach higher compressive strength than the minimum specified compressive strength f'_c as indicated in Table B of this Section.

2. Concrete strength will be considered acceptable if following conditions are satisfied:
 - a. Averages of all sets of 3 consecutive strength test results are greater than or equal to specified compressive strength f'_c .
 - b. No individual strength test (average of 2 cylinders tested at 28 days) falls below specified compressive strength f'_c by more than 500 pounds per square inch.
 3. Whenever one or both of the conditions stated above is not satisfied, provide additional curing or testing of the affected portion as directed by the Engineer.
 - a. Costs of such curing or testing shall be at the Contractor's expense.
- C. Remove and replace or repair defective work as directed by the Engineer:
1. Do not patch, repair, or cover defective work before observation by the Engineer.
 2. Make no repairs until the Engineer has accepted proposed methods for preparation and repair.

END OF SECTION

SECTION 03_35_29

CONCRETE FINISHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Concrete finishes.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 117-10 - Specification for Tolerances for Concrete Construction and Materials and Commentary.
- B. International Concrete Repair institute (ICRI):
 - 1. Guideline No. 301.2: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. Grade line: A reference line that separates surfaces considered to be above grade from those considered to be below grade. Located 12 inches below finished grades at the perimeter of the structure.
 - 2. Water line: A reference line that separates surfaces considered to be above the water level (and visible in the finished work) from those considered to be below the water level (and not visible in the finished work). For each water-bearing cell of a structure, defined as a line located 2 feet below the normal operating water level in that cell.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Finishing personnel:
 - a. Use qualified flatwork finishers.
 - b. Finishing supervisor must have at least 5 years of experience finishing concrete.
- B. Mockups:
 - 1. Construct mockup panels showing finishing of formed surfaces for review by the Engineer.
 - a. Construct mockup panels demonstrating concrete finishes for vertical surfaces:
 - 1) Construct mockup panels for F4 and F5 finishes and tie-hole repairs for review by the Engineer.

2. Construct mockup slabs showing finishing of unformed surfaces for review by the Engineer.
 - a. Construct mockup slabs demonstrating concrete finishes for horizontal surfaces:
 - 1) Construct mockup slabs for S1, S2, S4, and S5 finishes.
3. Include the following elements in mockup panels and slabs.
 - a. Concrete joints:
 - 1) Horizontal and vertical joints of the types included in the Work.
 - b. Concrete repairs:
 - 1) Repairs using materials and procedures proposed for the Work.
4. Construct mockup panels and slabs at beginning of project for review by the Engineer.
5. Panels and portions thereof accepted by the Engineer will serve as the standard of quality and workmanship for the Work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping:
 1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials for mortar:
 1. As specified in Section 03_30_01 – Concrete Work, unless otherwise noted.
 2. Where finished surfaces will be visible in the finished work, use same cement used for concrete batches in that area. Add white cement if required to obtain color match between base concrete and finishing mortars.

2.02 MIXES

- A. Cement mortar:
 1. As specified in Section 03_60_00 - Grouting.
- B. Dry-pack mortar:
 1. As specified in Section 03_60_00 - Grouting.
- C. Mortar mix for F4 finish ("F4 Mortar"):
 1. Consisting of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.
- D. Mortar mix for F5 finish ("F5 Mortar"):
 1. Consisting of 1 part cement to 1-1/2 parts of sand passing Number 16 screen.

2.03 EVAPORATION RETARDANT

- A. As specified in Section 03_30_01 – Concrete Work.

2.04 NON-SLIP ABRASIVE

- A. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate. Homogeneous, non-glazing, rust-proof, and unaffected by freezing, moisture, and cleaning compounds.
- B. Manufacturers: One of the following, or equal:
 - 1. Abrasive Materials Incorporated, Hillsdale MI.
 - 2. Exolon Company, Tonawanda NY.

2.05 CONCRETE SEALERS

- A. Floor sealer and dust-proofer:
 - 1. Non-membrane forming, breathable, non-yellowing, penetrating sealer designed to densify and seal a cured concrete surface.
 - 2. Low odor, VOC content of 0 grams per liter, and stable when exposed to ultraviolet radiation from sunlight.
 - 3. Manufacturers: One of the following, or equal:
 - a. Dayton Superior: Day-Chem Sure Hard Densifier (J-17).
 - b. Euclid Chemical Company: Euco Diamond Hard.
 - c. L&M Construction Chemicals: Seal Hard.
 - d. W.R. Meadows: Liqui-Hard.

PART 3 EXECUTION

3.01 CONCRETE FINISHING - FORMED SURFACES

- A. Scope:
 - 1. Finish formed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
 - 2. Formed surfaces are those surfaces that the plastic concrete is placed against a temporary containment surface that will be removed after the concrete sets and takes its final form.
- B. General:
 - 1. Provide setting and curing time from casting of concrete to removal of forms as specified in Section 03_30_01 – Concrete Work.
 - 2. Provide curing after removal of forms as specified in Section 03_30_01 – Concrete Work.
 - 3. Materials and mixes for finishes.
 - a. Cement: Add white cement to mortars and grouts used for finishing if required to match color of repairs to surrounding surfaces.
 - 4. Grinding:
 - a. Where grinding of concrete surfaces is permitted:
 - 1) Perform grinding using an iron-free wheel, such as an aluminum oxide wheel, to avoid entrapment of particles that produce rust stains.
 - 2) At locations where plastic-protected reinforcing bar supports are used, limit grinding to a maximum depth of 1/16 inch.

- C. F1 finish: "Rough Form Finish":
1. Repair defective work.
 2. Remove fins and other projections larger than 1/2 inch.
 3. Fill tie holes using dry-pack mortar.
 4. After removal of any curing compounds, fill depressions larger than 1-inch wide or 1/2-inch deep using dry-pack mortar.
 5. Leave surface with texture imparted by forms.
 6. Surface irregularity: Not exceeding a 1-inch gap when measured over the length of a 5-foot straightedge.
- D. F2 finish: "Form Finish":
1. Repair defective work.
 2. Remove fins and other projections larger than 1/4 inch.
 3. Fill tie holes using dry-pack mortar.
 4. Fill depressions.
 - a. Fill after removal of any curing compounds.
 - b. Fill depressions larger than 1/2 inch in width or 1/2 inch in depth using cement mortar.
 - c. Fill larger voids and depressions, use dry-pack mortar.
 5. Leave surfaces with texture imparted by forms.
 6. Surface irregularity: Not exceeding a 1/4-inch gap when measured over the length of a 5-foot straightedge.
- E. F3 finish: "Smooth Form Finish":
1. Repair defective work.
 2. Repair rough or irregular surface finishes resulting from failure of form release agent or other form conditions and provide a smooth, uniform surface appearance.
 3. Remove fins: Grind offsets, projections, and rough spots larger than 1/8 inch smooth.
 4. Fill tie holes using dry pack mortar.
 5. Fill depressions:
 - a. Fill after removal of any curing compounds.
 - b. Fill depressions 1/4 inch and larger in depth or width using cement mortar.
 - c. For larger depressions, fill using dry pack mortar.
 6. Top coat tie holes and filled depressions with cement mortar to provide uniform appearance.
 7. Leave surfaces with texture that is generally smooth and uniform in appearance.
 8. Surface irregularity: Not exceeding a 1/8 inch gap when measured over the length of a 5-foot straightedge.
- F. F4 finish: "Rubbed Finish":
1. As specified for F3 finish, except prepare surfaces and fill depressions 1/16 inch or larger in depth or width as follows.
 2. Fill depressions.
 - a. "Brush-off" sandblast surfaces to expose all depressions and voids near the surface of the concrete.
 - b. Thoroughly wet surfaces and begin filling depressions while surfaces are still damp.

- c. Use clean burlap, sponge rubber floats, or trowels to rub plastic F4 mortar over the entire surface to be finished. Fill pits, holes, and depressions.
 - d. Wipe surfaces clean. Do not leave any mortar on the surface, except that within the depressions.
 - e. Cure: Moist cure surfaces.
- G. F5 finish: "Stoned Finish":
- 1. As specified for F3 finish, except add stoned finish as follows:
 - 2. Fill depressions:
 - a. Wet surfaces thoroughly with brush.
 - b. Rub wetted surfaces with a hard wood float dipped in water containing 2 pounds of Portland cement per gallon of water.
 - c. Rub surfaces until form marks and projections are removed.
 - d. Using a brush, spread plastic grindings from the rubbing operation uniformly over the surface. Work the material in to fill pits and small voids.
 - e. Cure: Moist cure brushed surfaces for at least 72 hours.
 - 3. Finish surfaces:
 - a. After curing, obtain final finish by rubbing with a No. 50 grit carborundum stone.
 - b. Continue rubbing until entire surface has a smooth texture and is uniform in color.
 - c. Cure: Continue curing for remainder of specified time.
 - 4. Note: If surfaces have become too hard to finish as specified in the preceding paragraphs, the following alternative procedure may be used:
 - a. Sandblast and wash related surfaces exposed to view, whether finished or not.
 - b. While surfaces are still damp, rub surface with mortar mix for F5 finish.
 - c. Finish by rubbing mortared surface with No. 60 grit carborundum stone. Add F5 mortar until surface is evenly filled without excess mortar. Continue stoning until surface is hard.
 - d. Moist cure surface for 72 hours.
 - e. After curing, make surface smooth in texture and uniform in color by rubbing with a No. 50 or No. 60 grit carborundum stone.
 - f. Continue curing until 7-day curing period is complete.

3.02 CONCRETE FINISHING - UNFORMED SURFACES

- A. Scope:
- 1. Finish unformed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
 - 2. Unformed surfaces are those surfaces that are not cast against a temporary containment and the specified finish is achieved by tooling.
- B. General:
- 1. Concrete placement:
 - a. Place concrete at a rate that allows spreading, straight-edging, and initial floating before bleed water appears.
 - 1) Consider characteristics of concrete mixes used, including potential for accelerating or retarding effects of admixtures, fly ash, and temperatures, on plans for and scheduling of placement and finishing.

- b. Place, consolidate, strike-off, and screed concrete level to bring surfaces to required planes and lines. Eliminate high and low spots.
 - c. Strike tops of walls and similar surfaces smooth and finish as specified to a texture consistent with that of adjacent formed surfaces.
 - d. After screeding, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.
2. Floating and re-straightening:
- a. Float concrete to compact and consolidate the surface.
 - b. Initial floating:
 - 1) Provide initial floating immediately after screeding.
 - 2) Perform by hand using a wide bull float, darby, or highway straightedge.
 - 3) Complete before excess moisture or bleed water is present on the surface.
 - c. Wait for concrete to stiffen and for the bleed water to stop rising and dissipate before proceeding with edging, hand-tooled jointing, and second floating.
 - d. After initial floating, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.
 - e. Second floating:
 - 1) Do not commence until bleed water has dissipated and concrete has stiffened enough to support weight of finishers and finishing equipment.
 - 2) May be by hand, or, if accepted by the Engineer, may be done using a bladed power float equipped with float shoes, or a power disk float.
 - 3) Float surfaces to a true, even plane, with no coarse aggregate visible.
 - 4) Evaporation retardant may not be applied after second floating.
 - f. Flatness:
 - 1) Specified tolerances for flatness may require re-straightening of the surface between first and second floating operations and before steel troweling. Re-straighten concrete as required.
 - 2) Modify power equipment with alternate float shoes or other equipment if required to achieve specified flatness.
3. Troweling: Where finishes require troweling, conform to the following requirements:
- a. After surface moisture from floating has disappeared, steel trowel to a smooth, hard, dense concrete surface.
 - b. Provide at least 2 trowelings.
 - 1) Avoid excessive troweling.
 - 2) Use smaller trowels for successive troweling.
 - 3) Make each successive troweling perpendicular to the previous pass.
 - c. Do not add dry cement or additional water to the surface during troweling.
 - d. In lieu of hand steel troweling, a power machine for finishing concrete may be used if accepted by the Engineer.
 - 1) Do not use power machine if concrete has not attained the set necessary to permit finishing without introduction of high and low spots into the concrete surface.

- 2) Use equipment in full compliance with the manufacturer's recommendations.
- 3) Use smaller blades or higher pressure for each successive troweling.
- 4) Hand trowel areas of the concrete not accessible to power equipment.
- 5) Tolerances for flatness specified may require re-straightening of the surface during finishing. Modify power equipment with alternate shoes or other equipment if required to achieve these requirements.
- e. Finishing with a fresno trowel or finishing to a "fresno finish" is not allowed.
4. Finishing tolerances:
 - a. Slabs sloped to drain: Finish surfaces to adequately drain toward designated points or lines, regardless of tolerances specified.
- C. S1 finish: "Scratch Finish":
 1. Place, consolidate, and screed concrete level.
 2. Provide initial floating of concrete.
 3. Provide surface conforming to the "Conventional" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/2-inch gap in 10 feet at 90 percent of locations; maximum 3/4-inch gap at any location), unless otherwise indicated.
 4. Before final set, roughen the surface with rakes.
 - a. For sloped surfaces, rake grooves in the direction of drainage.
 - b. Provide roughness equivalent to CSP 6 surface as designated by ICRI Guideline 310.2.
 5. Pressure wash surface to remove laitance before placing grout or toppings.
- D. S2 finish: "Floated Finish":
 1. Place, consolidate, and screed concrete to required elevations and slopes.
 2. Provide initial and second floatings of concrete. Float to a uniform texture.
 3. Provide surface conforming to the "Flat" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/4-inch gap in 10 feet at 90 percent of locations; maximum 3/8-inch gap at any location), unless otherwise indicated.
 4. Remove laitance and leave surface clean.
- E. S3 finish: "Steel Trowel Finish":
 1. Place, consolidate, and screed concrete to required elevations and slopes.
 2. Provide S2 Floated Finish.
 3. Provide 2 trowelings:
 4. Provide finish conforming to the "Flat" floor flatness tolerance requirements of ACI 117 (maximum 1/4-inch gap in 10 feet), unless otherwise indicated.
- F. S4 finish: "Steel Trowel Finish - Free of Trowel Marks":
 1. Finish as specified for S3 Steel Trowel Finish, except that final troweling shall remove all trowel marks from the slab surface.
- G. S5 finish: "Broomed Finish":
 1. Finish as specified for S2 Floated Finish, except modify as follows:
 2. Finish surface by drawing a fine-hair broom lightly across the freshly floated surface.
 - a. Provide resulting roughness for a non-skid surface. Finishing and roughness is subject to review and acceptance by the Engineer.

- b. Direction of brooming:
 - 1) General:
 - a) In same direction of and parallel to expansion joints.
 - b) Perpendicular to primary direction of traffic.
 - 2) For sloped slabs, parallel to the direction of drainage.
 - 3) For round roof slabs, in the radial direction.
- H. S6 finish: "Non-Slip Abrasive Finish":
 - 1. Place, consolidate, and screed concrete to required elevations and slopes.
 - 2. Provide initial floating of surface.
 - 3. Prepare and apply abrasive as recommended by the manufacturer.
 - a. Apply using a shake screen or other accepted method to ensure even coverage without segregation of the abrasive.
 - b. Install abrasive at a rate of 25 pounds for each 100 square feet of surface area.
 - 4. After concrete has hardened enough to support the weight of a person, and unless otherwise indicated by the abrasive manufacturer, apply approximately 2/3 of the abrasive material required for coverage.
 - 5. Finish as specified for S2 Floated Finish, except that re-floating is not required.
 - 6. Apply remaining abrasive material at right angles to the first application and in locations necessary to provide the minimum specified thickness.
 - 7. Immediately after the second application, re-float the surface to embed abrasive.
 - 8. Finish as specified for S2 Steel Trowel Finish. Trowel abrasive into the surface, properly exposing material to produce a non-slip finish.

3.03 FIELD QUALITY CONTROL

- A. Provide field quality control for the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Field quality control by Contractor:
 - 1. Field inspections and testing:
 - a. Submit records of inspections and testing to Engineer within 24 hours after completion.
 - 2. Manufacturer's services.
 - a. Non-slip abrasive finish. Before beginning installation, conduct pre-installation meeting with manufacturer's technical representative to review product use and installation requirements.
- C. Field quality control by Owner:
 - 1. Special inspections, special tests, and structural observation:
 - a. Not required.
 - 2. Field inspections:
 - a. Observe construction for conformance to the Contract Documents and the accepted Submittals.
 - b. Provide record of each inspection. Submit copies to Engineer upon request.

3.04 NON-CONFORMING WORK

- A. Unsatisfactory finishes that have hardened will require removal, grinding, topping, or other correction acceptable to the Engineer.
- B. Re-work or refinish unsatisfactory finishes at no additional cost to the Owner.
- C. See Section 03_30_01 – Concrete Work for requirements.

3.05 SCHEDULE OF CONCRETE FINISHES

- A. Formed surfaces: See Table A in this Section.
- B. Unformed surfaces: See Table B in this Section.

Table A: Concrete Finishes - Formed Surfaces

	Elements	Location	Surface Exposure	Finish	Notes
EXTERIOR SURFACES	Walls Columns Slab edges	Wet structure:	Above grade or water line:		
			- Exposed to view	F4	
			- Covered	F2	1a
			Below grade or water line:		
			- No coating	F1	
			- Bituminous coating	F2	
			- Waterproofing	F3	
		Dry structure:	Above grade line:		
			- Exposed to view	F4	
			- Covered	F2	1a
			Below grade line:		
			- No coating	F1	
			- Bituminous coating	F2	
- Waterproofing	F3				
INTERIOR SURFACES	Walls Columns Slab edges	Wet structure:	Open basin:		
			- Above water line	F4	
			- Below water line	F3	
			Covered basin		
			- Above water line	F3	
			- Below water line	F3	
		Dry structure:	Exposed to view	F4	
			Covered	F2	1b
	Overhead slabs and beams	Wet structure:	Open basin	F3	1c, 1d
			Covered basin	F2	1d
		Dry structure:	Exposed	F3	1c, 1d
			Covered by ceiling	F1	1d
Notes:					
(1a) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, etc.					
(1b) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, furring strips with drywall, etc.					
(1c) Applies to overhead surfaces visible from normal pedestrian travel routes.					
(1d) At overhead slabs and beams, patch tie holes on sides of members.					

Table B: Concrete Finishes - Unformed Surfaces

	Element	Location	Exposure	Finish	Notes
EXTERIOR SURFACES	Footings	Extensions	Exposed	S3	
			Covered by soil	S2	
	Slabs and beams - exposed	Walking or possible walking paths	Tops of treatment structures	S5	2a, 2b, 2g
			Stairs & landings	S5	
		Roofs	Exposed	S5	
			Covered by roofing	S2	
	Slabs and beams - submerged	Unless otherwise noted	All	S5 if concrete is air entrained	2g
	Walls, Corbels	Top of wall or corbel	All	S3	One troweling
	Sidewalks	All		S5	
INTERIOR SURFACES	Floor slabs, includes flat and sloping surfaces	Wet structure	Exposed		
			- Basins & channels	S3	
			Covered		
			- To receive basin bottom grout	S1	2e
			- To receive concrete fill	S1	2f
		Dry structure	Exposed		
			- Pipe galleries	S4	2c
			- Stairs & landings	S4	2d
			- Shops & garages	S4	
			- Equipment rooms	S4	
			Covered		
			- Tile on mortar bed	S2	
			- Resilient flooring	S3	
			- Carpet	S3	

Notes:

- (2a) Includes slabs covering tanks, basins, channels and similar structures.
(2b) Includes tops of walls or beams that serve as walkways.
(2c) In galleries with slabs subject to wetting, provide broom finish (S5) where indicated on the Drawings.
(2e) Finish for basin bottom grout: N/A.
(2f) Finish for concrete fill: See Floor slab, wet structure, exposed basins and channels.
(2g) Slabs include flat and sloping surfaces.

END OF SECTION

SECTION 03_60_00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Cement grout.
 - 2. Cement mortar.
 - 3. Dry-pack mortar.
 - 4. Epoxy grout.
 - 5. Grout.
 - 6. Non-shrink epoxy grout.
 - 7. Non-shrink grout.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens).
 - 2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - 3. C531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
 - 5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - 6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - 7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - 8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
- B. International Concrete Repair Institute (ICRI):
 - 1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

- A. Cement grout:
 - 1. Mix design.
 - 2. Material Submittals.

- B. Cement mortar:
 - 1. Mix design.
 - 2. Material Submittals.
- C. Non-shrink epoxy grout:
 - 1. Manufacturer's literature.
- D. Non-shrink grout:
 - 1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.
- B. Store materials in cool dry place and in accordance with manufacturer's recommendations.
- C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Non-shrink epoxy grout:
 - 1. Manufacturers: One of the following, or equal:
 - a. Five Star Products, Inc., Five Star DP Epoxy Grout.
 - b. L&M Construction Chemicals, Inc., EPOGROUT.
 - c. Master Builder Solutions/Sika, MasterFlow 648.
 - 2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
 - 3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
 - 4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
 - 5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
 - 6. Compressive creep: Not exceed 0.0037 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
 - 7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.
- B. Non-shrink grout:
 - 1. Manufacturers: One of the following, or equal:
 - a. Five Star Products, Inc., Five Star Grout.
 - b. L&M Construction Chemicals, Inc., CRYSTEX.
 - c. Master Builder Solutions/Sika, MasterFlow 928.
 - 2. In accordance with ASTM C1107.
 - 3. Preportioned and prepackaged cement-based mixture.

4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
5. Require only addition of potable water.
6. Water for pre-soaking, mixing, and curing: Potable water.
7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
 - a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
 - a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
 - b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

- A. Cement grout:
 1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
 2. Use same materials for cement grout that are used for concrete.
 3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
 4. For spreading over surfaces of construction or cold joints.
- B. Cement mortar:
 1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
 2. Use same materials for cement mortar that are used for concrete.
 3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
 4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.
- C. Dry-pack mortar:
 1. Proportions by weight: 1 part Portland cement to 2 parts concrete sand.
 - a. Portland cement: As specified in Section 03_30_01 – Concrete Work.
 - b. Concrete sand: As specified in Section 03_30_01 – Concrete Work..
- D. Epoxy grout:
 1. Consist of mixture of epoxy or epoxy gel and sand.
 - a. Epoxy: As specified in Section 03_30_01 – Concrete Work..
 - b. Epoxy gel: As specified in Section 03_30_01 – Concrete Work..
 - c. Sand: Clean, bagged, graded, and kiln-dried silica sand.

2. Proportioning:
 - a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
 - b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.
- E. Grout:
 1. Mix in proportions by weight: 1 part Portland cement to 4 parts concrete sand.
 - a. Portland cement: As specified in Section 03_30_01 – Concrete Work..
 - b. Concrete sand: As specified in Section Section 03_30_01 – Concrete Work..
- F. Non-shrink epoxy grout:
 1. Mix in accordance with manufacturer's installation instructions.
- G. Non-shrink grout:
 1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

- A. Surface preparation for grouting other baseplates:
 1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
 2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
 - a. Remove loose or broken concrete.
 3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

- A. Mixing:
 1. Cement grout:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 2. Cement mortar:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 3. Dry-patch mortar:
 - a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.

4. Non-shrink epoxy grout:
 - a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
 5. Non-shrink grout:
 - a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
 - b. Do not retemper by adding more water after grout stiffens.
- B. Placement:
1. Cement grout:
 - a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
 - b. Do not use cement grout that has not been placed within 30 minutes after mixing.
 2. Cement mortar:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 3. Epoxy grouts:
 - a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
 4. Non-shrink epoxy grout:
 - a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
 - b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
 5. Non-shrink grout:
 - a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
 - b. Mix in accordance with manufacturer's instructions to uniform consistency.
- C. Curing:
1. Cement based grouts and mortars:
 - a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
 - b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
 2. Epoxy based grouts:
 - a. Cure grouts in accordance with manufacturers' recommendations.
 - 1) Do not water cure epoxy grouts.
 - b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.
- D. Grouting other baseplates:
1. General:
 - a. Use non-shrink grout as specified in this Section.
 - b. Baseplate grouting shall take place from 1 side of baseplate to other in continuous flow of grout to avoid trapping air in grout.

- c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
 - d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.
- 2. Forms and headboxes:
 - a. Build forms using material with adequate strength to withstand placement of grouts.
 - b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
 - c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
 - d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on 1 side of baseplate.
 - e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

- A. Non-shrink epoxy grout:
 - 1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.
- B. Non-shrink grout:
 - 1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 05_50_00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
1. Manhole frames and covers.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
1. Standard Specifications for Highway Bridges.
- B. ASTM International (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel.
 2. A48 - Standard Specification for Gray Iron Castings.
 3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
 4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- C. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

- A. Product data:
1. Manhole frames and covers.
- B. Shop drawings:
1. Manhole Frames and Covers

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron	A48	Class 40B

2.02 MANUFACTURED UNITS

- B. Manhole frames and covers:
 - 1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
 - 2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
 - 3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
 - 4. Frame:
 - 1) Per City of Arvada requirements.
 - 5. Cover:
 - a. Per City of Arvada requirements.
 - 6. Finish: Unpainted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of conditions:
 - 1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
 - 2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

- A. General:
 - 1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
 - 2. Interface between materials:
 - a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
 - 1) Make application so that the isolating or protective barrier is not visible in the completed construction.
 - 2) Isolating sleeves and washers: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.
 - b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces with epoxy mastic.
 - c.
- B. Manhole frames and covers:
 - 1. Installation: As recommended by Manufacturer.

END OF SECTION

SECTION 07_92_00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Acrylic-Latex sealant.
 - 2. Precast concrete joint sealant.
 - 3. Silicone sealant.
 - 4. Synthetic rubber sealing compound.
 - 5. Synthetic sponge rubber filler.
 - 6. Related materials.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
- B. ASTM International (ASTM):
 - 1. C920 - Standard Specification for Elastomeric Joint Sealants.
 - 2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
 - 4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
 - 5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - 6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

- A. Product data.
- B. Samples, include color selections.
- C. Manufacturer's Installation Instructions.
- D. Warranty.

1.04 QUALITY ASSURANCE

- A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.
- B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

- A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with manufacturer's recommendations.
- B. Code date packages. Do not use material older than manufacturer's published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer's instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

- A. Caulk joints prior to painting.

1.08 WARRANTY

- A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

- A. General:
 - 1. Provide colors matching materials being sealed.
 - 2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
 - 3. Nonsagging sealant for vertical and overhead horizontal joints.
 - 4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
 - 5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
 - 6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
 - a. Control joint depth.

- b. Break bond of sealant at bottom of joint.
- c. Provide proper shape of sealant bead.
- d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

- A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
 - 1. Manufacturers: One of the following or equal:
 - a. Tremco, Tremflex 834.
 - b. Pecora Corp., Number AC-20.
 - c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

- A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
 - 1. Manufacturers: One of the following or equal.
 - a. Henry Corp., Ram-Nek.
 - b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

- A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
 - 1. Manufacturers: One of the following or equal:
 - a. Tremco, Proglaze.
 - b. Pecora Corp., Number 864.
 - c. Dow Corning, Number 795.
 - d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

- A. Manufacturer: One of the following or equal:
 - 1. Sika Corporation, Sikaflex 2c NS or SL
 - 2. Sika Corporation, Sikaflex 2c NS EZ Mix.
 - 3. Pacific Polymers, Elastothane 227R.
- B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
 - 1. Base: Polyurethane rubber.
 - 2. Application time: Minimum 2 hours.
 - 3. Cure time: Maximum 3 days.
 - 4. Tack free time: Maximum 24 hours.
 - 5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
 - 6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.

7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.
 8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
 9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.
- C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

- A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
1. Manufacturers: The following or equal:
 - a. Presstite, No. 750.3 Ropax Rod Stock.
- B. Characteristics:
1. Suitable for application intended.
 2. Strength: As necessary for supporting sealing compound during application.
 3. Resiliency: Resistance to environmental conditions of installation.
 4. Bonding: No bonding to the sealing compound.
 5. Structure: Cellular, prevents absorption of water.
 6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
 7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

- A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.
- B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.
- C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify acceptability of joint dimensions, physical, and environmental conditions.
- B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

- A. Allow concrete to cure thoroughly before caulking.
- B. Synthetic sponge rubber filler:
 - 1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
 - 2. Do not stretch filler beyond its normal length during installation.
- C. Caulking:
 - 1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
 - 2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.
- D. Synthetic rubber sealing compound:
 - 1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
 - 2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.
- E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.
- F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.
- G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.
- H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
- I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.
- J. Do not stretch filler beyond normal length during installation.
- K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

- A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.
- B. Caulking, joints, and sealing:
 - 1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
 - 2. Install pipe and conduit in structures as indicated on the Drawings.

3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
5. Complete caulking prior to painting.
6. Verify that concrete is thoroughly cured prior to caulking.
7. When filler compressible material is used, use untreated type.
8. Apply caulking with pneumatic caulking gun.
9. Use nozzles of proper shape and size for application intended.
10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

- A. Clean surfaces adjacent to sealant as work progresses.
- B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.
- C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.
- D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

- A. Acrylic latex:
 1. Use where indicated on the Drawings.
 2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.
- B. Silicone:
 1. Use where indicated on the Drawings.
 2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
 3. Door threshold bedding.
 4. Moist or wet locations, including joints around plumbing fixtures.
 5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
 6. Plenum joints.
- C. Synthetic rubber sealing compound, non-sag Type II:
 1. Use where indicated on the Drawings.
 2. Water-bearing and earth-bearing concrete structures.

3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
 4. Joints between sheet metal flashing and trim.
 5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
 6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
 7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
 8. Expansion and control joints in masonry vertical surfaces.
- D. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
 2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
 3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
 4. Pavement joints.
 5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

- A. Adhesion testing:
1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
 - a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
 - b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
 - c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
 - d. Building expansion joints: 1 test per every 500 LF of joint sealed.
 - e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
 - f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 31_00_00

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to Site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
 - 2. Backfilling and compacting under and around structures.
 - 3. See Section 31_23_35 Trenching for trench backfill procedures.

1.02 REFERENCES

- A. Colorado Department of Transportation (CDOT):
 - 1. Standard Specifications for Road and Bridge Construction (Standard Specifications).
- B. ASTM International (ASTM):
 - 1. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 2. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
 - 3. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - 4. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.
 - 2. Embankments: Dikes, levees, berms, and similar facilities.
 - 3. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SUBMITTALS

- A. Copy of Property Owner's Agreement allowing placement of surplus soil material on their property.

- B. Excavation plan:
 - 1. Describe/show planned conformance with excavation limits, dimensions, depths, and other constraints put forth in the Contract documents and/or Geotechnical report(s).
 - 2. Describe/show proposed shoring and excavation methods.
 - 3. Describe/show how excavation process will be sequenced and coordinated.
 - 4. If confined site, describe/show how access will be maintained to necessary areas during excavation process.
 - 5. Describe/show proposed equipment and location of equipment placement, if critical to excavation stability.
- C. Testing lab: Submit the Contractor's proposed testing laboratory capabilities and equipment.
- D. Test reports:
 - 1. Submit certified test reports of tests specified to be performed by the Contractor.

1.05 QUALITY ASSURANCE

- A. Initial compaction demonstration:
 - 1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
 - a. 50 cubic yards of backfill adjacent to structures.
 - b. 100 cubic yards of embankment work.
 - c. 100 cubic yards of fill.
 - d. 50 cubic yards of roadway base material.
 - e. 100 cubic yards of road fill.
 - 2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
 - 3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under the Field Quality Control article.
- B. Perform Work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.06 SEQUENCING AND SCHEDULING

- A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.
- B. If necessary, stockpile excavated material in order to use it at specified locations.
- C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Performance requirements:
 - 1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
 - 2. Obtain acceptable import material from other sources if surplus obtained within the Project Site does not conform to specified requirements or are not sufficient in quantity.
 - 3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

2.02 MATERIALS

- A. Water for compacting: Use water from source acceptable to the Engineer.
- B. Soil and rock materials:
 - 1. General:
 - a. Provide materials referenced in Specification Section 31_05_15 - Soils and Aggregates for Earthwork where specified or indicated on the Drawings.
- C. Controlled low-strength material: As specified in Section 31_23_24 - Controlled Low Strength Materials (CLSM).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of conditions:
 - 1. Character and quantity of material:
 - a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in Work to be performed.
 - b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in Work to be performed.
 - c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from on-site excavations or imported materials. Include in cost of Work to be performed.
 - d. Include wasting of excess material, if required, in the cost of Work to be performed.

3.02 PREPARATION

A. Backfills:

1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompect scarified areas to density specified before placing backfill material or concrete.
3. If foundation areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.
4. Do not place backfill against walls until:
 - a. Walls have been cast full height of structure and concrete has reached the specified strength.
 - b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
5. Prior to backfilling:
 - a. Remove forms.
 - b. Clean trash and debris from the excavation site.
6. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:

1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompect scarified areas to density specified for embankments before placing of embankment material.
3. If embankment areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

C. Fills:

1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompect scarified areas to density specified for compacted fills before placing of fill material or concrete.
3. If fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

D. Roadway fills:

1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.

2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.
 3. If roadway fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.
- E. Sloped surfaces for fill or foundations:
1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
 - a. Bench or terrace to adequately key existing ground and fill built thereon.
 2. Slopes of original hillsides and old fills: Bench minimum of 10 feet horizontally as fill is placed.
 3. Provision of new benches:
 - a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
 - b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

- A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
 2. Dispose of surplus material on private property only when written permission agreement is furnished by the owner of the property. Submit copies of such agreements.
 3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from the Project Site at no additional cost to the Owner.
 4. Stabilization of subgrade: Provide materials used, or perform Work required, to stabilize subgrade so it can withstand loads that may be placed upon it by the Contractor's equipment.
- B. Borrow area: There is no borrow area on the Project Site.
1. Where material is required, import material from source located off Project Site selected by the Contractor and subject to acceptance by the Engineer.
 2. There will be no additional cost to the Owner for use of imported material.
- C. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
 2. Perform confirmation tests to verify and confirm that Work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
 3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556, or with ASTM D6938.
 4. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.
 5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed AASHTO Standard Specifications for

Highway Bridges, H-20 vehicle loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill.

- a. Depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
 - a. Backfill adjacent to structures: 95 percent.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - b. Backfilling voids: 95 percent.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - c. Top soil: 70 percent.

D. Dewatering: As specified in Section 31_23_22 - Dewatering.

E. Excavation:

1. Blasting: Not permitted.
2. Excavations for trenching: As specified in Section 31_23_35 - Trenching.
3. Excavations for structures:
 - a. Provide excavations conforming to the dimensions and elevations indicated on the Drawings for each structure.
 - b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by the Engineer, do not carry excavations below elevation indicated on the Drawings.
 - c. Where soil is encountered having unsuitable bearing value, the Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
 - d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
 - 1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
 - 2) Under footings: Restore to the proper elevation using one of the following:
 - a) CDOT Class 6 Aggregate base course.
 - b) Controlled low-strength material.
 - e. Excavation width:
 - 1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
 - 2) Do not undercut slopes.
 - f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
4. Excavation of lined channels:
 - a. Excavations in open cut for lined channels may be made so as to place concrete directly against excavated surfaces providing faces of excavations are:
 - 1) Firm and unyielding.
 - 2) Will stand or can be made to stand without sloughing.

- b. Excavations to provide subgrade for lined channel or subdrainage material: Excavate to lines and grades indicated on the Drawings.
 - 5. Excavation of unlined channels and basins:
 - a. Excavate to lines and grades indicated on the Drawings.
 - b. Perform excavation and grading so that finish surfaces are in uniform planes with no abrupt breaks in surface.
 - 6. Excavation of ditches and gutters:
 - a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
 - b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
 - c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
 - d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.
 - 7. Necessary over excavation:
 - a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
 - b. Backfill voids with material acceptable to the Engineer:
 - 1) With acceptance of the Engineer, backfill with one of the following:
 - a) CDOT Class 6 aggregate base course.
 - b) Controlled low-strength material.
- F. Materials for backfills, embankments, fills, and roadway fills:
- 1. General:
 - a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within the Project Site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
 - 2. Backfills:
 - a. Backfill adjacent to structures, slabs, or walls, unless otherwise specified or indicated on the Drawings.
 - 1) CDOT Class 2 fill material compacted to 95 percent maximum dry density.
 - a) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - 2) CDOT Class 1 material compacted to 95 percent maximum dry density.
 - a) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - b. Backfill material under concrete structures:
 - 1) CDOT Class 6 aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
 - 2) Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.

3. Embankments:
 - 1) CDOT Class 2 fill material compacted to 95 percent maximum dry density.
 - a) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - 2) CDOT Class 1 material compacted to 95 percent maximum dry density.
 - a) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
- G. Placement:
 1. General:
 - a. Lines and grades:
 - 1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
 - 2) Overbuild permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
 2. Backfills:
 - a. Place loose material in successive layers that do not exceed 8 inches in depth for heavy equipment after compaction, and that do not exceed 6 inches in depth for handheld equipment after compaction.
 - b. Bring each layer to a moisture content between 2 percent below optimum moisture content and 2 percent above optimum moisture content before compacting.
 - c. Defective compacted backfills: Remove and recompact.
 3. Embankments:
 - a. Place loose material in successive layers that do not exceed 8 inches in depth for heavy equipment after compaction, and that do not exceed 6 inches in depth for handheld equipment after compaction.
 - b. Bring each layer to a moisture content between 2 percent below optimum moisture content and 2 percent above optimum moisture content before compacting.
 - c. Defective compacted embankments: Remove and recompact.

3.04 FIELD QUALITY CONTROL

- A. Confirmation tests:
 1. Contractor's responsibilities:
 - a. Adequacy of compaction equipment and procedures:
 - 1) Demonstrate adequacy of compaction equipment and procedures.
 - 2) At each test location include tests for each type or class of backfill from bedding to finish grade.
 - b. Compaction sequence requirements:
 - 1) Do not perform additional earthwork of the same kind until specified degree of compaction has been demonstrated.
 - c. Cost of confirmation tests: Paid for by the Contractor.
 - d. Qualifications of the Contractor's testing laboratory: Acceptable to the Engineer.
 - e. Copies of confirmation test reports: Submit promptly to the Engineer.

2. Frequency of confirmation testing:
 - a. In-place density testing:
 - 1) Backfill: Minimum of 1 test per 900 square feet (or fraction thereof) per lift.
 - 2) Fill material maximum dry density versus moisture relationship testing:
 - a) For each fill material, minimum of 1 test at intervals not greater than the least of the following:
 - (1) Every 90 days;
 - (2) Every 5,000 cubic yard placed; or
 - (3) Whenever the type of characteristics of the material change.
 - b. Cost of confirmation tests:
 - 1) Paid for by the Contractor.
 - c. Qualifications of the Contractor's testing laboratory:
 - 1) Perform confirmation testing by soils testing laboratory acceptable to the Engineer. Copies of confirmation test reports: Submit promptly to the Engineer.
- B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
 - a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
 - b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
 2. Unlined channels and basins:
 - a. In both cut and fill, and levee and access road side slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.
 - b. On top surface of levee and access road in both cut and fill, and levee and access road side slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.
 3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
 - a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6-inches deep.
 - b. Intent of proceeding is to avoid sandy or gravelly areas.
 4. Finish grading of surfaces:
 - a. Reasonably smooth, compacted, and free from irregular surface changes.
 - b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
 - c. Uniformly grade areas that are not under concrete.
 - d. Finish ditches and gutters so that they drain readily.
- C. Compliance tests:
1. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.

3.05 ADJUSTING

- A. Finish grades of excavations, backfills, and fills:
 - 1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

- A. Finish grades of backfills, cuts, excavations, and fills:
 - 1. Protect newly graded areas from erosion and deterioration by action of the elements.
- B. Ditches and gutters:
 - 1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 31_05_15

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Material requirements for soils and aggregates.

1.02 REFERENCES

- A. ASTM International (ASTM):
 1. C117 - Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 4. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 5. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 6. D4829 - Standard Test Method for Expansion Index of Soils.
 7. D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
- B. Colorado Department of Transportation (CDOT):
 1. Standard Specifications for Road and Bridge Construction (Standard Specifications).

1.03 SUBMITTALS

- A. Product data:
 1. Material source.
 2. Gradation.
 3. Testing data.
- B. Quality control for aggregate base course:
 1. Test reports: As required by Sections of Standard Specifications.
 2. Certificates of compliance: As required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.
- B. Comply with Standard Specifications storage requirements, if applicable.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

- A. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.
- B. Comply with soil and aggregate material requirements in the Standard Specifications, unless specified otherwise.

2.02 CDOT CLASS 1 MATERIAL

- A. Imported structural backfill meeting the following requirements:
 - 1. A plasticity index less than 6.
 - 2. A liquid limit less than 35.
 - 3. Gradation as shown in the table below:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2-inch	100
No. 4	30 - 100
No. 50	10 - 60
No. 200	5 - 20

2.03 CDOT CLASS 2 MATERIAL

- A. Processed native material is acceptable under the following conditions:
 - 1. Processing onsite materials shall include removing expansive materials, frozen chunks, wood, trash, organic material, and cobbles and boulders larger than 3 inches in any dimension.
- B. Excavated bedrock shall not be used as backfill material.

2.04 CDOT CLASS 5 AGGREGATE BASE COURSE

- 1. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to required size and grading and free from vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
- 2. Materials derived from crushed reclaimed concrete or asphalt:
 - a. Shall not be used for aggregate base course under structures or around pipes.
 - b. May be used as base course under asphaltic concrete or concrete paving when accepted by the Engineer.
- 3. Conform to CDOT Standard Specifications, "Class 5 Aggregate Base Course" (CDOT Section 703.03). Gradation as shown in the following table, and liquid limit of 30 or less.

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
1 1/2-inch	100
1-inch	95 - 100
No. 4	30 - 70
No. 200	3 - 15

2.05 CDOT CLASS 6 AGGREGATE BASE COURSE

- A. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to required size and grading and free from vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
- B. Materials derived from crushed reclaimed concrete or asphalt:
 - 1. Shall not be used for aggregate base course under structures or around pipes.
 - 2. May be used as base course under asphaltic concrete or concrete paving when accepted by the Engineer.
- C. Conform to CDOT Standard Specifications, "Class 6 Aggregate Base Course" (CDOT Section 703.03). Gradation as shown in the following table, and liquid limit of 30 or less.

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
1-inch	100
3/4-inch	95 - 100
No. 4	30 - 65
No. 8	25 - 55
No. 200	3 - 12

2.06 CRUSHED ROCK FOR PRECAST MANHOLE BASES

- A. Consist of hard, durable particles or fragments of stone or gravel crushed to specified sizes and gradations.
- B. Free from organic matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
- C. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
 - 1. Plasticity Index: Not greater than 5 when tested in accordance with ASTM D4318.

2. Liquid Limit: Not greater than 25 percent when tested in accordance with ASTM D4318.
3. Conform to CDOT Standard Specifications "Class B Filter Material" (CDOT section 703.09), except with gradation modified as shown in the following table.

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
1-1/2-inch	100
3/4-inch	60 - 90
No. 4	0 - 20
No. 200	0 - 3

2.07 GRANULAR BEDDING MATERIAL

- A. Granular bedding material:
 1. No. 67 Stone material conforming to size and grade within the limits as follows when tested in accordance with ASTM C117 and C136.

No. 67 Stone	
Sieve Size (Square Openings)	Percent By Weight Passing Sieve
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
Number 4	0-10
Number 8	0-5

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 31_10_00

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Clearing, grubbing, and stripping project site.

1.02 DEFINITIONS

- A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.
- B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.
- C. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 6 inches, but the required depth of stripping will be determined by the Engineer.

1.03 QUALITY ASSURANCE

- A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.
- B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.04 SEQUENCING AND SCHEDULING

- A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

- A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

- A. Clearing:
 - 1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.
 - 2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.
 - 3. Contractor's temporary construction facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.
- B. Grubbing:
 - 1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
 - 2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment Over Stump	Depth of Clearing and Grubbing
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

- 3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.
- C. Stripping:
 - 1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.

2. Deposit stripped material in accordance with following requirements:
 - a. At locations acceptable to Engineer.
 - b. Use accepted material in top 6 inches of areas to be used for future planting.
3. Replace topsoil where grass, vegetation, or reseeding will be replaced as part of construction impacts.

END OF SECTION

SECTION 31_23_22

DEWATERING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements to dewater trench excavations.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 COORDINATION REQUIREMENTS

- A. Coordinate the dewatering system design with excavation and shoring design.
- B. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures in compliance with project geotechnical report requirements.
- C. Do not place concrete or masonry foundations or concrete slabs in water. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.
 - 1. Maintain operation of dewatering system:
 - a. Until complete structure has been constructed, including walls, slabs, beams, struts, and other structural elements.
 - b. Concrete has attained its specified compressive strength.
 - c. Backfill has been completed to finished grade.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_01 - Product Requirements.
- B. Dewatering plan.
- C. Copies of correspondence with the authorities having jurisdiction, regarding dewatering operations, including, but not limited to, the authorization to drill, well driller's license, well driller's permits, and completion report.
- D. Well construction logs: Include the following at a minimum:
 - 1. Descriptions of actual materials encountered, categorized in accordance with the Unified Soil Classification System.
 - 2. Construction details.
 - 3. Well development procedures and results.
 - 4. Deviations from original design.

- E. Submit a drainage encroachment permit.
- F. Submit a settlement monitoring plan.
- G. Qualifications:
 - 1. Dewatering Contractor.
 - 2. Dewatering design Engineer.
 - a. Civil Engineer, licensed in the state where the project is located.
 - b. Minimum experience: 8 years of experience in designing similar systems of equal type, size, and complexity to that required for the Work.
 - 3. Testing laboratory.
- H. Flowmeter:
 - 1. Product information on flowmeter and method for recording flow volume.
 - 2. Recent flowmeter calibration documentation.
 - 3. Flowmeter volume records.

1.05 CONTROLS

- A. Dewatering shall be performed at the discretion of the Contractor as approved by the Engineer.
- B. Demonstrate the system proposed and verify that adequate equipment, personnel, and materials are provided to dewater the excavations.
- C. Discharge water without damaging adjacent property, and in conformance with discharge permit and regulations, including meeting discharge limitation parameters.
 - 1. Any penalties and fees due to non-conformance with permit shall be the responsibility of the Contractor.
- D. Contractor shall be responsible for ensuring dewatering operations shall be adequate to ensure the integrity of the finished project.

1.06 DEWATERING WELLS

- A. Design the well casing, screen slot size, and gravel filter pack according to applicable laws and regulations.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Design the dewatering system to keep excavations reasonably free from water. Locally draw down static groundwater level in trench to minimum of 3 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
- B. Dewatering design and analysis. Include the following:
 - 1. Evaluation of anticipated subsurface conditions.
 - 2. Required well spacing.

3. Diameter of wells.
 4. Drilling method and development technique.
 5. Depth to screen, screen height, and mesh size.
 6. Backfill and filter pack.
 7. Pump size.
 8. Drawdown curves.
 9. Drawdown duration.
 10. Drawdown and steady state flow rates.
 11. Plans for treatment of groundwater treatment.
 12. Plans for de-silting of groundwater before discharge.
- C. Include water drawdown curves in dewatering calculations.
- D. Provide dewatering design sealed by a registered Professional Engineer, licensed in the project location.

2.02 DESIGN CRITERIA

- A. Prior to excavation, submit a detailed dewatering plan and operation schedule for dewatering of excavations.
- B. Design the dewatering system to keep excavations reasonably free from water.
1. Select appropriate method to dewater, subject to Engineer's review and concurrence.
 2. Shored excavation dewatering as specified in Section 31_23_35 - Trenching.
 3. Draw down static groundwater level to minimum of 3 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
 4. Dewatering analysis shall determine the following:
 - a. Evaluation of anticipated subsurface conditions.
 - b. Required well spacing.
 - c. Diameter of wells.
 - d. Depth to screen, screen height, and mesh size.
 - e. Backfill and filter pack.
 - f. Pump size.
 - g. Drawdown curves.
 - h. Drawdown duration.
 - i. Drawdown and steady state flow rates.
 - j. Plans for treatment of groundwater treatment.
 5. Prevent unstable excavation due to pumping and heave.
 6. Dewatering plan prepared by a professional Engineer licensed in the state where the project is located.
 7. Dewatering plan shall include, but not be limited to, the following:
 - a. Dewatering design analysis and supporting calculations.
 - b. Required permits.
 - c. Arrangement, location, and depths of dewatering system components including monitoring wells.
 - d. Type of proposed pumps to be used and their locations.
 - e. Header piping size, material, and piping alignments.
 - f. Meter type and locations.
 - g. Valve type and locations.
 - h. Piezometer locations.

- i. Well casing and well screen materials.
 - j. Gravel filter pack materials.
 - k. Proposed discharge locations, as identified in this Section.
 - l. Settling tanks and filters.
 - m. Pipeline material, alignment, and connection details.
 - n. Materials added to borehole during drilling and construction of wells.
 - o. Sample and sieve analysis of well materials.
 - p. Settlement monitoring plan for existing above and underground structures adjacent to the dewatering system.
 - q. Standby pumping equipment.
 - r. Required power supply equipment.
 - s. Design of any needed water treatment facilities shall comply with the NPDES discharge permit.
- C. Locate dewatering facilities where they will not interfere with utilities and construction work.
 - D. Design and install a water treatment system if necessary to comply with discharge limitation parameters.
 - E. Decommissioning:
 - 1. Obtain Engineer's approval to begin decommissioning activities.
 - 2. Decommission and remove dewatering system.
 - 3. Abandon existing monitoring wells located along the alignment.

2.03 EQUIPMENT

- A. Provide and maintain equipment necessary for dewatering.
- B. Keep standby equipment available at all times to ensure efficient dewatering and maintenance of dewatering operation during power failure.

2.04 DEWATERING PUMPS

- A. Specifically designed for dewatering applications where pumping sand may be encountered.
 - 1. Impeller and rotor shaft shall be hardened, heat-treated stainless steel. Mechanical seal material shall be silicon carbide.
 - 2. Pump motor shall have thermal overload protection.

2.05 FLOWMETER AND METHOD OF VOLUME MEASUREMENT

- A. Flowmeter: One of the following, or equal:
 - 1. Badger Turbo Series Meter.
 - 2. Provide method of volume measurement that is acceptable to the Engineer and the authorities having jurisdiction for the dewatering permit.

PART 3 EXECUTION

3.01 DEWATERING PROCEDURES

- A. Designer of the dewatering system shall oversee dewatering operations.
- B. Site grading shall promote drainage. Surface runoff shall be diverted away from excavations.
- C. Complete dewatering prior to excavation.
 - 1. Ensure that the subsurface soil is not being removed by the dewatering operation.
- D. Continue dewatering operations throughout construction to achieve the following:
 - 1. Maintain the groundwater level a minimum of 3 feet below bottom of excavation.
 - 2. Preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. Make provisions to maintain continuous dewatering.
 - 1. Provide standby power to maintain dewatering during power outages and interruptions.
 - 2. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of providing or obtaining work required to maintain system operation.
- F. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, excavate the affected areas and replaced with drain rock at no additional cost to Owner.
- G. Maintain a trench bottom free from standing water.
- H. Prevent flotation by maintaining a positive and continuous removal of water.
- I. Contractor shall be fully responsible and liable for damages that may result from failure to adequately keep excavations dewatered.
- J. Do not place concrete or masonry foundations or concrete slabs in water.
 - 1. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.
- K. Maintain operation of dewatering system until the pipeline has been installed and backfill has been completed to finished grade.
- L. Wells, well points, and drain lines for dewatering:
 - 1. Obtain Engineer's written acceptance prior to commencing operations.
 - 2. Fill dewatering wells, pipes, and French drains to be left in place within structure foundation limits with Class "C" concrete as specified in Section 03_30_01 – Concrete Work, or grout as specified in Section 03_60_00 - Grouting.

3.02 SETTLEMENT AND GROUNDWATER LEVEL MONITORING

- A. Conduct dewatering operation in a manner that will protect adjacent structures and facilities.
- B. Repair damage to adjacent structures and restore facilities at no expense to Owner.

3.03 WATER DISPOSAL

- A. Dispose of water from the Work in suitable manner:
 - 1. Without damage to adjacent property.
 - 2. That will not be a menace to public health or safety.
- B. Do not drain dewatering water or associated debris into the Work built or under construction.
- C. For discharge of water into holding tanks or infiltration ponds, include a means of overflow protection that is acceptable to the Engineer.

3.04 FIELD QUALITY CONTROL

- A. Monitoring wells:
 - 1. Record groundwater levels at least once a week. Submit readings to Engineer within 1 week.
- B. Flowmeter:
 - 1. Provide flowmeter and method for recording dewatering flow volume.
 - 2. Calibrate flowmeter and recorder device to provide accuracy within 5 percent.
 - 3. Submit written evidence of calibration of meter signed by a Professional Engineer registered in the state where Project is located.
 - 4. Submit readings to the Engineer on a weekly basis.

END OF SECTION

SECTION 31_23_24

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

- A. Controlled low strength material (CLSM), also known as "flowable fill," shall conform to City of Arvada Standard Specification Section 822.04. Provide a low-strength "diggable" mix for all CLSM used above pipes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.
- B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

- A. Pipes and trenches.
 - 1. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
 - 2. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.

3.03 FIELD QUALITY CONTROL

- A. Provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control and Section 01_45_17 - Contractor Quality Control Plan and as specified in this Section.
- B. General:
 - 1. Engineer inspection and acceptance required prior to placement.
 - 2. Make provisions for and furnish all material for the test specimens and provide manual assistance to assist the Testing Laboratory in preparing said specimens.

3.04 FIELD QUALITY ASSURANCE

- A. Provide quality control over the work of this Section as specified in Section 01_45_00 - Quality Control and Section 01_45_17 - Contractor Quality Control Plan.
- B. Field inspections:
 - 1. Engineer shall provide on-site inspection for the Work of this Section.
 - 2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
 - 3. Required inspections:
 - a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
 - 4. Record of inspections.
- C. Field sampling and testing:
 - 1. During construction, Contractor shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified.
 - 2. Sample CLSM for testing in accordance with ASTM D5971.
 - 3. Required tests:
 - a. Air content: Prepare sample and test in accordance with ASTM D6023.
 - b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832.
 - 1) Prepare 6-inch diameter by 12-inch high specimens for testing.
 - a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
 - b) Prepare and test not less than 3 cylinders for each set.
 - c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
 - d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.
 - 2) Place the cylinders in a safe location away from construction activities.
 - a) Protect cylinders from bumping and impact.
 - b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
 - c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.
 - 3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing.
 - a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
 - b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.

- 4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
- 5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
- 6) Cap and test for compressive strength in accordance with ASTM D4832.
 - a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
 - b) Test 1 cylinder at 7 days and 2 at 28 days.
- 7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.05 NON-CONFORMING WORK

- A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.
- B. Engineer may:
 1. Reject CLSM represented by those test specimens and require its removal and replacement.
 2. Require modification of the mix design to provide CLSM with the properties specified.
- C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 31_23_35

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Trench excavation and trench backfill for pipelines, manholes, vaults, and appurtenances.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
 - 2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - 3. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using Vibratory Table.
 - 4. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 5. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. Backfill: Material placed in trench above the pipe embedment zone.
 - 2. Bedding: Material placed under, around, and over pipes or ducts in trenches.
 - 3. Fine grading: Bedding material placed directly below pipes or ducts to provide support at the bottom of the trench and to bring those elements to required grades and elevations.
 - 4. Flexible pipe: Includes steel, ductile iron, thermoplastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.
 - 5. Haunch zone: Material placed below and beside the pipe up to the pipe springline.
 - 6. Lift: A layer of soil or aggregate material, measured before compaction.
 - 7. Maximum density, Field Compaction: Soil density and water content when tested in accordance with ASTM D1556 or ASTM D6938.
 - 8. Maximum density, Laboratory Compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557 or ASTM D698.
 - 9. Pavement section: Includes pavement plus underlying courses such as base course and subgrade.

10. Pipe embedment zone: Includes bedding, fine grading, and haunch zone.
11. Pipe foundation: Material placed at the bottom of trench to provide support.
12. Pipe foundation: Stabilization material placed at the bottom of trench to provide support when the trench bottom is not firm, dry, or uniform.
13. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.
14. Rigid pipe: Includes reinforced non-cylinder concrete, reinforced concrete cylinder, prestressed concrete cylinder, vitrified clay, polymer concrete, cast iron, asbestos cement, and cast-in-place pipes.

1.04 SUBMITTALS

- A. As specified in Section 01_33_00 - Submittal Procedures.
- B. Product data on soils and aggregates.
 1. Material source.
 2. Gradation.
 3. Test data to demonstrate compliance with requirements as specified in this Section.
- C. Samples:
 1. Provide 50-pound sample of materials when requested by the Engineer.
- D. Confirmation testing:
 1. Certification of Contractor's testing laboratory.
 2. Record copy report for tests performed by Contractor's testing laboratory.

PART 2 PRODUCTS

2.01 MATERIALS

- A. As specified in Section 31_05_15 - Soils and Aggregates for Earthwork.
- B. Class C concrete: As specified in Section 03_30_01 – Concrete Work.
- C. Controlled low-strength material: As specified in Section 31_23_24 - Controlled Low Strength Material (CLSM).

PART 3 EXECUTION

3.01 PREPARATION

- A. Stabilize excavations as specified in Section 31_50_00 - Excavation Support and Protection.
- B. Perform subsurface utility engineering (SUE) for utility locating and verification prior to any excavation work.

3.02 DEWATERING

- A. As specified in Section 31_23_22 - Dewatering.

3.03 TRENCH EXCAVATION

- A. Excavate bottom of trench to depth indicated on the Drawings.
- B. Areas of new fill or embankment:
1. Prior to laying pipes or electrical service, place fill and compact as specified to not less than 2 feet above top of pipe, conduit, or duct bank.
 2. Excavate through fill for pipe trench.
- C. Trench widths as specified in the following table:

Buried Pipe or Accessory	Minimum Trench Width	Maximum Trench Width
Nominal Pipe Diameter: 4-inch to 24-inch	OD + 18 inches	OD + 24 inches
Nominal Pipe Diameter: Greater than 24-inch	OD + 24 inches	OD + 36 inches
Manholes, vaults, valves, or other accessories	12 inches between outer surface and trench side or shoring	Not applicable

- D. Potable water pipe and appurtenances:
1. Lay in trenches separate from those used for sewers and recycled water.
 2. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground located at distance of not less than 10 feet clear horizontally from any parallel sewer and 1.5 foot clear vertically above any parallel sewer.
- E. At road crossings or existing driveways:
1. Provide notification, vehicular access, and traffic control as required by permits and special conditions.
 2. Provide temporary asphalt or plating for traffic or access at the end of each work day unless approved in writing by the Engineer.
 3. If unexpected utility conflicts or changed site conditions require trenchless technologies or temporary bridges, immediately notify the Engineer in writing. Approval is required before proceeding with construction.
 4. When trench width at top of pipe is increased beyond width specified in this Section because of soil conditions, safety requirements, or other reasons, Engineer approval for remedy is required without additional cost to the Owner.
 - a. Remedy may include upgrade laying conditions or install stronger pipe designed in accordance with Specifications.

3.04 TRENCH BACKFILL - GENERAL

- A. Trench area terminology and locations as indicated on the Drawings.

- B. Place material, except CLSM and concrete, in maximum 6-inch lifts, measured before compaction.
- C. Backfilling of manhole excavation: Conform to backfilling requirements for trenches as specified in this Section.

3.05 PIPE FOUNDATION

- A. Provide trench bottom with firm, dry, uniform bearing surface at the grade indicated on the Drawings.
- B. Excess excavation below elevation indicated on the Drawings will require installation of pipe foundation material to bring the trench bottom back to the elevation indicated on the Drawings at no additional cost to the Owner.
 - 1. Materials and placement:
 - a. CDOT Class 5 or 6 base course compacted to 95 percent maximum dry density.
 - b. Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
- C. If bottom of trench excavation consists of rock or any material that, by reason of its hardness, cannot be excavated to provide uniform bearing surface:
 - 1. Remove such rock or other material to a depth of not less than 4 inches below pipe embedment zone.
 - 2. Materials:
 - a. CLSM.
 - b. Class C concrete.
- D. If bottom of trench excavation consists of mud or other soft unstable material:
 - 1. Remove such unacceptable material to a depth of not less than 18 inches below pipe embedment zone.
 - 2. Material and placement:
 - a. CDOT Class 5 or 6 base course compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - b. Wrap base course in a stabilization product meeting the minimum requirements of the following:
 - 1) Tensar Biaxial Geogrid BX1200.
 - 2) Mirafi Woven Geotextil HP270.
 - 3) Or approved equal.

3.06 PIPE EMBEDMENT ZONE

- A. Pipe displacement:
 - 1. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
 - 2. In the event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.

- B. Fine grading:
 - 1. Place 6 inches of approved haunch zone bedding material from the trench bottom to the bottom of the pipe or duct to provide support at the bottom of the trench and to bring those elements to required line and grade.
- C. Depressions for joints or couplings:
 - 1. Excavate holes in the fine grading material at the bottom of the trench.
 - 2. Provide holes of sufficient width to provide ample room for grouting, banding, or welding as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.
- D. Flexible pipe:
 - 1. Haunch zone:
 - a. Materials and placement:
 - 1) Granular pipe bedding material compacted to a minimum relative density of 65% in accordance with ASTM D4263 and ASTM D4254.
 - 2) CLSM.
 - 2. Bedding:
 - a. Compacted depth above top of pipe: 12-inch minimum.
 - b. Materials and placement:
 - 1) Granular pipe bedding material compacted to a minimum relative density of 65% in accordance with ASTM D4263 and ASTM D4254.
 - 2) CLSM.

3.07 BACKFILL

- A. Trenches:
 - 1. Materials and placement:
 - a. CDOT Class 2 fill material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - b. CDOT Class 1 material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
- B. Trenches in rock:
 - 1. Backfill to top of rock.
 - a. Materials and placement:
 - 1) CLSM.
 - 2) Class C concrete.
 - 2. Backfill from top of rock to grade, if applicable:
 - a. Materials and placement:
 - b. CDOT Class 2 fill material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - c. CDOT Class 1 material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.

- C. Trenches below or within 10 feet of the outside perimeter of structures:
 - 1. Backfill to underside of structure.
 - 2. Materials and placement:
 - a. CLSM.
- D. Trenches under existing intersecting pipes, duct banks, or conduits larger than 3 inches in diameter:
 - 1. Backfill from above top of new pipe embedment zone to springline of intersecting pipe or conduit.
 - a. Extend backfill at least 2 feet on either side of intersecting pipe or conduit to ensure backfill material remains in place while other backfill is being placed.
 - b. Materials and placement:
 - 1) CLSM, unless otherwise indicated on the Drawings.
 - 2. Backfill remainder of trench:
 - a. Materials and placement:
 - b. CDOT Class 2 fill material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.
 - c. CDOT Class 1 material compacted to 95 percent maximum dry density.
 - 1) Moisture content from 2 percent below to 2 percent above optimum moisture content as determined by ASTM D698.

3.08 EXCESS MATERIAL

- A. Remove excess excavated material from the Project site as specified in Section 31_00_00 - Earthwork.

3.09 FIELD QUALITY CONTROL

- A. Provide field quality control for the Work as specified in Section 01_45_00 - Quality Control.
- B. Confirmation tests by Contractor: As specified in Section 31_00_00 - Earthwork.
 - 1. Minimum frequency of confirmation testing, unless more frequent testing is required by Colorado Department of Transportation (CDOT) standards:
 - a. At each test location include tests for each type or class of backfill from bedding to finished grade.
 - b. For trenches: Every 400 linear feet, at bottom third, middle third, and top third of bedding and backfill.
- C. Compliance tests by Owner:
 - 1. Make periodic compliance tests to verify that compaction is meeting requirements as specified in this Section.
 - 2. Perform remedial work if compaction test fails to meet specified requirements using one of the following methods:
 - a. Remove and replace backfill at the proper density.
 - b. Other means acceptable to the Engineer.

- 3. Retesting:
 - a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
 - b. Contractor's confirmation tests during performance of remedial work:
 - 1) Performance: Perform tests in manner acceptable to the Engineer.
 - 2) Frequency: Double amount specified for initial confirmation tests.
- D. Piping system testing:
 - 1. As specified in Section 33_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 31_50_00

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for designing, providing, maintaining, and removing excavation support and protection.

1.02 REFERENCES

- A. American Society of Civil Engineers (ASCE):
 - 1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
- B. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
 - 1. Design Manual 7.2 - Foundations and Earth Structures.
 - 2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.
- C. United States Steel Corporation (USS):
 - 1. Steel Sheet Piling Design Manual.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
 - 1. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.
 - 2. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, internally braced sheet piling, slurry walls, soldier piles and lagging, and other similar shoring systems. Sloping of the soil is not shoring.
 - 3. Support levels: Level of tiebacks, wales, rakers, bottom of excavation, and other types of support.

1.04 SUBMITTALS

- A. Shop Drawings and calculations:
 - 1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
 - 2. Sketches showing the condition at various stages of installation and removal of shoring.
 - 3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.

4. When utilities penetrate shoring, show location of penetrations on elevation of sides of shoring.
 5. Show details for ground support and sealing around utility penetrations.
 6. Indicate method used for installing driven shoring.
- B. Control points and schedule of measurements:
1. Submit location and details of control points and method and schedule of measurements.
 2. Survey data.
- C. Detailed sequence of installation and removal of shoring:
1. Consider effects of ground settlement in sequence of installation and removal of shoring.
 2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.
- D. Furnish Submittals for excavation support and protection as complete package and include items required in this Section:
1. Incomplete Submittals will not be reviewed and will be returned for resubmittal as complete package.
- E. Furnish dewatering Submittals as specified in Section 31_23_22 - Dewatering with Submittals for excavation support and protection.

1.05 SEQUENCING

- A. Do not begin construction of any shoring or excavation operations until:
1. Submittals for shoring and dewatering have been accepted.
 2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
 3. Materials necessary for installation are on site.
- B. Furnish Submittals a minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Where general engineering design practice is specified, provide Drawings and calculations that are performed and signed by civil or structural engineer registered in State where Project is located:
1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
 2. Submit list of references acceptable to the Engineer that substantiate appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:

1. General:

- a. Dewatering:
 - 1) Dewater soil inside shoring as specified in Section 31_23_22 - Dewatering.
- b. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code per City of Arvada and City of Westminster requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
- c. Minimum safety factor used for design shall not be less than 1.5.
- d. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
- e. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
- f. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
- g. Generally acceptable references for design of shoring and excavations are as follows:
 - 1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
 - 2) NAVFAC Design Manual 7.2.
 - 3) NAVFAC Design Manual 7.3.
 - 4) USS Steel Sheet Piling Design Manual.

2. Soldier piles and lagging:

- a. Provide lagging over full face of excavation. Joints between pieces of lagging shall be tight to prevent loss of soil.
- b. Provide full face lagging around penetrations through lagging.
- c. If the soldier piles are installed in predrilled holes and are not concrete encased, fill predrilled holes with controlled low strength material as specified in Section 31_23_24 - Controlled Low Strength Material (CLSM) after soldier piles are installed.
- d. Assumed effective width for passive soil resistance:
 - 1) Effective width of driven soldier piles shall not exceed 2 times width of pile.
 - 2) Effective width of CLSM encased soldier piles in drilled holes shall not exceed 2 times width of pile.
 - 3) Effective width of concrete encased soldier piles shall not exceed 2 times width of concrete encasement.
- e. Fill voids behind lagging with gravel or other material acceptable to the Engineer.
- f. Apply loads from tie back soil, rock, or deadman anchors concentrically to soldier piles or wales spanning between soldier piles:
 - 1) Wales shall be back-to-back double channels or other members acceptable to the Engineer.
 - 2) Do not eccentrically load structural section of soldier piles or wales.
- g. Design soldier piles for downward loads including vertical loads from tieback anchors.

3. Soil anchors, rock anchors, and deadman anchors:
 - a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.
 - b. Proof load production anchors to 125 percent of calculated load from shoring.
 - c. Lock off production anchors at calculated load from shoring.
 - d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
 - e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
 - f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.
 4. Set inside face of shoring back from structure not less than greater of following:
 - a. 5 feet from face of wall.
 - b. 2 feet 6 inches from edge of foundation.
 - c. Depth of excavation below bottom of foundation.
- C. Performance requirements:
1. General:
 - a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
 - b. Specified provisions:
 - 1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.
 - 2) Represent minimum requirement for:
 - a) Number and types of means needed to maintain soil stability.
 - b) Strength of such required means.
 - c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
 2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
 3. Provide support for trench excavations for protection of workers from hazard of caving ground.
 4. Provide shoring:
 - a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
 - 1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
 - 2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.

- b. For trenches 5 feet and deeper.
- c. For trenches less than 5 feet in depth, when there is potential for cave-in.
- d. Where indicated on the Drawings.
- 5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
 - a. Using stiff shoring systems.
 - b. Following appropriate construction sequence.
 - c. Using shoring system that is tight enough to prevent soil loss through the shoring.
 - d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
 - e. Design for safety factor of not less than 1.50.
 - f. Providing surface runoff routing and discharge away from excavations.
 - g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
 - h. Where sheet piling is used, use interlocking type sheets:
 - 1) Sheet piles shall be continuous and driven in interlock.
 - 2) If bottom of the excavation is located below the water table, use "ball and socket" or "thumb and finger" type interlock.
 - i. Not applying shoring loads to existing structures and other improvements.
 - j. Not changing existing soil loading on existing structures and other improvements.
 - k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Installation of shoring:
 - 1. Install means for providing safe and stable excavations as indicated in Submittals.
- B. Removal of shoring:
 - 1. Except for slurry walls, and similar shoring systems, remove shoring by completion of Work.
 - 2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
 - 3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
 - a. Inject grout starting at bottom of void and progressively fill void to grade.
 - b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
 - 4. Pressure preservative treated wood lagging may be left in place if acceptable to the Engineer.

- C. Control points:
1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
 - a. Set control points on shoring support system:
 - 1) Set points at distances not exceeding 25 feet at each support level.
 2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
 3. Perform horizontal and vertical survey and measurement of control points at least once every week.
 - a. Field notes shall show current measurement and change in measurement from first measurement taken.
 4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
 5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.
- D. Maintenance:
1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to the Engineer.
 2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 32_12_15
ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

- A. Asphalt concrete paving shall be per the Colorado Department of Transportation (CDOT) Standard Specifications Section 401 - Plant Mix Pavement - General, Section 403 - Hot Mix Asphalt, and Section 411 - Asphalt Materials.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 32_16_14

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 GENERAL

1.01 SUMMARY

- A. Concrete sidewalks shall meet the requirements of the Colorado Department of Transportation (CDOT) Standard Specification Section 608 - Sidewalks and Bikeways.
- B. Concrete curb and gutter shall meet the requirements of CDOT Standard Specification Section 609 - Curb and Gutter.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 32_17_23
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Pavement markings shall be per Colorado Department of Transportation (CDOT) Standard Plan S-627-1 and CDOT Standard Specification Section 627 - Pavement Marking.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 32_92_19

SEEDING

PART 1 GENERAL

1.01 SUMMARY

- A. Provide sod and seeding as indicated on the Drawings. Reseeding and sodding of areas impacted by construction shall be City of Westminster Standards and Specifications, Sections 2.20.00, 2.30.00, and 2.40.00.
- B. Reseeded and sodded areas shall be maintained and replaced during the 3-growing season period as required by the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 33_05_00.01

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Basic materials and methods for metallic and plastic piping systems.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24.
 - 2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard.
- B. American Water Works Association (AWWA):
 - 1. C11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe.
 - 2. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 3. C151 - Ductile-Iron Pipe, Centrifugally Cast.
 - 4. C207 - Standard for Steel Pipe Flanges for Waterworks Services-Size 4 In. through 144 In.
 - 5. C230 - Stainless-Steel Full-Encirclement Repair and Service Connection Clamps for 2 In. through 12 In. Pipe.
- C. ASTM International (ASTM):
 - 1. A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 - 2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - 3. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 4. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - 5. A536 - Standard Specification for Ductile Iron Castings.
 - 6. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 7. B88 - Standard Specification for Seamless Copper Water Tube.
 - 8. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
 - 9. D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings.
 - 10. F37 - Standard Test Methods for Sealability of Gasket Materials.
 - 11. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

12. F594 - Standard Specification for Stainless Steel Nuts.
 13. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
- D. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

- A. Buried Pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.
- B. Exposed Pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.
- C. Pipes Adjacent to a Wet Wall: Pipe centerline within 10 inches of the wet wall.
- D. Underground PIPES: Buried pipes - see A. above.
- E. Underwater Pipes: Pipes below the top of walls in basins or tanks containing water.
- F. Wet Wall: A wall with water on at least 1 side.

PART 2 PRODUCTS

2.01 GENERAL

- A. Materials as specified in Section 01_60_01 - Product Requirements including special requirements for materials in contact with drinking water.

2.02 LINK TYPE SEALS

- A. Characteristics:
1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
 2. Links to form a continuous rubber belt around the pipe.
 3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.
 4. Hardware to be Type 316 stainless steel.
 - a. Provide anti-galling lubricant for threads.
- B. One of the following or equal:
1. Link-Seal.
 2. Pipe Linx.

2.03 FLANGE BOLTS AND NUTS

- A. General:
 - 1. Washer:
 - a. Provide a washer for each nut.
 - b. Washer shall be of the same material as the nut.
 - 2. Nuts: Heavy hex-head.
 - 3. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
 - 4. Tap holes for cap screws or stud bolts when used.
 - 5. Lubricant for stainless steel bolts and nuts:
 - a. Chloride-free.
 - b. Manufacturers: One of the following or equal:
 - 1) Huskey FG-1800 Anti-Seize.
 - 2) Weicon Anti-Seize High-Tech.
- B. On buried pipes:
 - a. Bolts: ASTM A193, Grade B8M Stainless Steel, ASME B1.1 Class 2A threads, with dimensions in accordance with ASME B18.2.1.
 - b. Nuts: ASTM A194, Grade 8M Stainless Steel, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.

2.04 MECHANICAL JOINTS BOLTS AND NUTS

- A. Bolts, including T bolts:
 - 1. Type 304 stainless steel in accordance with ASTM F593.
- B. Heavy hex nuts:
 - 1. Type 304 stainless steel in accordance with ASTM F594.

2.05 GASKETS

- A. General:
 - 1. Gaskets shall be suitable for the specific fluids, pressure, and temperature conditions.
 - 2. Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure.
- B. Gaskets for flanged joints in ductile iron and steel piping for sewage service:
 - 1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 250 degrees Fahrenheit, and raw sewage service.
 - 2. Material:
 - a. SBR or neoprene elastomer with minimum Shore A hardness value of 70.
 - b. Reinforcement: Cloth or synthetic fiber.
 - c. Thickness:
 - 1) Minimum 3/32 inch for less than 10-inch pipe.
 - 2) Minimum 1/8 inch for 10-inch and larger pipe.

3. Manufacturers: One of the following or equal:
 - a. Pipe less than 48 inches in diameter:
 - 1) Garlock, Style 7797.
 - 2) John Crane, similar product.
 - b. Pipe 48 inches in diameter and larger:
 - 1) Garlock, Style 3760.
 - 2) John Crane, similar product.
- C. Gaskets for flanged joints in ductile iron or steel drinking water piping meeting NSF requirements:
 1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.
 2. Material:
 - a. EPDM material with 80 Shore A durometer rating.
 3. Manufacturers: One of the following or equal:
 - a. Garlock, 98206.
 - b. John Crane, similar product.

2.06 REPAIR BANDS

- A. Design requirements:
 1. In accordance with AWWA C230.
- B. Materials:
 1. Shells: Type 304 stainless steel.
 2. Lugs: Removable epoxy coated ductile iron in accordance with ASTM A536.
 3. Bolts and nuts: 304 Stainless Steel with fluoropolymer coated nuts.
 4. Gaskets: Compounded for water and sewer service.
- C. Manufacturers: One of the following or equal:
 1. Romac Industries, Inc.
 2. Smith-Blair Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 1. Piping drawings:
 - a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
 - b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
 - 1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.

2. Piping alternatives:
 - a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
 - b. Alternative pipe ratings:
 - 1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
 - 2) Piping of different material may not be substituted in lieu of specified piping.
 3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.
- B. Wall and slab penetrations:
1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
 2. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
 3. Core drilled openings:
 - a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.
 - b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
 - c. Remove dust and debris from hole using compressed air.
- C. Exposed piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
 - a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
 - 1) Slope plumbing drain piping with a minimum of 1/4-inch per foot downward in the direction of flow.
 2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
 3. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
 4. Assemble piping without distortion or stresses caused by misalignment:
 - a. Match and properly orient flanges, unions, flexible couplings, and other connections.
 - b. Do not subject piping to bending or other undue stresses when fitting piping.
 - c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
 - d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.

- e. Alter piping assembly to fit when proper fit is not obtained.
 - f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.
- D. Buried piping:
 - 1. Bury piping with minimum 4-foot cover without air traps, unless otherwise indicated on the Drawings.
 - 2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench.
 - a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
 - 3. Laying piping:
 - a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
 - b. Place piping with top or bottom markings with markings in proper position.
 - c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
 - d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
 - e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.
 - 4. Concrete encase buried pipe installed under concrete slabs or structures.
- E. Connections to existing piping:
 - 1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
 - a. Protect domestic water/potable water supplies from contamination:
 - 1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
 - 2) Provide devices approved by Owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
 - 2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
 - 3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
 - 4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.
- F. Connections between ferrous and nonferrous metals:
 - 1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
 - 2. Nonferrous metals include aluminum, copper, and copper alloys.

- G. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
 - 1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.02 CLEANING

- A. Piping cleaning:
 - 1. Upon completion of installation, clean piping interior of foreign matter and debris.
 - 2. Perform special cleaning when required by the Contract Documents.
- B. Conduct pressure and leak test, as specified.

3.03 PIPE SCHEDULE

- A. As indicated on the Drawings.

END OF SECTION

SECTION 33_05_00.03

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Underground warning tape.
 - 2. Tracer wire.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Product Submittals:
 - 1. As specified in Section 01_60_01 - Product Requirements.
 - 2. Product data.
 - 3. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 BURIED PIPELINE IDENTIFICATION

- A. Underground warning tape:
 - 1. Manufacturer: One of the following or equal:
 - a. Seton (of Brady Corporation).
 - b. T. Christy Enterprises, Inc.
 - 2. Material:
 - a. Polyethylene tape for prolonged underground use.
 - b. Minimum tape thickness: 4 mils.
 - c. Overall tape width: 4 inches.
 - d. Message: "CAUTION" with the name of the service followed by "LINE BURIED BELOW." in black lettering on colored background in accordance with approved American Wood Protection Association (APWA) colors.

Service	Color
Potable water	Blue
Reclaimed water, irrigation, and slurry lines	Purple
Sewers and drain lines	Green
Gas, oil, steam, petroleum, chemicals, or other service	Yellow

- B. Tracer wire:
 - 1. Manufacturers: One of the following or equal:
 - a. Aegion Corpro.
 - b. Kris-Tech Wire.
 - 2. Materials:
 - a. Solid copper conductor.
 - b. Thickness minimum: 10 gauge.
 - c. Insulation:
 - 1) Match insulation color to the color of the pipe being installed.
 - 2) UF type, direct bury.
 - 3) 30-mil HMWPE.
 - 3. Splicing kit:
 - a. Manufacturers: The following or equal:
 - 1) 3M, Model 82 A1N.
 - 4. Station box:
 - a. Lid and collar materials: Cast iron.
 - b. Lid type: Locking.
 - c. Able to withstand heavy traffic loading.
 - d. Manufacturers: One of the following or equal:
 - 1) CP Test & Valve Products, Inc., Glenn Test Station.
 - 2) Farwest Corrosion Control.

PART 3 EXECUTION

3.01 BURIED PIPING IDENTIFICATION

- A. Underground warning tape:
 - 1. Non-detectable:
 - a. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.
 - 2. Detectable:
 - a. Place continuous run of warning tape in pipe trench, 12 inches above the pipe or a greater height if necessary to limit the tape bury depth to 36 inches. Do not bury detectable warning tape deeper than 36 inches.
- B. Tracer wire:
 - 1. Install on all non-metallic pipe.
 - 2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
 - 3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
 - 4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts.
 - a. Twisting the wires together is not acceptable.
 - 5. Install tracer wire access points at a maximum spacing of 500 LF. Locate station boxes in the median, sidewalk, or as indicated on the Drawings and approved by the Owner.
 - 6. Provide 2-foot minimum slack of coiled wire in the station box after meeting final grade.

7. Ground the station box at dead ends such as manholes or dead-end pipe with 1.5 lb drive-in magnesium ground rod with a minimum of 20 feet of lead wire.
8. It is the Contractor's responsibility to protect the tracer wire from damage during pipe installation and backfill. All costs associated with finding discontinuities in the tracer wire and repair of the connections shall be borne by the Contractor.
9. Verify tracer wire installation by using low frequency (512 Hz or similar) line locating equipment.
 - a. Provide 2 days advance notice to the Owner prior to testing.
 - b. Test shall be witnessed and approved by the Owner.
 - c. Test tracer wire for continuity between test stations and/or valve boxes prior to final paving.
10. As part of the as-built drawings, record station and pipe offset of station boxes.

END OF SECTION

SECTION 33_05_00.09
PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Test requirements for piping systems.

1.02 REFERENCES

- A. National Fuel Gas Code (NFGC).
- B. American Society of Mechanical Engineers (ASME):
1. B31.1 - Power Piping.
 2. B31.3 - Process Piping.
 3. B31.8 - Gas Transmission and Distribution Piping Systems.
- C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

- A. General requirements:
1. Testing requirements are stipulated in Laws and Regulations; are specified in the specifications covering the various types of piping; and are specified in this Section.
 2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
 3. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
 - a. Lower test pressure as necessary (based on elevation) if testing is performed at a higher point of the pipe section.
- B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
- C. Water for testing, cleaning, and disinfecting:
1. Use potable water for all potable waterlines.
- D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

- E. Unsuccessful tests:
 - 1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
 - 2. Repeat testing until tests are successful.
- F. Test completion: Drain and leave piping clean after successful testing.
- G. Test water disposal:
 - 1. Dispose in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.
 - 2. Requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be the responsibility of the Contractor.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Schedule and notification of tests:
 - 1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
 - 2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
 - 3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.
- C. Pipe system test report:
 - 1. Submit a report for all piping tested. At a minimum, the test report shall include the following information:
 - a. Description of piping being tested:
 - 1) Pipe material.
 - 2) Section of piping being tested:
 - a) Date and time of pipe test.
 - b) Name of person performing the pipe test.
 - c) Specified test method and testing requirements (low-head, high-head, test pressure, test duration, etc.).
 - d) Initial test pressure and time of pressure.
 - e) Final test pressure and time of pressure.
 - f) Status of test: Pass or fail.
 - g) Signature of the Contractor and Owner's representative that witnessed the pipe test.

1.05 SEQUENCE

- A. Clean piping before pressure or leak tests.
- B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

- C. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.
- D. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SANITARY SEWER PIPE TESTING

- A. Provide sanitary sewer pipe testing per City of Arvada Specification Section 524.00. Entire length of sewer pipe on the project shall be tested together.

3.02 SANITARY SEWER MANHOLE TESTING

- A. Provide testing of sanitary sewer manholes per City of Arvada Specification Section 524.00.

3.03 TESTING HIGH-HEAD PRESSURE PIPING

- A. Test all potable water pressure piping per the requirements of the pipe owner (City of Arvada or City of Westminster). Test pressure shall be as indicated by the pipe owner (City of Arvada or City of Westminster).

END OF SECTION

SECTION 33_05_11

TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section describes the requirements for temporary bypass pumping of wastewater flows as needed to complete the Work.

1.02 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. C110 - Ductile-Iron and Gray-Iron Fittings.
 - 2. C150 - Standard for Thickness Design of Ductile-Iron Pipe.
 - 3. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.
- B. ASTM International (ASTM):
 - 1. B241 - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
 - 2. D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material.
- C. National Fire Protection Association (NFPA):
 - 1. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 REQUIREMENTS

- A. Provide all services related to, but not limited to, mobilization, setup, around-the-clock operations and maintenance, demobilization, traffic control, permits, and all other materials, labor, and equipment to install, maintain, and operate a complete continuous pumping and transport system for wastewater 24 hours per day, 7 days per week, until the portion(s) of the Work have been completed to the satisfaction of the Engineer.
- B. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities is the sole responsibility of Contractor.
- C. The temporary bypass pumping system shall be installed as a complete standalone system.
 - 1. Provide power, fuel, and backup power supply and/or backup pumps for operation of the system.
- D. The temporary bypass pumping shall be continuously monitored.

- E. Contractor shall be responsible for bypassing wastewater in a way that ensures that no wastewater is allowed to leak outside of the sanitary sewer system or the bypass pipelines.
 - 1. Bypass pumping shall be done in such a manner as not to damage private or public property, or create a nuisance or public menace.
 - 2. The pumped wastewater shall be in an enclosed pipe that is adequately protected from traffic, and shall be redirected into sanitary sewer system.
- F. No bypassing to the ground surface, receiving waters, storm drains, or bypassing that results in soil or groundwater contamination or any potential health hazards shall be permitted.
 - 1. Contractor shall adhere to all agency restrictions regarding the transport and conveyance of wastewater.
- G. Contractor shall be liable for all cleanup, damages, and resultant fines in the event of spills, leaks, or backups associated with bypass pumping activities, which includes commissioning, operation, and decommissioning of bypass pumping facilities.
- H. No interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all sanitary sewer overflows during construction of this Work and bypass operations.
- I. Coordinate the placement of the bypass piping and pumping equipment with Engineer, Owner, and Colorado Department of Transportation (CDOT).
- J. Where bypass pipelines are required to cross traffic lanes, and will be in place for more than 3 days, the piping and fittings shall be buried a minimum of 4 inches below the pavement surface and backfilled with temporary asphalt concrete surfacing or use an approved flow-through drivable apparatus approved by Engineer and CDOT.
 - 1. At no time shall traffic lanes be blocked or closed, unless specifically allowed in writing by Owner.
- K. For purposes of bypass pumping lateral flows, right of entry onto private property is not permitted without right-of-entry/right-of-access agreement, as specified in Section 01_14_00 - Work Restrictions.
 - 1. Laterals indicated on the Drawings are from the best-available records from Owner or provided by property owners.
 - 2. Not all laterals are indicated on the Drawings.
- L. Contractor is responsible to identify additional laterals not indicated on the Drawings that may require bypass pumping.
- M. After the Work is completed, flow shall be returned to the rehabilitated sewer and all temporary equipment removed.

1.04 DESIGN CRITERIA

- A. Contractor shall design system for a Peak Flow of 5,550 gpm from the nearest manhole upstream of the work to nearest manhole downstream of the work.

1.05 SUBMITTALS

- A. Contractor shall submit a temporary bypass pumping plan as required to complete the Work to Engineer and Owner, 30 days prior to bypass pipe installation, for review as specified in Section 01_33_00 - Submittal Procedures.
- B. The temporary bypass pumping plan submittal shall be satisfactory to Engineer and Owner prior to Contractor commencing the bypass pumping operation.
 - 1. Contractor shall notify Engineer and Owner 24 hours prior to commencing the bypass pumping operation.
- C. The temporary bypass pumping plan must provide for accessibility to pedestrians and vehicular traffic in accordance with Owner and CDOT requirements.
- D. The temporary bypass pumping plan shall include the following at a minimum:
 - 1. Number, type, capacity, and size of pumps, standby equipment, pipe material, pipe layout with pressure relief, and air/vacuum valves locations, and power requirements, if applicable.
 - 2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, and pump curves showing operating range of flow and TDH.
 - 3. Standby power generator size and location for electrically driven bypass pumps.
 - 4. Downstream Discharge Plan.
 - 5. Pipe thrust and restraint block sizes and locations.
 - 6. Temporary pipe supports and anchoring required.
 - a. The bypass corridor lies within a flood zone, therefore buoyancy restraint is required.
 - b. Buoyancy calculations are required.
 - 7. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.
 - 8. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping shall be provided.
 - 9. Plan indicating bypass pumping line locations.
 - a. Plan shall include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass corridor.
 - 10. Plans for access to bypass pumping locations.
 - 11. Detailed plans of a redundant backup system.
 - 12. Address access for pedestrians and vehicular traffic.
 - 13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
 - 14. Proposed type, catalog cutsheets, and location of collection system plugs.
 - 15. Emergency Response Plan.
 - 16. Staffing Plan.
 - 17. Spill prevention and cleanup plan.
 - 18. Catalog cutsheets for all pumping equipment including pump performance curves, all pipe and fittings, and all valves.

- E. Emergency Response Plan:
 - 1. Provide emergency response plan based on the example found in Attachment A.

1.06 QUALITY ASSURANCE

- A. Contractor's qualifications:
 - 1. Minimum 5 years of experience in performing substantially similar temporary bypass pumping operations.
 - 2. Submit list of at least 5 separate construction projects completed within the last 10 years that include the satisfactory setup, operation, and maintenance of a pumping and piping system used to bypass wastewater during construction similar to the specified Work.
- B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.01 CAPACITY

- A. Pumps, piping, and accessories shall be of adequate capacity and size to handle the range of wastewater flows from Minimum Flow to Peak Flow.
- B. All piping, fittings, and all accessories shall withstand 1.5 times the maximum pressure.
- C. Contractor shall maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
 - 1. Contractor shall have standby pump(s) incorporated into the system that provide 100-percent redundancy of the bypass system design Peak Flow.
 - a. The redundant pump(s) shall be plumbed, fueled, and available for operation in 5 minutes upon emergency backup.
 - 2. Contractor shall install sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
 - a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occur.
 - 3. Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

2.02 BYPASS PUMPS

- A. A minimum of 2 pumps and generators shall be provided, each capable of transporting 100 percent of the peak flow. The pumps shall be able to turn down to minimum flow rates without surcharging the sewer system.

- B. Pump capacity shall be sufficient to pump the anticipated peak hour flow with the largest pump out of service.
- C. Pumps shall be a packaged unit with a skid base or 2-wheel trailer.
- D. Pumps shall be fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.
- E. Pumps shall utilize oil-lubricated mechanical seal.
- H. Pumps shall be capable of passing 3-inch diameter solids, rags, rocks, hair, and other debris encountered in municipal wastewater.
- I. Pumps shall be operated by diesel engine or 480-volt electric engine and include the following:
 - 1. Minimum 12-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
 - 2. Fuel gauge with red warning light when tank approaches empty.
- J. Pumps shall be capable of dry operation for up to 5 hours to accommodate large fluctuations in flow.
- K. Maximum pump speed shall not exceed 2,200 revolutions per minute.
- L. The system shall include the following features:
 - 3. START/STOP operation.
 - 4. Instrumentation and controls for operation and monitoring for each pump.
- M. All electrical equipment, instrumentation, and accessories shall be suitable for Class 1 Division 1 or Class 2 Division 1 service in accordance with NFPA 820 in accordance with field conditions.
- N. Backup pumps and generators shall be periodically run to confirm proper operations.

2.03 BYPASS PIPING

- A. Contractor shall use HDPE piping for the temporary bypass pumping system.
- B. All piping shall have no leakage and shall include spill containment vessels or "spill guards" in areas indicated on the Drawings.
- C. HDPE Piping shall be as follows:
 - 1. In accordance with ASTM D3350.
 - 2. Minimum SDR of 32.5.
 - 3. Joints shall be butt-fusion welded.

2.04 PIPE PLUGS

- A. Pipe diameters 24 inches and smaller shall use mechanical plugs with SBR or EPDM gaskets.
- B. Pipe diameters larger than 24 inches shall use inflatable bag stoppers with 2 or more pieces.

2.05 NOISE CONTROL

- A. Pump equipment shall be equipped with devices or enclosures for noise attenuation, which includes, but is not limited to, mufflers and/or plywood/Styrofoam noise panels.
- B. The noise level shall be at or below 55 dBA at 50 feet from the pumping equipment for the duration of the Work.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall notify Owner a minimum of 30 days prior to the Work requiring temporary bypass pumping and notify Engineer at least 48 hours prior to bypassing or diverting flow in any of the pipelines or laterals or structures.
- B. All pumps, generators, and other equipment shall be placed on a plastic tarp to protect against spills of petroleum products used by the equipment.
- C. Before taking interceptor out of service, Contractor shall verify that bypass system is fully operational and acceptable to Engineer. Owner staff will be present when pressure testing occurs.
- D. Traffic control as specified in Section 01_55_26 - Traffic Control.
- E. Flow in the existing sewers shall not be restricted or dammed for any period of time without the approval of Engineer.
- F. All wastewater facilities, including laterals, shall remain in continuous and full operation during construction.
- G. The Contractor shall plug off and pump down the sewer manhole or line segment in the immediate work area and shall maintain the wastewater system so that surcharging does not occur. Where work requires the line to be blocked beyond normal working hours, and bypass pumping is utilized, the Contractor shall be responsible for monitoring the bypass pumping operation around the clock.

3.02 PROTECTION

- A. All pumps and piping shall be sized to adequately convey the flows anticipated at each bypass application.
 - 1. The bypass system shall be watertight; no leakage will be allowed.

- B. Contractor shall be responsible for all bypass flows.
 - 1. Contractor shall inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 2 times per hour.
 - 2. The temporary bypass system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from Engineer.
- C. The temporary bypass system will have trained and qualified attendants available 24 hours per day 7 days per week whose only duty is to maintain the bypass system until the bypassing of the system is no longer required. The attendants shall:
 - 1. Be capable of performing pump and piping maintenance required.
 - 2. Have a cellular phone for communication with Contractor and Engineer in the event of emergencies.
- D. In the event of any wastewater spill, Contractor shall be responsible for the prompt cleanup and disinfecting of the spill as called for in the temporary bypass pumping plan.
 - 1. Contractor shall compensate Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.
- E. Contractor shall implement measures to prevent interference between the public and the bypass pumping equipment, pipelines, and wastewater.
- F. Contractor shall take precautions to protect all bypass lines from damage.
- G. Any aboveground portions of the bypass lines shall be clearly identified by flashers, fencing, or other means to warn the public of their presence.
- H. The Contractor should immediately notify the Owner should any sanitary sewer overflow or spill occur and take the necessary action to clean up and disinfect spillage to the satisfaction of the Owner and/or other governmental agency with jurisdiction.
- I. The Contractor shall be responsible for all required pumping, equipment, piping, and appurtenances to accomplish the bypass and for any and all damage that results directly or indirectly from the bypass pumping equipment, piping, and appurtenances and operation. The Contractor shall also be liable for all Owner personnel and equipment costs, penalties, and fines resulting from sanitary sewer overflows and backups. It is the intent of these specifications to require the Contractor to establish an adequate bypass pumping plan regardless of the flow or site condition.

3.03 FIELD QUALITY CONTROL

- A. Hydrostatic Pressure Test:
 - 1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure.
 - 2. The test shall run for a duration of 2 hours.
 - 3. Contractor shall fill the line with water.

4. The line shall be sealed on the discharge end.
 5. The line may be put in service if, after the specified test duration, the pressure has been maintained and there are no observable leaks.
 6. Notify Engineer at least 48 hours prior to testing.
- B. Inspection:
1. An attendant/operator shall inspect temporary bypass piping system at a minimum of every hour 24 hours per day.
 2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times, 24 hours per day.
 3. Inspection Log: Keep at each pumping location.

3.04 CLEAN-UP

- A. The temporary bypass pumping system shall be cleaned and drained prior to being dismantled.
- B. Contractor shall alternate pigging and purging of the system to remove all loose material.
1. After Contractor has cleaned the pipe, and prior to dismantling of the piping for removal from the project site, Contractor shall disinfect the pipe with 10-percent chlorine solution.
- C. Disturbed Areas:
1. Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement restoration, at least equal to that which existed prior to start of Work.

3.05 SCHEDULING

- A. The temporary bypass pumping system shall not be shut down between shifts, on holidays or weekends, or during work stoppages.
- B. The bypass system shall have trained and qualified attendants 24 hours per day, 7 days per week whose only duty is to maintain the bypass system from the start of bypass until the bypassing of the system is no longer required.

END OF SECTION

ATTACHMENT A - EMERGENCY RESPONSE PLAN

EMERGENCY RESPONSE PLAN

Project Name: North Trunk Line Sewer Improvements (NTL7)

EMERGENCY NOTIFICATION PROCEDURES

In the event of a wastewater discharge, spill or overflow to the environment, partial or complete line blockage, manhole surcharge, construction debris entering the sewer stream, or another emergency, the following parties shall be notified immediately, and the Emergency Response Plan initiated. Calls will be placed in the numerical order shown below. If unable to reach a person, a voice message will be left and the next person will be called. This process will be repeated until contact is made with someone from the Contractor and Owner.

Contractor Contacts

Call Order	Name	Phone Number	Project Role
1			Superintendent
2			
3			
4			
5			
6			

Owner Contacts

Call Order	Name	Phone Number	Project Role
1			
2			
3			
4			
5			
6	After Hours		24-hour emergency line

EQUIPMENT AVAILABLE

All equipment, but not limited to the equipment listed below, necessary to contain or mitigate a sewage spill shall be on site within one hour of when the spill occurs. Contractor shall ensure subcontract agreements are in place prior to beginning bypass pumping operations.

- **Vac Con Combo Jet Truck (2700 gal. capacity).** This truck can be used to clear a blockage as well as provide 2,700 gallons of storage capacity.
- **6-inch pump with 550 feet of discharge hose.** This pump and hose will be on standby and can be delivered and set up quickly to help in the event of primary and redundant pump failures.
- **18-inch repair clamps for HDPE pipe.**
- **Heat welding equipment for HDPE pipe.**
- **Small backhoe to move earth and help contain spill.**

CONTAINMENT/MITIGATION

In the event of a wastewater discharge, spill, or overflow, Contractor will immediately implement the Emergency Response Plan. The first priority will be to prevent any wastewater from entering any waterways, lakes, streams, and storm sewers as well as following notification procedures listed above. Dikes or berms shall be constructed as needed. The next priority will be to prevent any wastewater from reaching and contaminating groundwater. Mitigation and cleanup will begin once the source of the emergency has been resolved. Any freestanding wastewater on the ground will be pumped, the soil will be removed until uncontaminated dry soil is reached, and the wastewater and contaminated soil disposed of in accordance with State regulations. Take photos to document the mitigation, any property damage (flooded basement, etc.), and other cleanup efforts.

A completed Wastewater Discharge Incident Report shall be submitted to the Owner as soon as possible or within a maximum of 48 hours of the start of any wastewater discharge, spill, or overflow.

In the event that a plug is lost, Contractor will immediately dispatch workers to a predetermined downstream manhole to attempt to retrieve the plug. Workers will be dispatched to MH XXXX where a plug retrieval device will have been installed just prior to plug insertion and removal. Simultaneously, the line will be televised in the direction of flow beginning at the location where the plug was lost and continue until the plug is found. If it is determined that the plug was not caught, wastewater treatment plant staff shall be called immediately at xxx-xxx-xxxx to alert staff to monitor the Headworks for a lost plug.

NOTIFICATION REQUIREMENTS

Contractor is solely responsible for any liability for violations of any State or federal environmental law or regulation, and hereby indemnifies the Owner from any such liability associated with the wastewater discharge, spill, or overflow as a result of their work on the Owner's facilities. In the event of a discharge, spill, or overflow of pollutants – including raw wastewater – that has the potential to affect public health or the environment, the following parties shall be notified:

Agency	Name	Phone Number	Role

PREPARED BY

_____ Contractor	_____ Signature	_____ Date
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APPROVED BY

_____ Owner's Project Manager	_____ Signature	_____ Date
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_____ Owner's Operator in Responsible Charge	_____ Signature	_____ Date
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SECTION 33_05_18

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Precast concrete vaults.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO).
 - 1. LRFD Bridge Design Specifications.
- B. American Concrete Institute (ACI):
 - 1. 318 - Building Code Requirements for Structural Concrete and Commentary.
- C. ASTM International (ASTM):
 - 1. C150 - Standard Specification for Portland Cement.
 - 2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - 3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
- D. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

- A. General:
 - 1. Furnish submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. Shop drawings:
 - 1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
 - 2. Structural design calculations for vaults, signed by a licensed registered Civil or Structural Engineer licensed in the State where project is located.
- C. Manufacturer's Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.04 QUALITY ASSURANCE

- A. Inspection:
 - 1. After installation, the Contractor shall demonstrate that vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 PRODUCTS

2.01 VAULTS

- A. Manufacturers: One of the following or equal:
 - 1. Utility Vault Co.
 - 2. Oldcastle Precast.
 - 3. Copeland.
- B. Provide precast vaults for the size indicated on the Drawings.
- C. The minimum structural member thickness for vaults shall be 5 inches.
 - 1. Cement shall be Type V portland cement in accordance with ASTM C150.
 - 2. The minimum 28-day concrete compressive strength shall be 4,000 pounds per square inch.
 - 3. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.
- D. Design requirements: Loads on structures:
 - 1. In accordance with ASTM C857, except as modified in this Section.
 - 2. Loads at the ground surface:
 - a. "Roadway": Load from heavy, frequently repeated vehicle traffic:
 - 1) ASTM C857, Table 1, Designation A-16 (AASHTO HS20-44).
 - 3. Loads against walls. Include effects of groundwater and seismic accelerations on earth pressures.
 - a. Equivalent lateral pressure:
 - 1) See project Geotechnical Report as referenced in Section 01_11_00 – Summary of Work.
 - b. Surface surcharge load: In accordance with ASTM C857 A-16 wheel load if such surcharge exceeds backfill loads described in the preceding paragraph.
 - c. Groundwater effects: Include groundwater effects on lateral earth pressure loads using design elevation assuming the groundwater is at the ground surface elevation at the vault location.
 - 1) See project Geotechnical Report as referenced in Section 01_11_00 – Summary of Work.
 - d. Seismic acceleration effects:
 - 1) See project Geotechnical Report as referenced in Section 01_11_00 – Summary of Work.
 - 4. Groundwater and flood loads, and buoyancy effects:
 - a. As specified in Geotechnical Report for design groundwater and design flood elevations.
 - b. Lateral pressure effects: Determine based on groundwater and flood elevations specified.
 - c. Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.20.
 - 1) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 63 pounds per cubic foot.

- 2) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.
 5. Soil bearing pressure at base:
 - a. Maximum 1,500 pounds per square foot total pressure on prepared subgrade soils.
 6. Lifting and handling loads:
 - a. Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.
 7. Load combinations:
 - a. Design structures to sustain the specified loads individually or in combination.
- E. Design requirements: Structural analysis, design, and detailing:
1. Analyze and design structures including the effects of 2-way action ("plate action") and of load transfer around current and future openings.
 2. Where structures include panels designed for future removal ("knockout panels"), design structures for loads and stresses with any combination of any or all such panels in place or removed.
 3. Design structures in accordance with the requirements of ACI 318 and this Section.
 4. Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
 5. Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
 6. Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
 - a. Vaults: 2 inches.
 7. Reinforcement details:
 - a. Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
 - b. Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
 - c. Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
 8. Joints:
 - a. Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
 - b. Provide structures with non-skid, shiplap, or tongue and groove joints between sections.
- F. Design requirements: Materials:
1. Portland cement concrete vaults:
 - a. In accordance with ASTM C858, except as modified in this Section.
 - b. Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. In accordance with ACI 318 requirements for minimum specified compressive strength and air entrainment.
 2. Seal joints watertight with precast concrete joint sealant as specified in Section 07_92_00 - Joint Sealants.

- G. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.
- H. Vault shall be solid walled construction.
 - 1. Where penetrations of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or core-drilled sections.
 - 2. Openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing.
 - 3. Vaults need not be designed to resist thrust from piping passing through the vault.
 - 4. Coordinate pipe penetration locations with piping arrangement as indicated on the Drawings.
- I. Slope bottom of vault to Drainage Sump as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations.
 - 1. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended.
 - 2. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.
- B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

END OF SECTION

SECTION 33_05_31.12

POLYVINYL CHLORIDE (PVC) PIPE: GRAVITY

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Gravity sewer pipe and fittings in accordance with ASTM D3034 and ASTM F679 standards.

1.02 REFERENCES

- A. ASTM International (ASTM):
 1. C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 3. D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 4. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 5. D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 6. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 7. F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.03 ABBREVIATIONS

- A. PVC: Polyvinyl chloride.
- B. SDR: Standard dimension ratio; the outside diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 33_05_00.01 - Common Work Results for General Piping.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect from sunlight, scoring, and distortion.
- B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.
- C. Store and handle as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 PIPE

- A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.
- B. PVC compound: Cell classification 12454-C in accordance with ASTM D1784.
- C. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers not to exceed 10 parts by weight per 100 of PVC resin in the compound.
- D. Pipe less than or equal to 15-inch diameter:
 - 1. In accordance with ASTM D3034.
 - 2. Wall thickness SDR 35 minimum.
 - 3. Joints: Push-on in accordance with ASTM D3212.
 - a. Integral bell.
 - b. Factory installed gaskets meeting the requirements in accordance with ASTM F477.
- E. Pipe greater than or equal to 18-inch diameter:
 - 1. In accordance with ASTM F679.
 - 2. Minimum pipe stiffness: in accordance with Table 1 in ASTM F679, based on equivalent SDR of 35.
 - 3. Joints: Push-on in accordance with ASTM D3212.
 - a. Integral bell.
 - b. Factory installed gaskets meeting the requirements in accordance with ASTM F477.
 - 4. Bell:
 - a. Fabricated from pipe sections.
 - b. Bell wall thickness equivalent to pipe wall thickness.
 - 5. Gasket ring: Locked into the bell.
 - 6. Spigot end of the pipe: Marked by the manufacturer to identify the final in place position of the spigot in the bell.
- F. Gasket:
 - 1. In accordance with ASTM F477.
 - 2. Manhole adapter gasket: Waterstop gasket with stainless steel clamp or similar device to seal the penetration.
- G. Flexible gaskets for precast bases with a flexible pipe connection: In accordance with ASTM C923:
 - 1. Manufacturer: One of the following or approved equal:
 - a. Press-Seal Gasket Corp.: PSX.
 - b. A-Lok Premium.

2.02 SOURCE QUALITY CONTROL

- A. Mark pipe and fittings in accordance with ASTM D3034 and ASTM F679 as appropriate.
- B. Mark the production control code on pipe and fittings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install piping in accordance with ASTM D2321 and manufacturer's published installation instructions.
 - 2. Provide plugs or caps for stubs and branch pipes left unconnected to laterals.
 - 3. Lubricate and assemble joints in accordance with the pipe manufacturer's published instructions.
 - 4. Trenching and backfill as specified in Section 31_23_35 - Trenching.
 - 5. For open cut installations, install underground warning tape as specified in Section 33_05_00.03 - Pipe Identification.
- B. Connections to manholes:
 - 1. Make connections to manholes with a manhole gasket that prevents infiltration and exfiltration through the penetrations using 1 of the following methods:
 - a. Precast bases with a flexible pipe connection:
 - 1) Pipe connectors shall be cast into the base.
 - a) Pipe openings shall contain flexible gaskets.
 - 2) Follow manufacturer's recommendation for lubrication to prevent damage to the gasket during pipe insertion.
 - 3) When PSX gaskets are used, the take-up screws for the gasket clamps shall be positioned a minimum of 90 degrees apart.
 - 4) Install and grout in place per manufacturer's instructions.
 - b. Cast in place or precast bases using grouting rings:
 - 1) Provide opening for connection large enough to allow subsequent grouting around the grouting ring.
 - 2) Grout around the pipe penetration manhole gasket and seal the opening.

3.02 FIELD QUALITY CONTROL

- A. Test pipe as specified in Section 33_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 33_05_31.15

POLYVINYL CHLORIDE (PVC) PIPE: PRESSURE

PART 1 GENERAL

1.01 SUMMARY

- A. Provide PVC pressure pipe in accordance with City of Westminster Standards and Specifications.
 - 1. PVC pipe material per Section 3.52.02.
 - 2. Ductile iron fittings per Section 3.53.00.
 - 3. Testing and disinfection per Section 3.40.00.

1.02 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. As specified in Section 33_05_00.01 - Common Work Results for General Piping.
- C. Product data and Shop Drawings.

PART 2 PRODUCTS

2.01 JOINT RESTRAINTS

- A. Joint restraints:
 - 1. All pressure pipe joints and fittings shall have restrained mechanical joints or restrained push-on joints.
 - 2. See City of Westminster and City of Arvada standards and specifications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install PVC piping in accordance with ASTM F645, AWWA C605, and manufacturer's or pipe supplier's published installation instructions.
 - 2. Trenching and backfill as specified in Section 31_23_35 - Trenching.

3.02 FIELD QUALITY CONTROL

- A. See City of Westminster Standards and Specifications Section 3.40.00 for testing and disinfection requirements.

END OF SECTION

SECTION 33_05_35.67

FIBERGLASS REINFORCED POLYMER MORTAR PIPE (FRPMP) FOR OPEN-CUT AND DIRECT JACKING/MICROTUNNELING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Fiberglass reinforced polymer mortar pipe (FRPMP) and fittings.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
1. Standard Specifications for Highway Bridges.
- B. American Water Works Association (AWWA):
1. C950 - Standard for Fiberglass Pressure Pipe.
 2. M45 - Fiberglass Pipe Design - Second Edition.
- C. ASTM International (ASTM):
1. C33 - Standard Specification for Concrete Aggregates.
 2. D638 - Standard Test Methods for Tensile Properties of Plastics.
 3. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 4. D2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
 5. D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
 6. D3681 - Standard Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition.
 7. D4161 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
 8. D5262 - Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
 9. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- D. International Organization for Standardization (ISO):
1. 9001 - Quality Management Systems - Requirements.

1.03 TERMINOLOGY

- A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Centrifugal Casting: A process used to manufacture tubular goods by applying resin and reinforcement to the inside mold that is rotated and heated, subsequently polymerizing the resin system. The outside diameter of the finished pipe is determined by the inside diameter (ID) of the mold tube. The

ID of the finished pipe is determined by the amount of material introduced into the mold. Other materials may be introduced in the process during manufacture of the pipe.

2. Fiberglass Reinforced Polymer Mortar Pipe (FRPMP): Pipe manufactured of polymer mortar with fiberglass reinforcement for strength. Pipe can be used for gravity or pressure applications dependent upon configuration of fiberglass reinforcement.
3. Filament Wound: A process used to manufacture tubular goods by winding continuous glass-fiber roving or roving tape onto the outside of a mandrel or core pipe liner in a predetermined pattern under controlled tension. The roving may be saturated with liquid resin or pre-impregnated with partially cured resin. Subsequent polymerization of the resin system may require application of heat. The inside diameter of the finished pipe is fixed by the mandrel diameter or the inner diameter of the core pipe liner. The outside diameter of the finished pipe is determined by the amount of material that is wound on the mandrel or core pipe liner. Other materials may be introduced in the process during the manufacture of the pipe.
4. Liner: A filled or unfilled thermoplastic or thermosetting resin layer, nonreinforced or reinforced, forming the interior surface of the pipe.
5. Pipe Stiffness Number (SN): A measure of the force required to deflect the diameter of a pipe ring and unit amount.
6. Roving: A collection of parallel glass strands or filaments coated with a finish or coupling agent to improve compatibility with resins, gathered without mechanical twist. Roving may be processed in a continuous or chopped form.
7. Surface Layer: A filled or unfilled resin layer, nonreinforced or reinforced, applied to the exterior surface of the pipe structural wall.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data.
- C. Shop Drawings:
 1. Catalog datasheets for all materials.
 2. Details of piping system components confirming that the pipe and fittings conform to the specified requirements.
 3. Fabrication drawings showing:
 - a. Wall thickness.
 - b. Pipe length.
 - c. Pipe joint.
 - d. Design of pipe and fittings.
 - e. Gasket details.
 4. Shop Drawings shall include fittings and specials that are to be installed.
 5. Pipeline layout and profile drawings showing location, station, and invert elevation of pipe sections, fittings, closure pieces and test closures.
 6. Test methods and results, including certification that pipe meets or exceeds the minimum requirements in accordance with AWWA C950, AWWA M45, ASTM D2412, ASTM D2992, and ASTM D3262, as appropriate.
 7. Testing equipment calibration certificate.

- D. Design calculations:
 - 1. Provided by a Professional Engineer licensed in the state where the project is located to meet the following loadings:
 - a. In-situ.
 - b. Service.
 - c. Handling.
 - 2. Manufacturer shall verify that pipe stiffness provided meets conditions as specified in the Contract Documents.
 - 3. If computer calculations are used, include example calculations to show the logic employed.
- E. Manufacturer shall provide a certificate of compliance to these specifications referencing project name and location.
- F. Manufacturer's Certificate of ASTM Production Testing (Lot Certificates).
- G. Test reports:
 - 1. Provide valid current ASTM D3681 long-term strain corrosion and ASTM D4161 joint integrity qualification test reports.
 - 2. Provide ASTM D3681 Strain Corrosion test report verifying that the proposed FRPMP meets the long-term corrosion resistance required for Septic Sanitary Sewer service when tested using 1N Sulfuric Acid.
 - a. Test report and data shall be from sample production pipe from the plant, which will be supplying pipe to this project.
 - b. Data from other manufacturing sites or report with mix data are subject to rejection by the Owner.
- H. Manufacturer shall provide, as a Shop Drawing, recommendations for embedment, manhole connection details, encasement details, and any repair details.

1.05 GENERAL PIPING REQUIREMENTS

- A. As specified in Section 33_05_00.01 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following, or equal:
 - 1. Hobas Pipe USA.
 - 2. Thompson Pipe Group (Flowtite).
- B. Current ISO 9001 certificate by an accredited third party auditing firm at the time of the bid and during construction period.

2.02 DESIGN CRITERIA

- A. Design calculations, detailing, and fabrication of FRPMP for the conveyance of raw sanitary sewage.

- B. Pipe design shall include the selection of external loads (dead and live loads), pressure class (PN), pipe stiffness class (SN) and other loads as determined by the Contractor.
- C. This Section covers the technical requirements for the installation of the fiberglass pipeline, fittings, and accessories.
- D. Contractor's Work shall include, but not necessarily be limited to, providing all items of labor, material, and equipment necessary to handle, install, and test the pipe, fittings, and accessories indicated on the Drawings.
- E. Other work performed under this Section includes shop testing; fabrication of fittings and appurtenances; handling, storage and protection; and loading and transportation of completed fittings and appurtenances to the construction site.
- F. Manhole bases shall be constructed as part of the pipe installation.
 - 1. Manhole base: A tee riser serving as the base.
 - 2. Manufacturer shall:
 - a. Provide a sealed connection between the tee base and the riser, as indicated on the Drawings.
 - b. Coordinate with the pipe manufacturer for dimensions.

2.03 BASIS OF DESIGN

- A. Provide calculations for pipe structural design and pipe stiffness stamped by a Professional Engineer licensed in the state where the project is located and verified by the pipe manufacturer in accordance with ASTM, and AWWA standards based on the following design conditions gravity service or pressurized service:
 - 1. Size: Nominal diameter varies as indicated on the Drawings.
 - 2. Pipe Stiffness (SN): 72 lbf/in² minimum as indicated on the Drawings.
 - 3. Composite modulus of soil reaction: $E' = 2,000$ pounds per square inch (maximum value for design), based on parameters found in the geotechnical report listed in Section 01_11_00 Summary of Work.
 - 4. Soil specific weight: $Y = 125$ lb/ft³.
 - 5. Dead load/depth of cover: As indicated on the Drawings. Vertical deflection not to exceed 3-percent in short term (30 days) and 5 percent thereafter.
 - 6. Live load: Equal to AASHTO Standard Specifications for Highway Bridges, HS-20 vehicle loading and including any construction live loads.
 - 7. Fluid temperature: 40 degrees Fahrenheit to 95 degrees Fahrenheit.
 - 8. Chemical resistance: The FRPMP shall meet or exceed the requirement for the 50-year strain value in accordance with ASTM D3262, Table 4, when tested in accordance with ASTM D3681.
 - 9. Fluid velocity: 12 feet per second (maximum).
- B. For the portions of the pipeline that parallel Little Dry Creek (approximately sheets PP01 and PP02), the pipe manufacturer shall perform an analysis checking for possible flotation for water depths above the top of pipe equal to the ground surface elevation shown on the Drawings. For all other pipeline segments, pipe manufacturer shall perform analysis checking for possible flotation for water depths as found in the geotechnical report listed in Section 01_11_00 Summary of Work.

2.04 MATERIALS

- A. Pipe and fittings:
1. Open-cut pipes for gravity service:
 - a. Manufactured and tested in accordance with ASTM D3262 Type 1, Liner 1 or 2, and Grade 1 or 3 with Pipe Stiffness Class SN 72 lbf/in² minimum as indicated on the Drawings. Stiffness shall be tested in accordance with the test method of ASTM D2412.
 - b. Manufactured to result in a dense, nonporous, corrosion-resistant, consistent composite structure.
 2. Resins, reinforcements, colorants, resin viscosity fillers, and other materials, when combined as a composite structure, shall produce a pipe that shall meet the performance requirements of this specification and applicable ASTM and AWWA standards.
 3. Basic structural wall composition of the pipe shall consist of a thermosetting resin, glass-fiber reinforcement, and premium silica sand aggregates.
 4. Manufacturer shall use only US made polyester resin systems with a proven history of performance in this particular application. Historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
 5. Reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass or ECR-glass filaments with binder and sizing compatible with impregnating resins.
 6. Sand shall be minimum 98 percent silica with a maximum moisture content of 0.2 percent. Sand in accordance with ASTM C33, except that requirements for gradation shall not apply.
 7. Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the performance of the product.
- B. Manufacture pipe by the centrifugal casting or continuous filament wound process to result in a dense, nonporous, corrosion-resistant, consistent composite structure.
1. For centrifugal casting and filament wound pipe, the interior surface liner shall provide chemical, crack and abrasion resistance and shall consist of nominal 40-mil (0.040-inch) thick layer.
 - a. For centrifugal casting, non-reinforced thermosetting polyester resin shall have a minimum elongation of 50 percent when tested in accordance with ASTM D638.
 - b. For filament wound, the liner shall be thermosetting polyester resin with glass reinforcements.
 2. If fiberglass C, E, or ECR-veil or equal reinforcements are placed, then the liner shall be minimum 40 mil (0.040 inch) measured from the inner glass-fiber reinforcement transition layer.
 - a. Thickness of the liner, defined as the final inner layer, shall not be used in structural calculations of the buried pipe loads.
 - b. Liner shall be color separated from the structural wall for QA/QC purposes by adding white, green, or gray die to the core of the pipe.

3. For centrifugally cast pipe, the exterior surface layer shall be at least 10 mils (0.010 inch) of a silica sand resin mixture over any fiber reinforcement.
 4. For filament wound pipe, the exterior surface layer shall be at least 10 mils (0.010 inch) of resin fiberglass over reinforcements to allow for smooth surface finish and provide a long-term UV protection layer if pipe is stored for over 6 months.
- C. Outside diameter of the pipe shall be in accordance with ASTM D3262 (gravity service) or in accordance with the manufacturer's published product datasheet.
 - D. Pipe shall be supplied in nominal lengths of 20 or 40 feet for open-cut installation with the exception of sections/fittings or direct jacked or microtunnel installation.
 - E. Transitions in pipe diameters:
 1. Pipe internal diameters shall be smooth and transitional between different types of pipe, open-cut verses tunneling pipe, in accordance with ASTM D5262, Table 2.
 2. Where pipe cannot meet these requirements, install a 5-ply polyester laminate weld to span the internal diameter gap between differing pipe diameters.
 - F. Pipe shall be round and true with outside diameter tolerances in accordance with ASTM D3262 (gravity service).
 1. Internal diameter of any portion of each piece of pipe shall not vary more than plus or minus 1 percent, but in no case shall exceed 3/4 inch from the nominal diameter.
 2. Wall thickness shall not be more than 5 percent less than that shown in the design, but in no case more than 3/16 in less. A wall thickness greater than that required in the design shall not be cause for rejection.
 - G. Each pipe shall be free from defects including indentations, delaminations, bubbles, pinholes, visible cracks, pits, blisters, foreign inclusions, and resin-starved areas that due to their nature, degree, or extent, detrimentally affects the strength and serviceability of the pipe.
 - H. Pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.
 - I. Inside surface of each pipe shall be free of bulges, dents, ridges, or other defects that result in a variation of inside diameter of more than 1/8 inches from that obtained on adjacent unaffected portions of the surface. No glass fiber reinforcement shall penetrate the interior surface of the pipe wall.
 - J. Pipe specimens when tested in accordance with ASTM D3681 shall be capable of being deflected to 5 percent of the nominal diameter per size, without failure, and demonstrate a minimum strain level (t/d) provided in Table 4 of ASTM D3262 (gravity service) when exposed to 1.0N sulfuric acid.

- K. Elastomeric gaskets shall be supplied by qualified gasket manufacturers and be suitable for raw wastewater service. Unless otherwise specified, the pipe joints shall be field connected with fiberglass sleeve couplings that utilize EPDM elastomeric sealing gaskets or Viton™/Nitril (for hydrocarbon exposure) in accordance with ASTM F477 as the sole means to maintain joint watertightness.
 - 1. Joints must meet the performance requirements in accordance with ASTM D4161.
 - 2. As part of Submittal, a certificate shall be issued by the pipe supplier that the EPDM and Viton™/Nitril gaskets meet the required ASTM standards and are covered under pipe warranty.
 - 3. Tie-ins, when needed, may utilize gasket-sealed mechanical couplings.
- L. Tees, wyes, and other fittings shall be capable of withstanding operating conditions when installed. They shall be manufactured from mitered sections of the same structural design as the adjoining pipe joined by glass-fiber-reinforced overlays.
- M. Fiberglass tees, wyes, or other similar fittings shall be fully encased in reinforced concrete designed to withstand the pressure forces.
- N. Unrestrained joints: Pipe shall be field connected with glass reinforced plastic sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water-tightness. Coupling joints shall meet the performance requirements in accordance with ASTM D4161 and ASTM F477 and shall have a deflection no greater than 75 percent of manufacturer's recommendations.
- O. Mark each length of pipe in accordance with ASTM D3262.

PART 3 EXECUTION

3.01 PIPELINE INSTALLATION AND TESTING

- A. Sewer pipe installation shall be tested per requirements of Specification Section 33_05_00.09 – Piping Systems Testing.

3.02 TRENCHING

- A. As specified in Section 31_23_35 - Trenching.

END OF SECTION

SECTION 33_05_61.01
CONCRETE MANHOLES

PART 1 GENERAL

1.01 SUMMARY

- A. Provide manhole frames, covers, grade rings, cones, risers, bases, and appurtenances per City of Arvada Specification Section 522.04.

1.02 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Shop Drawings:
 - 1. Manufacturer's catalog data and details of following items for approval:
 - a. Frame and covers.
 - b. Grade rings.
 - c. Manhole cones and risers.
 - d. Manhole bases, if precast.
 - 2. Manhole construction details, jointing methods, connection details, materials, and dimensions.
 - 3. Repair procedures and details.
- C. Calculations and criteria used in manhole design including material properties, loadings, load combinations, and dimensions assumed.
- D. Test methods and results including certification that the manhole riser exceeds the minimum requirements in accordance with ASTM C478.

1.03 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

Exhibit 6

Amendment No. 1

To "A Construction Management/General Contractor (CM/CG) Agreement by and Between the City of Arvada and Garney Companies, Inc. for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave.," for Purposes of Awarding Phase II, at a Guaranteed Maximum Price of \$20,107,055.66, Thereby Increasing the Contract Amount From \$192,522.00 to an Amount not to Exceed \$20,299,577.66

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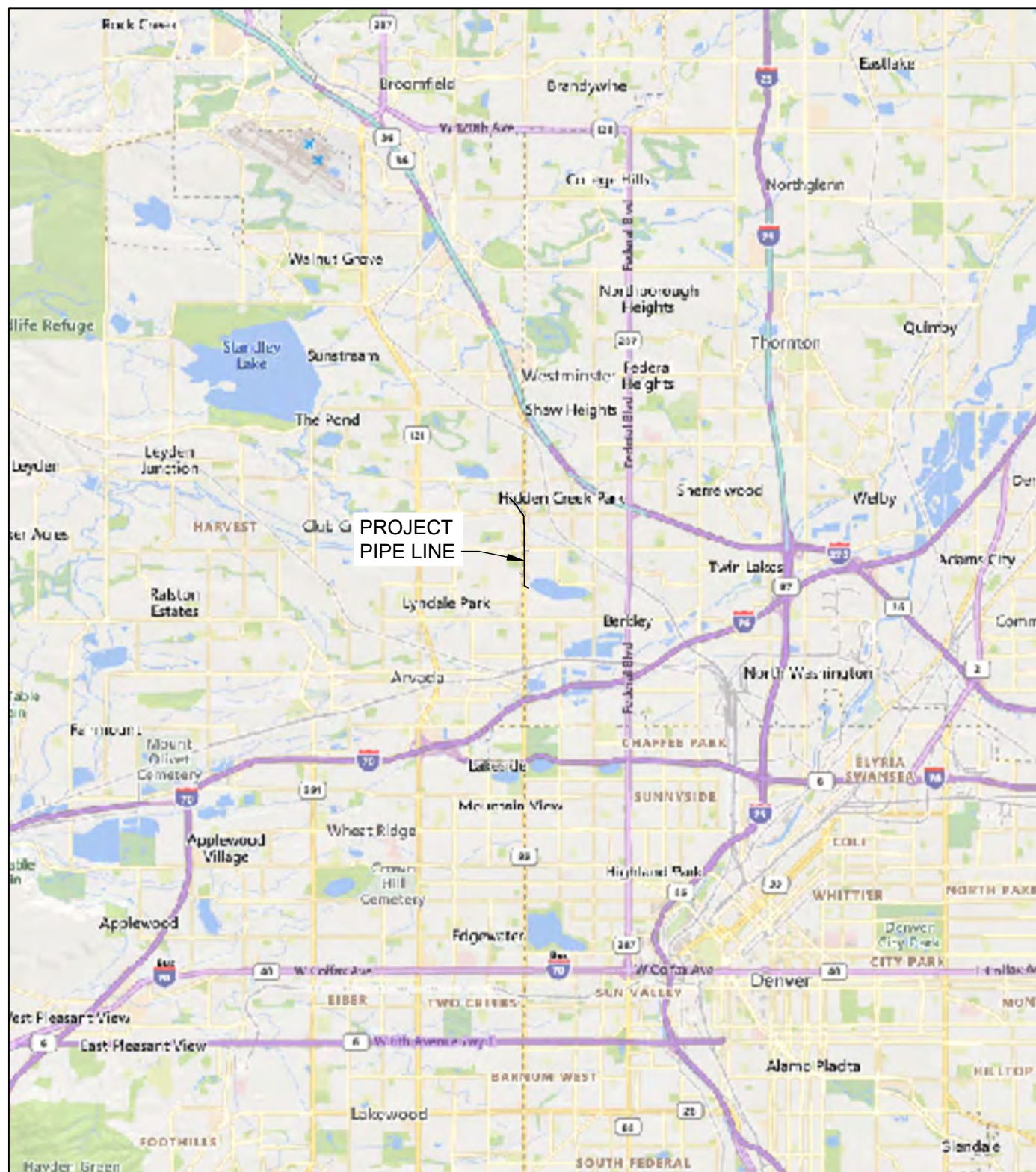
CITY OF ARVADA, COLORADO

NORTH TRUNK SEWER SHERIDAN, 76TH AVE TO 68TH AVE (NTL7)

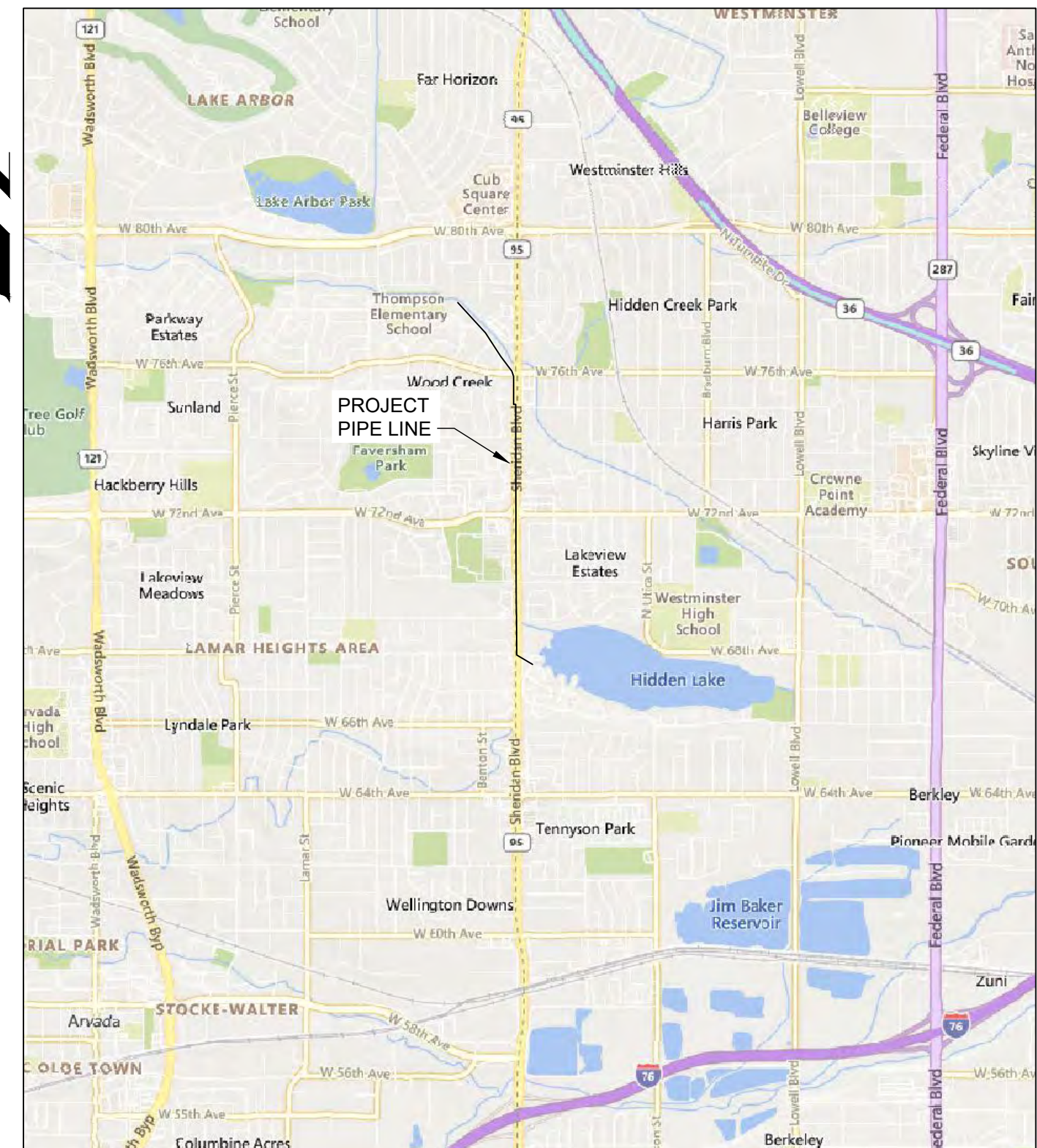
CITY OF ARVADA PROJECT NO. 24-SR-03

95% DESIGN
OCTOBER 2024

VOLUME 2 OF 2



VICINITY MAP



LOCATION MAP



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
DESIGNED CDH			
DRAWN CDH			
CHECKED JKK			
DATE OCTOBER 2024			
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DESIGNED CDH
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DATE OCTOBER 2024

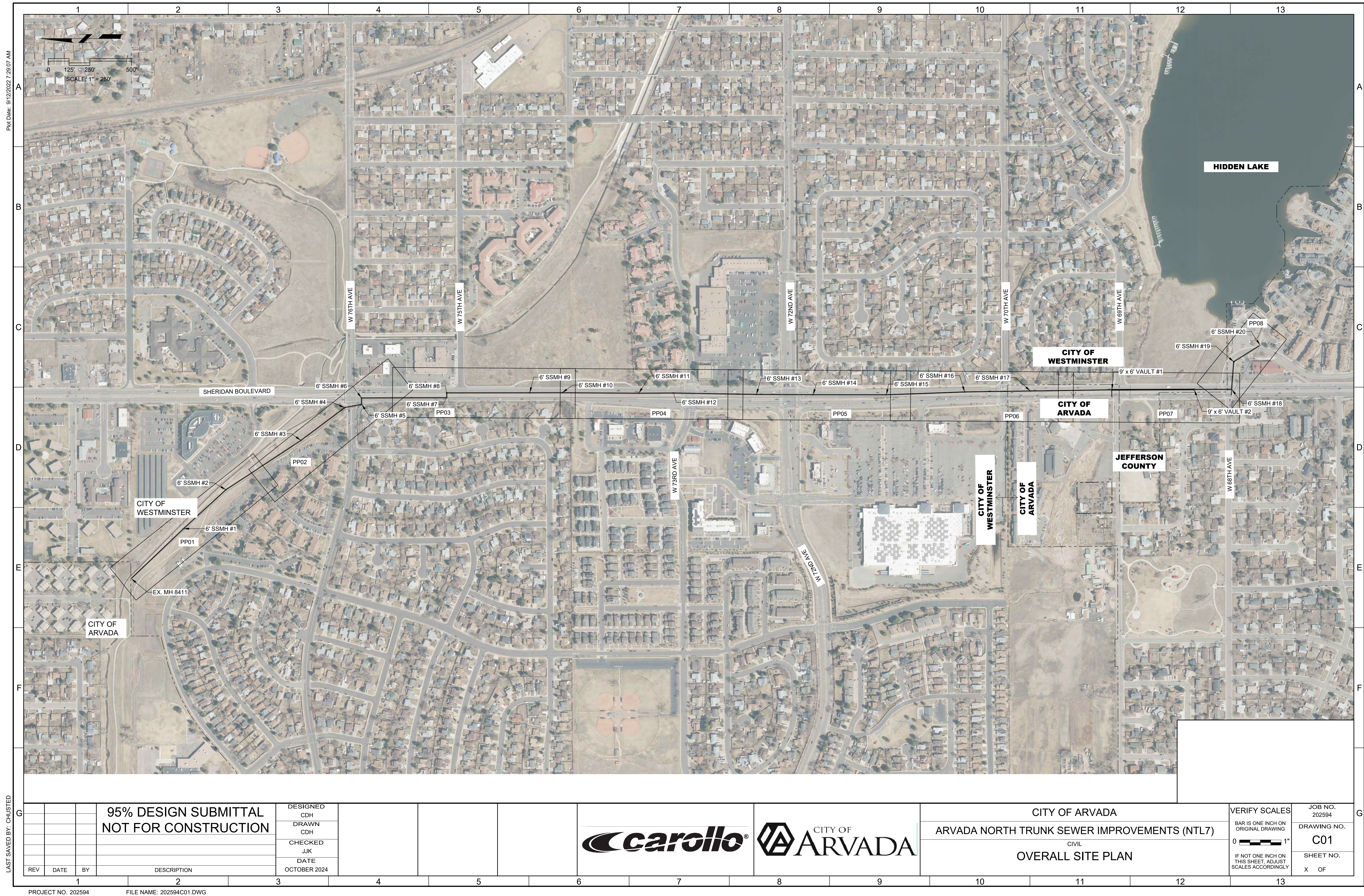
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ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
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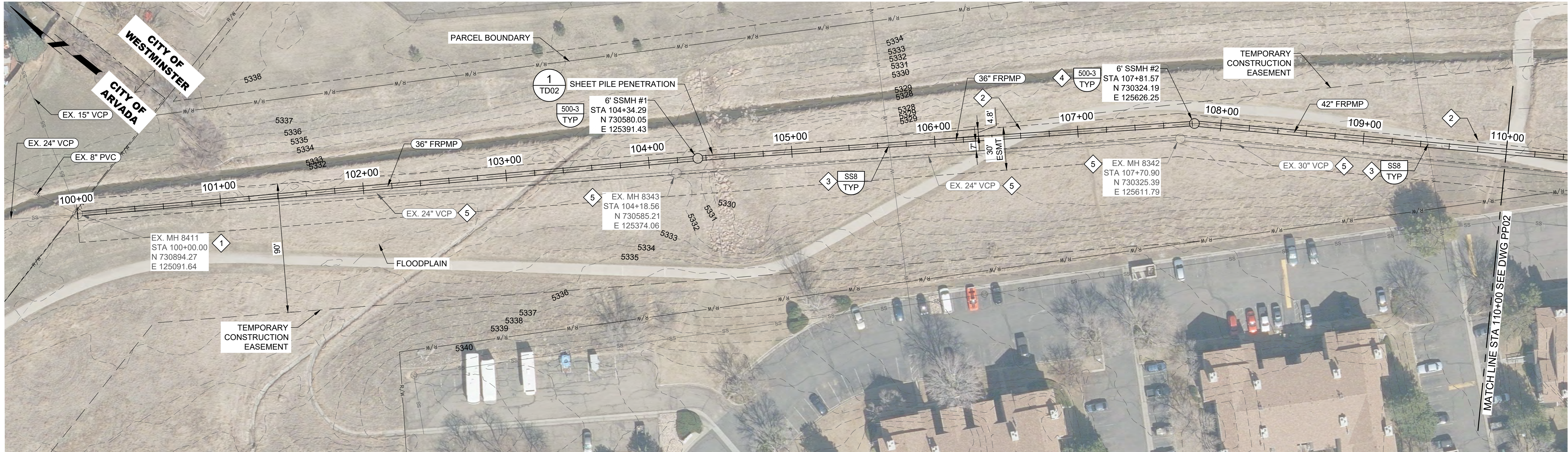
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	SHEET NUMBER		SHEET TITLE																								1. REFER TO THE GEOTECHNICAL INVESTIGATION REPORT(S) LOCATED IN THE CONTRACT DOCUMENTS FOR ADDITIONAL INFORMATION ON THE GEOTECHNICAL CONDITIONS AND BORING INFORMATION.										2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL SURVEY MONUMENTS AND CORNER MARKERS. SURVEY MONUMENTS AND PROPERTY CORNER MARKERS DAMAGED BY CONSTRUCTION ACTIVITIES SHALL BE REESTABLISHED BY A PROFESSIONAL SURVEYOR LICENSED IN THE STATE OF COLORADO.										3. DIMENSIONS TO STRUCTURES, REFERENCED PIPING, PAVING, AND OTHER IMPROVEMENTS ARE APPROXIMATE. THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND CONDITIONS 14 DAYS IN ADVANCE OF THE CONSTRUCTION PROGRESS. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER.										4. STRUCTURES SUCH AS CURBS AND GUTTERS, CONCRETE AND ASPHALT DRIVES AND WALKWAYS, PAVING BRICKS, FENCING, RETAINING WALLS, SIGNS, POSTS, MARKERS, MAIL BOXES, ETC., CROSSED BY THE PIPELINE ARE NOT INDICATED IN THE PROFILE. CONTRACTOR SHALL RESTORE TO PRECONSTRUCTION CONDITIONS AND LOCATIONS ANY EXISTING STRUCTURES THAT ARE DISTURBED, DAMAGED, OR REMOVED BY CONSTRUCTION.										5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO EXISTING ROADS, BUILDINGS, OR OTHER STRUCTURES RESULTING FROM CONTRACTORS CONSTRUCTION ACTIVITIES. REPAIRS SHALL BE MADE TO THE SATISFACTION OF THE OWNER AND THE ENGINEER AT NO COST TO THE OWNER.										6. CONTRACTOR SHALL PROTECT AND MAINTAIN ALL EXISTING TREES, SHRUBS, AND PLANTS, UNLESS OTHERWISE NOTED.										7. CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS PRIOR TO CONSTRUCTION IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.										8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ESTABLISHING STAGING AREAS FOR THEIR WORK AND FOR OBTAINING REQUIRED APPROVALS FROM REGULATORY AGENCIES.										9. CONTRACTOR SHALL INSTALL PIPELINES, PAVING, WALKWAYS, AND CURB AND GUTTER AT UNIFORM GRADE BETWEEN ELEVATIONS DEPICTED ON THE DRAWINGS.										10. THE CONTRACTOR SHALL MAINTAIN DRIVEWAY ACCESS TO ALL ADJOINING PROPERTIES ACCESSIBLE TO THE PUBLIC AND EMERGENCY VEHICLES. DESIGNS FOR MAINTAINING ACCESS WILL BE PREPARED BY THE CONTRACTOR AND SUBMITTED TO THE CONTROLLING AGENCY FOR REVIEW AND APPROVAL.										11. TRENCH PLATES ARE NOT ALLOWED IN CDOT ROW.										12. THE CONTRACTOR SHALL COMPLY WITH ALL FEDERAL, STATE, COUNTY, AND LOCAL LAWS AND ORDINANCES RELATING TO THE SAFETY AND CHARACTER OF WORK, EQUIPMENT, AND PERSONNEL. THIS INCLUDES, BUT IS NOT LIMITED TO SHEETING, SHORING, BRACING, VENTILATION, CONFORMANCE WITH TRAFFIC CONTROL AND MAINTENANCE OF BARRICADES AND WARNING DEVICES.										13. CONTRACTOR SHALL KEEP COMPLETE AND ACCURATE RECORD DRAWINGS OF THE WORK, UTILITY POTHOLE DATA, AND EXISTING CONDITIONS THAT HAVE CHANGED OR ARE DIFFERENT THAN SHOWN ON THE PLANS. UPON COMPLETION OF THE WORK, THE CONTRACTOR'S REDLINED AS-BUILT DRAWINGS SHALL BE SUBMITTED TO THE CONSTRUCTION MANAGER FOR REVIEW AND COMMENT.										14. BURNING OF TRASH, VEGETATION, OR ANY OTHER WASTE GENERATED DURING CONSTRUCTION IS PROHIBITED.										15. CONTRACTOR SHALL RESTORE ALL PROPERTIES TO PRECONSTRUCTION CONDITIONS INCLUDING SURFACE RESTORATION, SEEDING, AND REMOVAL AND REPLACEMENT OF EXISTING INFRASTRUCTURE INCLUDING FENCE, GATES, ROADS, AND TRAILS.																																							
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	C01		OVERALL SITE PLAN																								1. THE FOLLOWING NOTES ARE GENERAL AND APPLY TO ALL SHEETS OF THESE CONTRACT DOCUMENTS AS IF THEY WERE WRITTEN IN THEIR ENTIRETY ON EACH SHEET.										2. CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK AND SHALL IMMEDIATELY NOTIFY THE ENGINEER OF ANY DISCREPANCIES. CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFYING ALL EXISTING CONDITIONS INCLUDING LOCATION AND DIMENSIONS OF ALL EXISTING CONSTRUCTION AND UTILITIES. CONTRACTOR SHALL NOTIFY ENGINEER IF THERE IS A CONFLICT BETWEEN THE CONTRACT DOCUMENTS AND EXISTING CONSTRUCTION BEFORE PROCEEDING WITH WORK.										3. CONTRACTOR SHALL MAINTAIN A MINIMUM CLEARANCE OF 10 FEET HORIZONTAL AND 18 INCHES VERTICAL BETWEEN THE SEWER LINES AND EXISTING WATER LINES UNLESS OTHERWISE NOTED.										4. UNLESS DETAILED, SPECIFIED, OR OTHERWISE INDICATED ON THE DRAWINGS, CONSTRUCTION SHALL BE AS INDICATED IN THE APPLICABLE TYPICAL DETAILS AND GENERAL NOTES. TYPICAL DETAILS SHALL APPLY EVEN THOUGH NOT REFERENCED AT SPECIFIC LOCATIONS ON DRAWINGS.										5. WHERE NO CONSTRUCTION DETAILS ARE SHOWN OR NOTED FOR A GIVEN PART OF THE WORK, DETAILS SHALL BE THE SAME AS FOR OTHER SIMILAR WORK.										6. CONTRACTOR SHALL COMPLY WITH LOCAL AND STATE CONSTRUCTION STORM WATER DISCHARGE REGULATIONS AND REQUIREMENTS.										7. PRIOR TO EXCAVATION FOR NEW STRUCTURES, ELECTRICAL CONDUIT, FABRICATION OF NEW PIPING AND/OR OTHER PROPOSED UTILITIES, CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION OF ALL EXISTING PIPING AND UTILITIES IN THE CONSTRUCTION AREA.										8. EXISTING FACILITY AND UTILITY INFORMATION SHOWN ON THE DRAWINGS WAS OBTAINED FROM AVAILABLE RECORDS OR ELECTRONIC FILES. NEITHER THE OWNER NOR ENGINEER ASSUMES ANY RESPONSIBILITY FOR FACILITIES AND UTILITIES NOT SHOWN OR NOT IN THE LOCATION SHOWN. THE CONTRACTOR SHALL FIELD VERIFY ALL LOCATIONS, SIZES, MATERIAL TYPES, AND ELEVATIONS SHOWN AROUND OR NEAR AREAS OF NEW CONSTRUCTION PRIOR TO START OF CONSTRUCTION.										9. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT FROM DAMAGE EXISTING FACILITIES AND UTILITIES SHOWN OR NOT SHOWN THAT ARE TO REMAIN IN PLACE. ALL FACILITIES DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED TO THE ORIGINAL OR BETTER CONDITION AT THE CONTRACTOR'S EXPENSE WITHOUT ADDITIONAL COMPENSATION.										10. CONTRACTOR SHALL MAKE CONNECTIONS TO EXISTING PIPE, EQUIPMENT, ETC. AS REQUIRED AND SHALL PROVIDE ALL FITTINGS, ADAPTERS, AND APPURTENANCES REQUIRED TO MAKE THE CONNECTIONS. PROVIDE ALL SUPPORTS REQUIRED FOR A RIGIDLY SUPPORTED COMPLETE AND WORKING SYSTEM.										11. ADJUST ALL VALVE BOXES, VAULTS, PULL BOXES, AND MANHOLES TO FINISHED GRADE UNLESS OTHERWISE SHOWN OR DIRECTED. MANHOLES AND VAULTS IN OPEN FIELDS SHALL BE SET AT FINISHED GRADE.										12. THE CONTRACTOR SHALL CONTACT 811 ALONG WITH THE PROPER UTILITY REPRESENTATIVE AS PRESENTED ON THE UTILITY GENERAL NOTES SHEET. FOR UTILITIES WITHOUT CONTACT INFORMATION PROVIDED, CONTACT 811.										13. THE CONTRACTOR SHALL TAKE SPECIAL PRECAUTIONS IN THE VICINITY OF ANY OVERHEAD ELECTRIC LINES. CONTRACTOR SHALL ABIDE BY THE NATIONAL ELECTRIC CODE AND ANY REQUIREMENT BY THE OWNER OF THE ELECTRIC LINES.										14. BLASTING IS NOT ANTICIPATED BASED ON GEOTECHNICAL INVESTIGATIONS AND IS PROHIBITED.										15. PROVIDE ALL SHEETING/SHORING REQUIRED TO PROTECT EXISTING STRUCTURES, PIPES AND FACILITIES.										16. CONSTRUCT TRENCHES IN ACCORDANCE WITH SECTION 31_23_35 AND CIVIL STANDARD TRENCHING DETAILS. ALL OPEN TRENCHES, WORK AREAS, AND SHAFTS SHALL BE SLOPED OR HAVE A SHORING SYSTEM IN ACCORDANCE WITH OSHA, STATE, AND LOCAL REQUIREMENTS.										17. SCHEDULE TIE-INS IN ACCORDANCE WITH THE SEQUENCING REQUIREMENTS OF THE CONTRACT. SCHEDULE AND COORDINATE TIE-INS AROUND THE OWNER'S OPERATIONAL REQUIREMENTS AND LIMITATIONS. ADVANCE NOTICE SHALL BE GIVEN TO THE ENGINEER PRIOR TO COMMENCEMENT OF ANY TIE-IN WORK.										18. THE CONTRACTOR IS RESPONSIBLE FOR ARRANGING FOR REQUIRED INSPECTIONS. THE PRESENCE OR ABSENCE OF THE INSPECTOR WILL NOT RELIEVE THE CONTRACTOR OF FULL RESPONSIBILITY FOR THE PROPER PERFORMANCE OF THE WORK.									
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PP05		PLAN AND PROFILE 5																								2. EXISTING UTILITIES IN THE PROJECT MAY BE IN A FRAGILE CONDITION. THE CONTRACTOR SHALL EXERCISE NECESSARY CAUTION WHEN WORKING NEAR EXISTING UTILITIES.										3. SUPPORT ALL EXISTING UTILITIES AT CROSSING LOCATIONS. PROTECT EXISTING UTILITIES RUNNING PARALLEL TO CONSTRUCTED TRENCHES FROM DAMAGE CAUSED BY THE REMOVAL OF ADJACENT MATERIALS.										4. SOME UTILITY SERVICES MAY NOT BE SHOWN ON THESE DRAWINGS. THE CONTRACTOR SHALL TAKE NECESSARY MEASURES TO LOCATE AND PROTECT SERVICE DURING CONSTRUCTION.										5. PRIOR TO CONSTRUCTION OF ANY NEW PIPELINE THAT TIES INTO AN EXISTING UTILITY, EXPOSE AND VERIFY LOCATION AND ELEVATION OF THE TIE-IN POINT. CONFIRM THE EXISTING PIPE MATERIAL AND ANY OTHER INFORMATION REQUIRED BY THE DRAWINGS. SURVEY AND ACCURATELY RECORD THE LOCATION AND ELEVATION OF TIE-IN POINT ON THE RECORD DRAWINGS.										6. OVERHEAD UTILITIES ARE NOT INDICATED IN PROFILE OR SECTION DRAWINGS.										7. BEFORE CONSTRUCTION IS STARTED, CONTRACTOR SHALL COORDINATE WITH THE OWNER OF EACH UTILITY TO DEFINE THE REQUIREMENTS AND METHODS TO ACCOMMODATE THE PROTECTION, TEMPORARY SUPPORT, ADJUSTMENT, OR RELOCATION OF ANY UTILITIES AFFECTED BY THE PROPOSED WORK.										8. REPLACE ALL UTILITY MARKERS, MARKING TAPE, TRACER WIRE, AND ANY OTHER UTILITY IDENTIFICATION DEVICES FOR EXISTING UTILITIES THAT ARE DAMAGED DURING CONSTRUCTION.																																																																																																																								
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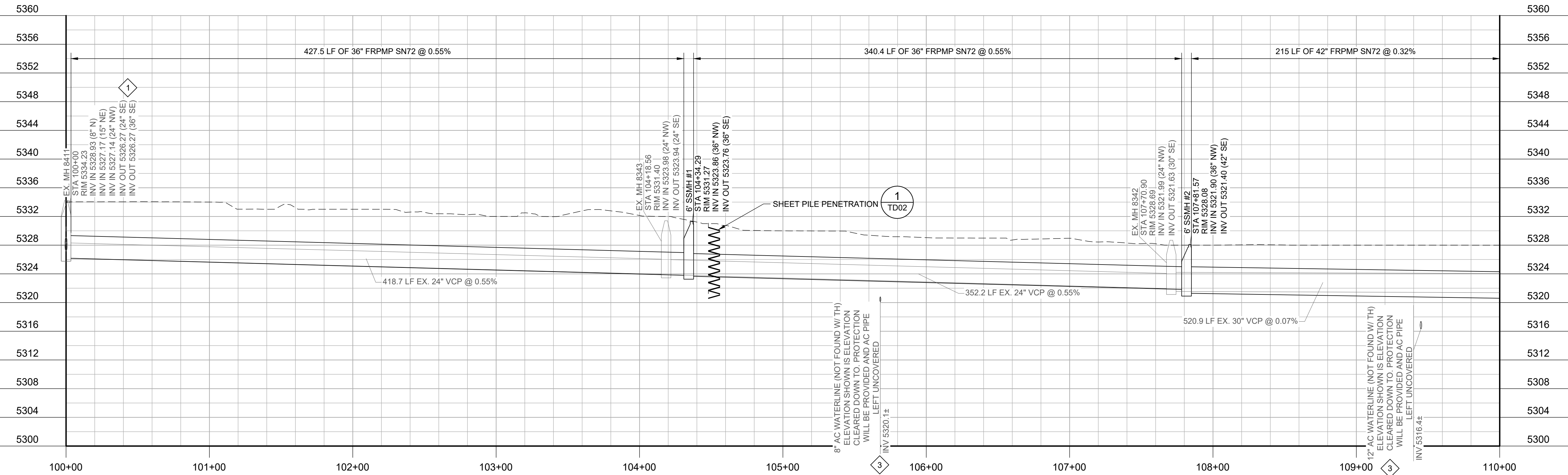


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PLAN
FILE: 20259400C0800



PROFILE
FILE: 20259400C0800

GENERAL NOTES:

- PIPELINES THAT ARE ABANDONED IN PLACE ARE TO BE FILLED WITH FLASH FILL. MANHOLES THAT ARE TO BE ABANDONED IN PLACE ARE TO HAVE THE CONE REMOVED AND THE REMAINDER OF THE MANHOLE FILLED WITH FLASH FILL.
- EXISTING MANHOLE RIMS AND INVERTS WERE COLLECTED FROM SAM, INC.
- SURFACE ELEVATIONS BASED ON DRCOG LIDAR, ADJUSTED DOWN BY 1.25 FEET BASED ON TEST HOLE SURFACE ELEVATIONS COLLECTED BY SAM, INC. ALL MANHOLE RIM ELEVATIONS WERE COLLECTED BY SAM, INC AND ARE TO BE VERIFIED.

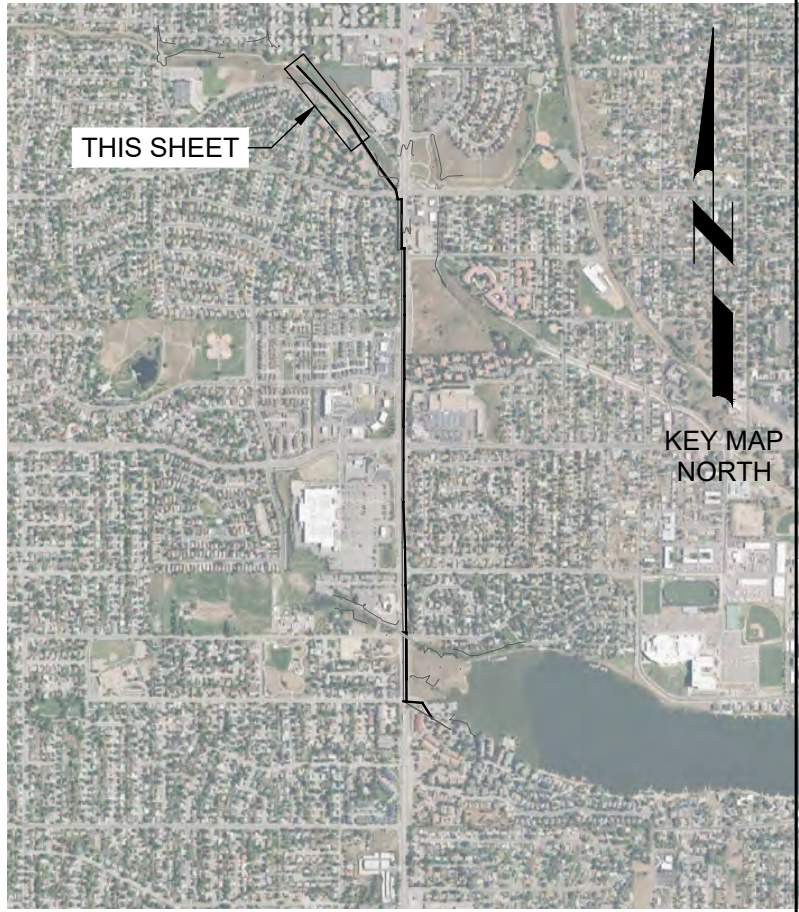
KEY NOTES:

- CORE DRILL OPENING IN MANHOLE FOR 36" FRMP PIPE TO MATCH THE INVERT OF THE EXISTING 24" VCP PIPE. EXISTING 24" VCP SHALL BE REMOVED.
- SAWCUT AND REMOVE EXISTING SIDEWALK AS REQUIRED FOR CONSTRUCTION. REPLACE SIDEWALK TO MATCH EXISTING. SEE ATKINS REALIS PLANS FOR PATH DETOUR.
- CONCRETE ENCASE SANITARY SEWER 10 FT ON EITHER SIDE OF WESTMINSTER WATERLINE.
- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- ABANDON IN PLACE.



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KEY MAP



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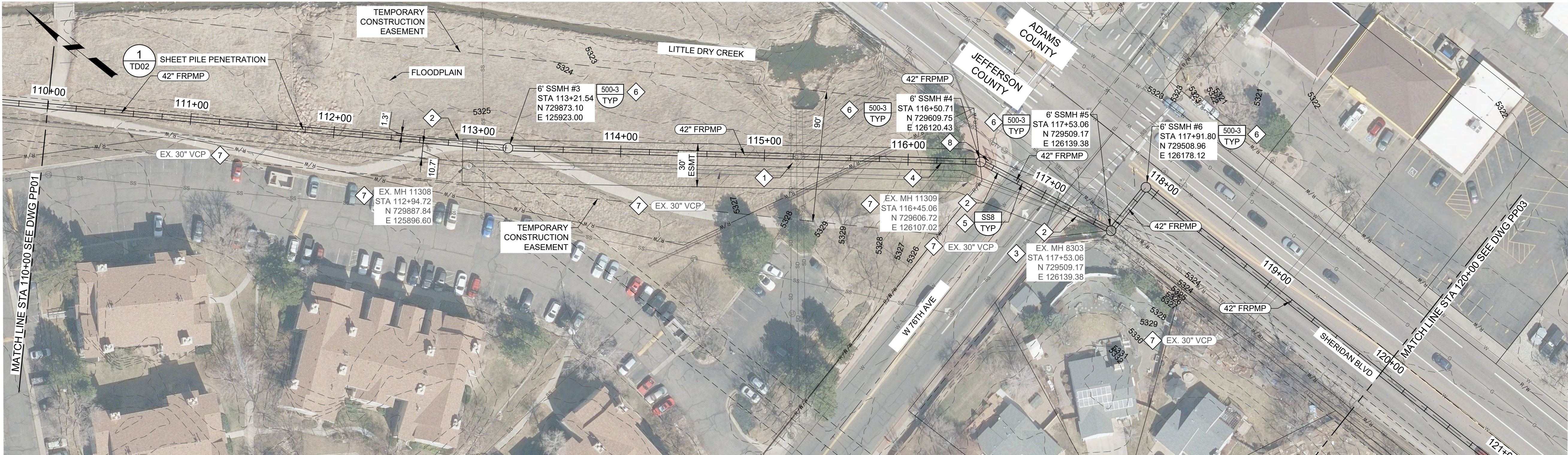
CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 1

VERIFY SCALES
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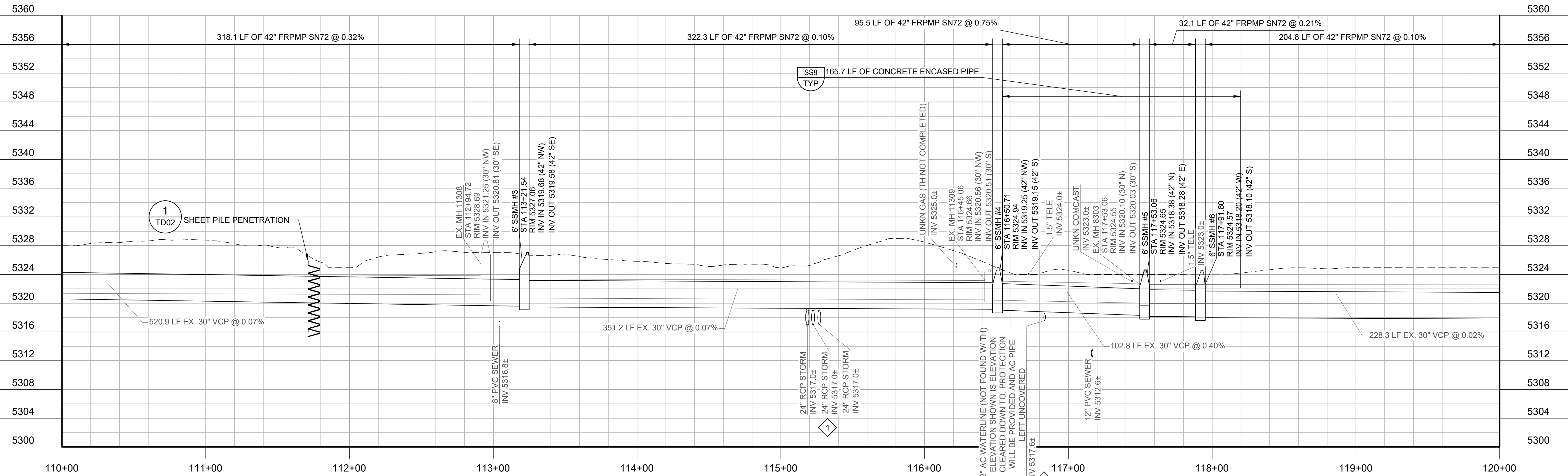
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PLAN
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PROFILE
FILE: 20259400C0800

GENERAL NOTES:

- PIPELINES THAT ARE ABANDONED IN PLACE ARE TO BE FILLED WITH FLASH FILL. MANHOLES THAT ARE TO BE ABANDONED IN PLACE ARE TO HAVE THE CONE REMOVED AND THE REMAINDER OF THE MANHOLE FILLED WITH FLASH FILL.
- EXISTING MANHOLE RIMS AND INVERTS WERE COLLECTED FROM SAM, INC.
- SURFACE ELEVATIONS BASED ON DRGO LIDAR, ADJUSTED DOWN BY 1.25 FEET BASED ON TEST HOLE SURFACE ELEVATIONS COLLECTED BY SAM, INC. ALL MANHOLE RIM ELEVATIONS WERE COLLECTED BY SAM, INC AND ARE TO BE VERIFIED.

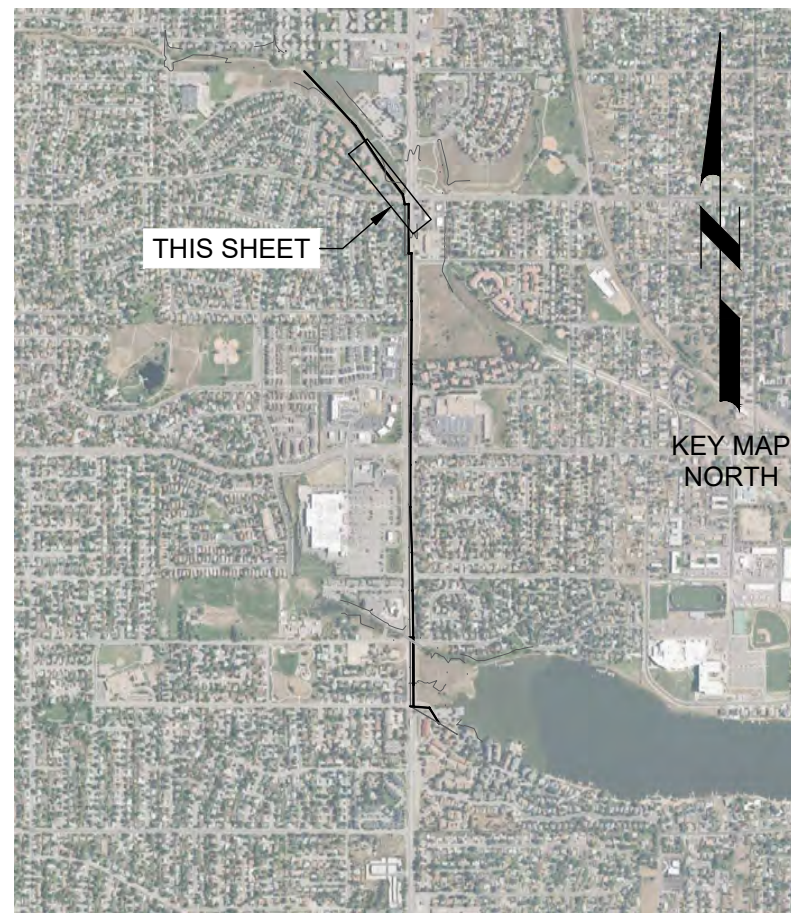
KEY NOTES:

- CONCRETE ENCASE SEWER PIPE ABOVE THE STORM SEWER PIPES 9 FT ON EITHER SIDE OF THE CROSSING.
- SAWCUT AND REMOVE EXISTING SIDEWALK AS REQUIRED FOR CONSTRUCTION. REPLACE SIDEWALK TO MATCH EXISTING SEE ATKINS REALIS PLANS FOR PATH DETOUR.
- REMOVE AND REPLACE EXISTING MANHOLE.
- COORDINATE WITH WESTMINSTER AND APARTMENT COMPLEX FOR TREE AND ARCHITECTURAL SIGN REMOVAL AND REPLACEMENT.
- CONCRETE ENCASE SANITARY SEWER 10 FT ON EITHER SIDE OF WESTMINSTER WATERLINE.
- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- ABANDON IN PLACE.
- REMOVE AND REPLACE TRAFFIC SIGNAL AS NEEDED FOR CONSTRUCTION AND TRAFFIC CONTROL. NEEDS IN COORDINATION WITH THE ATKINS REALIS PLANS.



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CITY OF ARVADA
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CIVIL
PLAN AND PROFILE 2

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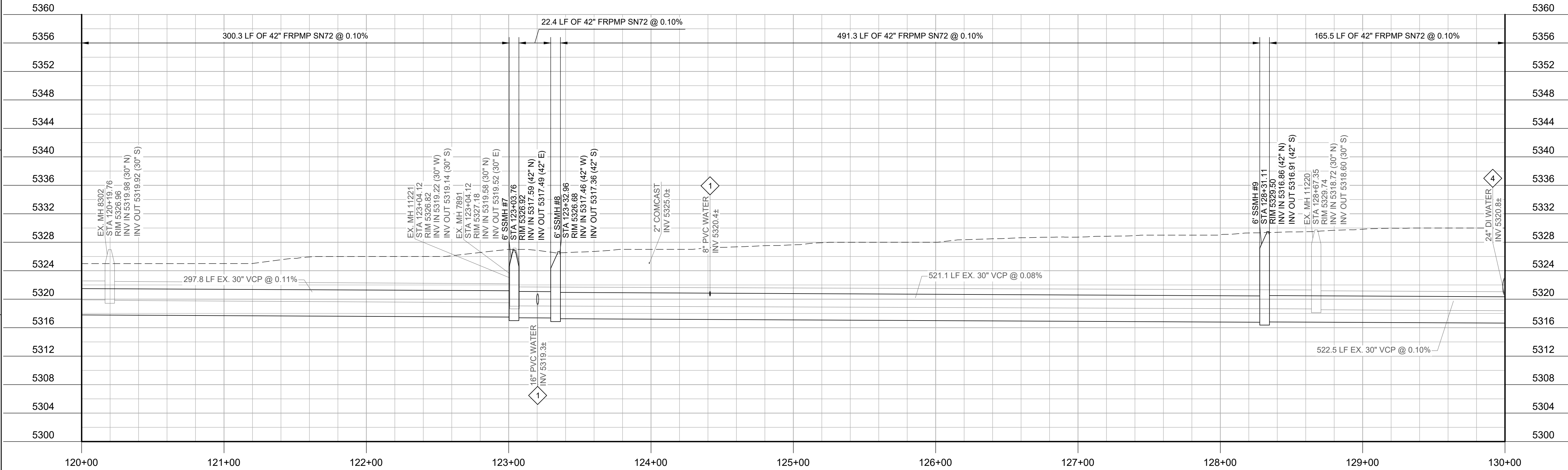
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PROFILE
FILE: 202594800

GENERAL NOTES:

- PIPELINES THAT ARE ABANDONED IN PLACE ARE TO BE FILLED WITH FLASH FILL. MANHOLES THAT ARE TO BE ABANDONED IN PLACE ARE TO HAVE THE CONE REMOVED AND THE REMAINDER OF THE MANHOLE FILLED WITH FLASH FILL.
- EXISTING MANHOLE RIMS AND INVERTS WERE COLLECTED FROM SAM, INC.
- SURFACE ELEVATIONS BASED ON DRACO LIDAR, ADJUSTED DOWN BY 1.25 FEET BASED ON TEST HOLE SURFACE ELEVATIONS COLLECTED BY SAM, INC. ALL MANHOLE RIM ELEVATIONS WERE COLLECTED BY SAM, INC AND ARE TO BE VERIFIED.

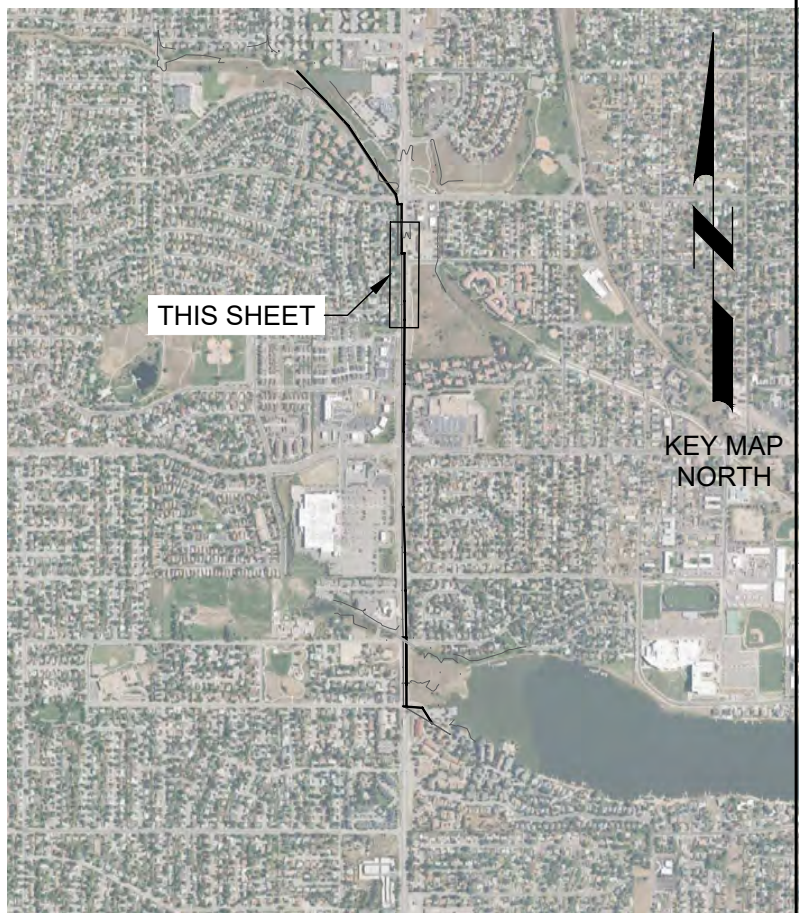
KEY NOTES:

- LOWER WATER LINE WITH MINIMUM 18" CLEARANCE UNDER SANITARY SEWER. CONCRETE ENCASE SANITARY SEWER 10 FT ON EITHER SIDE OF WESTMINSTER WATER LINE. SERVICE TO WESTMINSTER CUSTOMERS TO BE MAINTAINED PER WESTMINSTER STANDARDS.
- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- ABANDON IN PLACE.
- RAISE WATER LINE WITH MINIMUM 18" CLEARANCE OVER SANITARY SEWER LINE. CONCRETE ENCASE SANITARY SEWER 10 FT ON EITHER SIDE OF WESTMINSTER WATER LINE.



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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
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PLAN AND PROFILE 3

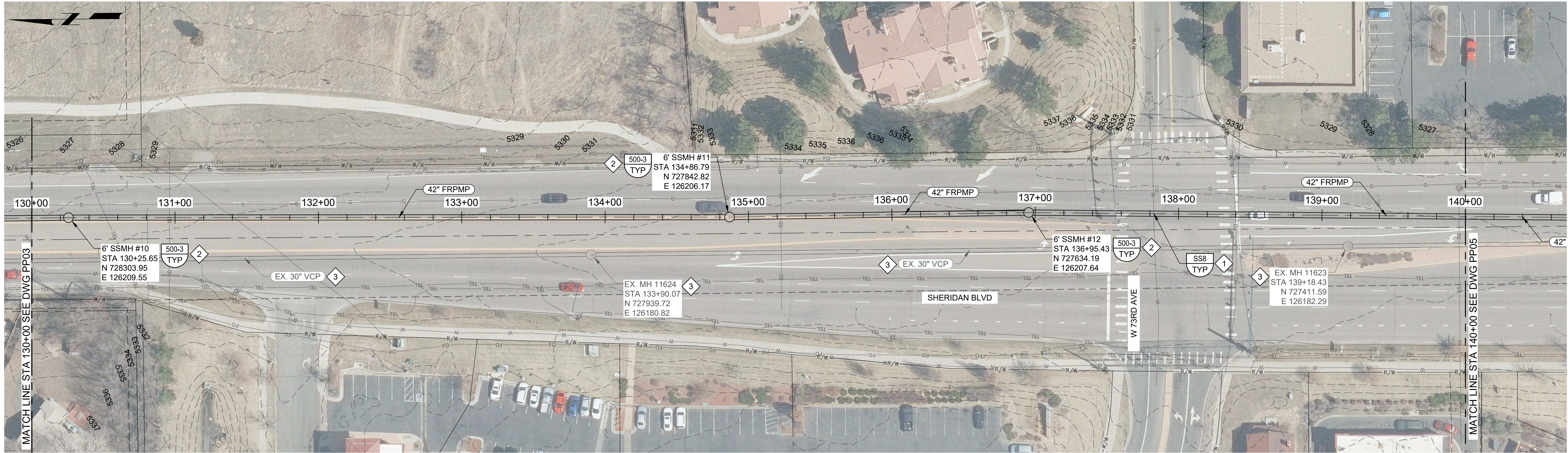
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IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

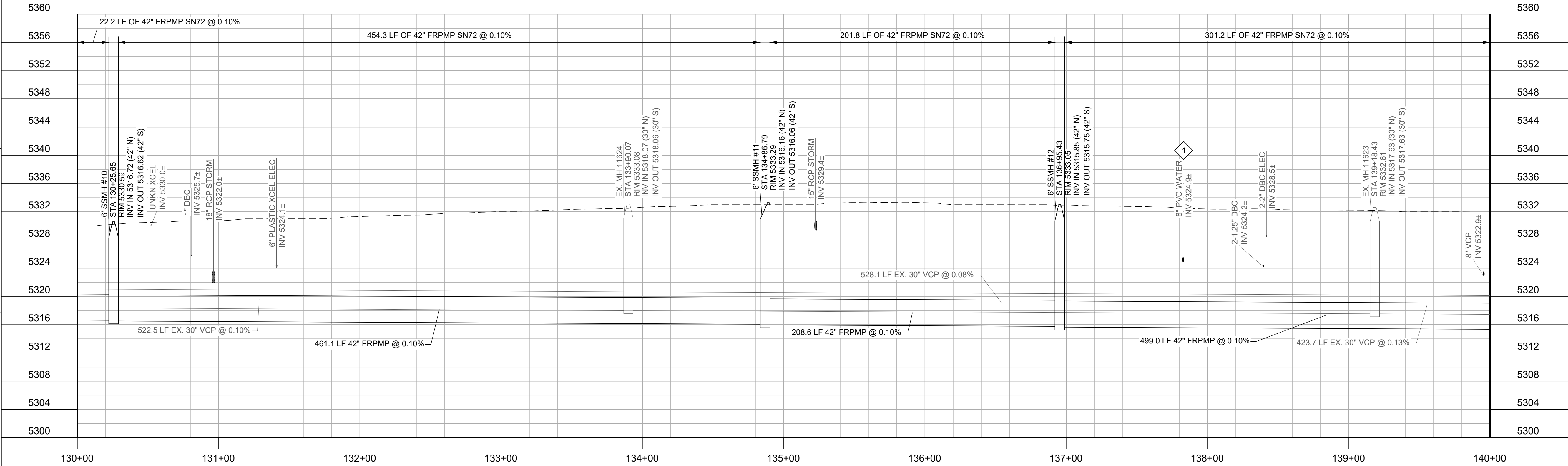
JOB NO.
202594
DRAWING NO.
PP03
SHEET NO.
X OF

Plot Date: 9/29/2024 2:47:54 PM

LAST SAVED BY: CHUSTED



PLAN
FILE: 20259400C0800



PROFILE
FILE: 20259400C0800

GENERAL NOTES:

- PIPELINES THAT ARE ABANDONED IN PLACE ARE TO BE FILLED WITH FLASH FILL. MANHOLES THAT ARE TO BE ABANDONED IN PLACE ARE TO HAVE THE CONE REMOVED AND THE REMAINDER OF THE MANHOLE FILLED WITH FLASH FILL.
- EXISTING MANHOLE RIMS AND INVERTS WERE COLLECTED FROM SAM, INC.
- SURFACE ELEVATIONS BASED ON DRCOG LIDAR, ADJUSTED DOWN BY 1.25 FEET BASED ON TEST HOLE SURFACE ELEVATIONS COLLECTED BY SAM, INC. ALL MANHOLE RIM ELEVATIONS WERE COLLECTED BY SAM, INC AND ARE TO BE VERIFIED.

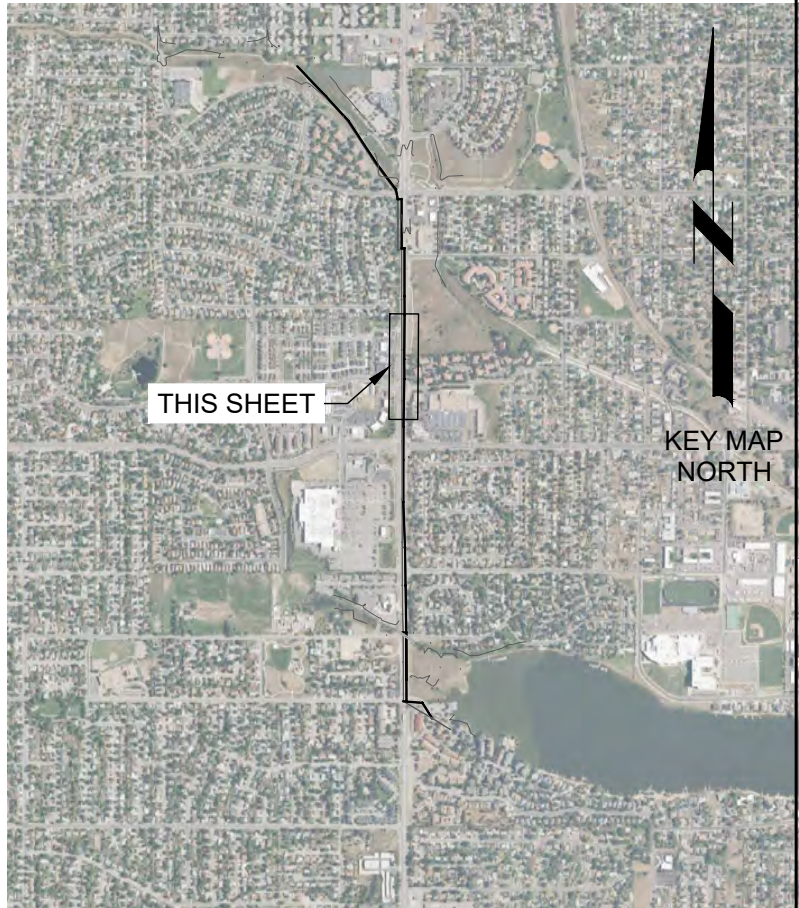
KEY NOTES:

- CONCRETE ENCASE SANITARY SEWER 10 FT ON EITHER SIDE OF WESTMINSTER WATERLINE.
- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- ABANDON IN PLACE.



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KEY MAP



95% DESIGN SUBMITTAL
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DESIGNED
CDH
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JKK
DATE
OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 4

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

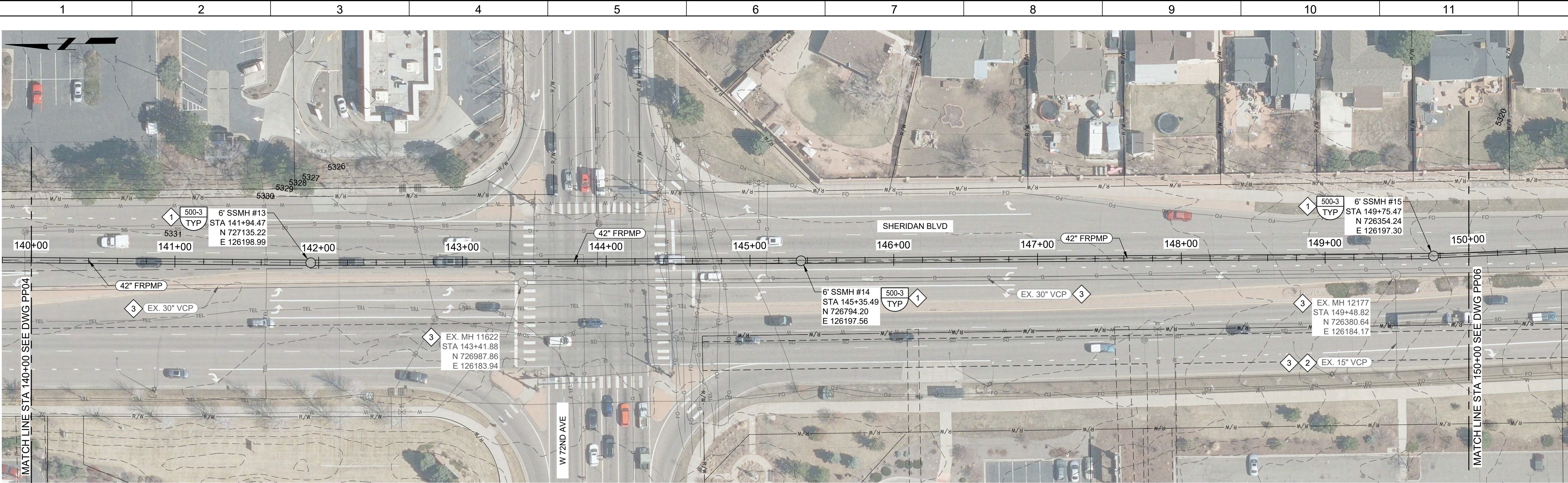
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202594

DRAWING NO.
PP04

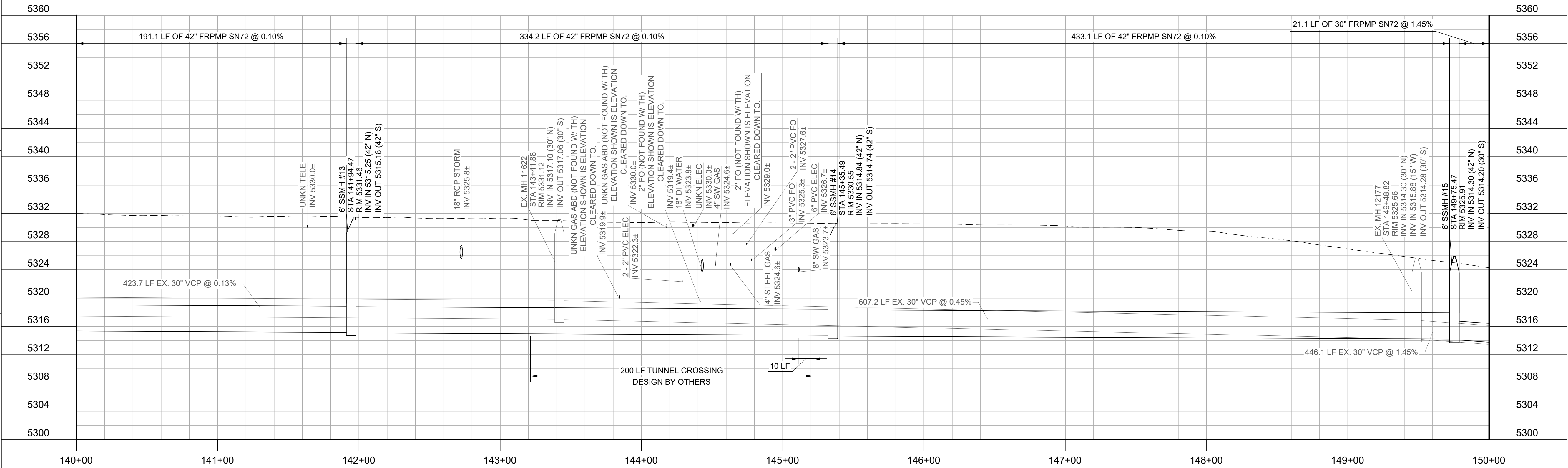
SHEET NO.
X OF

Plot Date: 9/29/2024 2:47:54 PM

LAST SAVED BY: CHUSTED



PLAN
FILE: 20259400C0800



PROFILE
FILE: 20259400C0800

GENERAL NOTES:

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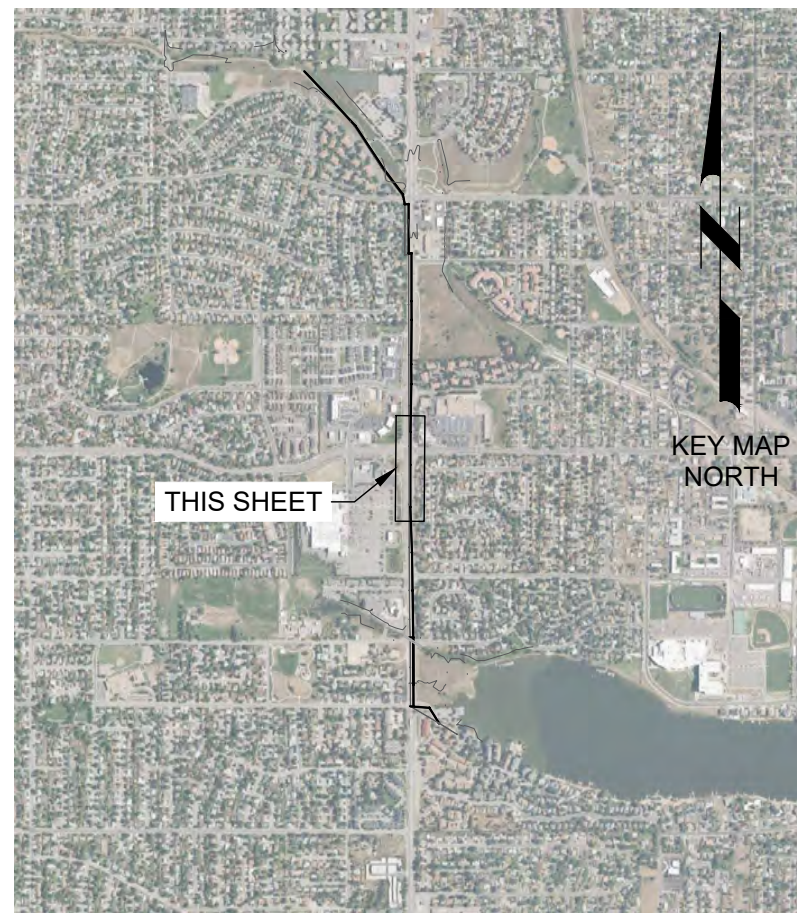
KEY NOTES:

- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- PIPE STUB OUT. DOES NOT NEED TO BE RECONNECTED TO THE NEW SANITARY SEWER.
- ABANDON IN PLACE.



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KEY MAP



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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 5

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

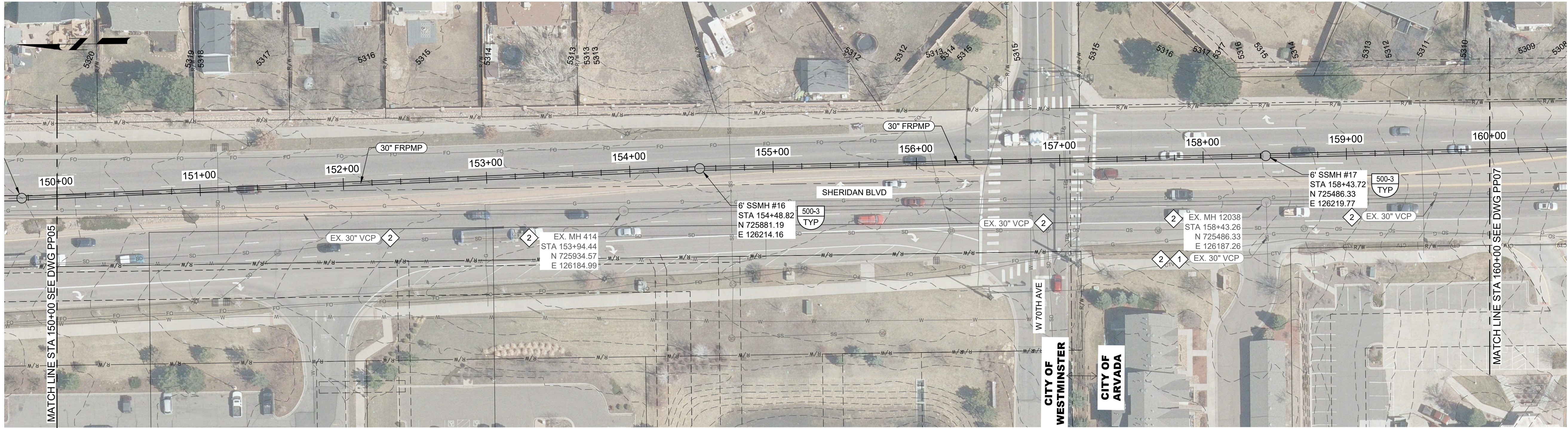
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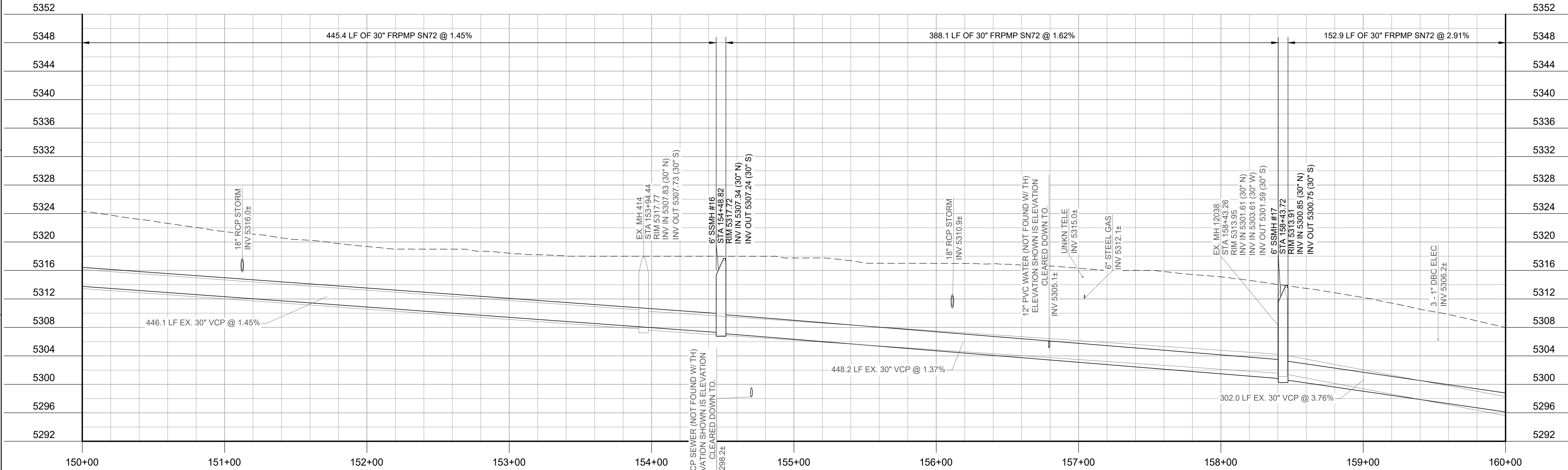
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X OF

Plot Date: 9/29/2024 2:47:54 PM

LAST SAVED BY: CHUSTED



PLAN
FILE: 20259400C0800



PROFILE
FILE: 20259400C0800

GENERAL NOTES:

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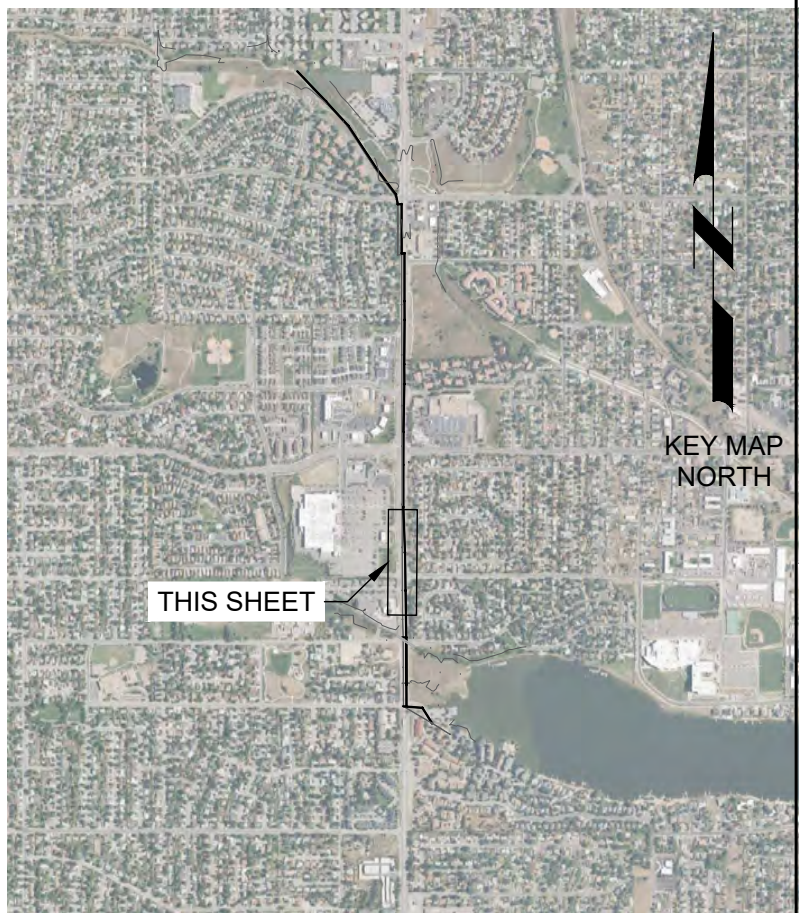
KEY NOTES:

- PIPE STUB OUT. DOES NOT NEED TO BE RECONNECTED TO THE NEW SANITARY SEWER.
- ABANDON IN PLACE.



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KEY MAP



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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 6

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

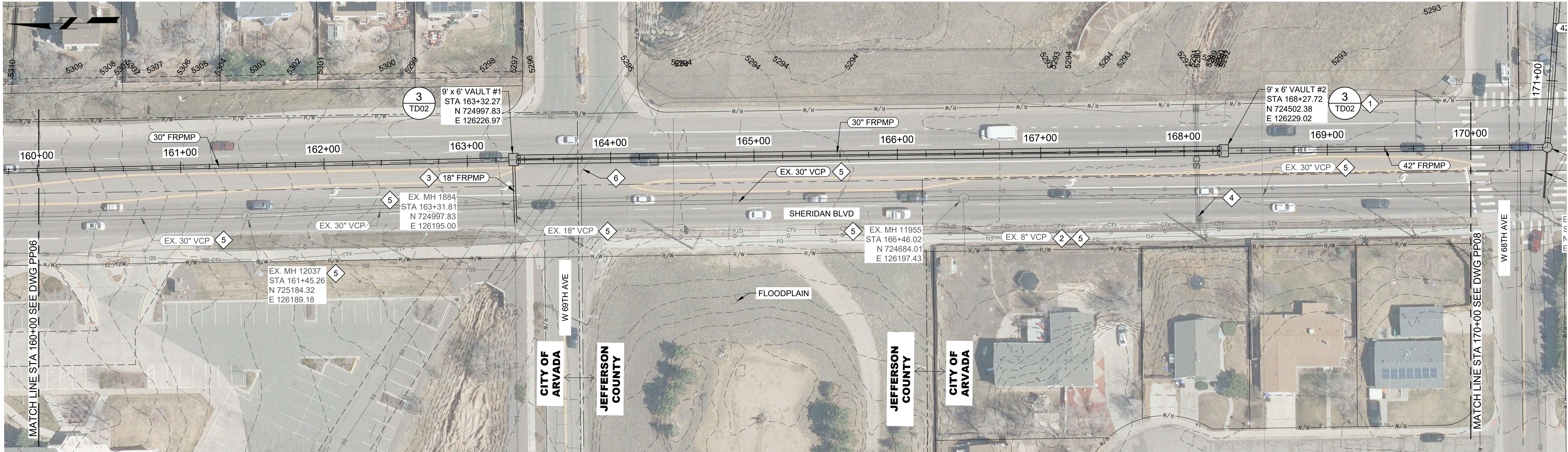
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DRAWING NO.
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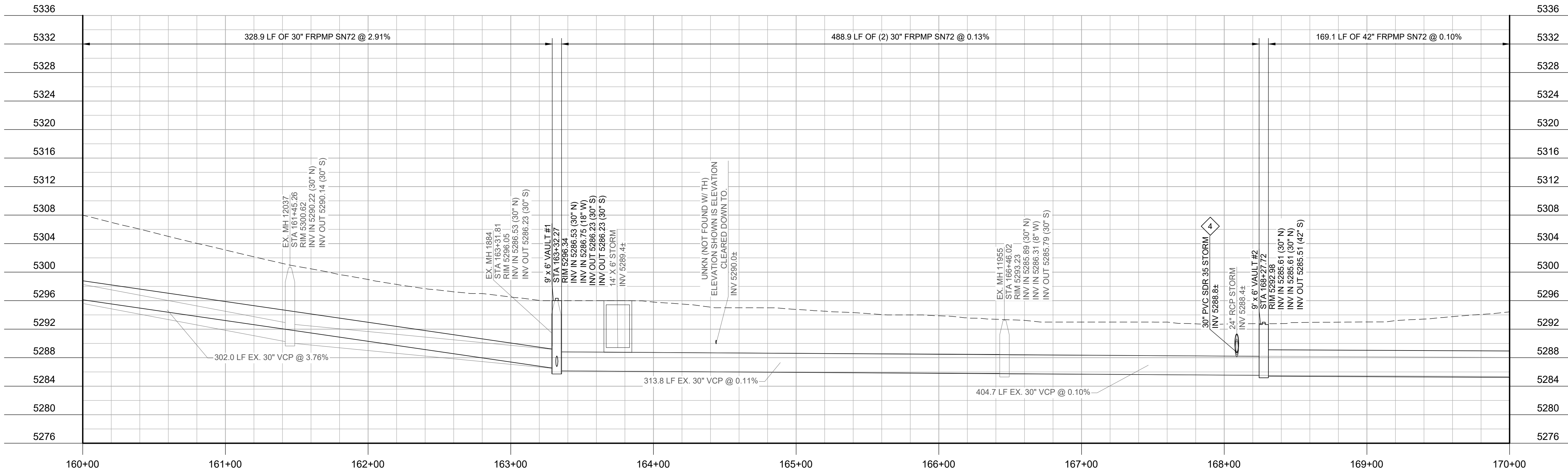
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Plot Date: 9/29/2024 2:47:54 PM

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PLAN
FILE: 20259400C0800



PROFILE
FILE: 20259400C0800

GENERAL NOTES:

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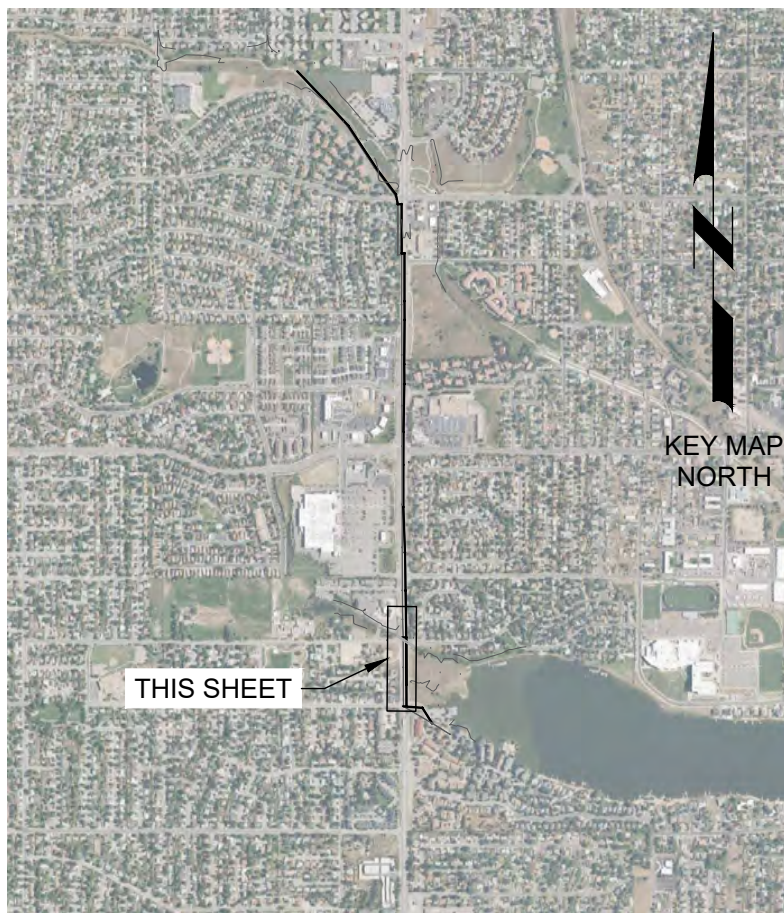
KEY NOTES:

- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- PIPE STUB OUT. DOES NOT NEED TO BE RECONNECTED TO THE NEW SANITARY SEWER.
- 18" FRPMP SN72 PIPE TO BE INSTALLED AT 0.95% SLOPE TO CONNECT EXISTING MANHOLE TO NEW MANHOLE. MATCH EXISTING INVERT FOR THE EXISTING MANHOLE CONNECTION. RUN NEW PIPE THROUGH EXISTING MANHOLE TO BE ABANDONED IN PLACE PRIOR TO FILLING WITH FLASH FILL.
- EXISTING 24" RCP STORM PIPE TO BE REMOVED AND REPLACED WITH A 30" PVC SDR 35 STORM PIPE AT 0.5% SLOPE. MATCH EXISTING INVERT AT THE INLET STRUCTURE ON THE WEST. CONTRACTOR TO VERIFY IF EXISTING INLET STRUCTURES CAN BE CORE DRILLED AND SEALED FOR THE NEW PIPE CONNECTIONS.
- ABANDON IN PLACE.
- SAWCUT, DEMOLISH, REMOVE, AND RECONSTRUCT 10-FOOT SECTION OF EXISTING DOUBLE BOX CONCRETE CULVERT PERPENDICULAR TO SPAN AS REQUIRED FOR CONSTRUCTION. RECONSTRUCT PER DETAIL S900/TYP.



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KEY MAP



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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 7

VERIFY SCALES

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0 1"
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JOB NO.
202594
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PP07
SHEET NO.
X OF

Plot Date: 9/29/2024 2:47:54 PM

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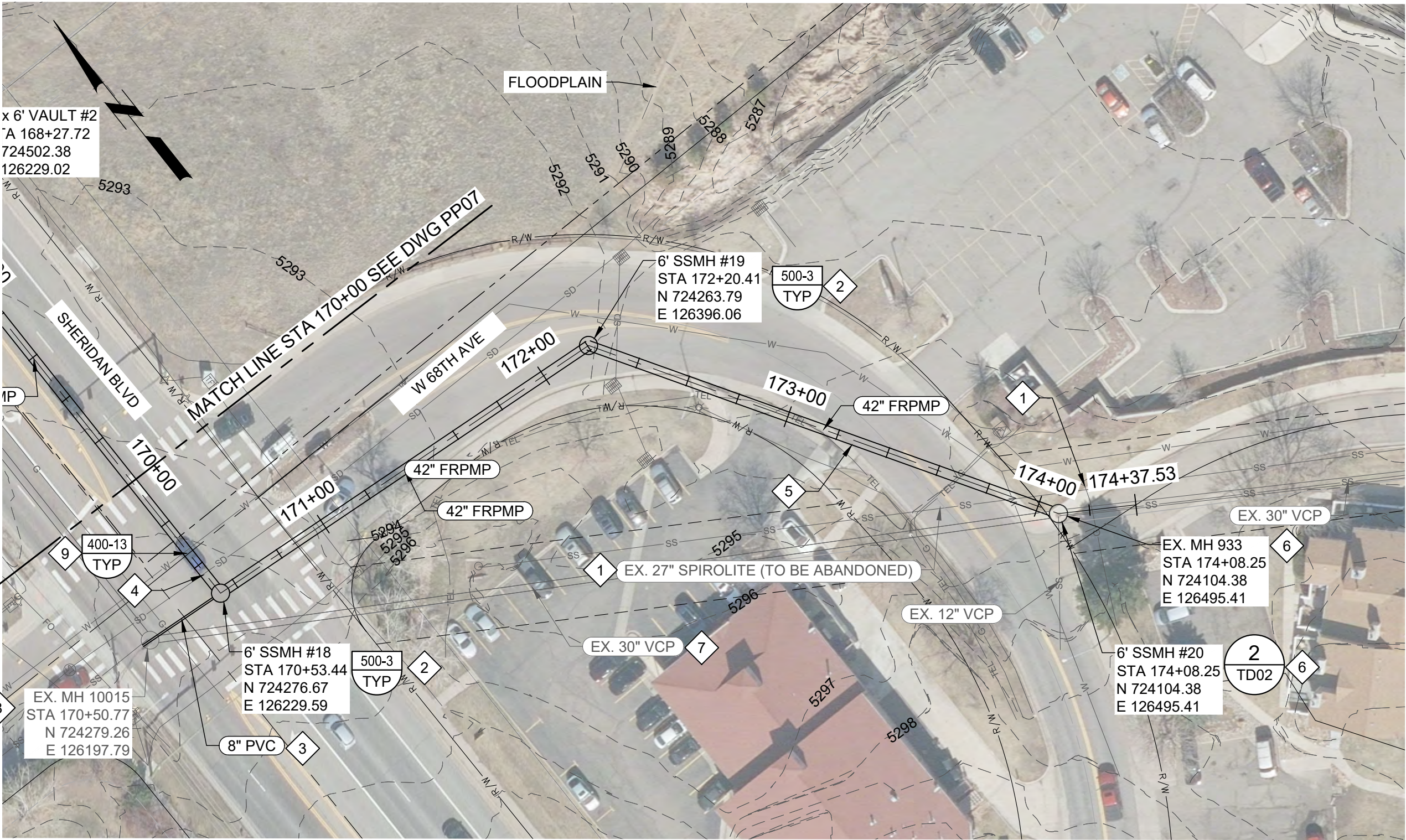
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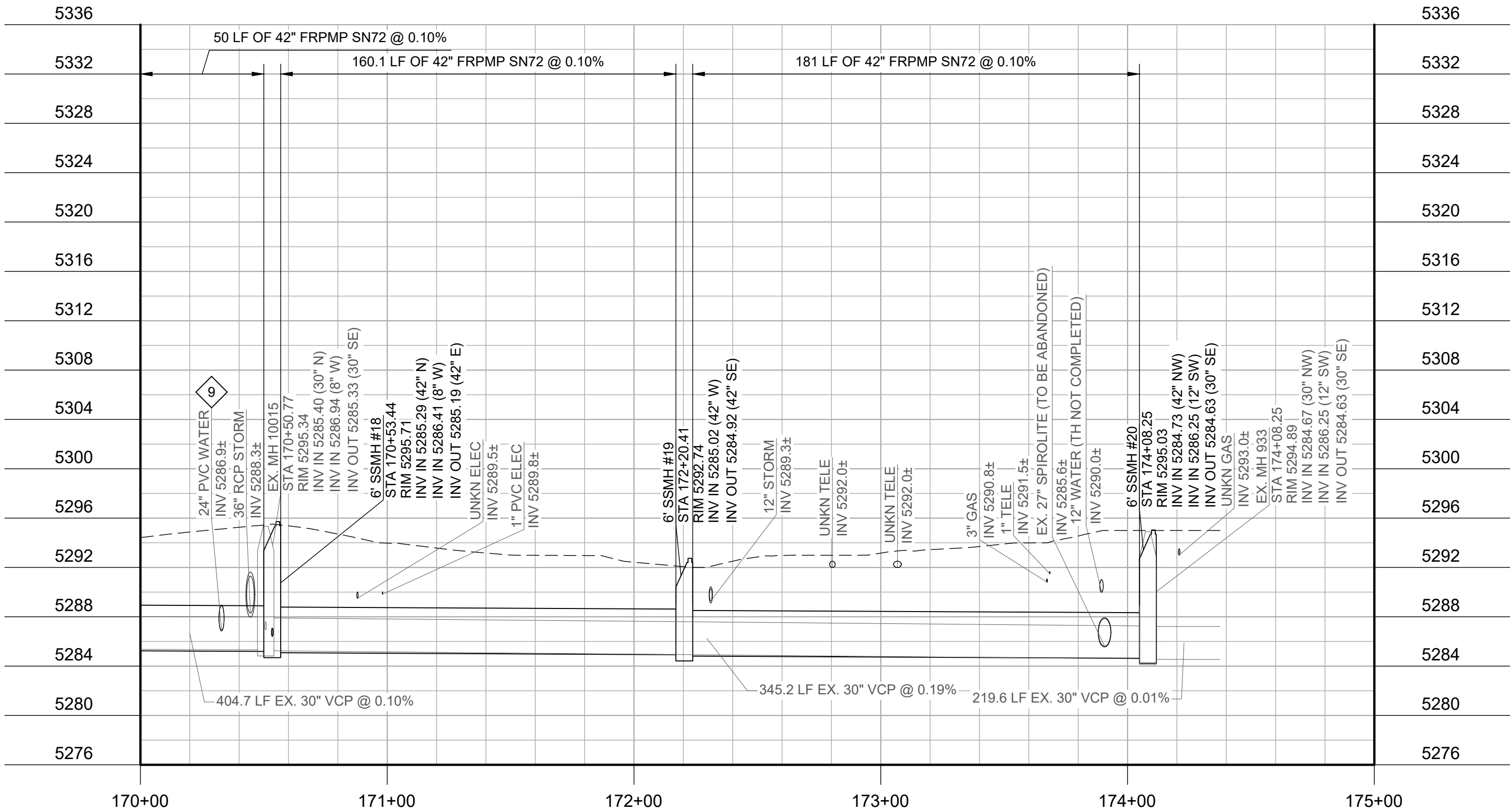
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PLAN

FILE: 20259400C0800



PROFILE

FILE: 20259400C0800

GENERAL NOTES:

- PIPELINES THAT ARE ABANDONED IN PLACE ARE TO BE FILLED WITH FLASH FILL. MANHOLES THAT ARE TO BE ABANDONED IN PLACE ARE TO HAVE THE CONE REMOVED AND THE REMAINDER OF THE MANHOLE FILLED WITH FLASH FILL.
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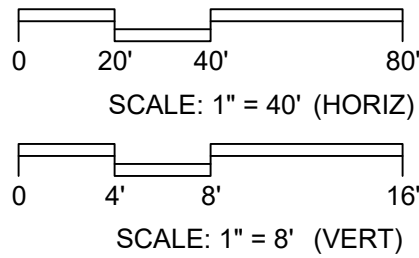
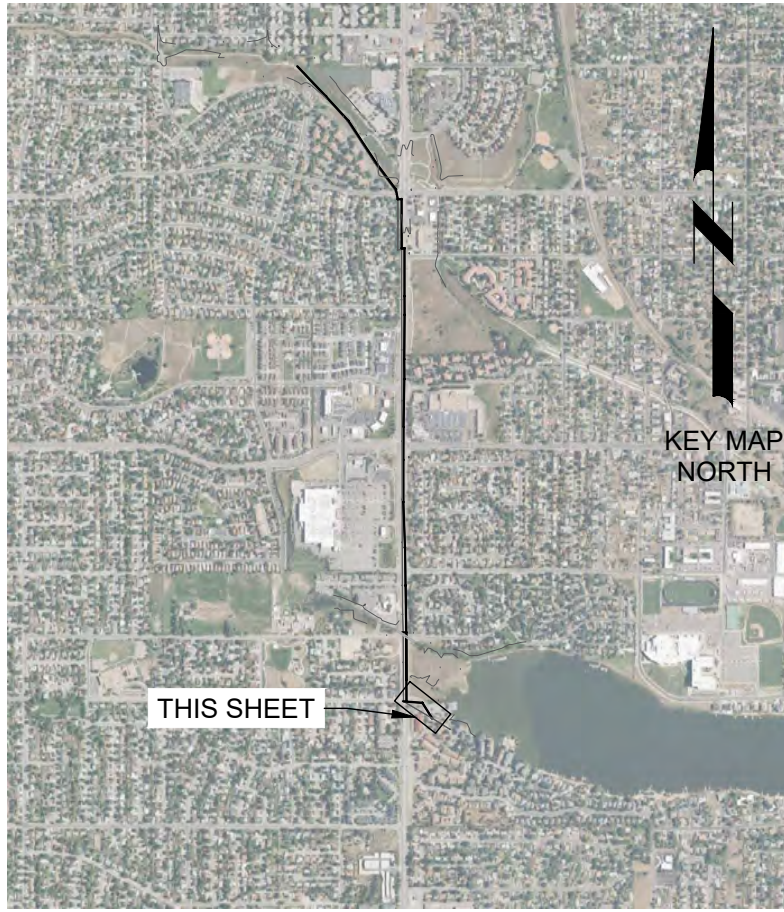
KEY NOTES:

- EXISTING 27" SPIROLITE PIPELINE TO BE CUT AND PLUGGED. ABANDONED PORTION TO THE NORTH TO BE FILLED WITH FLASH FILL THROUGH THE MANHOLE. PORTION TO THE SOUTH IS TO REMAIN IN OPERATION AFTER BEING PLUGGED.
- FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE 42" PLUG FOR MANHOLE TESTING.
- EXTEND EXISTING 8" PVC SDR 35 PIPE TO NEW MANHOLE. PROVIDE PIPE DEFLECTION AS NECESSARY PER PIPE MANUFACTURERS RECOMMENDATIONS.
- EXISTING STORM SEWER PIPELINE TO BE ADJUSTED IN COORDINATION WITH THE ENGINEER ONCE ADDITIONAL INFORMATION FROM THE VIDEOS AND CLEANING IS COMPLETED.
- APPROXIMATE LOCATION OF COMMERCIAL BUILDING TIE IN LOCATION. EXACT LOCATION TO BE DETERMINED FROM POTHOLE INFORMATION.
- REMOVE AND REPLACE EXISTING MANHOLE. FURNISH AND INSTALL 30" FRAME AND COVER TO ACCOMMODATE A 42" PLUG FOR MANHOLE TESTING.
- ABANDON IN PLACE.
- REMOVE EXISTING MANHOLE AS NEEDED FOR PIPE INSTALLATION.
- LOWER WATERLINE PER ARVADA STANDARD DETAILS



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KEY MAP



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DATE
OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
PLAN AND PROFILE 8

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

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JOB NO.
202594

DRAWING NO.
PP08

SHEET NO.
X OF



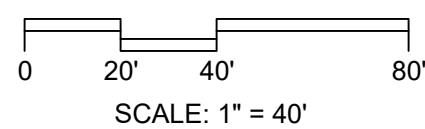
PLAN

FILE: 20259400C0102



PLAN

FILE: 20259400C0102

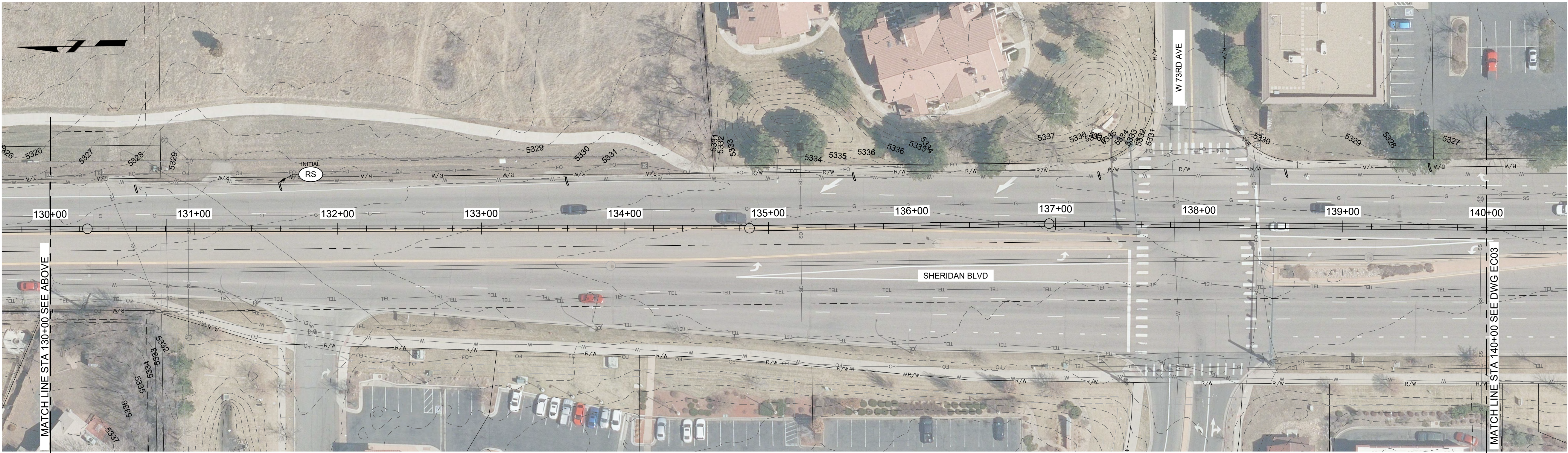


			95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION	DESIGNED CDH								CITY OF ARVADA	VERIFY SCALES	JOB NO. 202594
				DRAWN CDH								ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)	BAR IS ONE INCH ON ORIGINAL DRAWING	DRAWING NO.
				CHECKED JKK								CIVIL	0  1"	EC01
REV	DATE	BY		DESCRIPTION	DATE OCTOBER 2024							EROSION CONTROL PLAN 1	IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	SHEET NO. X OF

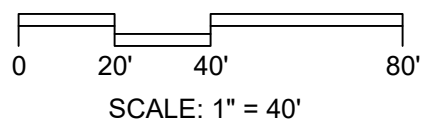
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PLAN
FILE: 20259400C0102



PLAN
FILE: 20259400C0102



GENERAL NOTES:

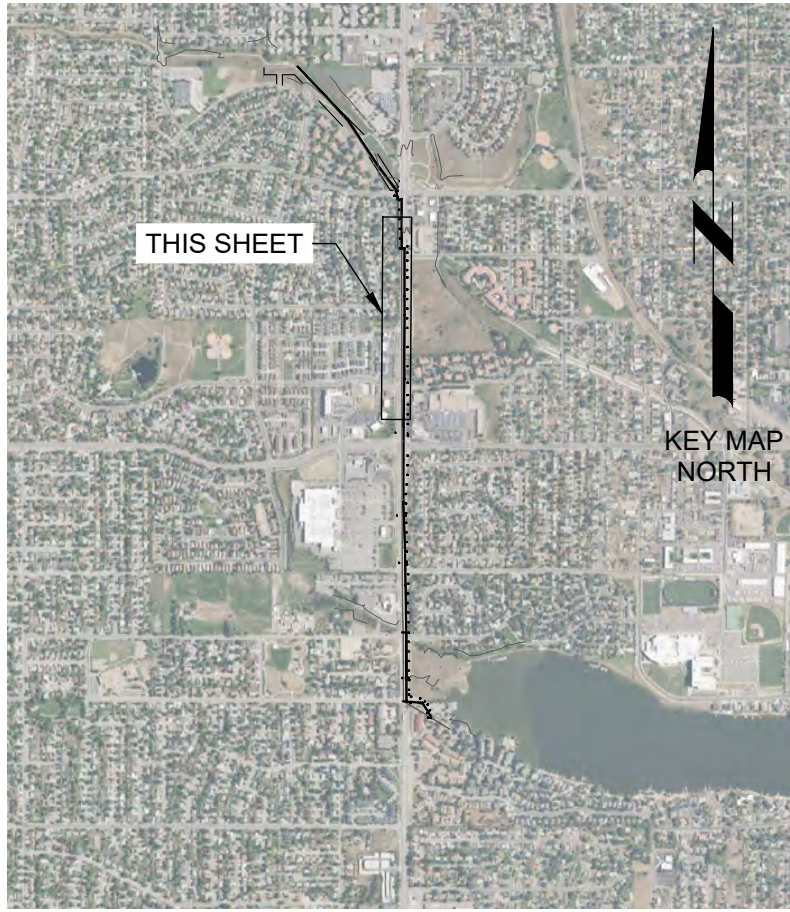
1. ALL STORM INLETS WITHIN THE PROJECT AREA ARE TO BE PROTECTED WHETHER CALLED OUT ON THE PLANS OR NOT.
2. TOTAL ESTIMATED DISTURBANCE AREA IS 1 ACRE.
3. VEHICLE TRACKING CONTROL (VTC) AND PORTABLE TOILET LOCATIONS ARE TO BE COORDINATED ONCE A STAGING AREA FOR THE PROJECT IS DETERMINED. CONTRACTOR TO PROVIDE VTC AS NECESSARY FOR ACCESS IN THE OPEN SPACE AREA.
4. ROCK SOCKS TO BE INSTALLED EVERY 100-FEET IN THE ROAD GUTTERS. APPROXIMATE LOCATIONS SHOWN. ROCK SOCK ARE TO BE REPLACED WHEN DAMAGED AND REMOVED WHEN CONSTRUCTION IS NOT IN THE AREA TO PREVENT DAMAGE TO VEHICLES.

- SF — SILT FENCE
-  INLET PROTECTION
-  ROCK SOCK
-  SEEDING AND MULCHING



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KEY MAP



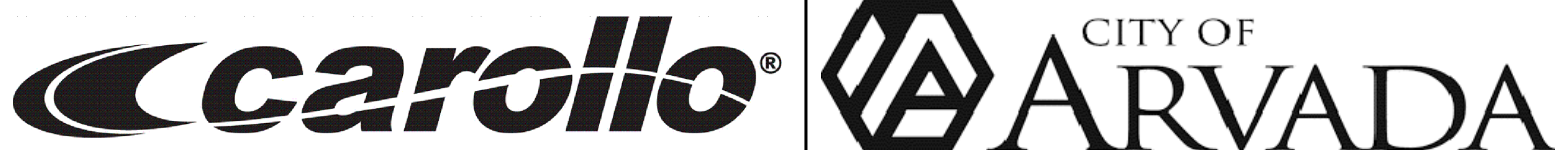
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CHK

DATE
OCTOBER 2024

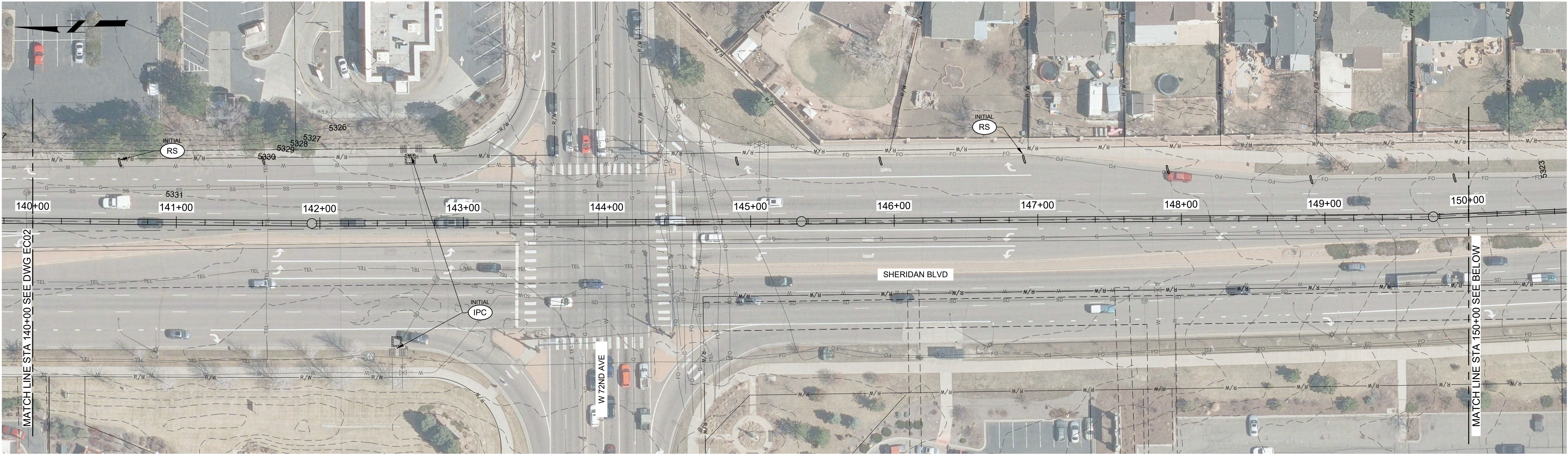


CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
EROSION CONTROL PLAN 2

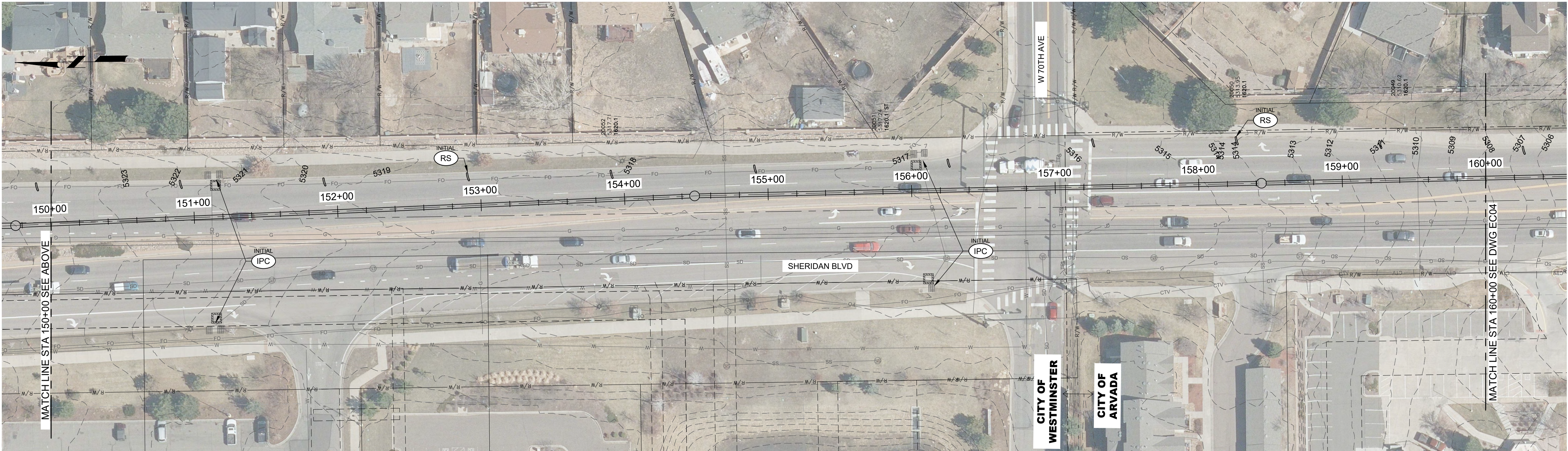
VERIFY SCALES
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IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
202594
DRAWING NO.
EC02
SHEET NO.
X OF

Plot Date: 9/30/2024 2:51:38 PM



PLAN
FILE: 20259400C0102



PLAN
FILE: 20259400C0102

GENERAL NOTES:

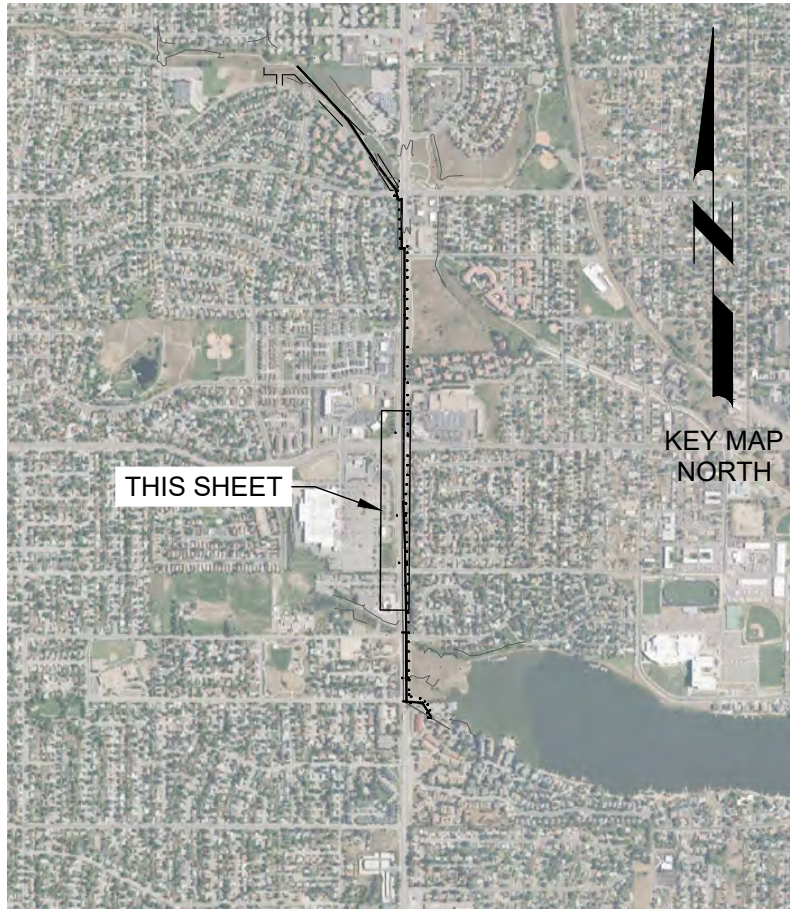
- ALL STORM INLETS WITHIN THE PROJECT AREA ARE TO BE PROTECTED WHETHER CALLED OUT ON THE PLANS OR NOT.
- TOTAL ESTIMATED DISTURBANCE AREA IS 1 ACRE.
- VEHICLE TRACKING CONTROL (VTC) AND PORTABLE TOILET LOCATIONS ARE TO BE COORDINATED ONCE A STAGING AREA FOR THE PROJECT IS DETERMINED. CONTRACTOR TO PROVIDE VTC AS NECESSARY FOR ACCESS IN THE OPEN SPACE AREA.
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- SF — SILT FENCE
- INLET PROTECTION
- ROCK SOCK
- SEEDING AND MULCHING



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KEY MAP



0 20' 40' 80'
SCALE: 1" = 40'

95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
REV	DATE	BY	DESCRIPTION
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DESIGNED DES DRAWN DWN
CHECKED CHK
DATE OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
EROSION CONTROL PLAN 3

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING

0 1"

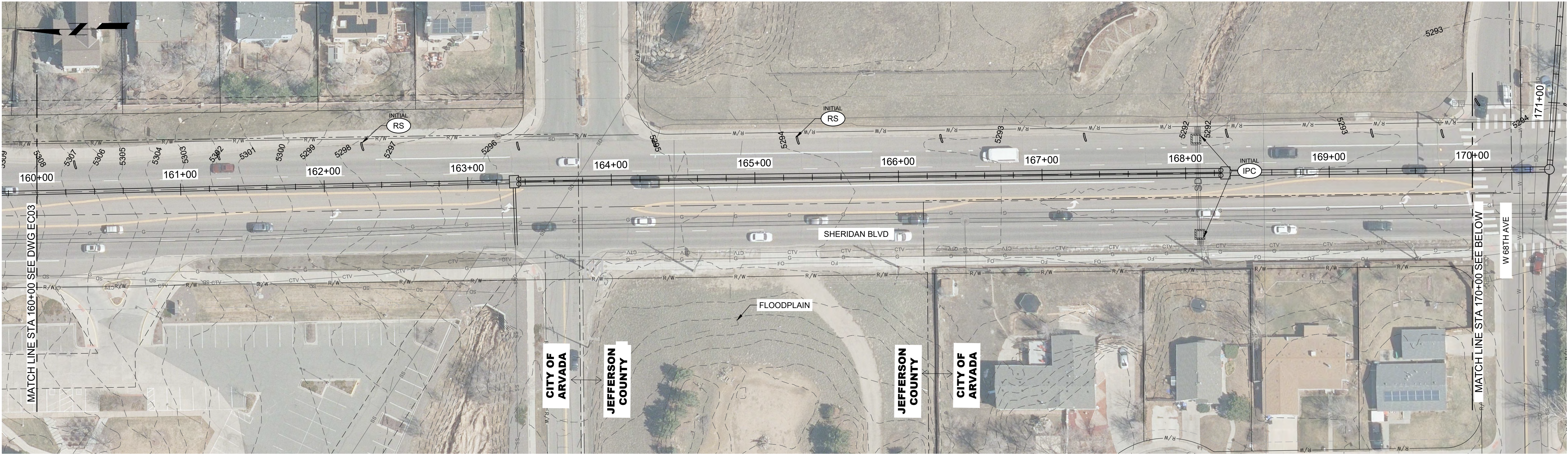
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
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DRAWING NO.
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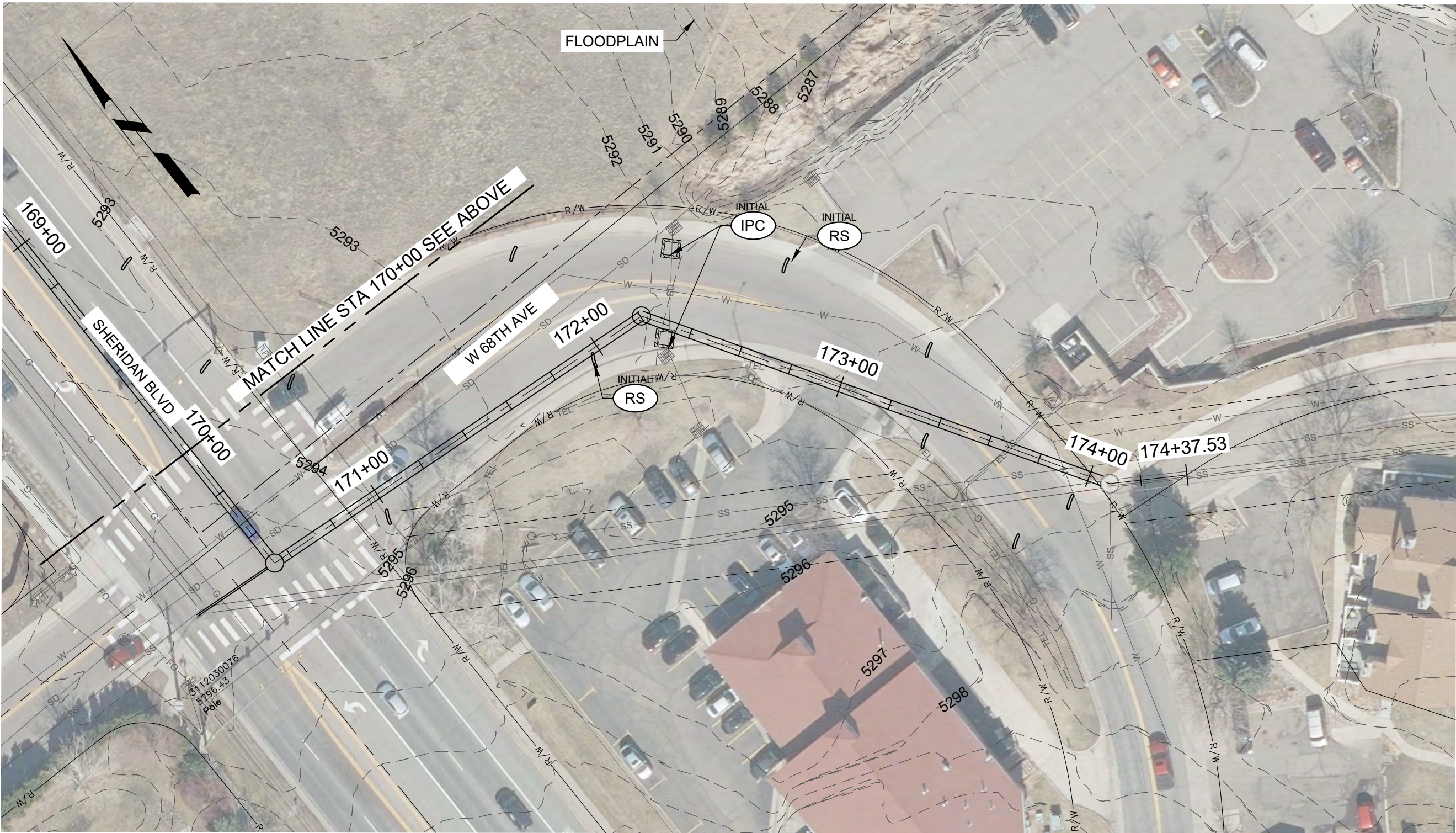
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PLAN

FILE: 20259400C0102



PLAN

FILE: 20259400C0102

GENERAL NOTES:

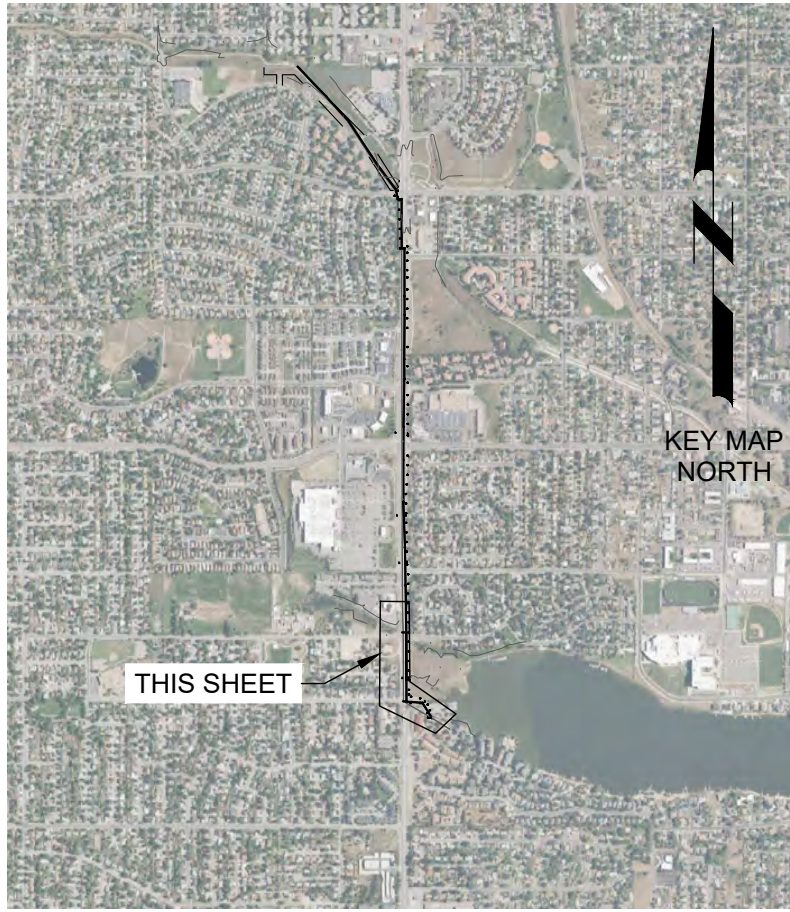
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- SF — SILT FENCE
- INLET PROTECTION
- ROCK SOCK
- SEEDING AND MULCHING



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KEY MAP



0 20' 40' 80'
SCALE: 1" = 40'

95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
DESIGNED DES DRAWN DWN			
CHECKED CHK			
DATE OCTOBER 2024			
REV	DATE	BY	DESCRIPTION
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DESIGNED DES DRAWN DWN
CHECKED CHK
DATE OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
EROSION CONTROL PLAN 4

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING

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IF NOT ONE INCH ON
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SCALES ACCORDINGLY

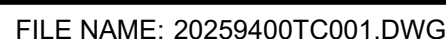
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DRAWING NO.
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X OF

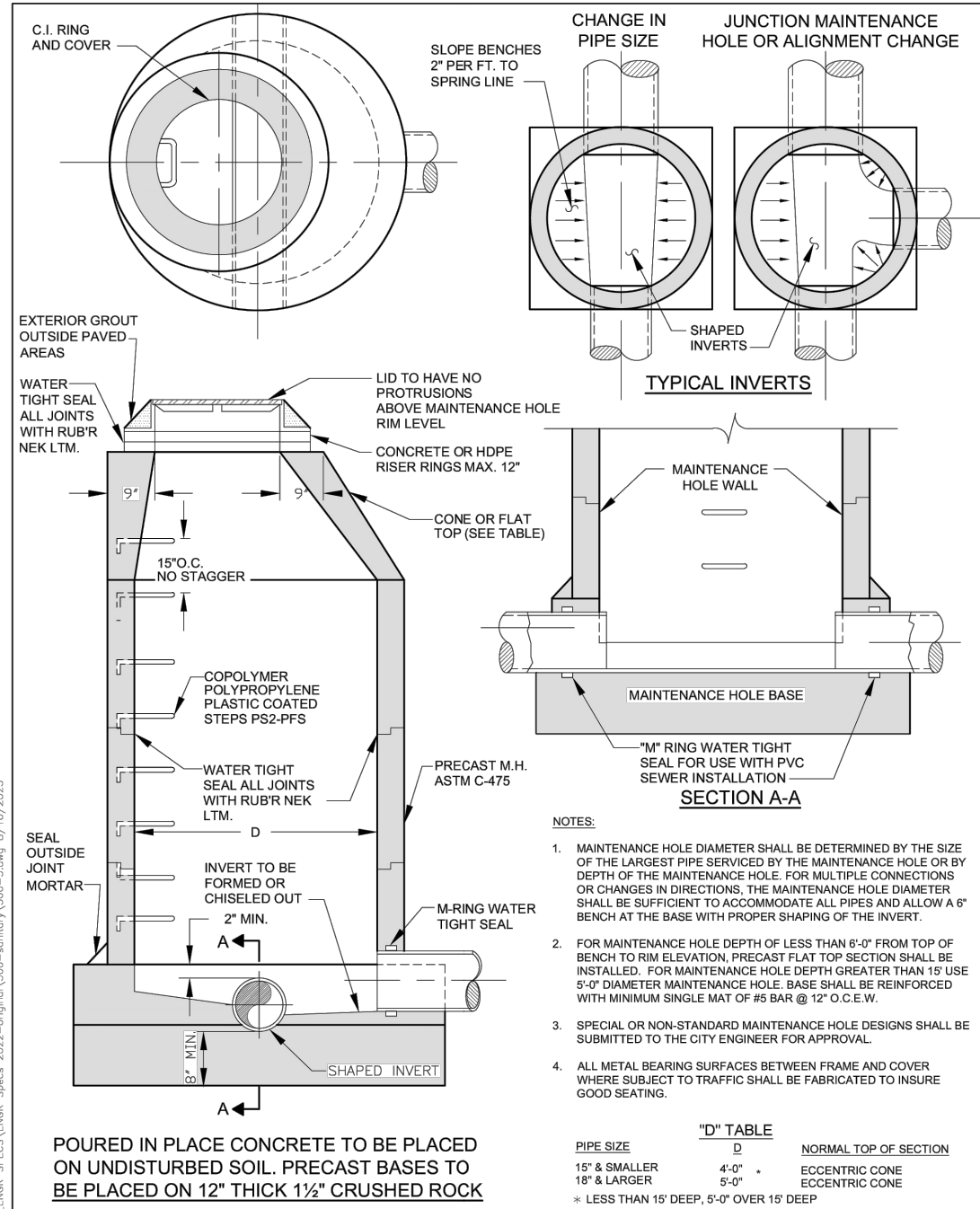
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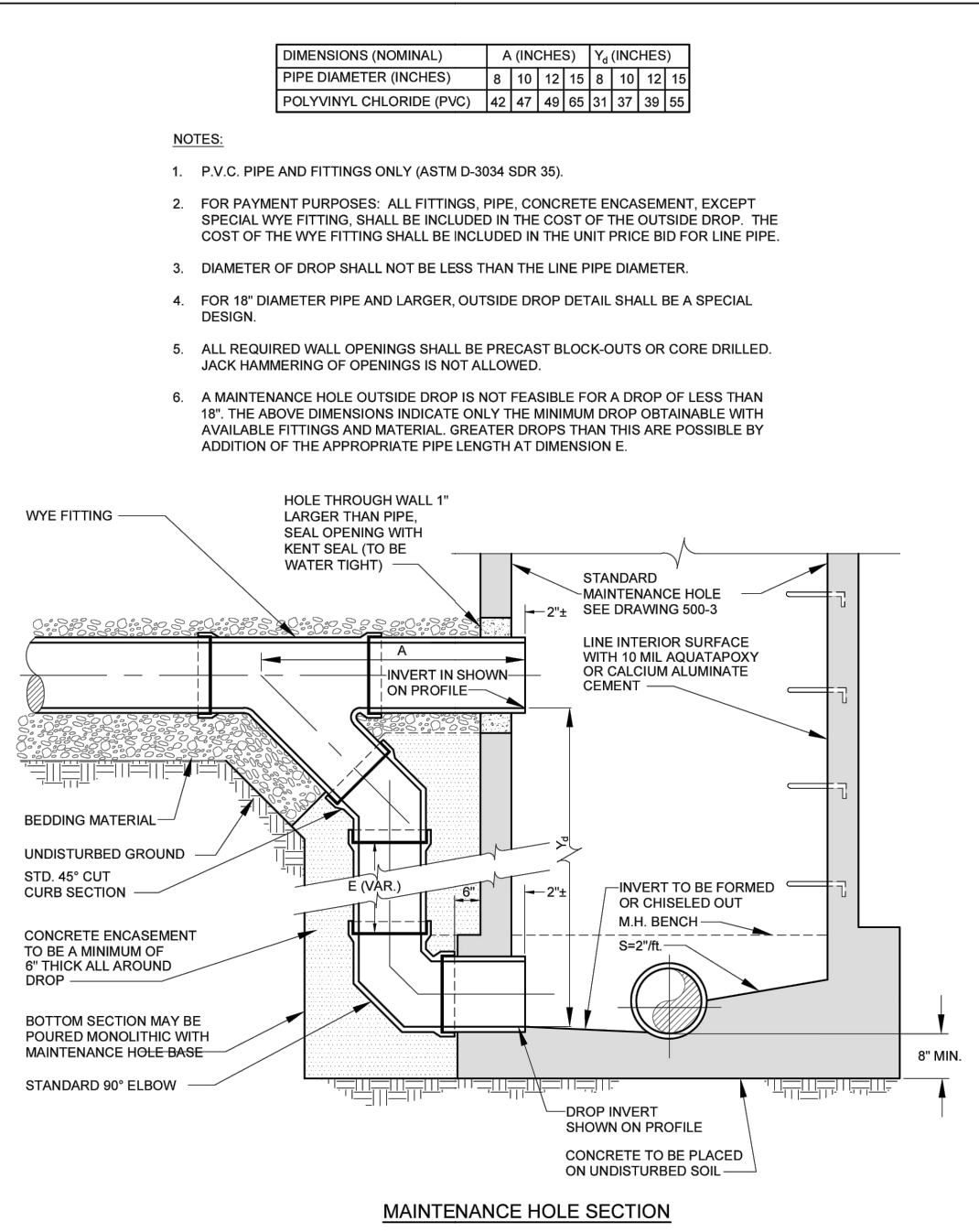


NO.	DATE	REVISION
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CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

TYPICAL MAINTENANCE HOLE
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-3

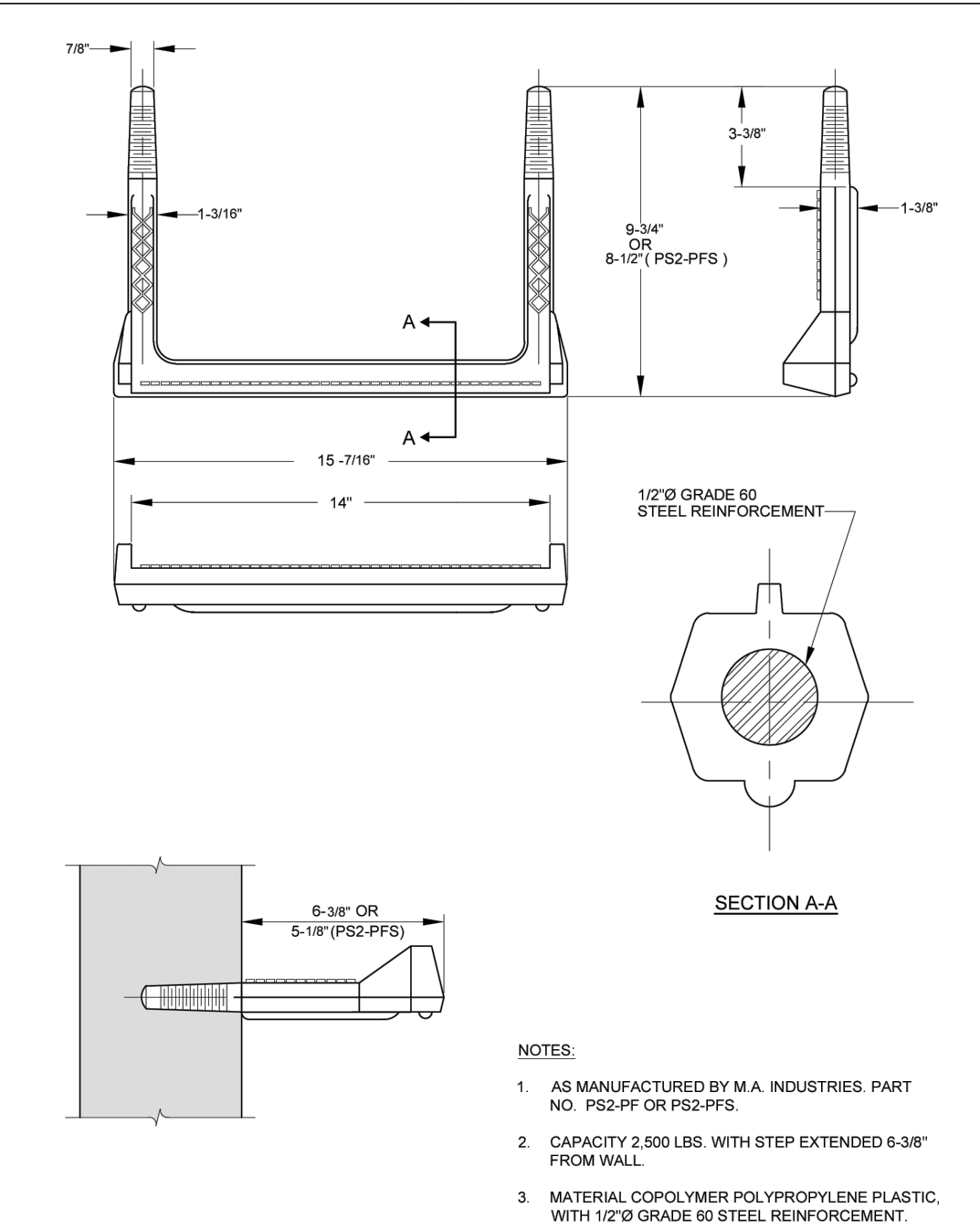


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1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

MAINTENANCE HOLE EXTERIOR DROP TYPE
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-4

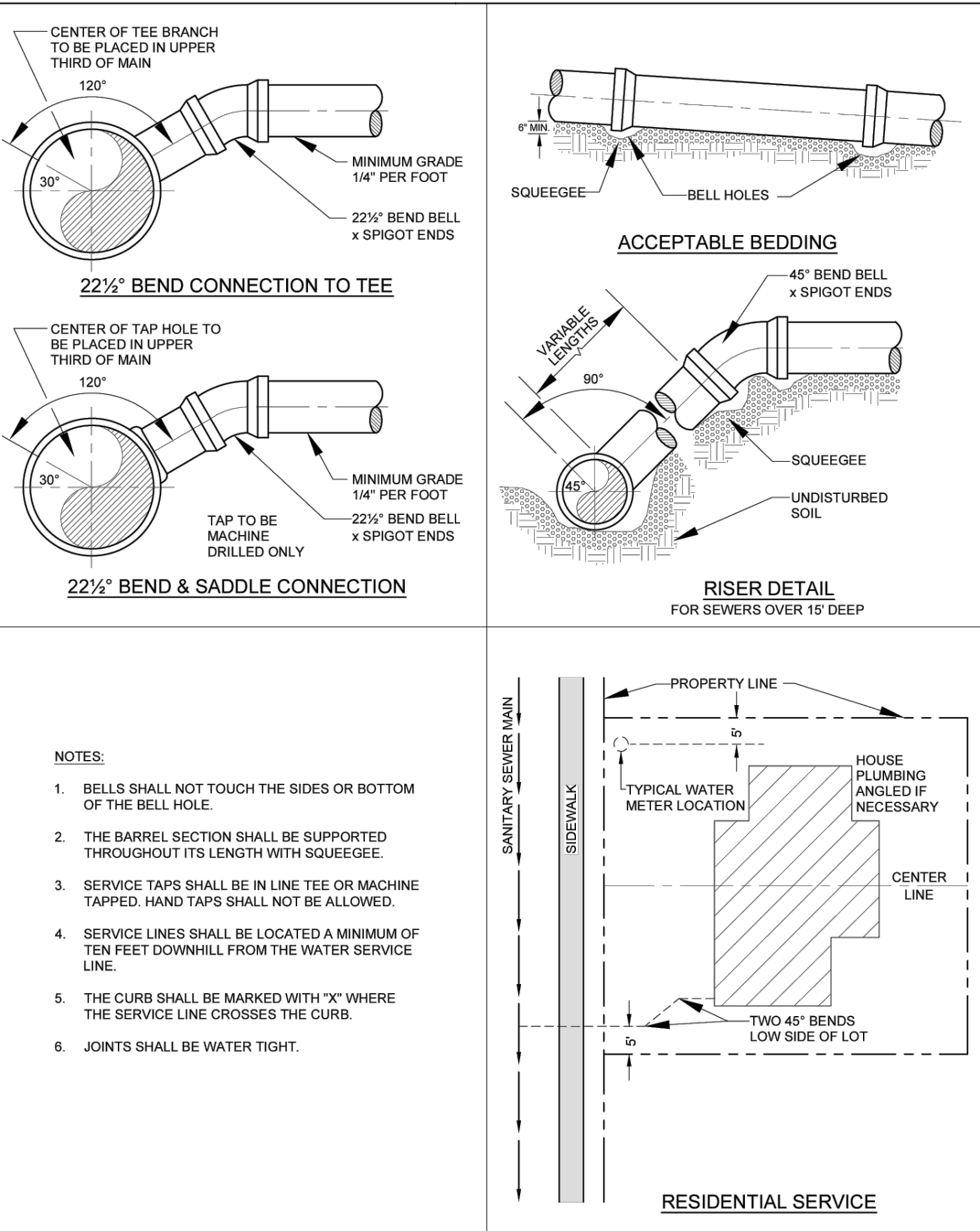


NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

MAINTENANCE HOLE STEP
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-5

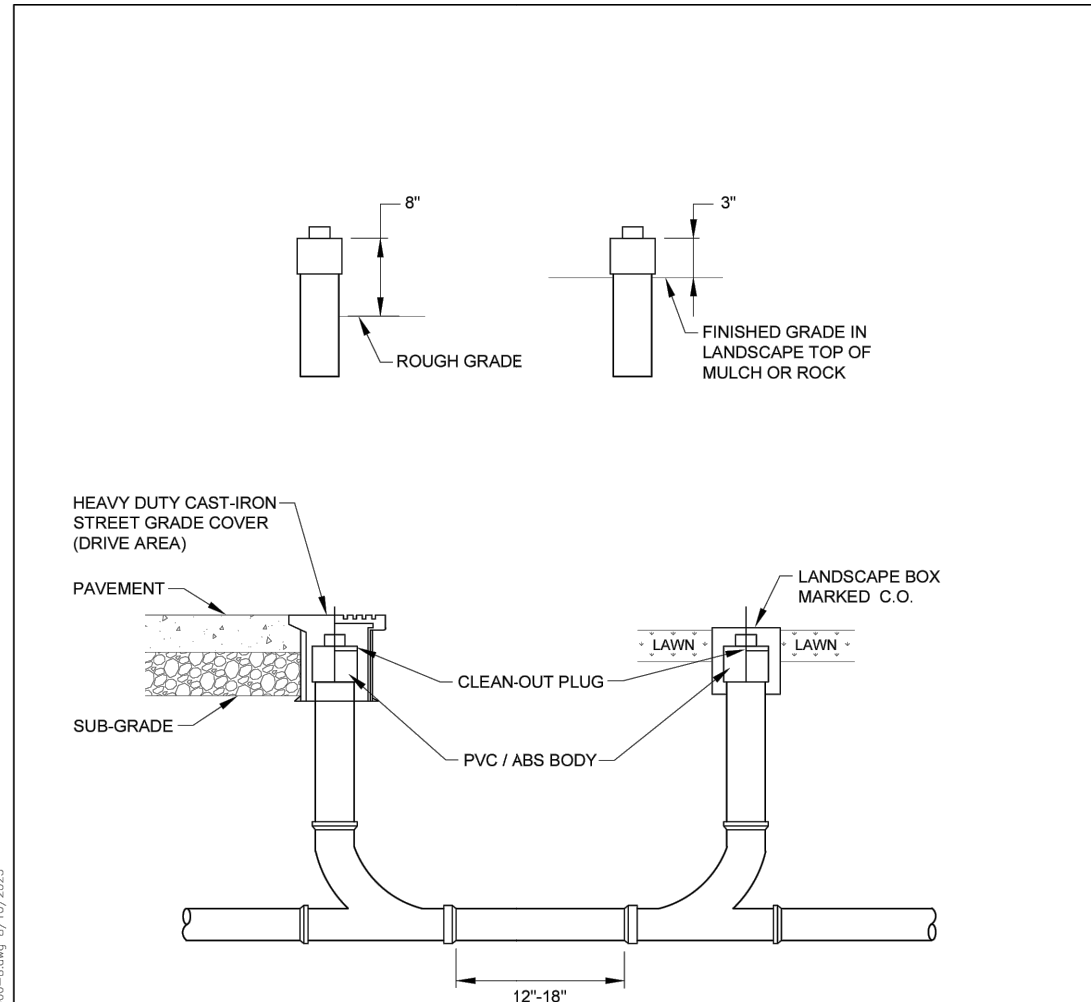


NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

SANITARY SEWER SERVICE DETAIL
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-7

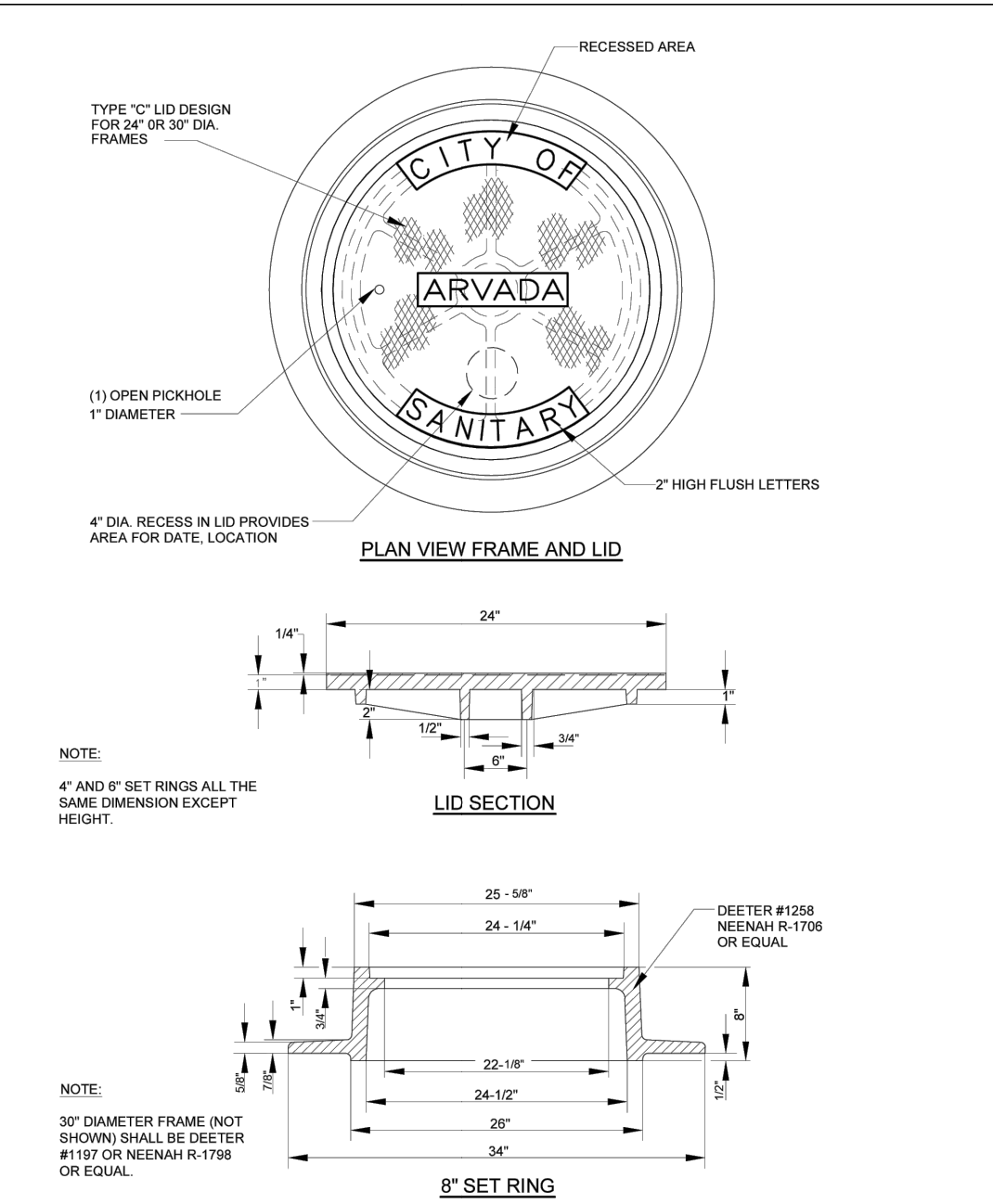


NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

SANITARY SEWER SERVICE CLEAN-OUT
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-8

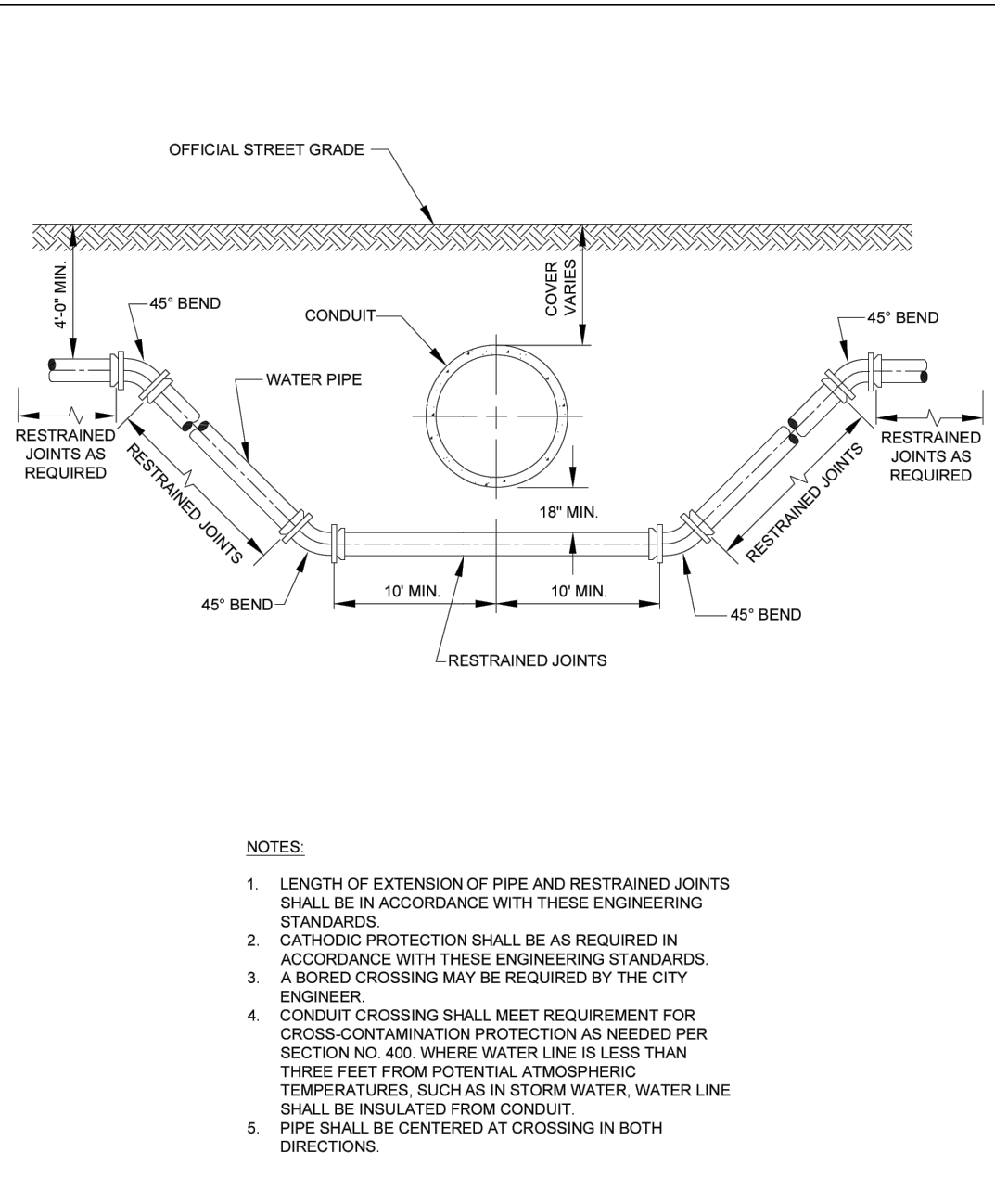


NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

SANITARY MAINTENANCE HOLE FRAME AND LID DETAIL
2023 ENGINEERING STANDARDS & SPECIFICATIONS

500-9

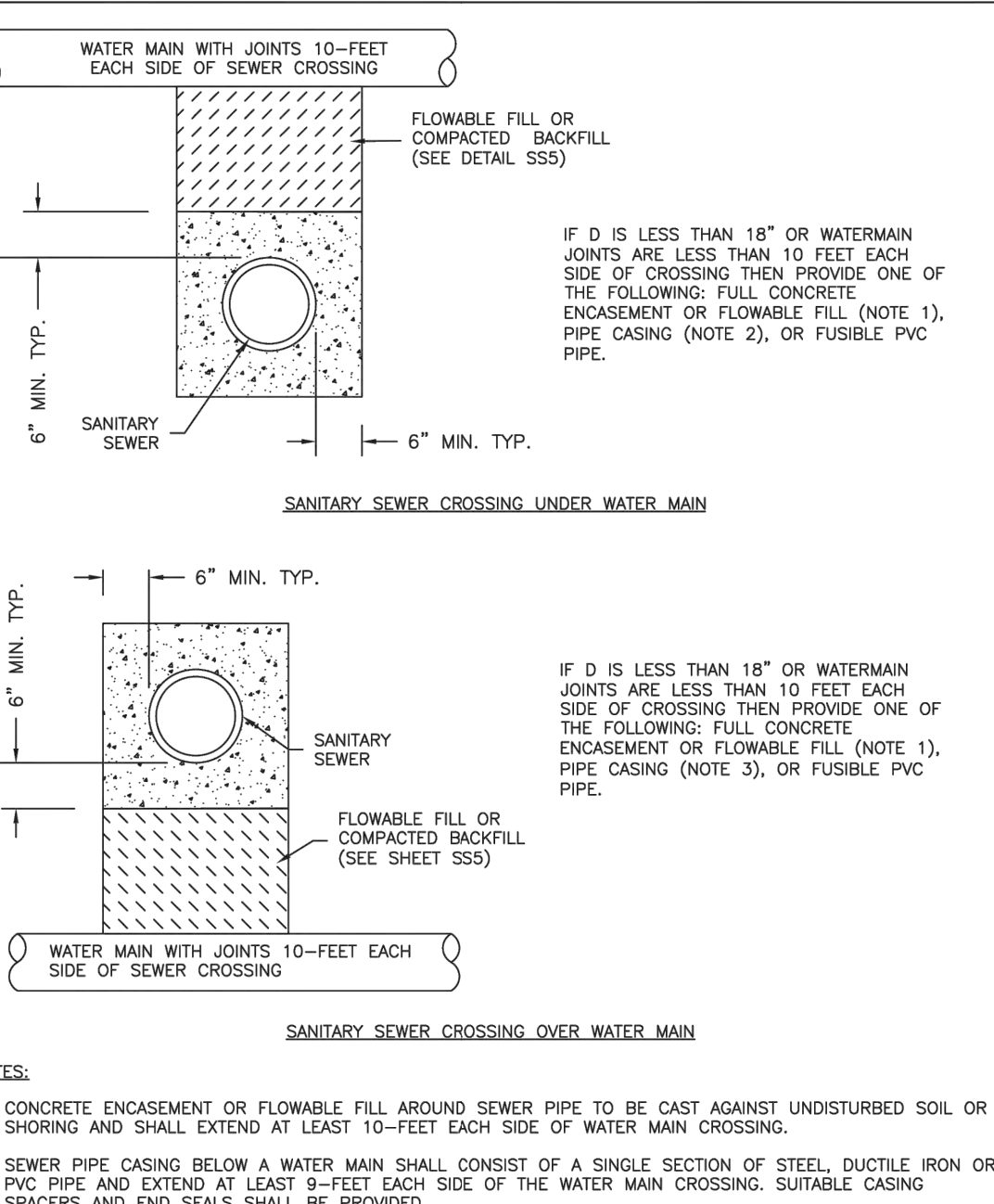


NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

OPEN CUT CROSSING BENEATH CONDUIT
2023 ENGINEERING STANDARDS & SPECIFICATIONS

400-13



NO.	DATE	REVISION
1	2023	2023 REVISIONS

CITY OF ARVADA
8101 Ralston Road
Arvada, Colorado 80002

OPEN CUT CROSSING BENEATH CONDUIT
2023 ENGINEERING STANDARDS & SPECIFICATIONS

400-13



CITY OF WESTMINSTER
4800 WEST 92ND AVENUE
WESTMINSTER, COLO. 80031

UTILITY CROSSINGS
DATE: MARCH 2022 SHEET SS8

95% DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

DESIGNED
CDH
DRAWN
CDH
CHECKED
JKK
DATE
OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TYPICAL DETAILS -1

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
202594
DRAWING NO.
TD01
SHEET NO.
X OF

Plot Date: 9/12/2024 3:11:43 PM

A

B

C

D

E

F

G

A

B

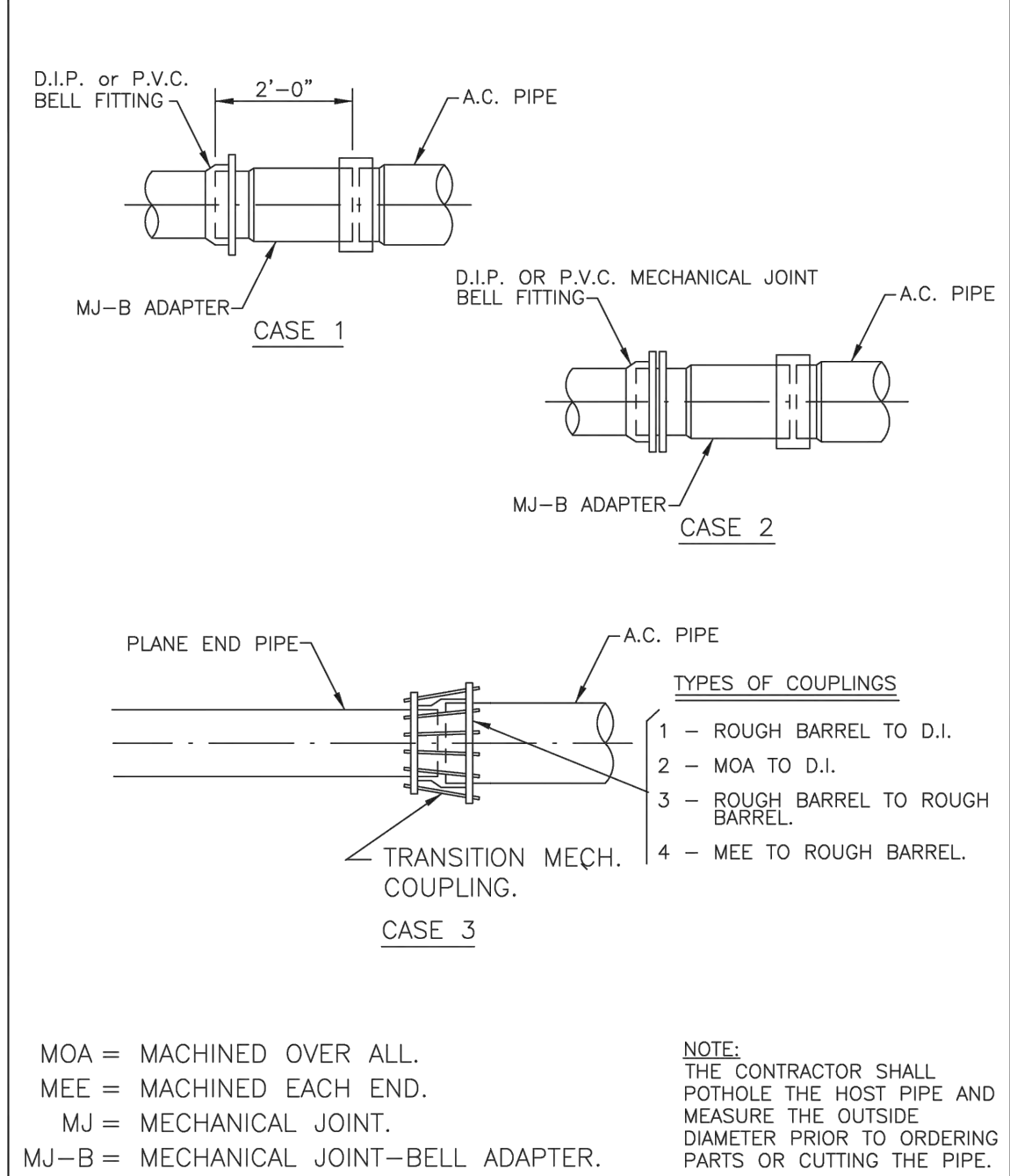
C

D

E

F

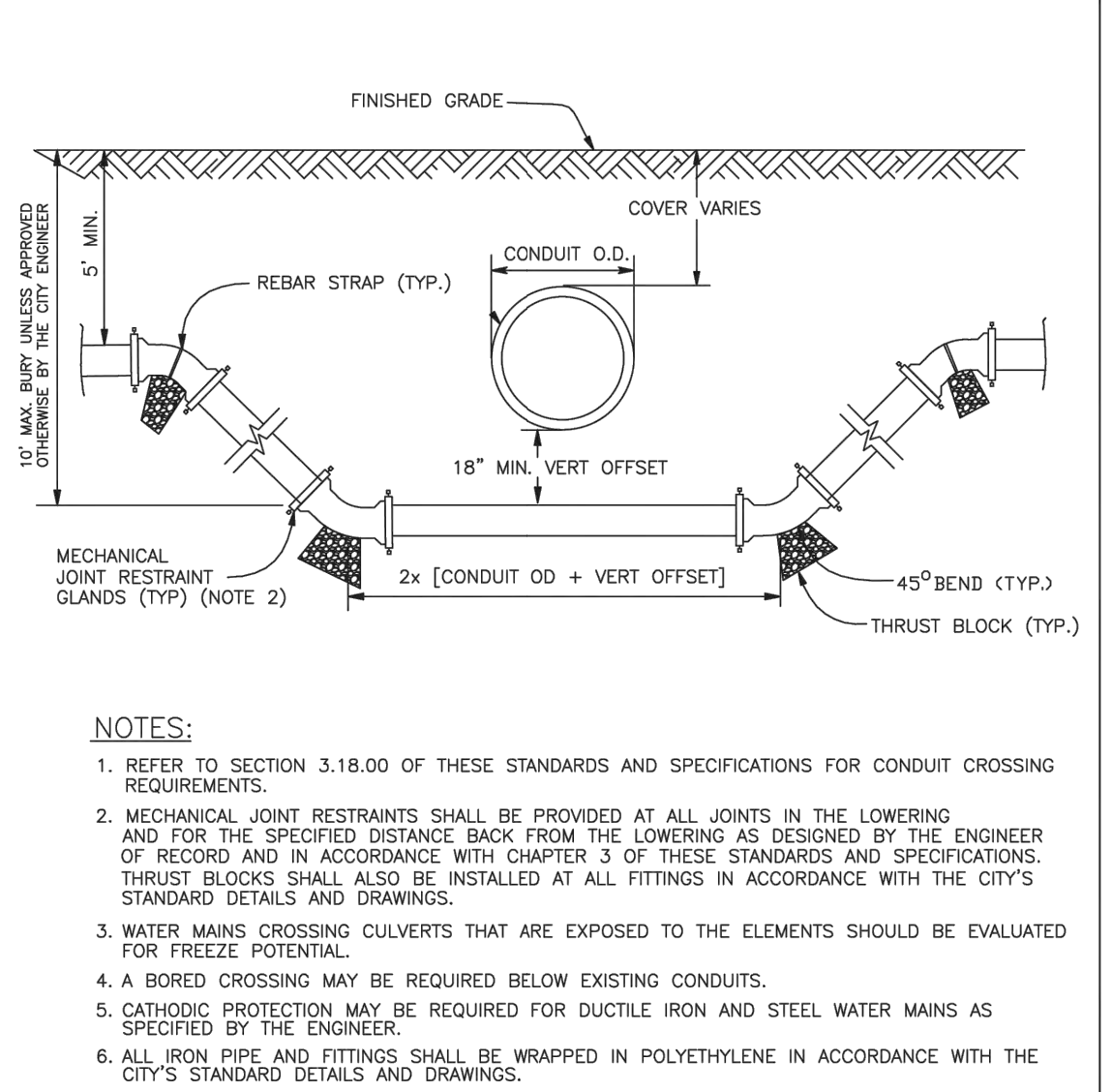
G



CITY of WESTMINSTER
4800 WEST 92ND AVENUE
WESTMINSTER, COLO. 80031

A.C. PIPE ADAPTER DETAILS

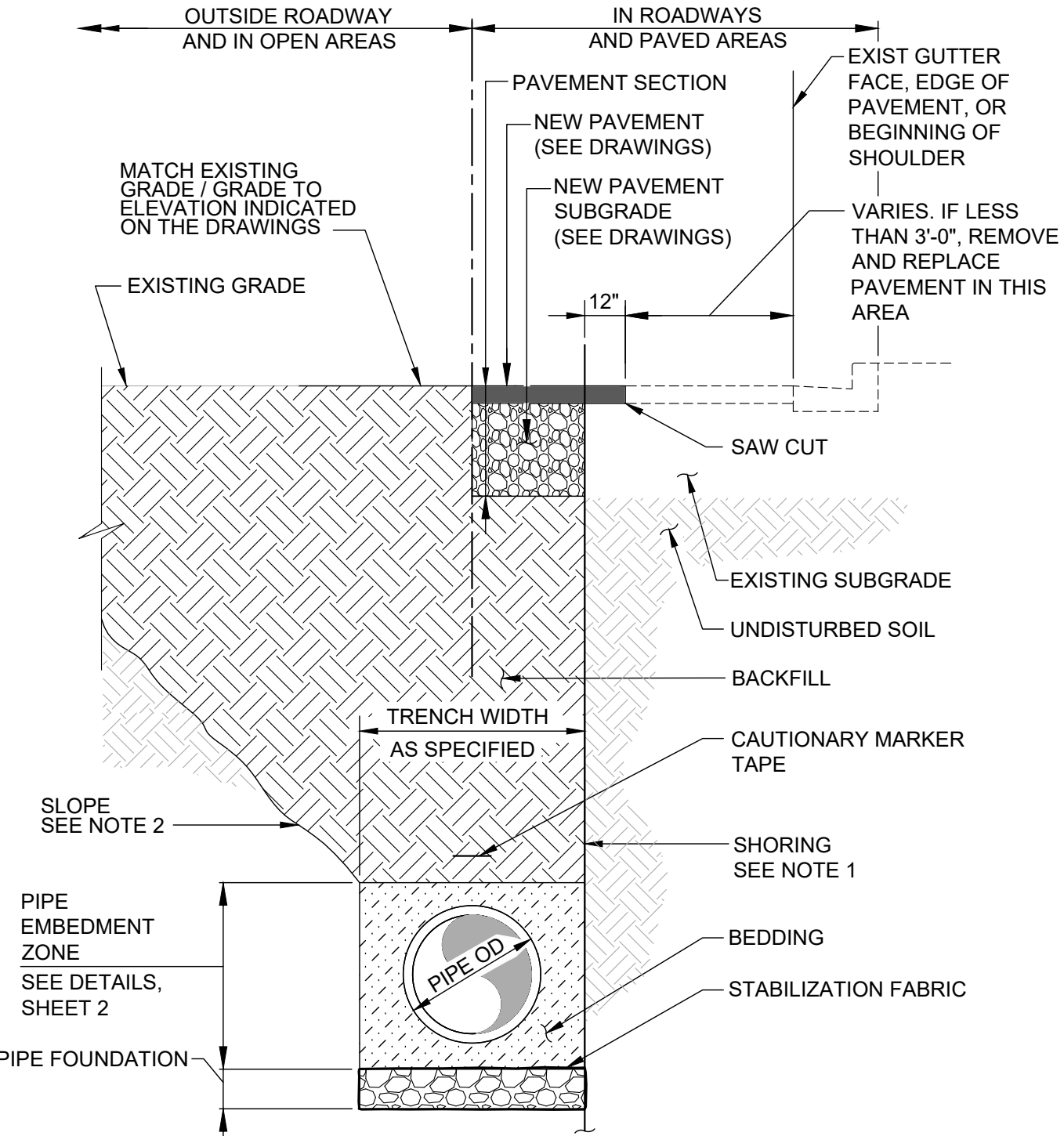
DATE: MARCH 2022 SHEET W16



CITY of WESTMINSTER
4800 WEST 92ND AVENUE
WESTMINSTER, COLO. 80031

CONDUIT CROSSING

DATE: MARCH 2022 SHEET W17



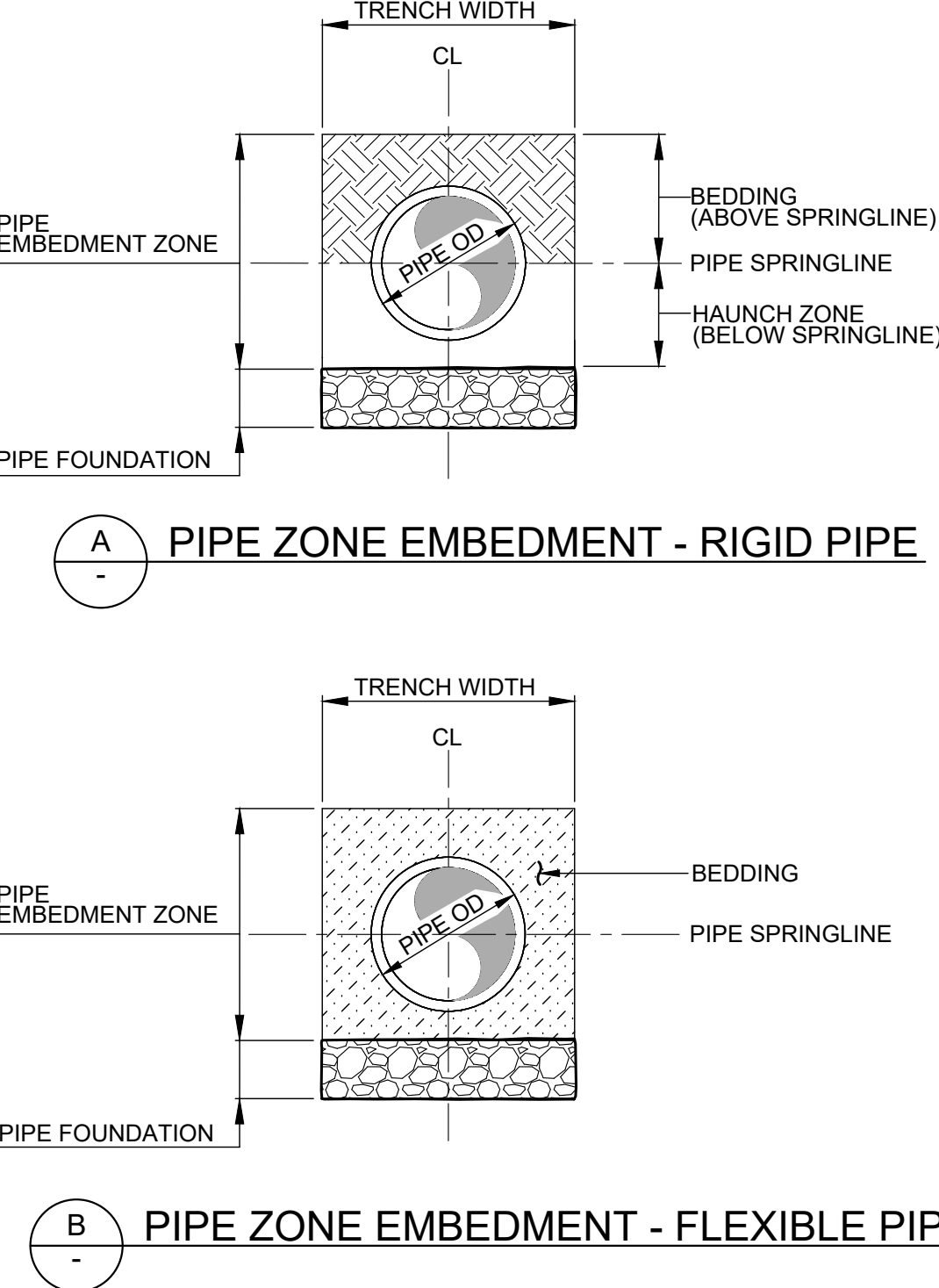
CY111 PIPE TRENCH

TYP

SN

SHEET 1 OF 2

08/19/22



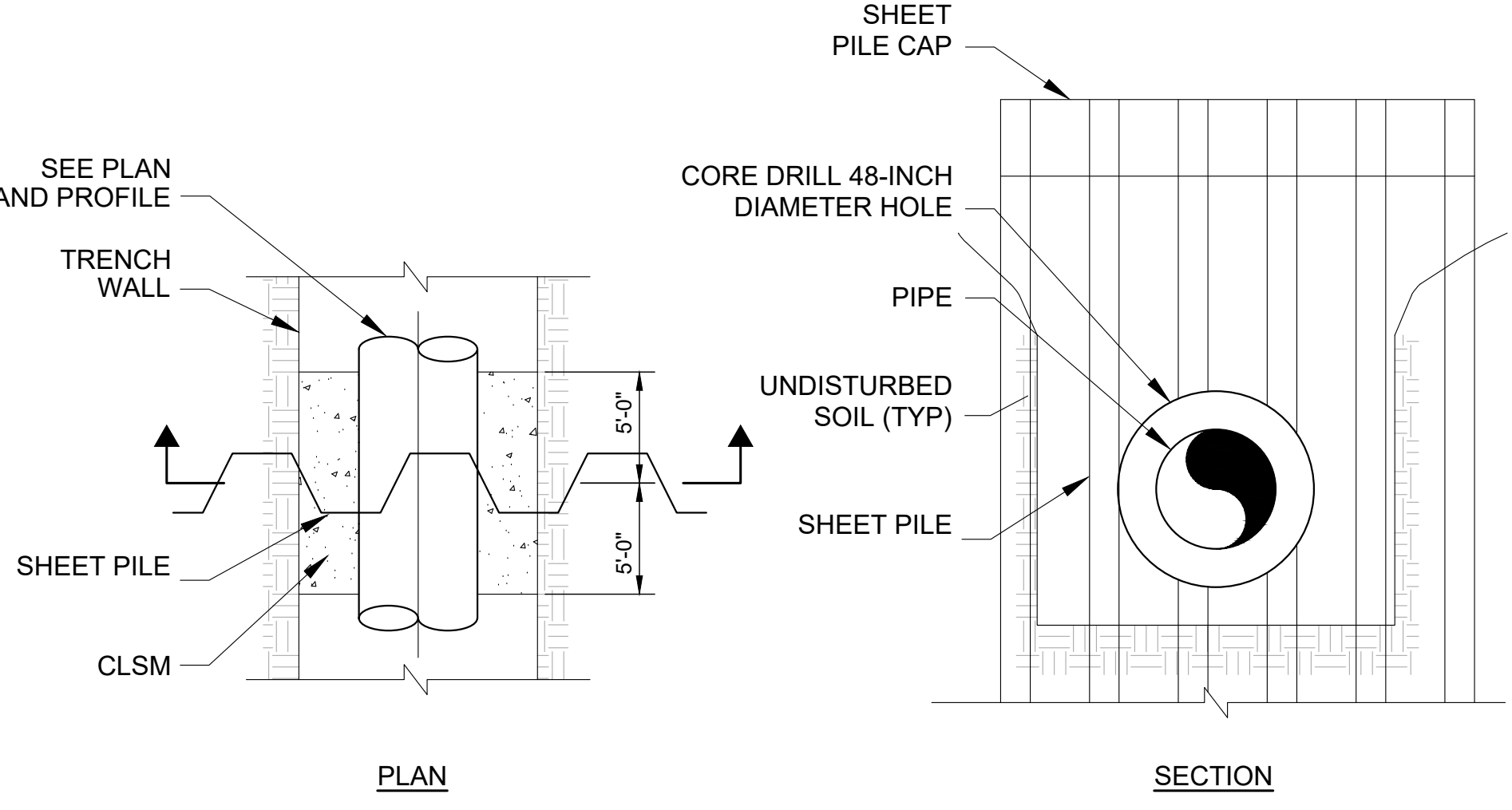
CY111 PIPE TRENCH

TYP

SN

SHEET 2 OF 2

08/19/22

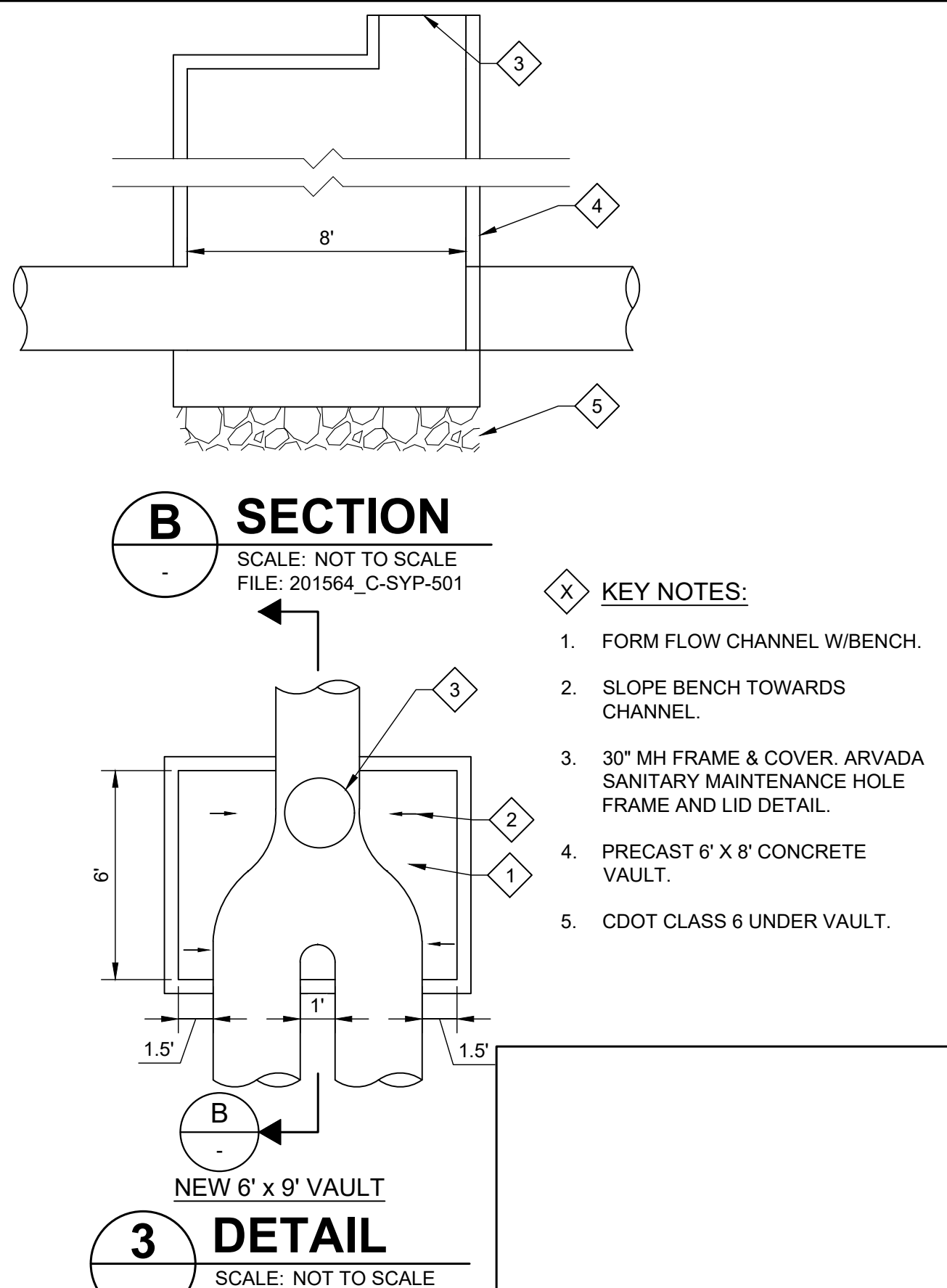
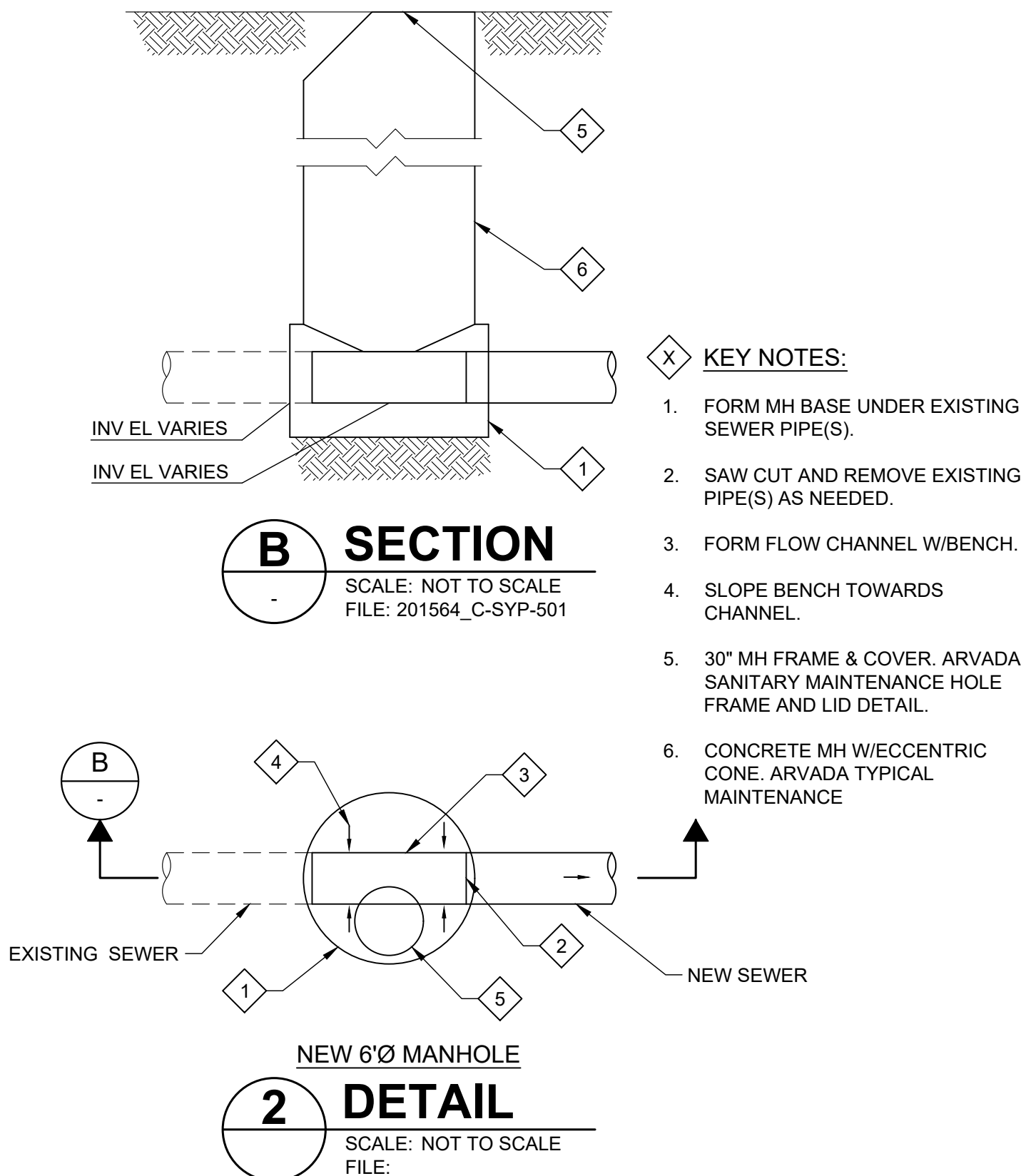


1 SHEET PILE PENETRATION

PP01

SCALE: NTS

FILE:

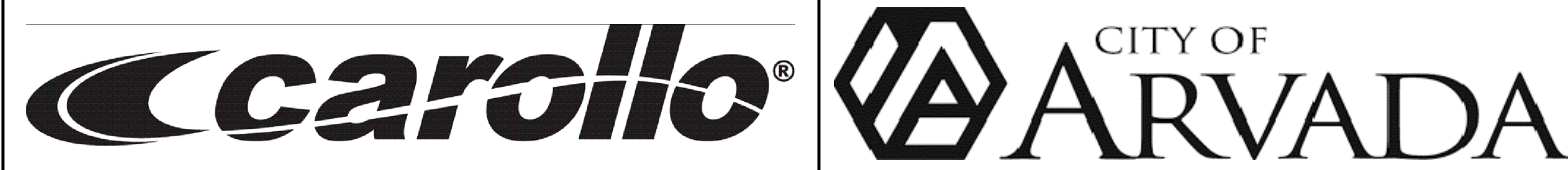


3 DETAIL

SCALE: NOT TO SCALE

FILE:

95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION				DESIGNED CDH				CHECKED JKK				DATE OCTOBER 2024			
REV	DATE	BY	DESCRIPTION												
1															



CITY OF ARVADA				VERIFY SCALES	JOB NO. 202594
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)				BAR IS ONE INCH ON ORIGINAL DRAWING	DRAWING NO. TD02
CIVIL				0 1"	SHEET NO. X OF
TYPICAL DETAILS - 2				IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	



- GENERAL NOTES:
- SEE SHEET TC03 FOR MESSAGE BOARD MESSAGES.
 - VARIABLE MESSAGE BOARDS SHALL BE PLACED AT LEAST 1 WEEK IN ADVANCE OF LANE CLOSURES. PLACEMENT IS RECOMMENDED CLOSER TO THE SITE OF THE ACTUAL CLOSURE IN ADDITION TO THESE LOCATIONS PRIOR TO CONSTRUCTION.
 - ADD PROJECT SIGN FOR EACH APPROACH ON SHERIDAN BLVD WITH ADVANCED CONSTRUCTION SIGNS.
 - TEMPORARY CONSTRUCTION SIGNS SHALL BE DOUBLE POSTED USING THE EXISTING MEDIAN OR TEMPORARY BARRELS WHERE POSSIBLE WHEN TWO OR MORE LANES ARE OPEN.
 - EACH DAY THE TRAFFIC CONTROL SUPERVISOR SHALL DEVELOP THE MESSAGES FOR THE MESSAGE BOARDS, DETERMINE THE LOCATIONS OF THE MESSAGE BOARDS, COORDINATE WITH FIELD LABOR TO LOCATE THE MESSAGE BOARDS, AND PROGRAM THE MESSAGE BOARDS.
 - EACH EVENING AND MORNING, SIGNS SHALL BE COVERED AND UNCOVERED AS NEEDED TO INFORM THE PUBLIC OF ROADWAY CLOSURES, DETOURS, WORK ZONES, AND OTHER TRAFFIC INFORMATION. EACH EVENING JUST BEFORE CREWS LEAVE, ALL SIGNS NOT REQUIRED SHALL BE COVERED AND ALL SIGNS REQUIRED SHALL BE UNCOVERED. EACH MORNING BEFORE START OF CONSTRUCTION, ALL SIGNS NOT REQUIRED SHALL BE COVERED AND ALL SIGNS REQUIRED SHALL BE UNCOVERED. THE TRAFFIC CONTROL SUPERVISOR SHALL OVERSEE THE COVERING AND UNCOVERING OF SIGNS EACH EVENING AND MORNING.

Call before you Dig
Avoid cutting underground utility lines. It's costly.



OR
1-800-227-2600

95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
REV	DATE	BY	DESCRIPTION

DESIGNED JSW
DRAWN WDE
CHECKED KAM
DATE OCTOBER 2024

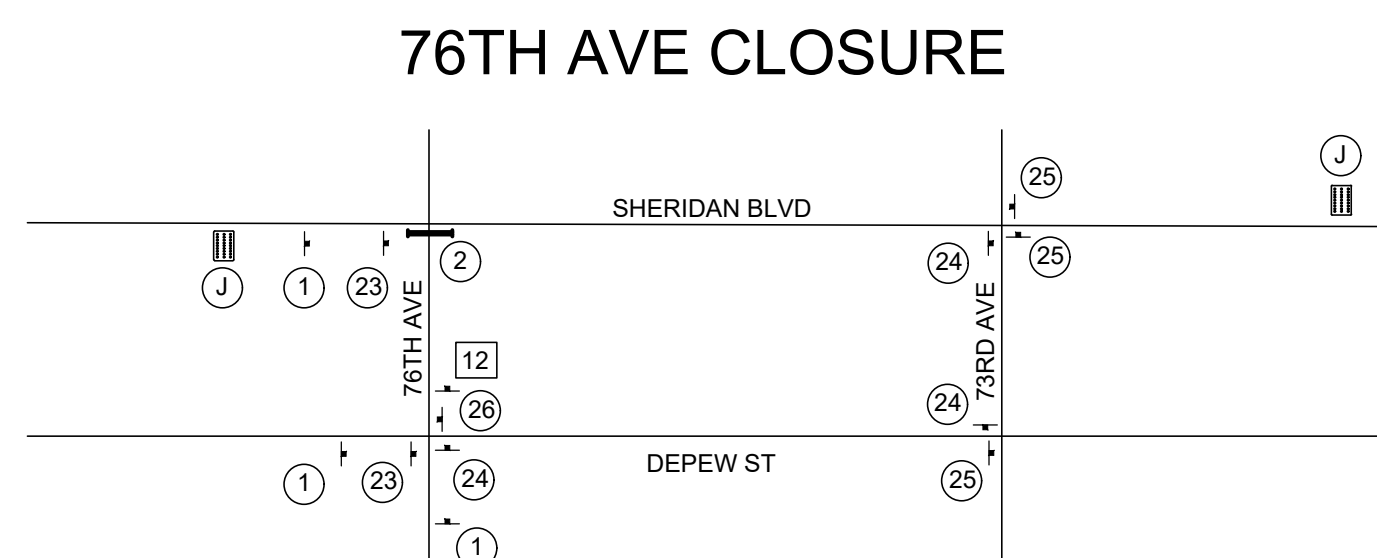
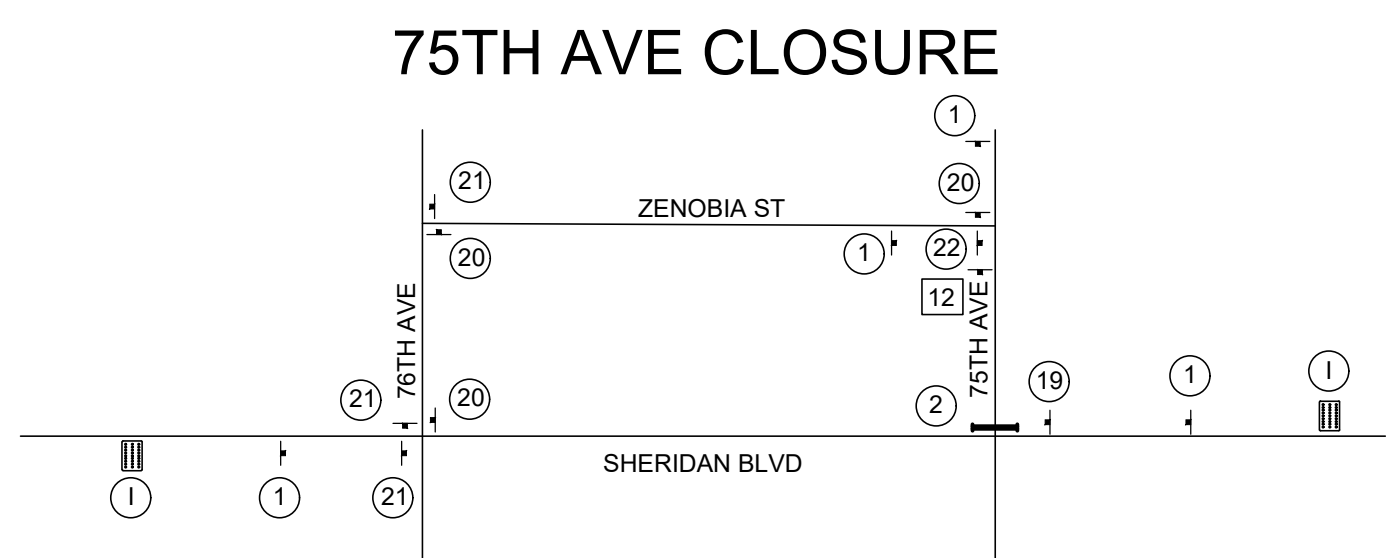
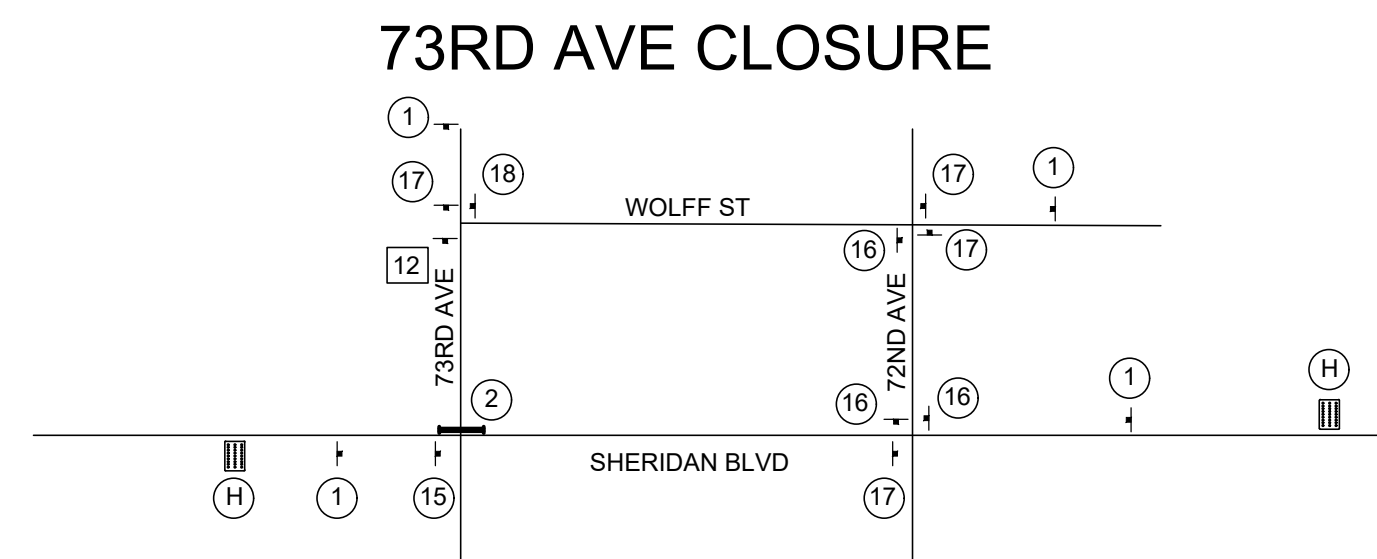
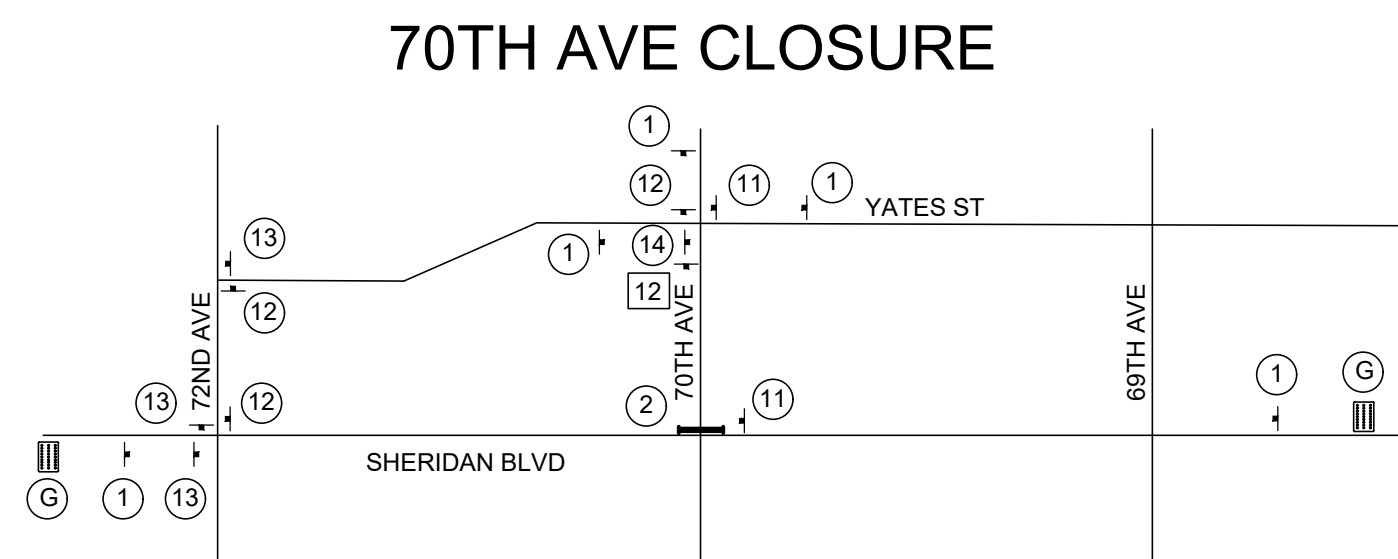
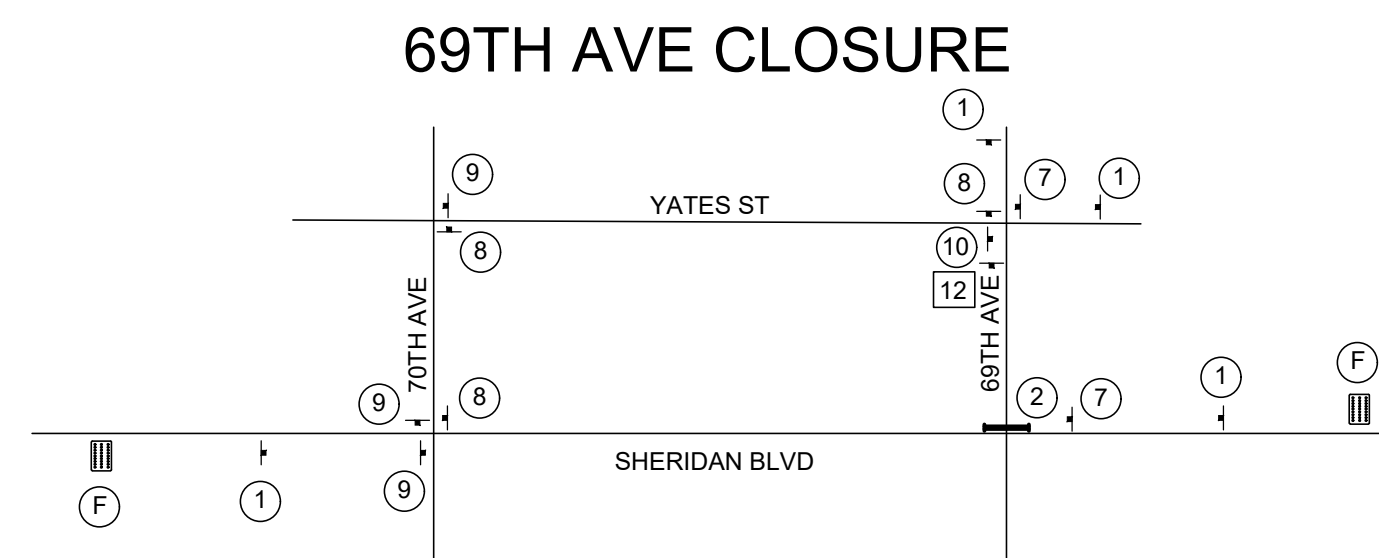
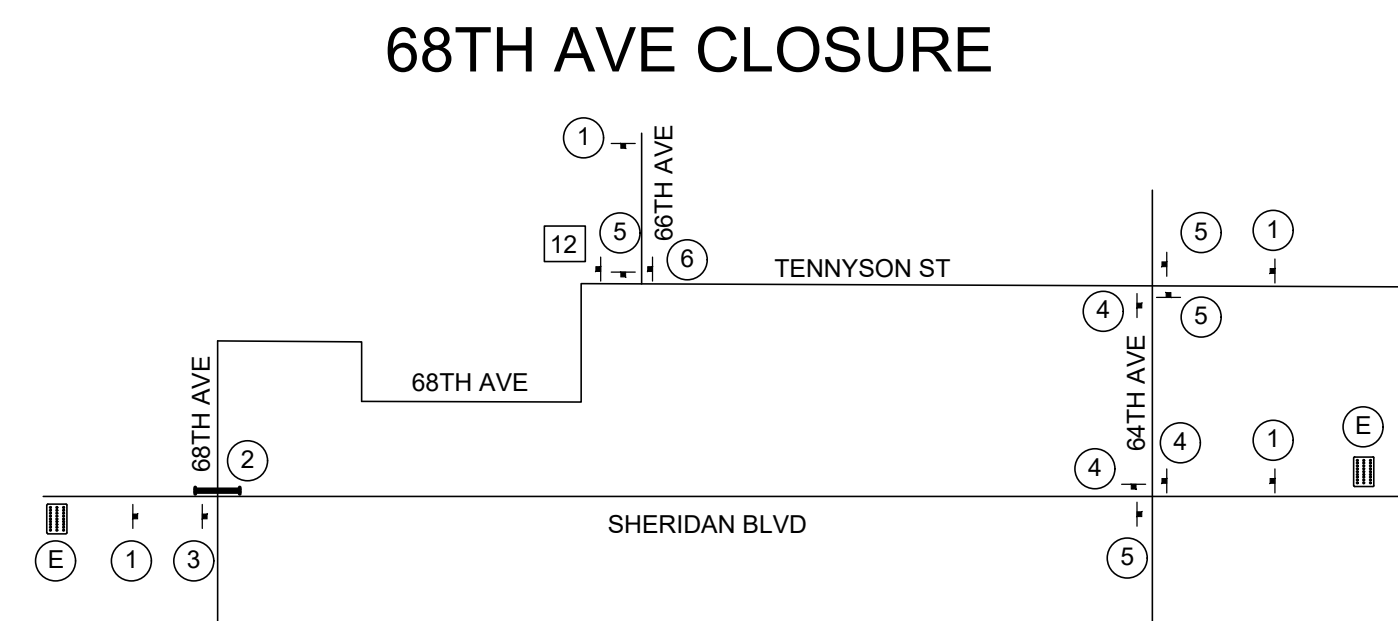


CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
APPROACH PLAN MESSAGE BOARDS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 202594
DRAWING NO. TC01
SHEET NO.

LAST SAVED BY: lbb@ig



GENERAL NOTES:

1. SEE SHEET TC03 FOR TEMPORARY TRAFFIC CONTROL SIGN DETAILS

Call before you Dig
Avoid cutting underground utility lines. It's costly.

utility lines. It's costly.



R

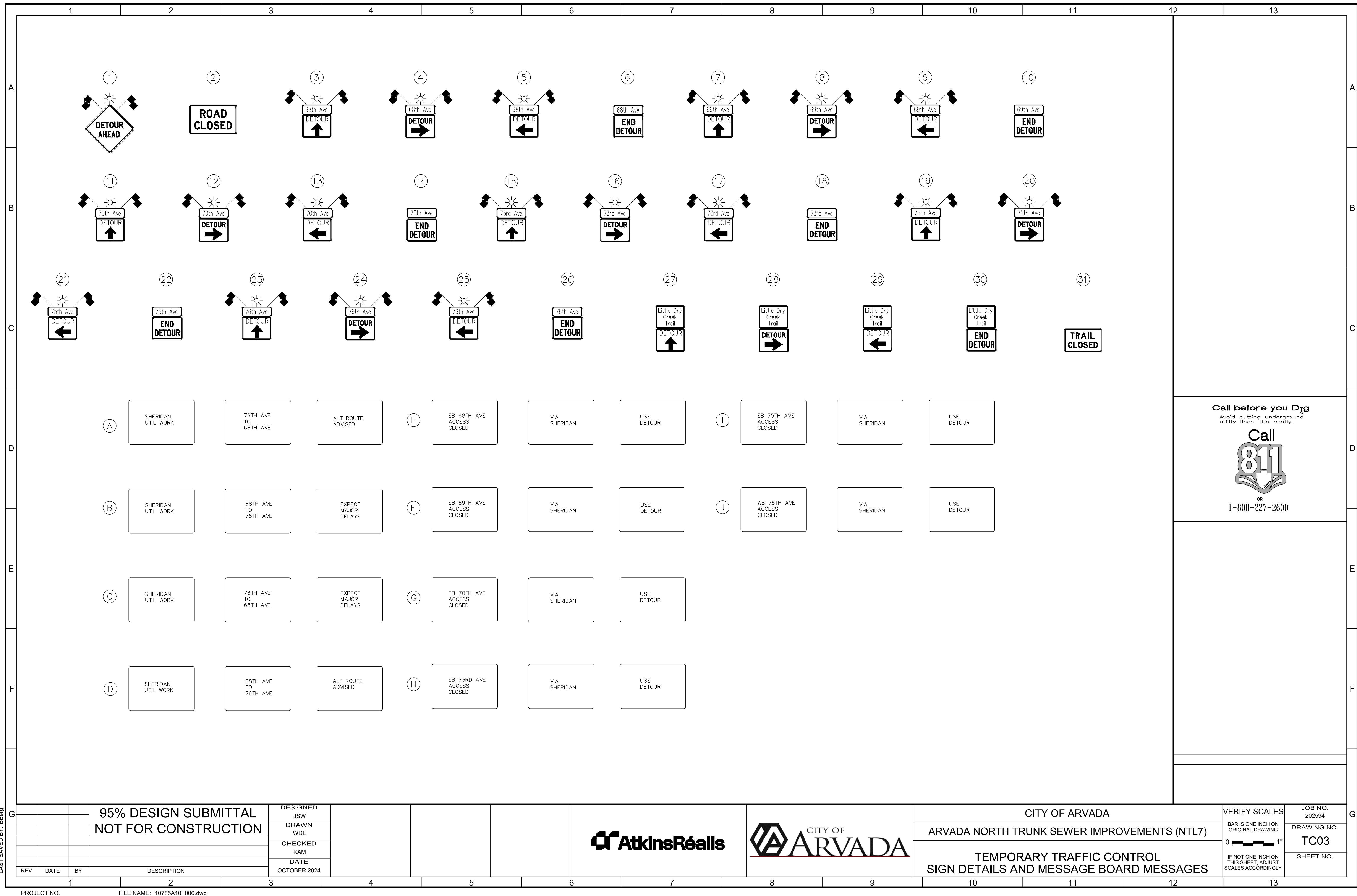
1-800-227-2600

S				95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION	DESIGNED JSW							CITY OF ARVADA		VERIFY SCALES	JOB NO. 202594
					DRAWN WDE							ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)	BAR IS ONE INCH ON ORIGINAL DRAWING	DRAWING NO.	
					CHECKED KAM								0  1"	TC02	
					DATE OCTOBER 2024							TRAFFIC CONTROL PLAN DETOURS	IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	SHEET NO.	
	REV	DATE	BY		DESCRIPTION										

LAST SAVED BY: BBerg

PROJECT NO.

FILE NAME: 10785A10T006.dwg



12

13

1

2

3

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11

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F

G

ROAD WORK

MMM YY-MMM YY

FOR INFORMATION

XXX-XXX-XXXX

36G20-11

ROAD WORK AHEAD

36W20-1 (AHEAD)

BEGIN DOUBLE FINES ZONE

36R2-10

WORK ZONE

24G20-5

SPEED LIMIT

40

36R2-1 (40)

WORK ZONE

24G20-5

FINES DOUBLE

24R2-6P

36R2-11

END DOUBLE FINES ZONE

36R2-11

XYZ

CONSTRUCTION THANKS YOU

555-555-555

36G20-10

SPEED LIMIT

45

36R2-1 (45)

ARROW PANEL

ARROW PANEL

1

ROAD CLOSED

48R11-2

2

ROAD WORK AHEAD

36W4-2R

3

ROAD WORK AHEAD

36W4-2L

4

RIGHT LANE CLOSED AHEAD

36W20-5R AHEAD

5

LEFT LANE CLOSED AHEAD

36W20-5L AHEAD

6

ROAD CLOSED AHEAD

36W20-3 (AHEAD)

7

ROAD CLOSED AHEAD

30W12-1

8

ROAD CLOSED AHEAD

36W1-4L

9

ROAD CLOSED AHEAD

36W1-4R

10

RIGHT LANE MUST TURN RIGHT

36R3-7R

11

LEFT LANE MUST TURN LEFT

36R3-7L

12

ROAD CLOSED TO THRU TRAFFIC

60R11-4

13

NO LEFT TURN

36R3-2

14

NO RIGHT TURN

36R3-1

15

DO NOT ENTER

36R5-1

16

ROAD CLOSED AHEAD

LOCAL TRAFFIC ONLY

R11-3a

17

ROAD CLOSED AHEAD

36R4-7

18

STOP

36R1-1

19

BUSINESSES OPEN

SPECIAL

20

SIDEWALK CLOSED

24R9-9

21

SIDEWALK CLOSED

USE OTHER SIDE

24R9-10

22

SIDEWALK CLOSED AHEAD

CROSS HERE

24R9-11L

23

SIDEWALK CLOSED AHEAD

CROSS HERE

24R9-11R

IMPACT ATTENUATOR (TEMPORARY)

TYPE 3 BARRICADE

CONCRETE BARRIER (TEMPORARY)

CHANNELIZING DEVICE

95% DESIGN SUBMITTAL

NOT FOR CONSTRUCTION

DESIGNED JSW

DRAWN WDE

CHECKED KAM

DATE OCTOBER 2024

PROJECT NO.

FILE NAME: 10785A10T006.dwg

AtkinsRéalls

CITY OF ARVADA

CITY OF ARVADA

ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)

TRAFFIC CONTROL PLAN

CONSTRUCTION TRAFFIC CONTROL SIGNS

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 202594

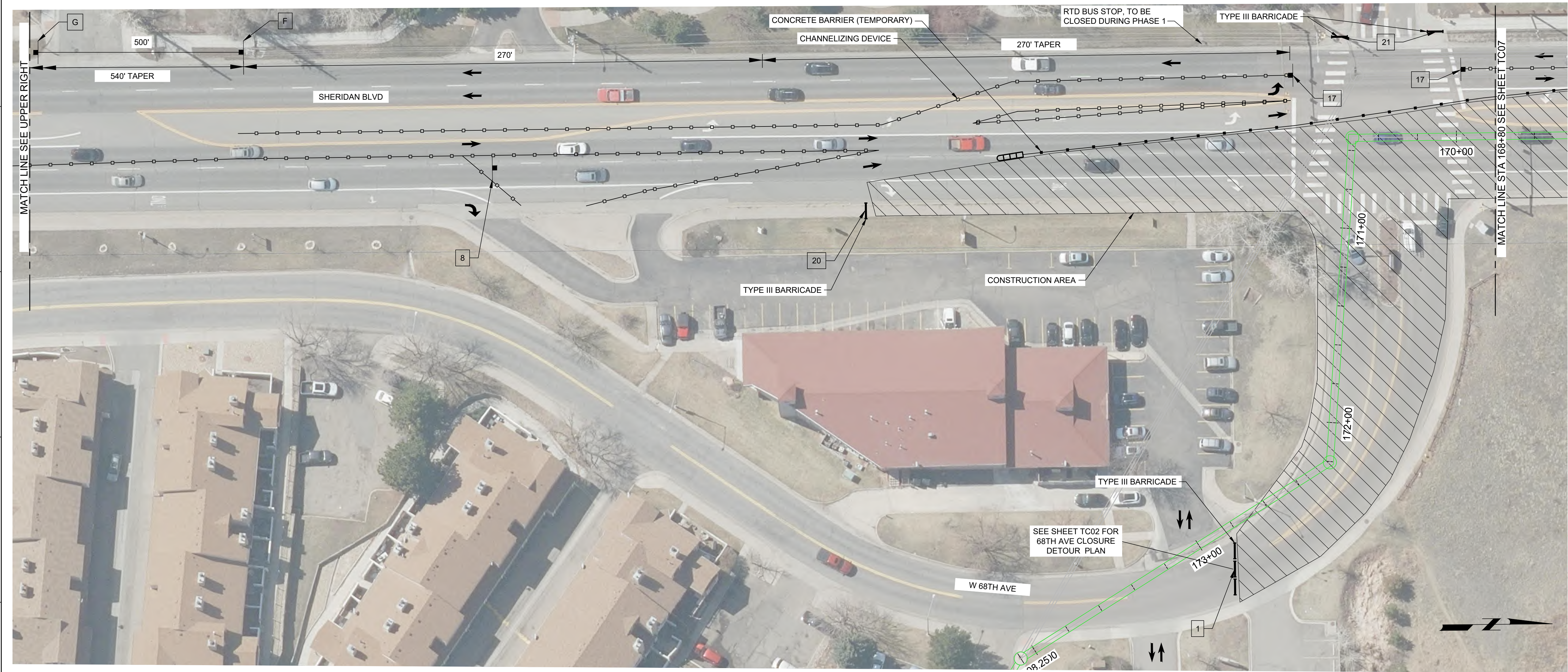
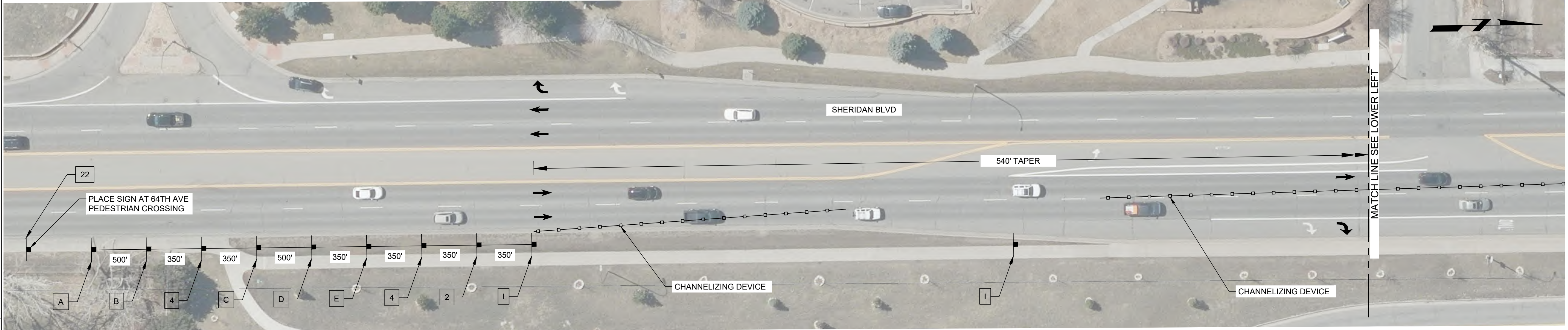
DRAWING NO. TC04

SHEET NO.

LAST SAVED BY: BB@ig

Plot Date: 9/9/2024 3:36:03 PM

LAST SAVED BY: WITH2361



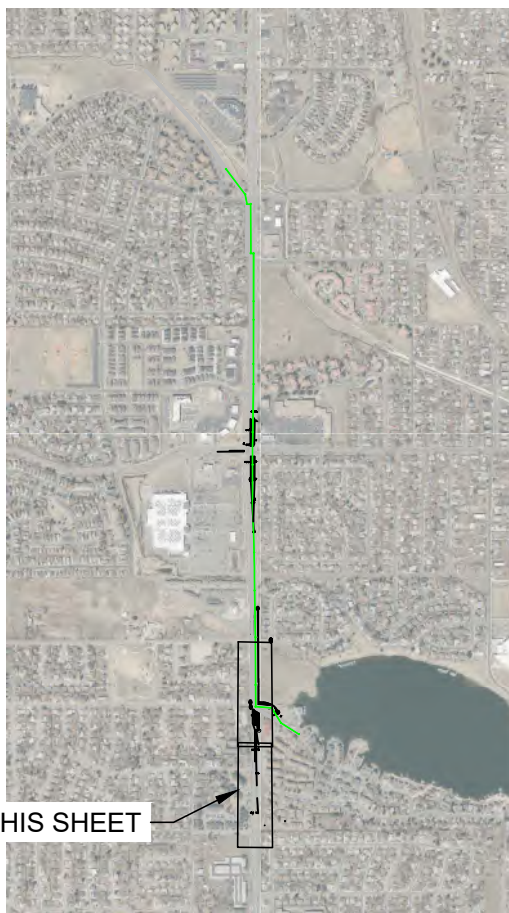
CONSTRUCTION NOTES:

1. INSTALL TEMPORARY STRIPING AS SHOWN.
2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
3. MAKE TEMPORARY SIGNAL HEAD AND DETECTION ADJUSTMENTS FOR PROPOSED LANE CONFIGURATION AT 68TH AVE INTERSECTION. SIGNAL HEADS TO REMAIN IN PLACE UNLESS OTHERWISE NOTED. WHEN THIS PHASE IS COMPLETE, SIGNAL HEADS AND DETECTION MUST BE REINSTALLED IN THEIR ORIGINAL CONFIGURATION.
4. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
5. CLOSE SHERIDAN BLVD EAST SIDEWALK, DETOUR TO USE SHERIDAN BLVD WEST SIDEWALK.
6. SHERIDAN BLVD NB - CLOSE RIGHT LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THROUGH LANE AT CONSTRUCTION AREA.
7. SHERIDAN BLVD SB - CLOSE LEFT LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THROUGH LANE AT CONSTRUCTION AREA.
8. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.

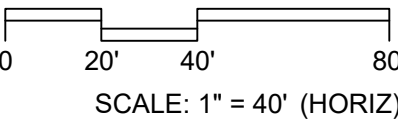


Know what's below.
Call before you dig.
usanorth811.org

KEY MAP



SCALE



95% DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

DESIGNED
JSW
DRAWN
WDE
CHECKED
KAM
DATE
OCTOBER 2024

AtkinsRéalis

CITY OF
ARVADA

CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 1A - 1

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

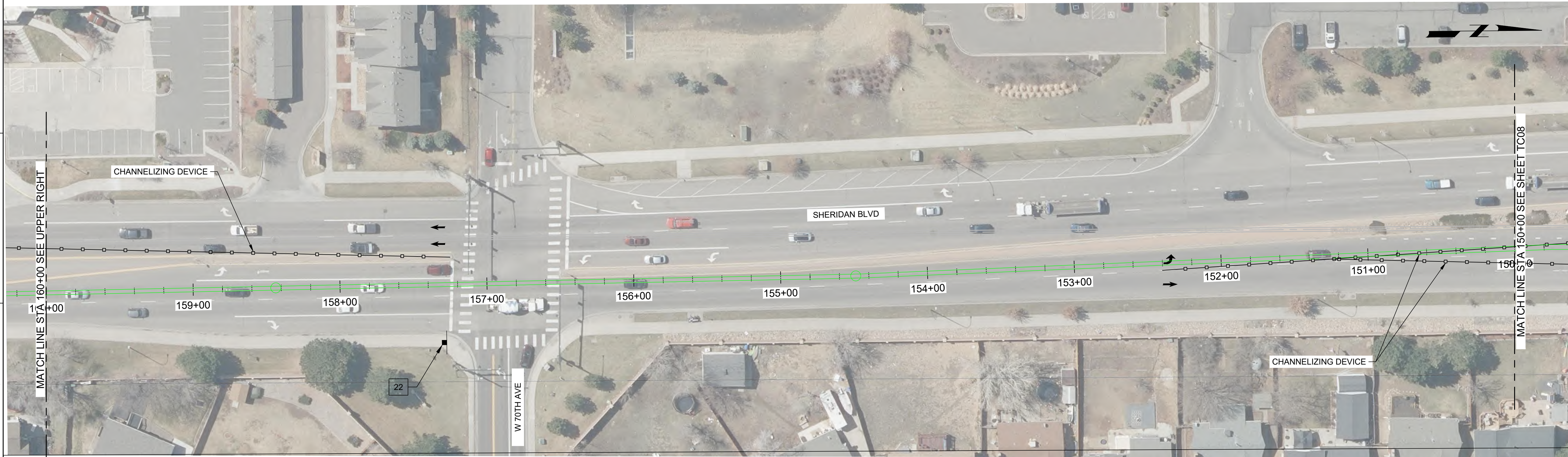
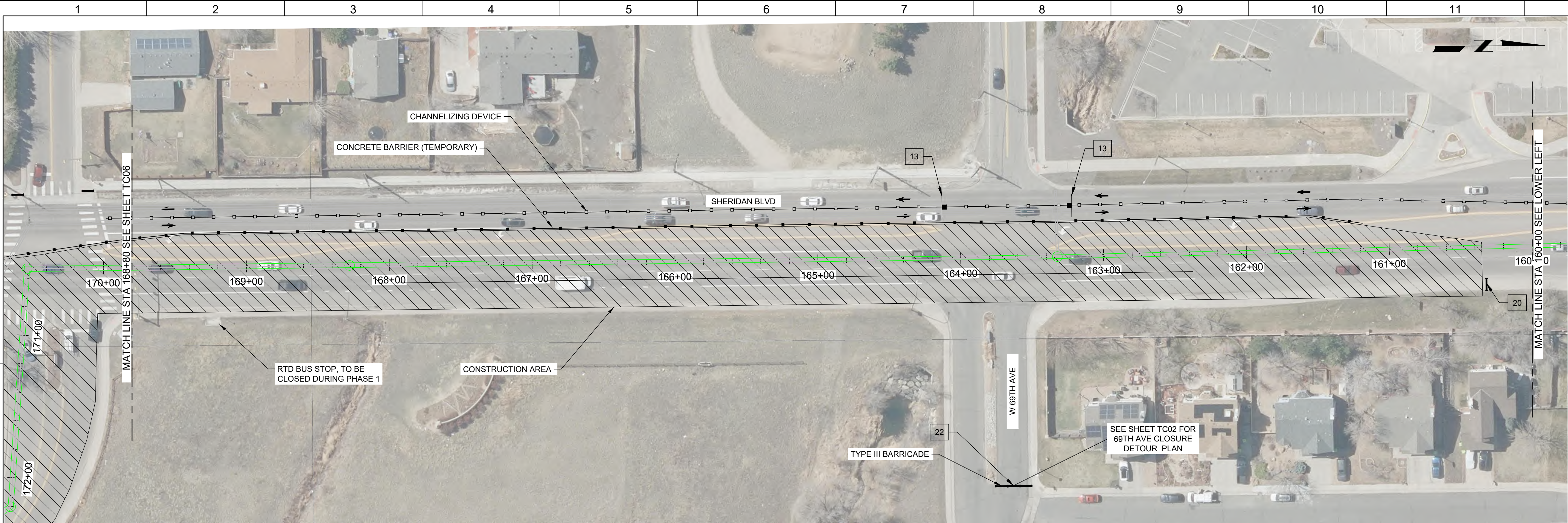
JOB NO.
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DRAWING NO.
TC06

SHEET NO.

Plot Date: 9/9/2024 3:36:03 PM

LAST SAVED BY: WTH2361



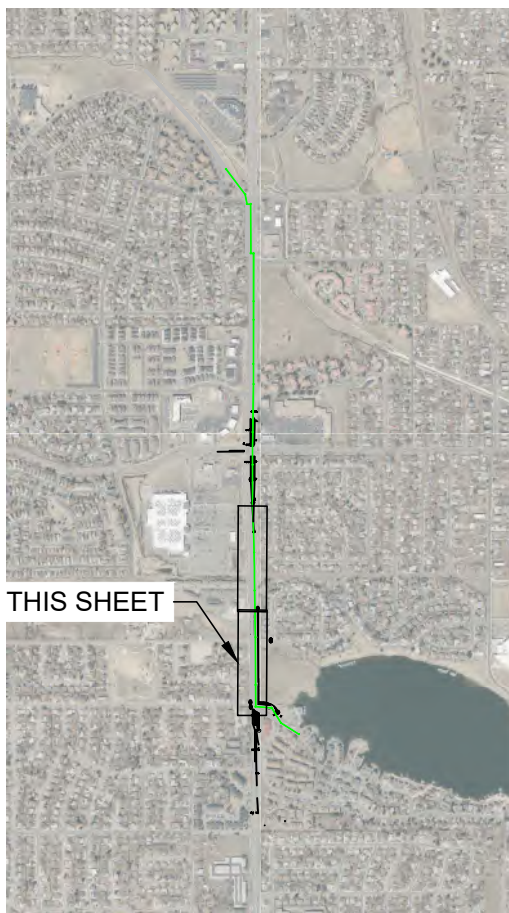
CONSTRUCTION NOTES:

1. INSTALL TEMPORARY STRIPING AS SHOWN.
2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
3. MAKE TEMPORARY SIGNAL HEAD AND DETECTION ADJUSTMENTS FOR PROPOSED LANE CONFIGURATION AT 68TH AVE INTERSECTION. SIGNAL HEADS TO REMAIN IN PLACE UNLESS OTHERWISE NOTED. WHEN THIS PHASE IS COMPLETE, SIGNAL HEADS AND DETECTION MUST BE REINSTALLED IN THEIR ORIGINAL CONFIGURATION.
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6. SHERIDAN BLVD NB - CLOSE RIGHT LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THROUGH LANE AT CONSTRUCTION AREA.
7. SHERIDAN BLVD SB - CLOSE LEFT LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THROUGH LANE AT CONSTRUCTION AREA.
8. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.

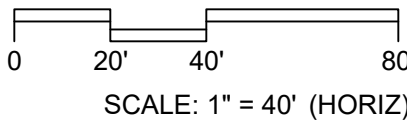


Know what's below.
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KEY MAP



SCALE



95% DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

DESIGNED
JSW
DRAWN
WDE
CHECKED
KAM
DATE
OCTOBER 2024



CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 1A - 2

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING

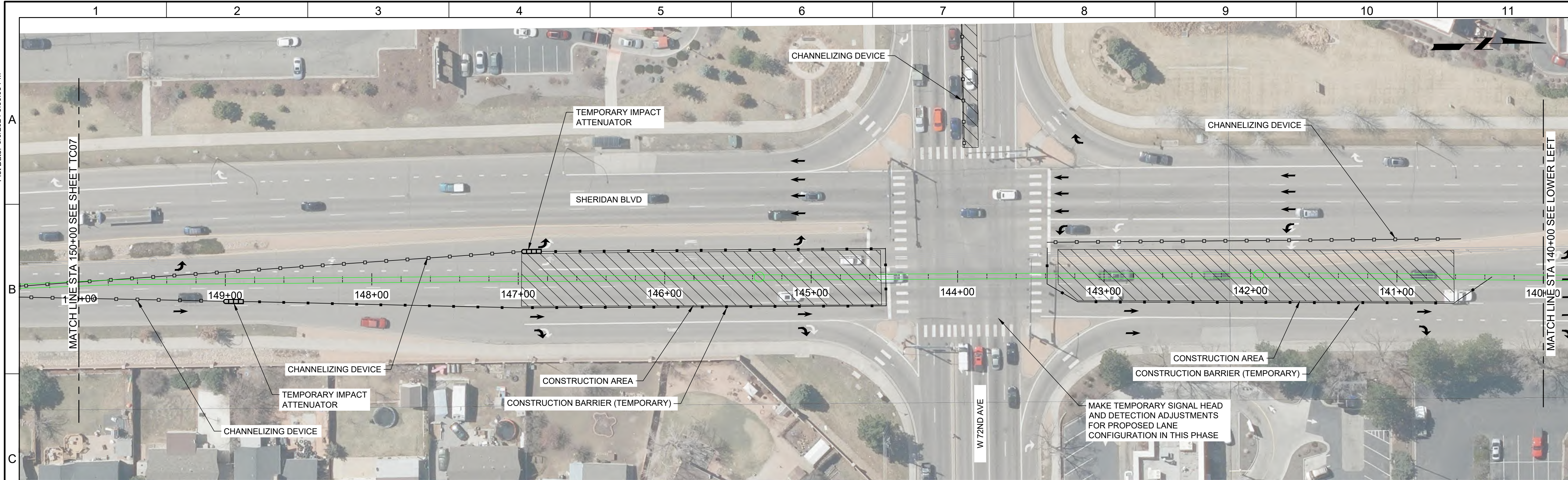
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
202594

DRAWING NO.
TC07

SHEET NO.

Plot Date: 9/9/2024 3:36:03 PM



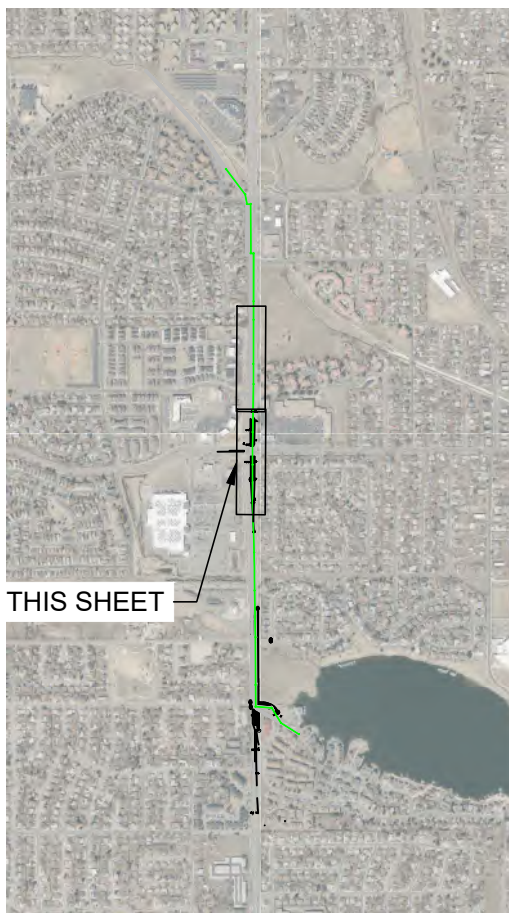
CONSTRUCTION NOTES:

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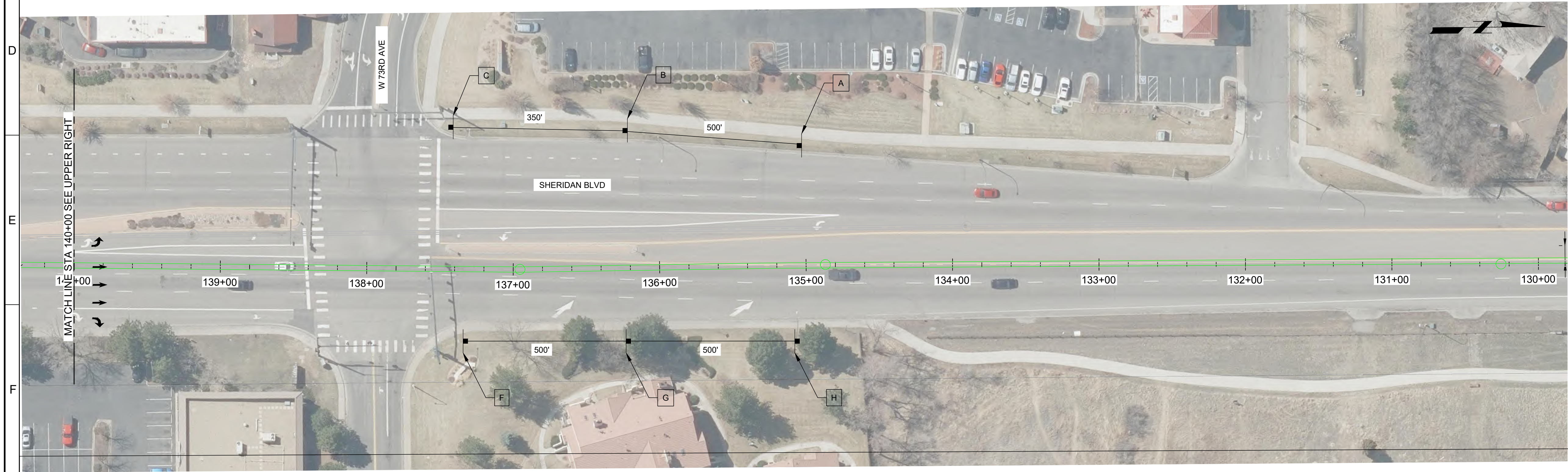
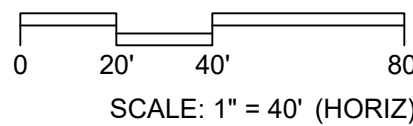


Know what's below.
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usanorth811.org

KEY MAP

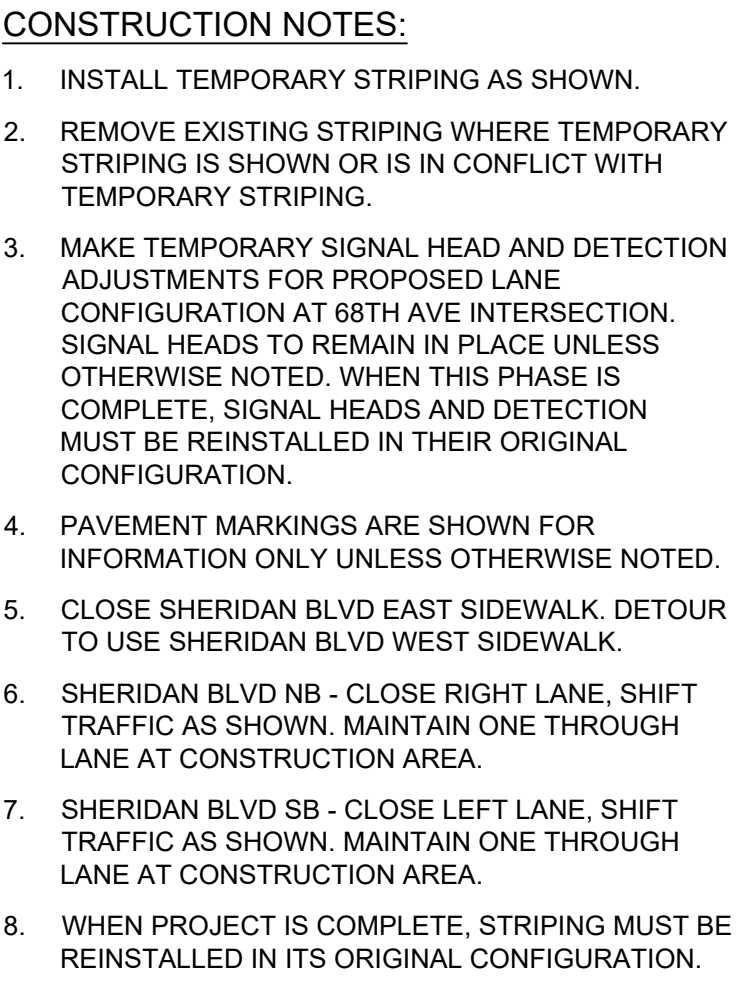


SCALE

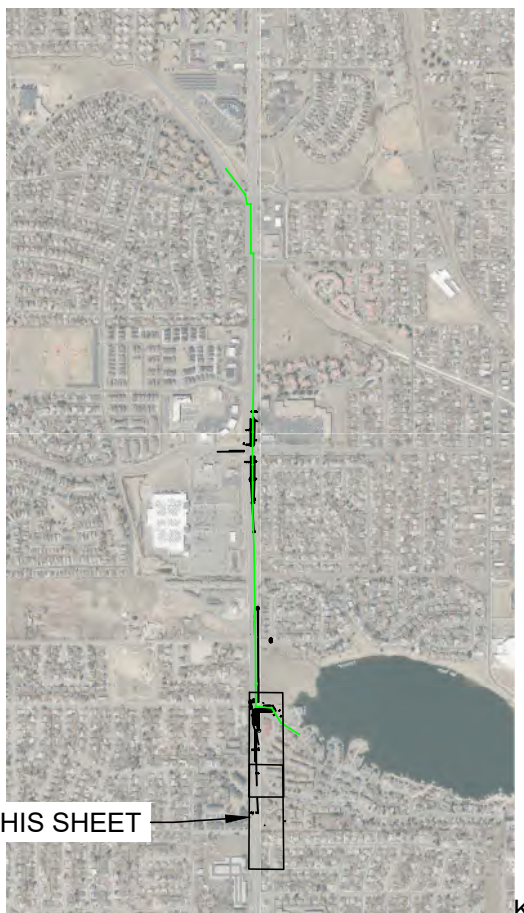


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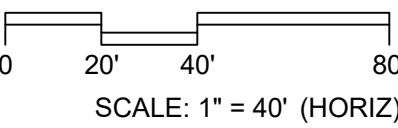
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KEY MAP



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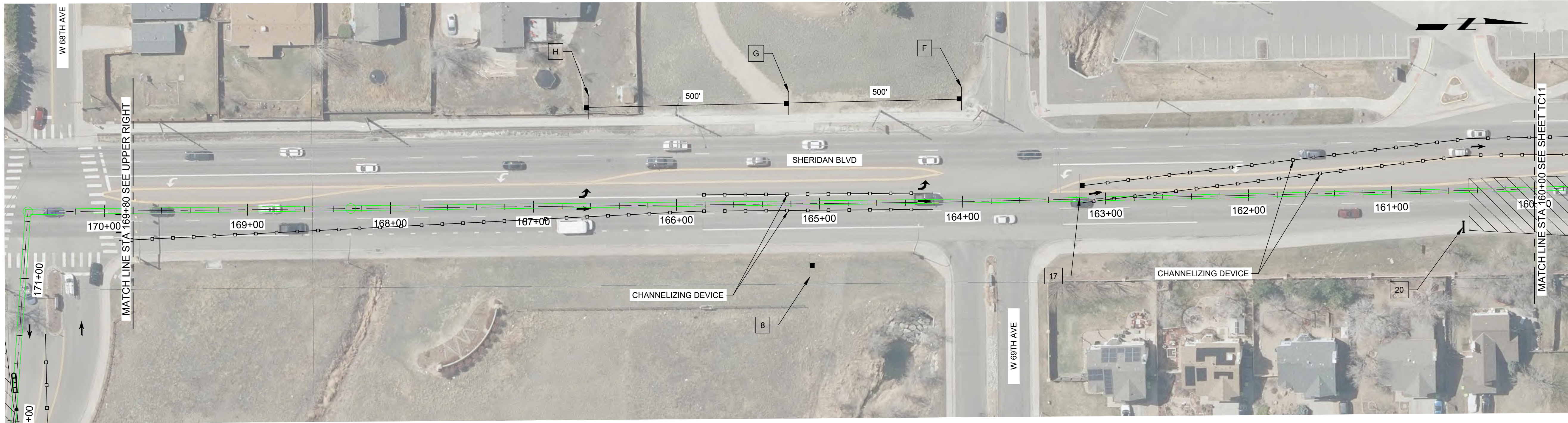


- CONSTRUCTION NOTES:**
1. INSTALL TEMPORARY STRIPING AS SHOWN.
 2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
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 4. SEE SHEET TC02 FOR 70TH AVE CLOSURE DETOUR PLANS.
 5. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
 6. SHERIDAN BLVD EAST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD WEST SIDEWALKS.
 7. SHERIDAN BLVD NB - REDUCE TO ONE THRU LANE AND ONE LEFT TURN LANE AT 72ND AVE INTERSECTION. SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 8. SHERIDAN BLVD SB - REDUCE TO TWO THRU LANES AT 72ND AVE INTERSECTION.
 9. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.



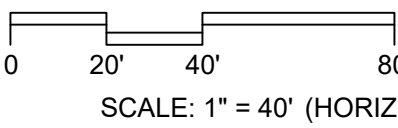
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KEY MAP



KEY MAP
NORTH

SCALE



**95% DESIGN SUBMITTAL
NOT FOR CONSTRUCTION**

DESIGNED
JSW
DRAWN
WDE
CHECKED
KAM
DATE
OCTOBER 2024

AtkinsRéalis

**CITY OF
ARVADA**

CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 2-1

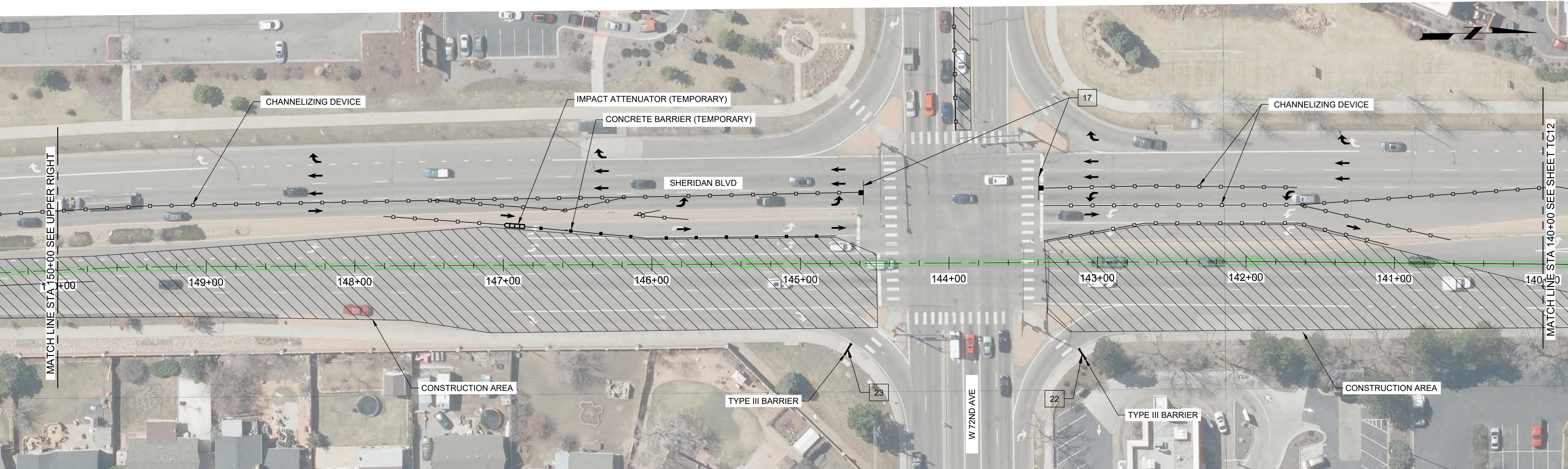
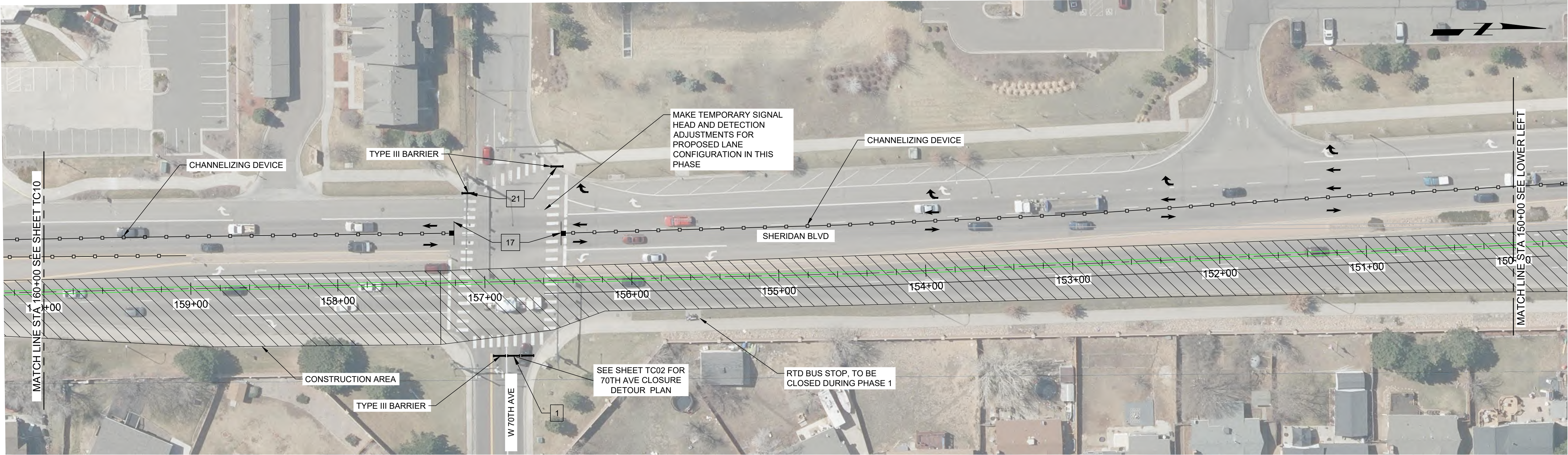
VERIFY SCALES
BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
202594
DRAWING NO.
TC10
SHEET NO.

LAST SAVED BY: WTH2361

Plot Date: 9/19/2024 1:27:04 PM

LAST SAVED BY: WITH2361



CONSTRUCTION NOTES:

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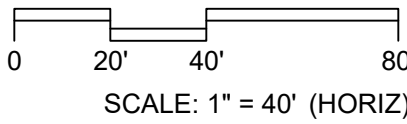
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KEY MAP



KEY MAP
NORTH

SCALE



95% DESIGN SUBMITTAL
NOT FOR CONSTRUCTION

DESIGNED
JSW
DRAWN
WDE
CHECKED
KAM
DATE
OCTOBER 2024

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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 2-2

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

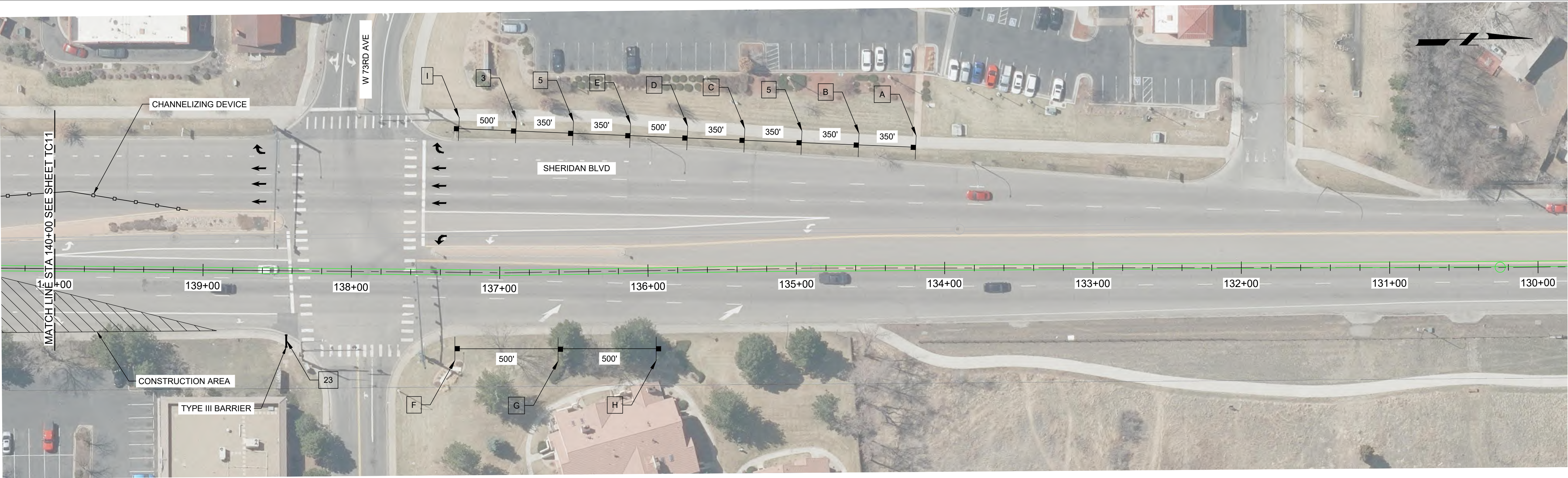
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202594

DRAWING NO.
TC11

SHEET NO.

Plot Date: 9/19/2024 1:27:04 PM

LAST SAVED BY: WITH2361

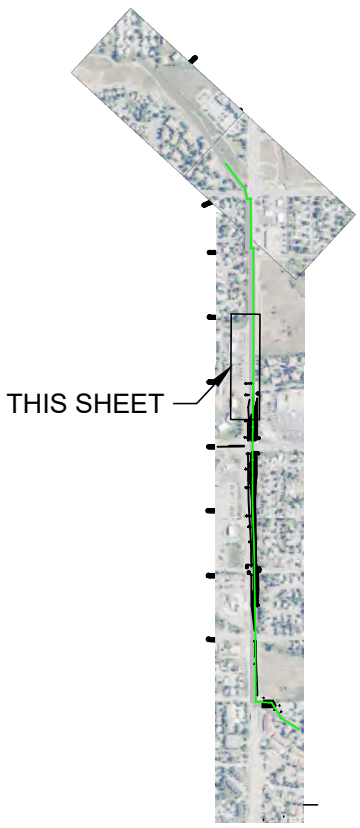


- CONSTRUCTION NOTES:
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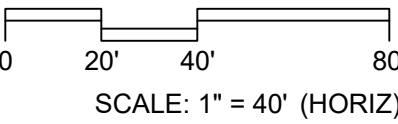
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KEY MAP



KEY MAP
NORTH

SCALE



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
REV	DATE	BY	DESCRIPTION

DESIGNED JSW
DRAWN WDE
CHECKED KAM
DATE OCTOBER 2024

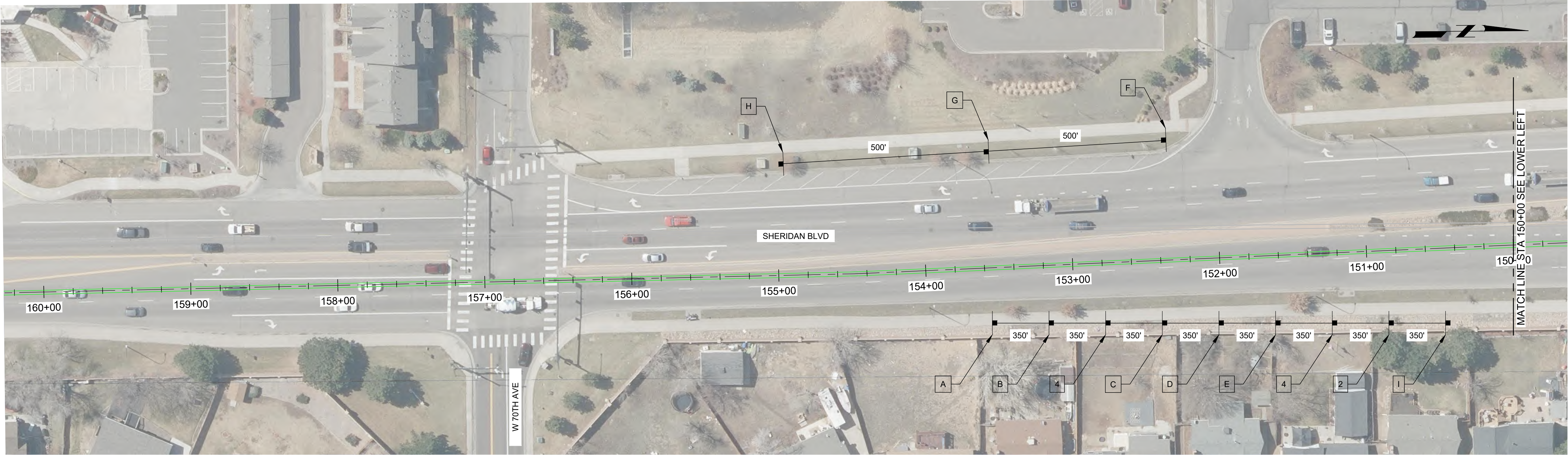


CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 2-3

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
202594
DRAWING NO.
TC12
SHEET NO.

Plot Date: 9/19/2024 1:27:04 PM



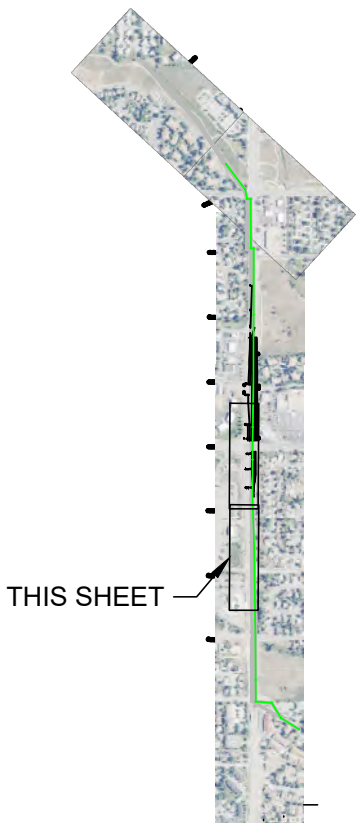
CONSTRUCTION NOTES:

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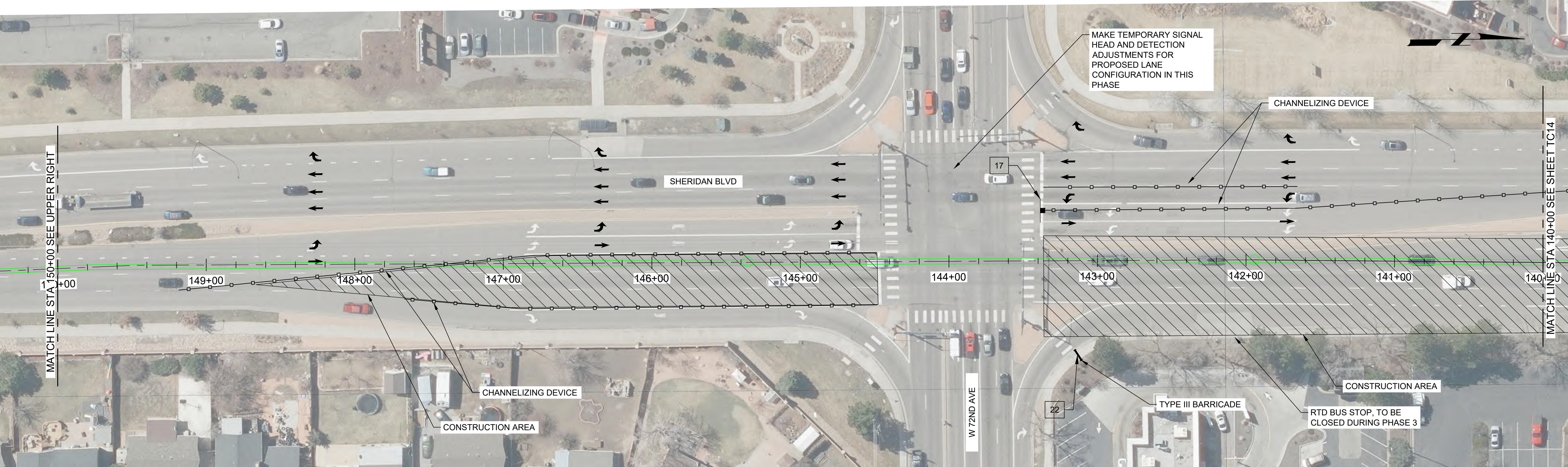
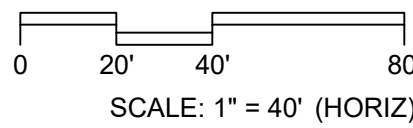


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KEY MAP



SCALE



95% DESIGN SUBMITTAL
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WDE
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KAM
DATE
OCTOBER 2024

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CITY OF
ARVADA

CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 3-1

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.

202594

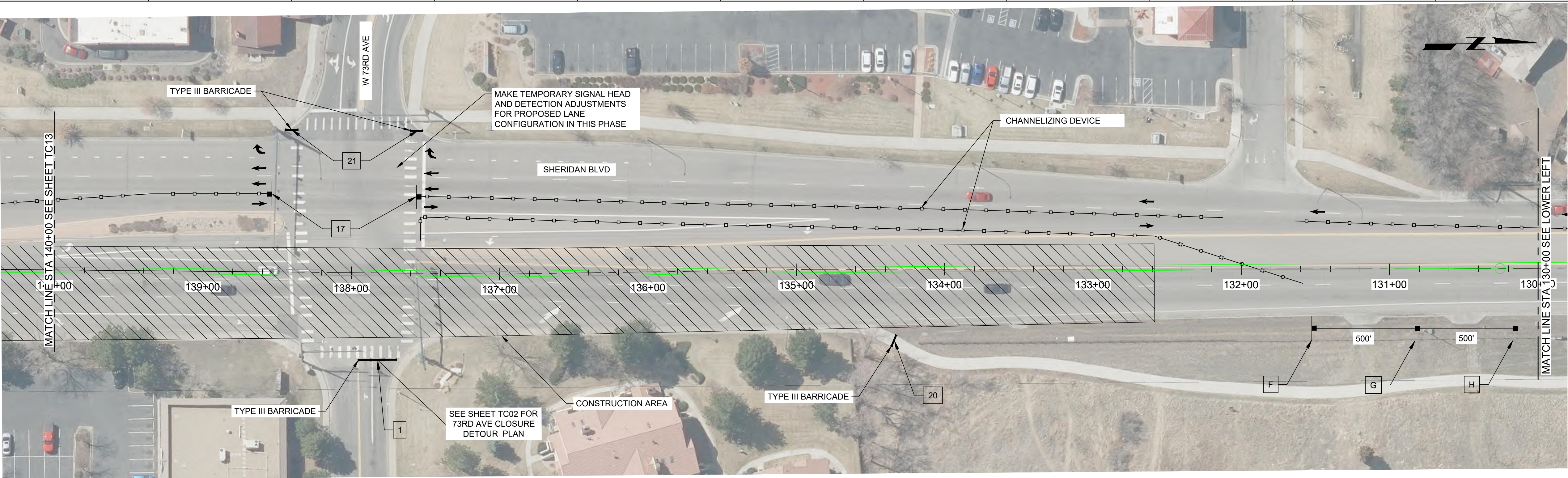
DRAWING NO.

TC13

SHEET NO.

Plot Date: 9/19/2024 1:27:04 PM

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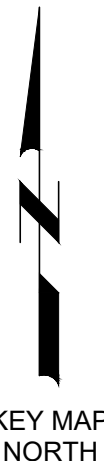
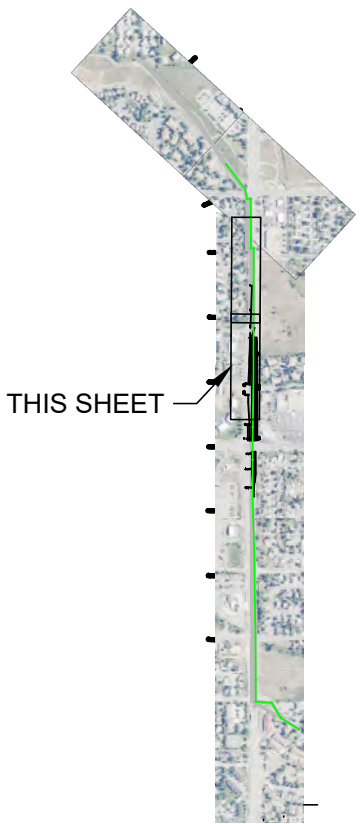
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4. SEE SHEET TC02 FOR 73RD AVE CLOSURE DETOUR PLANS.
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6. SHERIDAN BLVD EAST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD WEST SIDEWALKS.
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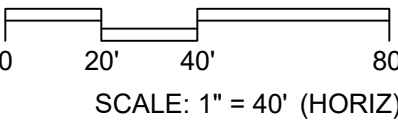


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KEY MAP



SCALE



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
REV	DATE	BY	DESCRIPTION

DESIGNED JSW
DRAWN WDE
CHECKED KAM
DATE OCTOBER 2024



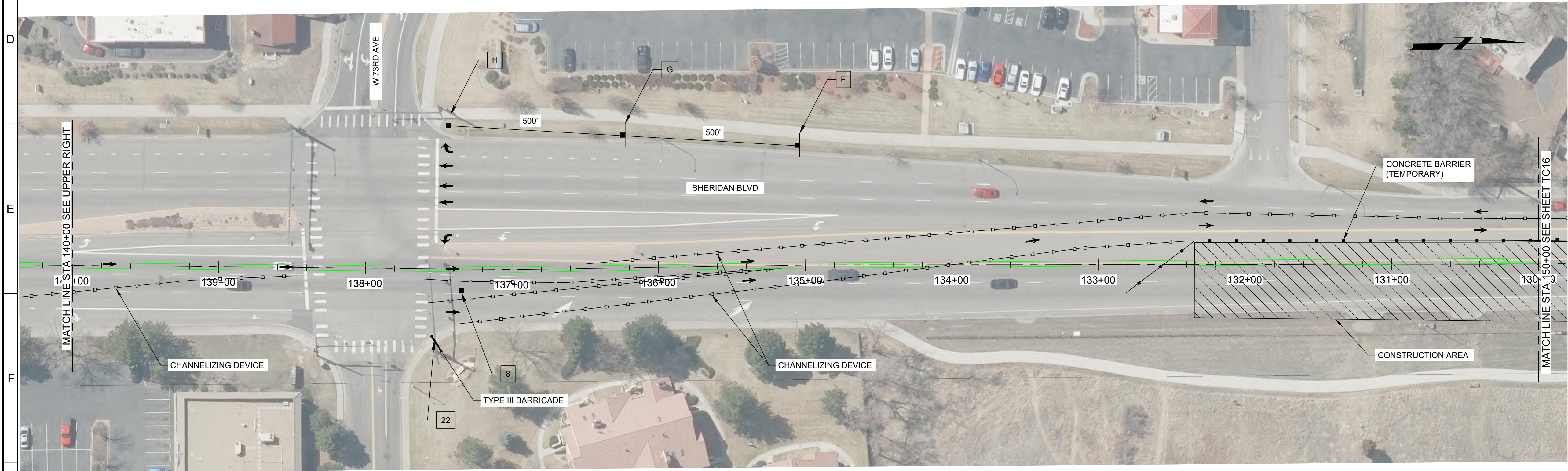
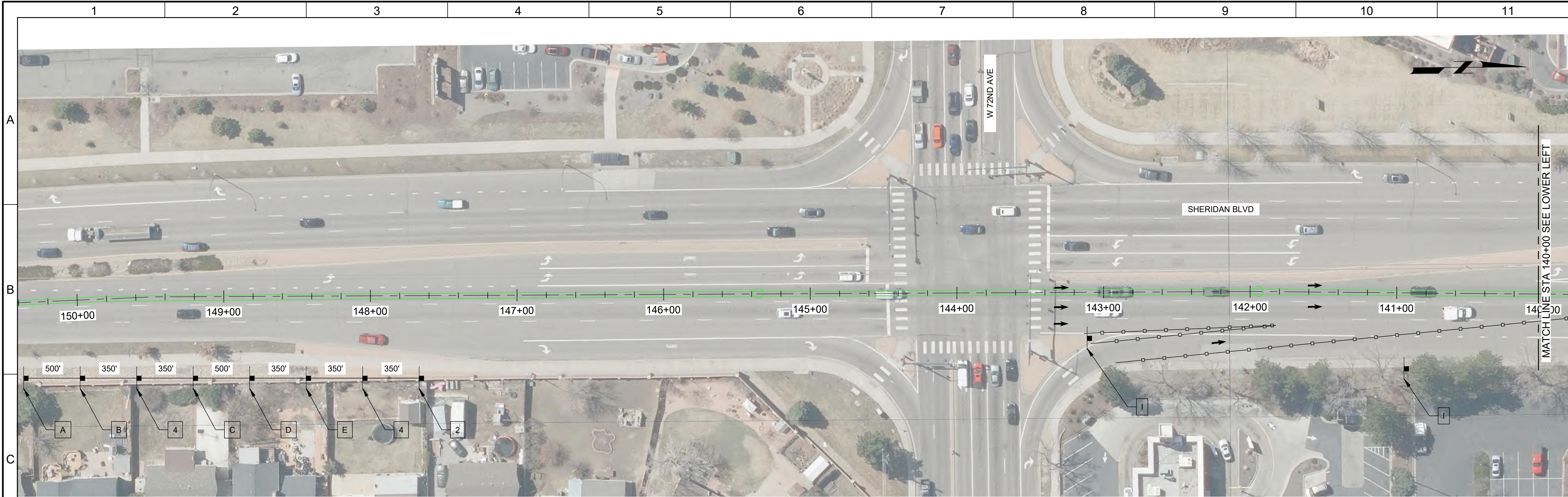
CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 3-2

VERIFY SCALES BAR IS ONE INCH ON ORIGINAL DRAWING 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
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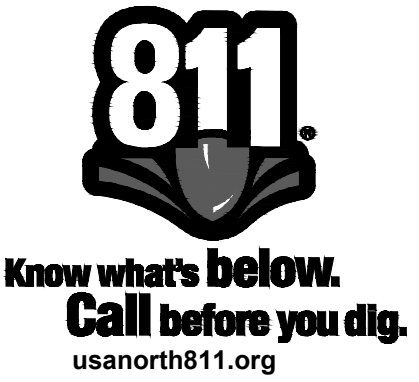
JOB NO. 202594
DRAWING NO. TC14
SHEET NO.

Plot Date: 11/7/2024 6:39:06 AM

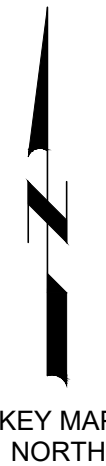
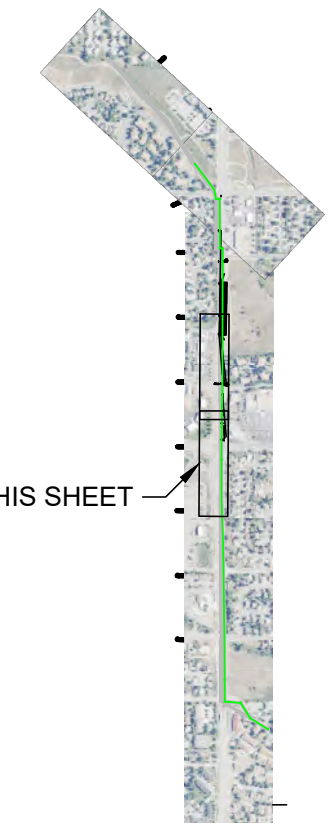
LAST SAVED BY: WITH2361



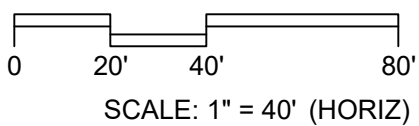
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 5. SHERIDAN BLVD NB - CLOSE RIGHT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 6. SHERIDAN BLVD SB - CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 7. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.



KEY MAP



SCALE



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
DESIGNED CDH			
DRAWN CDH			
CHECKED JKK			
DATE OCTOBER 2024			
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DATE OCTOBER 2024

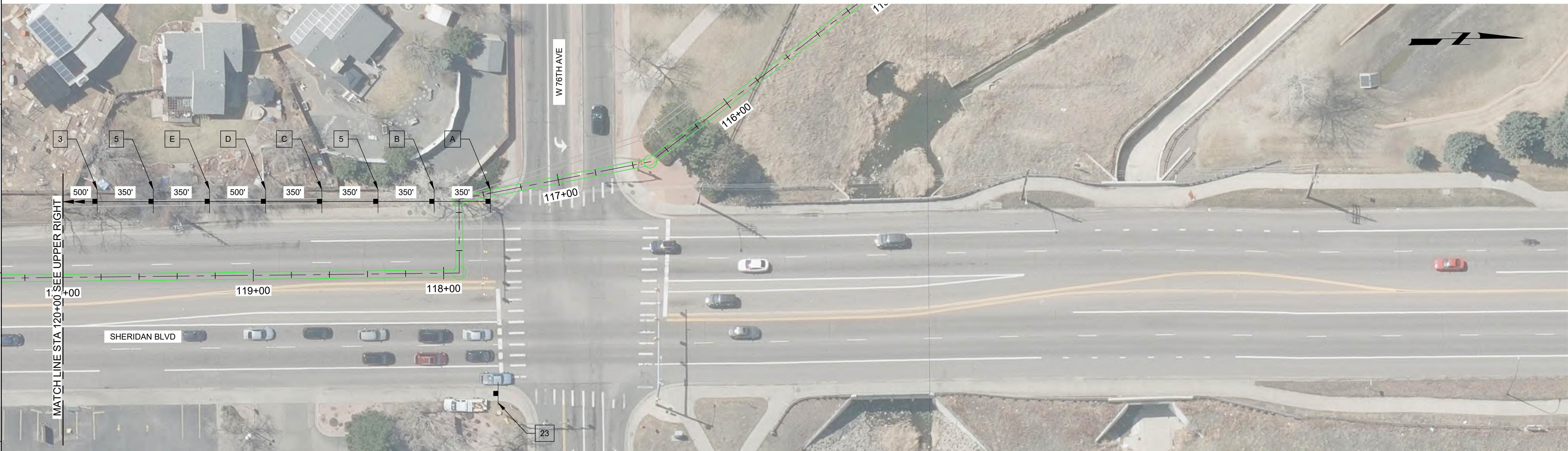
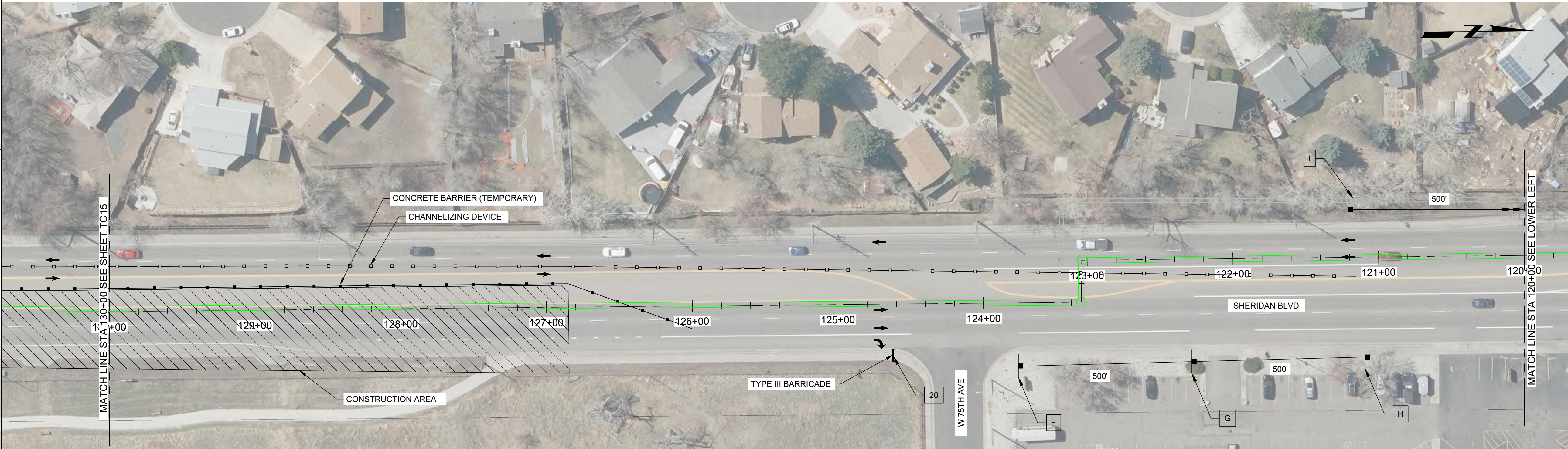


CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 4A-1

VERIFY SCALES BAR IS ONE INCH ON ORIGINAL DRAWING 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	JOB NO. 202594 DRAWING NO. TC15 SHEET NO.
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Plot Date: 11/7/2024 6:39:06 AM

LAST SAVED BY: WITH2361



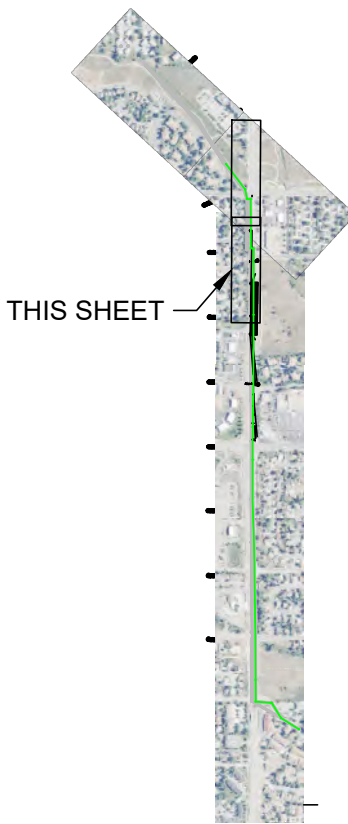
CONSTRUCTION NOTES:

1. INSTALL TEMPORARY STRIPING AS SHOWN.
2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
3. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
4. SHERIDAN BLVD EAST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD WEST SIDEWALKS.
5. SHERIDAN BLVD NB - CLOSE RIGHT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
6. SHERIDAN BLVD SB - CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
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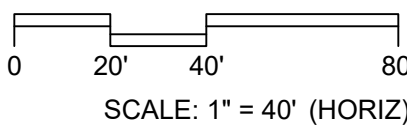
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KEY MAP



KEY MAP
NORTH

SCALE



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
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DESIGNED JSW
DRAWN WDE
CHECKED KAM
DATE OCTOBER 2024

AtkinsRéalis

CITY OF
ARVADA

CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 4A-2

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

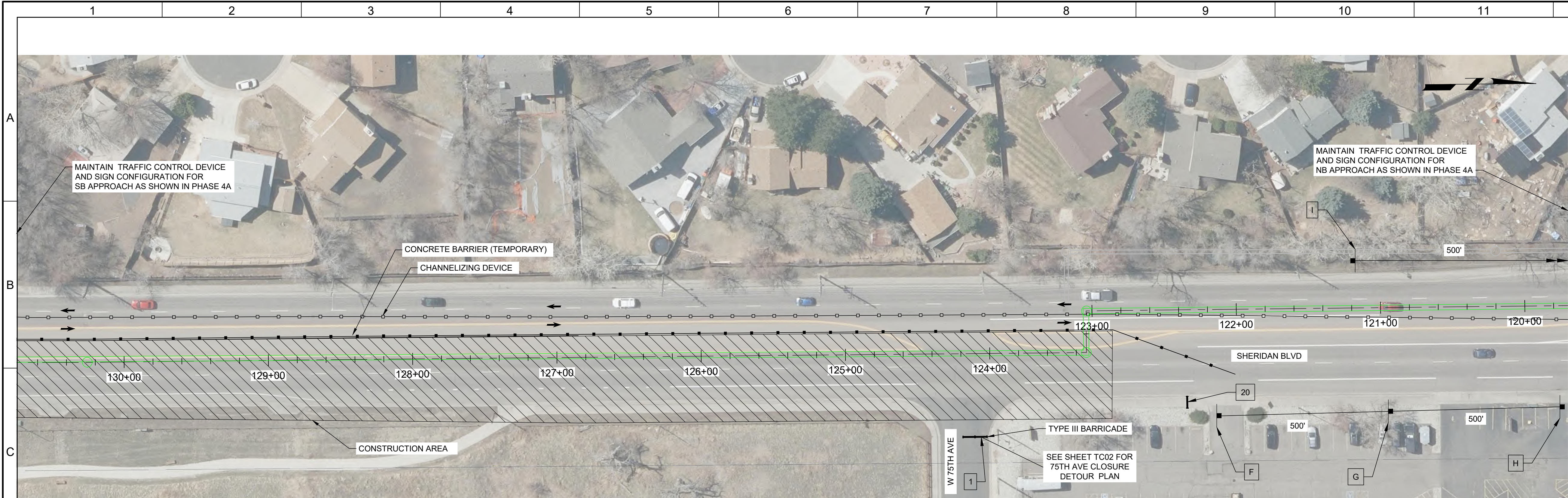
JOB NO.
202594

DRAWING NO.
TC16

SHEET NO.

Plot Date: 11/7/2024 6:39:06 AM

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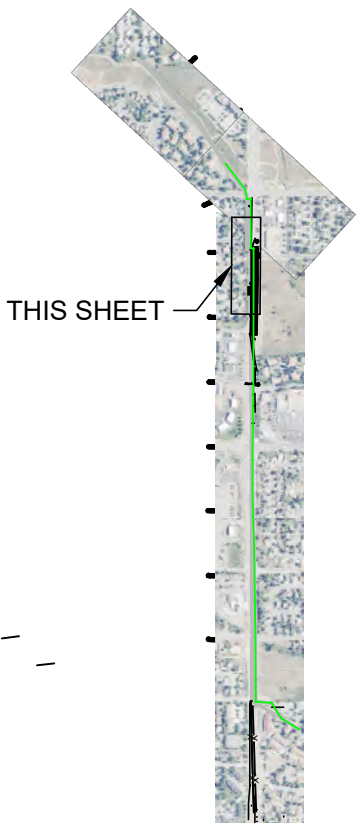


- CONSTRUCTION NOTES:
1. TRAFFIC CONTROL SET-UP FROM PHASE 4A SHALL REMAIN IN PLACE, WITH THE EXTENSION OF TRAFFIC CONTROL FOR THE CLOSURE THROUGH 75TH AVE INTERSECTION.
 2. INSTALL TEMPORARY STRIPING AS SHOWN.
 3. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
 4. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
 5. SEE SHEET TC02 FOR 75TH AVE CLOSURE DETOUR.
 6. SHERIDAN BLVD EAST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD WEST SIDEWALKS.
 7. SHERIDAN BLVD NB - CLOSE RIGHT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
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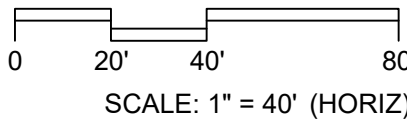


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KEY MAP



SCALE



95% DESIGN SUBMITTAL NOT FOR CONSTRUCTION			
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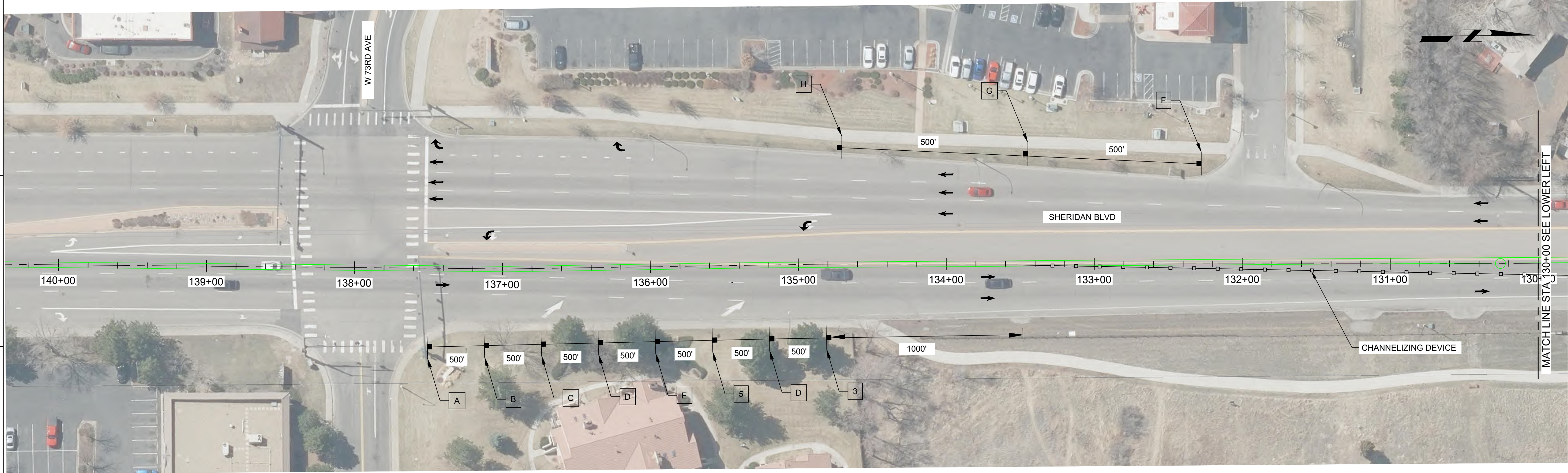


CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 4B-1

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
202594
DRAWING NO.
TC17
SHEET NO.

Plot Date: 9/16/2024 8:27:42 AM

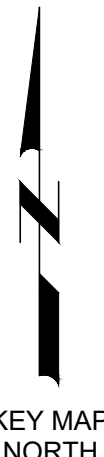
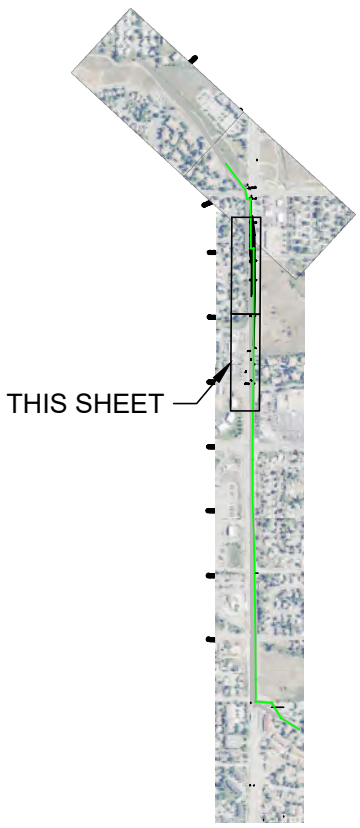


- CONSTRUCTION NOTES:
1. INSTALL TEMPORARY STRIPING AS SHOWN.
 2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
 3. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
 4. SHERIDAN BLVD EAST AND WEST SIDEWALKS OPEN DURING THIS PHASE.
 5. SHERIDAN BLVD NB – CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 6. SHERIDAN BLVD SB – CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 7. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.

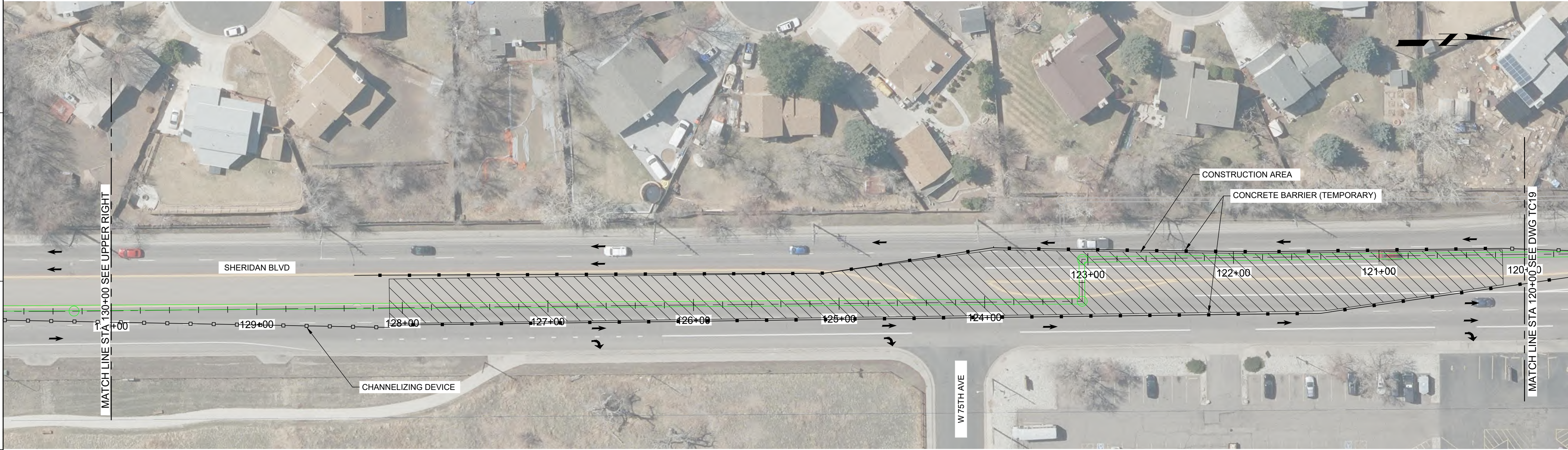
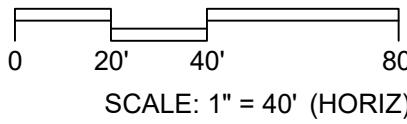


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KEY MAP



SCALE



95% DESIGN SUBMITTAL
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JSW
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WDE
CHECKED
KAM
DATE
OCTOBER 2024



CITY OF ARVADA

ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)

CIVIL
TRAFFIC CONTROL PHASE 5-1

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

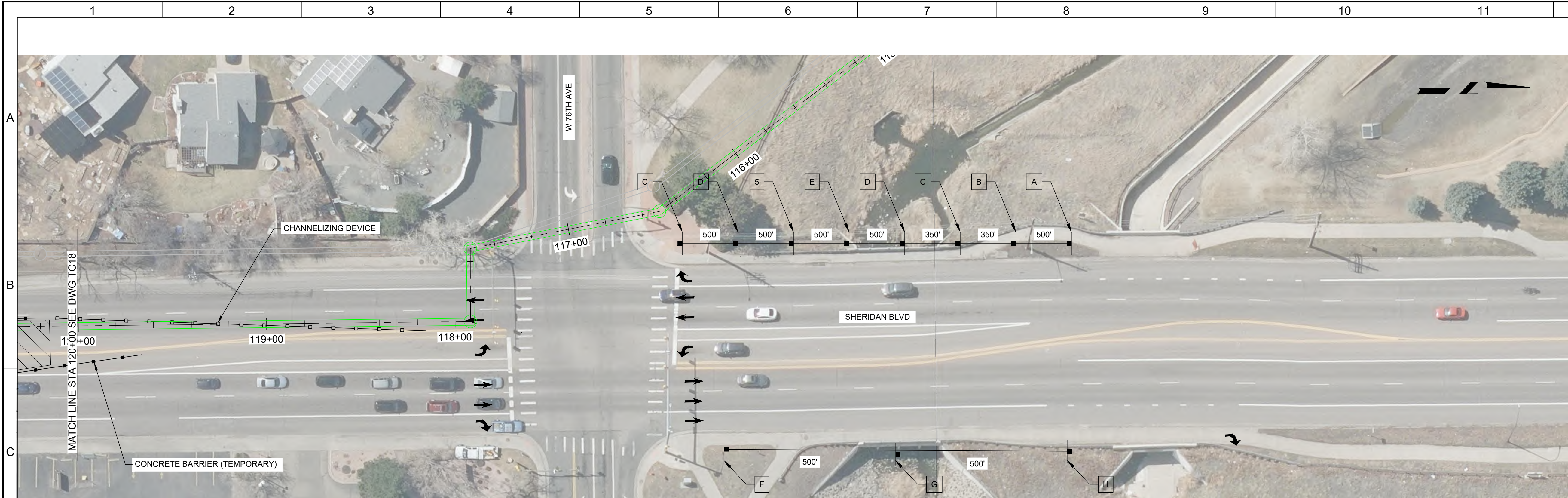
JOB NO.
202594

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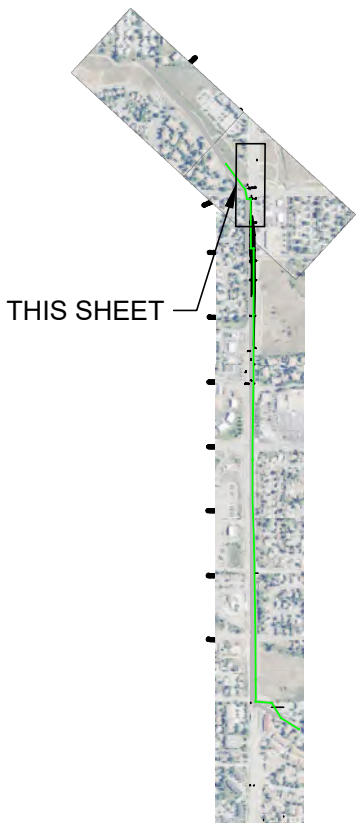
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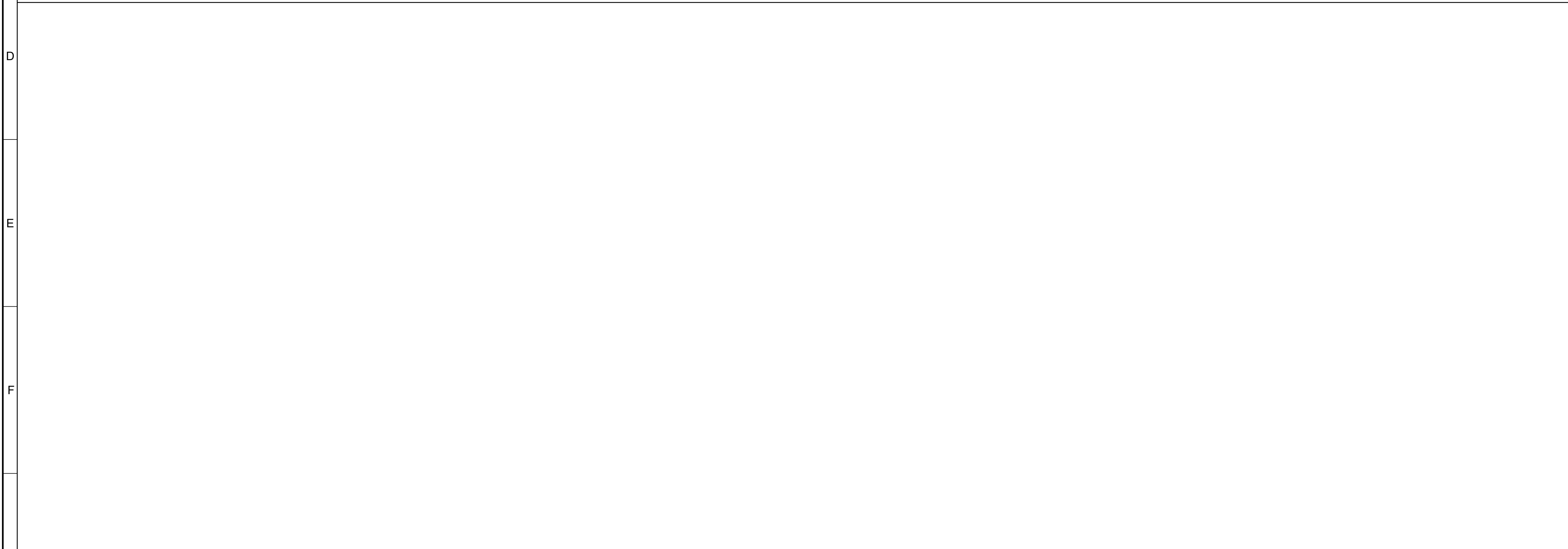
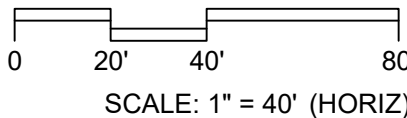
- CONSTRUCTION NOTES:
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 3. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
 4. SHERIDAN BLVD EAST AND WEST SIDEWALKS OPEN DURING THIS PHASE.
 5. SHERIDAN BLVD NB – CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
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 7. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.



KEY MAP

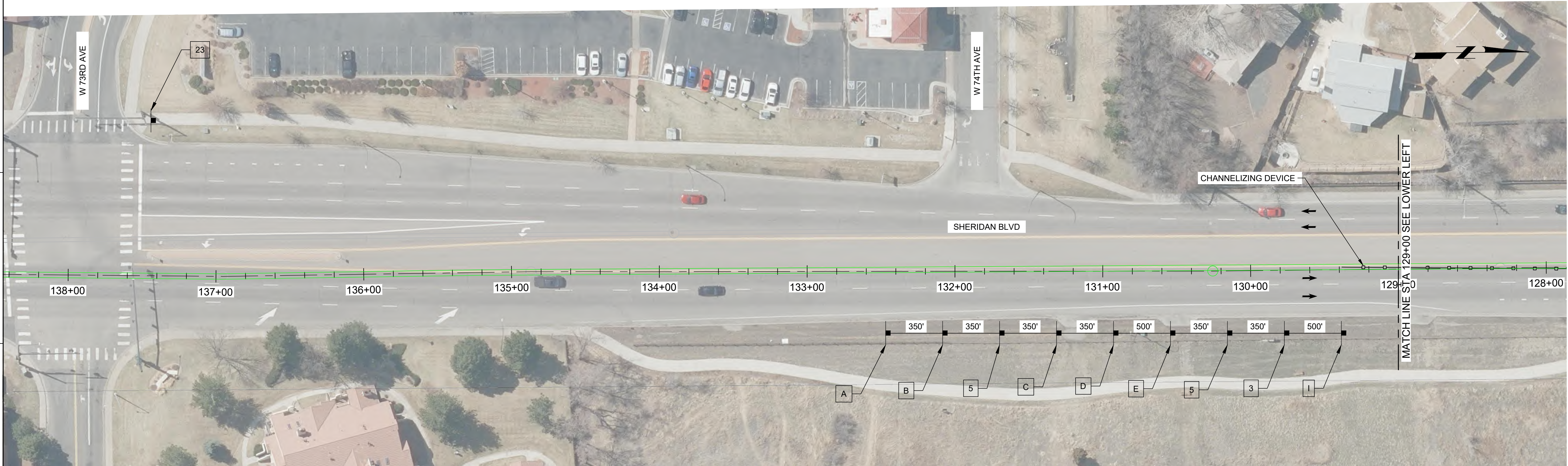


SCALE



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						DRAWN WDE										ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)			BAR IS ONE INCH ON ORIGINAL DRAWING	DRAWING NO.
						CHECKED KAM										CIVIL			0 1"	TC19
						DATE OCTOBER 2024										TRAFFIC CONTROL PHASE 5-2			IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	SHEET NO.
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Plot Date: 11/7/2024 6:39:06 AM



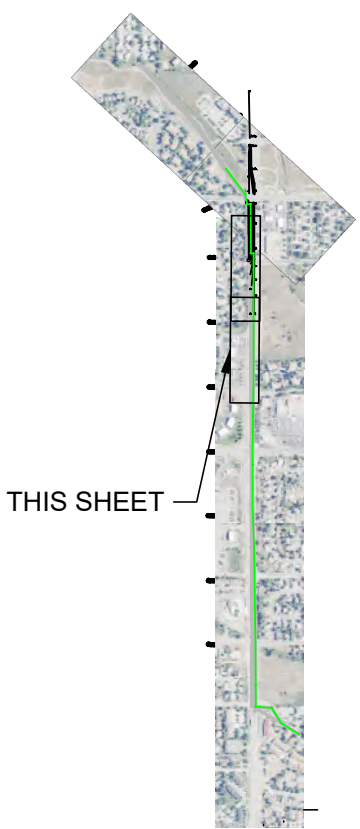
CONSTRUCTION NOTES:

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2. REMOVE EXISTING STRIPING WHERE TEMPORARY STRIPING IS SHOWN OR IS IN CONFLICT WITH TEMPORARY STRIPING.
3. MAKE TEMPORARY SIGNAL HEAD AND DETECTION ADJUSTMENTS FOR PROPOSED LANE CONFIGURATION AT 76TH AVE INTERSECTION. SIGNAL HEADS TO REMAIN IN PLACE UNLESS OTHERWISE NOTED. WHEN THIS PHASE IS COMPLETE, SIGNAL HEADS AND DETECTION MUST BE REINSTALLED IN THEIR ORIGINAL CONFIGURATION.
4. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
5. SHERIDAN BLVD WEST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD EAST SIDEWALKS.
6. SHERIDAN BLVD NB - CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
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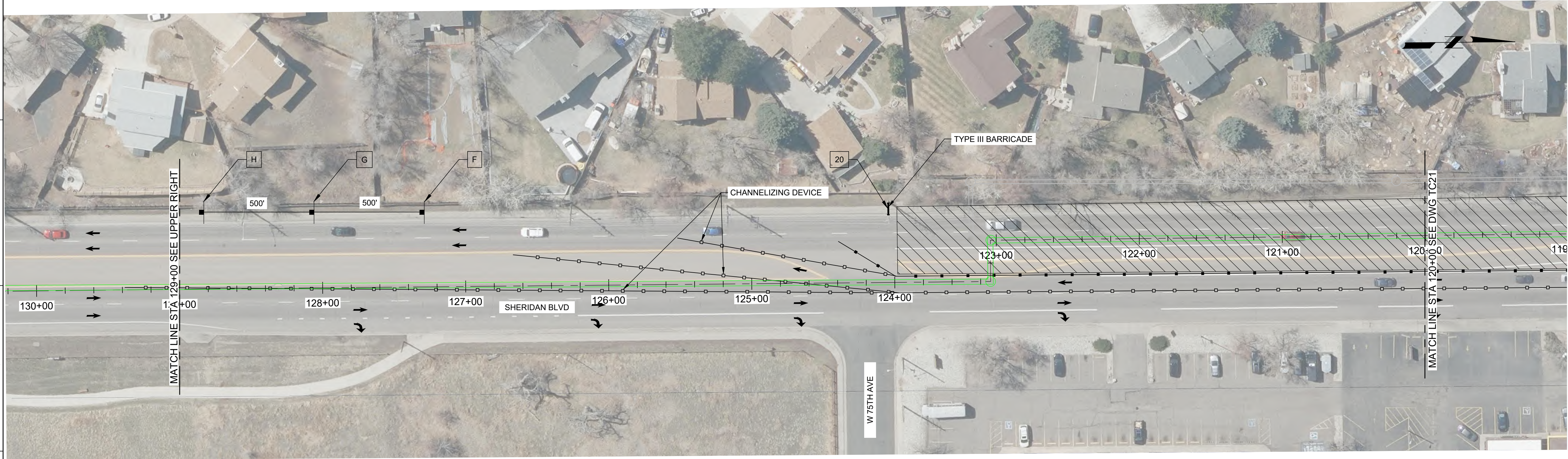
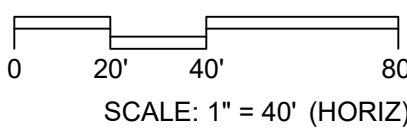
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KEY MAP



KEY MAP
NORTH

SCALE



95% DESIGN SUBMITTAL
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CHECKED
KAM
DATE
OCTOBER 2024

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CITY OF ARVADA

ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)

CIVIL
TRAFFIC CONTROL PHASE 6-1

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

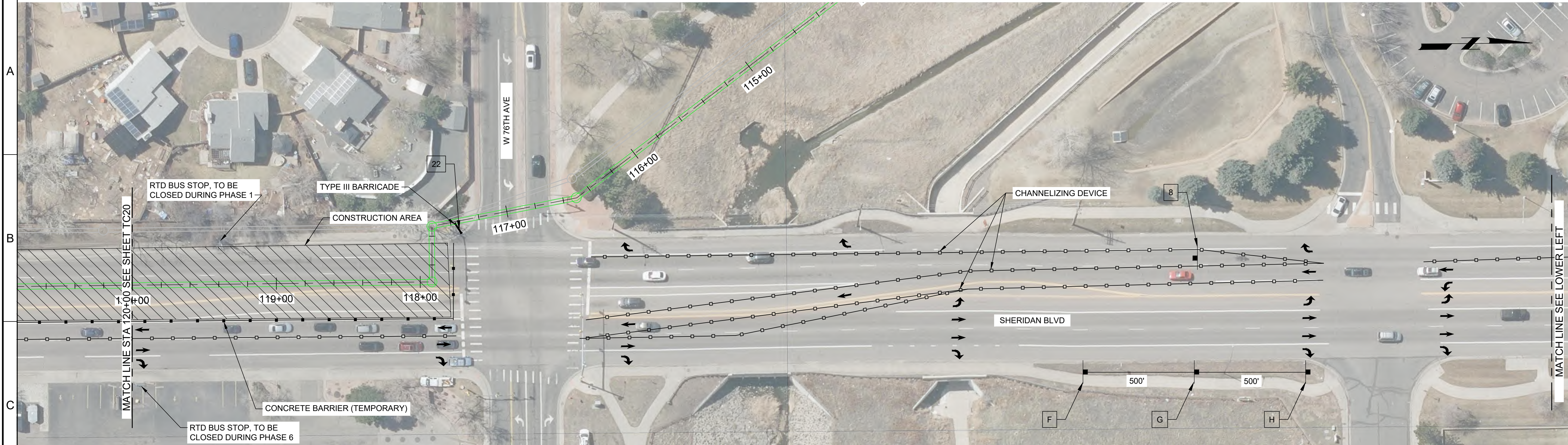
JOB NO.
202594

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TC20

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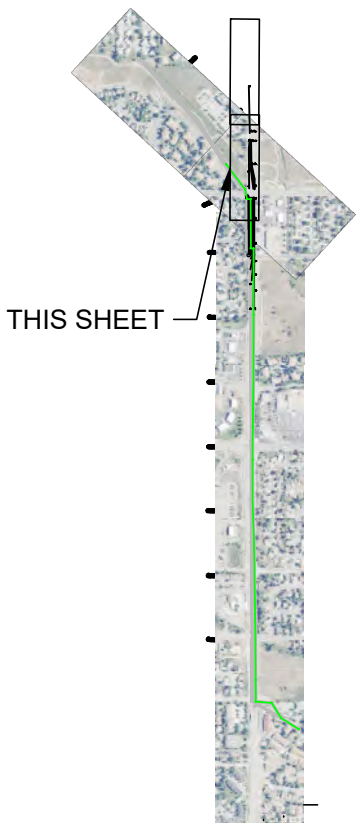
CONSTRUCTION NOTES:

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3. MAKE TEMPORARY SIGNAL HEAD AND DETECTION ADJUSTMENTS FOR PROPOSED LANE CONFIGURATION AT 76TH AVE INTERSECTION. SIGNAL HEADS TO REMAIN IN PLACE UNLESS OTHERWISE NOTED. WHEN THIS PHASE IS COMPLETE, SIGNAL HEADS AND DETECTION MUST BE REINSTALLED IN THEIR ORIGINAL CONFIGURATION.
4. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
5. SHERIDAN BLVD WEST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD EAST SIDEWALKS.
6. SHERIDAN BLVD NB - CLOSE LEFT THROUGH LANE, SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
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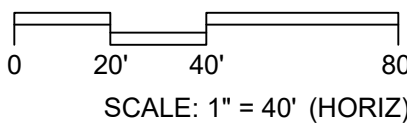
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KEY MAP



KEY MAP
NORTH

SCALE



SCALE: 1" = 40' (HORIZ)



95% DESIGN SUBMITTAL
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DATE
OCTOBER 2024

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CITY OF
ARVADA

CITY OF ARVADA

ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)

CIVIL

TRAFFIC CONTROL PHASE 6-2

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

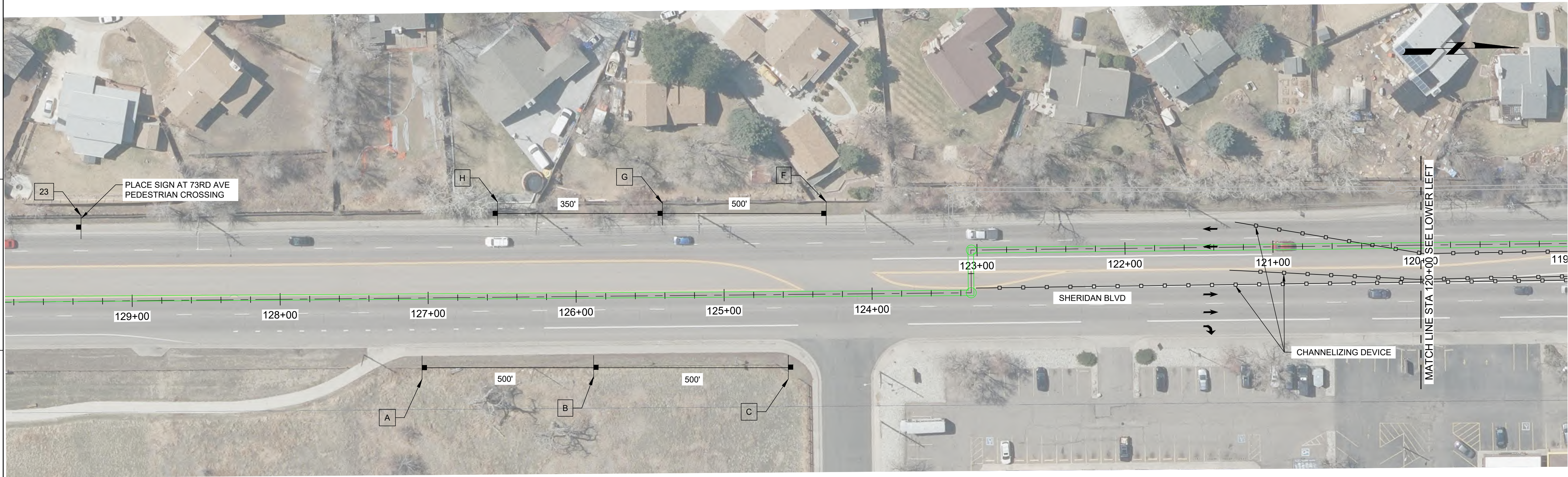
JOB NO.
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Plot Date: 11/7/2024 6:39:06 AM

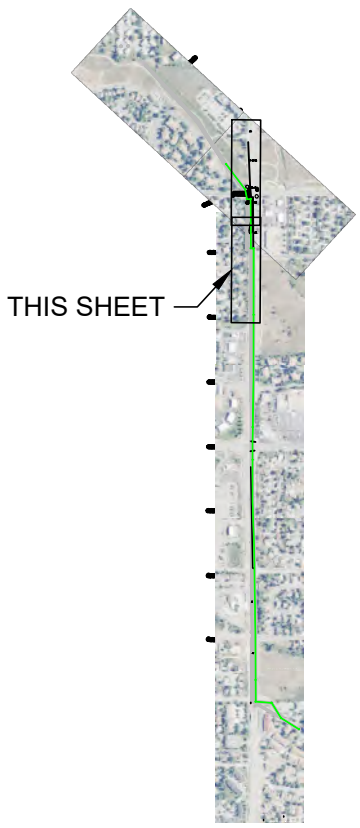


- CONSTRUCTION NOTES:
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 4. TRAFFIC SIGNAL POLE, MAST ARM, AND EQUIPMENT SHALL BE REMOVED AND RESET ON THE SOUTHWEST AND NORTHWEST CORNERS OF THE 76TH AVE INTERSECTION.
 5. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
 6. SHERIDAN BLVD WEST SIDEWALKS CLOSED DURING THIS PHASE. DETOUR PEDESTRIANS TO SHERIDAN BLVD EAST SIDEWALKS.
 7. SHERIDAN BLVD NB - MAINTAIN EXISTING CONFIGURATION.
 8. SHERIDAN BLVD SB - CLOSE RIGHT THROUGH LANE. SHIFT TRAFFIC AS SHOWN. MAINTAIN ONE THRU LANE AT CONSTRUCTION AREA.
 9. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.



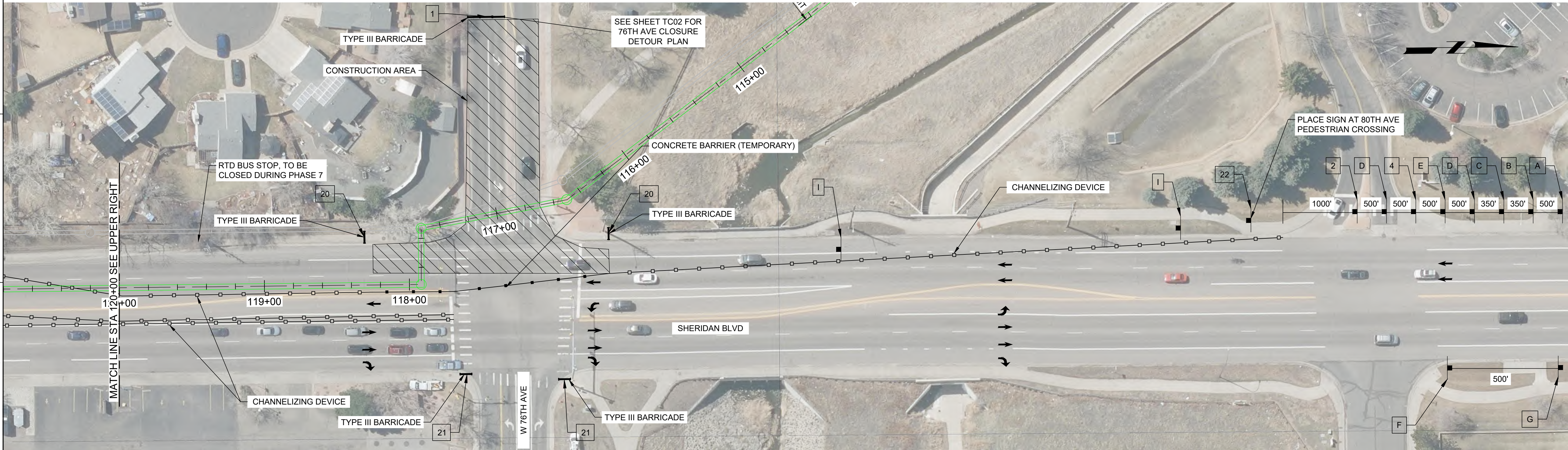
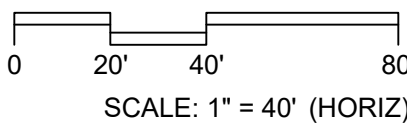
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KEY MAP



KEY MAP
NORTH

SCALE



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KAM
DATE
OCTOBER 2024

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CITY OF
ARVADA

CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 7-1

VERIFY SCALES

BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1"

IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
202594

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TC22

SHEET NO.

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Plot Date: 9/9/2024 3:36:03 PM

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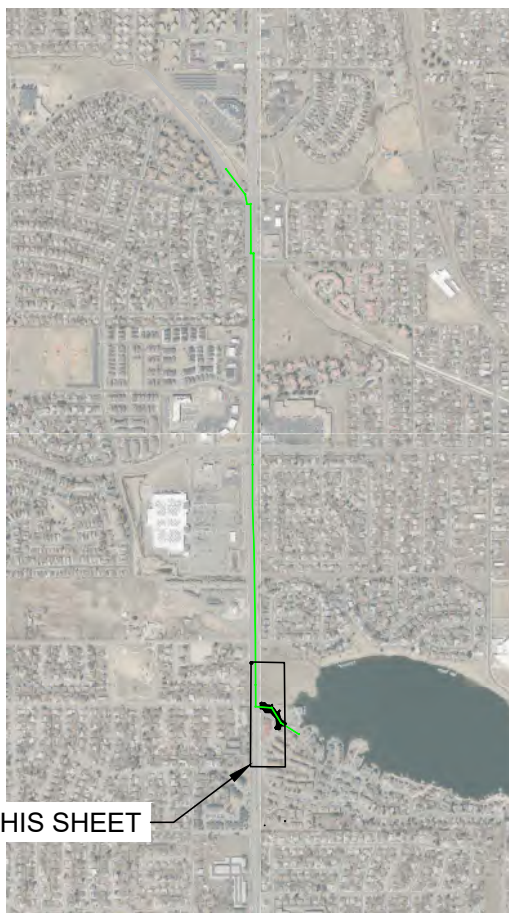
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4. PAVEMENT MARKINGS ARE SHOWN FOR INFORMATION ONLY UNLESS OTHERWISE NOTED.
5. SIDEWALKS ALONG SHERIDAN BLVD TO REMAIN OPEN DURING THIS PHASE.
6. WHEN PROJECT IS COMPLETE, STRIPING MUST BE REINSTALLED IN ITS ORIGINAL CONFIGURATION.

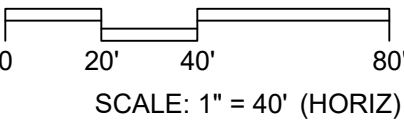


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KEY MAP



SCALE



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CITY OF ARVADA
ARVADA NORTH TRUNK SEWER IMPROVEMENTS (NTL7)
CIVIL
TRAFFIC CONTROL PHASE 8

VERIFY SCALES

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ORIGINAL DRAWING

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IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
202594

DRAWING NO.
TC23

SHEET NO.



REPORT TO CITY COUNCIL RESOLUTION

AGENDA ITEM
8.A.3.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00

Report in Brief

Amendment No. 2 to the existing design phase contract between the City of Arvada and Carollo Engineering, Inc (Carollo) for the North Trunk Sewer Improvements at Sheridan Blvd. and 76th Ave. project will increase the existing contract amount by \$1,062,921.00 to a new contract total of \$1,779,983.00.

The Arvada team recommends that the City Council approve R24125-, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00.

Financial Impact

CIP Project: 23-SR-03 NTL7 Sheridan and 76th

Financial Impact: \$1,062,921.00

This is a one-time request for Project Construction costs.

Funding Source: UT Wastewater Bond Projects (42)

CIP Account Number: 98552

Workday Account: PRJ23098552

Background

In 2022, the City of Arvada completed a Sanitary Sewer Master Plan that provided the hydraulic modeling results of the existing sanitary sewer infrastructure servicing northern Arvada. This report highlighted several areas of capacity concerns under existing and build-out conditions. NTL7 was identified as one of the four priority areas and one of the most time-sensitive portions.

The Arvada team contracted with Carollo to provide engineering design phase services beginning in October 2023. The design is now complete and the construction phase is anticipated to start in Q1 2025. As part of the construction phase services, Carollo will provide part-time construction oversight, review contractor pay applications, review submittals, manage a 3rd party CDOT inspector, and provide materials testing services to ensure that the project is constructed according to signed drawings and specifications.

Discussion

SUBJECT: R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00

PAGE: 2
ITEM: 8.A.3.

With the subject Amendment No. 2, Carollo will be contracted for construction phase engineering services for a total contract amount not to exceed \$1,779,983.00. This Amendment package includes part-time construction oversight, reviewing contractor pay applications, submittal review, managing the 3rd party CDOT inspector, and providing materials testing services. This project will be entirely funded by the Wastewater Bond Funds.

The City recommends that Resolution R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00.

Public Contact

Posting of the City Council agenda.

Commission Recommendation

N/A

Strategic Alignment

The recommended action aligns with the Infrastructure Priority Area within the City Council Strategic Plan. Specifically, the recommended action is consistent with the following work system service included in the Infrastructure Priority Area:

Provides the community with a safe, reliable high quality water supply, drainage system, and wastewater disposal services for full city build-out, as defined in the Comprehensive Plan. This includes maintaining utility rates at the lowest practical levels with accurate billing that supports replacement of aging infrastructure in order to maintain robust utility systems.

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00.

Suggested Motion:

I move that R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00, be (approved) (rejected).

Prepared by:
Matthew Amidei, Civil Engineer III

Reviewed by:

SUBJECT: R24-125, A Resolution Authorizing Amendment No. 2 to “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount from \$717,062.00 to an Amount Not to Exceed \$1,779,983.00

PAGE: 3
ITEM: 8.A.3.

Approved by:

Mary Stahl, Senior Civil Engineer	11/6/2024
Chris Lisberg, Assistant City Engineer	11/7/2024
Jacqueline Rhoades, Public Works Director	11/11/2024
Bryan Archer, Director of Finance	11/13/2024
Tammy Hedlund, Legal Specialist	11/14/2024
Jessica Morales, Assistant City Attorney	11/14/2024
Don Wick, Deputy City Manager	11/14/2024
Rachel Morris, City Attorney	11/19/2024
Linda Haley, Acting City Manager	11/20/2024

Enclosure, exhibits & attachments required to support the report

RESOLUTION NO. R24-125

A RESOLUTION AUTHORIZING AMENDMENT NO. 2 TO “AN AGREEMENT BETWEEN THE CITY OF ARVADA AND CAROLLO ENGINEERS, INC. FOR FINAL DESIGN AND CONSTRUCTION PHASE SERVICES RELATING TO THE NORTH TRUNK LINE SANITARY SEWER IMPROVEMENTS” FOR THE ADDITION OF TASK 3 – CONSTRUCTION PHASE SERVICES, AT A COST OF \$1,062,921.00, THEREBY INCREASING THE CONTRACT AMOUNT FROM \$717,062.00 TO AN AMOUNT NOT TO EXCEED \$1,779,983.00

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The Mayor or Mayor Pro Tem is authorized to sign and the City Clerk to attest, in form approved by the City Attorney, an Agreement that is in substantially the same form as that attached hereto.

Section 2. This resolution shall be effective upon its approval by the City Council.

APPROVED AND ADOPTED this 2nd day of December, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney:

BY: _____

AMENDMENT NO. 2
TO “AN AGREEMENT BETWEEN THE CITY OF ARVADA
AND CAROLLO ENGINEERS, INC. FOR FINAL DESIGN AND
CONSTRUCTION PHASE SERVICES RELATING TO THE
NORTH TRUNK LINE SANITARY SEWER IMPROVEMENTS”
FOR THE ADDITION OF TASK 3 – CONSTRUCTION PHASE
SERVICES, AT A COST OF \$1,062,921.00, THEREBY
INCREASING THE CONTRACT AMOUNT FROM \$717,062.00
TO AN AMOUNT NOT TO EXCEED \$1,779,983.00

1. **PARTIES.** The Parties to this Amendment No. 2 are the City of Arvada, a Colorado home rule municipal corporation, whose mailing address is 8101 Ralston Road, Arvada, CO 80002 (“Arvada” or the “City”) and Carollo Engineers, Inc., a Delaware Corporation located at 390 Interlocken Crescent, Suite 800, Broomfield, CO 80021 (“Consultant” or “Contractor”). The Parties may be referred to individually as a “Party” and collectively as the “Parties.”
2. **RECITALS AND PURPOSE.**
 - 2.1. Arvada required a qualified engineering consulting firm to provide final design and construction phase services for the replacement of approximately 8,000 feet of sanitary trunk sewer, as described in Arvada’s Request for Proposal Number 23-ENG-055, titled North Trunk Sewer Improvements (NTL7) – Sheridan and 76th (“Arvada’s RFP” or “RFP”).
 - 2.2. On or about October 16, 2023, after approval by the Arvada City Council, the Parties entered into an agreement for these professional engineering services, in an amount not to exceed \$598,912.00 (“Original Agreement”).
 - 2.3. On or about July 22, 2024, the Parties executed Amendment No. 1 to the Original Agreement (“Amendment No. 1”) for purposes of including additional Subsurface Utility Engineering (SUE) Quality Level (QL) A and Geotechnical services. The cost of Amendment No. 1 was \$118,150.00, thereby increasing the contract amount from \$598,912.00 to an amount not to exceed \$717,062.00 for all services.
 - 2.4. For the convenience of the Parties, (due to the voluminous nature of the Original Agreement and Amendment No. 1), the Original Agreement and Amendment No. 1 are not attached hereto but are incorporated herein by reference.
 - 2.5. As detailed in **Exhibit A** to the Original Agreement, Task 3 – Construction Phase Services, is an optional phase, to be completed if determined necessary by Arvada.
 - 2.6. The purpose of this Amendment No. 2 to the Original Agreement (“Amendment No. 2”) is for the addition of Task 3 – Construction Phase Services. The cost of this Amendment No. 2 is **\$1,062,921.00**, thereby increasing the contract amount from \$717,062.00 to an amount not to exceed **\$1,779,983.00** for all services.

3. CONTRACT DOCUMENTS AND EXHIBITS.

- 3.1. Contract Documents. The Contract Documents shall consist of this Amendment No. 2, Amendment No. 1, and the Original Agreement, together with the following:

Exhibit D: Consultant's November 14, 2024, Scope of Work and Fee for Task 3 - Construction Phase Services.

All exhibits referred to in this Amendment No. 2 are attached hereto and are, by reference, incorporated herein for all purposes. In the event any matter, term, provision, or condition that is the subject of this Agreement requires clarification or is in dispute, or is the subject of a difference of opinion, the purpose and intent of the Original Agreement, Amendment No. 1, and Amendment No. 2 shall be first ascertained by reference to the Contract Documents in their entirety. In the event of any dispute or differences between the respective documents that constitute the Contract Documents, then Consultant shall secure the written instructions from Arvada before proceeding with the performance of the services affected by such conflicts, omissions, or discrepancies.

- 4. SCOPE OF SERVICES.** The Scope of Services are expanded to include Task 3 – Construction Phase Services, as further detailed in **Exhibit D** to this Amendment No. 2, and the Original Agreement.

5. AMENDMENT TO SECTION 6, COMPENSATION, OF THE ORIGINAL AGREEMENT.

- 5.1. Section 6.1. of the Original Agreement is amended, as follows, to include Task 3 – Construction Phase Services:

“6.1. Payment. Arvada shall pay Consultant for the Work requested by Arvada and rendered by Consultant under this Agreement in an amount not to exceed **\$1,779,983.00** for all services.”

- 6. FULL FORCE AND EFFECT.** All other terms and conditions shall be as set forth in the Original Agreement and Amendment No. 1.

- 7. BINDING AUTHORITY.** Consultant represents and affirms that the signature page hereof accurately states the full legal name of Consultant (whether as a corporation, partnership, limited liability company, sole proprietorship, or other), contains all requisite signature(s) on behalf of Consultant, and in all other respects is effective to bind Consultant, in accordance with all applicable statutes, regulations, resolutions, rules, bylaws, agreements, or similar sources of authority or limitation. This Agreement may be executed in counterpart(s), each of which shall be deemed to be an original, and all of which, taken together, shall constitute one instrument.

DATED this _____ day of _____, 2024.

CITY OF ARVADA, a Colorado home
rule municipal corporation

Lauren Simpson
Mayor
8101 Ralston Road
Arvada, CO 80002

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney

By: _____

CAROLLO ENGINEERS, INC., a Delaware
Corporation

Kim Zulliger
Client Services Manager/Associate Vice
President
390 Interlocken Crescent, Suite 800
Broomfield, CO 80021
kzulliger@carollo.com

Exhibit D

Amendment No. 2

To “An Agreement Between the City of Arvada and Carollo Engineers, Inc. for Final Design and Construction Phase Services Relating to the North Trunk Line Sanitary Sewer Improvements” for the Addition of Task 3 – Construction Phase Services, at a Cost of \$1,062,921.00, Thereby Increasing the Contract Amount From \$717,062.00 to an Amount not to Exceed \$1,779,983.00



November 14, 2024

Matt Amidei, PE
Civil Engineer
City of Arvada – Public Works Utility Engineering
8101 Ralston Rd
Arvada, CO 80002

Subject: Scope and Fee for North Trunk Line Sanitary Sewer Improvements (NTL7) Engineering Services
During Construction

Dear Mr. Amidei:

Please find below the scope of services for the North Trunk Line Sewer Improvements (NTL7) Engineering Services During Construction.

Task Series 300 – Construction Phase Services

Task 301 – Pre-Construction Kickoff Meeting

- Attend the pre-construction kickoff meeting for the project.

Assumptions:

- » 3 people from the design team will attend.
- » The pre-construction meeting will last 4 hours, including travel time.
- » The pre-construction meeting will be held at the Arvada Town Hall.
- » 1 hour for meeting minutes.

Deliverables:

- » Meeting minutes.

Task 302 –Weekly Construction Meetings

- Attend the weekly construction progress meeting virtually (unless it coincides with a site visit).

Assumptions:

- » 2 people from the design team will attend once per week for 10 months each.
- » Each meeting will last 1 hour plus 1 hour for meeting minutes.

Deliverables:

- » Meeting minutes.

Page 2

Task 303 – Monthly Invoice and Progress Report

- Review the monthly invoice and complete the associated progress report

Assumptions:

- » 3 hours per month for 10 months.

Deliverables:

- » Invoice and progress report.

Task 304 – Permitting & Public Outreach Assistance and Stakeholder Coordination

- Assist with permitting, public outreach, and stakeholder coordination.

Assumptions:

- » N/A

Deliverables:

- » N/A

Task 305 – Review of Contractor Submittals

- Provide review of up to 88 contractor submittals for the project, of which half require a resubmittal.

Assumptions:

- » Up to 4 hours for each submittal
- » Up to 2 hours for each resubmittal.
- » 88 total submittals. Less if more than one item is combined in one submittal.

Deliverables:

- » Submittal reviews posted to an electronic construction management platform such as Procore.

Task 306 – Response to RFIs

- Provide review of up to 80 construction RFIs for the project.

Assumptions:

- » Up to 4 hours for each RFI review and response.
- » 80 total RFIs.

Deliverables:

- » RFI responses posted to an electronic construction management platform such as Procore.
- 

Page 3

Task 307 – Change Order Consultation

- Provide review and supporting documents to issue up to 5 Change Orders for the project.

Assumptions:

- » Up to 32 hours for each change order review and response.
- » 5 total Change Orders.

Deliverables:

- » Change Order supporting documents to be posted to an electronic construction management platform such as Procore.

Task 308 – Prepare Record Drawings

- Create a set of Record Drawings for the project that includes changes and modifications that occurred to the project during construction for the pipeline (20 drawings).

Assumptions:

- » Changes will be tracked by the contractor on a set of plans.
- » Record drawings will be based on the contractor's set of marked up plans.

Deliverables:

- » A set of Record Drawings (20 drawings).

Task 309 – Additional Engineering Tasks

- Update the risk register monthly.
- Review Pay Applications.

Assumptions:

- » 2 people coordinating for 2 hours a month on the risk register updates.
- » 4 hours per month to review pay applications.

Deliverables:

- » Provide updated Risk Register.
- » Provide comments on the pay applications.

Task 310 – Weekly Site Visits

- Make a site visit once a week during the construction phase of the project.

Assumptions:

- » 3 hours per site visit including travel time.
- » 1 hour for a report from the site visit.

Deliverables:

- » Site visit reports.
- 

Page 4

Task 311 – Box Culvert Structural Design and Coordination

- Provide the structural design for the portion of the existing box culvert that will be cut and then replaced with a cast-in-place section at 69th Ave and Sheridan.
- Coordinate with CDOT on the requirements.

Assumptions:

- » Comments from CDOT will be minor.
- » Design is completed as a PDF.

Deliverables:

- » Stamped structural design for the box culvert replacement section.

Task 312 – Storm Designs (68th & 69th Ave)

- Complete redesign of the stormwater lines that conflict with the new sewer line at 68th Ave and near 69th Ave.

Assumptions:

- » Stormwater redesign is only required for the single line in conflict.
- » Line can be adjusted to match current line capacity.
- » Stormwater analysis is not required.

Deliverables:

- » Stormwater redesign plan information.

Task 313 – Survey Secondary Control

- Set a secondary control point due to one of the city's control points being inaccessible.

Assumptions:

- » N/A

Deliverables:

- » N/A

Task 314 – SBAR and Coordination

- Coordinate with CDOT and team on SBAR requirements and complete the reports.

Assumptions:

- » 2 SBARs are needed for the project.

Deliverables:

- » Two SBAR reports.
- 

Page 5

Task 315 – Additional Pipeline & Vault Design for North End

- Provide sanitary sewer design for the north end of the project to get out of the Westminster Open Space area.
- Provide a structural design for a new vault with 5 sewer inverts.

Assumptions:

- » One additional plan and profile sheet and a one vault detail sheet.
- » Connecting pipe sizes and inverts will be provided by the City.

Deliverables:

- » Additional plan and profile sheet and a structural design sheet for the vault design.

Task 316 – Intersection Design and Coordination

- Design of the intersection traffic lights and ramps to current CDOT and ADA standards at 76th Ave and Sheridan.
- Additional survey for the intersection.

Assumptions:

- » Includes additional survey of the area to aid in the design.
- » No storm evaluation or changes will be required.
- » No electrical upgrades will be required.
- » Just the west side of the intersection where construction is occurring will require upgrades.

Deliverables:

- » 76th Ave and Sheridan intersection design package.

Task 317 – Tunnel Design

- Tunnel design and specifications for 72nd Ave.

Assumptions:

- » Just basic specifications and design with casing pipe requirements will be provided.

Deliverables:

- » Tunnel design plans and specification.



Matt Amidei
Civil Engineer
City of Arvada – Public Works Utility Engineering
November 14, 2024

Page 6

Task 318 – Materials Testing Allowance

- Provide materials testing as quality assurance on the project.

Assumptions:

- » Includes full-time to part-time, as-scheduled basis, for earthwork, cast-in-place concrete, and asphalt observation and testing.
- » Includes 2 hours per week for Carollo coordination and report review.

Deliverables:

- » Test results from the materials testing.

Task 319 – CDOT Inspections

- Provide full-time inspections as required by CDOT.

Assumptions:

- » Includes full-time inspections as required by CDOT to determine CDOT standards are met.
- » Includes 2 hours per week for Carollo coordination and report review.

Deliverables:

- » Inspection reports.

Sincerely,
CAROLLO ENGINEERS, INC.



Kim Zulliger, PE
Client Services Manager, Associate Vice President

Attachments: Fee Proposal



City of Arvada
North Trunk Line (NTL7) Project
Engineering Services During Construction Fee Estimate

10/31/2024

	Team Member	Senior Technical Advisor	Project Manager/ Senior Professional	Lead Project Professional	Project Professional	Senior Technician	Document Processing/ Clerical	Carollo Hours	Carollo Labor Cost	Sub Consultants	Carollo ODCs	Total Engineering Cost
	2025 Fee Schedule	\$ 287	\$ 276	\$ 256	\$ 223	\$ 179	\$ 124					
		J. Kriss/M. Keller	K. Zulliger/B. Giles	B. Falk	C. Husted/E. Sbabo							
Task	Description	\$ 287	\$ 276	\$ 256	\$ 223	\$ 179	\$ 124					
300	Construction Phase Services (10 months)											
301	Pre-construction Kickoff Meeting (4 hr meeting, 1 hr minutes)	4	4	0	5	0	0	13	\$ 3,367	\$0	\$ 25	\$ 3,392
302	Weekly Progress Meetings (1 hr ea w/ 2ppl, 1 hr ea minutes, virtual unless coincides w/ site visit)	20	60	0	60	0	0	140	\$ 35,680	\$0		\$ 35,680
303	Monthly Invoice & Progress Report (3 hr ea)	0	10	0	20	0	0	30	\$ 7,220	\$0		\$ 7,220
304	Permitting & Public Outreach Assistance and Stakeholder Coordination	4	80	0	80	0	0	164	\$ 41,068	\$0	\$ 100	\$ 41,168
305	Review of Contractor Submittals (88 submittals 4 hr ea, half resubmittal 2 hr ea)	24	192	6	218	0	0	440	\$ 110,030	\$0		\$ 110,030
306	Responses to RFIs (80 RFIs) 4 hr ea	40	96	8	176	0	0	320	\$ 79,272	\$0		\$ 79,272
307	Change Orders (5 changes) 32 hr ea	20	40	8	92	0	0	160	\$ 39,344	\$0		\$ 39,344
308	Prepare Record Drawings (20 drawings)	2	8	0	80	24	24	138	\$ 27,894	\$0		\$ 27,894
309	Additional Engineering Tasks (monthly risk register updates 2 hr ea w/ 2 ppl, pay app review 4 hr ea)	0	40	0	40	0	0	80	\$ 19,960	\$0		\$ 19,960
310	Weekly Site Visits (3 hr ea, 1 hr ea report)	40	40	4	76	0	0	160	\$ 40,492	\$0	\$ 1,000	\$ 41,492
311	Box Culvert Structural Design and Coordination	4	4	0	24	0	0	32	\$ 7,604	\$0		\$ 7,604
312	Storm Designs (68th & 69th Ave)	4	12	4	36	0	0	56	\$ 13,512	\$0		\$ 13,512
313	Survey - Secondary Control	0	4	0	2	0	0	6	\$ 1,550	\$4,400		\$ 5,950
314	SBAR & Coordination	0	24	0	24	0	0	48	\$ 11,976	\$0		\$ 11,976
315	Additional Pipeline & Vault Design for North End	6	16	0	64	24	0	110	\$ 24,706	\$0	\$ 25	\$ 24,731
316	Intersection Design and Coordination (Includes Additional Survey of Intersection)	4	16	0	16	0	0	36	\$ 9,132	\$120,000		\$ 129,132
317	Tunnel Design	4	16	0	16	0	0	36	\$ 9,132	\$20,000		\$ 29,132
318	Materials Testing (2 hr/week Carollo coordination, report review)	4	40	0	36	0	0	80	\$ 20,216	\$115,000		\$ 135,216
319	CDOT Inspections (2 hr/week Carollo coordination, report review)	4	40	0	36	0	0	80	\$ 20,216	\$280,000		\$ 300,216
	Subtotal Task 300 Hours	184	742	30	1101	48	24	2,129				
	Subtotal Task 300 Costs	\$ 52,808	\$ 204,792	\$ 7,680	\$ 245,523	\$ 8,592	\$ 2,976		\$ 522,371	\$539,400	\$ 1,150	\$ 1,062,921



REPORT TO CITY COUNCIL RESOLUTION

AGENDA ITEM
8.B.1.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada (Presenter: Jessica Garner, Director of CED)

Report in Brief

As part of the FY 2025 budget process, the City Council provided support to the BID by allocating matching funds of \$93,000 to create a total BID operating budget for 2025 of approximately \$258,000. In addition to the \$93,000, the City, through a separate agreement, provides a not to exceed amount of \$50,000 for leaf and snow removal for the 2024/2025 winter season.

This Agreement summarizes the business relationship between the City and the BID. The Agreement is for one year, which will allow the City to evaluate the BID's performance prior to considering an allocation for 2026. City funds will be used by the BID to support public programs and services, including enhanced maintenance, public safety, and event support. City services are defined by the Arvada Services document.

The BID will present a status update in July and an annual report in December to the City Manager in order to continuously evaluate the services provided through the Agreement. The Arvada team believes that the Agreement provides the foundation for a successful, collaborative and productive implementation of the Business Improvement District for Olde Town, a stated objective of the City and the Olde Town area for many years.

The Arvada team recommends that the City Council approve R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada.

Financial Impact

The City's allocation to the BID in 2025 will be \$93,000.00 This amount was approved in the 2025 operating budget.

Background

On November 4, 2014, as part of the general election, business and property owners voted 49-14 to approve the the establishment of the BID and to authorize the mill levy. The City Council subsequently approved the first Memorandum of Agreement with the Olde Town BID in early 2015 and have annually approved such agreements each year.

Discussion

Attached is the Agreement that outlines the terms and conditions which will continue the cooperative relationship between the City and the Olde Town BID. Through this Agreement the City and BID believe that improved coordination will help focus mutual efforts, provide accountability of how public dollars are utilized, establish clear communication, clarify roles and responsibilities and support the entire community by fostering Olde Town Arvada's ongoing economic vitality.

As in previous years, City team members will continue to work closely with the BID Board to address opportunities, concerns and issues associated with Olde Town and to support effective governance. The City's Baseline Services, which is also attached, is provided to the BID. These services include economic development support such as grants to support infrastructure, park and landscape maintenance of common areas and gathering spaces, site amenities such as benches and bike racks, snow

removal of the plaza area and basic patrol services to maintain public safety. Some services will be scaled back due to City resource limitations. The City team will continue working with the BID to help resolve any service gaps. City team members, including the City Manager, Deputy City Manager, Community and Economic Development Director and Police Commanders will meet periodically with BID representatives.

The 2025 BID Operating Plan and 2025 BID Budget are also attached. The Plan includes goals, ideas and direction that support the mission and vision of the BID Board and the funding sources and expenditures to implement that vision.

Public Contact

Posting of the City Council agenda and notification to the Olde Town BID Board of Directors.

Commission Recommendation

The Olde Town BID Board of Directors collaborated with the City team to develop the Agreement and support the recommendation presented herein.

Strategic Alignment

The recommended action aligns with the Community and Economic Development and Vibrant Community and Neighborhoods Priority Areas of the City Council Strategic Plan.

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada.

Suggested Motion:

I move that R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada, be (approved) (rejected).

Prepared by:

Josie Suk, Development Systems and Administrative Manager

Reviewed by:

Approved by:

Jessica Garner, Director of Community and Economic Development	10/29/2024
Gail Walker, Legal Specialist-Contracts	11/4/2024
Emily Grogg, Senior Assistant City Attorney	11/5/2024
Rachel Morris, City Attorney	11/19/2024
Linda Haley, Acting City Manager	11/19/2024

SUBJECT: R24-126, A Resolution Authorizing an Agreement between the City of Arvada and the Olde Town Arvada Business Improvement District for the Fiscal Year 2025 Programs and Services in Olde Town Arvada (Presenter: Jessica Garner, Director of CED)

PAGE: 3
ITEM: 8.B.1.

Enclosure, exhibits & attachments required to support the report

RESOLUTION NO. R24-126

A RESOLUTION AUTHORIZING AN AGREEMENT BETWEEN THE CITY OF
ARVADA AND THE OLDE TOWN ARVADA BUSINESS IMPROVEMENT DISTRICT
FOR THE FISCAL YEAR 2025 PROGRAMS AND SERVICES IN OLDE TOWN
ARVADA

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The Mayor or Mayor Pro Tem is authorized to sign and the City Clerk to attest, in form approved by the City Attorney, an Agreement, which is in substantially the same form as that attached hereto, by and between the City of Arvada and the Olde Town Arvada Business Improvement District.

Section 2. This resolution shall be effective upon its approval by the City Council.

APPROVED AND ADOPTED this 2nd day of December, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney

By: _____

**AGREEMENT BETWEEN THE CITY OF ARVADA AND THE OLDE TOWN
ARVADA BUSINESS IMPROVEMENT DISTRICT FOR THE FISCAL YEAR
2025 PROGRAMS AND SERVICES IN OLDE TOWN ARVADA**

1.0 PARTIES. The parties to this Agreement are the City of Arvada, a Colorado home rule municipal corporation ("Arvada") and the Olde Town Arvada Business Improvement District ("BID").

2.0 RECITALS AND PURPOSE.

2.1 Both Arvada and the BID acknowledge that a cooperative relationship is mutually beneficial to each organization and in the best interest of Arvada residents and Historic Olde Town Business and Property owners; and

2.2 Both Arvada and the BID believe that improved coordination will help focus mutual efforts, provide accountability of how public dollars are utilized, establish clear communication, clarify roles and responsibilities, and benefit the entire community while fostering Olde Town Arvada's ongoing economic vitality.

3.0 TERM. This Agreement shall be effective January 1, 2025 to December 31, 2025.

4.0 EXHIBITS. This Agreement shall include the following:

Exhibit A: The BID's Operating Plan;

Exhibit B: The BID's Fiscal Year 2025 Budget; and

Exhibit C: Arvada's Baseline Services.

5.0 ROLES AND RESPONSIBILITIES.

5.1. The BID agrees to:

5.1.1. Provide those programs and services identified in Exhibit A, "Operating Plan".

5.1.2. Acknowledge the partnership between Arvada and the BID, including noting the support of Arvada on advertising, and promotional literature.

5.1.3. The BID's Executive Director shall communicate directly with the City Manager or his or her designee regarding programs, service delivery, and cooperative opportunities and will facilitate regular communications with the City Council.

5.1.4. Permit Arvada the right and ability to review financial records upon request from Arvada including, but not limited to monthly financial transaction reports and auditing of financial statements.

5.2. In addition to the funding identified in Paragraph 6.0, Arvada agrees to:

5.2.1 Designate one staff member to work with the BID Board to help ensure ongoing communication and program implementation.

5.2.2. Acknowledge the partnership between Arvada and the BID on Arvada's website and The Arvada Report.

5.2.3. Continue those baseline services now provided to the Olde Town as described in Exhibit C.

5.2.4. The City Manager or his or her designee shall communicate directly with the BID's Executive Director regarding programs, service delivery and cooperative opportunities.

6.0 BUDGET. Arvada agrees to provide \$93,000 for fiscal year 2025 to support the operation of the BID with the primary use of Arvada funds on public programs and services, such as enhanced maintenance, public safety, and event support as outlined in Exhibit B.

7.0 INSTALLMENT PAYMENTS. The BID will invoice Arvada in January for the first half of monies for the fiscal calendar year and on a quarterly basis thereafter for the total funding identified in Paragraph 6.0. Upon receipt of an invoice, Arvada shall have 30 days to render payment to the BID. The BID shall expend Arvada contributed funds on public programs and services as outlined in the Operating Plan and Fiscal Year 2025 budget (Exhibit A and B respectively). The BID shall provide a semi-annual status update and annual report summarizing all activities, events, programs, and significant accomplishments to the City Manager in July and December.

8.0 TERMINATION. Either party may, with 60 days written notice to the other party, terminate this contract. If the contract is terminated, the BID shall submit a final budget report within 45 days of receipt/submittal of such written notice detailing all funds received and expended to date. In the event there are unexpended funds remaining, the BID shall return such funds to Arvada. Termination of this contract shall not imply lack of support or affect other cooperative efforts by and between both parties.

9.0 AMENDMENT. Either party may seek to amend this Agreement including the Work Plan and budget by providing a written request detailing the terms of the

requested amendment. Both Arvada and the BID must approve any amendment for the amendment to take effect.

DATED THIS _____ day of _____, 2024.

CITY OF ARVADA

Lauren Simpson, Mayor

Attest:

City Clerk

Approved as to Form:

Rachel A. Morris, City Attorney

By: _____

OLDE TOWN ARVADA
BUSINESS IMPROVEMENT
DISTRICT

Joe Hengstler, Executive Director
director@oldetownarvada.org

EXHIBIT A
AGREEMENT BETWEEN THE CITY OF ARVADA AND THE OLDE TOWN
ARVADA BUSINESS IMPROVEMENT DISTRICT FOR THE FISCAL YEAR 2025
PROGRAMS AND SERVICES IN OLDE TOWN ARVADA

Olde Town Arvada BID 2025 Operating Plan

Name: Olde Town Arvada Business Improvement District (BID).

Legal Authority: A BID in Colorado is organized pursuant to the Business Improvement District Act, Section 31-25-1201 et seq.,

BID Boundaries: The BID area encompasses generally the commercial property in the area from the south side of Ralston Road on the north, Grandview Avenue on the south, Yukon on the west and Teller on the east, encompassing the Olde Town core, and allowing for future expansion south of Grandview Avenue and/or north of Ralston Road when the opportunity to do so arises. Personal property is not included in the BID boundary.

City Services: BID services are designed to supplement existing City services and will be in addition to City services that are currently provided in Olde Town.

Operating Plan: This plan includes goals, ideas and direction that support the mission and visions of the BID Board. The plan shall subside and flow throughout the year and into the future as funding and priorities evolve. In no order, the plan includes and may not be limited to the following:

MARKETING - To create, partner and implement unique strategies that draw people from near and far to enjoy and patronize Olde Town Arvada through programs such as:

- Continued refinement and implementation comprehensive marketing plan.
- Host events and support partners' events and festivals.
- Increase social media engagement.
- Consistently provide monthly E-Newsletter to Merchants and/or public on current and up & coming information.
- Continue to market the district wide gift card program.
- Partnership with the Visitors Center and other strategic partners to promote Olde Town as a destination for visitors.
- Utilize board members and staff to engage new and existing businesses and owners to educate and promote the BID's efforts and projects.
- Identify and pursue other marketing opportunities as they arise throughout the year.

PLACEMAKING - To emphasize an attractive, historic, and engaging Olde Town through physical, interactive, and branding enhancements through programs such as:

- Continue to be an active participant in the implementation of the Olde Town Strategic Reinvestment Plan
- Creative public art opportunities and/or installations.
- Directional wayfinding and directories.
- Identify ways to enhance public spaces in the District.

- Continue to pursue partnerships with the City to enhance public spaces.
- Other vitality initiatives as appropriate.

PHYSICAL IMPROVEMENTS & ENHANCED MAINTENANCE - To create an attractive and appealing environment while maintaining the District's unique character and ambiance through programs and partnership such as:

- Streetscape and public space improvements.
- Power washing sidewalks.
- Other initiatives as appropriate.

ADVOCACY - To advocate for all aspects of a culturally and economically vibrant Olde Town through areas such as:

- Unified district voice.
- Advancing policies.
- Executive staffing oversight of operational advocacy and program management of increased partnerships and opportunities to promote the heart of the City.

PUBLIC SAFETY - To ensure Olde Town remains safe and inviting through programs such as:

- Arvada PD/CORE Team updates.
- Lighting & deterrent solutions.
- Continued safety training opportunities for businesses.

ADMINISTRATION - Annual compliance and delivery of BID programs and services through items such as but not limited to:

- Reporting
- Staffing & support
- Day to day operations

Assessment Methodology/Budget: The budget is based upon an 8.5 mill levy on taxable commercial real property (exempt and residential properties are not included in the BID), raising an estimated \$155,578. The City of Arvada is considering matching the BID assessment on a dollar-for-dollar basis up to \$93,000 for 2025 and amounts to be determined annually thereafter.

BID Governance: The BID statute allows for a board of 5 to 11 members who are BID electors. The Olde Town BID board currently consists of 11 members who are commercial property or business owners, or designees of such within the district.

Program Management Structure: The BID delivers programs and services for the areas of the district that pay into the BID through a mill levy. The BID has its own board, operating plan and staffing to support programming.

Term: The Olde Town Arvada BID has an initial ten-year term which began in 2014. This will allow for property owners to evaluate the BID's effectiveness at the end of the term. If the BID is deemed successful, the BID will request that the City Council renew the BID by ordinance after the initial period. If the BID is not considered to be successful, it will sunset at the end of the initial term.

EXHIBIT B
AGREEMENT BETWEEN THE CITY OF ARVADA AND THE OLDE TOWN
ARVADA BUSINESS IMPROVEMENT DISTRICT FOR THE FISCAL YEAR 2025
PROGRAMS AND SERVICES IN OLDE TOWN ARVADA

Olde Town Arvada
Business Improvement District
2025 Draft Budget

	2023 Actual Budget	2024 Approved Budget	2024 Actual Budget* - estimate	2025 Budget - Draft
<u>Estimated Resources</u>				
<i>Beginning Fund Balance, Estimated</i>	\$45,584	\$27,440	\$27,440	\$10,136
Property tax	\$ 131,037	\$ 152,807	\$ 152,807	\$155,578
City of Arvada match	\$ 68,000	\$ 68,000	\$ 84,767	\$93,000
Partnerships & Sponsorships	\$ 35,304	\$ -	\$ 28,300	\$0
Event & Merchandise Revenue	\$ 242,273	\$ -	\$ 213,257	\$0
Transfer from Savings		\$ -	\$ -	\$0
Interest	\$ 16	\$ 40	\$ 16	\$40
TOTAL AVAILABLE RESOURCES	\$ 522,214	\$ 248,247	\$ 506,587	\$258,714
<u>Estimated Expenditures</u>				
Marketing	\$39,157.00	\$9,000	\$27,475.00	Marketing \$9,000.00
Physical Improvements:	\$27,069.00	\$7,500	\$25,087.00	Placemaking/Mobility \$9,000.00
Enhanced Maintenance:	\$16,891.00	\$30,000	\$40,478.75	Enhanced Maintenance \$30,000.00
Advocacy:	\$2,145.00	\$1,500	\$1,862.00	Advocacy \$1,500.00
Safety:	\$507.00	\$2,000	\$85.00	Safety \$1,000.00
Administration:	\$191,796.00	\$194,000	\$203,401.00	Administration \$205,000.00
Event/Merchandise	\$217,209.00	\$0	\$198,063.00	Event/Merchandise \$0.00
ESTIMATED EXPENDITURES	\$494,774.00	\$244,000	\$496,451.75	\$255,500
Reserve Funds	\$0.00	\$3,000	\$0.00	\$3,000
TOTAL EXPENDITURES	\$494,774.00	\$247,000	\$496,451.75	\$258,500
<i>Ending fund balance</i>	<i>\$27,440</i>	<i>\$1,247</i>	<i>\$10,136</i>	<i>\$214</i>
Assessed value	15,957,202	17,977,360	17,977,360	18,303,396
Mill levy	8.5	8.5	8.5	8.5

Ending Fund Balance does not reflect savings account amount of \$20,052.91

EXHIBIT C
AGREEMENT BETWEEN THE CITY OF ARVADA AND THE OLDE TOWN
ARVADA BUSINESS IMPROVEMENT DISTRICT FOR THE FISCAL YEAR
2025 PROGRAMS AND SERVICES IN OLDE TOWN ARVADA

City of Arvada Services

Olde Town Business Improvement District

2025

Services for Olde Town Arvada, defined as the area roughly between Ralston Road on the north to the G Line railroad tracks on the south, and from Wadsworth Bypass on the east to Yukon Street on the west, are provided by a variety of work groups within each work system.

City of Arvada Services provided to the entire City, including Olde Town

The following list of services are those that the city provides across the entire city, including the Olde Town Arvada area.

Organizational and Service Effectiveness

- Review and approve special event permits and new liquor licensing applications/transfers of ownership
- Sales tax collection and assistance with sales tax licensing, education and compliance.

Community and Economic Development and Urban Renewal

- Building permit applications and review.
- Code enforcement actions.
- Planning and zoning review, including site development plans and building permit applications.
- Design review for Applications for Certificates of Compliance with the Design Guidelines for Olde Town Arvada
- Façade loans and grants for building and site improvements, signage, water lines and taps, and other assistance.
- Marketing and relocation assistance about available properties in the downtown area.
- Marketing and information about area businesses and attractions through the Arvada Visitor's Center in conjunction with the Arvada Chamber of Commerce.
- Assistance with new business development and retention of existing businesses.
- Development financing and incentives and revitalization projects through the Arvada Urban Renewal Authority (AURA)
- Review of building permit applications and issuance of building permits as needed.
- Building permit construction inspections as needed.
- Building inspections as needed for safety concerns.

Vibrant Community and Neighborhoods

- Parks Maintenance Services: Weekly mowing and weeding of park turf, including twice yearly aeration and fertilization; Extensive tree, shrub and plant care within parks to maintain health, vigor and aesthetic appearance according to accepted horticultural practices; Pruning of park ground covers to maintain a neat, well-kept appearance
- Regular pruning of right of way trees to maintain desirable form, eliminate diseased or damaged growth, prevent health or safety hazards, and maintain sidewalk and street clearance.
- Annual preparation of irrigated flower beds in parks, including soil turning once a year in the fall and flower deadheading on an as needed basis
- Coordination of public art program, including RFQ process, siting and installation support
- Olde Town Square fountain equipment pre-operation verification, and operation and maintenance from May 1st through September 30th if functional.
- Weekly mowing and weeding of Olde Town Square turf, including twice yearly aeration and fertilization.
- Within parks, cutting back ornamental grasses, herbaceous perennials, and pruning all dead, diseased and dying branches.
- Energizing park irrigation systems in the spring, winterizing in the fall, adjusting heads as needed, repairing breaks in a timely manner, and preventing any interruptions in the watering cycles for all landscaping (McIlvoy Park and the Olde Town Square). Performance of routine maintenance on the system components on a weekly basis and winterization of the sprinkler system completed by October 15th.
- Park-specific site amenities such as trash receptacles located in the Olde Town Square, bike racks, light poles, banner poles, benches, history walk signs, electrical to tree wells and in shrub beds, and shade structures are inspected once a week and repairs made as necessary.
- Graffiti eradication in parks, including but not limited to: walkways, hard surfaces, benches, tables, boulders, retaining walls, signage, lighting and fencing as needed.

Safe Communities

- Police Officers assigned to the overall 24 hours a day/seven days per week.
- Premise checks involving contact with business owners and employees, building relationships and security checks.
- Security for special events.
- Programs for businesses and residents in the area, including crime prevention through environmental design, training to businesses and their employees in reducing the occurrences of crime, as well as a number of other programs based on the needs of the business or resident.

- Ongoing collaboration with community partners in addressing homelessness awareness and impacts.
- Responding to service requests related to crime or traffic, as well as increases to crime or traffic in a particular area.
- Performance of directed traffic enforcement activities as needed
- Responding to animal control and code enforcement calls for service.

Infrastructure

- Street and alley patching as needed.
- Traffic Signal installation, operation and maintenance as needed.
- Assess traffic circulation and access management as needed.
- Roadway sign installation and maintenance as needed.
- Striping and pavement marking of streets as needed
- Meter reading every two months for utility billing and maintenance purposes.
- Fire hydrant maintenance once per year per hydrant.
- Water system flushing every two years.
- Water line valve rotation once every two years.
- Repair of meter pits as needed (rare).
- Replacement of water system lines when needed—new system installed in 2005.
- Quarterly cleaning of sanitary sewer pipes.
- Replacement of wastewater system as needed.
- Grease trap inspection and maintenance.
- Inspection of sanitary sewer pipes every 2 years.
- Review and consultation about private sewer service line issues.
- On-call system for after-hours emergencies.
- Cleaning of stormwater system pipelines as needed—generally every 3 years.
- Replacement of stormwater system as needed—relatively new system at present.
- On-call system for after-hours stormwater management emergencies.

City of Arvada Services that are Unique to Olde Town

The following list of services are those that the city provides to the Olde Town BID and the Olde Town area in addition to all of the service items listed above.

Organizational and Service Effectiveness

- Meeting and collaborating with BID leadership as needed
- Facilitating Council consideration of annual request for City matching funds.
- Appointment of staff liaison to BID Board and consultation with the BID and other downtown stakeholders for regular reporting to City Council.

Vibrant Community and Neighborhoods

- Replacement of Olde Town banners when damaged
- Weather permitting, the holiday lights are installed on the street trees approximately November 1st and displayed through March 1st. The holiday display in Olde Town Square is installed around Thanksgiving and displayed through January 1st. The entire display is inspected daily throughout the work week and repaired as necessary.
- Daily hand watering of non-irrigated plants during the growing season. Hand watering of flower pots on Grandview Avenue and the new pots installed since the closure on Olde Wadsworth daily.
- On call services for all of the special events that are held in Olde Town.
- Once a day, 7 days a week trash bag removal from non-park trash receptacles (storefront trash receptacles located outside of McIlvoy and Olde Town Square parks) from April 1st through October 31st. Once a day, Monday through Friday wintertime trash bag removal from non-park trash receptacles (weather permitting).
- Replacement of brick pavers outside of park areas.
- Flags will be displayed on President's Day, Memorial Day, Flag Day, Independence Day, Labor Day, Harvest Festival and Veteran's Day.
- Flower pots on Old Wadsworth watered through an irrigation controller, with flowers displayed from May 1st through September 30th, weather permitting.
- Snow removal though the plaza, public parking lots and on all public sidewalk arteries (not adjacent to businesses). Snow removal occurs within twenty four hours after the snow fall, conducted with light duty equipment such as ATV's, snow blowers, etc.
- Bi-annual electrical maintenance and repair for tree lighting throughout Olde Wadsworth and Grandview

Safe Communities

- Education and enforcement actions in Olde Town.
- CORE team established with presence in Olde Town since 2019.

Infrastructure

- Parking operation, enforcement, and analysis to better utilize on-street and public parking areas. Staff to be available for BID Board meetings and Parking committee meetings to consider issues and problem resolution.
- Street sweeping outside of the closure area.
- Snow removal outside of the street closure area.
- Operation and maintenance of historic style Acorn street lights.
- Managing leases and city obligations for private parking lots.
- Managing leases of City owned parklets.

- Coordination with RTD (monthly reports) related to Commuter Parking at the OTTH.
- OTTH and Transit Plaza Maintenance and Services through contracted services.
- Transportation data collection and analysis as needed.

City of Arvada Services for Olde Town which have been suspended

The following list of services are those that the city has provided only in the Olde Town area in previous years and no longer has capacity to provide moving forward due to competing priorities.

Vibrant Community and Neighborhoods

- Daily hand watering of non-irrigated plants during the growing season. Daily hand watering of flower pots on Grandview Avenue and the new pots installed since the closure on Olde Wadsworth.
- Once a day, 7 days a week trash bag removal from non-park trash receptacles (storefront trash receptacles located outside of McIlvoy and Olde Town Square parks) from April 1st through October 31st. Once a day, Monday through Friday wintertime trash bag removal from non-park trash receptacles (weather permitting).
- Replacement of brick pavers outside of park areas
- On call services for all of the special events that are held in Olde Town.

Infrastructure

- Street sweeping within the closure area.
- Snow removal inside the closure area.



REPORT TO CITY COUNCIL RESOLUTION

AGENDA ITEM
8.B.2.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities (Presenter: Jacqueline Rhoades, Director of Public Works)

Report in Brief

Presenter: Jacqueline Rhoades

The Sanitary Sewer Master Plan, completed in 2022, indicated the North Trunk Line in Tennyson was over capacity and this section was identified as one of four priority areas. This line is also over 60 years old. The Arvada team has moved forward with design and is ready to start construction with the CMGC contractor, BT Construction.

The final design for the project includes a new, larger meter structure for discharging sewage to Metro Water Recovery. A larger meter structure is required for both the larger pipe and for the increased flows carried by the larger pipe. This agreement provides for demolition of the old structure and construction of the new structure.

The Arvada team recommends that the City Council approve R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities.

Financial Impact

The financial cost associated with this Resolution has been and will continue to be presented to Council with the contracts and contract amendments for the Consultant and the Contractor.

Background

The City performed a Sanitary Sewer Master Plan in 2020 through early 2022. The results of work were presented to the Council in January 2022 with details on projects and a schedule presented in March 2022.

The Sanitary Sewer Master Plan identified 10 segments of the North Trunk Line that are not big enough, including the segment in Tennyson from about 60th to the meter with Metro Water Recovery, just north of I-76. This segment, NT10, is one of the four highest priority areas as evaluated on risk. The Arvada team hired Kennedy Jenks as the design consultant and BT Construction as the contractor. The project is at 100% design.

As part of the design work, the Arvada team worked with Metro Water Recovery staff to determine the requirements for metering sewage flow through the new, larger pipe resulting in the need for a new meter structure built to Metro Water Recovery standards. The new meter structure will be owned by Metro Water Recovery once completed.

Discussion

The project, NT10, is required for the City to provide sanitary sewer service for existing conditions and build-out conditions. The existing sewer is overcapacity now under the City's Level of Service, all sanitary flow and all inflow/infiltration for up to a 25 year storm. Additionally, the project is required to address aging infrastructure, as this portion of the sewer was installed in 1962 and has reached the end of useful life.

The IGA is required for the project to move forward and for Metro Water Recovery to receive sewage from the new pipe. There are no alternatives to constructing a new meter structure as the existing meter structure is undersized for projected flows.

The Arvada team has worked with Metro Water Recovery staff on the terms of the IGA. This IGA will be presented to the Metro Water Recovery Board of Directors in December for their approval.

Public Contact

Posting of the City Council agenda.

Commission Recommendation

N/A

Strategic Alignment

The recommended action aligns with the Infrastructure Priority Area within the City Council Strategic Plan. Specifically, the recommended action is consistent with the following work system service included in the Infrastructure Priority Area:

Provides the community with a safe, reliable high quality water supply, drainage system, and wastewater disposal services for full city build-out, as defined in the Comprehensive Plan. This includes maintaining utility rates at the lowest practical levels with accurate billing that supports replacement of aging infrastructure in order to maintain robust utility systems.

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities.

Suggested Motion:

I move that R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities, be (approved) (rejected).

Prepared by:
Mary Stahl, Senior Civil Engineer

Reviewed by:

Approved by:

Chris Lisberg, Assistant City Engineer	11/7/2024
Jacqueline Rhoades, Public Works Director	11/14/2024
Sharon Israel, Director of Utilities	11/14/2024
Bryan Archer, Director of Finance	11/14/2024

SUBJECT: R24-127, A Resolution Authorizing an Intergovernmental Agreement between the City of Arvada and Metro Water Recovery for Relocation of the Interceptor Facilities (Presenter: Jacqueline Rhoades, Director of Public Works)

PAGE: 3
ITEM: 8.B.2.

Tammy Hedlund, Legal Specialist	11/15/2024
Jessica Morales, Assistant City Attorney	11/15/2024
Don Wick, Deputy City Manager	11/15/2024
Rachel Morris, City Attorney	11/19/2024
Linda Haley, Acting City Manager	11/20/2024

Enclosure, exhibits & attachments required to support the report

RESOLUTION NO. R24-127

A RESOLUTION AUTHORIZING AN INTERGOVERNMENTAL AGREEMENT BETWEEN
THE CITY OF ARVADA AND METRO WATER RECOVERY FOR RELOCATION OF THE
INTERCEPTOR FACILITIES

WHEREAS, the City of Arvada is planning to replace its 30-inch existing sanitary sewer line running along Tennyson Street, with a larger line that will discharge to the Metro Water Recovery owned Arvada-Tennyson Metering Facility (“Meter”);

WHEREAS, Metro Water Recovery owns and operates the Meter and downstream piping that discharges to Metro’s Clear Creek Interceptor;

WHEREAS, the City of Arvada desires to relocate the Meter and downstream piping and construct a new 42-inch sanitary sewer main between the Meter and Clear Creek Interceptor (the “Relocation”); and

WHEREAS, an Intergovernmental Agreement is necessary in order to achieve the Relocation.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The Mayor or Mayor Pro Tem is authorized to sign and the City Clerk to attest, in form approved by the City Attorney, an Intergovernmental Agreement that is in substantially the same form as that attached hereto.

Section 2. This resolution shall be effective upon its approval by the City Council.

APPROVED AND ADOPTED this 2nd day of December, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney:

BY: _____

INTERGOVERNMENTAL AGREEMENT FOR RELOCATION OF INTERCEPTOR FACILITIES

This Agreement, made and entered this ____ day of _____, 2024 by and between City of Arvada, a Colorado home rule municipal corporation (the “City”) and Metro Water Recovery, a metropolitan sewage disposal district organized and existing pursuant to Part 5 of Article 4 of Title 32 of the Revised Statutes of the State of Colorado (“Metro”); and hereinafter individually referred to as “Party” or collectively referred to as “the Parties”.

WITNESSETH

WHEREAS, The City is planning to replace their 30” existing sanitary sewer line running along Tennyson Street with a larger line that will discharge to the Metro owned Arvada-Tennyson Metering Facility (“Meter”);

WHEREAS, Metro owns and operates the Meter and downstream piping that discharges to Metro’s Clear Creek Interceptor;

WHEREAS, The City desires to relocate the Meter and downstream piping and construct a new 42” sanitary sewer main between the Meter and Clear Creek Interceptor (the “Relocation”);

WHEREAS, The Relocation is generally shown on **Exhibit A** attached hereto;

NOW, THEREFORE, in consideration of the covenants and mutual promises herein contained and for other good and valuable consideration, the Parties hereto agree as follows:

1. The City, through its professional consulting engineer, shall prepare construction plans and specifications for the Relocation as generally shown on **Exhibit A**.
2. Metro shall review, provide comments, and approve the construction plans and specifications. Metro standards shall be used to develop the plans and specifications. Metro’s approval shall not be unreasonably withheld or delayed.
3. The City shall pay 100% of the design and construction costs for the Relocation. In addition, The City will be responsible for 100% of any costs for damage to existing public or private improvements.
4. The City shall arrange for the construction of the Relocation, in accordance with the plans and specifications approved by Metro, by a responsible and responsive contractor. The contractor shall carry insurance as set forth below, and Metro will be included as an additional insured, except for workers’ compensation, on a primary and non-contributory basis. Proof of insurance shall be provided to Metro prior to commencement of construction.
 - a. Commercial General Liability insurance of not less than \$2,000,000 each

occurrence and \$2,000,000 aggregate;

- b. Worker's Compensation coverage as required by statute;
- c. Comprehensive Business/Automobile Liability insurance with a combined single limit for Bodily Injury and Property Damage of not less than \$1,000,000 per accident;
- d. Builder's Risk insurance covering the work under this Agreement; and
- e. Contractor's Pollution Liability insurance with limits of \$5,000,000 each occurrence and \$5,000,000 aggregate.

5. If the Relocation will require wastewater flow management (i.e. by-pass pumping), The City shall submit a Wastewater Flow Management Plan ("WFMP") that conforms with Metro's WFMP Specifications, a copy of which is attached as **Exhibit B**. The City shall submit its WFMP in accordance with paragraph 1.5 of **Exhibit B**. If no wastewater flow management is required for the Relocation, then no later than ten (10) business days prior to starting construction on the Relocation, the City shall submit to Metro a Wastewater Discharge Emergency Response Plan ("WDERP"). Construction on the Relocation shall not begin until the WDERP has been approved in writing by Metro.

A contractor implementing the WFMP and/or the WDERP is a contractor to the City, not Metro. Therefore, the City and its contractor will be responsible for compliance with all federal, state and/or local environmental laws and regulations. Metro shall not be liable for any noncompliance with those laws or regulations, including notification requirements, by the City or the City's contractor.

In the event of a spill, overflow or discharge of pollutants, including raw wastewater, which may cause pollution of state waters¹, the City shall immediately notify the following parties:

- a. Colorado Department of Public Health and Environment, Spill Report Line, 1-877-518-5608; and
- b. National Response Center, 1-800-424-8802.

In addition to the reporting requirements of the paragraph above, the City shall immediately notify Metro's Process Control Center (303-286-3275) in the event of **any** spill, overflow or discharge of pollutants to the environment, regardless of whether or not it may cause pollution of state waters.

6. The City, or the City's professional consulting engineer, shall provide throughout the term of the construction of the Relocation, competent and qualified project administration, and

¹ For purposes of this paragraph 5, the phrases "discharge of pollutants" and "state waters" shall have the same meanings as in the Colorado Water Quality Control Act, C.R.S. § 25-8-101 *et. seq.*

quality control. Metro shall have the right to visit the site and inspect the Relocation work at any time and to confer with the City project administrator.

7. Metro shall have the right to review and comment on all shop drawings and other contractor submittals pertaining to the Relocation. The City, or the City's professional consulting engineer, shall submit four (4) approved electronic copies of such shop drawings and submittals to Metro prior to construction of the Relocation.

8. The City, or the City's professional consulting engineer, shall notify Metro of any change to the construction plans or specifications during construction which involve the Relocation, and shall obtain Metro approval, not to be unreasonably withheld or delayed, prior to authorizing such change.

9. The City shall be responsible for obtaining and complying with any permits or approvals necessary from any governmental entity with jurisdiction over the Relocation.

10. The City, or the City's professional consulting engineer, and Metro shall jointly inspect the Relocation during construction and upon completion of construction, and the City shall coordinate and pay for repair of any defects noted.

11. The City shall not discharge wastewater to the Relocation until Metro has accepted the Relocation for operation and maintenance. Metro shall accept the Relocation for operation and maintenance only after the following have been completed:

- a. The City, through the City's professional consulting engineer, has certified that the constructed flow capacity of the Relocation meets or exceeds 19.4 million gallons per day ("MGD"), based on Manning's equation with an "n" value of 0.013 and "S" equal to the installed pipe slope.
- b. Final inspection and written approval by Metro, which will not be unreasonably withheld or delayed.

12. Ownership of the Relocation shall be transferred by quit claim deed in the form attached hereto as **Exhibit C** within thirty (30) days of acceptance of the Relocation by Metro.

14. The City, or the City's professional consulting engineer, will provide Metro with acceptable Record Drawings of the Relocation within 30 days of Metro acceptance of the Relocation.

15. The City shall warranty the Relocation for a period of one year from the date of acceptance by Metro.

16. Ownership of the Meter shall be transferred via quit claim by the attached **Exhibit C** by Metro prior to construction beginning on the Relocation.

17. In the event of a default, in addition to any remedies that may be available to the Parties in law or in equity, the Parties shall be entitled to seek specific performance or injunctive relief to enforce the provisions of this Agreement. However, prior to filing legal action the Party alleging the default shall first provide notice of the default to the other Party and allow a minimum of fourteen (14) days to cure the default.

18. **Governmental Immunity.** The Parties intend that nothing herein shall be deemed or construed as a waiver by either Party of any immunities, rights, benefits, or protections afforded to them under the Colorado Governmental Immunity Act (Section 24-10-101, C.R.S., et seq.).

19. **Governing Law and Venue.** This Agreement shall be construed and enforced in accordance with the laws of the state of Colorado. The Parties consent to venue for any legal action relating to the Agreement being in the District Court in and for the City and County of Denver. In any legal action for damages or to enforce the terms of this Agreement, the prevailing party shall be entitled to recover their reasonable attorneys' fees and costs.

20. **No Third Party Beneficiaries.** The enforcement of the terms and conditions of this Agreement and all rights of action relating to enforcement shall be strictly reserved to the Parties. No third party beneficiary rights shall be created by this Agreement in favor of any person not a Party to this Agreement, unless the Parties mutually agree otherwise in writing.

21. **Force Majeure.** Neither Party shall be liable for any failure to perform as required by this Agreement, to the extent such failure to perform is caused by any of the following occurrences: strikes, labor disturbances or disputes, failure of any governmental (other than the Parties to this Agreement) or third party action or approval required for full performance, riots, civil disorder, war, floods, earthquakes, acts of God, explosion, or similar occurrences outside the control of such Party.

22. **Notices.** Except as otherwise required in this Agreement, any notice shall be deemed to be validly given at the time that written notice is delivered in person, received by registered mail, postage prepaid, or transmitted by facsimile (with confirmation of receipt) to the following addresses:

To Metro Water Recovery:

Chief Executive Officer
Metro Water Recovery
6450 York St.
Denver, CO 80229
(303) 286-3030

To City of Arvada:

Director of Utilities
City of Arvada
8101 Ralston Rd.
Arvada, CO 80002
(720) 898-7761

23. **Entire Agreement.** This Agreement is intended as a complete integration of all understandings between the Parties pertaining to the Relocation. No prior or contemporaneous addition, deletion or other amendment shall have any force or effect, unless embodied herein or in a written amendment or other agreement executed by the Parties. This Agreement and any amendments shall be binding upon the Parties, their successors and assigns.

24. **Severability.** In the event any provision of this Agreement is found to be invalid, void, or otherwise unenforceable by a court of competent jurisdiction or by operation of applicable law, such invalid, void, or unenforceable provision shall not affect the validity of the Agreement as a whole and the remainder of the Agreement shall be given full force and effect.

25. **Waiver.** Any waiver by any Party hereto of a breach of any provision of this Agreement shall not operate as or be construed to be a waiver of any other breach of such provision or of any breach of any other provision of this Agreement. To be effective, any waiver must be in writing. Failure by any Party hereto to insist upon strict adherence to any term of this Agreement on one or more occasions shall not be considered a waiver or deprive such Party of the right thereafter to insist upon strict adherence to that term or any other term of this Agreement.

26. **Employees, Agents, Contractors, and Volunteers.** Employees, agents, contractors, and volunteers of each Party will remain so of that Party. Nothing in this Agreement requires any Party to fund the activities of another Party.

27. **Assignment.** Neither party shall assign this Agreement without the prior written consent of the other party.

28. **Availability of Funds and Constitutional Limitations on Debt.** Financial obligations of any one Party that is a Colorado governmental entity or governmental subdivision (“Governmental Party”) payable after the current Municipal Fiscal Year or District Fiscal Year are contingent upon funds for that purpose being appropriated, budgeted, or otherwise made available. A Governmental Party may also be relying on state or federal funding to satisfy its payment obligations under the Agreement. The Governmental Parties’ payment obligations under the Agreement are subject to and conditioned upon the continuing availability of all funding for the purposes set forth in the Agreement. In the event funds are not appropriated, budgeted or otherwise made available, a Governmental Party may terminate the Agreement as of the last day of the period for which funds were appropriated or monies made available for such purposes. All payments of the Governmental Parties under this Agreement constitute currently budgeted expenditures and do not constitute or give rise to a general obligation, indebtedness, or multiple-fiscal year direct or indirect debt or other financial obligation within the meaning of any constitutional or statutory provision or limitation. No provision of this Agreement shall be construed to pledge or to create a lien on any class or source of the Governmental Parties’ monies.

29. **Paragraph Captions.** The captions of the paragraphs are set forth only for convenience and reference and are not intended in any way to define, limit or describe the scope or intent of this Agreement.

30. **Counterparts, Electronic Signatures and Electronic Records.** This Agreement may be executed in counterparts, each of which shall be deemed to be an original, but all of which shall together constitute one and the same document. Facsimile signatures shall be accepted as originals. The Parties consent to the use of electronic signatures by each of the Parties. The Parties agree not to object to the admissibility of this Agreement in the form of an electronic record, a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the grounds that it is an electronic record or an electronic signature or that it is not in its original form or is not an original.

31. **Exhibits Incorporated.** All exhibits attached hereto are incorporated herein by this reference.

32. **Binding Effect and Authority.** This Agreement shall inure to the benefit of, and be binding upon, the Parties, their respective legal representatives, successors, and assigns; provided, however, that nothing in this paragraph shall be construed to permit the assignment of this Agreement except as otherwise expressly authorized herein. The undersigned to this Agreement warrant that each has the authority to execute and enter into this Agreement, that their signatures are authorized and binding, and that all actions and approvals necessary for the execution and delivery of the Agreement have been properly taken by their respective governing boards.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized respective representatives as of the date and year written above.

(Signatures on next page.)

METRO WATER RECOVERY

By: _____
William J. Conway
Chief Executive Officer

APPROVED AS TO FORM

By: _____
Emily Jackson
Chief Legal Officer

CITY OF ARVADA

Lauren Simpson
Mayor
8101 Ralston Road
Arvada, CO 80002

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, Arvada City Attorney

By: _____

EXHIBIT A - DESIGN PLANS

Plot Date: 9/6/2024 9:39 AM
User: ROBERT INOPEA
p:\k\ce-pw\benley.com\k\ce-pw\Documents\Clients\Arvada, City of CO\Projects\North Trunk Sewer Improvements_2246059_00\10-Design\10.06-Drawings\General\2246059_00-G-001



LOCATION MAP
SCALE: NTS



VICINITY MAP
SCALE: NTS

CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS



DRAWING INDEX

SHEET NO	DRAWING NO	SHEET TITLE
GENERAL:		
1	G-001	COVER, LOCATION AND VICINITY MAPS, AND DRAWING INDEX
2	G-002	GENERAL NOTES AND LEGEND
3	G-003	GENERAL PROCESS SYMBOLS
4	G-004	SURVEY CONTROL DIAGRAM
CIVIL:		
5	C-001	CIVIL NOTES AND ABBREVIATIONS
6	C-002	CIVIL LEGEND
7	C-003	CIVIL DETAILS - I
8	C-004	CIVIL DETAILS - II
9	C-005	JACK AND BORE DETAILS- I
10	C-006	JACK AND BORE DETAILS - II
11	C-350	PLAN AND PROFILE STA 1+00 TO 6+00
12	C-351	PLAN AND PROFILE STA 6+00 TO 11+00
13	C-352	PLAN AND PROFILE STA 11+00 TO 16+00
14	C-353	PLAN AND PROFILE STA 16+00 TO 20+50
15	C-354	PLAN AND PROFILE STA 20+50 TO 25+50
16	C-355	PLAN AND PROFILE STA 25+50 TO 30+50
17	C-356	PLAN AND PROFILE STA 30+50 TO 35+50
18	C-357	PLAN AND PROFILE STA 35+50 TO 37+00
19	C-450	SITE RESTORATION STA 1+00 TO 11+00
20	C-451	SITE RESTORATION STA 11+00 TO 20+50
21	C-452	SITE RESTORATION STA 20+50 TO 30+50
22	C-453	SITE RESTORATION STA 30+50 TO 37+00
STRUCTURAL:		
23	S-001	STRUCTURAL GENERAL NOTES AND SPECIAL INSPECTIONS
24	S-002	STRUCTURAL PLANS
25	S-003	STRUCTURAL SECTIONS
26	S-004	STRUCTURAL DETAILS - I
MECHANICAL:		
27	M-001	METERING VAULT PLAN
28	M-002	METERING VAULT SECTIONS AND DETAILS

DRAWING INDEX - CONTINUED

SHEET NO	DRAWING NO	SHEET TITLE
ELECTRICAL:		
29	E-001	ELECTRICAL ABBREVIATIONS AND NOTES
30	E-002	ELECTRICAL LEGEND - I
31	E-003	ELECTRICAL LEGEND - II
32	E-004	ELECTRICAL TYPICAL DETAILS - I
33	DE-010	OVERALL DEMOLITION SITE PLAN
34	E-010	ELECTRICAL OVERALL SITE PLAN
35	E-011	ELECTRICAL METER VAULT DETAILS
36	E-020	ELECTRICAL ONE LINE DIAGRAM AND SCHEDULES
37	E-030	ELECTRICAL CONDUIT AND CABLE SCHEDULE
38	E-040	ELECTRICAL CONDUIT ROUTING BLOCK DIAGRAM
INSTRUMENTATION:		
39	I-001	INSTRUMENTATION LEGEND AND NOTES
40	I-002	INSTRUMENTATION STANDARD DETAILS
41	I-011	PARSHALL FLUME PROCESS AND INSTRUMENTATION DIAGRAM
EROSION CONTROL:		
42	EC-601	EROSION CONTROL NOTES
43	EC-602	EROSION CONTROL DETAILS - I
44	EC-603	EROSION CONTROL DETAILS - II
45	EC-650	GRADING, EROSION, AND SEDIMENT CONTROL STA 1+00 TO 11+00
46	EC-651	GRADING, EROSION, AND SEDIMENT CONTROL STA 11+00 TO 20+50
47	EC-652	GRADING, EROSION, AND SEDIMENT CONTROL STA 20+50 TO 30+50
48	EC-653	GRADING, EROSION, AND SEDIMENT CONTROL STA 30+50 TO 37+00

OWNER/CONSULTANTS

CITY OF ARVADA PUBLIC WORKS 8101 RALSTON RD ARVADA, CO 80002	KRIS GARDNER KGARDNER@ARVADA.ORG 720-898-7647
KENNEDY/JENKS CONSULTANTS 165 S UNION BLVD SUITE 570 LAKEWOOD, CO 80228	BRAD FLORENTIN BRADFLORENTIN@KENNEDYJENKS.COM 720-779-1006
GEI CONSULTANTS 350 INDIANA ST, SUITE 750 GOLDEN, CO 80401	AUSTIN WILKES AWILKES@GEICONSULTANTS.COM 770-862-7425
UNDERGROUND CONSULTING SOLUTIONS 5778 KELLY AVE LITTLETON, CO 80125	KEN GOFF UCS@DONTDIGWITHOUTUCS 303-904-7422

REGULATORY AGENCIES

REGIONAL TRANSPORTATION DISTRICT - DENVER 1660 BLAKE ST DENVER, CO 80202	NIKITA ZANICHKOWSKY NIKITA.ZANICHKOWSKY@RTD-DENVER.COM 303-299-2420
BNSF RAILWAY - DENVER 585 W 53RD PL DENVER, CO 80216	ALLAN BREDEN ALLAN.BREDEN@BNS.COM 720-415-8398
UNION PACIFIC RAILROAD CO 1180 W 52ND AVE DENVER, CO 80221	JUSTIN SORIANO JASORIAN@UP.COM 402-544-5433
MANHART DITCH COMPANY 6575 WEST 88TH AVE WESTMINSTER, CO 80031	BOB KRUGMIRE WESTY.DITCHES.2019@GMAIL.COM 303-658-2181
ADAMS COUNTY PUBLIC WORKS 4955 E 74TH AVE COMMERCE CITY, CO 80022	MARK MCDONALD MMCDONALD@ADCOGOV.ORG 720-523-6809
DENVER WATER 1600 W 12TH AVE DENVER, CO 80204	DENVER WATER LOCATING DEPT. DWLOCATE@DENVERWATER.ORG 303-628-6666
METRO WATER RECOVERY 6450 YORK ST DENVER, CO 80229	KELSEY GEDGE KGEDGE@METROWATERRECOVERY.COM 303-286-3357
XCEL ENERGY 414 NICOLLET MALL MINNEAPOLIS, MN 55401	DANIEL NIVAL DANIEL.NIVAL@XCELENERGY.COM 303-619-3805
COLORADO DEPARTMENT OF TRANSPORTATION 2829 W. HOWARD PL, 2551 DENVER, CO 80204	TANISHA ALFORD TANISHA.ALFORD@STATE.CO.US 303-880-3693
MILE HIGH FLOOD DISTRICT 12575 W BAYAUD AVE LAKEWOOD, CO 80228	DAN HILL DHILL@MHFD.ORG 303-455-6277
CITY OF WESTMINSTER PARKS AND RECREATION 4800 W 92ND AVE WESTMINSTER, CO 80031	TOMÁS HERRERA-MISHLER PRL@CITYOFWESTMINSTER.US 303-658-2192
HYLAND HILLS PARK & RECREATION DISTRICT 8801 N PECOS ST FEDERAL HEIGHTS, CO 80260	STEVE HEGER SHEGER@HYLANDHILLS.ORG 303-650-7590
CRESTVIEW WATER AND SANITATION DISTRICT 7145 MARIPOSA ST #7200 DENVER, CO 80221	MITCHELL TERRY MANAGER@CRESTVIEWWATER.COM 303-429-1881
BERKELEY WATER AND SANITATION DISTRICT	CONTACT DENVER WATER



APPROVED City of Arvada, Colorado			
CITY ENGINEER	DATE	JOB NUMBER	
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.			
SEP 2024 - 90% DESIGN			
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.			
NO	REVISION	DATE	BY

SCALES
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0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED TS	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	Kennedy Jenks
DRAWN WAS		
CHECKED LS		

COVER, LOCATION AND VICINITY MAPS,
AND DRAWING INDEX

SCALE NTS
JOB NO 2246059*00
DATE SEP 2024
SHEET 1 OF 48 G-001

Plot Date: 9/6/2024 9:43 AM
User: ROBERT INOPEA
pww\kjc-pw.bentley.com\kjc-pw\Documents\Clients\Arvada, City of CO\Projects\North Trunk Sewer Improvements_2246059\0010-Design\10.06-Drawings\General\2246059-00-G-002

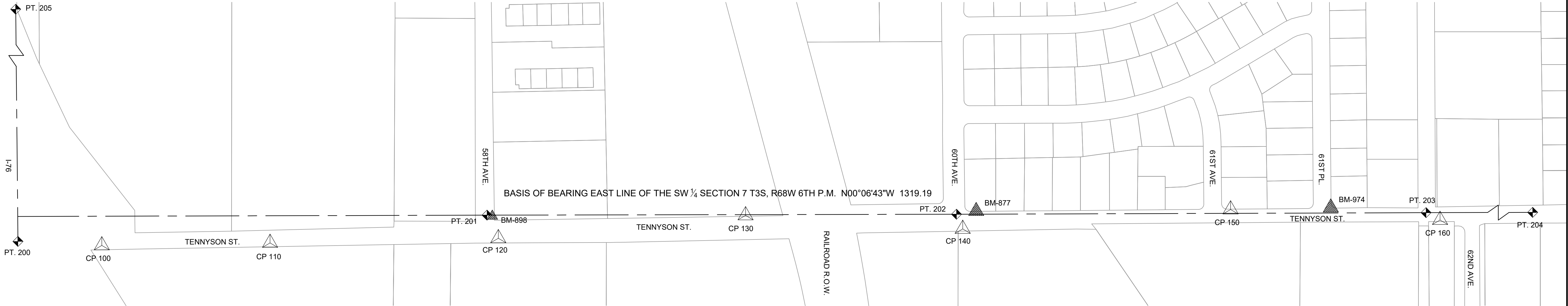
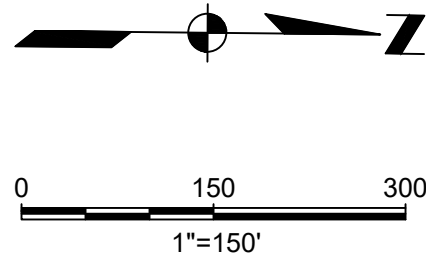
NOTES				NOTES (CONTINUED)				SYMBOLLOGY				CROSS-REFERENCING SYMBOLS											
<u>GENERAL</u> 1. THIS PROJECT IS WITHIN CITY OF ARVADA AND ADAMS COUNTY RIGHT OF WAY. CONTRACTOR SHALL CONFORM TO CITY OF ARVADA AND ADAMS COUNTY PERMITS AND REQUIREMENTS. 2. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH CITY OF ARVADA STANDARDS, ADAMS COUNTY STANDARDS, AND APPLICABLE AWWA STANDARDS. 3. PRE-EXISTING SITE CONDITION PHOTOS SHALL BE PROVIDED BY THE CONTRACTOR AND SHALL SHOW EXISTING CONDITIONS OF ALL CONCRETE, ASPHALT, LANDSCAPED AREAS, ETC. SURROUNDING THE CONSTRUCTION AREAS. PHOTOS SHALL BE SUBMITTED TO THE OWNER PRIOR TO BREAKING GROUND. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT EXISTING IMPROVEMENTS WHICH ARE TO REMAIN IN PLACE FROM DAMAGE. ALL IMPROVEMENTS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED AT THE CONTRACTOR'S EXPENSE WITHOUT ADDITIONAL COMPENSATION. 4. CONTRACTOR SHALL RESTORE ALL SURVEY MONUMENTS THAT ARE DAMAGED OR DESTROYED DURING CONSTRUCTION. 5. OBSERVATIONS OF WORK IN PROGRESS DURING SITE VISITS SHALL NOT ALTER THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. <u>UTILITIES</u> 1. LOCATIONS OF UNDERGROUND UTILITIES SHOWN ON THE DRAWINGS WERE OBTAINED FROM AVAILABLE RECORDS AND ARE SHOWN IN THEIR APPROXIMATE LOCATION. THERE IS NO GUARANTEE THAT ALL EXISTING PIPELINES AND OBSTRUCTIONS ARE SHOWN OR THAT LOCATIONS INDICATED ARE ACCURATE. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL POTHOLE TO DETERMINE ACTUAL LOCATION AND ELEVATION OF ALL EXISTING UTILITIES IN AND AROUND THE AREAS OF NEW CONSTRUCTION. 2. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT ALL REMAINING EXISTING UTILITIES WHETHER SHOWN OR NOT SHOWN. 3. PRIOR TO ANY CONNECTION TO AN EXISTING UTILITY, THE CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER. 4. PRIOR TO ANY EXCAVATION IN THE VICINITY OF ANY EXISTING UNDERGROUND FACILITIES, INCLUDING ALL WATER, SEWER, STORM DRAIN, GAS, PETROLEUM PRODUCTS, OR OTHER PIPELINES; ALL BURIED ELECTRIC POWER, COMMUNICATIONS, OR TELEVISION CABLES; ALL TRAFFIC SIGNAL AND STREET LIGHTING FACILITIES; AND ALL ROADWAY, STATE HIGHWAY, AND RAILROAD RIGHTS-OF-WAY, THE CONTRACTOR SHALL NOTIFY THE RESPECTIVE AUTHORITIES REPRESENTING THE OWNERS OR AGENCIES RESPONSIBLE FOR SUCH FACILITIES TO FACILITATE A TIMELY MANNER OF WORK SO THAT A REPRESENTATIVE OF SAID OWNERS OR AGENCIES CAN BE PRESENT DURING SUCH WORK IF THEY SO DESIRE. IN THE CASE OF THE UNDERGROUND UTILITY SERVICE ALERT CENTER, THIS NOTICE WILL GIVE THEM TIME TO MARK THE LOCATION OF THE UTILITIES. THE CONTRACTOR SHALL ALSO NOTIFY UNDERGROUND SERVICES ALERT (USA) AT (811) IN ACCORDANCE WITH THE SPECIFICATIONS TO FACILITATE A TIMELY MANNER OF WORK, PRIOR TO SUCH EXCAVATION. <u>SUE QUALITY LEVEL</u> 1. EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL B STANDARDS, UNLESS NOTED OTHERWISE. 2. SUBSURFACE, GAS, ELECTRIC, WATER, STORM SEWER, AND FIBER OPTIC MAINLINE CROSSINGS OF THE PROPOSED SANITARY PIPE, WITHIN THE EXPECTED LIMITS OF EXCAVATION, WERE LOCATED TO ASCE QUALITY LEVEL A STANDARDS. SANITARY SEWER LINE DEPTHS ARE DERIVED FROM SURVEYED INVERT INFORMATION PROVIDED BY THE OWNER SHOWING A LINEAR PIPE SLOPE FROM INVERT TO INVERT. POTHOLE INFORMATION FOR EXISTING UTILITIES AND CROSSINGS IS PROVIDED ON SHEET C-357. ALL OTHER EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL C STANDARDS. INDIVIDUAL SERVICE LINES FOR SUBSURFACE UTILITIES ARE LOCATED TO QUALITY LEVEL C, EXCEPT THOSE SERVICES AS IDENTIFIED ON SHEET C-357. 3. ALL SANITARY AND STORM INFORMATION FOR INSTANCES NOT CROSSING THE PROPOSED SANITARY PIPE IS QUALITY LEVEL C. 4. THE CONTRACTOR SHALL REQUEST LOCATE INFORMATION FOR THE PROJECT PRIOR TO ANY EXCAVATION. KENNEDY/JENKS DOES NOT GUARANTEE THE LOCATIONS OF THE UTILITIES SHOWN OR THAT THE UTILITIES SHOWN INCLUDE ALL UTILITIES IN THE AREA. RELIANCE UPON THESE DATA DOES NOT RELIEVE THE CONTRACTOR FROM FOLLOWING ALL THE APPLICABLE UTILITY DAMAGE PREVENTION STATUTES, POLICIES, AND/OR PROCEDURES DURING EXCAVATION. IT IS IMPORTANT THAT THE CONTRACTOR INVESTIGATES AND UNDERSTANDS THE SCOPE OF WORK BETWEEN THE PROJECT OWNER AND THEIR ENGINEER REGARDING THE SCOPE AND LIMITS OF THE UTILITY INVESTIGATIONS LEADING TO THESE UTILITY DEPICTIONS. CONTRACTOR SHALL MEET ALL REQUIREMENTS OF COLORADO SENATE BILL 18-167 AS PART OF THIS PROJECT. QUALITY LEVEL - A: (3D INFORMATION) USE OF APPROPRIATE NONDESTRUCTIVE DIGGING EQUIPMENT AT DISCREET, CRITICAL POINTS TO DETERMINE THE PRECISE HORIZONTAL AND VERTICAL POSITION OF UNDERGROUND UTILITIES, AS WELL AS THE TYPE, SIZE, CONDITION, MATERIAL, AND OTHER CHARACTERISTICS. QLA IS THE HIGHEST QUALITY LEVEL PRESENTLY AVAILABLE. QUALITY LEVEL - B: (2D INFORMATION) USE OF APPROPRIATE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND HORIZONTAL POSITION OF VIRTUALLY ALL SUBSURFACE UTILITIES. 1). UTILITY QUALITY LEVEL B (QLB) IS VALUE ASSIGNED TO A UTILITY SEGMENT OR SUBSURFACE UTILITY FEATURE WHOSE EXISTENCE AND POSITION ARE BASED UPON				GEOPHYSICAL METHODS COMBINED WITH PROFESSIONAL JUDGEMENT AND WHOSE LOCATION IS TIED TO THE PROJECT SURVEY DATUM. QLB IS MORE UNCERTAIN THAN QLA, AND LESS UNCERTAIN THAN QLC OR QLD. 2). APPROXIMATE HORIZONTAL LOCATION OF UTILITY. QUALITY LEVEL - C: SURVEYING VISIBLE ABOVE GROUND UTILITY FACILITIES. <u>RTD NOTES:</u> 1. CONTRACTOR SHALL CONTACT DENVER TRANSIT OPERATORS (DTO) BY EMAIL AT TRACK.USAGE@RTDCRAIL.COM 30-DAYS PRIOR TO CONSTRUCTION TO OBTAIN THE MOST UP TO DATE PERMIT REQUEST FORMS AND TO INITIATE A REQUEST FOR AN ACCESS PERMIT. 2. CONTRACTOR SHALL COMPLETE ALL APPLICABLE COMMUTER RAIL SAFETY TRAINING, WHICH DTO SHALL PROVIDE AT CONTRACTORS COST. CONTRACTOR SHALL PROVIDE PROOF OF CURRENT SAFETY TRAINING, PRIOR TO THE PRE-ENTRY MEETING, FOR ANY WORK ON, ADJACENT TO, OR ACROSS RTD CRT ROW. PROOF OF CURRENT SAFETY TRAINING MUST BE READILY AVAILABLE WHILE WORKING ON SITE. 3. CONTRACTOR SHALL NOTIFY RTD'S UTILITY ENGINEERING/CONSTRUCTION TEAM (303-299-2811) AND DTO'S RAIL OPS (720-460-5803) A FULL 30-DAYS PRIOR TO CONSTRUCTION AND SHALL ARRANGE TO ATTEND A MONTHLY 3RD PARTY RAIL CONSTRUCTION MEETING WITH RTD AND DTO CURRENTLY HELD AT 3PM ON THE FIRST WEDNESDAY OF EACH MONTH AT THE COMMUTER RAIL MAINTENANCE FACILITY. 4. CONTRACTOR SHALL ATTEND RTDC-DTO'S TRACK USAGE RAIL CONSTRUCTION MEETING AT LEAST ONE WEEK PRIOR TO THE START OF CONSTRUCTION AT A TIME AND DATE ESTABLISHED BY DTO. CONTRACTOR MAY NOT BEGIN ANY WORK WITHOUT AN RTDC-DTO ACCESS PERMIT. RTDC-DTO WILL NOT ISSUE A PERMIT WITHOUT AN EXECUTED UTILITY AGREEMENT IN PLACE. 5. CONTRACTOR SHALL NOT BEGIN ANY WORK ON OR ACROSS RTD ROW/TRACKS UNTIL RTD HAS ISSUED AND EXECUTED UTILITY AGREEMENT. 6. CONTRACTOR SHALL NOTIFY RTD'S UTILITY ENGINEERING/CONSTRUCTION TEAM (303-299-2811) AND RTDC-DTO'S RAIL OPS (720-460-5803) A FULL TWO (2) WEEKS PRIOR TO CONSTRUCTION AND SHALL COORDINATE A UTILITY PRE-CONSTRUCTION MEETING WITH RTD AND RTDC-DTO, AND ARRANGE FOR AN RTD REPRESENTATIVE TO BE ON-SITE DURING CONSTRUCTION. THE UTILITY PRE-CONSTRUCTION MEETING SHALL OCCUR WITHIN A WEEK OF THE START OF CONSTRUCTION. 7. CONTRACTOR MAY NOT BEGIN WORK UNTIL RTD AND RTDC-DTO HAS ISSUED A PRE-CONSTRUCTION RESOLUTION RECORD (PCRR). A PCRR WILL BE COMPLETED, SIGNED, AND ISSUED BY RTDC-DTO'S REPRESENTATIVE DURING THE UTILITY PRE-CONSTRUCTION MEETING AND MUST BE KEPT ON-SITE AT ALL TIMES DURING CONSTRUCTION. 8. TRAFFIC CONTROL PLANS ARE REQUIRED IF WORK HAS THE POTENTIAL OF IMPACTING RTD COMMUTER RAIL OPERATIONS OR AUTOMOBILE TRAFFIC NEAR RTDC RAILROAD CROSSINGS. TRAFFIC CONTROL PLANS MUST BE SUBMITTED TO RTD FOR APPROVAL PRIOR TO CONSTRUCTION. 9. CONTRACTOR SHALL NOTIFY RTDC-DTO OCC (OPERATIONS CONTROL CENTER) DISPATCH PRIOR TO ENTERING THE RTD RIGHT-OF-WAY (ROW) IN ORDER TO ACTIVATE THE PERMIT, AND IMMEDIATELY AFTER CLEARING THE SITE IN ORDER TO DEACTIVATE THE PERMIT AS FOLLOWS: -CALL (720-460-5807) FOR WORK ALONG THE A-LINE -CALL (720-460-5808) FOR WORK ALONG THE B-LINE AND G-LINE AN RTDC-DTO EIC (EMPLOYEE IN CHARGE) / FLAGGER IS REQUIRED TO BE ON-SITE ANYTIME CONTRACTOR WORKERS OR EQUIPMENT ARE WITHIN 10 FEET OF THE NEAREST RUNNING RAIL. IF RTDC-DTO DEEMS NECESSARY AN RTD-DTO EIC/FLAGGER MAY ALSO BE REQUIRED AT OTHER TIMES DURING CONSTRUCTION. THE EIC/FLAGGER MUST BE SCHEDULED AT LEAST ONE WEEK PRIOR TO THE START OF WORK AND SHALL BE COORDINATED AT THE PRE-ENTRY MEETING AND SHALL BE PROVIDED AT THE CONTRACTORS EXPENSE. IF THERE ARE OTHER ADJACENT RAILROADS (BNSF, UP, ETC.) A SEPARATE EIC/FLAGGER MUST BE ARRANGED THRU THOSE RAILROADS. THE RTDC-DTO EIC/FLAGGER WILL NOT FLAG FOR OTHER RAILROADS. 10. RTD AND RTDC-DTO ASSUMES NO RESPONSIBILITY FOR UTILITY LOCATIONS SHOWN ON THESE CONSTRUCTION DRAWINGS. IT IS THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY THE LOCATION OF ALL UTILITIES PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION. 11. CONTRACTOR SHALL IDENTIFY THE HORIZONTAL LOCATION AND VERTICAL DEPTH OF RTD UNDERGROUND ELECTRIC AND COMMUNICATION DUCTS AND INSTALL THE NEW UTILITY WITHOUT COMPROMISING THE INTEGRITY OF THE RTD TRACKS OR DYNAMIC ENVELOPE. THIS MUST BE ACCOMPLISHED BY NON-DESTRUCTIVE EXPLORATORY MEANS AND METHODS OF LOCATING THE RTD DUCTS THAT DOES NOT INCLUDE POTHOLING OR DIGGING WITHIN THE RTD TRACK ENVELOPE. THE LOCATING METHOD MUST BE AGREED UPON BY BOTH CONTRACTOR AND RTDC-DTO AND SHALL BE DESCRIBED AT PRE-CONSTRUCTION MEETING AND SHALL BE PART OF THE PRE-CONSTRUCTION RESOLUTION RECORD (PCRR). THE CONTRACTOR SHALL BE RESPONSIBLE TO MAKE RTD WHOLE FROM ANY DAMAGE TO RTD FACILITIES, INCLUDING DAMAGE DONE AFTER ASSISTANCE BY RTDC-DTO'S STAFF TO HELP LOCATE RTD DUCTS. 12. CONTRACTOR SHALL PROVIDE FOR CONSTANT MONITORING OF RAIL ELEVATIONS DURING CONSTRUCTION EITHER BY THE USE OF SURVEY TARGETS PLACED ON THE RAIL OR OTHER METHODS APPROVED BY RTDC-DTO. CONTRACTOR SHALL SUBMIT DAILY MONITORING REPORTS TO RTDC-DTO. ANY VARIATIONS IN RAIL ELEVATION MUST BE REPORTED TO THE DESIGNATED RTD-DTO EIC/FLAGGER AND TO THE RTDC-DTO CHIEF ENGINEER IMMEDIATELY FOR EVALUATION OF TRACK SAFETY. IF AN RTD-DTO EIC/FLAGGER IS NOT PRESENT ON SITE AND THE CHIEF ENGINEER IS UNREACHABLE, THE OCC SUPERVISOR SHOULD BE CONTACTED IMMEDIATELY INSTEAD AT (720-460-5809). 13. AS-BUILT DOCUMENTATION: CONTRACTOR SHALL SURVEY AND SUBMIT THE COMPLETED HORIZONTAL PLAN AND VERTICAL PROFILE AS-BUILTS TO RTD AND RTDC-DTO WITHIN 30 CALENDAR DAYS OF THE COMPLETION OF CONSTRUCTION WITHIN RTD RIGHT-OF-WAY. THE PLAN AND PROFILE AS-BUILTS MUST CONTAIN THE FOLLOWING INFORMATION: a. PRE AND POST CONSTRUCTION AND SURVEY OF TOP OF RTD TRACKS TO SHOW NO MOVEMENT OF TRACKS DUE TO CONSTRUCTION: AT A MINIMUM, THE CONTRACTOR SHALL SURVEY EACH RAIL AT THE CENTERLINE AND 10' EACH SIDE OF THE NEW PIPELINE CROSSING LOCATION. TOP OF RAIL SURVEYS MUST BE COMPLETED IMMEDIATELY PRIOR TO AND IMMEDIATELY FOLLOWING CONSTRUCTION. b. AT A MINIMUM THE CONTRACTOR SHALL SURVEY THE EXACT HORIZONTAL AND VERTICAL LOCATION OF THE PIPELINE WHERE IT CROSSES EACH RIGHT-OF-WAY LINE, TRACK CENTER LINE, AND MIDWAY BETWEEN THE OUTMOST TRACKS AND EACH RIGHT-OF-WAY LINE. c. ALL SURVEY DATA SHALL BE TIED TO RTD CONTROL POINTS. d. CONTRACTOR SHALL SUPPLY RTD WITH A COPY OF THE SURVEYOR'S FIELD NOTES TO SUPPORT THE BEFORE AND AFTER SURVEY DATA AND FINAL UTILITY INSTALLATION DATA. e. RTD UTILITY AGREEMENT NUMBER. f. DATE THE FACILITY WAS INSTALLED. g. SIZE OF PIPE AND SIZE OF CASING. h. MATERIAL BEING CARRIED IN THE PIPE. i. AS-BUILTS MUST BE STAMPED, SIGNED, AND DATED BY A LICENSED SURVEYOR OR ENGINEER. 14. CONTRACTOR SHALL CLEARLY MARK UTILITY CROSSING USING A METHOD AGREED UPON BY CONTRACTOR AND RTD AT PRE-CONSTRUCTION MEETING. MARKERS MAY INCLUDE 4 FOOT UTILITY POSTS OVER UTILITY OR VISIBLE MANHOLES ON BOTH SIDES OF RTD ROW/TRACKS. THE CONTRACTOR SHALL INSTALL TRACER WIRE IN ALL NON-METALLIC PIPES. ALL UTILITIES INSTALLED WITHIN RTD ROW OR CROSSING RTD TRACKS MUST BE LOCATABLE WITH STANDARD LOCATING EQUIPMENT.				NORTH ARROW NEW (E) CIPP LINED EXISTING; SCREENED TEXT LABELS FOR SCREENED ELEMENTS IMPLY THE ELEMENT IS EXISTING FUTURE EXISTING LINEAR ELEMENTS TO BE REMOVED OR DEMOLISHED EXISTING NON-LINEAR ELEMENTS TO BE REMOVED, DEMOLISHED, OR ABANDONED CENTERLINE MATCHLINE BREAK LINE NATIVE EARTH (IN SECTION) ENGINEERED FILL (IN SECTION) LANDSCAPE FILL (IN PLAN AND SECTION) SAND OR GROUT (IN PLAN AND SECTION) GRAVEL (IN PLAN AND SECTION) AGGREGATE BASE (IN PLAN AND SECTION) CRUSHED ROCK (IN PLAN AND SECTION) CONCRETE (IN PLAN AND SECTION) GRATING (IN PLAN) CHECKER PLATE (IN PLAN) MASONRY (IN SECTION) STEEL (IN SECTION) UTILITY CROSSING UNDERNEATH UTILITY CROSSING OVER CROSSING UTILITIES				FOUND ON DRAWING WHERE DETAIL, SECTION, OR ELEVATION IS CALLED OUT FOUND ON DRAWING WHERE DETAIL, SECTION, OR ELEVATION IS DRAWN DETAIL NUMBER 1 C-15 SHEET ON WHICH DETAIL IS DRAWN, "-" IF ON SAME SHEET SECTION LETTER A A-13 SHEET ON WHICH SECTION IS DRAWN, "-" IF ON SAME SHEET LETTERS USED WHEN MORE THAN ONE ELEVATION IS DRAWN WITHIN A SINGLE ROOM 2 A-9 ELEVATION NUMBER 2 A-9 SHEET ON WHICH ELEVATION IS DRAWN, "-" IF ON SAME SHEET STANDARD DETAIL NUMBER S-5605 STANDARD DETAIL NUMBER C-5605 STANDARD DETAIL TITLE SUB-TITLE SCALE: ##" = 1'-0" REV 00 NOTE STANDARD DETAILS ARE LOCATED WITHIN THEIR RESPECTIVE DISCIPLINE, IMMEDIATELY FOLLOWING THE GENERAL ABBREVIATIONS, NOTES, AND LEGEND SHEETS.				REVISION SYMBOLS CLOUDED AREA INDICATES CHANGED INFORMATION; NUMBER IN TRIANGLE INDICATES THE DRAWING VERSION AND MATCHES WITH REVISION INFORMATION IN THE REVISION BLOCK WITHIN THE DRAWING BORDER							
SEP 2024 - 90% DESIGN NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.				REVISION DATE BY				DESIGNED TS DRAWN WAS CHECKED LS				CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 Kennedy Jenks				GENERAL NOTES AND LEGEND				SCALE NTS JOB NO 2246059'00 DATE SEP 2024 SHEET 2 OF 48 G-002			

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PIPING - SINGLE LINE				VALVES AND GATES				PRIMARY INLINE ELEMENTS				EQUIPMENT				PIPING ACCESSORIES AND FITTINGS			
NEW WORK (NOT SCREENED) EXISTING (SCREENED) FUTURE (LONG DASH, SHORT DASH) PROCESS - PRIMARY PROCESS - SECONDARY PROCESS - DRAIN PROCESS - HEAT TRACED OR CONNECTED NOT CONNECTED				* FC = FAIL CLOSED FO = FAIL OPEN FL = FAIL LOCKED IN LAST GATE VALVE (NORMALLY OPEN, NORMALLY CLOSED) GLOBE VALVE (NORMALLY OPEN, NORMALLY CLOSED) PLUG VALVE (NORMALLY OPEN, NORMALLY CLOSED) CHECK VALVE ANGLED CHECK VALVE DUCKBILL CHECK VALVE BALL CHECK VALVE BACKFLOW PREVENTER (DOUBLE CHECK ASSEMBLY) BACKFLOW PREVENTER (REDUCED PRESSURE PRINCIPLE) PINCH VALVE DIAPHRAGM VALVE BUTTERFLY VALVE BALL VALVE (NORMALLY OPEN, NORMALLY CLOSED) NEEDLE VALVE PRESSURE REDUCING VALVE, SELF-CONTAINED PRESSURE REDUCING VALVE WITH EXTERNAL PRESSURE TAP PRESSURE SUSTAINING VALVE, SELF-CONTAINED PRESSURE SUSTAINING VALVE WITH EXTERNAL PRESSURE TAP DIFFERENTIAL PRESSURE REGULATING VALVE, SELF-CONTAINED DIFFERENTIAL PRESSURE REGULATING VALVE WITH EXTERNAL PRESSURE TAP 3-WAY VALVE 4-WAY VALVE SHADING INDICATES PORT TO BE CLOSED DURING NORMAL OPERATION. DOT INDICATES PORT TO BE CLOSED DURING ALTERNATE OPERATION. ANGLE VALVE FOOT VALVE VACUUM RELIEF/AIR INLET VALVE (AV) PRESSURE RELIEF VALVE (PREL) AIR RELEASE/VACUUM RELIEF VALVE (ARVR) COMBINATION AIR/VACUUM VALVE (CA) AIR RELEASE VALVE (AR) GATE - NORMALLY CLOSED GATE - NORMALLY OPEN FLAP GATE				ORIFICE PLATE MAGNETIC FLOW TUBE SINGLE PORT PITOT TUBE OR PITOT-VENTURI TUBE VENTURI TUBE AVERAGING PITOT TUBE FLUME WEIR TURBINE OR PROPELLER-TYPE PRIMARY ELEMENT THERMAL MASS FLOWMETER POSITIVE DISPLACEMENT TYPE FLOW TOTALIZING INDICATOR VORTEX SENSOR TARGET TYPE SENSOR CORIOLIS EFFECT SENSOR MISCELLANEOUS PIPE MATERIAL CHANGE ROTAMETER ROTAMETER WITH INTEGRAL VALVE VENT FLAME ARRESTOR SILENCER SNUBBER WEIGH SCALE CHEMICAL DIFFUSER INJECTION MIXER STATIC MIXER EDUCTOR/INJECTOR SHELL AND TUBE HEAT EXCHANGER PLATE AND FRAME HEAT EXCHANGER EYEWASH EYEWASH AND SHOWER				MISCELLANEOUS DRIVE UNIT MOTOR CENTRIFUGAL PUMPS HORIZONTAL SUBMERSIBLE VERTICAL TURBINE PUMP HEAD VERTICAL TURBINE PUMP T-HEAD VERTICAL TURBINE PUMP CAN VERTICAL TURBINE PUMP INTAKE POSITIVE DISPLACEMENT PUMPS METERING PUMP METERING SOLENOID PERISTALTIC/ HOSE PUMP ROTARY PUMP PROGRESSIVE CAVITY PUMP BLOWERS, FANS AND COMPRESSORS BLOWER FAN CENTRIFUGAL COMPRESSOR RECIPROCATING COMPRESSOR MIXERS VERTICAL SUBMERSIBLE CONVEYORS HORIZONTAL SCREW INCLINED SCREW BELT THICKENERS AND GRINDERS BELT FILTER PRESS GRAVITY BELT THICKENER CENTRIFUGE SLUDGE GRINDER				FLANGE UNION TEE Y STRAINER FLOW STRAIGHTENING VANE SCREWED CAP WELDED CAP BLIND FLANGE QUICK DISCONNECT REDUCER (CONCENTRIC) REDUCER (ECCENTRIC) HOSE BIBB CONNECTION CHEMICAL PIPING FLEXIBLE CONNECTION/ FLEXIBLE HOSE FLEXIBLE TANK CONNECTION BRAIDED METAL HOSE METAL BELLOWS EXPANSION JOINT FLEXIBLE COUPLING FLANGED COUPLING ADAPTER DISASSEMBLING JOINT DRAIN SPRAY NOZZLE THERMOWELL CALIBRATION CYLINDER PULSATION DAMPER DIAPHRAGM SEAL ANNULAR SEAL RUPTURE DISK, PRESSURE RUPTURE DISK, VACUUM PURGE VALVE AND GATE OPERATORS DIAPHRAGM CYLINDER OPERATOR DIAPHRAGM PRESSURE BALANCED SOLENOID HAND/MANUAL MOTOR NOTES 1. SEE THE PRECEDING DRAWING FOR EQUIPMENT DESIGNATIONS AND PROCESS IDENTIFICATION CODES. 2. THIS IS A GENERALIZED LEGEND SHEET. SEE ALSO ISA S5.1, S5.3 AND S7.3.			
SEP 2024 - 90% DESIGN						SCALES			DESIGNED	CITY OF ARVADA				GENERAL PROCESS SYMBOLS				SCALE	
NOT FOR CONSTRUCTION						0 1"			TS	NORTH TRUNK SEWER IMPROVEMENTS								NTS	
THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.						0 25mm			DRAWN	NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11								JOB NO 2246059*00	
						IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.			CHECKED	KJ Kennedy Jenks								DATE SEP 2024	
		NO	REVISION	DATE	BY				LS					SHEET 3 OF 48				G-003	

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NORTH TRUNK SEWER IMPROVEMENTS
TENNYSON STREET SURVEY CONTROL DIAGRAM
61ST PL. TO HIGHWAY 76



PROJECT BENCHMARK INFORMATION

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION
	NORTHING	EASTING		NORTHING	EASTING		
BM-877	1718690.601	3128077.474	5248.35	719098.501	128819.867	5245.90	2" BRASS CAP TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER 60TH AVE. & TENNYSON ST.

PROJECT COORDINATE TABLE

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION OF MONUMENT
	NORTHING	EASTING		NORTHING	EASTING		
100	1716235.485	3128174.019	5242.33	716642.802	128916.435	5239.93	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 100, .10' BELOW GRAVEL SHOULDER SURFACE
110	1716707.689	3128166.503	5242.42	717115.118	128908.916	5240.07	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 110, FLUSH WITH GROUND
120	1717348.954	3128153.540	5243.76	717756.535	128895.951	5241.40	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 120, FLUSH WITH GROUND
130	1718043.519	3128089.233	5246.66	718451.266	128831.628	5244.10	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 130, FLUSH WITH GROUND
140	1718653.577	3128127.307	5248.86	719061.468	128869.711	5246.50	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 140, FLUSH WITH GROUND
150	1719406.089	3128072.783	5269.56	719814.159	128815.174	5267.09	FOUND CHISELED TRIANGLE WITH PUNCH MARK ON 5' TYPE R INLET AT NW CORNER 61ST AVE. & TENNYSON ST.
160	1719994.598	3128102.218	5278.84	720402.808	128844.617	5276.41	SET 18" #5 REBAR WITH A 2 ½" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 160, FLUSH WITH GROUND
200	1715999.301	3128162.299		716406.563	128904.713		70' W.C. EAST OF THE S ¼ SEC. 7 FOUND A 3 ¼" CAP IN RANGE BOX ILLEGIBLE
201	1717317.224	3128088.588		717724.799	128830.985		C-S ⅙ SEC. 7 FOUND A 2 ½ " ALUM. CAP IN RANGE BOX STAMPED: S 7 C-S ⅙ 2005 LS 16837
202	1718636.102	3128086.014		719043.989	128828.409		C ¼ SEC. 7 3 ¼" ALUM. CAP ON 2" STEEL PIPE IN RANGE BOX STAMPED: ERNEST KNIGHT LS 7276 T3S, R68W S7 C ¼ 1988 ADAMS COUNTY
203	1719955.381	3128081.771		720363.582	128824.166		C-N ⅙ SEC. 7 3 ¼" ALUM. CAP ON #6 REBAR IN RANGE BOX STAMPED: GREENHORNE & OMARA N ⅙ S7 1986 PLS 20696
204	1721275.134	3128077.632		721683.648 C.O.A. CALC.	128820.025 C.O.A. CALC.		N ¼ SEC. 7 1" AXLE 1.2' BELOW ASPHALT SURFACE IN RANGE BOX @ 64TH & TENNYSON ST.
205	1715973.927	3125529.897		716381.183 C.O.A. CALC.	126271.685 C.O.A. CALC.		SW CORNER SEC. 7 3 ¼" ALUM. CAP IN CONCRETE ON BRIDGE IN RANGE BOX STAMPED: LANE ENG. SRV INC T3S R69W R68W 13-7 2006 LS 16837 @ 56TH & SHERIDAN BLVD.

GENERAL NOTES:

- THIS PROJECT CONTROL DIAGRAM IS FOR THE EXCLUSIVE USE OF THE CITY OF ARVADA, FOR THE DESIGN AND CONSTRUCTION OF THE TENNYSON AND 58TH NORTH TRUNK SEWER PROJECT. IT IS NOT A MONUMENTED LAND SURVEY OR LAND SURVEY PLAT. IT IS INTENDED ONLY TO DEPICT THE CONTROL INFORMATION AND MONUMENTATION SHOWN HEREON, AND IS SUBJECT TO CHANGE. CONTACT THE CITY OF ARVADA FOR THE MOST RECENT DIAGRAM.
- PUBLISHED UNITS FOR COORDINATES AND ELEVATIONS ARE IN US SURVEY FEET.
- SURVEY CONTROL DIAGRAM WAS PROVIDED BY THE CITY OF ARVADA DATED SEPTEMBER 22ND, 2022.
- DESIGN SURVEY WAS PERFORMED BY THE CITY OF ARVADA DATED AUGUST, 2023. ADDITIONAL DESIGN SURVEY WAS PERFORMED BY THE CITY DATED JULY 2024.
- CONTRACTOR SHALL PROTECT IN PLACE THE ALIQUOT SECTION CORNER MONUMENTS WITHIN THE AREA OF WORK. IF MONUMENTS ARE TO BE DISTURBED DURING CONSTRUCTION, THEY SHALL BE REFERENCED IN PLACE PRIOR TO DISTURBANCE AND REESTABLISHED IN PLACE AFTER CONSTRUCTION COMMENCES BY A PLS REGISTERED IN THE STATE OF COLORADO.

BASIS OF BEARINGS:

ASSUMES THE LINE BETWEEN POINT 201 AND POINT 202 BEARS N 00° 06' 43" W A DISTANCE OF 1313.19 FEET. POINT 201 IS THE S ⅙ AT 58TH AND TENNYSON ST. AND 202 IS THE C ¼ AT 60TH AND TENNYSON

BASIS OF ELEVATIONS:

THE VERTICAL CONTROL IS BASED ON EXCLUSIVE CITY OF ARVADA DATUM AND IS NOT RELATED TO NGVD29 OR NAVD88. A LEVEL LOOP WAS RAN THROUGH EACH CONTROL POINT FROM BM-877 USING A LEICA DNA 10 (DIGITAL LEVEL) FROM BENCHMARK #877 WHICH IS A 2" BRASS CAP AT TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER OF 60TH AND TENNYSON ST.

COORDINATE DATUM:

STATE PLANE COORDINATES ARE COLORADO CENTRAL ZONE (0502) NAD83 GEOID 18 BASED ON FAST STATIC GPS SURVEY. PROJECT COORDINATES ARE MODIFIED COLORADO STATE PLANE CENTRAL ZONE COORDINATES. PROJECT COORDINATES ARE DERIVED FROM STATE PLANE COORDINATES USING THE FOLLOWING FORMULAS.

PROJECT NORTHING = (STATE PLANE NORTHING * 1.000237332) - 1000000.00
PROJECT EASTING = (STATE PLANE EASTING * 1.000237332) - 3000000.00

CONVERSION OF PROJECT COORDINATES TO COLORADO STATE PLANE CENTRAL ZONE:

ADD 1,000,000 FEET TO THE PROJECT NORTHING AND 3,000,000 FEET TO PROJECT EASTING AND MULTIPLY EACH BY THE COMBINED SCALE FACTOR OF 0.999762724.

APPROVED

City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

LEGEND:

- = SECTION, QUARTER & SIXTEENTH CORNERS
- = CONTROL POINT SET BY THE CITY OF ARVADA
- = CITY OF ARVADA BENCH MARK

SEP 2024 - 90% DESIGN

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NO

REVISION

DATE

BY

SCALES

0 1" = 150'
0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED
TS

DRAWN
WAS

CHECKED
LS



NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SURVEY CONTROL DIAGRAM

SCALE

1" = 150'

JOB NO
2246059'00

DATE
SEP 2024

SHEET 4 OF 48

G-004

Plot Date: 9/6/2024 10:52 AM

User: ROBERT INOPEA

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CIVIL NOTES

GENERAL

1. OBTAIN PERMITS NECESSARY TO COMPLETE FEATURES WITHIN EASEMENTS, DEDICATIONS, AND PUBLIC RIGHT-OF-WAY.

2. COORDINATES ARE PROVIDED AS FOLLOWS UNLESS OTHERWISE NOTED ON DRAWINGS:

2.1. FACE OF WALL

2.2. FACE OF CURB

2.3. CORNER OF EQUIPMENT PADS AND VAULTS

3. ORIENT SURFACE FEATURES PARALLEL TO CURB/GUTTER OR WALLS UNLESS OTHERWISE NOTED.

4. PROTECT ALL SURVEY MONUMENTS.

5. SHOULD THE CONTRACTOR DISCOVER ANY DISCREPANCIES BETWEEN THE CONDITIONS EXISTING IN THE FIELD AND THE INFORMATION SHOWN ON THESE DRAWINGS, CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION.

6. THE CONTRACTOR SHALL MAINTAIN A COPY OF AN APPROVED SET OF PLANS ON THE CONSTRUCTION SITE AT ALL TIMES.

7. "LIMITS OF EXCAVATION" INDICATES THE MINIMUM MATERIAL REMOVAL REQUIRED DUE TO GEOTECHNICAL RECOMMENDATIONS AND THE NATURE OF THE WORK. TAKE CARE NOT TO EXCAVATE BEYOND THE LIMITS INDICATED IN THE CONTRACT DOCUMENTS.

8. "LIMITS OF WORK" INDICATES THE TOTAL AREA OF DISTURBANCE DUE TO THE NATURE AND SCOPE OF THE WORK. THE TERM MAY ALSO BE USED TO INDICATE AREAS WHERE ACCESS IS LIMITED OR RESTRICTED.

9. PROVIDE TEMPORARY TRAFFIC SIGNAGE IN ACCORDANCE WITH STATE AND LOCAL AGENCIES DURING THE COURSE OF CONSTRUCTION.

10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL WITHIN THE PUBLIC RIGHT OF WAY IN ACCORDANCE WITH LOCAL ORDINANCES. NO WORK SHALL COMMENCE UNTIL ALL REQUIRED TRAFFIC CONTROL MEASURES ARE IN PLACE.

11. FOR WORK ASSOCIATED WITH METRO WATER RECOVERY: METRO MAY REQUIRE PRE- AND POST-VIDEO INSPECTIONS OF THE EXISTING METRO TRANSMISSION MAINLINE DURING CONSTRUCTION TO ENSURE NO DAMAGE IS DONE TO THE EXISTING SANITARY LINE. COORDINATE WITH THE METRO FIELD INSPECTOR FOR REQUIREMENTS:

a. NOTIFY TYLER HOPKINS 2-WEEKS PRIOR TO CONSTRUCTION STARTING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.

b. NOTIFY AND INVITE METRO TO THE PRECONSTRUCTION MEETING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.

12. ALL PROPOSED WORK FROM SSMH 4-7 SOUTH TO THE SOUTHERN MOST EXTENTS OF CONSTRUCTION LIMITS ARE LOCATED WITHIN THE 100-YEAR FLOODPLAIN AND/OR FLOODWAY. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL NECESSARY PERMITS FOR WORK WITHIN THE ADAMS COUNTY AND CITY OF ARVADA RIGHT OF WAY INCLUDING ANY NECESSARY PERMITS REQUIRED RELATED TO WORK WITHIN THE FLOODPLAIN AND/OR FLOODWAY.

13. THE OWNER, OWNER'S REPRESENTATIVE, AND/OR THE ENGINEER, IS NOT A GUARANTOR OF THE CONSTRUCTION CONTRACTORS' OBLIGATIONS AND PERFORMANCE OF CONTRACT.

14. OBSERVATIONS OF WORK IN PROGRESS AND ON-SITE VISITS ARE NOT TO BE CONSTRUED AS A GUARANTEE BY THE CITY OR ENGINEER OF THE CONTRACTORS' PERFORMANCE.

15. THE OWNER OR ENGINEER, IS NOT RESPONSIBLE FOR SAFETY IN, ON, OR ABOUT THE PROJECT SITE, NOR FOR COMPLIANCE BY THE APPROPRIATE PARTY OF ANY REGULATIONS RELATING THERETO.

16. THE OWNER OR ENGINEER, EXERCISES NO CONTROL OF THE SAFETY OR ADEQUACY OF ANY EQUIPMENT, BUILDING COMPONENTS, SCAFFOLDING, FORMS, OR ANY OTHER WORK AIDS USED IN OR ABOUT THE PROJECT, OR IN THE SUPERINTENDING OF THE SAME.

17. WORK WITHIN ADAMS COUNTY R/W SHALL MILL/OVERLAY ENTIRE LANE TO THE CENTERLINE OF THE ROAD. IF WORK EXTENDS PAST THE CENTERLINE, CONTRACTOR SHALL MILL/OVERLAY THE ENTIRETY OF THE ROAD EXTENTS.

GRADING

1. ADJUST VALVE BOXES, PULL BOXES, VAULTS, AND MAINTENANCE HOLES TO FINISHED GRADES AND SLOPES SHOWN ON CIVIL GRADING DRAWINGS UNLESS OTHERWISE SHOWN OR SPECIFIED. MAINTENANCE HOLES IN OPEN FIELDS SHALL BE SET ONE FOOT ABOVE GRADE. APPROXIMATE RIM ELEVATIONS ARE SHOWN ON DRAWINGS.

2. GRADES SHOWN ARE TO TOP OF THE FINISHED SURFACE UNLESS OTHERWISE NOTED.

DEMOLITION

1. DEMOLITION EXTENTS INDICATED IN DRAWINGS ARE THE MINIMUM REQUIRED TO COMPLETE THE WORK. CONTRACTOR SHALL DETERMINE FULL DEMOLITION EXTENTS DURING FIELD RECONNAISSANCE PRIOR TO CONSTRUCTION.

2. PROVIDE COORDINATES OF ABANDONED UTILITIES IN THE RECORD DRAWINGS.

3. EXISTING METERING VAULT SHALL BE REMOVED. REMOVE VAULT BASE AS NEEDED TO PERFORM THE PIPELINE BEDDING, TRENCHING, AND BACKFILLING REQUIREMENTS OUTLINED IN THE PROJECT SPECIFICATIONS. BACKFILL REMAINING AREAS TO GRADE.

APPROVED

City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

PIPING

1. THESE NOTES ARE GENERIC IN NATURE. PROJECT SPECIFIC NOTES ON FOLLOWING DRAWINGS TAKE PRECEDENCE.

2. THE CONTRACTOR SHALL COMPLY WITH THE STATE DEPARTMENT OF HEALTH SERVICES CRITERIA FOR THE SEPARATION BETWEEN WATER MAINS, NON-POTABLE WATER UTILITIES, AND SEWER.

3. INSTALL WATER, STORM, AND SEWER PIPELINES WITH A MINIMUM OF 48 INCHES OF COVER, UNLESS OTHERWISE NOTED OR SHOWN ON THE DRAWINGS.

4. PRIOR TO SUBMITTAL OF PIPE SHOP DRAWINGS, VERIFY THE INVERT ELEVATIONS, ALIGNMENT, OUTSIDE DIAMETER, LOCATION, AND MATERIAL OF ALL EXISTING PIPELINES TO WHICH NEW PIPELINES WILL BE CONNECTED.

5. PIPE STATIONING REPRESENTS THE HORIZONTAL PROJECTION OF THE PIPE CENTERLINE BETWEEN MAINTENANCE HOLES, POINTS OF INFLECTION, AND/OR CENTER OF FITTINGS.

6. RESTRAIN ALL WATER PIPE AND FITTINGS AT UTILITY CROSSINGS PER CITY OF ARVADA LENGTH OF RESTRAINED PIPE DETAIL.

7. LOCATION OF EXISTING UTILITIES ARE APPROXIMATE. CONTRACTOR SHALL EXPOSE EXISTING PIPE(S) OR STRUCTURE(S) TO WHICH NEW PIPE(S) IS/ARE CONNECTING. VERIFY EXACT LOCATION, SIZE, MATERIALS, AND INVERT ELEVATIONS PRIOR TO SUBMITTING PIPE DRAWINGS.

8. PROTECT EXISTING UTILITIES UNLESS OTHERWISE NOTED.

9. USE CAUTION WHEN WORKING IN PROXIMITY TO GAS. NOTIFY UTILITY COMPANY WHEN WORKING WITHIN THE VICINITY AND FOLLOW UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.

10. USE CAUTION WHEN WORKING IN PROXIMITY TO OVERHEAD ELECTRICAL LINES. FOLLOW ELECTRICAL UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.

11. CROSSING PIPELINES SHOWN IN PROFILE REPRESENT OUTSIDE DIAMETER UNLESS OTHERWISE NOTED.

12. ORIENT ECCENTRIC MAINTENANCE HOLE(S) SUCH THAT THE LID IS OUTSIDE OF WHEEL PATH.

13. COORDINATES LOCATING MAINTENANCE HOLES ARE TO THE CENTER OF THE STRUCTURE.

14. SIZE OF FITTING SHOWN ON THE DRAWINGS CORRESPONDS TO THE ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED. MATCH TYPE OF JOINT AND FITTING MATERIAL TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED.

15. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS ARE APPROXIMATE. PROVIDE UNIONS AS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.

16. COORDINATE AND PERFORM CONNECTIONS TO THE WORK OF OTHER CONTRACTORS, IF APPLICABLE.

17. MINIMUM HORIZONTAL CLEARANCE FOR UTILITIES IS 10 FEET FROM EDGE OF SANITARY SEWER PIPE. MINIMUM VERTICAL CLEARANCE FOR UTILITIES IS 18 INCHES FROM EDGE OF SANITARY SEWER PIPE. IF MINIMUM HORIZONTAL AND VERTICAL UTILITY CLEARANCES CANNOT BE MET DUE TO FIELD CONDITIONS, SANITARY PIPING DESIGN CONSISTS OF PRESSURE RATED MATERIALS WITH LEAK TIGHT JOINTS. CONTRACTOR SHALL WORK WITH UTILITY OWNERS TO ACCOMMODATE REQUIRED CLEARANCES WHEN POSSIBLE.

18. WHEN CROSSING UNDERNEATH POTABLE WATER WITH LESS THAN 18-INCHES OF CLEARANCE, THE CONTRACTOR SHALL NOTIFY THE ENGINEER. THE CONTRACTOR SHALL CROSS THE UTILITY WITH NO PIPE JOINTS WITHIN 9-FEET OF EITHER SIDE OF THE CROSSING.

WATER

1. WATER MAIN ABANDONMENT, CITY OF ARVADA:

CITY OF ARVADA WATER MAINS TO BE ABANDONED MUST BE REMOVED AND DISPOSED OF OFF SITE.

2. MINIMUM BURY DEPTH FOR ALL WATERLINES IS 4-FEET DEEP TO TOP OF PIPE UNLESS OTHERWISE NOTED ON THE PLANS.

3. NEW WATER MAIN SHOULD BE TESTED IN SECTIONS AS TO MINIMIZE THE AMOUNT OF POTENTIAL DOWNTIME OF WATER SERVICE TO CUSTOMERS. CONTRACTOR SHALL NOTIFY CUSTOMER A MINIMUM 48 HOURS IN ADVANCE OF UPCOMING UTILITY DISRUPTIONS. FOR DOWNTIMES RESULTING IN 4 HOURS OR MORE, CONTRACTOR SHALL PROVIDE TEMPORARY WATER SERVICE TO CUSTOMERS.

4. CONTRACTOR SHALL COORDINATE WITH THE CITY OF ARVADA WATER DEPARTMENT BEFORE, AND DURING, THE WATERLINE REPLACEMENT WORK. COORDINATION WILL INCLUDE CONSTRUCTION SEQUENCING, WATER SERVICE DISRUPTIONS, INSTALLATION OF TEMPORARY BLOWOFFS, AND OPERATION OF EXISTING VALVES. CONTRACTOR IS NOT PERMITTED TO OPERATE EXISTING ARVADA WATER DEPARTMENT VALVES. VALVES WILL OPERATED BY ARVADA PERSONNEL ONLY.

5. A POTENTIAL WATERLINE CONSTRUCTION SEQUENCE IS PROVIDED ON SHEETS C-355 THROUGH C-357. THIS IS NOT A REQUIRED SEQUENCE AS THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE MEANS AND METHODS OF WATERLINE CONSTRUCTION SEQUENCING IN THE FIELD TO MINIMIZE UTILITY DISRUPTIONS.

6. CITY RECORDS INDICATE AN ABANDONED 6" CI WATER LINE IS LOCATED IN THE VICINITY OF THE PROPOSED WATER MAIN ALONG TENNYSON STREET. CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING WATER LINE IF ENCOUNTERED IN THE FIELD DURING CONSTRUCTION.

7. FOR WATERLINE RAISINGS AND LOWERINGS, CONTRACTOR SHALL WORK WITH THE UTILITY OWNER TO DETERMINE THE APPROPRIATE METHOD FOR MAINTAINING VERTICAL CLEARANCES AND ON WHETHER A PERMANENT BLOWOFF ASSEMBLY IS REQUIRED.

SANITARY SEWER

1. ALL SANITARY SEWER SYSTEM PLANS AND CONSTRUCTION SHALL CONFORM TO THE CURRENT CITY OF ARVADA ENGINEERING STANDARDS AND SPECIFICATIONS AND SHALL BE SUBJECT TO CONSTRUCTION OBSERVATION BY CITY PERSONNEL OR REPRESENTATIVES. THE ENGINEER OR CONTRACTOR SHALL SCHEDULE A PRE-CONSTRUCTION MEETING WITH THE OWNER AT LEAST 48-HOURS PRIOR TO START OF CONSTRUCTION. NO CONSTRUCTION WILL BE PERMITTED UNTIL ALL EASEMENTS ARE SIGNED AND RECORDED, AS APPLICABLE, AND THE PRE-CONSTRUCTION MEETING HAS BEEN HELD.

2. PROBATIONARY ACCEPTANCE OF THE NEW SANITARY SEWER MAINS WILL NOT BE CONSIDERED UNTIL ALL REQUIREMENTS FOR ACCEPTANCE HAVE BEEN MET, INCLUDING:

a. SANITARY SEWER TRENCH COMPACTION TEST RESULTS

b. SANITARY SEWER PIPE LEAK TESTING RESULTS

c. CCTV FOOTAGE OF THE NEWLY INSTALLED PIPELINE

d. RECORD DRAWINGS

3. MAINTENANCE HOLE RIMS SHALL BE SET AT AN ELEVATION RELATIVE TO THE PAVEMENT, IN ACCORDANCE WITH THE APPROPRIATE CITY, COUNTY, OR STATE HIGHWAY DEPARTMENT STANDARDS. WHETHER OR NOT THE MAINTENANCE HOLE IS IN A PAVED OR UNPAVED AREA, A MINIMUM OF 4-INCHES OF CONCRETE RISER RINGS SHALL BE USED TO ADJUST RIM ELEVATIONS TO FINAL GRADE. THE MAXIMUM ACCEPTABLE VERTICAL ADJUSTMENT UTILIZING RISER RINGS IS 12-INCHES.

4. THE CONTRACTOR SHALL VERIFY EXISTING MAINTENANCE HOLE INVERTS AT PROPOSED POINTS OF CONNECTION, PRIOR TO CONSTRUCTION STAKING.

5. THE CONTRACTOR SHALL TAKE CARE TO PROPERLY SHAPE ALL MAINTENANCE HOLE INVERTS AND BENCHES IN ACCORDANCE WITH CITY ENGINEERING STANDARDS AND SPECIFICATIONS. MAINTENANCE HOLE INVERTS SHALL BE CONSTRUCTED WITH A SMOOTH TROWEL FINISH, AND BENCHES FINISHED WITH A LIGHT BROOM, NON-SKID FINISH.

6. ALL NEW MAINS MUST BE JETTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.

7. ALL NEW MAINS SHALL BE VIDEO-INSPECTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.

8. THE INVERT ELEVATIONS OF ALL EXISTING PIPES WHERE CONNECTIONS ARE TO BE MADE MUST BE FIELD VERIFIED PRIOR TO CONSTRUCTION.

9. SANITARY SEWER ABANDONMENT, CITY OF ARVADA R/W:

EXISTING SANITARY SEWER TRUNKLINE SHALL BE REMOVED AS PART OF CONSTRUCTION UNLESS OTHERWISE DENOTED WITH DEMO HATCHING. IF DEMO HATCHING IS SHOWN, CONTRACTOR CAN ABANDON IN PLACE. SANITARY SEWER MAINS TO BE ABANDONED IN PLACE SHALL BE FILLED WITH CONCRETE OR FLOW FILL. WHERE A PIPE IS ABANDONED AT A MAINTENANCE HOLE, THE PIPE SHALL BE PLUGGED AT THE MAINTENANCE HOLE AND REMOVED FOR A MINIMUM OF 2-FEET. PRIOR TO FILLING WITH CONCRETE OR FLOW FILL, ANY PIPE TO BE ABANDONED IN PLACE SHALL BE FLUSHED WITH CLEAN WATER TO REMOVE DEBRIS. THE FLUSHING WATER SHALL BE PROPERLY CAPTURED AND TREATED AND NOT RELEASED TO THE STORM WATER SYSTEM OR NATURAL CHANNEL. FLUSHING WATER AND DEBRIS SHALL NOT BE DISCHARGED TO DOWNSTREAM SANITARY SEWER PIPING.

10. SANITARY SEWER ABANDONMENT, ADAMS COUNTY R/W:

THE EXISTING SANITARY SEWER MAINS WITHIN ADAMS COUNTY R/W MUST BE REMOVED AND DISPOSED OF OFF SITE.

11. MAINTENANCE HOLE ABANDONMENT:

MAINTENANCE HOLES SHALL HAVE THE TOP CONE REMOVED AND THE REMAINING MAINTENANCE HOLE VOID SPACE SHALL BE FILLED WITH FLOWABLE FILL WITH COMPRESSIBLE STRENGTH OF LESS THAN 200 PSI SO THAT IT CAN BE EXCAVATED IN THE FUTURE AS NEEDED.

12. CONTRACTOR SHALL ROTATE ECCENTRIC MAINTENANCE HOLE RIMS AND COVERS TO AVOID DRAINAGE AREAS SUCH AS GUTTERS, SURFACE STORMWATER FLOWLINES, AND DRAINAGE PANS. ROTATE RIMS AND COVERS OUT OF THE LIKELY WHEEL PATH OF VEHICLES WITHIN THE RIGHT-OF-WAY. ROTATE RIMS AND COVERS SO THAT THEY ARE LOCATED OUTSIDE OF THE CURB AND SIDEWALK WHERE POSSIBLE.

13. ALL MAINTENANCE HOLE RIMS AND COVERS SOUTH OF AND INCLUDING SSMH 4-7 SHALL BE WATER TIGHT, SEE SECTION 02080 FOR REQUIREMENTS.

14. FOR CONNECTING PIPELINES LESS THAN OR EQUAL TO 30-INCHES IN DIAMETER, 5'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED. FOR CONNECTING PIPELINES GREATER THAN 30-INCHES IN DIAMETER, 6'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED.

15. 6'-0" DIAMETER MAINTENANCE HOLES SHALL BE INSTALLED WITH 30" RINGS AND COVERS. 5'-0" DIAMETER MAINTENANCE HOLES SHALL BE INSTALLED WITH 24" RINGS AND COVERS. SEE SECTION 02080 FOR DETAILS.

16. ALL MAINTENANCE HOLES SHALL INCLUDE EXTERNAL SEALING BANDS ON THE OUTSIDE OF THE STRUCTURE AT ALL JOINTS TO PREVENT GROUNDWATER INTRUSION. COAL TAR EPOXY COAT THE EXTERIOR OF THE MAINTENANCE HOLE. LINE THE INSIDE OF THE MAINTENANCE HOLE WITH AN H2S RESISTANT COATING. SEE SECTION 02080 FOR REQUIREMENTS.

17. ALL MAINTENANCE HOLES AND PIPING SOUTH OF THE METER VAULT SHALL BE DESIGNED AND CONSTRUCTED TO METRO WATER RECOVERY STANDARD DETAILS AND SPECIFICATIONS. THIS INCLUDES THE 30" BYPASS PIPING AROUND THE METER VAULT.

18. SANITARY SEWER OWNERSHIP TRANSITIONS FROM THE CITY OF ARVADA TO METRO DOWNSTREAM OF SSMH M-3. ALL SANITARY RELATED INFRASTRUCTURE DOWNSTREAM OF THIS LOCATION, INCLUDING BYPASS INFRASTRUCTURE AND ELECTRICAL INFRASTRUCTURE, WILL BECOME THE PROPERTY OF METRO ONCE CONSTRUCTION IS ACCEPTED BY METRO.

PIPE SCHEDULE

LINE	SYSTEM	SIZE	SERVICE	FLOW	PIPE TYPE	SPECIFICATION
SS	SANITARY	21" - 42"	BURIED	GRAVITY	FRP, SN 46	SEE SPEC 02530
SS	SANITARY	< 21"	BURIED	GRAVITY	PVC, SDR 35	SEE SPEC 02530
SS-RR	SANITARY SEWER RAILROAD	30"	BURIED	GRAVITY	CIPP*	SEE SPEC 02550
SSFM	SANITARY FORCE MAIN	≤ 4"	BURIED	PRESSURE	PVC, DR 21	SEE SPEC 02531
W	WATER MAIN	≥ 6"	BURIED	PRESSURE	PVC, C909	SEE SPEC 02510
W	FIRE HYDRANT LATERAL	6"	BURIED	PRESSURE	PVC, C909	SEE SPEC 02510
W	WATER SERVICE	≤ 2"	BURIED	PRESSURE	CUP	SEE SPEC 02510
-	CASING PIPE	30"	BURIED	-	STEEL	SEE SPEC 02411

*CIPP APPLICATION TO BE UTILIZED FOR EXISTING 30" VCP/RCP AS WELL AS FOR LINING THE NEW 30" STEEL CASING PIPE

PIPING DESIGNATIONS

NEW PIPING

CENTERLINE ELEVATION (UNLESS OTHERWISE NOTED)

XXX.X

6"-RW

XXX.X

PROCESS CODE, SEE PIPE SCHEDULE

NOMINAL PIPE DIAMETER

EXISTING PIPING

6"-RW

FUTURE PIPING

6"-RW

ABBREVIATIONS

'	FOOT, FEET	G	GAS
"	INCH, INCHES	HDPE	HIGH DENSITY POLYETHYLENE
#	POUND, NUMBER	ID	INSIDE DIAMETER
%	PERCENT	IJTS	INSULATING JOINT TEST STATION
&	AND	INV	INVERT
@	AT	LF	LINEAR FEET
±	APPROXIMATELY	MAX	MAXIMUM
ℓ	CENTERLINE	MIN	MINIMUM
<	LESS THAN	MJ	MECHANICAL JOINT
≤	LESS THAN OR EQUAL TO	MW	MONITORING WELL
=	EQUALS	(N)	NEW
>	GREATER THAN	NAD	NORTH AMERICAN DATUM
≥	GREATER THAN OR EQUAL TO	NAVD	NORTH AMERICAN VERTICAL DATUM
Δ	DEFLECTION	NGVD	NATIONAL GEODETIC VERTICAL DATUM
∠	ANGLE	OD	OUTSIDE DIAMETER
°	DEGREE(-S) (ANGULAR)	OHE	OVERHEAD ELECTRICAL
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS	OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
ALUM	ALUMINUM	PE	POLYETHYLENE
APPROX	APPROXIMATE(-LY)	P/L	PROPERTY LINE
ASCE	AMERICAN SOCIETY OF CIVIL ENGINEERS	PH	POTHOLE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS	PVC	POLYVINYL CHLORIDE
AR/AV	AIR RELEASE/AIR VACUUM	QLA	QUALITY LEVEL A
BMP	BEST MANAGEMENT PRACTICE	QLB	QUALITY LEVEL B
CATS	CASING TEST STATION	QLC	QUALITY LEVEL C
CCTV	CLOSED CIRCUIT TELEVISION	QLD	QUALITY LEVEL D
CDOT	COLORADO DEPARTMENT OF TRANSPORTATION	R/R	REMOVE AND REPLACE
CDPHE	COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT	R/W	RIGHT OF WAY
CI	CAST IRON	RCP	REINFORCED CONCRETE PIPE
CIP	CAST IRON PIPE	RTD	REGIONAL TRANSPORTATION DISTRICT
CIPP	CURED IN PLACE PIPE	SD	STORM DRAIN
CM	CONTROL MEASURE	SDMH	STORM DRAIN MAINTENANCE HOLE
CSTS	CURRENT SPAN TEST STATION	SQ	SQUARE
CTS	CORROSION TEST STATION	SS	SANITARY SEWER, STAINLESS STEEL
CUP	COPPER PIPE	SSA	STABILIZED STAGING AREA
CWA	CONCRETE WASHOUT AREA	SSFM	SANITARY SEWER, FORCE MAIN
DIA	DIAMETER	SSMH	SANITARY SEWER MAINTENANCE HOLE
DIP	DUCTILE IRON PIPE	STA	STATION
DNF	DID NOT FIND	SUE	SUBSURFACE UTILITY ENGINEERING
(E)	EXISTING	SW	STEEL WELD
EC	EROSION CONTROL	SWMP	STORMWATER MANAGEMENT PLAN
ESCP	EROSION AND SEDIMENT CONTROL PLAN	TP	TEST PIT
ESMT	EASEMENT	TYP	TYPICAL
ETS	ELECTROLYSIS TEST STATION	VCP	VITRIFIED CLAY PIPE
FOC	FIBER OPTIC CABLE	VTC	VEHICLE TRACKING CONTROL
FPTS	FOREIGN PIPELINE TEST STATION		
FRP	FIBERGLASS REINFORCED PLASTIC		
FT	FEET		

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

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CIVIL NOTES AND ABBREVIATIONS

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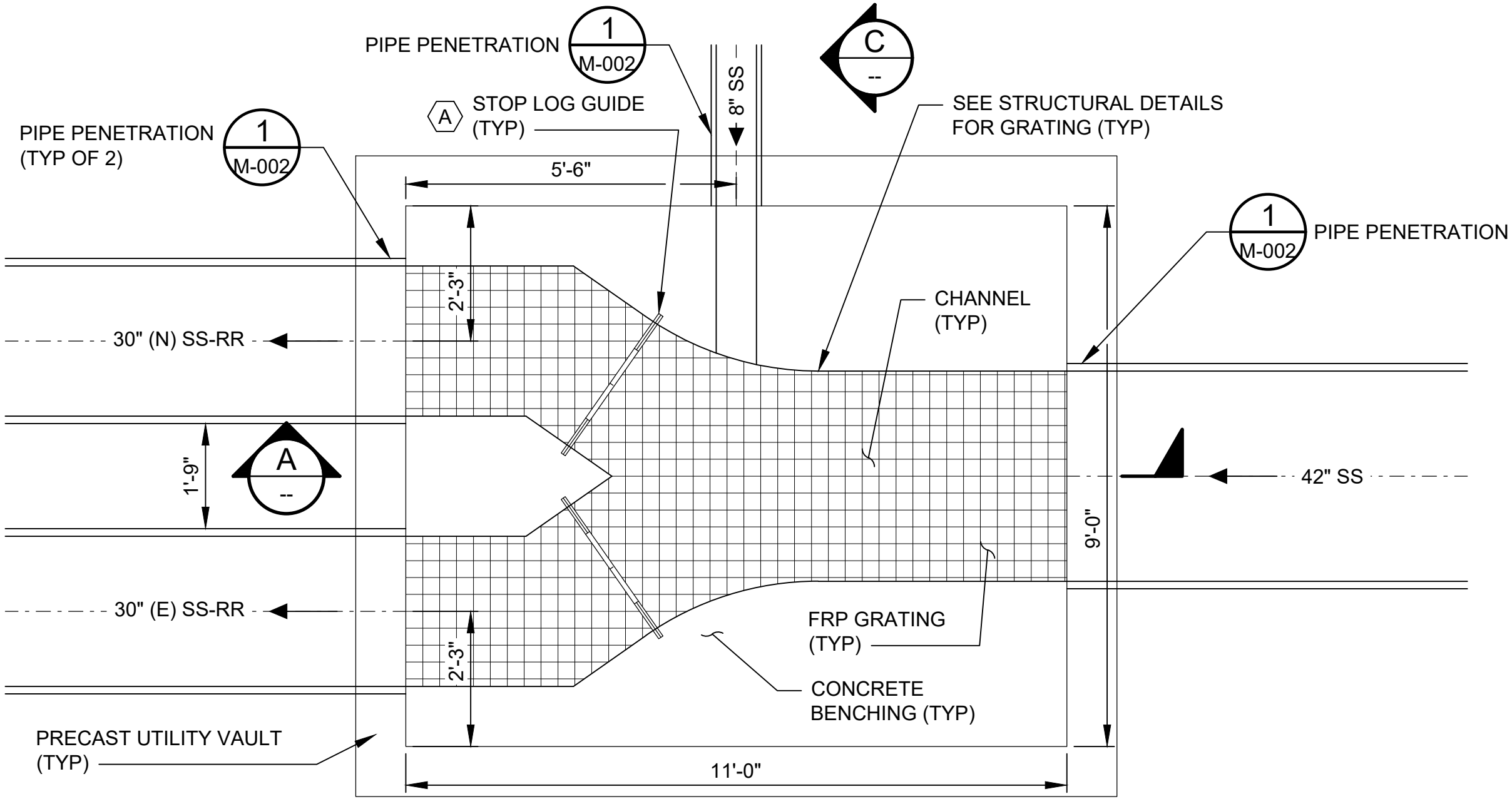
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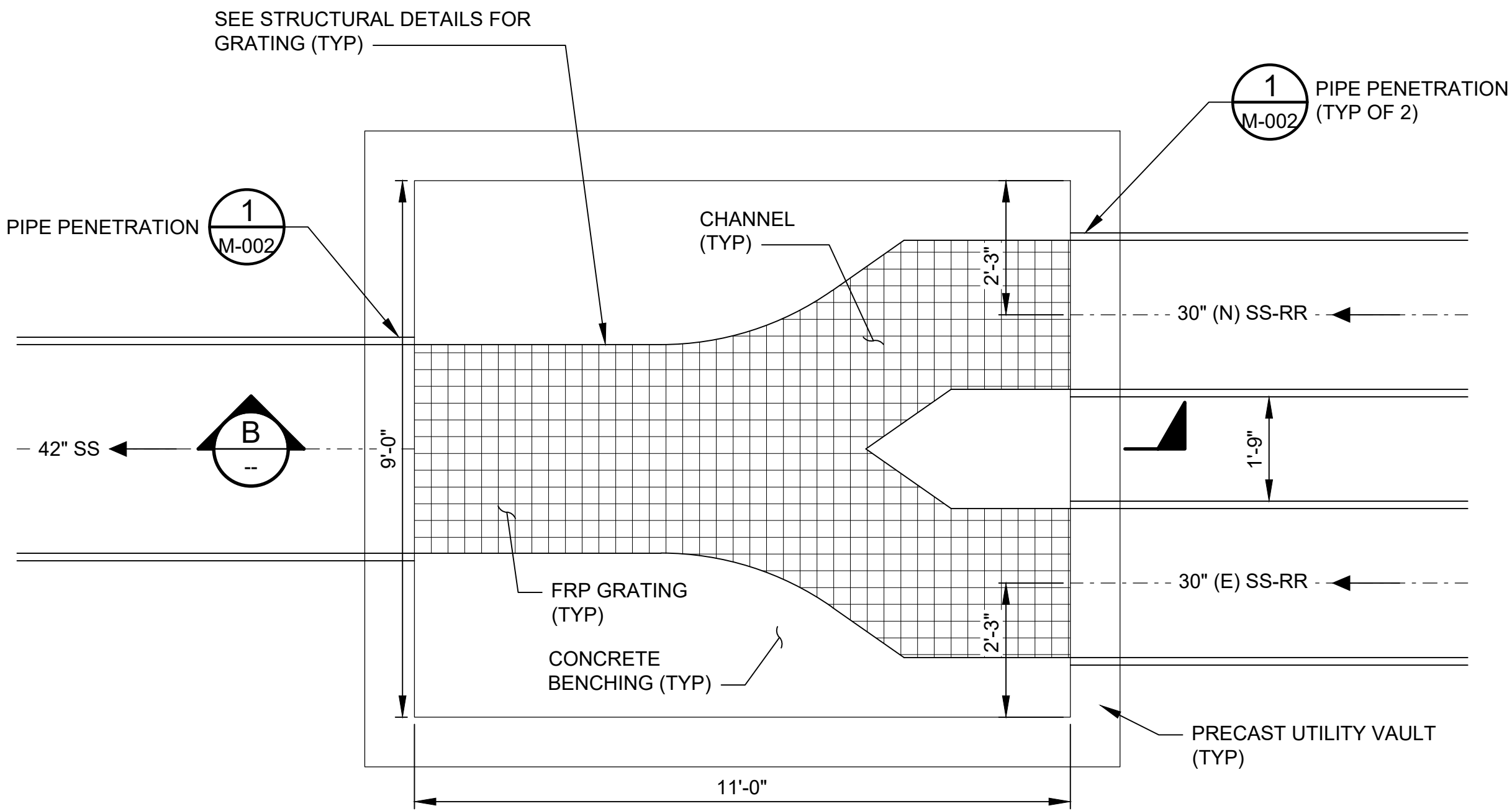
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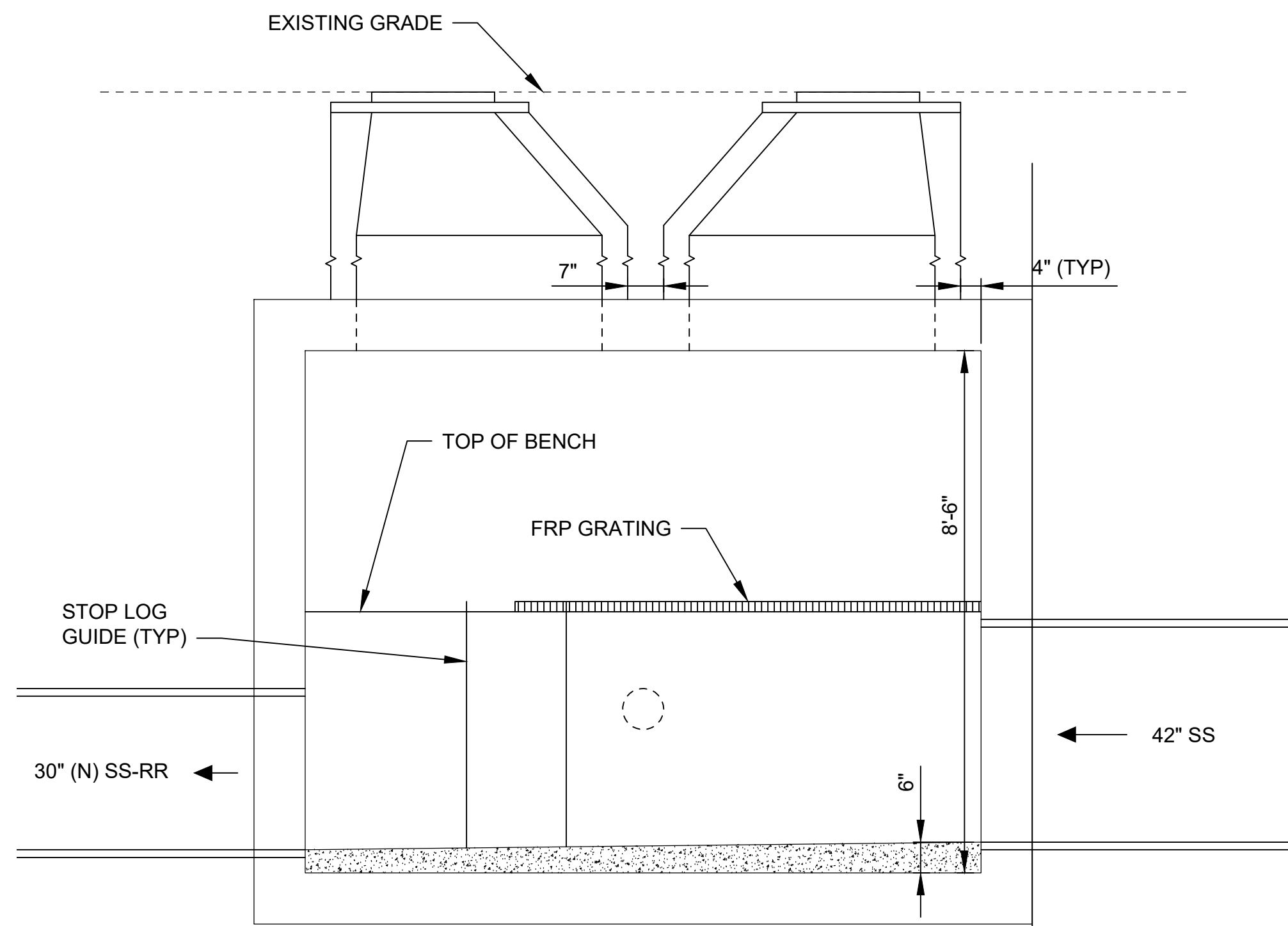
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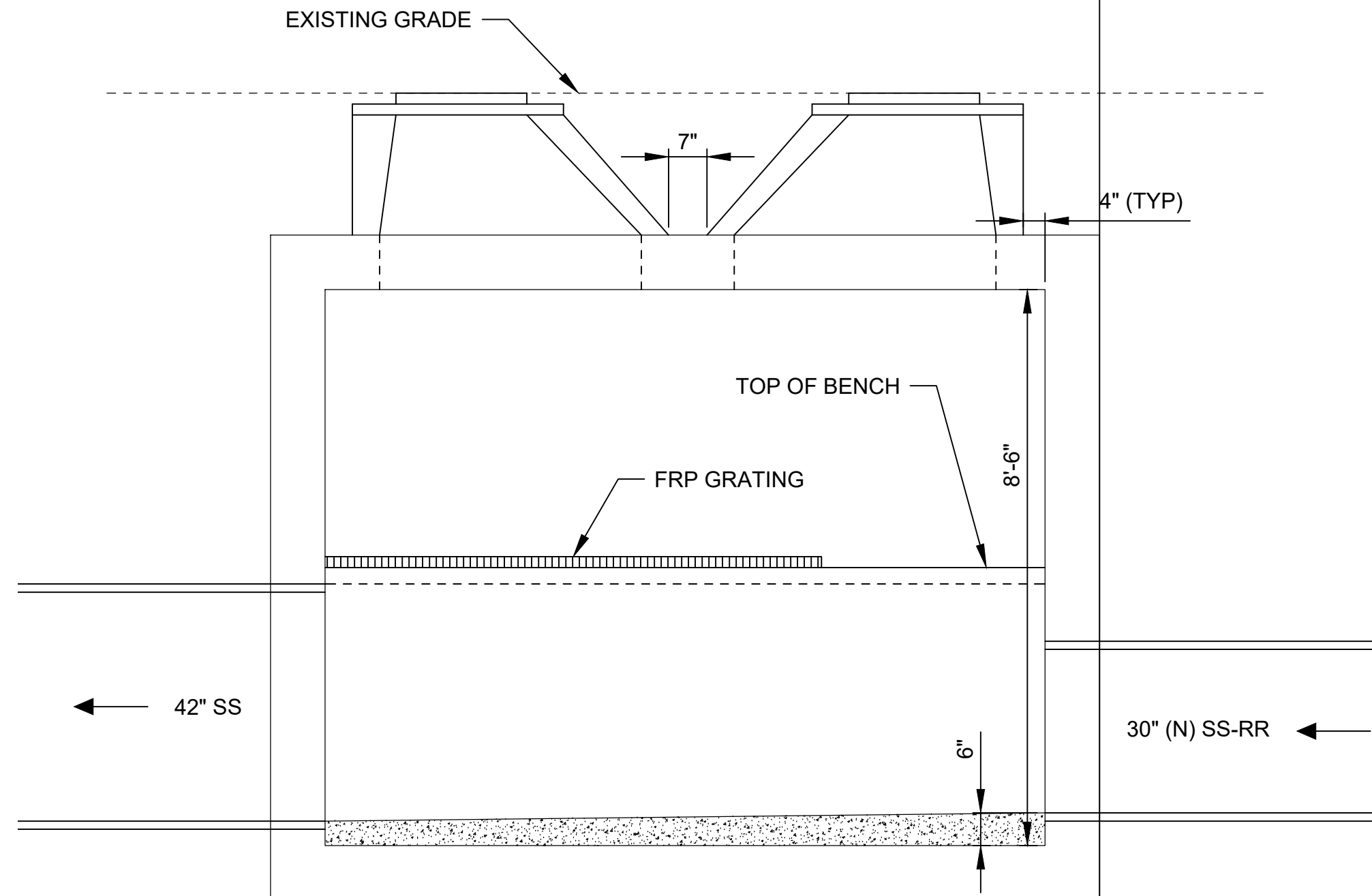
FLOW DIVERSION VAULT CHANNEL PLAN - SSMH-8
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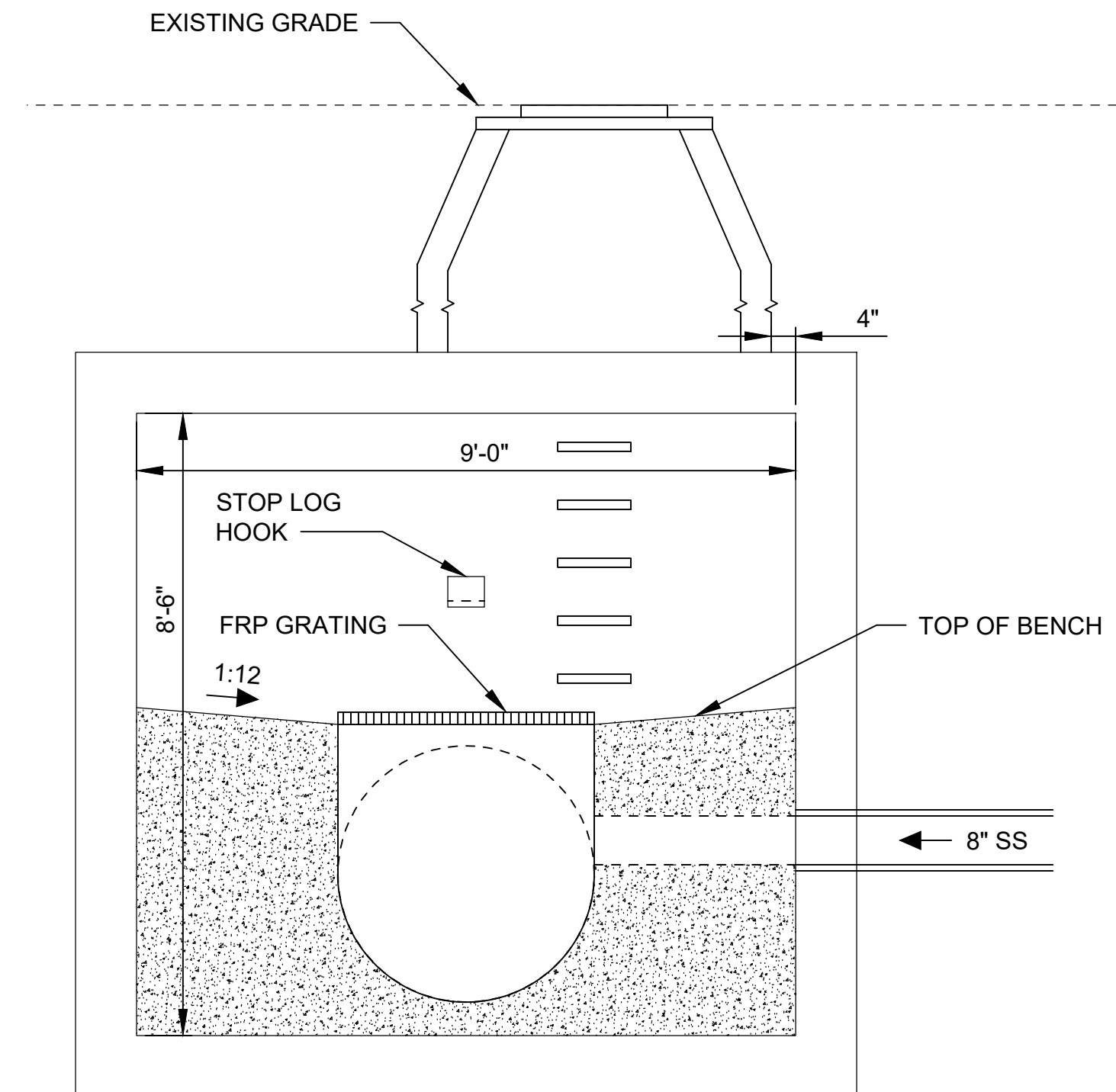
FLOW DIVERSION VAULT CHANNEL PLAN - SSMH-7
SCALE: 1/2"=1'-0"



A SECTION
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B SECTION
SCALE: 1/2"=1'-0"



C SECTION
SCALE: 1/2"=1'-0"

GENERAL SHEET NOTES

- CHANNELIZATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL EITHER PROVIDE PRECAST CHANNELS OR FIELD FORM CHANNELS. INVERTS INTO AND OUT OF THE STRUCTURE SHALL MATCH THOSE SHOWN ON SHEET C-354. CARE SHALL BE TAKEN TO AVOID UNEVEN SURFACES THAT COULD POTENTIALLY CAUSE A HYDRAULIC JUMP WHEN FLOWING WASTEWATER IS PRESENT. CONTRACTOR SHALL TAKE CARE TO ACCOMMODATE THE STOP LOG CHANNEL GUIDES SO THAT STOP LOGS CAN BE INSERTED/REMOVED WITH EASE AFTER INSTALLATION.
- CONTRACTOR SHALL COORDINATE VAULT DEPTHS, CHANNEL INVERTS, PIPE PENETRATIONS, DOWELING LOCATIONS, AND ADDITIONAL REQUIREMENTS WITH THE PRECAST VAULT MANUFACTURER. VAULTS SHALL BE SUBMITTED AS A COMPLETE PACKAGE FOR FAVORABLE REVIEW BY THE ENGINEER PRIOR TO DELIVERY.
- FLOW DIVERSION VAULTS ARE CONSIDERED A CLASS 1, DIVISION 1 CLASSIFIED SPACE SIMILAR TO MAINTENANCE HOLES.
- BENCHES SHALL EXTEND 3" ABOVE THE SOFFIT OF THE LARGEST PIPE. SLOPE OF BENCH IS 1:12.
- "COLD JOINTS" ARE NOT ALLOWED.
- SEE SHEET C-354 FOR PIPE INVERT INFORMATION.

SHEET KEYNOTES

- A. PROVIDE A LEAK TIGHT CONNECTION BETWEEN THE STOP LOGS AND CHANNEL GUIDES. PROPOSED MATERIALS SHALL BE SUITABLE FOR MUNICIPAL WASTEWATER SERVICE. SEE METRO STANDARD DETAIL 40 05 59.1.

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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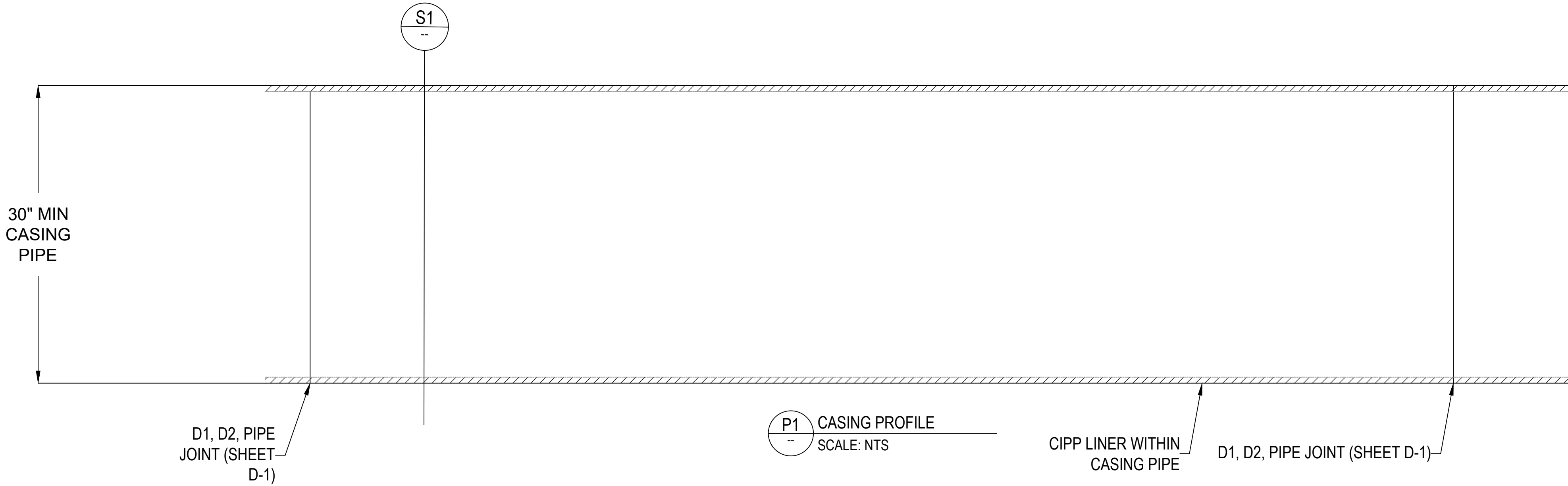
NORTH TRUNK SEWER IMPROVEMENTS
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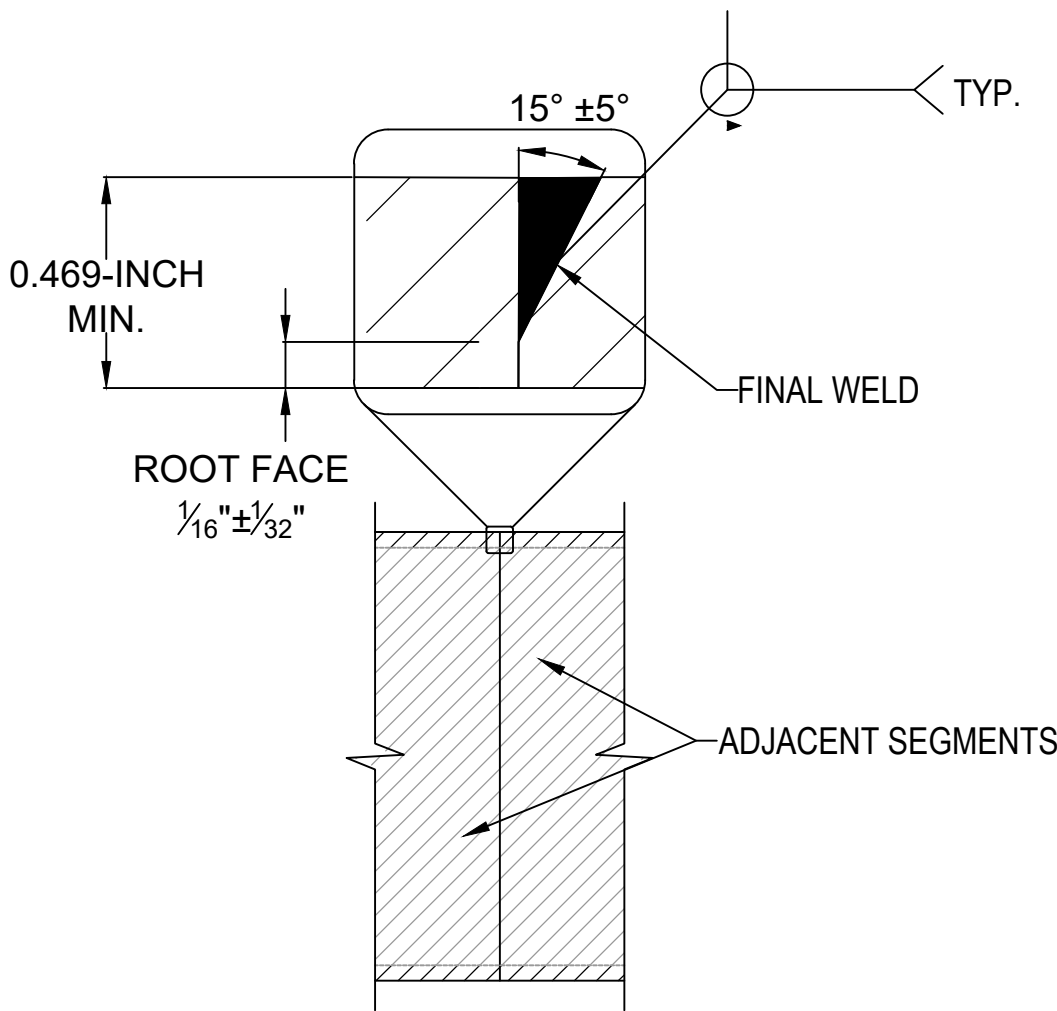
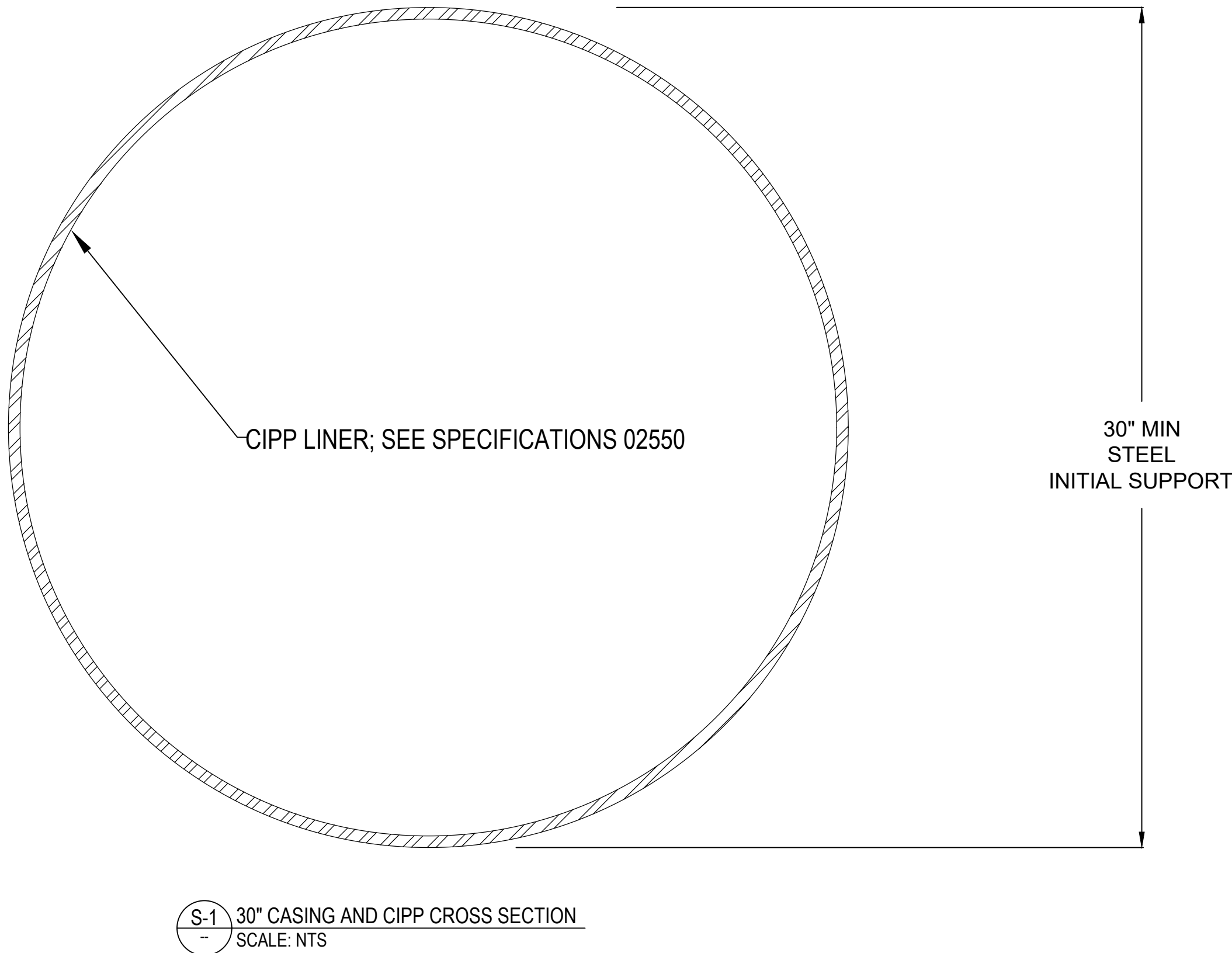
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GENERAL NOTES:

- TUNNEL EXCAVATION & INITIAL SUPPORT
 - THE TUNNEL EXCAVATION AND INITIAL SUPPORT SPECIFICATION PROVIDES THE ACCEPTABLE TUNNELING TECHNIQUES, THE MINIMUM SPECIFIED INITIAL SUPPORT THICKNESS, AND INSTALLATION TOLERANCES.



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City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS

NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

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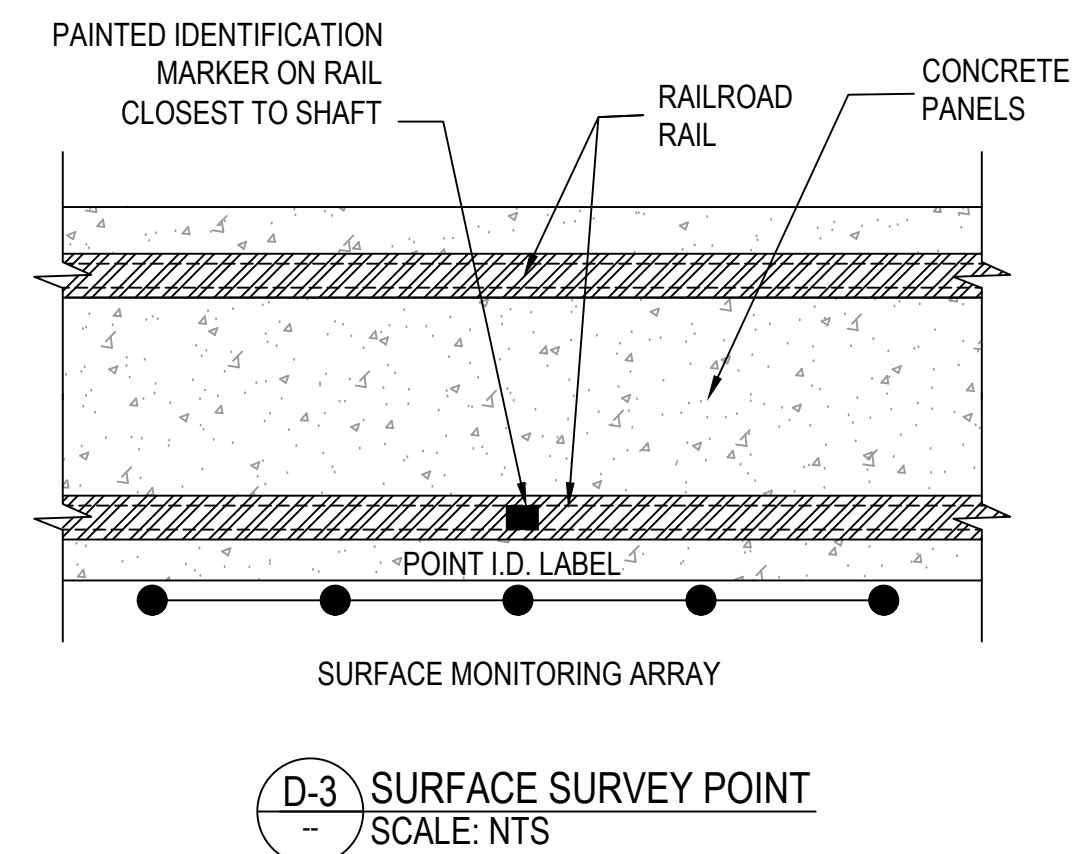
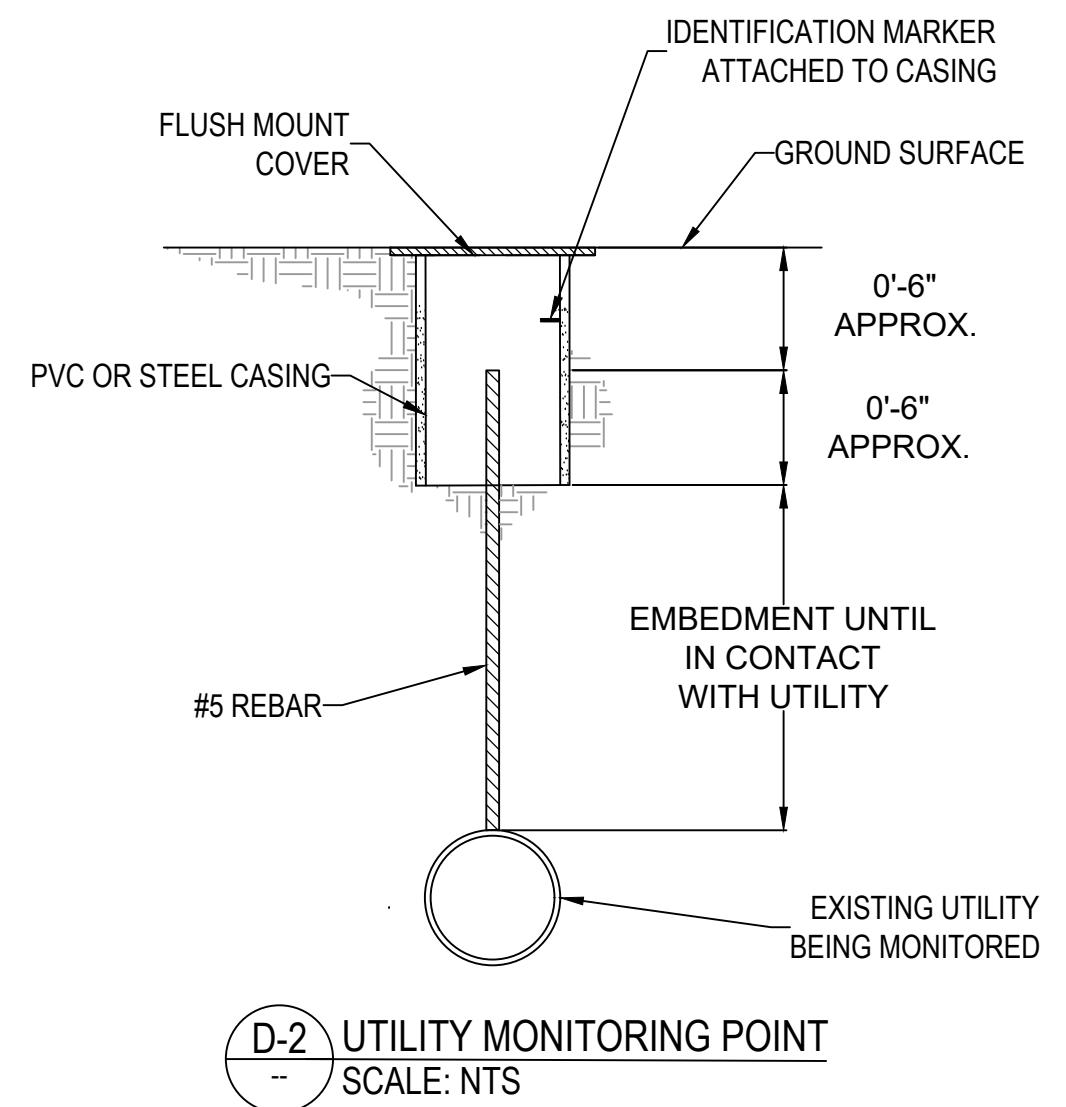
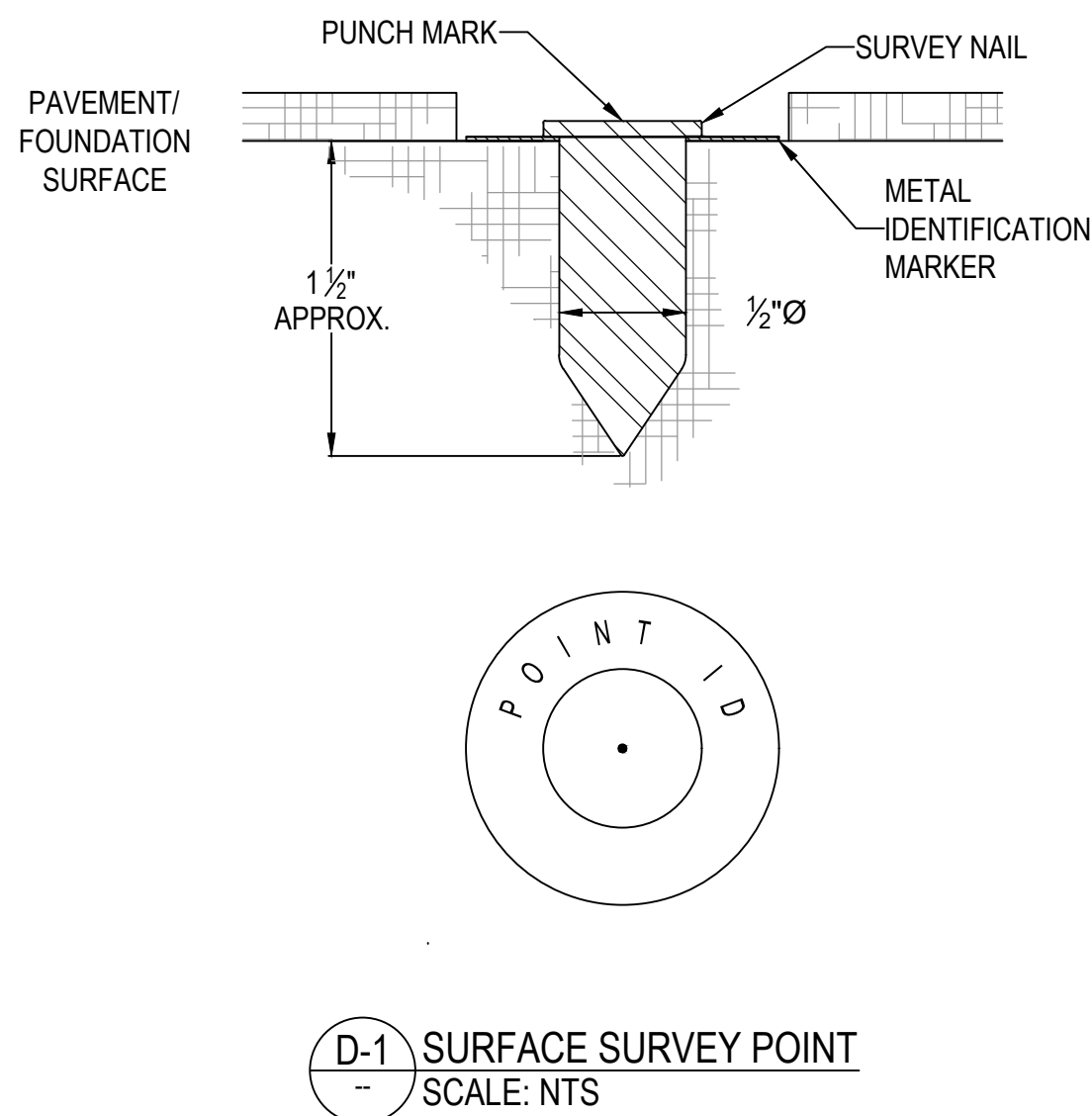
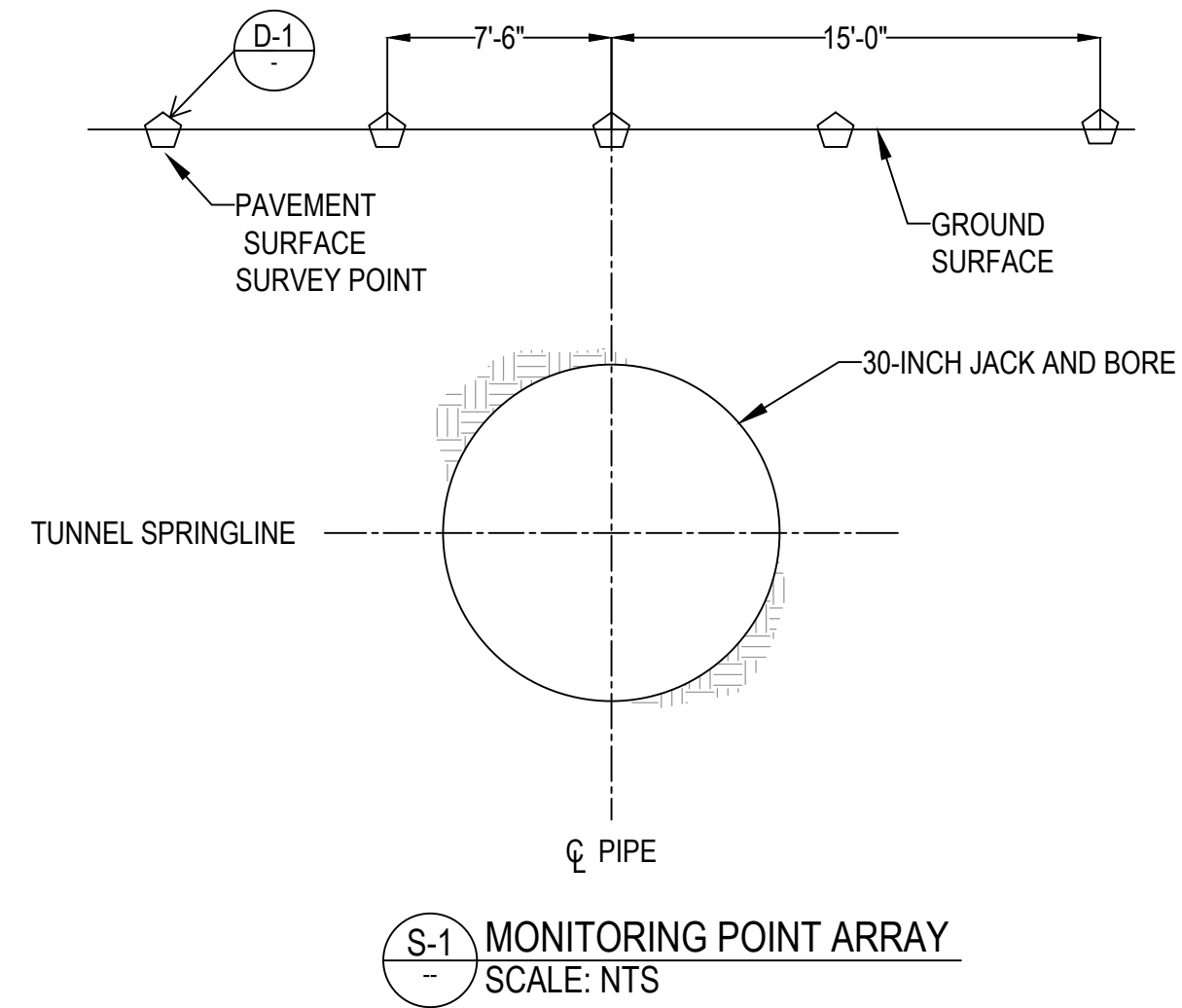
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NOTES:

1. SITE SAFETY INCLUDING SURVEY READINGS CONDUCTED WITHIN RAILROAD RIGHT OF WAY AND ROADWAY SHOULDER SHALL BE AT THE INSTRUMENTATION SPECIALIST'S DISCRETION. RAILROAD FLAGGERS AND TRAFFIC CONTROL SHALL BE PROVIDED BY THE INSTRUMENTATION SPECIALIST AS NECESSARY TO MEET UPRR, BNSF, AND RTD REQUIREMENTS AND CONDUCT SURVEY READINGS IN THE RIGHT OF WAY.
2. THE SURFACE MONITORING ARRAYS SHALL CONSIST OF EVENLY SPACED SURFACE SURVEY POINTS, AS SHOWN IN SECTION S-1, INSTALLED AS CLOSE TO THE RAILROAD TRACKS AS POSSIBLE WITH PAINTED IDENTIFICATION MARKERS PLACED ON THE RAILROAD TRACKS CORRESPONDING TO THE MONITORING ARRAY (DETAIL D-3).
3. SURFACE MONITORING POINTS, UTILITY MONITORING POINTS, AND MONITORING POINT ARRAYS SHALL HAVE MEASUREMENT READ TWICE WEEKLY DURING SHAFT CONSTRUCTION, ONCE DAILY DURING TUNNELING, AND WEEKLY AFTER COMPLETION OF THE TUNNEL UNTIL MOVEMENT BETWEEN SUCCESSIVE MEASUREMENTS IS NEGLIGIBLE AS DETERMINED BY THE ENGINEER.
4. RESPONSE VALUES FOR COLLECTED SURVEY DATA ARE AS SHOWN IN THE TABLE BELOW:

INSTRUMENTATION RESPONSE VALUES		
INSTRUMENTATION TYPE	THRESHOLD VALUE	SHUTDOWN VALUE
UTILITY MONITORING POINTS	0.04 FEET IN Z	0.08 FEET IN Z
SURFACE MONITORING POINTS	0.01 FEET IN Z 0.2 FEET IN ANY OF X OR Y	0.02 FEET IN Z 0.4 FEET IN ANY OF X OR Y

- 4.1. IF A THRESHOLD VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND/OR RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST. THE CONTRACTOR SHALL MEET WITH THE OWNER, OWNER'S REPRESENTATIVE, ENGINEER, UPRR, BNSF, AND/OR RTD TO REVIEW COLLECTED DATA AND DETERMINE WHETHER ANY CHANGES TO THE CONSTRUCTION PROCEDURES ARE NECESSARY TO ENSURE THE SAFE COMPLETION OF THE WORK.
- 4.2. IF A SHUTDOWN VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST AND THE CONTRACTOR SHALL STOP TUNNEL WORK UNTIL MEETING WITH THE OWNER, ENGINEER, UPRR, BNSF, RTD, AND/OR ANY OTHER AFFECTED THIRD PARTIES OCCURS. A SEPARATE PLAN OF ACTION DIFFERING FROM THE MEANS AND METHODS UTILIZED CAUSING EXCESSIVE MOVEMENT SHALL BE ADOPTED TO HELP MITIGATE FUTURE GROUND MOVEMENT. IF THE OWNER AND ENGINEER DEEM EXCESSIVE MOVEMENT HAS OCCURRED, MITIGATION TO CORRECT THE DISPLACED SURFACE SHALL BE COMPLETED FOR THE AFFECTED STRUCTURES AT THE CONTRACTORS EXPENSE.
5. ALL MONITORING INSTRUMENTATION SHALL BE REMOVED AND RESTORED IN ACCORDANCE WITH THE OWNER'S REPRESENTATIVE'S PERMIT REQUIREMENTS AFTER THE ENGINEER HAS DETERMINED THAT ADDITIONAL SURVEY DATA IS NO LONGER REQUIRED.



APPROVED City of Arvada, Colorado		
CITY ENGINEER	DATE	JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS". LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

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	NO	REVISION	DATE	BY

SCALES

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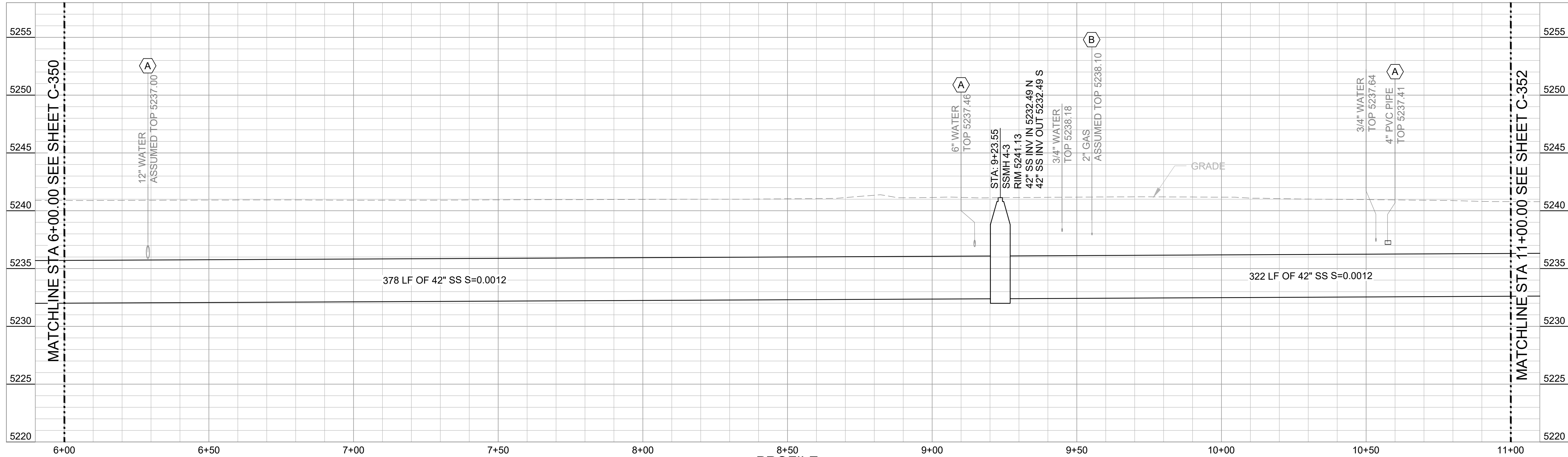
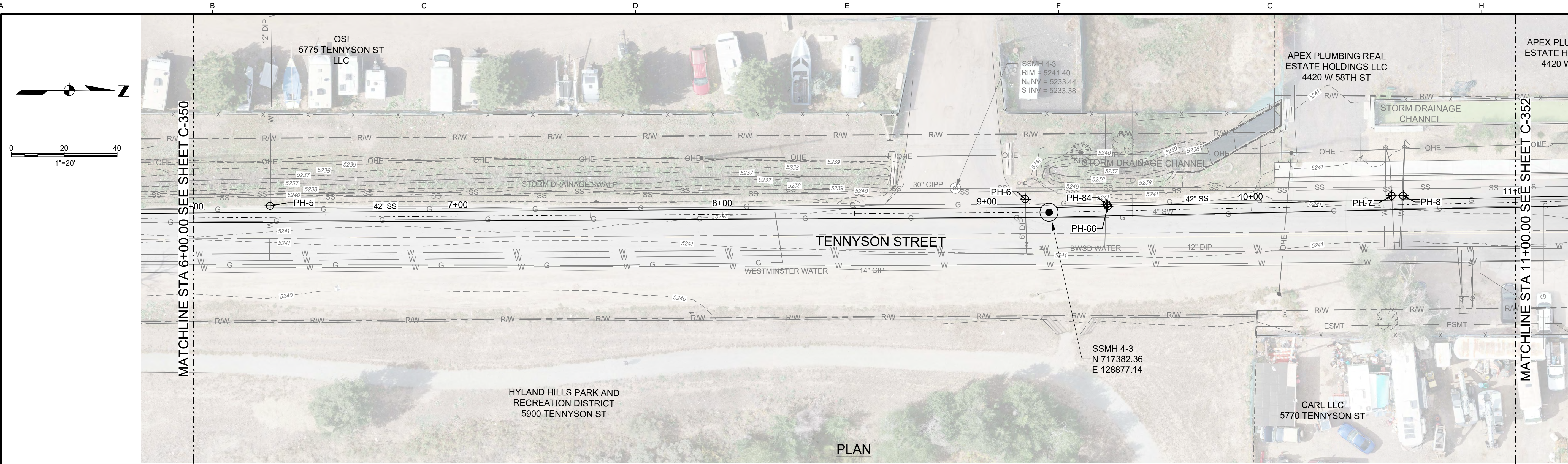
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AM	
CHECKED	 GEI Consultants
RD	

TUNNELING DETAILS - II

Plot Date: 9/6/2024 11:25 AM
User: ROBERT INOPEA
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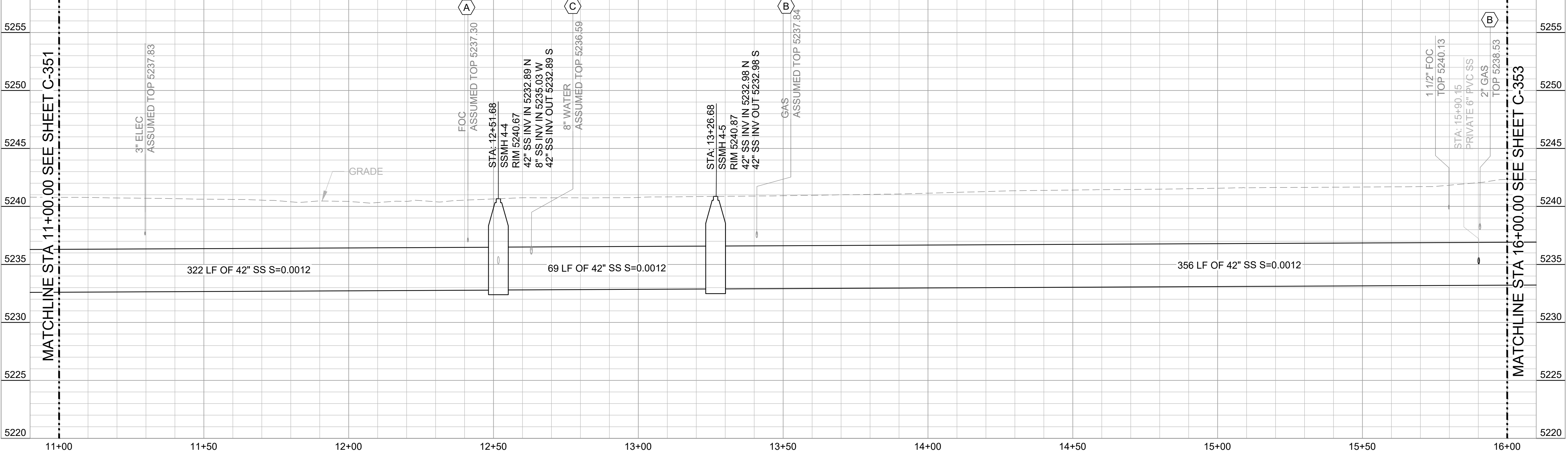
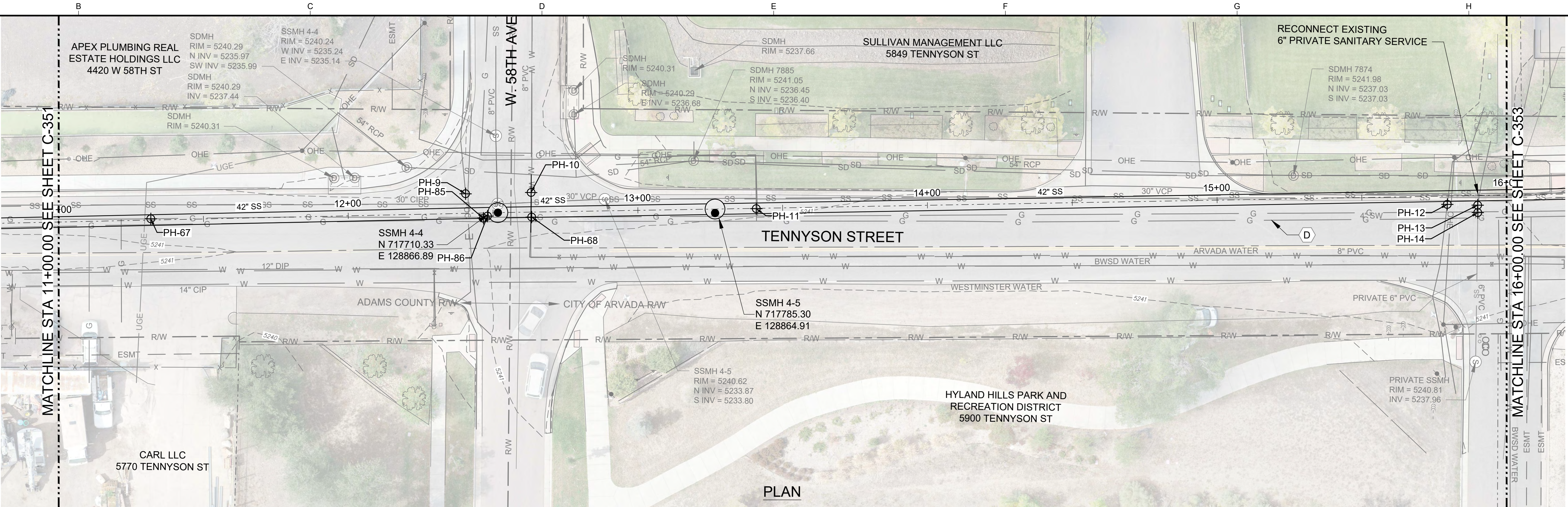


APPROVED City of Arvada, Colorado		
CITY ENGINEER	DATE	JOB NUMBER
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⬡ SHEET KEYNOTES	⬡ SHEET KEYNOTES (CONT.)
A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASEMENT AS NEEDED FOR VERTICAL CROSSINGS.	B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.

SEP 2024 - 90% DESIGN								DESIGNED TS		CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11		PLAN AND PROFILE STA 6+00 TO 11+00		SCALE 1" = 20' JOB NO 2246059.00 DATE SEP 2024 SHEET 12 OF 48 C-351	
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.								DRAWN WAS							
								CHECKED LS		Kennedy Jenks					
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User: ROBERT INOPEA
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APPROVED		
City of Arvada, Colorado		
CITY ENGINEER	DATE	JOB NUMBER

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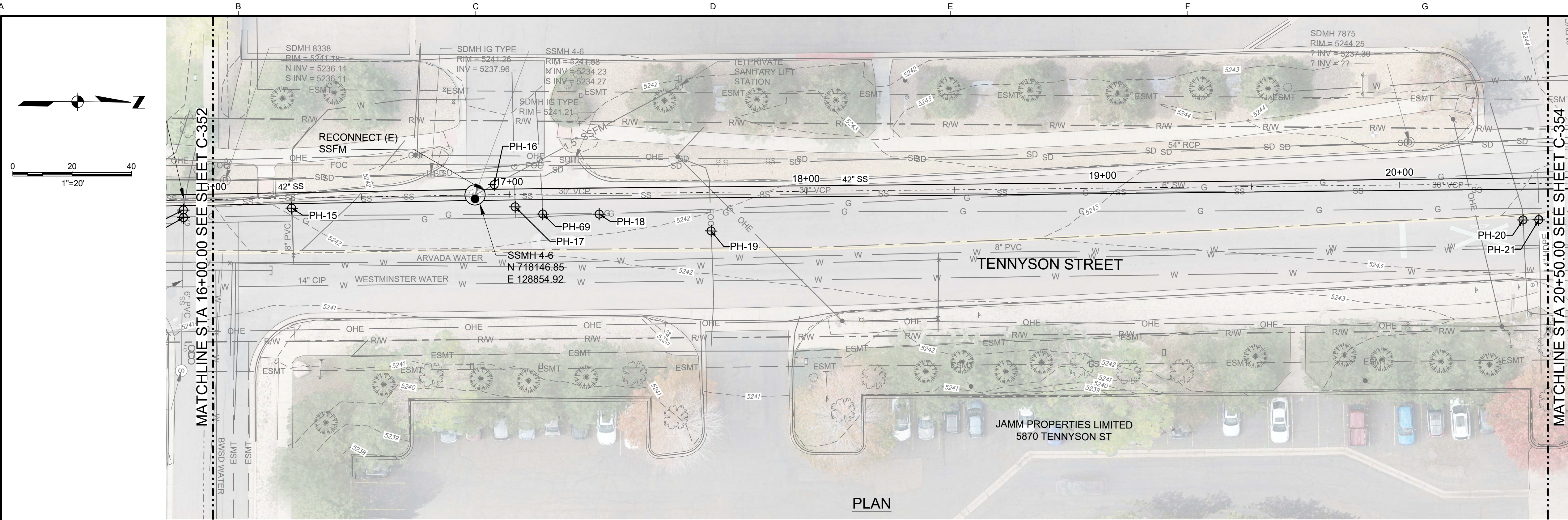
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A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASEMENT AS NEEDED FOR VERTICAL CROSSINGS.	B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.	C. LOWER 8" WATER MAIN AT SEWER CROSSING TO RELOCATE UNDER PROPOSED SEWER AT A MINIMUM OF 18" CLEARANCE. RELOCATE WATER MAIN PER CITY OF ARVADA CROSSING STORM AND SANITARY SEWERS AND OPEN CUT CROSSING BENEATH CONDUITS DETAILS ON SHEET C-003.	D. END XCEL GAS REALIGNMENT.

SEP 2024 - 90% DESIGN					DESIGNED TS	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	Kennedy Jenks	PLAN AND PROFILE STA 11+00 TO 16+00	SCALE 1" = 20'
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	NO	REVISION	DATE	BY				SHEET 13 OF 48	C-352

Plot Date: 9/6/2024 12:34 PM

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PLAN



PROFILE

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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REVISION

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BY

SCALES

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IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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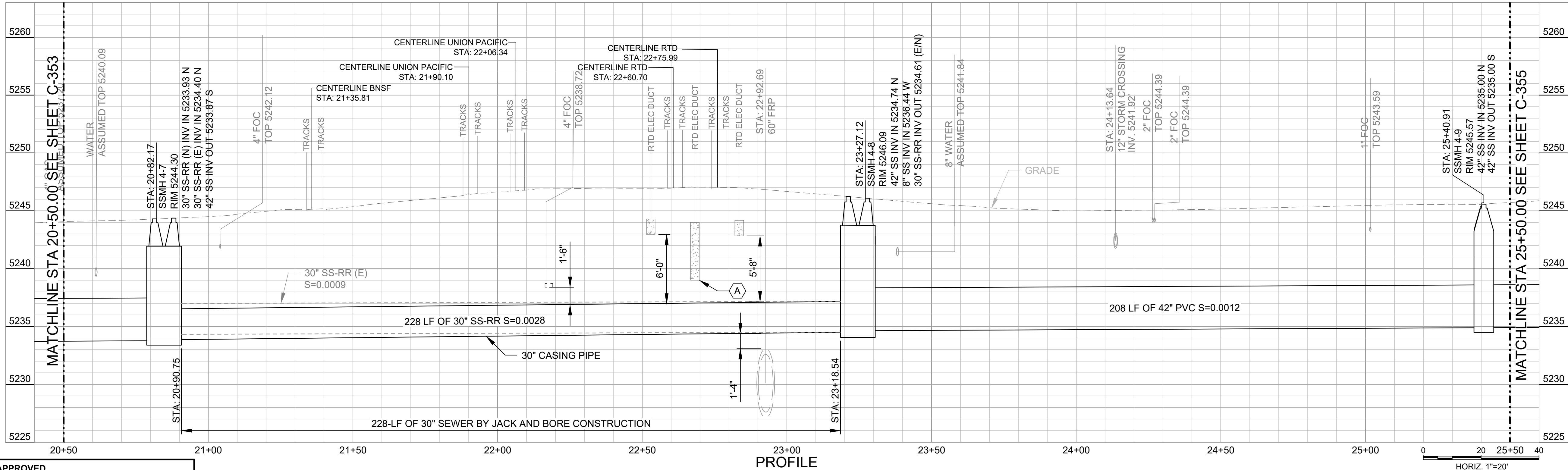
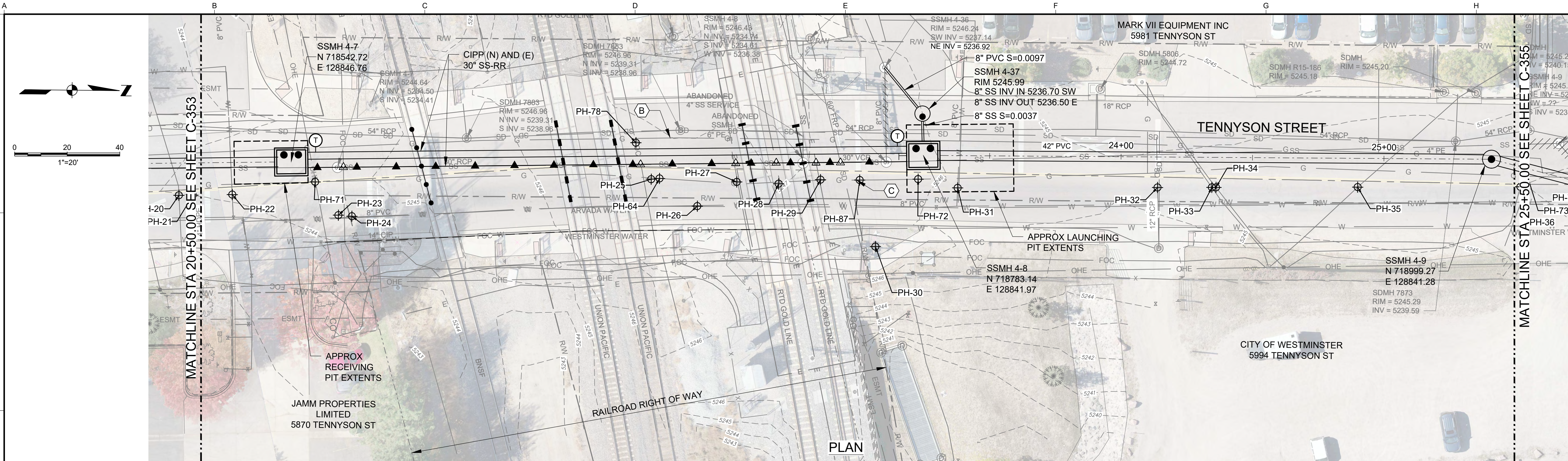


NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

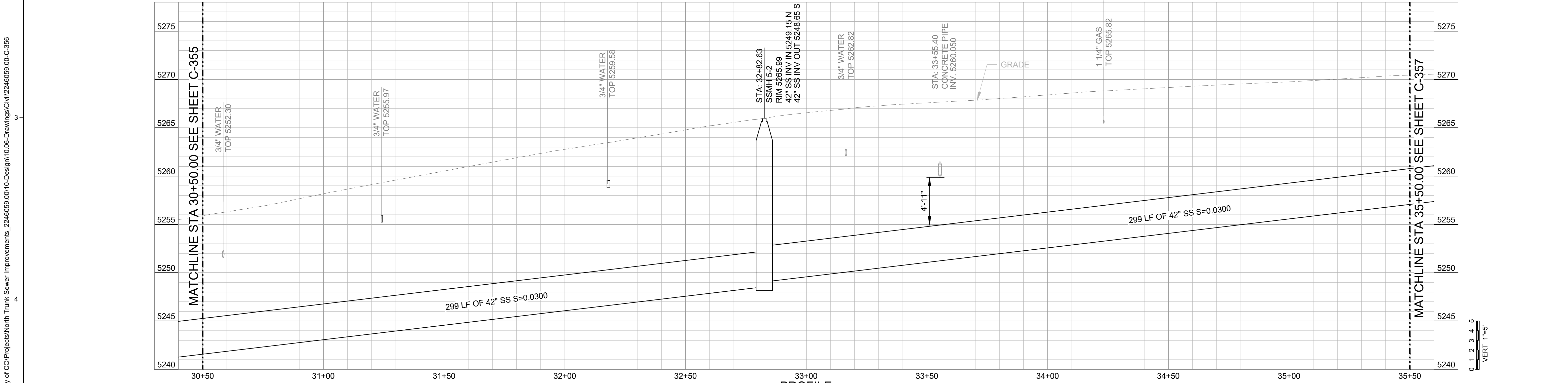
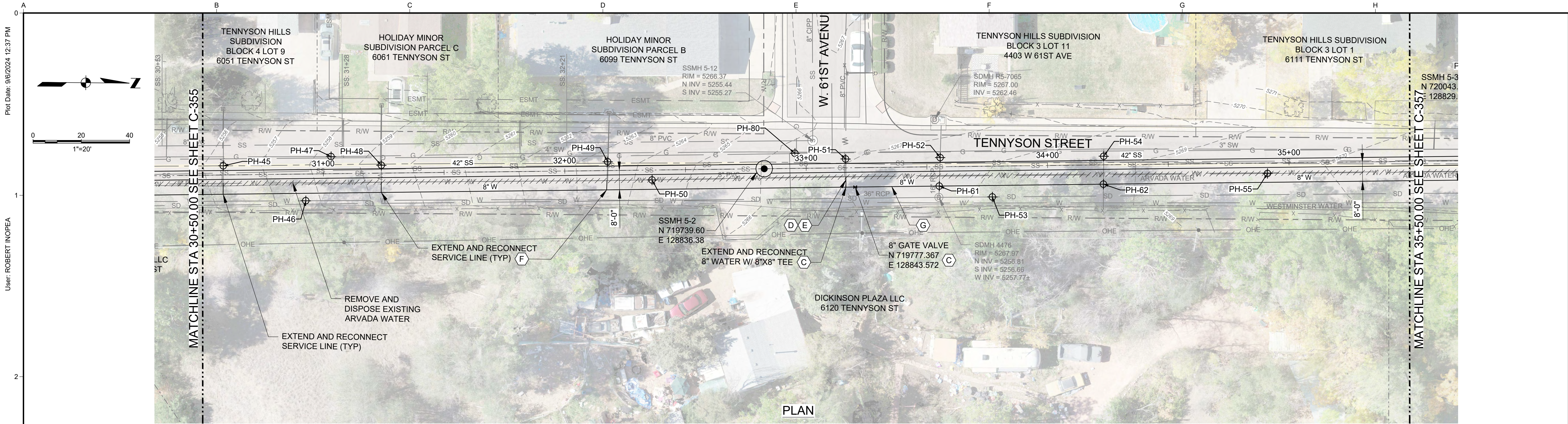


PLAN AND PROFILE
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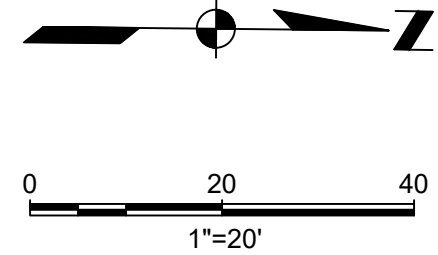
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1" = 20'
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DATE
SEP 2024
SHEET 14 OF 48
C-353



APPROVED City of Arvada, Colorado			PROFILE				HORIZ. 1"=20'					
GENERAL SHEET NOTES			GENERAL SHEET NOTES (CONT.)				SHEET KEYNOTES		SHEET KEYNOTES (CONT.)			
1. CONTRACTOR TO VERIFY WITH SURVEY THAT MAINTENANCE HOLES AND TEST STATIONS WILL BE LOCATED OUTSIDE OF RAILROAD R/W.			2. CONTRACTOR SHALL PLAN FOR ACTIVE BYPASSING OF THE EXISTING SANITARY PIPE FROM EXISTING SSMH 4-9 TO EXISTING SSMH 4-6 AT A MINIMUM SO THAT CIPP LINING OF THE EXISTING SANITARY PIPE WITHIN THE RAILROAD CORRIDOR CAN PROCEED AHEAD OF TUNNELING WORK. CONTRACTOR TO COORDINATE WITH THE CITY OF ARVADA UTILITIES DEPARTMENT FOR ACCESS TO THE ADJACENT STORMWATER INFRASTRUCTURE FOR ACTIVE BYPASSING PRIOR TO CONSTRUCTION.				A. POTHOLING ACTIVITIES WERE UNABLE TO UNCOVER THE BOTTOM DEPTH OF THE MIDDLE RTD DUCT BANK IN MULTIPLE LOCATIONS. GIVEN THE DEPTHS OF THE EXISTING UTILITIES THAT CROSS THIS DUCT BANK (54" STORM, 30" SANITARY, 14" WATER, 8" WATER, AND 6" GAS), IT IS PRESUMED TO BE OF IDENTICAL SIZE OF THE OTHER TWO DUCT BANKS AND IS THUS NOT A CONFLICT WITH THE PROPOSED DESIGN.		B. GAS LINE IN THIS LOCATION WAS NOT FOUND AND DETERMINED BY XCEL TO HAVE BEEN ABANDONED. CONTRACTOR TO VERIFY EXISTING CASING PIPE WAS REMOVED PRIOR TO TUNNELING WORK.			
							C. START XCEL GAS REALIGNMENT					
SEP 2024 - 90% DESIGN			DESIGNED TS DRAWN WAS CHECKED LS				CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11		PLAN AND PROFILE		SCALE	
NOT FOR CONSTRUCTION											1" = 20'	
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											2246059*00	
									DATE		SEP 2024	
									SHEET		15 OF 48	
NO REVISION			DATE BY				Kennedy Jenks				C-354	



APPROVED City of Arvada, Colorado			WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) C. INSTALL TEMPORARY PLUG ON THE WEST SIDE OF THE NEW TEE. INSTALL SEGMENT 1 THROUGH THE GATE VALVE NORTH OF THE TEE. D. ISOLATE, CUT, AND DRAIN 8" WATERLINE LATERAL TO THE WEST.			WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) E. REMOVE TEMPORARY PLUG FROM TEE, EXTEND NEW WATERLINE WEST, AND CONNECT TO 8" WATERLINE LATERAL FOR W. 61ST AVE. F. DISINFECT AND TEST SEGMENT 1. UPON COMPLETION, SERVICE LINE RECONNECTIONS AND EXTENSIONS CAN BE COMPLETED.			WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.) G. RECHARGE SEGMENT 1 AND WEST LATERAL AND BEGIN INSTALL OF SEGMENT 2.			02040 HORIZ. 1"=20'																	
SEP 2024 - 90% DESIGN			NO			REVISION			DATE			BY			DESIGNED TS			CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11			PLAN AND PROFILE STA 30+50 TO 35+50			SCALE 1" = 20' JOB NO 2246059*00 DATE SEP 2024 SHEET 17 OF 48 C-356					
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SITE RESTORATION LEGEND

- APPROX ASPHALT PATCHING, CONCRETE REPAIR, AND TRENCH RESTORATION EXTENTS (LIMITS OF WORK)
- ASPHALT RESTORATION
- CONCRETE RESTORATION
- DRAINAGE SWALE RESTORATION
- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

SHEET KEYNOTES

- A. CONTRACTOR SHALL PROTECT STORMWATER HEADWALLS, CULVERTS, AND SWALE IN PLACE. IF EXISTING INFRASTRUCTURE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REPLACE IN KIND.

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE | ADAMS COUNTY

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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NO	REVISION	DATE	BY

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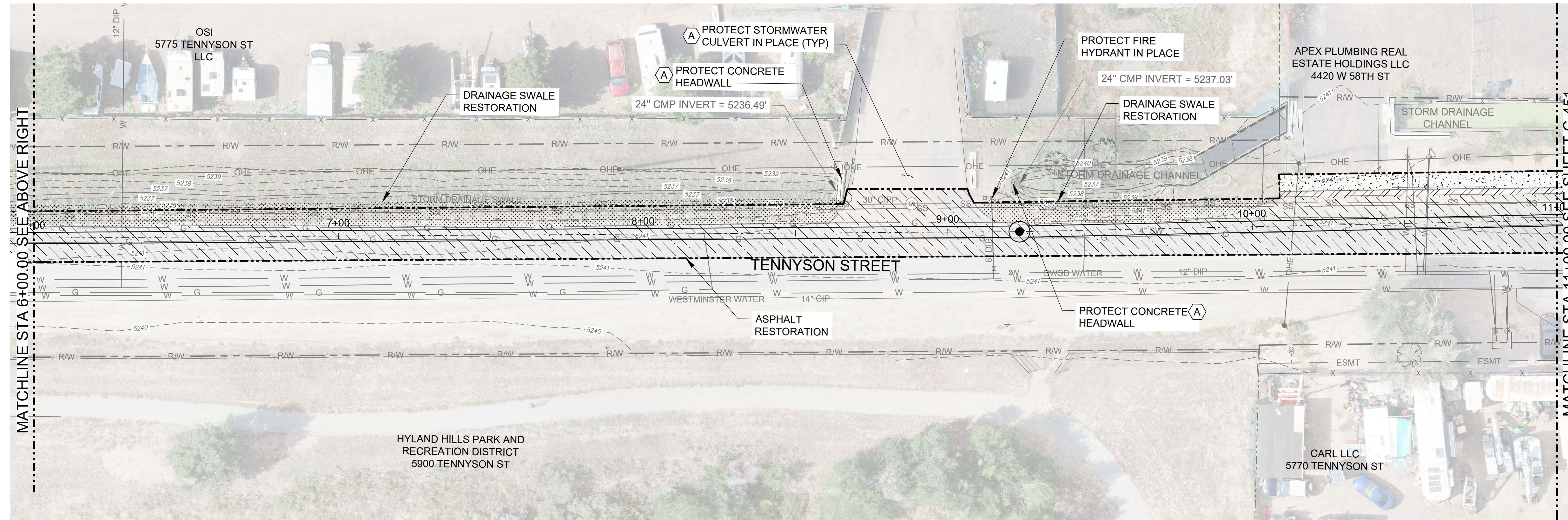
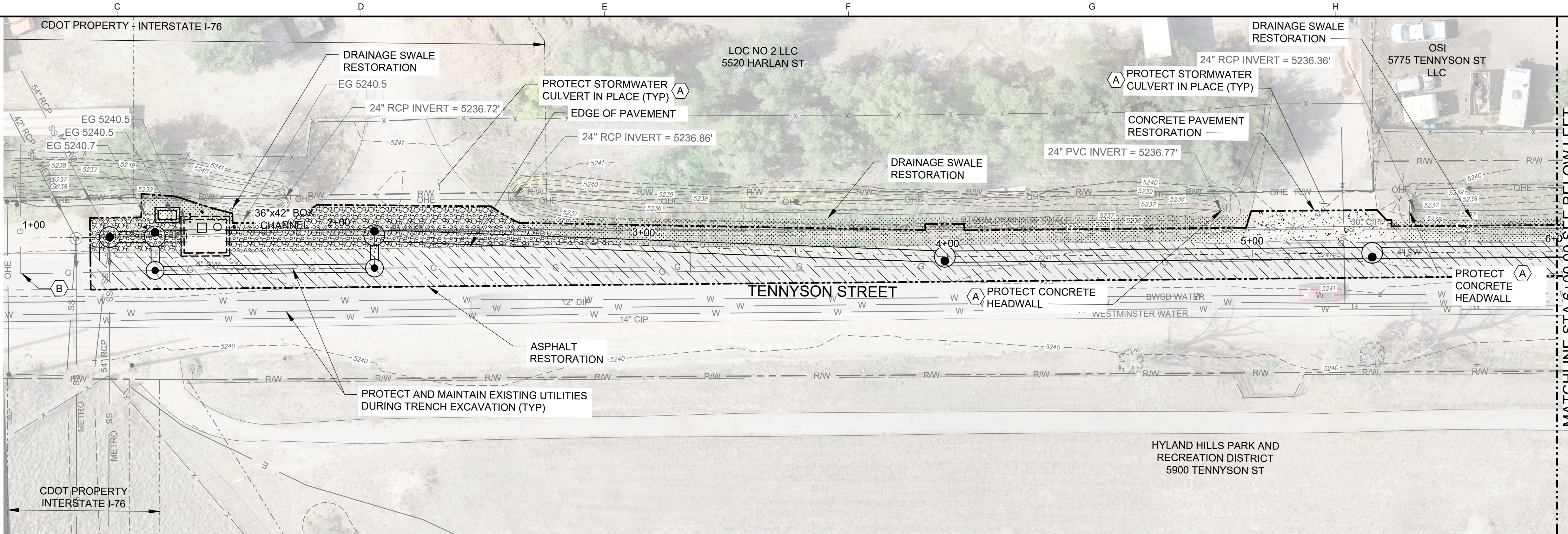
CITY OF ARVADA

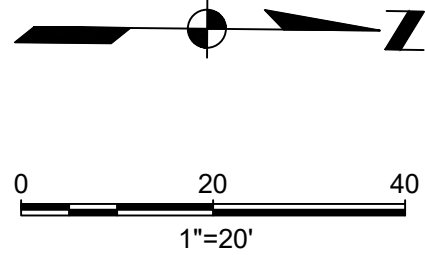
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

 Kennedy Jenks

SITE RESTORATION
STA 1+00 TO 11+00

SCALE
1" = 20'
JOB NO
2246059-00
DATE
SEP 2024
SHEET 19 OF 48
C-450





SITE RESTORATION LEGEND

- APPROX ASPHALT PATCHING, CONCRETE REPAIR, AND TRENCH RESTORATION EXTENTS (LIMITS OF WORK)
- ASPHALT RESTORATION
- CONCRETE RESTORATION
- DRAINAGE SWALE RESTORATION
- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

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GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE I ADAMS COUNTY

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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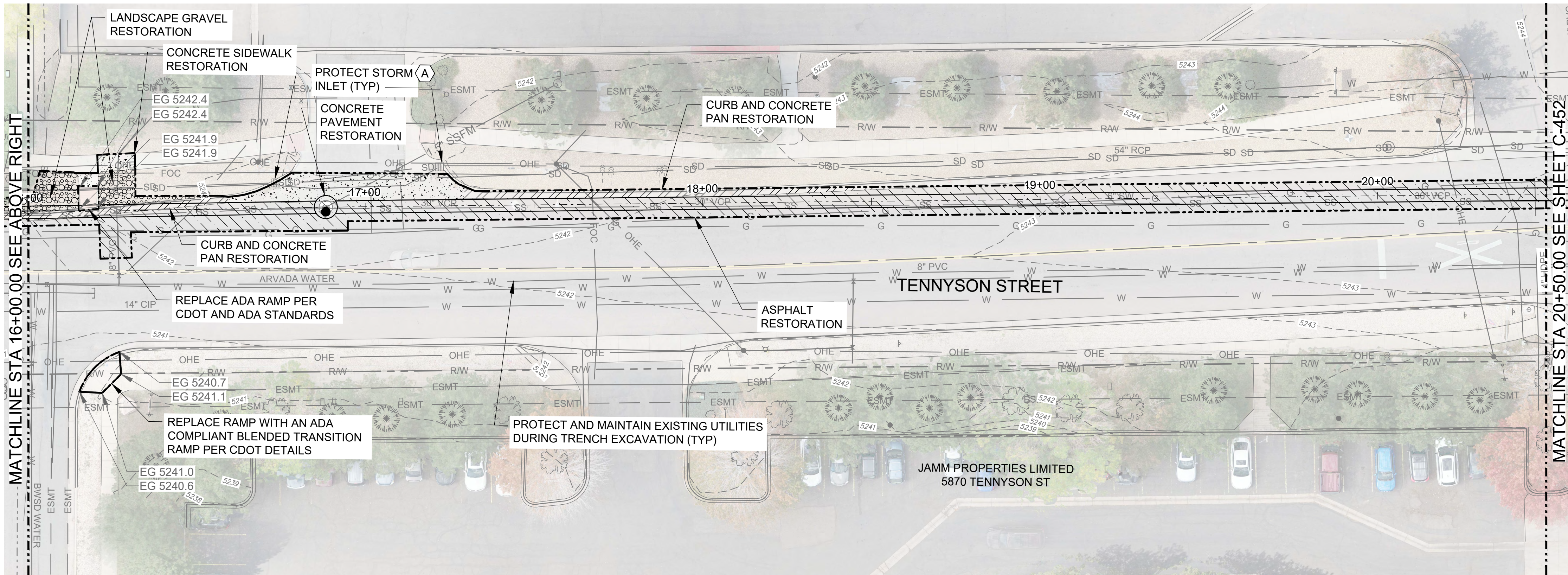
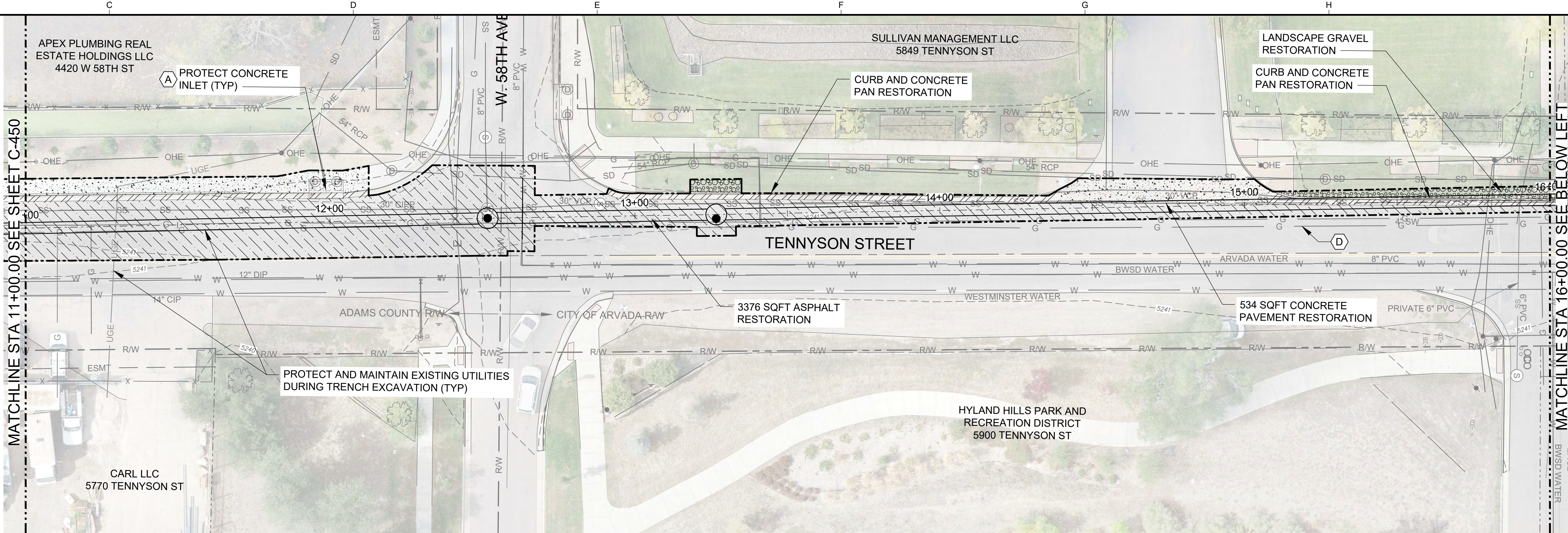


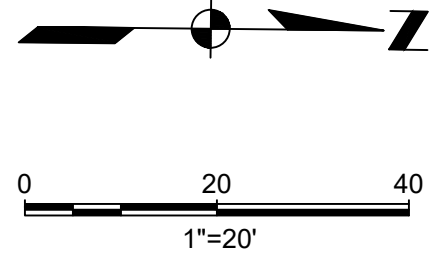
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SITE RESTORATION
STA 11+00 TO 20+50

SCALE
1" = 20'
JOB NO
2246059.00
DATE
SEP 2024
SHEET 20 OF 48
C-451





SITE RESTORATION LEGEND

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- CONCRETE RESTORATION
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- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE I ADAMS COUNTY

APPROVED
City of Arvada, Colorado

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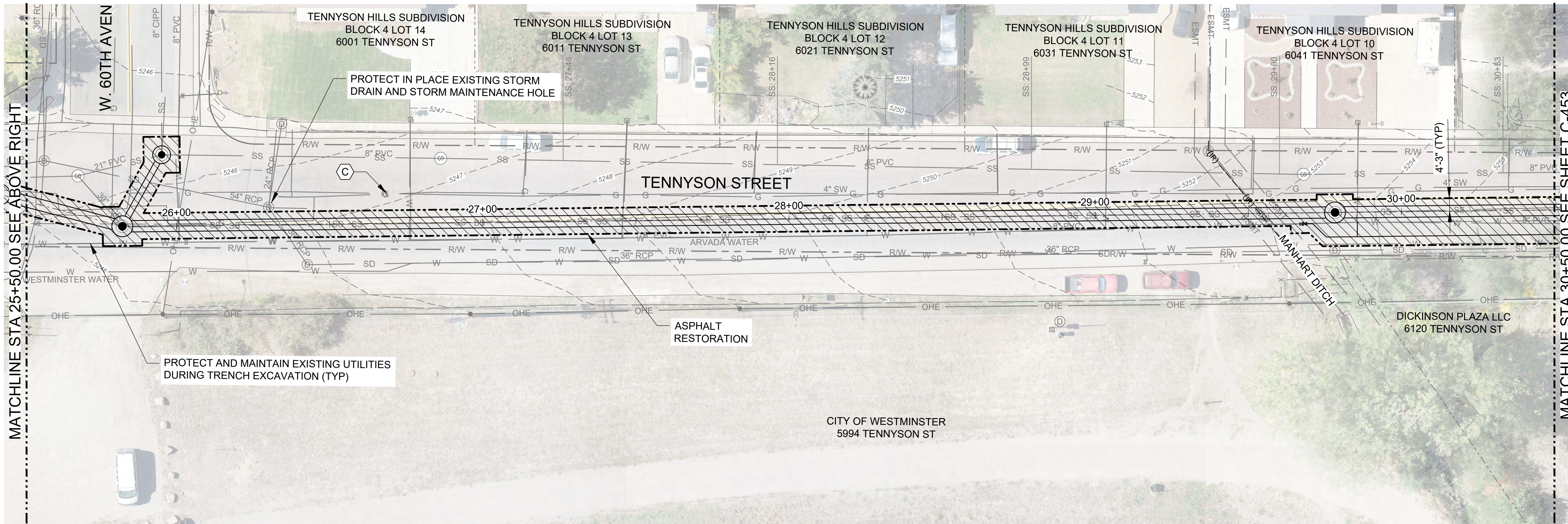
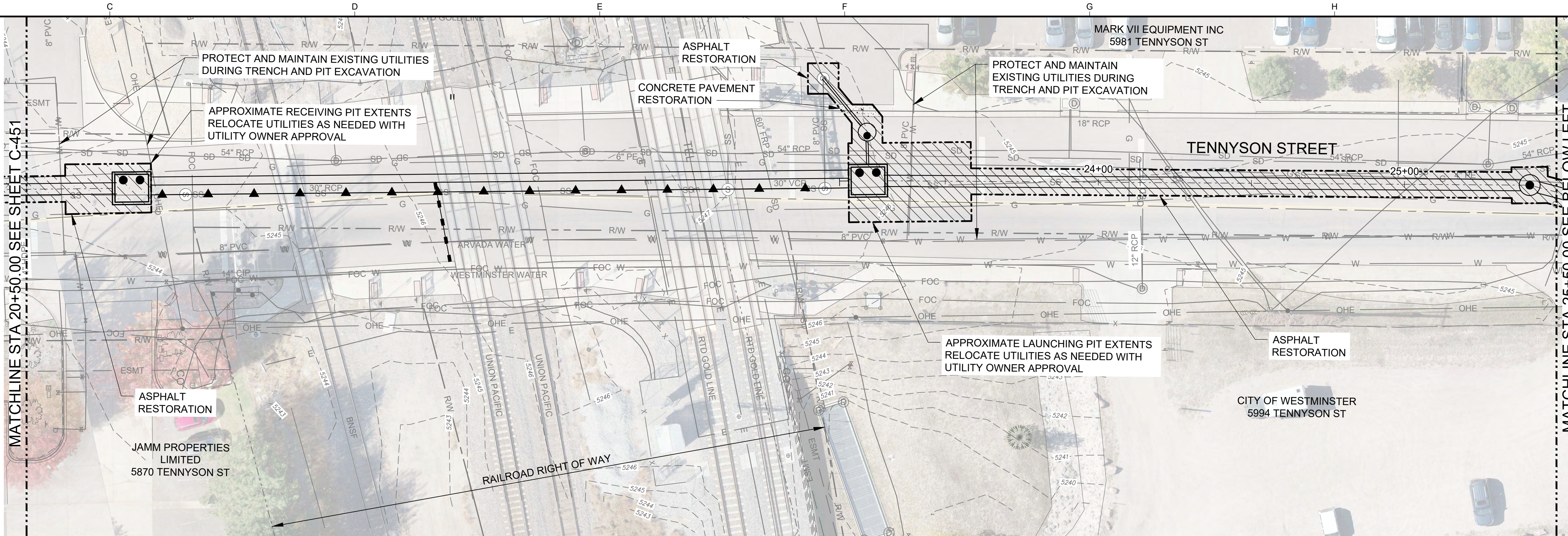


NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SITE RESTORATION
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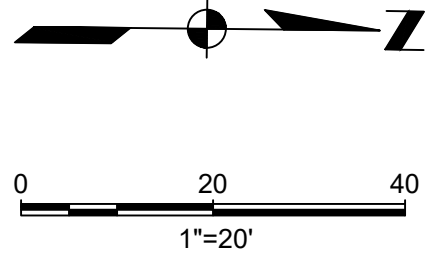
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JOB NO
2246059.00
DATE
SEP 2024
SHEET 21 OF 48
C-452



Plot Date: 9/6/2024 12:44 PM

User: ROBERT INOPEA

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SITE RESTORATION LEGEND

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- DRAINAGE SWALE RESTORATION
- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

GENERAL SHEET NOTES

1. MILL AND OVERLAY ENTIRE DISTURBED LANE | ADAMS COUNTY

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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SCALES
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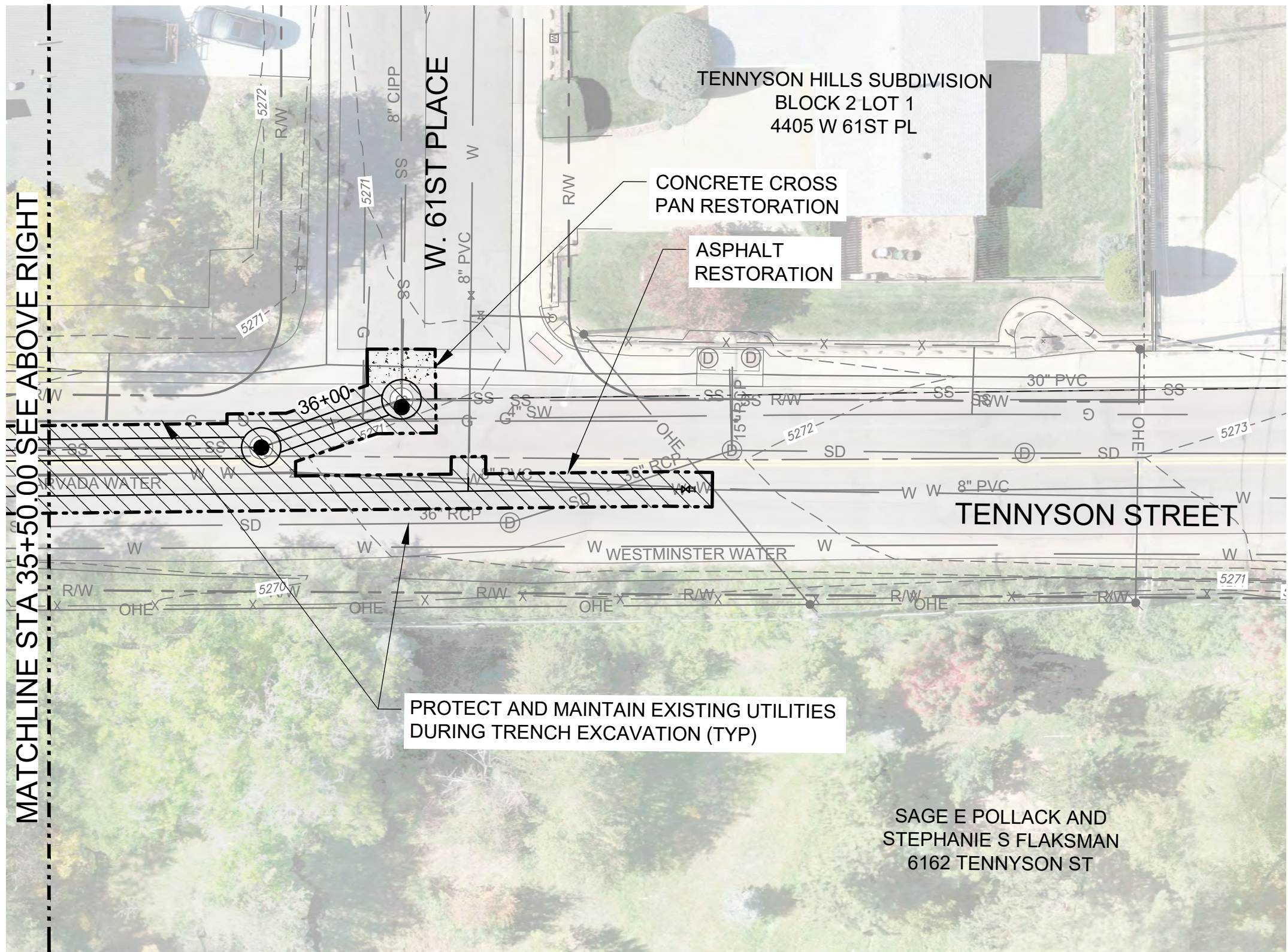
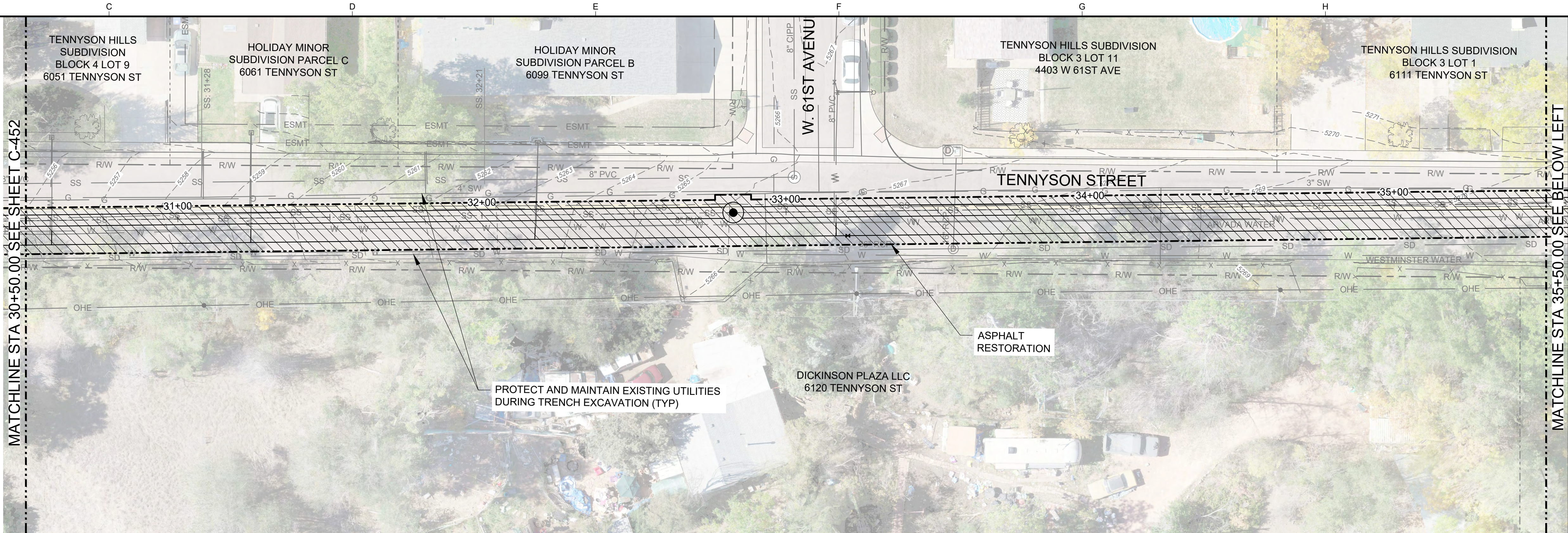


NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SITE RESTORATION
STA 30+50 TO 37+00

SCALE
1" = 20'
JOB NO
2246059'00
DATE
SEP 2024
SHEET 22 OF 48
C-453



QUANTITIES TABLE				
#	ITEM	DESCRIPTION	QUANTITY	UNIT
1	TRENCH RESTORATION - ASPHALT	ASPHALT ROAD	39,990	SF
2	TRENCH RESTORATION - CONCRETE	CONCRETE ROAD/DRIVE	960	SF
3	TRENCH RESTORATION - SWALE	GRASS DRAINAGE SWALE	5,506	SF
4	TRENCH RESTORATION - SIDEWALK	CONCRETE SIDEWALK	1,255	SF
5	TRENCH RESTORATION - CURB	CONCRETE CURB	304	LF
6	TRENCH RESTORATION - PAN	CONCRETE PAN	653	SF
7	TRENCH RESTORATION - ADA RAMP	CITY OF ARVADA ADA RAMP	2	EA
8	TRENCH RESTORATION - GRAVEL	LANDSCAPE GRAVEL	2,524	SF
9	UTILITY - WATER	8" PVC WATER MAIN	733	LF
10	UTILITY - WATER	8" GATE VALVE	5	EA
11	UTILITY - WATER	8" 45° BEND	2	EA
12	UTILITY - WATER	8" RESTRAINED COUPLING	2	EA
13	UTILITY - WATER	SERVICE LINE EXTEND AND RECONNECT	4	EA
14	UTILITY - WATER	8" X 8" TEE	2	EA
15	UTILITY - SANITARY	42" GRAVITY PIPE	3,096	LF
16	UTILITY - SANITARY	30" GRAVITY PIPE	239	LF
16	UTILITY - SANITARY	21" GRAVITY PIPE	24	LF
17	UTILITY - SANITARY	8" GRAVITY PIPE	50	LF
18	UTILITY - SANITARY	RECONNECT 1.5" FORCE MAIN	1	EA
19	UTILITY - SANITARY	5' DIA MAINTENANCE HOLE	4	EA
20	UTILITY - SANITARY	6' DIA MAINTENANCE HOLE	16	EA
21	UTILITY - WATER RELOCATION	WATER SERVICE RELOCATION	1	EA
22	UTILITY - WATER RELOCATION	6" WATER RELOCATION	1	EA
23	UTILITY - WATER RELOCATION	8" WATER RELOCATION	2	EA
24	UTILITY - WATER RELOCATION	12" WATER RELOCATION	1	EA
25	UTILITY - GAS RELOCATION	2" GAS RELOCATION	4	EA
26	UTILITY - GAS RELOCATION	6" GAS RELOCATION	1	EA
27	UTILITY - FIBER/ELEC RELOCATION	FIBER/ELEC RELOCATION	1	EA

GENERAL STRUCTURAL NOTES

GENERAL

1. DESIGN AND CONSTRUCTION SHALL CONFORM TO THE 2018 INTERNATIONAL BUILDING CODE AND THE REFERENCED BUILDING CODE STANDARDS.
2. THESE NOTES AS WELL AS THE TYPICAL DETAILS APPLY TO ALL PARTS OF THE PROJECT UNLESS NOTED OTHERWISE.
3. SHOP DRAWINGS FOR THIS CONTRACT SHALL BE COORDINATED WITH FAVORABLY REVIEWED EQUIPMENT MANUFACTURER'S DRAWINGS.
4. DIMENSIONS NOTED WITH AN ASTERISK, "*", ARE TO BE COORDINATED WITH FAVORABLY REVIEWED SUBMITTAL BY THE EQUIPMENT MANUFACTURER(S).
5. APPLY THE DETAILS SHOWN WHERE APPLICABLE AND COORDINATE WITH OTHER DISCREPANCY DRAWINGS.
6. ALL STRUCTURES HAVE BEEN DESIGNED FOR THE COMPLETE CONDITION, CONSIDERING OPERATIONAL, HYDROSTATIC, AND BACKFILL LOADS ONLY. THE STRUCTURES HAVE NOT BEEN DESIGNED TO RESIST OPERATIONAL, HYDROSTATIC, OR BACKFILL LOADS WHILE PARTIALLY CONSTRUCTED. OVERLOADING OF ANY STRUCTURES WILL BE FULLY RESPONSIBLY CONSISTANT WITH THE CONSTRUCTION.
7. ALL DIMENSIONS AND SIZES SHOWN ARE APPROXIMATE AND PROVIDED AS AN AID IN INTERPRETING THE ANTICIPATED EXISTING CONDITIONS. FIELD VERIFY ALL DIMENSIONS SHOWN WITH EXISTING CONDITIONS.
8. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO ORDERING OR FABRICATING ANY MATERIALS. NOTIFY THE STRUCTURAL ENGINEER OF ANY DISCREPANCY OF THE EXISTING CONDITIONS PRIOR TO THE CONSTRUCTION.
9. DO NOT DAMAGE, OVERCUT, SCRATCH, OR CRACK ANY PORTION OF THE EXISTING STRUCTURE NOT INTENDED TO BE MODIFIED, PROTECT AND PRESERVE PORTIONS OF THE EXISTING STRUCTURE NOT INTENDED TO BE MODIFIED.

PERMITS AND INSPECTIONS

1. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL PERMITS AND INSPECTIONS REQUIRED BY THE LOCAL BUILDING INSPECTOR AND AS DESCRIBED IN THE SPECIFICATIONS.
2. THE CONTRACTOR SHALL SELECT, INSTALL AND MAINTAIN SAFETY WORKING, SHEETING, BRACING AND SHORING TO MAINTAIN SAFE WORKING CONDITIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING FULL COMPLIANCE WITH 29 CFR PART 1926 OSHA SUBPART P EXCAVATIONS AND TRENCHES REQUIREMENTS. ALL EARTHWORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH APPLICABLE LAW, INCLUDING LOCAL ORDINANCES AND APPLICABLE OSHA REQUIREMENTS.

SPECIAL INSPECTIONS AND STRUCTURAL OBSERVATIONS

1. THE CONTRACTOR SHALL NOTIFY THE ENGINEER 48-HOURS BEFORE PLACEMENT OF REINFORCING STEEL AND CONCRETE SO THAT EXISTING CONDITIONS MAY BE INSPECTED BY ENGINEER.
2. STRUCTURAL OBSERVATION SHALL BE PROVIDED BY THE DESIGN ENGINEER(S) OF RECORD OR THEIR AUTHORIZED REPRESENTATIVES IN ACCORDANCE WITH THE IBC, CHAPTER 17. STRUCTURAL OBSERVATION SHALL CONSIST OF SITE VISITS AT WHICH IT IS APPROPRIATE TO THE STAGE OF CONSTRUCTION. OBSERVATION OF CONSTRUCTION IN PROGRESS AND REVIEW OF TESTING AND INSPECTION REPORTS FOR GENERAL COMPLIANCE WITH THE CONSTRUCTION DOCUMENTS RELATING TO THE STRUCTURAL WORK AND THE NONSTRUCTURAL COMPONENTS AND EQUIPMENT ANCHORAGE.
3. SPECIAL INSPECTION IN ACCORDANCE WITH IBC CHAPTER 17, SHALL BE REQUIRED AS INDICATED IN THE SPECIAL INSPECTION AND TESTING SCHEDULE ON THIS SHEET.

SOIL AND FOUNDATIONS

1. (PENDING FINAL GEOTECHNICAL RECOMMENDATIONS REPORT)
2. ALLOWABLE BEARING CAPACITY OF THE METERING VAULT IS 3500 PSF.
3. SUBGRADE PREPARATION: THE EXPOSED SUBGRADE SHOULD BE CAREFULLY INSPECTED VIA PROBE ROLLING, PROBING, AND TAPPING, AS DETERMINED NECESSARY BY THE GEOTECHNICAL ENGINEER. FROZEN, WET, SOFT, OR LOOSE SOIL, AS WELL AS ANY OTHER UNDESIRABLE MATERIAL SHOULD BE REMOVED. ONCE SUITABLE SOIL CONDITIONS ARE ACHIEVED, THE SUBGRADE SHOULD BE SCARIFIED AND COMPACTED PRIOR TO FILL PLACEMENT. THE SUITABLE EXPOSED SOIL MATERIALS SHOULD BE SCARIFIED AND MOISTENED OR DRIED, AS NECESSARY, TO A MINIMUM DEPTH OF 8 INCHES BELOW THE PROPOSED CONSTRUCTION.
4. BACKFILL STRUCTURE WITH SUITABLE MATERIALS TO THE FOLLOWING CONDITIONS:
 - a. TO WITHIN 1% AND +3% RELATIVE TO THE MAXIMUM DRY DENSITY PER ASTM D698.
 - b. COMPACT TO 95% RELATIVE COMPACTION PER ASTM D698. BACKFILL IN LIFTS NOT EXCEEDING 8-INCHES.

LOADING CRITERIA

- | | | |
|----|--|--|
| 1. | MINIMUM LOADING REQUIREMENTS PER CHAPTER 16 OF THE 2018 IBC. | |
| 2. | DEAD LOAD: | |
| 3. | MATERIAL SELF WEIGHT | SEE DRAWINGS, CONC: 150PCF |
| | METERING VAULT LIVE LOADS: | |
| | ROOF SLAB | 250 PSF UNIFORM OR H20 VEHICLE (HL-93) |
| | LADDER RUNGS | 300 LBS POINT |
| | TRAFFIC LOADING: | HL-93 |
| 4. | WIND LOAD: | |
| | BASIC WIND SPEED, V_{ULT} | 134 MPH (CITY OF ARVADA) |
| | NOMINAL WIND SPEED, V_{ASD} | 105 MPH |
| | EXPOSURE | C |
| 5. | RISK CATEGORY | III |
| 6. | SNOW LOAD: | |
| | IMPORTANCE FACTOR, I_s | 1.10 |
| | BASIC GROUND SNOW LOAD, P_g | 30 PSF (CITY OF ARVADA) |
| 7. | SEISMIC LOAD: | |
| | SEISMIC IMPORTANCE FACTOR, I_e | 1.25 |
| | MAPPED RESPONSE PARAMETER, S_s | 0.216 |
| | MAPPED RESPONSE PARAMETER, S_1 | 0.059 |
| | SITE CLASS | D, DEFAULT |
| | DESIGN RESPONSE PARAMETER, S_{DS} | 0.23 |
| | DESIGN RESPONSE PARAMETER, S_{D1} | 0.094 |
| | SEISMIC DESIGN CATEGORY | B |
| | LONG PERIOD TRANSITION PERIOD, T_L | 4s |

REINFORCING STEEL

1. REINFORCING BARS SHALL BE ASTM A615-GRADE 60.
2. ARRANGEMENT AND DETAILING OF REINFORCING STEEL, INCLUDING BAR SUPPORTS AND SPACERS, SHALL BE IN ACCORDANCE WITH THE LATEST ACI 315 DETAILING MANUAL.
3. NO WELDING OF REINFORCING BARS SHALL BE PERMITTED, UNLESS APPROVAL IN WRITING IS OBTAINED FROM THE ENGINEER PRIOR TO CONSTRUCTION.
4. DIMENSIONS TO REINFORCING ARE TO BAR CENTERLINES, UNLESS NOTED OTHERWISE. BAR COVER IS CLEAR DISTANCE BETWEEN THE BAR AND THE CONCRETE SURFACE. UNLESS NOTED OR SHOWN OTHERWISE BAR COVER FOR REINFORCING STEEL SHALL BE AS FOLLOWS:

SLAB AND PADS, EXTERIOR

FORMED SURFACES AND BOTTOMS ON CONCRETE WORK MAT
TOP SURFACES EXPOSED TO EARTH, WATER, OR WEATHER
BOTTOMS AND SIDES IN CONTACT WITH EARTH

EQUIPMENT PADS, INTERIOR

FORMED SURFACES AND TOP SURFACE 1-1/2-INCH

CONCRETE:

1. CEMENT SHALL BE ASTM C150 TYPE II FOR ALL STRUCTURES. CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH (PSI) AS NOTED IN THE TABLE BELOW AND AS FURTHER DEFINED IN THE SPECIFICATIONS:

CONCRETE STRENGTH (PSI)		
TYPE	STRENGTH	LOCATION
A	4,500	ALL CONCRETE UNLESS OTHERWISE NOTED
B	4,000	CONCRETE FILL, PAVING/ SIDEWAKS

2. CONCRETE CONSTRUCTION SHALL CONFORM TO ACI 305-06 INCLUDING BAR BENDS AND HOOKS, UNLESS DETAILED OTHERWISE.
3. OPENINGS, PIPE SLEEVES, CONDUITS, INSERTS AND OTHER EMBEDDED ITEMS SHALL BE IN PLACE BEFORE CONCRETE IS PLACED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE ARCHITECTURAL, CIVIL, MECHANICAL, ELECTRICAL, LANDSCAPING, HVAC, PLUMBING, INSTRUMENTATION AND OTHER PLANS FOR ITEMS REQUIRING SLEEVES AND EMBEDMENTS IN CONCRETE WHICH ARE NOT INDICATED OR SHOWN ON STRUCTURAL DRAWINGS. NO REINFORCING SHALL PASS THROUGH STRUCTURAL MEMBERS (UNLESS SHOWN ON STRUCTURAL DRAWINGS). COORDINATE WITH EQUIPMENT MANUFACTURERS DRAWINGS FOR ANCHORING DEVICES.
4. UNLESS OTHERWISE NOTED, ALL EXPOSED EDGES AND CORNERS SHALL BE CHAMFERED 3/4-INCH. INTERIOR FLOOR SLABS AND EXTERIOR SIDEWALKS SHALL HAVE TOOLED 3/8-INCH RADIUS CONSTRUCTION JOINT.

FRP:

1. SEE SPECIFICATION 06600.

DEFERRED SUBMITTALS

IN ACCORDANCE WITH THE IBC, SUBMITTAL DOCUMENTS FOR DEFERRED SUBMITTAL ITEMS SHALL BE SUBMITTED TO THE ARCHITECT OR ENGINEER OF RECORD WHO SHALL REVIEW THEM WITH SUBSEQUENT SUBMITTAL TO THE BUILDING OFFICIAL WITH A NOTATION INDICATING THAT THE DEFERRED SUBMITTAL DOCUMENTS HAVE BEEN REVIEWED AND THAT THEY HAVE BEEN FOUND TO BE IN GENERAL CONFORMANCE WITH THE DESIGN. THE DEFERRED SUBMITTAL ITEMS SHALL NOT BE INSTALLED UNTIL DESIGN AND SUBMITTAL DOCUMENTS HAVE BEEN APPROVED BY THE BUILDING OFFICIAL. THE FOLLOWING ITEMS WILL BE DEFINED AS DEFERRED SUBMITTAL ITEMS:

1. METERING VAULT ACCESS HATCH
2. FRP GRATING

SPECIAL INSPECTIONS AND TESTING

GENERAL

- THE OWNER OR THE OWNER'S AUTHORIZED AGENT, OTHER THAN THE CONTRACTOR, SHALL EMPLOY ONE OR MORE APPROVED AGENCIES TO PROVIDE SPECIAL INSPECTIONS AND TESTS IN ACCORDANCE WITH CHAPTER 17 OF THE 2018 INTERNATIONAL BUILDING CODE DURING CONSTRUCTION ON THE TYPES OF WORK SPECIFIED AND IDENTIFY THE APPROVED AGENCIES TO THE BUILDING OFFICIAL. STRUCTURAL SPECIAL INSPECTIONS AND TESTS SHALL GOVERN THE QUALITY, WORKMANSHIP AND REQUIREMENTS FOR MATERIALS COVERED. MATERIALS OF CONSTRUCTION AND TESTS SHALL CONFORM TO THE APPLICABLE STANDARDS LISTED IN THE REFERENCED BUILDING CODE.
2. APPROVED AGENCY: AN ESTABLISHED AND RECOGNIZED AGENCY THAT IS REGULARLY ENGAGED IN CONDUCTING TESTS OR FURNISHING INSPECTION SERVICES, WHERE SUCH AGENCY HAS BEEN APPROVED BY THE BUILDING OFFICIAL. THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE AND ENGINEERS OF RECORD INVOLVED IN THE DESIGN OF THE PROJECT ARE PERMITTED TO ACT AS THE APPROVED AGENCY.
3. ACCESS FOR SPECIAL INSPECTION: THE CONSTRUCTION OR WORK FOR WHICH SPECIAL INSPECTION OR TESTING IS REQUIRED SHALL REMAIN ACCESSIBLE AND EXPOSED FOR SPECIAL INSPECTION OR TESTING PURPOSES UNTIL COMPLETION OF THE REQUIRED SPECIAL INSPECTIONS OR TESTS.
4. REPORT REQUIREMENT: APPROVED AGENCIES SHALL KEEP RECORDS OF SPECIAL INSPECTIONS AND TESTS. THE APPROVED AGENCY SHALL SUBMIT REPORTS OF SPECIAL INSPECTIONS AND TESTS TO THE BUILDING OFFICIAL AND TO THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE. REPORTS SHALL INDICATE THAT WORK INSPECTED OR TESTED WAS OR WAS NOT COMPLETED IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS. DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION. IF THEY ARE NOT CORRECTED, THE DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE BUILDING OFFICIAL AND TO THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE PRIOR TO THE COMPLETION OF THAT PHASE OF THE WORK. A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND TESTS AND CORRECTION OF ANY DISCREPANCIES NOTED IN THE INSPECTIONS OR TESTS SHALL BE SUBMITTED AT A POINT IN TIME AGREED UPON PRIOR TO THE START OF WORK BY THE OWNER OR THE OWNER'S AUTHORIZED AGENT TO THE BUILDING OFFICIAL.
5. SPECIAL INSPECTIONS OF FABRICATED ITEMS: WHERE FABRICATION OF STRUCTURAL, LOAD-BEARING OR LATERAL LOAD-RESISTING MEMBERS OR ASSEMBLIES IS BEING CONDUCTED ON THE PREMISES OF A FABRICATOR'S SHOP, SPECIAL INSPECTIONS OF THE FABRICATED ITEMS SHALL BE PERFORMED DURING FABRICATION.
6. STATEMENT OF SPECIAL INSPECTIONS: THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE SHALL PREPARE A STATEMENT OF SPECIAL INSPECTIONS.
7. MATERIAL TESTS: IN THE ABSENCE OF SUFFICIENT DATA OR DOCUMENTATION PROVIDING EVIDENCE OF CONFORMANCE TO QUALITY STANDARDS FOR MATERIALS IN CHAPTERS 19 AND 20 OF ACI 318, THE BUILDING OFFICIAL SHALL REQUIRE TESTING OF MATERIALS IN ACCORDANCE WITH THE APPROPRIATE STANDARDS AND CRITERIA FOR THE MATERIAL IN CHAPTERS 19 AND 20 OF ACI 318.
8. CONTRACTOR RESPONSIBILITY: CORRECT DISCREPANCIES IDENTIFIED IN THE SPECIAL INSPECTIONS AND TESTS WHERE WORK WAS NOT COMPLETED IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS.

STRUCTURAL OBSERVATIONS

1. STRUCTURAL OBSERVATIONS SHALL BE PROVIDED AT THE FOLLOWING EXTENT AND FREQUENCY:
 - 1.1. PRIOR TO METERING VAULT BASE SLAB PLACEMENT AFTER REINFORCEMENT AND FORMWORK IS INSTALLED.
 - 1.2. PRIOR TO METERING VAULT WALL PLACEMENT AFTER REINFORCEMENT IS INSTALLED.
 - 1.3. PRIOR TO METERING VAULT TOP SLAB PLACEMENT AFTER REINFORCEMENT AND FORMWORK IS INSTALLED.

CONCRETE TESTING SCHEDULE:

- [X] EACH MIX PLACED, EACH DAY PLACED, SEE SPECIFICATIONS FOR
QUANTITY OF CYLINDERS
- [X] SLUMP TEST - PER 50 CY & AT STRENGTH SAMPLE
- [X] AIR TEST - PER STRENGTH SAMPLES SCHEDULE
- [X] UNIT WEIGHT TEST - PER STRENGTH SAMPLES

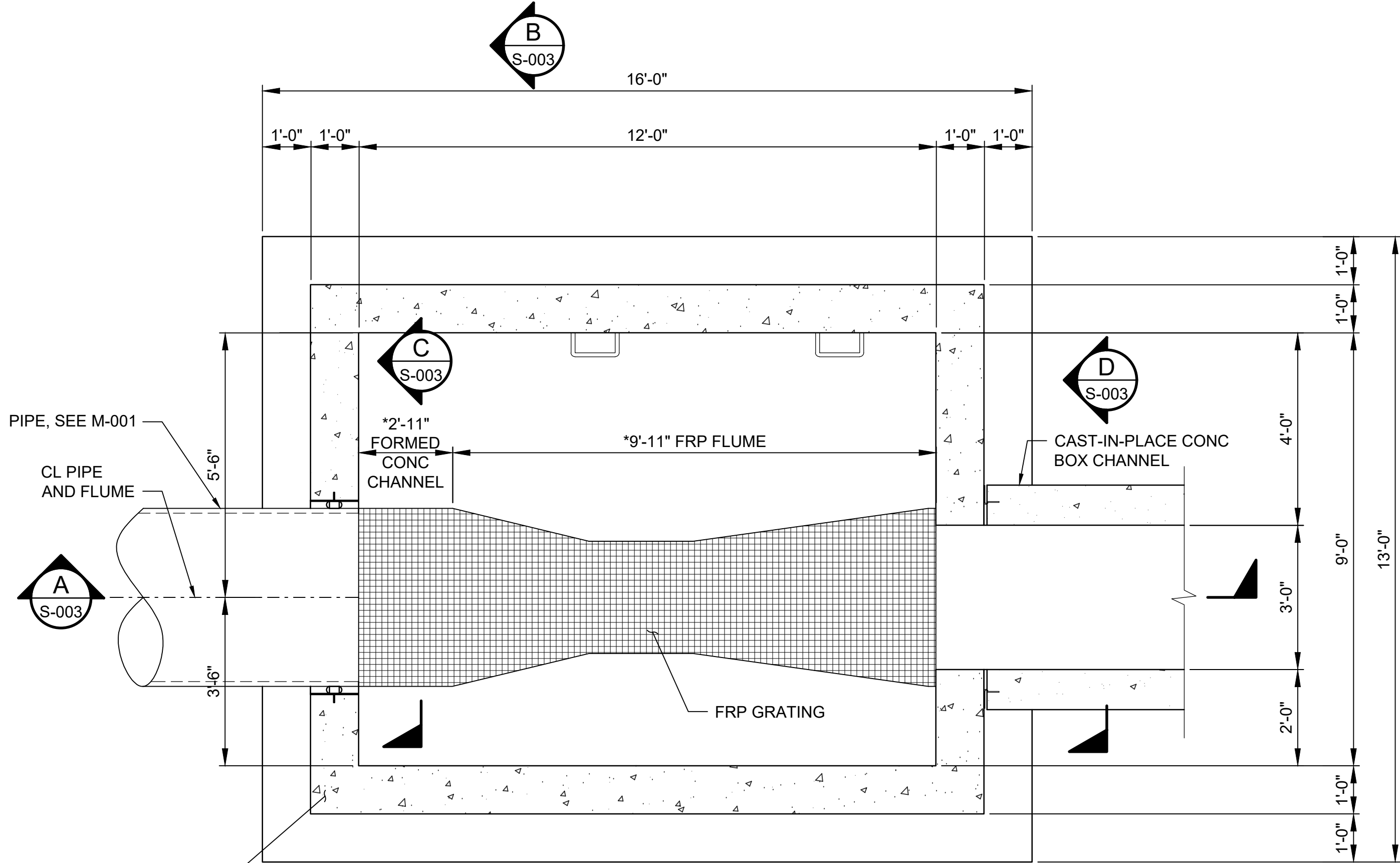
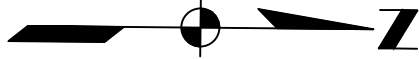
REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION					
SPECIAL INSPECTION REQUIRED	VERIFICATION AND INSPECTION	CONT	PERIODIC	REFERENCED STANDARD	IBC REF
YES	1. INSPECTION OF REINFORCING STEEL, AND VERIFY PLACEMENT	--	X	ACI 318: CH. 20, 25.2, 25.3, 26.6.1-26.6.3	1908.4
YES	2. INSPECT ANCHORS CAST IN CONCRETE	--	X	ACI 318: 17.8.2	--
	3. INSPECTION OF ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS:				
YES	a. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIST SUSTAINED TENSION LOADS	--	X	ACI 318 17.8.2.4	--
	b. MECHANICALLY ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 3.a				
YES	4. VERIFYING USE OF REQUIRED DESIGN MIX	--	X	ACI 318:Ch 19.26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
YES	5. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE	X	--	ASTM C172 ASTM C31 ACI 318:26.5, 26.12	1908.10
YES	6. INSPECT CONCRETE FOR PROPER APPLICATION TECHNIQUES.	X	--	ACI 318: 26.5	1908.6, 1908.7, 1908.8
YES	7. VERIFY MAINTENANCE OF SPECIAL CURING TEMPERATURE AND TECHNIQUES.	--	X	ACI 318: 26.5.3-26.5.5	1908.9
YES	8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES.	--	X	ACI 318: 26.5.3-26.5.5	1908.9

SOILS			
REQUIRED SPECIAL INSPECTIONS AND TESTS			
SPECIAL INSPECTION REQUIRED	TYPE	CONT	PERIODIC
YES	1. VERIFY MATERIALS BELOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY.	--	X
YES	2. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL.	--	X
YES	3. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS.	--	X
YES	4. VERIFY USE OF PROPER MATERIALS, DENSITIES AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL	X	--
YES	5. PRIOR TO PLACEMENT OF COMPACTED FILL, OBSERVE SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY.	--	X

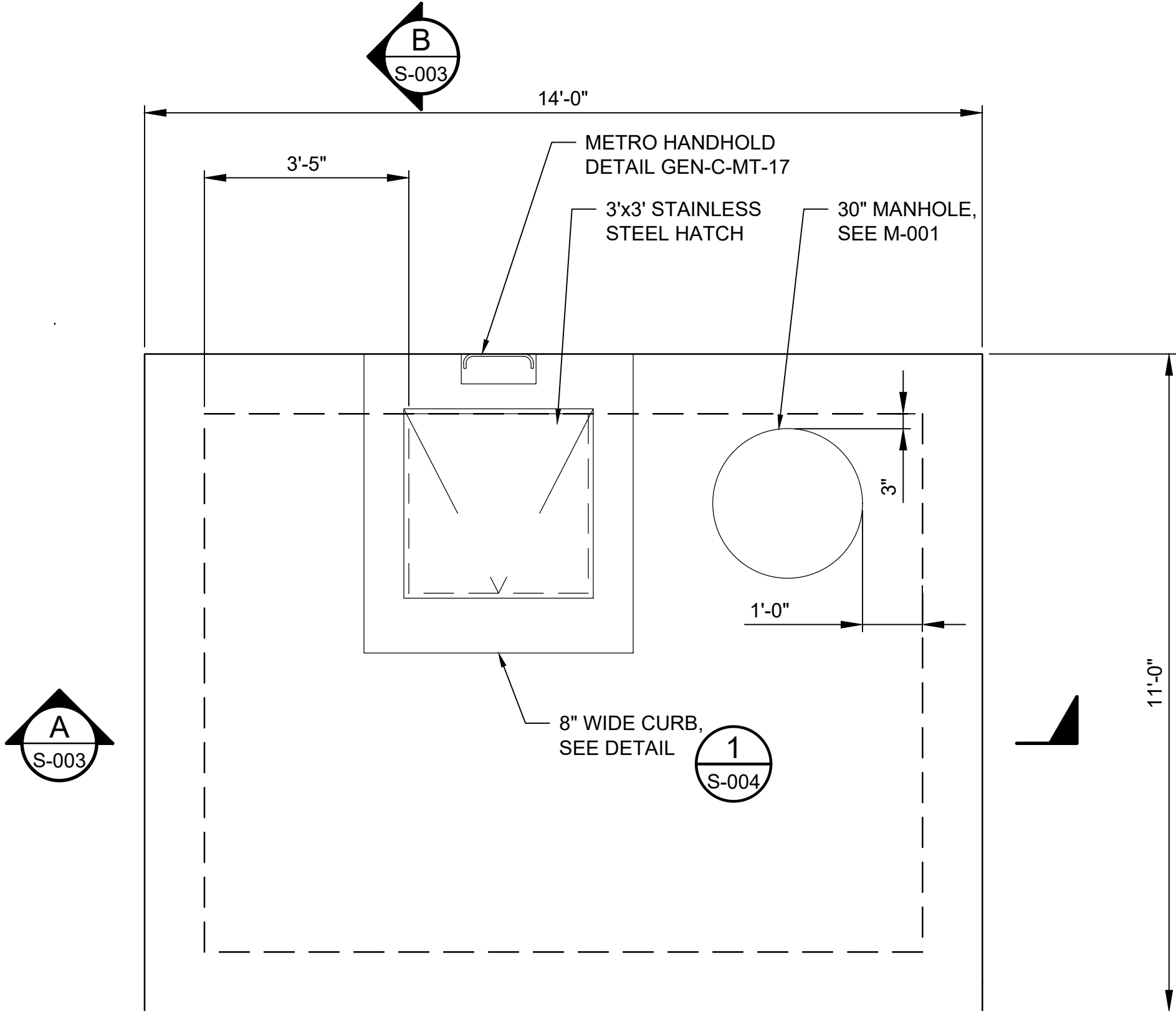
APPROVED City of Arvada, Colorado		
CITY ENGINEER	DATE	JOB NUMBER
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS". LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.		

SEP 2024 - 90% DESIGN																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				</
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FOUNDATION PLAN
SCALE: 1/2"=1'-0"



TOP PLAN
SCALE: 1/2"=1'-0"

GENERAL SHEET NOTES

- SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
- OPENINGS IN GRATING NOT SHOWN FOR CLARITY. COORDINATE GRATING LAYOUT WITH FAVORABLY REVIEWED EQUIPMENT SHOP DRAWINGS.
- COATING SYSTEMS NOT SHOWN. SEE MECHANICAL DRAWINGS AND PROJECT SPECIFICATIONS FOR COATING REQUIREMENTS.
- PROVIDE CONSTRUCTION JOINT IN SLAB, WALLS, AND TOP SLAB AT CENTER POINT ALONG THE LENGTH OF CAST-IN-PLACE BOX CHANNEL
- PROVIDE ADDITIONAL REINFORCEMENT AT ALL OPENINGS PER DETAIL S-3421.

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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NO REVISION DATE BY

SCALES
0 1"
0 25mm
IF THIS BAR IS NOT
DIMENSION SHOWN,
ADJUST SCALES
ACCORDINGLY.

PRELIMINARY
NOT FOR
CONSTRUCTION

DESIGNED
MW
DRAWN
MS
CHECKED
PIB



NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



STRUCTURAL PLANS

SCALE

JOB NO
2246059'00

DATE
SEP 2024

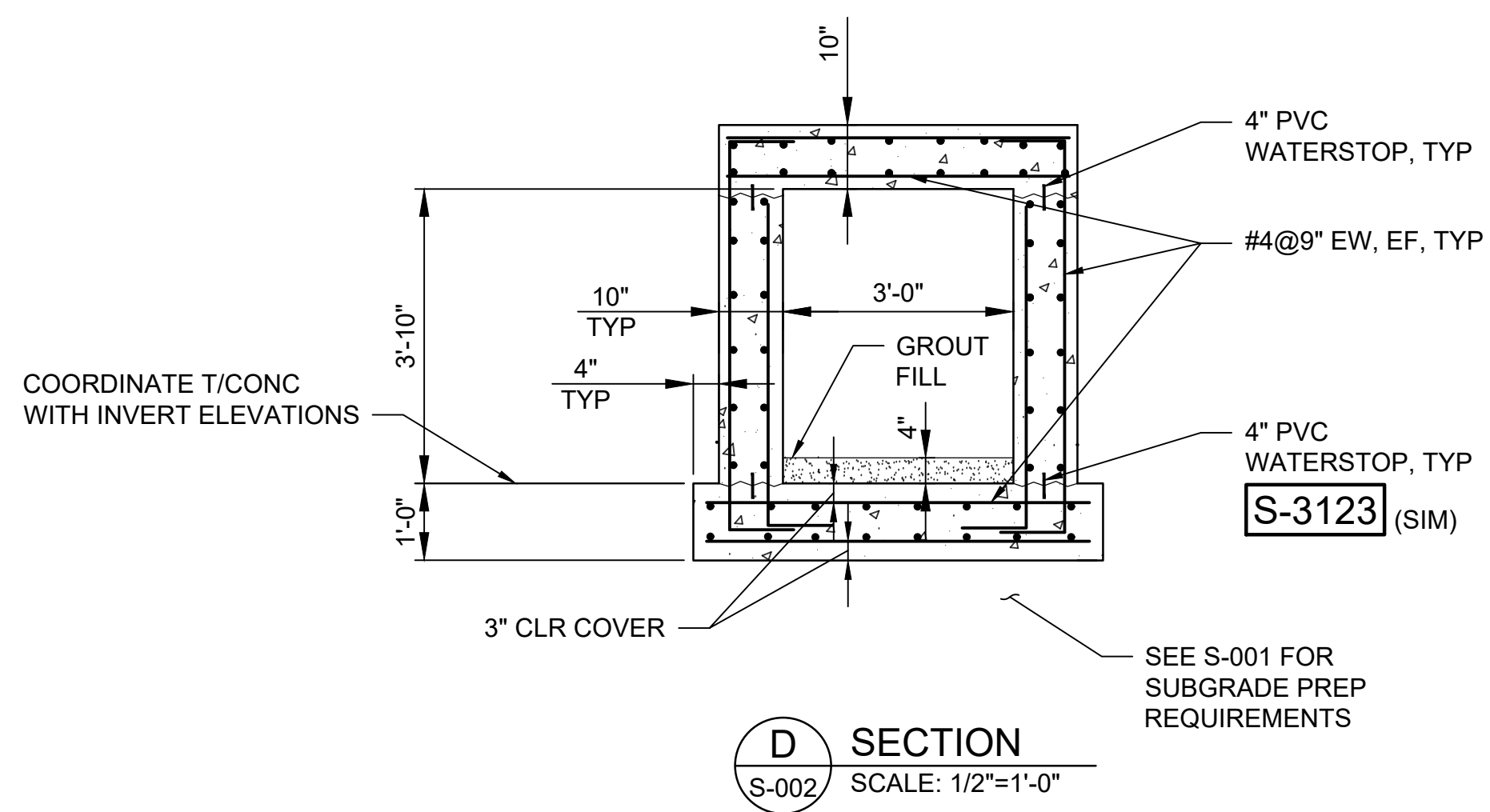
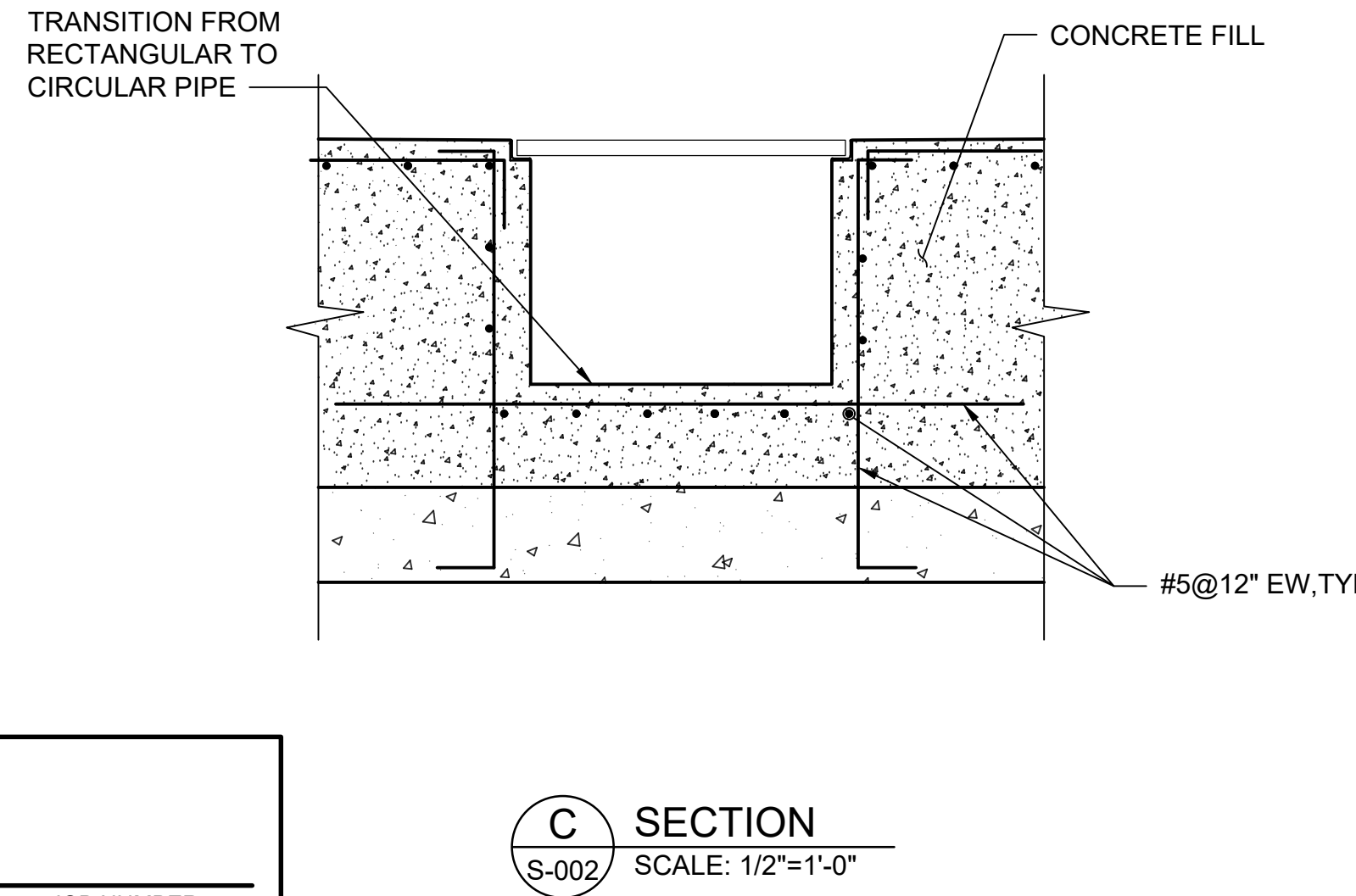
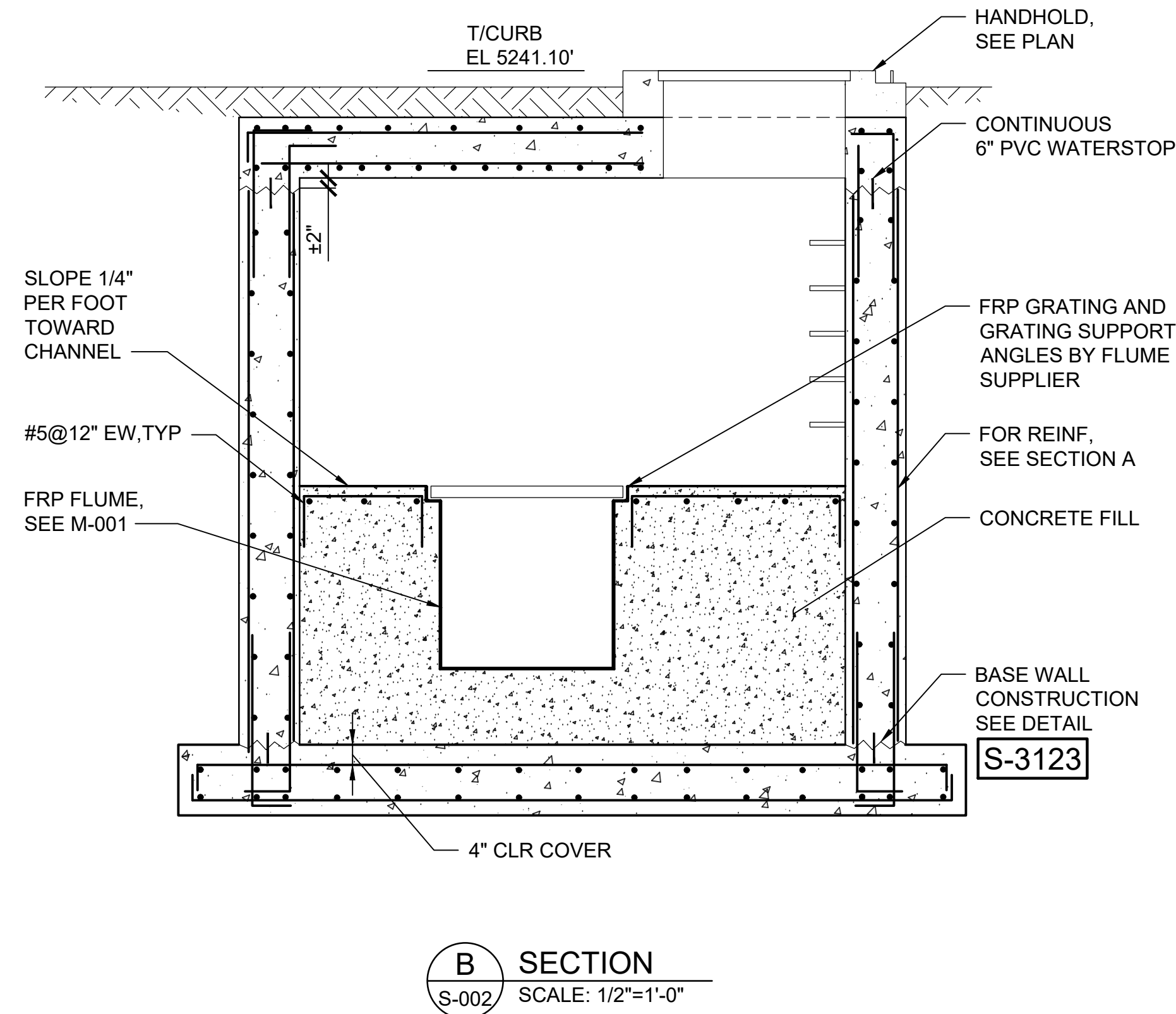
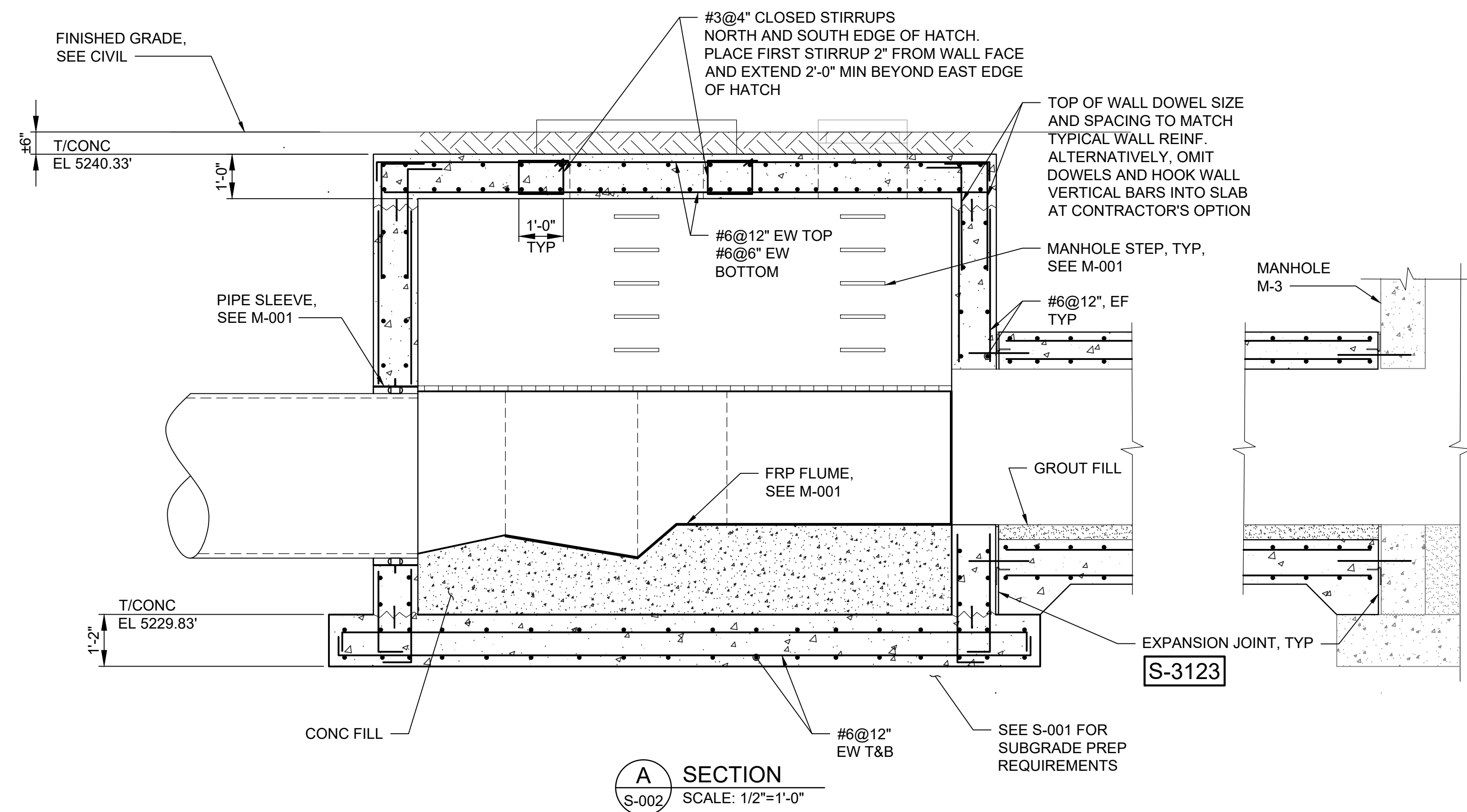
SHEET 24 OF 48
S-002

Plot Date: 9/6/2024 1:23 PM

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- GENERAL SHEET NOTES
- SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
 - PLACEMENT OF CONCRETE FILL SHALL FOLLOW ACI 301 TEMPERATURE LIMITATIONS. SUBMIT THERMAL CONTROL PLAN FOR REVIEW.
 - ROUGHEN SURFACES IN CONTACT WITH CONCRETE FILL AND GROUT FILL TO 1/4" AMPLITUDE.



APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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NO	REVISION	DATE	BY		

SCALES

0 1" 0 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED MW

DRAWN MS

CHECKED PIB

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

STRUCTURAL SECTIONS	
SCALE	
JOB NO	2246059'00
DATE	SEP 2024
SHEET	25 OF 48
S-003	

Plot Date: 9/6/2024 1:23 PM

User: ROBERT INOPEA

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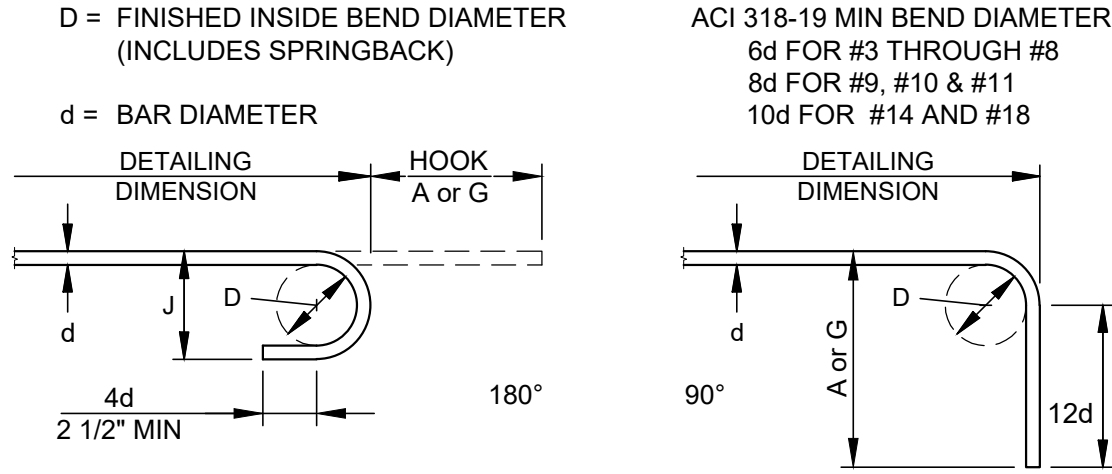
LAP SPLICE LENGTH FOR REINFORCING BARS IN WALLS, SLABS & FTNGS (INCHES)						
CONCRETE COMPRESSIVE STRENGTH, $f_c \geq 3,000$ PSI						
BAR SIZE	COVER=1.00 IN.		COVER=1.50 IN.		COVER=2.00 IN.	
IMPERIAL [SOFT METRIC]	TOP ⁴	OTHER	TOP ⁴	OTHER	TOP ⁴	OTHER
#3 [#10]	17	13	17	13	17	13
#4 [#13]	23	17	23	17	23	17
#5 [#16]	33	26	28	22	28	22
#6 [#19]	46	35	34	26	34	26
#7 [#22]	74	57	55	43	49	38
#8 [#25]	93	72	70	54	56	43
#9 [#29]	113	87	86	66	69	53
#10 [#32]	137	106	105	81	85	66
#11 [#36]	162	125	125	97	102	79

- NOTES:
- THE SPLICE LENGTH TABLE IS SPECIFIC TO TENSION DEVELOPMENT AND TENSION LAP SPLICE LENGTHS FOR WALLS, SLABS AND FOOTINGS DETERMINED IN ACCORDANCE WITH ACI 318-19, CHAPTER 25, ACI 350-06 CHAPTER 12, AND THE CRITERIA IN THIS DETAIL. CONTACT THE EOR FOR ANY DISCREPANCIES TO THE CRITERIA IN THIS DETAIL.
 - LAP SPLICE LENGTHS ARE CLASS B LAPS, IN INCHES, FOR GRADE 60 REINF IN NORMAL-WEIGHT CONC WITH $f_c \geq 3,000$ PSI.
 - OC SPACING OF REINF SHALL BE > 2 TIMES THE CONC COVER PLUS ONE BAR DIA.
 - TOP BARS ARE HORIZ BARS WITH $> 12"$ OF CONC CAST BELOW BARS.
 - FOR EPOXY-COATED REINF OR LIGHTWEIGHT CONC, CONTACT THE EOR FOR LAP SPLICE LENGTHS.
 - FOR BARS OF DIFFERENT SIZES, THE LAP SPLICE LENGTHS OF THE SMALLER BAR SHALL BE USED.
 - STAGGER LAPS A DISTANCE OF ONE-HALF THE SPLICE LENGTH, UON.
 - DO NOT LOCATE LAP SPLICE IN CONSTRUCTION JOINTS (CJ), EXPANSION JOINTS (EJ), OR CONTRACTION JOINTS (CNJ). LOCATE LAPS AT LEAST $4'$ PAST JOINT UON, TYP.

CONCRETE REBAR LAP SPLICE

S-3010

SCALE: NTS
REV 00



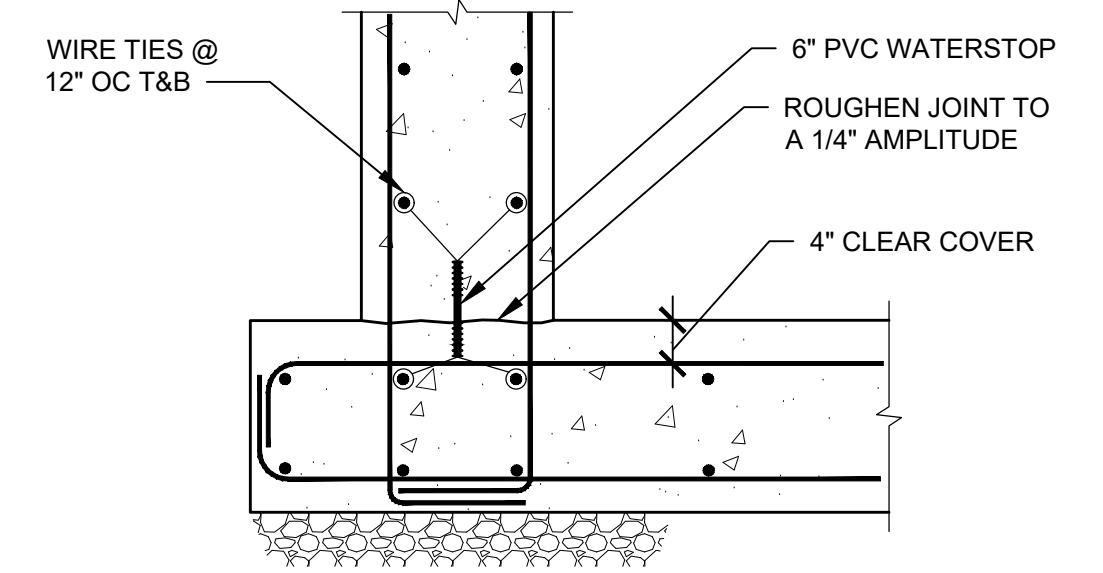
RECOMMENDED END HOOK DIMENSIONS				
BAR SIZE	D	180 ° HOOKS		90 ° HOOKS
		A or G	J	A or G
#3	0'-2 1/4"	0'-5"	0'-3"	0'-6"
#4	0'-3"	0'-6"	0'-4"	0'-8"
#5	0'-3 3/4"	0'-7"	0'-5"	0'-10"
#6	0'-4 1/2"	0'-8"	0'-6"	1'-0"
#7	0'-5 1/4"	0'-10"	0'-7"	1'-2"
#8	0'-6"	0'-11"	0'-8"	1'-4"
#9	0'-9 1/2"	1'-3"	0'-11 3/4"	1'-7"
#10	0'-10 3/4"	1'-5"	1'-1 1/4"	1'-10"
#11	1'-0"	1'-7"	1'-2 3/4"	2'-0"

REINFORCING HOOKS

S-3020

SCALE: NTS
REV 00

- NOTES:
- LOCATE WATERSTOP WITH WIRE TIES BETWEEN TWO CURTAINS OF REINFORCING.
 - AT INTERSECTIONS OF CONST JOINTS, CONNECT WATERSTOP WITH FACTORY MITERED ELLS AND TEES TO FORM CONTINUOUS WATER BARRIER. REFER TO SPECS FOR INSTALLATION & DETAILED PRODUCT REQ'S.
 - EXTEND BAR HOOKED ENDS TO BOTTOM OF SLAB.

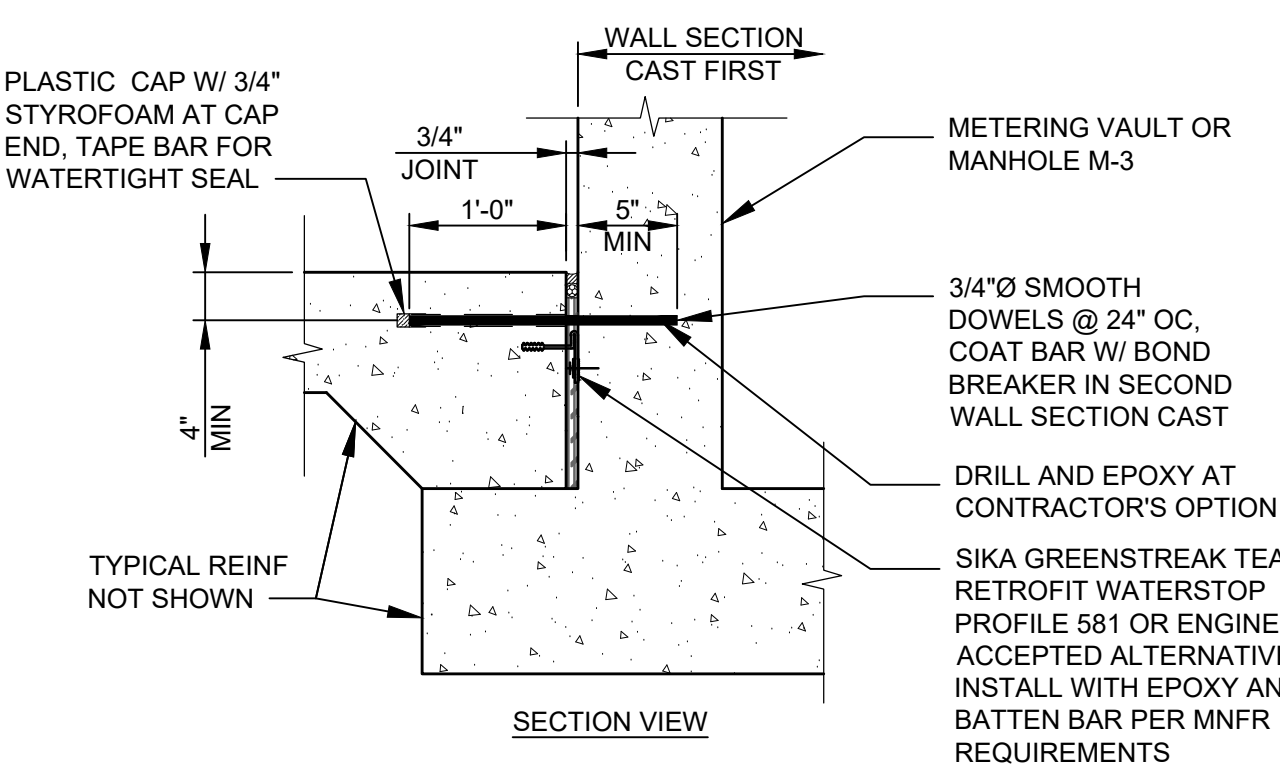


WALL-TO-SLAB JOINT

S-3123

INVERTED KEY
SCALE: NTS
REV 01

- NOTES:
- WATERSTOP SHALL BE CONTINUOUS. PROVIDE SHOP FABRICATED BENDS AS REQUIRED.
 - SCAN FOR EXISTING REINF. PRIOR TO POST INSTALLING BARS AND ANCHORS. NO EXISTING REINF. SHALL BE DAMAGED.

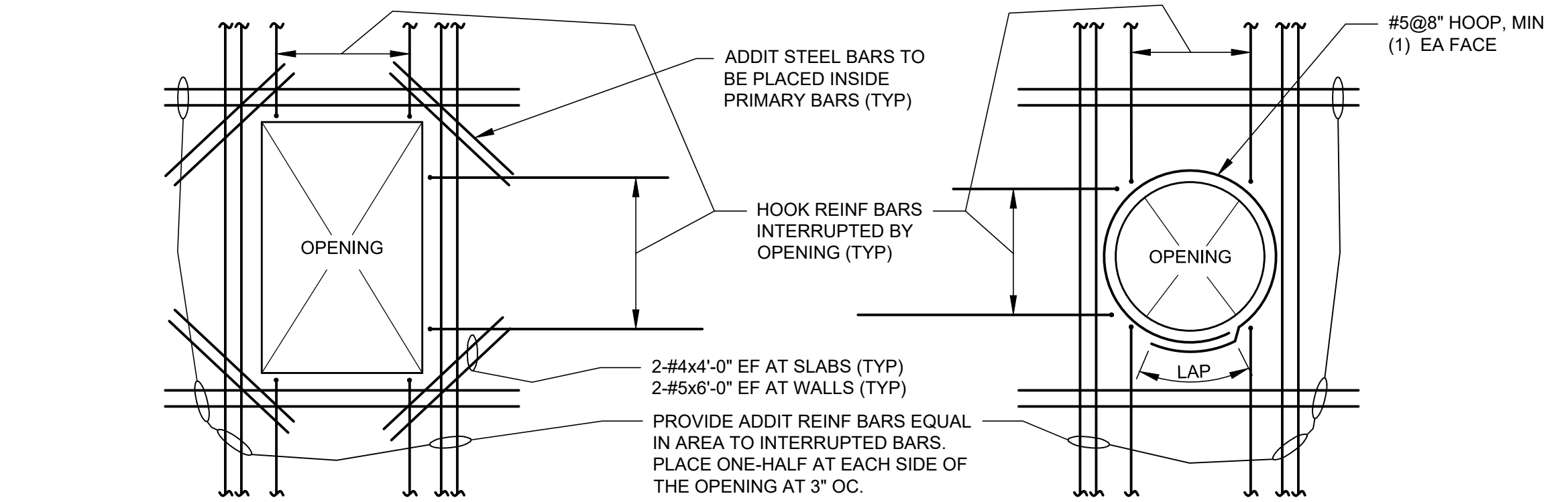


EXPANSION JOINT

S-3164

SCALE: NTS
REV 00

- NOTES:
- PROVIDE ADDITIONAL VERTICAL REINF EQUAL IN LENGTH TO THE UNINTERRUPTED BARS.
 - EXTEND ADDITIONAL HORIZONTAL REINF $5'-0"$ MIN BEYOND EITHER SIDE OF OPENING (HOOK BARS IF $5'-0"$ NOT AVAILABLE).
 - THIS DETAIL APPLIES TO ALL WALLS AND SLABS USED FOR RETAINING LIQUIDS AND SOIL.

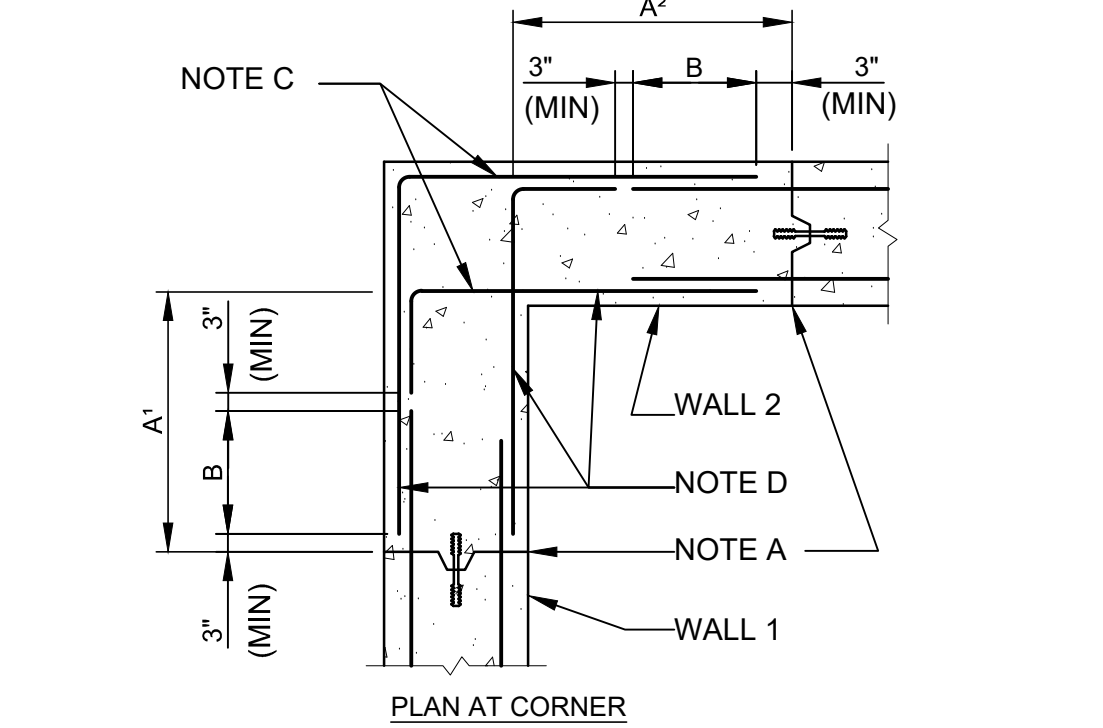


ADDIT REINF AT OPENINGS

S-3421

PRESSURE WALLS AND SLABS
SCALE: 1" = 1'-0"
REV 00

- NOTES:
- VERTICAL REINFORCING NOT SHOWN.
 - THESE DETAILS SHALL BE APPLICABLE TO ALL WALL CORNERS UNLESS NOTED OTHERWISE ON THE PLANS.
 - ALL SPLICES ARE IN THE VERTICAL PLANE.

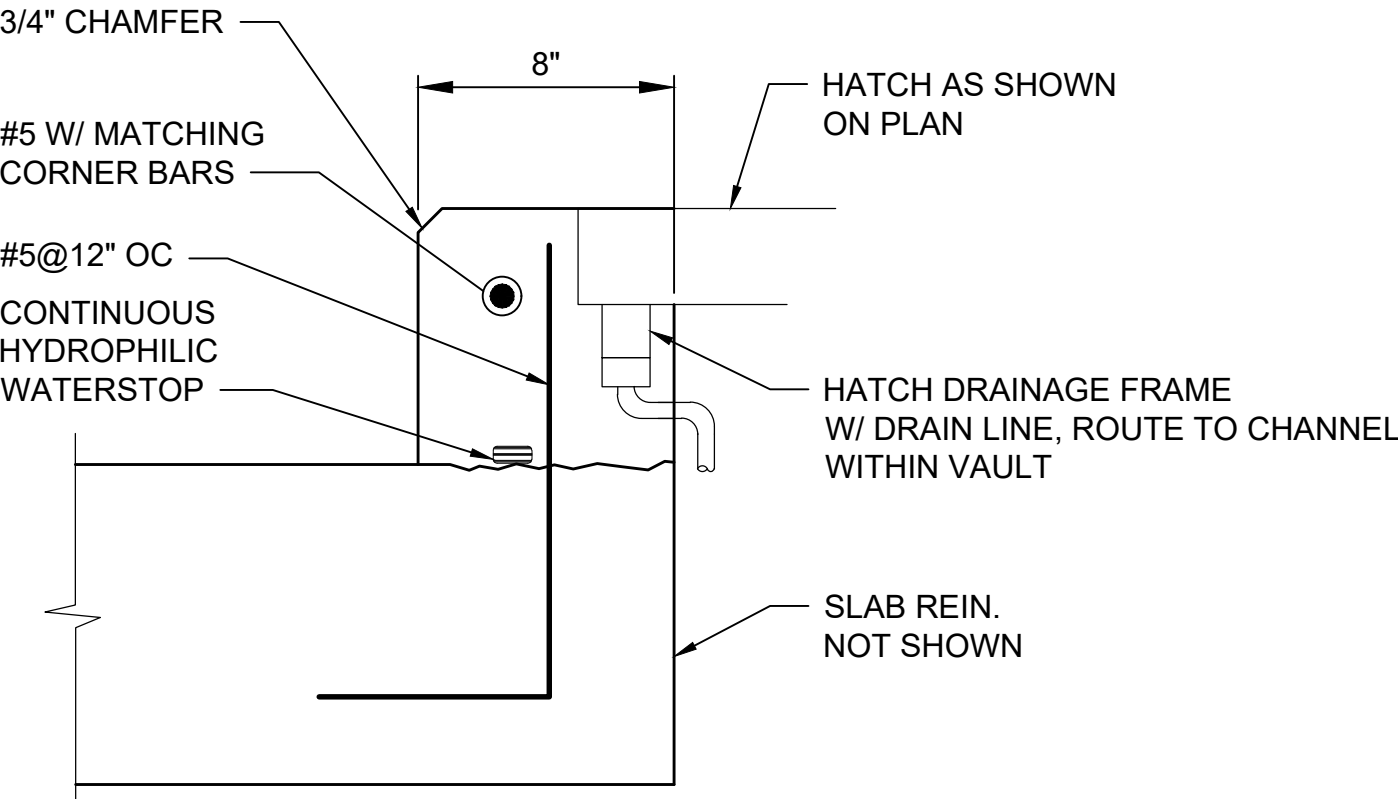


- A = VERTICAL CONSTRUCTION JOINT NEAREST TO WALL CORNER. WITH WATERSTOP AT CONTAINMENT STRUCTURES ONLY WHERE SHOWN IN PLAN.
A* = DISTANCE FROM INSIDE CORNER FACE TO NEAREST VERTICAL CONSTRUCTION JOINT IN SIMILARLY NUMBERED WALL. "A" SHALL NOT BE LESS THAN DIMENSIONS INDICATED BY THESE DETAILS; NOR GREATER THAN INDICATED ON PLAN DRAWINGS; BUT IN ANY CASE THE SUM OF TWO ADJACENT "A" DIMENSIONS SHALL NOT EXCEED 30 FEET.
B = STANDARD LAP SPLICE LENGTH. USE SPLICE LENGTH FOR THE SMALLER OF THE TWO BARS BEING SPLICED.
C = STANDARD HOOK
D = TYPICAL CORNER REINFORCEMENT. SIZE SHALL MATCH LARGEST ADJACENT WALL HORIZONTAL REINFORCEMENT; SPACING SHALL MATCH MINIMUM ADJACENT WALL HORIZONTAL REINFORCEMENT SPACING.

WALL CORNER REINFORCING

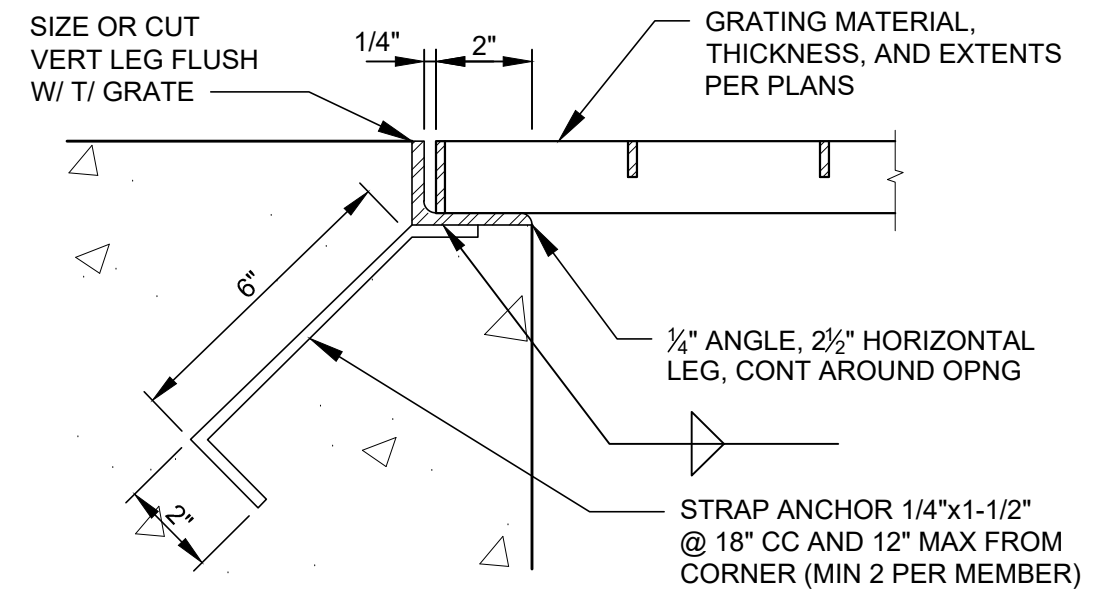
S-3412

DOUBLE MAT
SCALE: 3/8" = 1'-0"
REV 00



1 HATCH CURB DETAIL

S-002 SCALE: NTS



SUPPORT MATERIAL SCHEDULE		
FRP	FRP	FRP

GRATING SUPPORT

S-3560

EMBEDDED ANGLE
SCALE: 3" = 1'-0"
REV 00

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SCALES

0 1"
0 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

PRELIMINARY
NOT FOR
CONSTRUCTION

DESIGNED

MW

DRAWN

MS

CHECKED

PIB



NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



STRUCTURAL DETAILS - I

SCALE

JOB NO

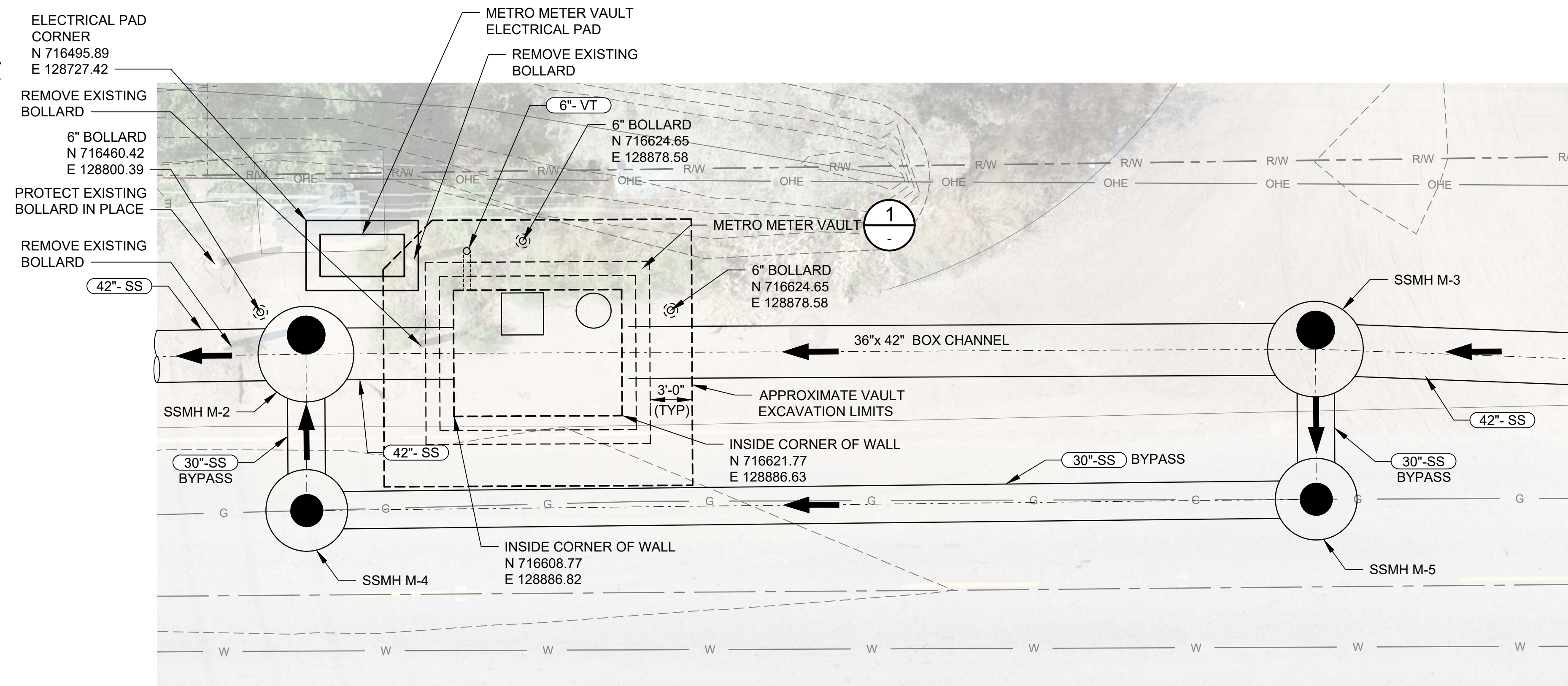
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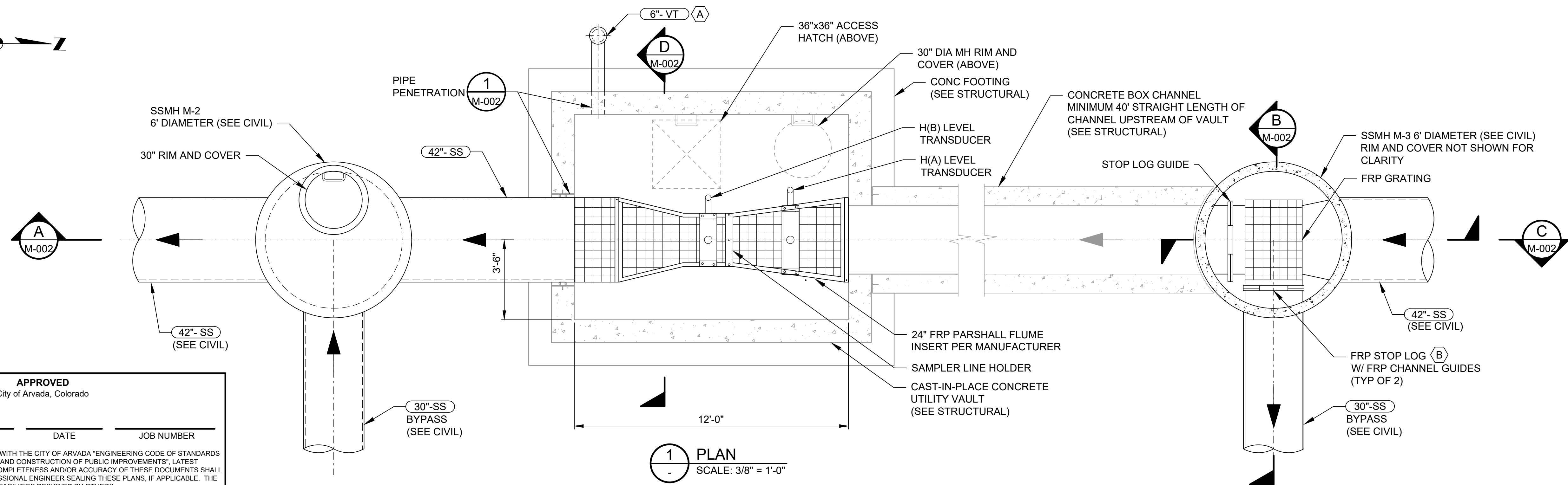
SEP 2024

SHEET 26 OF 48

S-004



METERING VAULT ENLARGED SITE PLAN
SCALE: 3/16"=1'-0"



1 PLAN
- SCALE: 3/8" = 1'-0"

GENERAL SHEET NOTES

1. CONFINED SPACE ENTRY SAFETY PRECAUTIONS MEETING OR EXCEEDING OSHA REQUIREMENTS SHALL BE IMPLEMENTED PRIOR TO ENTERING THE VAULT. A CONFINED SPACE ENTRY PERMIT MAY BE REQUIRED BY THE OWNER PRIOR TO ENTRY BY NON-AUTHORIZED PERSONNEL.
2. METER VAULT SHALL INCLUDE EXTERNAL SEALING BANDS ON THE OUTSIDE OF THE STRUCTURE AT ALL JOINTS TO PREVENT GROUNDWATER INTRUSION. COAL TAR EPOXY COAT THE EXTERIOR OF THE VAULT. LINE THE INSIDE OF THE VAULT WITH A METRO APPROVED H2S RESISTANT COATING.
3. ONCE THE VAULT IS CONSTRUCTED, INSTALLED, AND TESTED PER THE PROJECT SPECIFICATIONS, IT SHALL BECOME THE PROPERTY OF METRO.
4. CONTRACTOR SHALL DESIGN AND CONSTRUCT THE METER VAULT IN ACCORDANCE WITH METRO'S STANDARD METER VAULT DETAILS. SEE TABLE THIS SHEET.
5. CONTRACTOR MUST RECEIVE APPROVAL FROM METRO OF THE METER VAULT DESIGN AND CONSTRUCTION PRIOR TO ACCEPTANCE OF THE WORK.
6. SEE ELECTRICAL DRAWINGS FOR SAMPLE LINE ROUTING. CONTRACTOR SHALL LIMIT BENDS IN THE SAMPLE LINE TO THE EXTENT POSSIBLE IN THE FIELD.
7. CONTRACTOR SHALL USE CUTOFF WALLS AS NEEDED FOR EXCAVATION STABILIZATION IF APPROVED BY THE AUTHORITY HAVING JURISDICTION.

 SHEET KEYNOTES

- A. CONTRACTOR SHALL LOCATE VENT PIPING OUTSIDE OF DRIVEWAY AND ROADWAY AREAS AND PROTECT WITH BOLLARDS.
- B. PROVIDE A LEAK TIGHT CONNECTION BETWEEN THE STOP LOGS AND CHANNEL GUIDES. PROPOSED MATERIALS SHALL BE SUITABLE FOR MUNICIPAL WASTEWATER SERVICE.

<u>METRO DETAIL NO.</u>	<u>METRO TYPICAL MERTER/SAMPLER FACILITIES DETAIL TITLE</u>
GEC-C-MT-12	VPP FLOOR LEVEL PLAN AND SECTION
GEC-C-MT-16	GRATING PLANS AND DETAILS
GEC-C-MT-17	HANDHOLD DETAILS
GEC-C-MT-18	STOP PLATE HOOK AND LIFTING EYE DETAILS
GEC-C-MT-19	SAMPLE LINE HOLDER DETAILS
GEC-C-MT-20	CABINET EQUIPMENT DETAILS

APPROVED
City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

SEP 2024 - 90% DESIGN

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NO

REVISION

DAT

BY

SCALES

0 1"

0 25mm

0 25mm

IF THIS BAR IS NOT
DIMENSION SHOWN,
ADJUST SCALES
ACCORDINGLY.

DESIGNED

T.S.

DRAWN

WA

CHECKED

19



NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



METERING VAULT PLAN

SCALE
1" = 5'

OB NO
2246059*00

SEP 2024

SHEET 27 OF

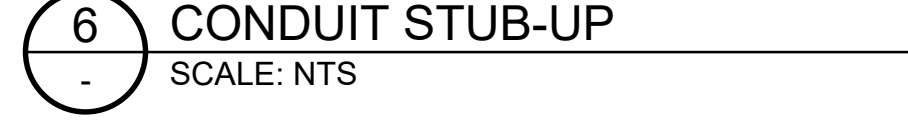
ABBREVIATIONS										ELECTRICAL NOTES										ELECTRICAL DEMOLITION NOTES																																																											
' INCH, FEET " INCH, INCHES # NUMBER % PERCENT & AND @ AT ± APPROXIMATELY < LESS THAN = EQUALS > GREATER THAN A AMPERE(-S) A/C AIR CONDITIONING A/D ANALOG TO DIGITAL A/M AUTO/MANUAL ABAN(-D) ABANDON(-ED) AC ALTERNATING CURRENT AF AMPERE FRAME AFCI ARC-FAULT CIRCUIT INTERRUPTER AFF ABOVE FINISHED FLOOR AFG ABOVE FINISHED GRADE AI ANALOG INPUT AIC AMPERES INTERRUPTING CAPACITY ANN ANNUNCIATOR ANT ANTENNA AO ANALOG OUTPUT APPROX APPROXIMATE(-LY) ARCH ARCHITECT(-URAL) AS AMMETER SWITCH ASD ADJUSTABLE SPEED DRIVE (DC) AT AMPERE TRIP ATS AUTOMATIC TRANSFER SWITCH AUTO AUTOMATIC AUX AUXILIARY AWG AMERICAN WIRE GAGE BATT BATTERY BC BARE COPPER BKR BREAKER C CONDUCTOR, CONTACT C/S CONSTANT SPEED CAB CABINET CALC(S) CALCULATION(S) CAT CATEGORY CB CATCH BASIN CCTV CLOSED-CIRCUIT TELEVISION CHEM CHEMI(-CAL, -STRY) CID1 CLASSIFICATION I, DIVISION 1 CID2 CLASSIFICATION I, DIVISION 2 CKT CIRCUIT CLR CLEAR(-ANCE) CLSM CONTROLLED LOW STRENGTH MATERIAL CO CONDUIT ONLY COAX COAXIAL COM COMMON COMM COMMUNICATION COND CONDUIT CPT CONTROL POWER TRANSFORMER CR CONTROL RELAY CT CURRENT TRANSFORMER CTRL CONTROL CU IN CUBIC INCH(-ES) DC DIRECT CURRENT DCS DISTRIBUTED CONTROL SYSTEM DEG DEGREE(-S) DEG C DEGREES CELSIUS DEG F DEGREES FAHRENHEIT DEMO DEMOLISH DI DISCRETE INPUT DIA DIAMETER DIAG DIAGRAM DISC DISCONNECT DISTR DISTRIBUTION DO DISCRETE OUTPUT DPDT DOUBLE POLE, DOUBLE THROW DPST DOUBLE POLE, SINGLE THROW DR DOOR DTL(-S) DETAIL(-S) DUP DUPLEX EFFIC EFFICIENCY EFFL EFFLUENT ELEC ELECTRIC(-AL) ELEM ELEMENTARY EMERG EMERGENCY ENCL ENCLOSURE ENET ETHERNET ENGR ENGINEER EPA ENVIRONMENTAL PROTECTION AGENCY EQPM EQUIPMENT EST ESTIMATE(-D) E-STOP EMERGENCY STOP ETC CETERA										ETM ELAPSED TIME METER EUSERC ELECTRIC UTILITY SERVICE EQUIPMENT REQUIREMENTS COMMITTEE EXIST EXISTING EXP EXPANSION EXT EXTERNAL FA FIRE ALARM FACILITY(-Y, -IES) FDR FEEDER FIG FIGURE FLA FULL LOAD AMPERES FLEX FLEXIBLE FO FIBER OPTIC FREQ FREQUENCY FT FOOT, FEET FU FUSE FUT FUTURE FVNR FULL VOLTAGE, NON REVERSING FVR FULL VOLTAGE, REVERSING FWD FORWARD G GROUND (ELECTRICAL) GAC GRANULAR ACTIVATED CARBON GAL GALLON(-S) GFCI GROUND-FAULT CIRCUIT INTERRUPTER GND GROUND GRS GALVANIZED RIGID STEEL H HIGH, HEIGHT HD HEAT DETECTOR HDPE HIGH DENSITY POLYETHYLENE HGR HANGER HH HANDHOLE HMI HUMAN MACHINE INTERFACE HOA HAND-OFF-AUTOMATIC HOR HAND-OFF-REMOTE HP HORSEPOWER HR(S) HOUR(-S) HTR HEATER HVAC HEATING, VENTILATING, AND AIR CONDITIONING HZ HERTZ (CYCLES PER SECOND) I&C INSTRUMENTATION AND CONTROL I/O INPUT/OUTPUT IEEE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS IL INDICATING LIGHT IN INCH(-ES) INST INSTANTANEOUS INSTR INSTRUMENT(-ATION) IP INTERNET PROTOCOL IR INFRARED IS INTRINSICALLY SAFE ISA INTERNATIONAL SOCIETY OF AUTOMATION ISO ISOLAT(-E, -ION) ISR INTRINSICALLY SAFE RELAY JB JUNCTION BOX KA KILOAMPERE(-S) KCMIL THOUSANDS OF CIRCULAR MILS KHZ KILOHERTZ KV KILOVOLT(-S) KVA KILOVOLT-AMPERE(-S) KVAR KILOVOLT-AMPERE(-S) REACTIVE KVARH KILOVOLT-AMPERE REACTIVE HOUR(-S) KW KILOWATT(-S) KWH KILOWATT HOUR(-S) L LENGTH, LINE LA LIGHTNING ARRESTER LAN LOCAL AREA NETWORK LB(-S) POUND(-S) LCP LOCAL CONTROL PANEL LCS LOCAL CONTROL STATION LEL LOWER EXPLOSIVE LIMIT LOC LOCATION LOR LOCAL-OFF-REMOTE LOT LOCK-OUT, TAG-OUT LP LIGHTING PANELBOARD L-R LOCAL-REMOTE LS LIMIT SWITCH LT LIGHT LTG LIGHTING LV LOW VOLTAGE mA MILLIAMPERE(-S) MAX MAXIMUM MCB MAIN CIRCUIT BREAKER MCC MOTOR CONTROL CENTER MCP MOTOR CIRCUIT PROTECTOR MECH MECHANICAL										MFR MANUFACTURER MH MEGAHERTZ MHZ MINUTE(-S) MIN MINIMUM, MINUTE(-S) MISC MISCELLANEOUS MLO MAIN LUGS ONLY MM MULTIMODE MOCP MAXIMUM OVERCURRENT PROTECTION MOD(-S) MODIFY(-Y, -ICATIONS) MOV MOTOR OPERATED VALVE MT(-D, -G) MOUNT(-ED, -ING) MTR MOTOR MTS MANUAL TRANSFER SWITCH MV MEDIUM VOLTAGE N NORTH, NEUTRAL N/A NOT APPLICABLE NAOCL SODIUM HYPOCHLORITE NAOH SODIUM HYDROXIDE NC NORMALLY CLOSED NEC NATIONAL ELECTRICAL CODE (NFPA 70) NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION NEMA NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION NETA INTERNATIONAL ELECTRICAL TESTING ASSOCIATION NFC NOT FOR CONSTRUCTION NFPA NATIONAL FIRE PROTECTION ASSOCIATION NH3 AMMONIA NIC NOT IN CONTRACT NO NORMALLY OPEN, NUMBER NORM NORMAL NTS NOT TO SCALE O/C OPEN/CLOSE O3 OZONE ODP OPEN DRIP PROOF OFCI OWNER FURNISHED, CONTRACTOR INSTALLED OIT OPERATOR INTERFACE TERMINAL OL THERMAL OVERLOAD RELAY ORIG ORIGINAL OSC OPEN/STOP/CLOSE OT OVER TEMPERATURE P POLE PA PUBLIC ADDRESS PB PULLBOX, PUSHBUTTON PC(-S) PIECE(-S), PHOTOCELL PCC POINT OF COMMON COUPLING PE PHOTOELECTRIC PF POWER FACTOR PFR POWER FACTOR RELAY PH PHASE PLC PROGRAMMABLE LOGIC CONTROLLER PM POWER MONITOR PNL PANEL PNLBD PANELBOARD POE POWER OVER ETHERNET PP POWER POLE PRI PRIMARY PRV PRESSURE RELIEF VALVE, PRESSURE REDUCING VALVE PS POWER SUPPLY PT(-S) POTENTIAL TRANSFORMER PVC POLYVINYL CHLORIDE PWR POWER R, RAD RADIUS RCPT RECEIPTACLE RCT REPEAT CYCLE TIMER RIO REMOTE INPUT/OUTPUT RM ROOM RMT REMOTE RPM REVOLUTIONS PER MINUTE RST RESET RT RESET TIMER RTU REMOTE TELEMETRY UNIT RVSS REDUCED VOLTAGE, SOLID STATE S/S START/STOP SCADA SUPERVISORY CONTROL AND DATA ACQUISITION SCR SILICON CONTROLLED RECTIFIER SD SMOKE DETECTOR SEC SECONDARY SER SERVICE ENTRANCE RATED SGNL SIGNAL (SH) SHIELDED SHT SHEET SM SINGLEMODE SP SET POINT SPD SURGE PROTECTIVE DEVICE SPDT SINGLE POLE, DOUBLE THROW SPEC(-S) SPECIFICATION(-S) SS STAINLESS STEEL, SOLID STATE STB SHORTING TERMINAL BLOCK STD(-S) STANDARD(-S) STL STEEL STP SHIELDED TWISTED PAIR STRC STRUCTUR(-E, -AL) SWBD SWITCHBOARD SWG R SWITCHGEAR SYNC SYNCHRONIZING										T TIME(-R) TB TERMINAL BLOCK TC TRAY CABLE TCP TRANSMISSION CONTROL PROTOCOL TEFC TOTALLY ENCLOSED FAN COOLED TEL TELEPHONE TEMP TEMPERATURE, TEMPORARY TENV TOTALLY ENCLOSED NON-VENTILATED THROUGH TOT TOTAL, TOTALIZE(R) TSTAT THERMOSTAT TYP TYPICAL UG UNDERGROUND UL UNDERWRITERS LABORATORIES UNKN UNKNOWN UPS UNINTERRUPTIBLE POWER SUPPLY UTP UNSHIELDED TWISTED PAIR UV ULTRAVIOLET V VOLTS V/S VARIABLE SPEED VA VOLT-AMPERES VAR VARIES, VARIABLE, VOLT-AMPERES REACTIVE VCP VENDOR CONTROL PANEL VFD VARIABLE FREQUENCY DRIVE (AC) VFI VACUUM FAULT INTERRUPTER VS VOLTMETER SWITCH W WIDE, WIDTH, WIRE, WATTS, WEST W/ WITH W/O WITHOUT WAN WIDE AREA NETWORK WHD M WATT-HOUR DEMAND METER WHM WATT-HOUR METER WP WEATHERPROOF, WEATHER PROTECTED WR WEATHER RESISTANT WTR WATER TREATMENT PLANT WW WASTE WWTP WASTEWATER TREATMENT PLANT XFMR TRANSFORMER XP EXPLOSION PROOF										1. THIS IS A GENERALIZED LEGEND SHEET. THIS CONTRACT MAY NOT USE ALL INFORMATION SHOWN. 2. THE INSTALLATION OF ALL EQUIPMENT, RACEWAYS, CONDUCTORS, AND CABLES SHOWN ON THESE DRAWINGS OR DESCRIBED IN THE SPECIFICATIONS SHALL CONFORM TO THE REQUIREMENTS SET FORTH IN THE LATEST EDITIONS OF THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE LOCAL CODES AND UTILITY COMPANY STANDARDS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTACT THE UTILITY COMPANY AND VERIFY THEIR REQUIREMENTS. 3. ELECTRICAL CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING THE PROJECT TO VERIFY THE SCOPE OF WORK WITH FIELD CONDITIONS. PARTICULAR ATTENTION SHOULD BE GIVEN TO NEW CONDUIT RUNS IN EXISTING BUILDINGS. 4. NOTIFY THE ENGINEER IMMEDIATELY IN WRITING IF CONFLICTS IN EQUIPMENT LOCATIONS ARE DISCOVERED OR IF PROBLEMS ARISE DUE TO FIELD CONDITIONS, LACK OF INFORMATION OR ANY OTHER REASON. NO PAYMENT WILL BE MADE FOR CHANGES WHICH HAVE NOT BEEN FAVORABLY REVIEWED BY THE ENGINEER. 5. CONDUIT ROUTING SHOWN ON PLAN DRAWINGS IS DIAGRAMMATIC ONLY. RACEWAYS SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT OR STRUCTURAL CONDITIONS. EXPOSED RACEWAYS SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO BEAMS AND WALLS. REFER ALSO TO THE CONTRACT SPECIFICATIONS. 6. VERIFY THE EXACT LOCATION OF TERMINAL BOXES AND CONDUIT ENTRANCES TO ALL EQUIPMENT AGAINST APPROVED SHOP DRAWINGS BEFORE STUBBING UP CONDUITS. CONDUIT SUB-UPS SHALL NOT BE MORE THAN 6 INCHES FROM THE CENTERLINE OF TERMINAL BOXES. 7. CONNECTIONS BETWEEN RIGID CONDUIT AND MOTOR TERMINAL BOXES OR SIMILAR EQUIPMENT SUBJECT TO VIBRATION SHALL BE FLEXIBLE LIQUID-TIGHT CONDUIT. 8. CONDUITS SHALL BE TERMINATED SO AS TO PERMIT NEAT CONNECTION TO MOTORS AND OTHER EQUIPMENT. 9. CONDUITS FOR FUTURE EQUIPMENT OR EXTENSIONS SHALL BE TERMINATED AS SHOWN IN THE DETAILS OR AS SPECIFIED. 10. LOCATIONS OF PULLBOXES ARE APPROXIMATE. COORDINATE EXACT LOCATION IN THE FIELD TO ENSURE 6 INCHES (MINIMUM) CLEARANCE FROM MECHANICAL PIPING FLOW LINES. 11. ONLY MAJOR PULLBOXES ARE SHOWN. PROVIDE ADDITIONAL PULLBOXES WHERE REQUIRED TO MAKE A WORKABLE INSTALLATION. 12. PERFORM WORK IN ACCORDANCE WITH THE DETAILS WHETHER OR NOT THEY ARE REFERENCED ON THE DRAWINGS. 13. VERIFY ALL COLOR REQUIREMENTS BEFORE ORDERING MATERIALS. 14. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUIT REPRESENT A SUGGESTED ARRANGEMENT BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS ACCEPTABLE TO THE ENGINEER MAY BE MADE BY THE CONTRACTOR TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED. THE BASIC SEQUENCE AND METHOD OF CONTROL MUST BE MAINTAINED AS INDICATED ON THE DRAWINGS AND/OR SPECIFICATIONS. 15. REFER TO THE MECHANICAL DRAWINGS FOR CERTAIN CONTROL DIAGRAMS, EXACT LOCATIONS OF MECHANICAL EQUIPMENT, AND FOR CERTAIN CONNECTIONS TO BE MADE TO ELECTRICAL CIRCUITS. 16. CONDUIT SIZE AND FILL SHALL BE AS INDICATED ON THE CONDUIT AND CABLE SCHEDULES. WHERE NO SIZE IS SHOWN, THE CONDUIT SHALL BE SIZED IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE ADOPTED BY THE AUTHORITY HAVING JURISDICTION. MINIMUM CONDUIT SIZE IS 3/4 INCH, EXCEPT WHERE ENCASED OR BURIED. MINIMUM ENCASED OR BURIED CONDUIT SIZE IS 1 INCH. 17. PROVIDE EXPANSION OR EXPANSION AND DEFLECTION FITTINGS FOR ALL CONDUIT RUNS CROSSING EXPANSION JOINTS. REFER TO THE STRUCTURAL DRAWINGS FOR LOCATIONS OF EXPANSION JOINTS. 18. PROVIDE 3/16 INCH NYLON PULL ROPE IN EACH EMPTY CONDUIT. 19. FOR LIGHTING AND RECEPTACLE SYSTEMS, ONLY CIRCUIT NUMBERS ARE SHOWN. PROVIDE ALL NECESSARY CONDUITS, WIRES, FITTINGS, JUNCTION BOXES AND NECESSARY COMPONENTS SHOWN OR NOT SHOWN ON THE DRAWINGS. TO MAKE THE ELECTRICAL INSTALLATION COMPLETE AND OPERATIONAL, SIZE CONDUITS AND WIRING IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. ALL CONDUIT RUNS SHALL BE CONCEALED UNLESS INDICATED OTHERWISE. CIRCUIT LOADING SHALL BE AS INDICATED IN THE PANEL SCHEDULES. ALL LIGHTING AND RECEPTACLE CIRCUITS SHALL INCLUDE GROUND WIRE. 20. MOUNT LUMINAIRES ACCORDING TO THE MOUNTING HEIGHT GIVEN ON THE DRAWINGS, WITH THE DISTANCE BEING MEASURED FROM THE BOTTOM OF THE LUMINAIRE TO THE FINISHED FLOOR. PROVIDE APPROPRIATE BRACKETS AND HARDWARE FOR MOUNTING. 21. ALL RECEPTACLES IN OUTDOOR AND ANTICIPATED WET AREAS SHALL BE GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLES WITH WEATHERPROOF WHILE IN-USE COVERS. 22. ALL FREE STANDING ELECTRICAL EQUIPMENT AND CONTROL PANELS SHALL BE SET ON CONCRETE HOUSEKEEPING PADS WITH LEVELING CHANNELS EMBEDDED IN THE PAD. 23. ALL PANELBOARDS SHALL BE MOUNTED SO THAT THE DISTANCE FROM THE CENTERLINE OF THE TOP CIRCUIT BREAKER OPERATING HANDLE IN THE UPPERMOST POSITION TO THE FINISHED FLOOR SHALL NOT EXCEED 6'-7". 24. ALL SURFACE MOUNTED PANELS AND PANELBOARDS ON THE INTERIOR OF EXTERIOR WALLS ABOVE GRADE OR IN OTHER LOCATIONS CONSIDERED DAMP OR WET SHALL BE MOUNTED SO AS TO MAINTAIN A 1/4 INCH (MINIMUM) AIR SPACE BETWEEN THE ENCLOSURE AND THE WALL. 25. PROVIDE LOCKOUTS IN STRICT ACCORDANCE WITH OWNER'S REQUIREMENTS. 26. REFER TO THE SINGLE LINE DIAGRAMS, EQUIPMENT ELEVATIONS, PANELBOARD SCHEDULES, AND COMPONENT/DEVICE LABELS IN THE CONTROL SCHEMATICS FOR NAMEPLATE INFORMATION. SEE THE CONTRACT SPECIFICATIONS FOR NAMEPLATE SIZE, COLOR, MATERIAL, AND PLACEMENT REQUIREMENTS. 27. "NORMAL" STATUS OF SWITCHES OR CONTACTS SHOWN IN CONTROL SCHEMATICS IS THE SHELF POSITION.										1. BIDDING CONTRACTORS SHALL VISIT THE SITE TO ASSESS THE SCOPE OF DEMOLITION, REMOVAL AND MODIFICATION WORK. 2. ELECTRICAL CONTRACTOR AND THE OWNER SHALL DE-ENERGIZE ALL WIRING PRIOR TO REMOVAL OF EQUIPMENT, DEVICES, MOTORS INSTRUMENTATION, CONTROL PANELS, ETC. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE OWNER. 3. EXPOSED RACEWAYS: REMOVE CONDUIT, WIRES, AND BOXES. PATCH TO MATCH EXISTING. FINISH ALL OPENINGS LEFT IN WALLS AND FLOORS. 4. CONCEALED CONDUITS IN THE SLAB: REMOVE EXISTING WIRES TO THE EXTENT POSSIBLE AND ABANDON CONDUITS IN THE SLAB. CUT CONDUIT FLUSH AND PATCH THE FLOOR TO MATCH EXISTING. 5. CONTROL PANELS: ELECTRICAL CONTRACTOR SHALL DE-ENERGIZE AND REMOVE ALL CONDUIT AND WIRE AS DESCRIBED IN NOTES 3 AND 4. CONTRACTOR SHALL REMOVE PANELS AS NOTED ON THE CONTRACT DRAWINGS. 6. MOTOR CONTROL CENTERS: DISCONNECT AND REMOVE ALL CONDUITS AND WIRING TO EXISTING STARTERS AND/OR BREAKERS, PANELBOARDS, BRANCH CIRCUITS, INTERLOCKS AND STATUS WIRING WITHIN MCC. 7. REFER TO THE CONTRACT SPECIFICATIONS FOR ADDITIONAL ELECTRICAL DEMOLITION AND REMOVAL REQUIREMENTS.																													
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PLAN SYMBOLS										
CONDUIT AND RACEWAYS			LIGHTING			SECURITY AND COMMUNICATION				
CONDUIT - MULTIPLE IN DUCT BANK MULTIPLE CONDUIT RUN CONDUIT - ENCASED OR UNDERGROUND CONDUIT - EXPOSED OR CONCEALED CALLOUT INDICATING CONDUIT PER SCHEDULE HOME RUN TO PANELBOARD OR AS INDICATED (3/4 " CONDUIT, 2 #12, 1 #12 GND UNLESS INDICATED OTHERWISE) FLEXIBLE CONDUIT CONDUIT RUN, CONTINUES ON SAME SHEET OR AS NOTED CONDUIT - CAPPED OR SEALED OPEN CIRCLE DENOTES UPWARD CONDUIT RISER SEMI CIRCLE DENOTES DOWNWARD CONDUIT RISER JUNCTION BOX UNDERGROUND RACEWAY HANDHOLE HH-# UNDERGROUND RACEWAY MANHOLE MH-#			LUMINAIRE CALLOUT A = LUMINAIRE TYPE * = APPROXIMATE MOUNTING HEIGHT AFF CLG = CEILING MOUNT (SEE LUMINAIRE SCHEDULE FOR MORE DETAILS) LUMINAIRE - STRIP OR TROFFER TYPE (SWITCHED/UNSWITCHED) X = LIGHTING PANEL DESIGNATION # = CIRCUIT NUMBER a = SWITCH DESIGNATION WALL MOUNTED LUMINAIRE (SWITCHED/UNSWITCHED) PENDANT/CEILING MOUNTED LUMINAIRE (SWITCHED/UNSWITCHED) POLE, BRACKET, ARM, AND MOUNTED LUMINAIRE RECESSED CAN LUMINAIRE (SWITCHED/UNSWITCHED) EMERGENCY LUMINAIRE WITH SELF CONTAINED BATTERY WALL/CEILING MOUNTED EXIT LIGHT DIRECTIONAL ARROW WHERE INDICATED, SHADED AREA INDICATES ILLUMINATED FACE LIGHT SWITCH X = LIGHTING PANEL DESIGNATION # = CIRCUIT NUMBER a = SWITCH DESIGNATION * = SWITCH TYPE 1 1 WAY 3 3 WAY 4 4 WAY D DIMMER MOTION SENSOR OCCUPANCY SENSOR PHOTOCELL TIME CLOCK			ANTENNA VIDEO CAMERA * = TYPE F FIXED PTZ PAN-TILT-ZOOM 360 360 DEGREE FIXED SECURITY ACCESS DEVICE * = TYPE CR CARD READER KS KEY SWITCH KP KEYPAD RF RADIO FREQUENCY ID TELEPHONE OUTLET WALL MOUNTED/FLOOR MOUNTED DATA OUTLET WALL MOUNTED/FLOOR MOUNTED TELEPHONE/DATA COMBINATION OUTLET WALL MOUNTED/FLOOR MOUNTED TELEVISION ANTENNA/CABLE OUTLET				
EQUIPMENT						MISCELLANEOUS				
MOTOR PANEL OR CABINET - AS LABELED SWBD, SWGR, MCC, LP, PNLBD, PLC, ETC						DISCONNECT SAFETY SWITCH INSTRUMENT SWITCH - SPECIAL PURPOSE X = LIGHTING PANEL DESIGNATION # = CIRCUIT NUMBER * = SWITCH TYPE M MOTOR RATED K KEY OPERATED T TIMER THERMOSTAT CLASS I, DIVISION 1 HAZARDOUS AREA BOUNDARY (LABEL APPEARS IN CLASSIFIED AREA) CLASS I, DIVISION 2 HAZARDOUS AREA BOUNDARY (LABEL APPEARS IN CLASSIFIED AREA)				
GROUNDING			RECEPTACLES			FIRE PROTECTION				
BARE COPPER GROUND TO GROUND WIRE IN SLAB, OR UNDERGROUND GROUND GRID, SIZE AS NOTED GROUND CONNECTION - BOLTED GROUND CONNECTION - EXOTHERMICALLY WELDED GROUND ROD - IN WELL WITH BOX GROUND ROD - BURIED			DUPLEX RECEPTACLE, 120V, WALL MOUNT NEMA 5-20R CONFIGURATION X = LIGHTING PANEL DESIGNATION # = CIRCUIT NUMBER * = RECEPTACLE TYPE WP WEATHERPROOF XP EXPLOSION PROOF GFCI GROUND FAULT CIRCUIT INTERRUPTER DUPLEX RECEPTACLE, 120V, FLOOR MOUNT NEMA 5-20R CONFIGURATION SINGLE SPECIAL RECEPTACLE, 208V OR 240V, 1-PHASE X = PANEL DESIGNATION # = CIRCUIT NUMBER A = AMPERAGE SINGLE SPECIAL/WELDING RECEPTACLE, 208V OR 240V, 3-PHASE X = PANEL DESIGNATION # = CIRCUIT NUMBER A = AMPERAGE SINGLE SPECIAL RECEPTACLE, 480V, 3-PHASE X = PANEL DESIGNATION # = CIRCUIT NUMBER A = AMPERAGE			FIRE ALARM PULL STATION FIRE ALARM STROBE FIRE ALARM HORN FIRE ALARM HORN/STROBE SMOKE DETECTOR HEAT DETECTOR				
APPROVED City of Arvada, Colorado CITY ENGINEER DATE JOB NUMBER										
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.										
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								SCALE NTS		
								JOB NO 2246059*00		
								DATE SEP 2024		
								SHEET 31 OF 48		
								E-003		

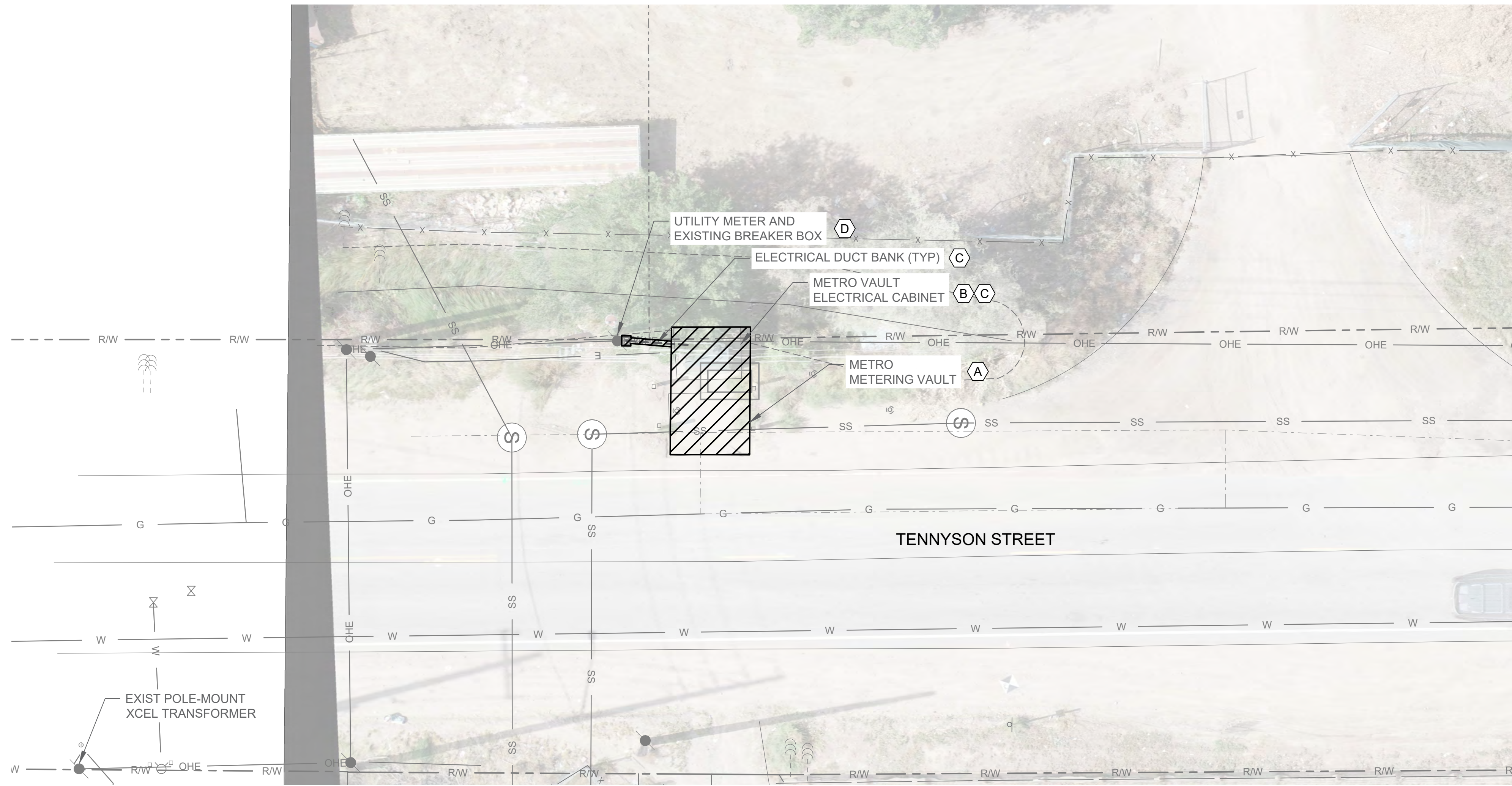
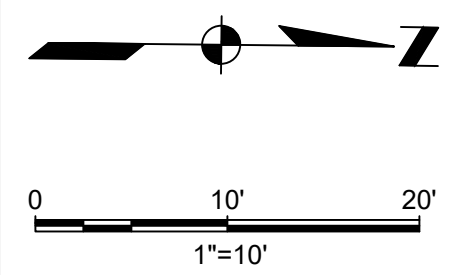


A. ALL DETAILS SHOWN ARE TYPICAL. DETAILS SHALL BE USED THROUGHOUT THE PROJECT AS APPLICABLE.



-004

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- GENERAL SHEET NOTES
1.

REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF DEMOLITION.
2.

COORDINATE WITH THE ELECTRIC UTILITY, ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES
- A.

EXISTING METRO METERING VAULT TO BE DEMOLISHED. DIFFERENTIAL LEVEL INSTRUMENTATION ELEMENTS AND ASSOCIATED EQUIPMENT SHALL BE REMOVED FROM VAULT, PROTECTED IN STORAGE, AND REINSTALLED IN NEW VAULT. REFER TO THE REST OF THE ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
- B.

EXISTING METRO VAULT ELECTRICAL CABINET SHALL BE REMOVED, PROTECTED IN STORAGE, AND REINSTALLED IN LOCATION ADJACENT TO EXISTING AS SHOWN.
- C.

EXISTING CONCRETE HOUSEKEEPING PAD, EXISTING ELECTRICAL DUCTBANK, AND EXISTING CONDUIT STUB-UPS SHALL BE DEMOLISHED
- D.

EXISTING BREAKER BOX SHALL BE DEMOLISHED.

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City of Arvada, Colorado

CITY ENGINEER

DATE

JOB NUMBER

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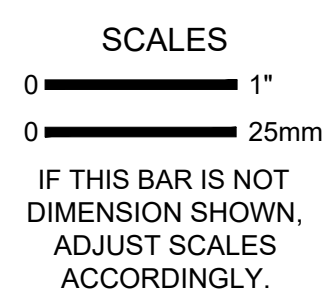
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REVISION

DATE

BY



DESIGNED

ZLP

DRAWN

ZLP

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ZCD

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

KJ

Kennedy Jenks

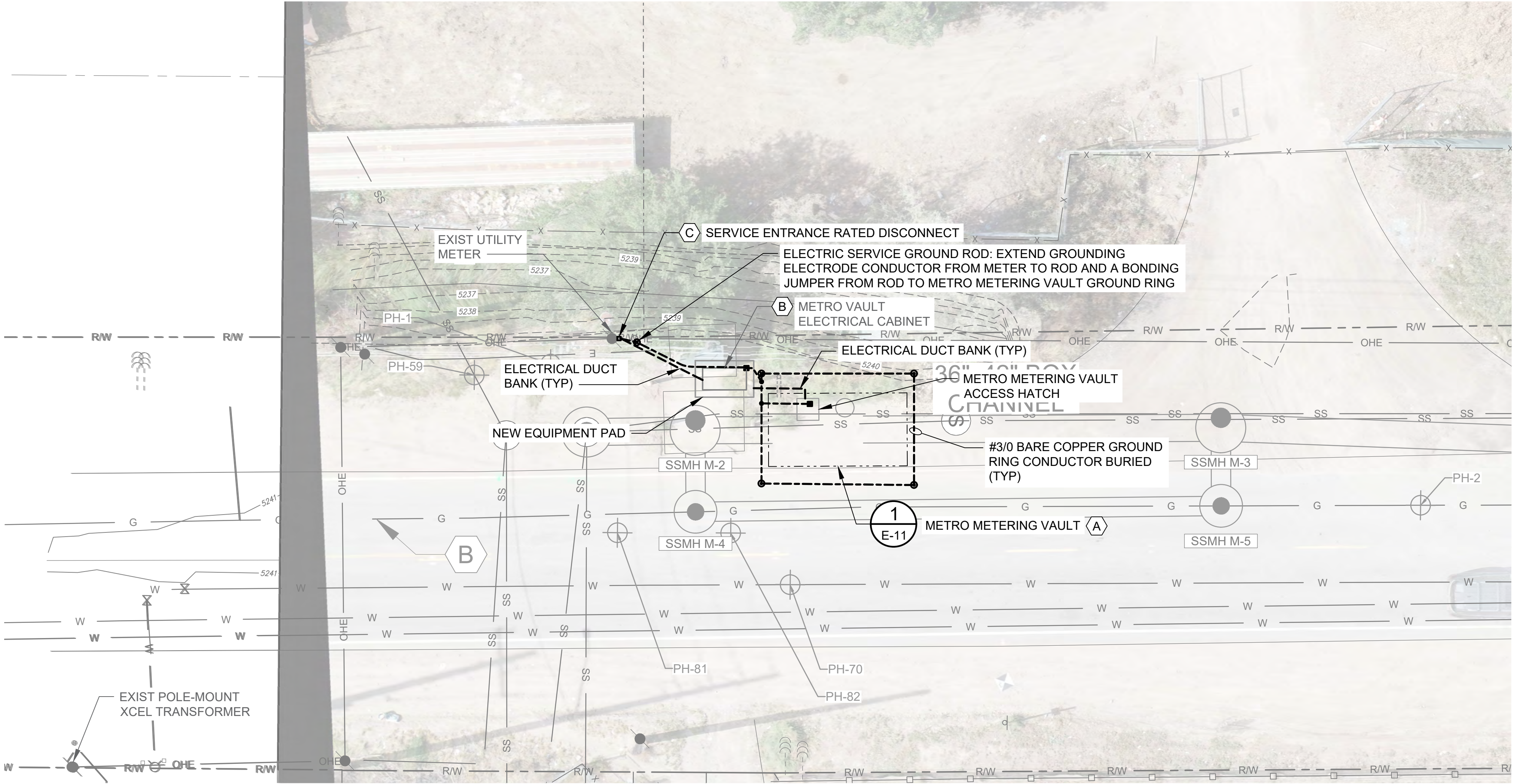
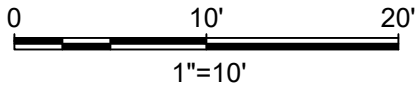
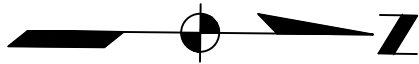
OVERALL DEMOLITION SITE PLAN

SCALE	1" = 10'
JOB NO	2246059*00
DATE	SEP 2024
SHEET	33 OF 48
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- GENERAL SHEET NOTES
1.

REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF PROPOSED WORK.
2.

COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- ⬡

SHEET KEYNOTES
- A.

THE ENTIRE SPACE OF THE METRO METERING VAULT SHALL BE A NEC CLASS I, GROUP D, DIVISION 1 HAZARDOUS LOCATION PER NFPA 820. INSTALL ALL WORK IN ACCORDANCE WITH ARTICLE 500 AND 501 OF THE NEC.
- B.

THE EXISTING METRO VAULT ELECTRICAL CABINET EQUIPMENT PAD, AND ASSOCIATED CONDUIT AND CONDUCTORS SHALL BE SAFED OFF AND REMOVED TO ALLOW FOR CONSTRUCTION IN THIS VICINITY AS SHOWN ON CIVIL AND MECHANICAL CONTRACT DRAWINGS. THE EXISTING METRO VAULT ELECTRICAL CABINET SHALL BE REMOVED AND PROTECTED IN STORAGE. AFTER AND/OR IN PARALLEL WITH CONSTRUCTION OF NEW WORK AS SHOWN ON CIVIL AND MECHANICAL DRAWINGS, INSTALL NEW EQUIPMENT PAD, REQUIRED CONDUITS AND CONDUCTORS, AND EXISTING METRO VAULT ELECTRICAL CABINET.
- C.

NEMA 4X SS 60AF FUSED DISCONNECT SWITCH 120/240VAC 2P, 1φ, 3W SUITABLE FOR USE AS SERVICE EQUIPMENT (SUSE) w/ SERVICE GROUND KIT.

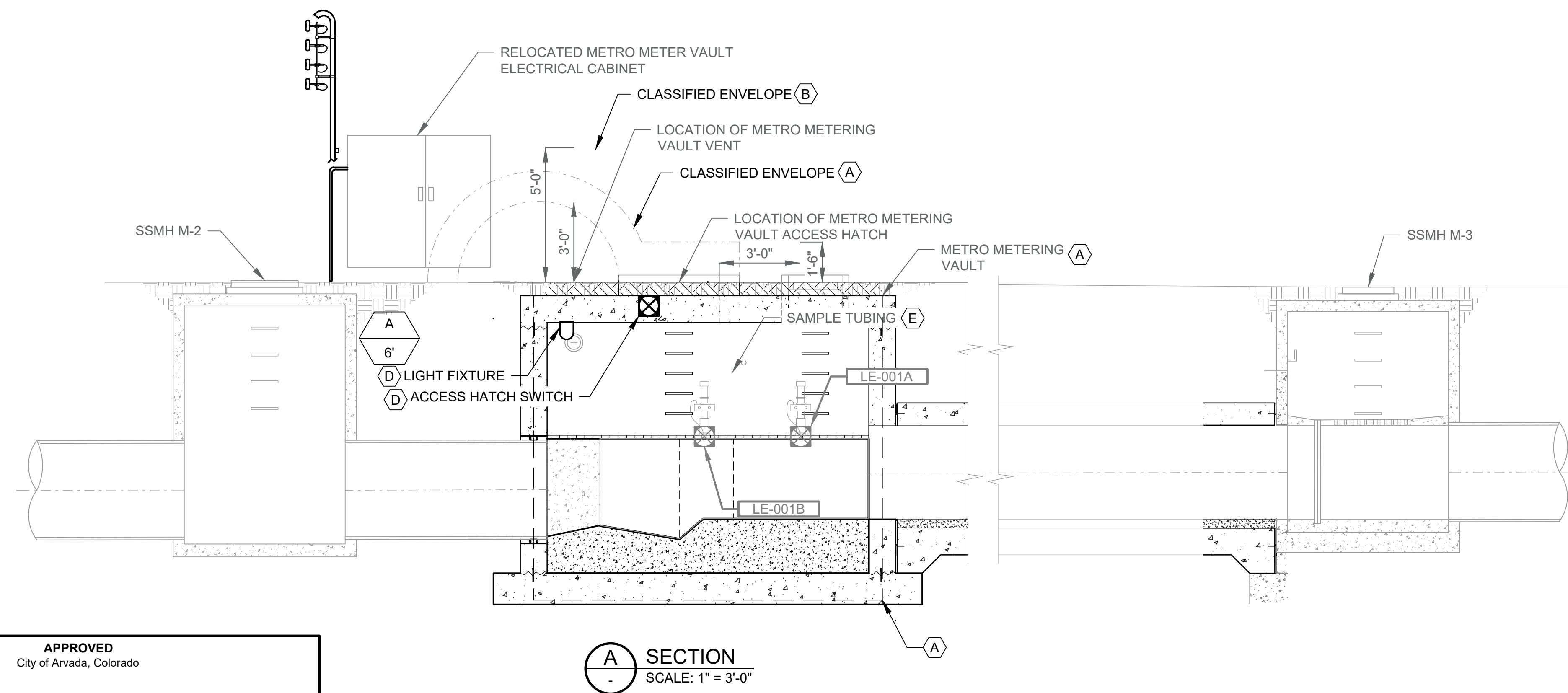
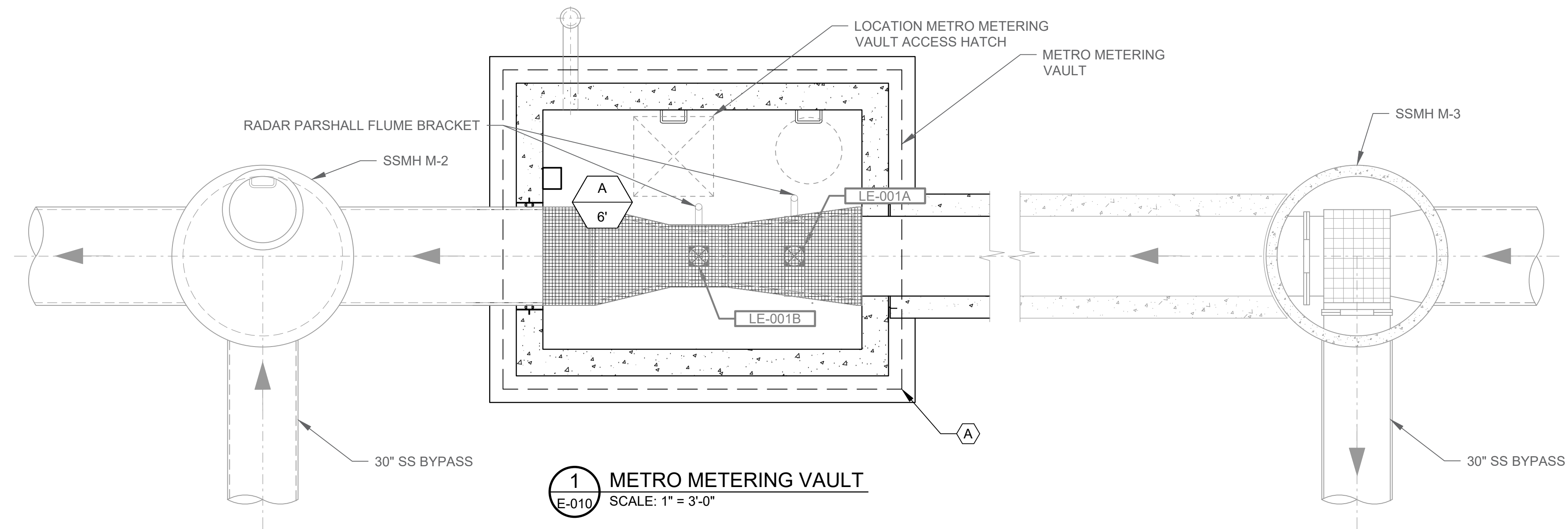
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CITY ENGINEER	DATE	JOB NUMBER		
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.				
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NO				

SCALES
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0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED ZLP	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	Kennedy Jenks
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CHECKED ZCD		

OVERALL SITE PLAN

SCALE 1" = 10'
JOB NO 2246059*00
DATE SEP 2024
SHEET 34 OF 48 E-010



GENERAL SHEET NOTES

1. REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF PROPOSED WORK..
2. COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, AS NECESSARY FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).

 SHEET KEYNOTES

- A. THE ENTIRE SPACE OF THE METRO METERING VAULT AS WELL AS THE SPACE AROUND THE VENT EXTENDING FOR A 3' RADIUS IS A NEC CLASS I, GROUP D, DIVISION 1 HAZARDOUS LOCATION PER NFPA 820.
- B. THE SPACE AROUND THE VENT STARTING FROM A 3' RADIUS TO A 5' RADIUS FROM THE VENT AS WELL AS THE SPACE AROUND THE HATCH OPENING EXTENDING 18" AFG AND 3' HORIZONTALLY IN ALL DIRECTIONS IS A NEC CLASS I, GROUP D, DIVISION 2 HAZARDOUS LOCATION PER NFPA 820.
- C. MOUNT LEVEL TRANSMITTERS PER INSTRUMENTATION AND MECHANICAL DETAILS.
- D. ACCESS HATCH SWITCH SHALL BE WIRED IN SERIES WITH METRO METER VAULT LIGHT.
- E. SAMPLE TUBING FROM AUTO-SAMPLER TO BE ROUTED IN THE CONDUIT, SEE CONDUIT AND CONDUCTOR SCHEDULE.

APPROVED
City of Arvada, Colorado

CITY ENGINEER	DATE	JOB NUMBER
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SECTION
SCALE: 1" = 3'-0"

SCALES

0 1"
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IF THIS BAR IS NOT
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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



METERING VAULT PLAN AND SECTION

SCALE
1" = 3'

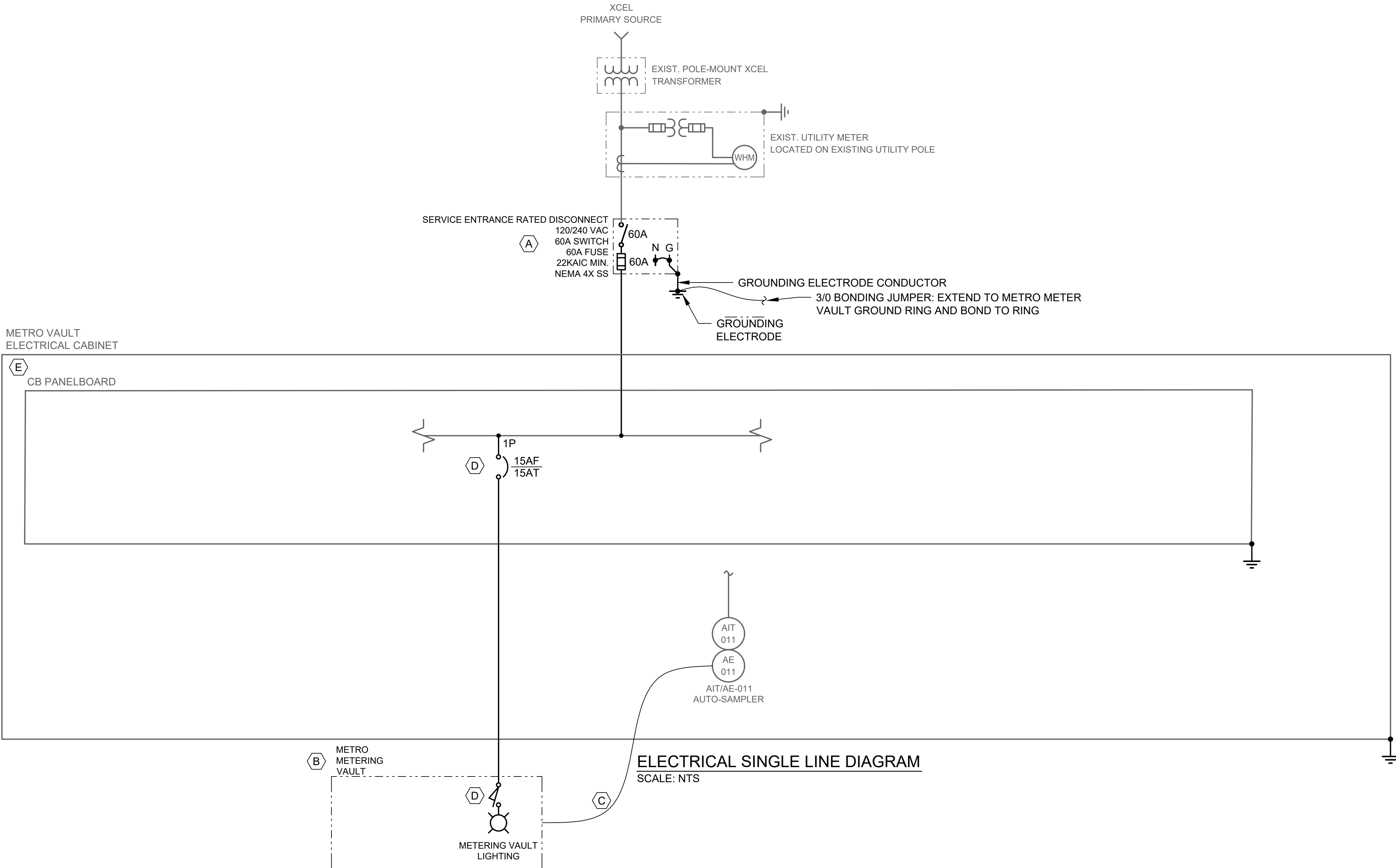
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ELECTRICAL SINGLE LINE DIAGRAM
SCALE: NTS

LUMINAIRE SCHEDULE					
TYPE	DESCRIPTION	LAMPS	WATTS /FIXTURE	MANUFACTURER CATALOG NUMBER	MOUNTING
A	CLASS I, DIVISION I, GROUP D LED FLOODLIGHT, WALL MOUNT, YOKE MOUNT KIT	LED	40	HOLOPHANE, HEXF1 P2 MV 4K T2M CL OR EQUAL	WALL MOUNT, YOKE MOUNT KIT

LUMINAIRE SCHEDULE
SCALE: NTS

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

KJ

Kennedy Jenks

ONE-LINE DIAGRAM AND SCHEDULES

SCALE
NTS

JOB NO
2246059*00

DATE
SEP 2024

SHEET 36 OF 48
E-020

- GENERAL SHEET NOTES
1. COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES
- A. MOUNT NEW SERVICE ENTRANCE RATED DISCONNECT ON OR ADJACENT TO XCEL ENERGY UTILITY POLE WITH METER.

B. ENTIRE SPACE OF METRO METERING VAULT IS A CLASS I, GROUP D, DIVISION 1 HAZARDOUS LOCATION PER NFPA 820.

C. SAMPLE TUBING FROM AUTO-SAMPLER TO BE ROUTED IN CONDUIT, SEE CONDUIT AND CONDUCTOR SCHEDULE.

D. METRO VAULT LED LIGHT SHALL BE CONTROLLED BY THE HATCH DOOR SWITCH. SEE LUMINAIRE SCHEDULE, LUMINAIRE TYPE A. CONNECT TO EXISTING SPARE 15AT/1P CIRCUIT BREAKER OR FURNISH AND INSTALL NEW 15AT/1P CIRCUIT BREAKER WITH AIC RATING TO MATCH LARGEST AIC RATING OF EXISTING BRANCH CIRCUIT BREAKERS WITHIN THE PANELBOARD IF NO SPARE IS AVAILABLE.

E. WITHIN THE REMOVED AND RELOCATED METRO VAULT ELECTRICAL CABINET, THERE ARE ELECTRICAL UTILIZATION EQUIPMENT WHICH MAY INCLUDE BUT NOT BE LIMITED TO VENTILATION FAN, ENCLOSURE HEATER, SAMPLER, LEVEL TRANSMITTER, RECEPTACLE, COMMUNICATION RADIO, AND SPD. THIS EQUIPMENT SHALL BE PROTECTED DURING REMOVAL, STORAGE, AND REINSTALLATION OF CABINET. CONTRACTOR SHALL VERIFY ALL EQUIPMENT IS FUNCTIONAL AFTER REINSTALLATION. CONTRACTOR SHALL RECONNECT ALL NEW AND ANY IMPACTED EXISTING BRANCH CIRCUITS, CONTROL CIRCUITS, AND INSTRUMENTATION CIRCUITS FOR A FULLY FUNCTIONAL SYSTEM.

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CONDUIT AND CABLE SCHEDULE							
NUMBER	FROM	TO	SIZE (")	POWER	CONTROL	SIGNAL	COMMENTS
P-001	EXISTING UTILITY METER	SERVICE ENTRANCE RATED DISCONNECT	1"	3-#6, #8 GND.			RE-USE EXISTING CONDUIT
P-002	SERVICE ENTRANCE RATED DISCONNECT	CB PANELBOARD (WITHIN METRO VAULT ELECTRICAL CABINET)	1"	3-#6, #8 GND.			
P-010	CB PANELBOARD	METERING VAULT LIGHTING	1"	2-#12, #12GND.			IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)
S-005	LIT-001	LE-001A, LE-001B	1"			2-MFR CABLE	IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)
M-001	AUTOSAMPLER AIT-011	PARSHALL FLUME SAMPLING POINT	2"				CONTAINS 3/8" PVC SA SAMPLE TUBING IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)

APPROVED

City of Arvada, Colorado

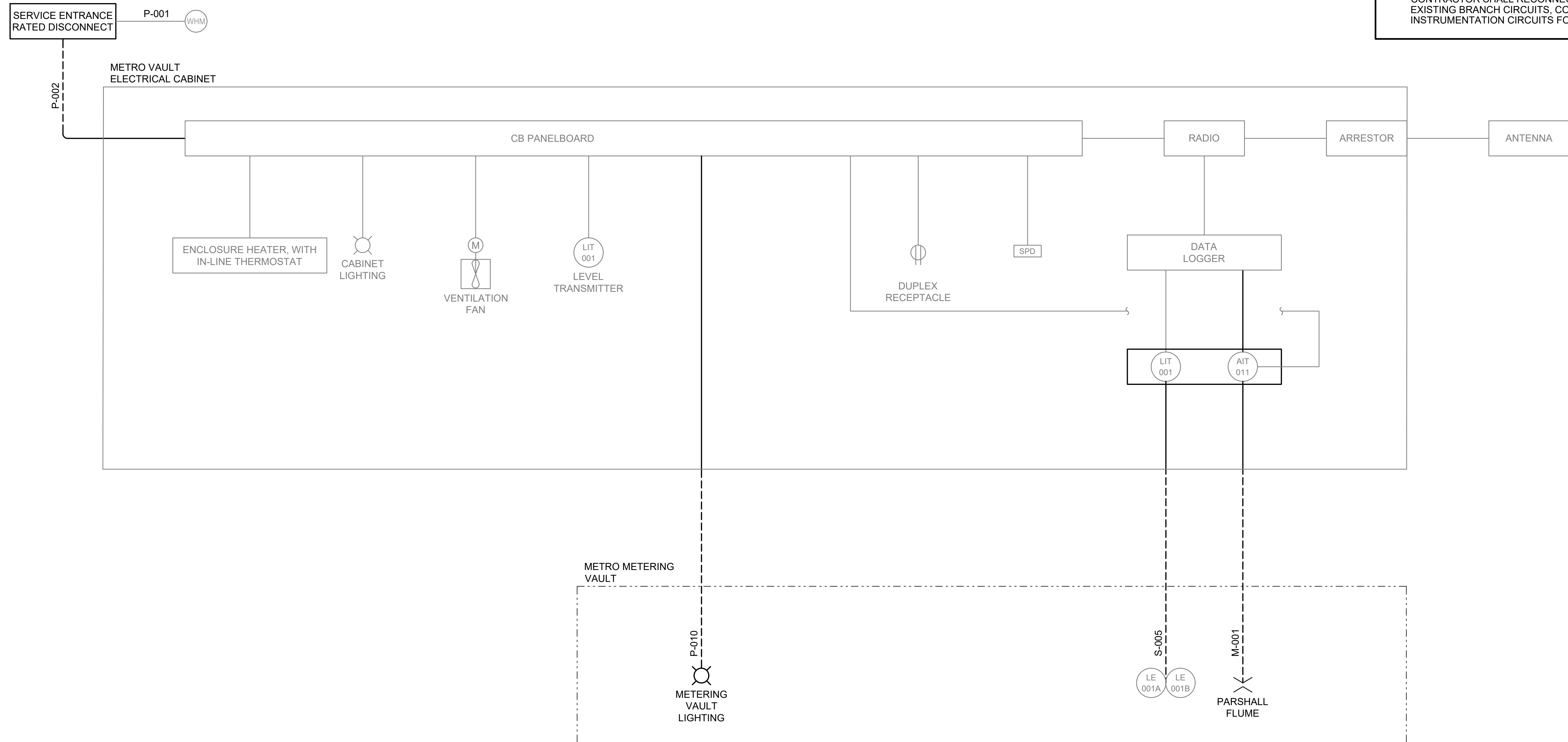
CITY ENGINEER

DATE

JOB NUMBER

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

SEP 2024 - 90% DESIGN					SCALES 01" 025mm IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.		DESIGNED ZLP	CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11	CONDUIT AND CABLE SCHEDULE	SCALE NTS
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.						DRAWN VZ	JOB NO 2246059*00			
						CHECKED ZCD	DATE SEP 2024			
	NO	REVISION	DATE	BY		KJ Kennedy Jenks	SHEET 37 OF 48 E-030			



GENERAL SHEET NOTES

1. WITHIN THE REMOVED AND RELOCATED METRO VAULT ELECTRICAL CABINET, THERE ARE ELECTRICAL UTILIZATION EQUIPMENT WHICH MAY INCLUDE BUT NOT BE LIMITED TO VENTILATION FAN, ENCLOSURE HEATER, SAMPLER, LEVEL TRANSMITTER, RECEPTACLE, COMMUNICATION RADIO, AND SPD. THIS EQUIPMENT IS SHOWN FOR CLARITY IN LIGHT LINWORK ON THIS SHEET. THE EQUIPMENT AND ASSOCIATED RACEWAYS AND CONDUCTORS SHALL BE PROTECTED DURING REMOVAL, STORAGE, AND REINSTALLATION OF CABINET. CONTRACTOR SHALL VERIFY ALL EQUIPMENT IS FUNCTIONAL AFTER REINSTALLATION. CONTRACTOR SHALL RECONNECT ALL NEW AND ANY IMPACTED EXISTING BRANCH CIRCUITS, CONTROL CIRCUITS, AND INSTRUMENTATION CIRCUITS FOR A FULLY FUNCTIONAL SYSTEM.

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City of Arvada, Colorado

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NO

REVISION

DATE _____

BY

SCALES

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IF THIS BAR IS NOT
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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



Kennedy Jenks

CONDUIT BLOCK ROUTING DIAGRAM

CALE	NTS
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JOB NO

SEP 2024

HEET 38 OF 48

E-040

Plot Date: 9/6/2024 1:56 PM
User: ROBERT INOPEA
pww\kjc-pw.bentley.com\kjc-pw\Documents\Clients\Arvada, City of CO\Projects\North Trunk Sewer Improvements_2246059_00\10-Design\10.06-Drawings\Instrumentation\2246059-00-1001.DWG

INSTRUMENT CALLOUTS AND TAG SCHEMA

FIRST LETTER

SUCCEEDING LETTER(S)

LIT-123

LIT

L

IT

123

LOOP NUMBER
(SEE NOTE 5)

TYPICAL TAG FORMAT

LIT-123
INSTRUMENT TAG NUMBER
FUNCTIONAL IDENTIFICATION
FIRST LETTER
SUCCEEDING LETTER(S)
LOOP NUMBER

EXPANDED TAG FORMAT

20LIT-123A
INSTRUMENT TAG NUMBER
AREA NUMBER
FUNCTIONAL IDENTIFICATION
FIRST LETTER
SUCCEEDING LETTER(S)
LOOP NUMBER
OPTIONAL SUFFIX

	FIRST LETTER (1)	SUCCEEDING LETTERS (15)
	MEASURED OR INITIATING VARIABLE	MODIFIER READOUT OR PASSIVE FUNCTION OUTPUT FUNCTION MODIFIER
A	ANALYSIS (2)(3)(4)	ALARM
B	BURNER, COMBUSTION (2)	USER'S CHOICE (5)
C	USER'S CHOICE (3a)(5)	USER'S CHOICE (5)
D	DENSITY	CONTROL (23a)(23e)
E	VOLTAGE (2)	CLOSED (27b)
F	FLOW, FLOW RATE (2)	DAMPER
G	USER'S CHOICE	SENSOR (PRIMARY ELEMENT)
H	HAND (2)	GLASS, VIEWING DEVICE (16)
I	CURRENT (ELECTRICAL)(2)	
J	POWER (2)	INDICATE (17)
K	TIME, TIME SCHEDULE (2)	SCAN (18)
L	LEVEL (2)	CONTROL STATION (24)
M	MOISTURE	
N	USER'S CHOICE (5)	LOW (27b)(28)(29)
O	USER'S CHOICE (5)	MIDDLE, INTERMEDIATE
P	PRESSURE, VACUUM (2)	USER'S CHOICE (5)
Q	QUANTITY (2)	ORIFICE, RESTRICTION
R	RADIATION (2)	POINT (TEST) CONNECTION
S	SPEED, FREQUENCY (2)	INTEGRATE, TOTALIZE
T	TEMPERATURE (2)	RECORD (20)
U	MULTI VARIABLE (2)(6)	RUN
V	VIBRATION, MECHANICAL ANALYSIS (2)(4)(7)	STOP
W	WEIGHT, FORCE (2)	SWITCH (23b)
X	UNCLASSIFIED (8)	TRANSMIT
Y	EVENT, STATE, PRESENCE (2)(9)	MULTIFUNCTION (21)
Z	POSITION, DIMENSION (2)	MULTIFUNCTION (21)

NOTE: NUMBERS IN PARENTHESES REFER TO EXPLANATORY NOTES IN ANSI/ISA-5.1-2009, SECTION 4.2

	LOCATED IN FIELD VISIBLE AT LOCATION OPERATOR ACCESSIBLE	LOCATED ON MAIN PANEL VISIBLE ON PANEL FRONT OPERATOR ACCESSIBLE	LOCATED IN MAIN PANEL CABINET NOT VISIBLE ON PANEL FRONT NOT OPERATOR ACCESSIBLE	LOCATED ON SECONDARY PANEL VISIBLE ON PANEL FRONT OPERATOR ACCESSIBLE	LOCATED IN SECONDARY PANEL CABINET NOT VISIBLE ON PANEL FRONT NOT OPERATOR ACCESSIBLE
SHARED DISPLAY SHARED CONTROL					
PROGRAMMABLE LOGIC CONTROL					
COMPUTER FUNCTION					
INSTRUMENT					
PILOT LIGHT					

LETTER MAPPING:

A: IDENTIFICATION LETTERS (SEE TABLE OR REFER TO ANSI/ISA-5.1-2009; TABLE 4.1)

B: LOOP NUMBER

C: USER DESCRIPTOR/FUNCTION DESIGNATION (SEE LIST THIS SHEET)

D: MEASUREMENT (REFER TO ANSI/ISA-5.1-2009; TABLE 5.2.2)

E: PROCESS CONTROL DESCRIPTOR LINE 1

F: PROCESS CONTROL DESCRIPTOR LINE 2

G: PROCESS CONTROL DESCRIPTOR LINE 3

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DISPLAY AND CONTROL SYMBOLS FOR ANALOG MEASURED VARIABLES MAY ALSO INDICATE THE PRESENCE OF DERIVED SETPOINTS USED FOR ALARM GENERATION

PLC I/O

DISCRETE INPUT

DISCRETE OUTPUT

ANALOG INPUT

ANALOG OUTPUT

COMMUNICATION INPUT/OUTPUT
(LINETYPE INDICATES PROTOCOL)

IS
INTRINSICALLY SAFE
BARRIER OR RELAY

LSA
LIGHTNING SURGE
ARRESTER

MISCELLANEOUS

OFF-SHEET CONNECTORS (ARROW IN DIRECTION OF PROCESS OR CONTROL)

TO/FROM EQUIPMENT ID
I-### X

EQUIPMENT TO/FROM IDENTIFIER

LINE IDENTIFICATION

TO/FROM DRAWING REFERENCE

TO/FROM EQUIPMENT ID
I-### X

TO/FROM EQUIPMENT ID
I-### X

TOUCHING BUBBLES INDICATE A SINGLE INSTRUMENT OR COMPONENT PERFORMING MULTIPLE FUNCTIONS, OR AN INSTRUMENT WITH INTEGRAL TRANSMITTER

INSTRUMENT WITH REMOTE TRANSMITTER

RELAY INTERLOCK
REFER TO CONTROL SCHEMATICS AND/OR
PROCESS CONTROL NARRATIVES FOR BEHAVIOR

FUNCTION DESIGNATIONS

SWITCHES

A/M AUTO-MANUAL
ESTOP EMERGENCY STOP
F-R FORWARD-REVERSE
HOA HAND-OFF-AUTO
HOR HAND-OFF-REMOTE
LJR LOCAL-REMOTE
LOR LOCAL-OFF-REMOTE
O/C OPEN-CLOSE
OCA OPEN-CLOSE-AUTO
O-O ON-OFF
OSC OPEN-STOP-CLOSE
POT POTENTIOMETER
RST RESET
S-S START-STOP

ANALYTICAL INSTRUMENTS

ALK ALKALINITY
CL2* CHLORINE CONCENTRATION
CO CARBON MONOXIDE
CO2 CARBON DIOXIDE
COMB COMBUSTIBLE GAS
COND CONDUCTIVITY
COMB COMBUSTIBLE GAS
DO DISSOLVED OXYGEN
H2S HYDROGEN SULFIDE
HUM HUMIDITY
NO3 NITRATE
O2 OXYGEN CONCENTRATION
O3 OZONE
ORP OXIDATION REDUCTION POTENTIAL
PH HYDROGEN ION CONCENTRATION
SO2 SULFUR DIOXIDE
TH TOTAL HARDNESS
TURB TURBIDITY
UV ULTRAVIOLET TRANSMITTANCE
OR INTENSITY
NOTED AS TOTAL OR FREE

INSTRUMENT AND EQUIPMENT SERVICES

IA INSTRUMENT AIR SUPPLY (SEE NOTE 4)

ES ELECTRICAL SERVICE
(DIFFERENT VOLTAGES ARE SPECIFICALLY NOTED)

POE POWER OVER ETHERNET

LINE SYMBOLOGY

NEW WORK (NOT SCREENED)

EXISTING (SCREENED)

FUTURE (LONG DASH, SHORT DASH)

PROCESS - PRIMARY

PROCESS - SECONDARY

PROCESS - DRAIN

MISCELLANEOUS INSTRUMENT CONNECTION

ELECTRIC BINARY SIGNAL (DISCRETE)

ELECTRICAL SIGNAL (ANALOG)

INSTRUMENT INTERNAL SIGNAL

DATA LINK (SOFTWARE) CONNECTION

CAPILLARY SIGNAL

ELECTROMAGNETIC (RADAR) GUIDED SIGNAL

ELECTROMAGNETIC (RADAR) UNGUIDED/FREE AIR SIGNAL

HYDRAULIC LINK OR CONNECTION

MECHANICAL LINK OR CONNECTION

PNEUMATIC BINARY SIGNAL

PNEUMATIC SIGNAL

PROPRIETARY SIGNAL

CONTROLNET SIGNAL

DEVICENET SIGNAL

ETHERNET (TCP/IP OR ETHERNET/IP) SIGNAL

MODBUS PLUS SIGNAL

MODBUS RTU SIGNAL

MODBUS TCP SIGNAL

PROFIBUS DP SIGNAL

PROFIBUS PA SIGNAL

PROFINET SIGNAL

FIBER OPTIC SIGNAL

LINE BREAK OR GAP

SIGNAL LINE ARROW

SIGNAL LINES - CONNECTED

SIGNAL LINES - NOT CONNECTED

SIGNAL PROCESSING FUNCTIONS

SUMMING

DIFFERENCE

INTEGRAL

DERIVATIVE

MULTIPLYING

DIVIDING

ROOT EXTRACTION

SQUARE ROOT

EXPONENTIAL

HIGH SELECTING

LOW SELECTING

BIAS

NONLINEAR OR UNSPECIFIED FUNCTION

CONVERT:

E - VOLTAGE

I - CURRENT

P - PNEUMATIC

A - ANALOG

B - BINARY

H - HYDRAULIC

O - ELECTROMAGNETIC/SONIC

R - RESISTANCE (ELECTRICAL)

D - DIGITAL

NOTES

1. SEE THE GENERAL AND ELECTRICAL DISCIPLINE DRAWINGS FOR ADDITIONAL SYMBOLS AND ABBREVIATIONS.

2. SEE THE GENERAL DISCIPLINE DRAWINGS FOR EQUIPMENT DESIGNATIONS AND PROCESS IDENTIFICATION CODES.

3. THIS IS A GENERALIZED LEGEND SHEET. SEE ALSO ISA S5.1, S5.3 AND S7.3.

4. FOR INSTRUMENT AIR QUALITY STANDARDS, REFER TO ISA RP7.7.

5. WHERE LOOP NUMBERS EXCEED THE LENGTH AVAILABLE WITHIN A BUBBLE, THE LOWER HALF OF THE BUBBLE MAY APPEAR BROKEN TO ALLOW SPACE FOR THE LOOP NUMBER.

6. SEE SPECIFICATION 17010 FOR COMPLETE DETAILS OF LOOP DRAWING AND INTERCONNECTION DRAWING SUBMITTAL REQUIREMENTS.

7. POWER SUPPLIES FOR INSTRUMENT LOOPS OR SYSTEMS SHALL BE PROVIDED BY THE INSTRUMENTATION SUPPLIER TO MEET THE VOLTAGE AND CURRENT REQUIREMENTS OF THE COMPONENTS IN EACH LOOP OR SYSTEM.

8. FIELD SWITCHES FOR ELECTRICAL MOTOR OPERATION SHALL BE SUPPLIED BY THE ELECTRICAL CONTRACTOR UNLESS THEY ARE PART OF A VENDOR PACKAGE.

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NO

REVISION

DATE

BY

DESIGNED
ZLP

DRAWN
VZ

CHECKED
ZCD

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

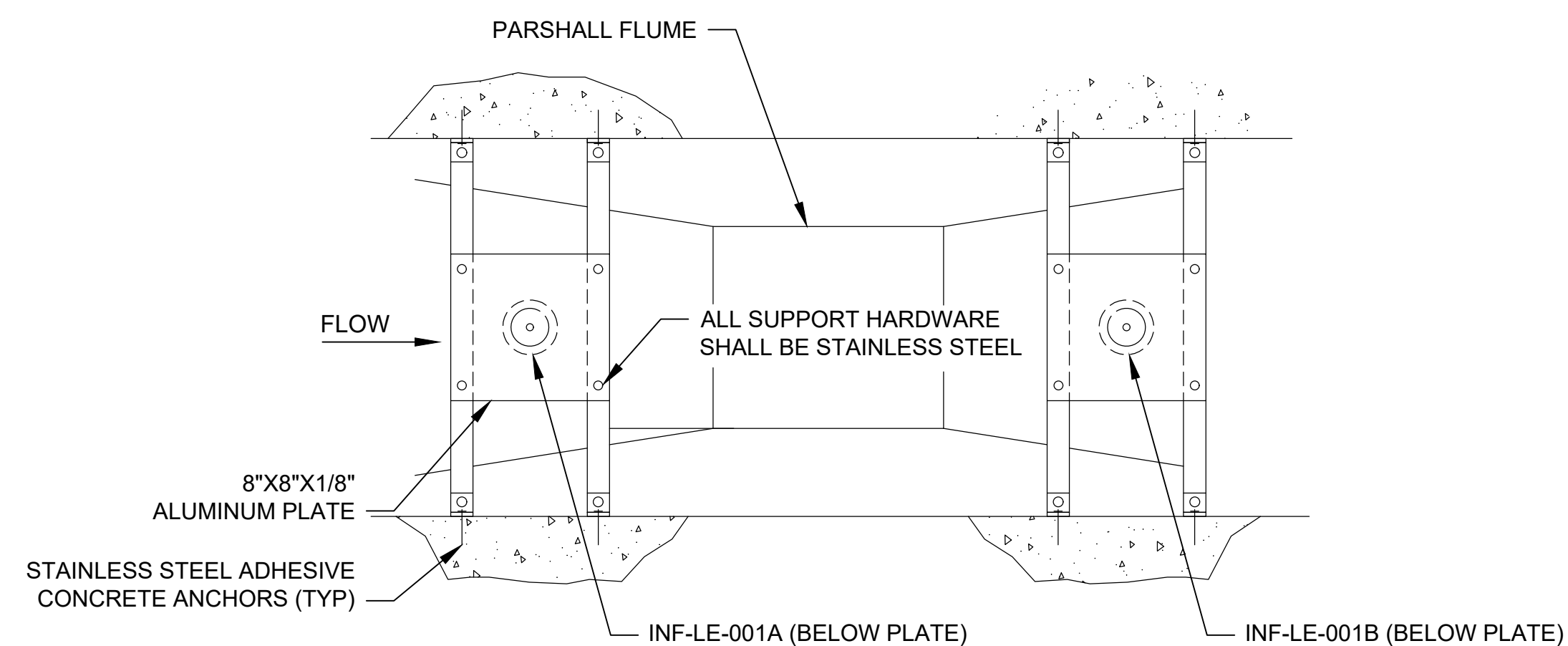
INSTRUMENTATION
LEGEND AND NOTES

SCALE
NTS

JOB NO
2246059*00

DATE
SEP 2024

SHEET 39 OF 48



PARSHALL FLUME TRANSMITTER MOUNTING DETAIL

SCALE: NTS
REV 00

GENERAL SHEET NOTES

1. ALL DETAILS SHOWN ARE TYPICAL. DETAILS SHALL BE USED THROUGHOUT THE PROJECT AS APPLICABLE.

APPROVED
City of Arvada, Colorado

CITY ENGINEER _____ DATE _____ JOB NUMBER _____

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BY

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DESIGNED

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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



STANDARD DETAILS

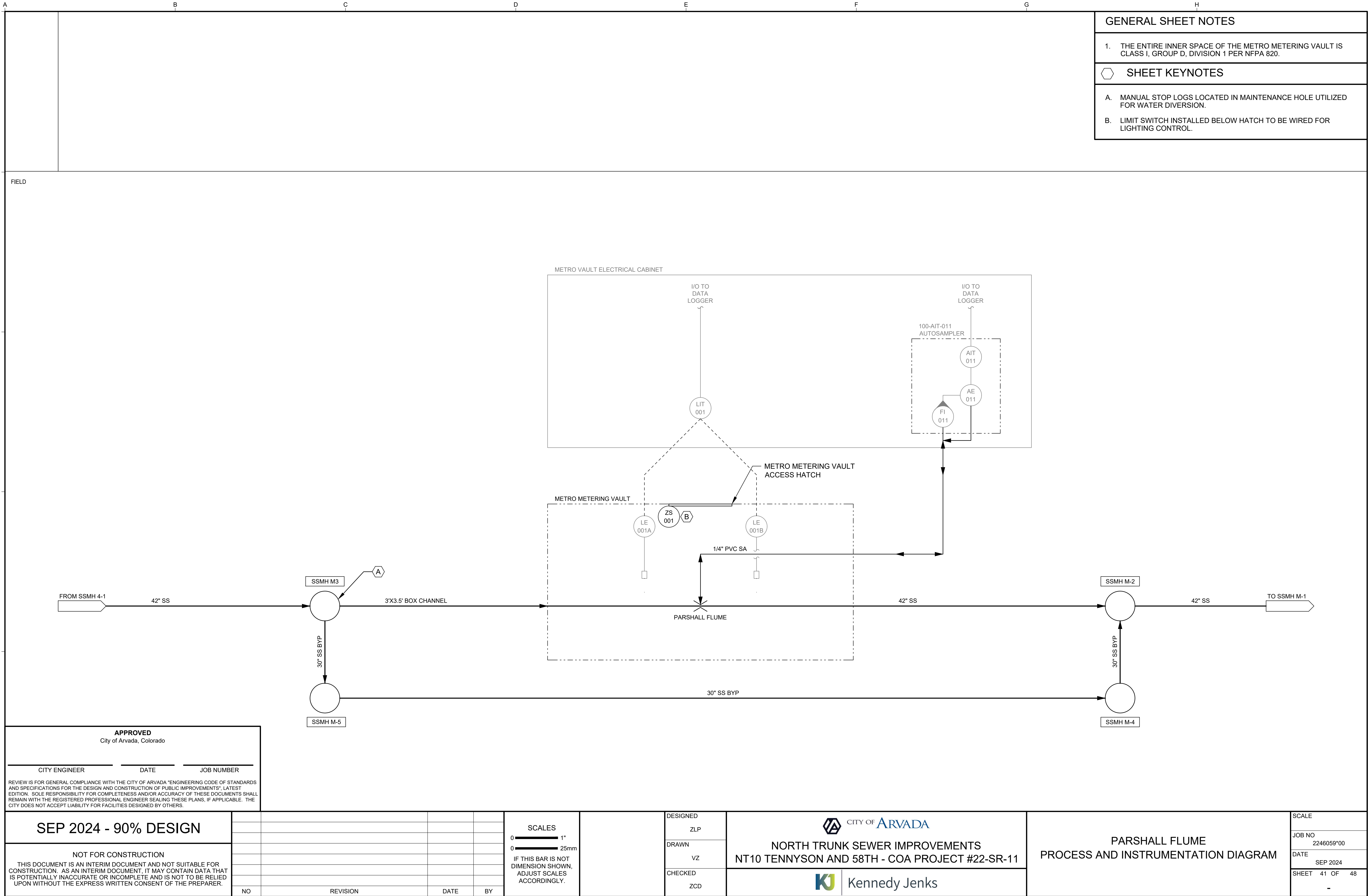
SCALE

NTS

JOB NO

DATE	SEP 2024
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SHEET 40 OF 48



CITY OF ARVADA EROSION CONTROL NOTES				ADAMS COUNTY EROSION CONTROL NOTES				ADAMS COUNTY EROSION CONTROL NOTES (CONT)				ADAMS COUNTY EROSION CONTROL NOTES (CONT)			
1. AT ANYTIME THE CITY DETERMINES THE PROJECT TO BE OUT OF COMPLIANCE WITH EROSION AND SEDIMENT CONTROL/GOOD HOUSEKEEPING REQUIREMENTS, THEY HAVE THE AUTHORITY TO IMMEDIATELY STOP WORK ON THE PROJECT UNTIL THE DETERMINATION HAS BEEN MADE BY THE CITY STAFF THAT THE SITE HAS REGAINED COMPLIANCE WITH REQUIREMENTS. 2. THE CONTRACTOR SHALL ENSURE STORMWATER QUALITY BEST MANAGEMENT PRACTICES SHALL BE IMPLEMENTED TO MINIMIZE SOIL EROSION, SEDIMENTATION, INCREASED POLLUTANT LOADS, AND CHANGED WATER FLOW CHARACTERISTICS RESULTING FROM LAND DISTURBING ACTIVITY TO THE MAXIMUM EXTENT PRACTICAL, SO AS TO MINIMIZE POLLUTION TO THE MS4 OR RECEIVING WATERS. 3. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REQUIRED STATE OR LOCAL PERMITS. STANDARD FEES FOR THE CITY PERMIT SHALL BE WAIVED BY THE CITY. THE CITY RESERVES THE RIGHT TO WITHHOLD RETAINAGE ON A PROJECT AS NECESSARY FOR PERFORMANCE OF MAINTENANCE ON BMP'S DUE TO CONTRACTOR'S FAILURE TO COMPLY OR PERFORM EROSION CONTROL MEASURES IN ACCORDANCE WITH THIS PLAN. 4. AT A MINIMUM ALL BEST MANAGEMENT PRACTICES (BMP'S) AS GENERALLY OUTLINED IN STANDARD DRAWINGS, IN ACCORDANCE WITH THE CITY OF ARVADA SITE DEVELOPMENT PERMIT REQUIREMENTS AND IN ACCORDANCE WITH APPROVED INSTALLATION AND MAINTENANCE DETAILS, SHALL BE CORRECTLY INSTALLED AND FUNCTIONING AS DESIGNED AT ALL TIMES. 5. CONTRACTOR SHALL DESIGNATE AN EROSION CONTROL REPRESENTATIVE AVAILABLE ON-CALL AT ALL TIMES. REPRESENTATIVE SHALL PERFORM ROUTINE AND POST-STORM INSPECTIONS OF ALL BMP's PER CITY SITE DEVELOPMENT PERMIT REQUIREMENTS. 6. ALL BMP's IDENTIFIED BY THE CITY AS DEFICIENT SHALL BE MAINTAINED, REPAIRED, OR INSTALLED BY CONTRACTOR AS SOON AS POSSIBLE, IN MOST CASES IMMEDIATELY. 7. CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION AND SEDIMENT CONTROL MEASURES AT ALL TIMES BEFORE, DURING AND AFTER LAND DISTURBING ACTIVITIES. SUCH MEASURES SHALL BE PLACED AS CONSTRUCTION SEQUENCING AND ACCESS DICTATES. CONTRACTOR SHALL REMOVE ALL SEDIMENT FROM EROSION CONTROL MEASURES AFTER EACH EROSION EVENT, AS NEEDED AND AT THE DIRECTION OF THE CITY. 8. THE CITY MAY REQUEST THE MODIFICATION OF THE EROSION AND SEDIMENT CONTROLS AS FIELD CONDITIONS WARRANT. 9. SEE ARVADA DETAILS FOR BMP INSTALLATION AND MAINTENANCE STANDARDS FOR THE FOLLOWING BMP's: ROCK SOCKS, INLET PROTECTION, SILT FENCE, SEDIMENT CONTROL LOGS, CONCRETE WASHOUT AREA, EROSION CONTROL BLANKET, STABILIZED STAGING AREA AND VEHICLE TRACKING CONTROL. OTHER APPROVED BMP INSTALLATION/MAINTENANCE DETAILS CAN BE FOUND IN THE UDFCD VOLUME III CRITERIA MANUAL. 10. SURFACE DRAINAGE PASSING THROUGH OR ORIGINATING FROM EACH SITE SHALL BE TREATED/CAPTURED BY ONE OR MORE BMP's DEPENDENT ON AREA OF DISTURBANCE. 11. SOIL STABILIZATION MEASURES SHALL BE IMPLEMENTED WITHIN 14 DAYS TO ALL DISTURBED AREAS THAT MAY OR MAY NOT BE AT FINAL GRADE BUT WILL REMAIN UNDISTURBED FOR PERIODS LONGER THAN 30 CALENDAR DAYS OR FOR AN INDETERMINATE LENGTH OF TIME. 12. ALL TEMPORARY EROSION AND SEDIMENT CONTROL BMP's MUST BE REMOVED UPON FINAL STABILIZATION. 13. ALL CONSTRUCTION WASTES, FUEL, LUBRICANTS, CHEMICAL WASTES, TRASH OR DEBRIS SHALL BE CONTAINED WHEN STORED ON-SITE AND PROTECTED FROM CONTACT WITH RAIN/SNOWFALL OR SURFACE RUNOFF. PROPER DISPOSAL OF SUCH WASTES SHALL BE IMMEDIATE AND THE RESPONSIBILITY OF THE CONTRACTOR. 14. ROUTINE VEHICLE MAINTENANCE SHALL NOT BE PERFORMED ON-SITE. IF EQUIPMENT MAINTENANCE/REPAIR BECOMES NECESSARY, APPROPRIATE BMP's SHALL BE IMPLEMENTED SUCH AS DRIP PANS, SPILL MATERIALS, ETC. ON-SITE FUELING SHOULD BE PERFORMED BY DELIVERY VEHICLES WITH ADEQUATE SPILL PREVENTION AND RESPONSE CAPABILITY. 15. CONCRETE WASHOUT ACTIVITIES MUST BE CONDUCTED IN A MANNER THAT DOES NOT CONTRIBUTE POLLUTANTS TO SURFACE WATERS OR STORMWATER RUNOFF. CONCRETE WASHOUT SHALL BE PERFORMED IN A DESIGNATED CONCRETE WASHOUT AREA OR OFF-SITE WASHOUT. PORTABLE UNITS ARE ACCEPTABLE WITH A MANUFACTURERS SPECIFICATION. 16. CONTRACTOR IS RESPONSIBLE FOR CONTROLLING DUST EMISSIONS. A WATER TRUCK SHALL BE USED WITHIN TWENTY-FOUR (24) HOURS OF REQUEST BY CITY. 17. CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL OF TRACKED MATERIALS ON STREETS, SIDEWALKS, DRIVEWAYS OR PARKING LOTS. TRACKED MATERIAL SHALL BE REMOVED IMMEDIATELY BY SCRAPING AND SWEEPING. FLUSHING MATERIALS FROM HARD SURFACE WITH WATER IS PROHIBITED. CONTRACTOR SHALL HAVE ACCESS TO MEANS OF MECHANICAL SWEEPING AT ALL TIMES. 18. AREAS TO BE RESEEDD AT THE COMPLETION OF UTILITY INSTALLATION OR GRADING ACTIVITIES SHALL BE IN ACCORDANCE WITH UDFCD VOL III SEED/MULCH SPECIFICATIONS. 19. NECESSARY EROSION CONTROL MEASURES MUST REMAIN IN PLACE AND FUNCTIONING AS DESIGNED UNTIL A VIABLE VEGETATIVE COVER HAS BEEN ESTABLISHED OR ROAD RESURFACED. 20. IN HIGH TRAFFIC AREAS WHERE LANE CLOSURES ARE OPENED AT THE END OF THE WORK DAY, BMP's MAY BE REMOVED AT THE END OF THE DAY AND REINSTALLED AT THE BEGINNING OF THE NEXT WORK DAY PROVIDED ALL DIRT AND MATERIALS ARE REMOVED FROM THE AREA AND AT THE DISCRETION OF THE CITY OF ARVADA INSPECTOR.				GENERAL: 1. ALL CONSTRUCTION PROJECTS, REGARDLESS OF THE SIZE, SHALL INSTALL, MAINTAIN AND REPAIR STORMWATER POLLUTION CONTROL MEASURES (CM's) TO EFFECTIVELY MINIMIZE EROSION, SEDIMENT TRANSPORT, AND THE RELEASE OF POLLUTANTS RELATED TO CONSTRUCTION ACTIVITY. CM's EXAMPLE INCLUDE: SEDIMENT CONTROL LOGS (SCL), SILT FENCE (SF), DIKES/SWALES, SEDIMENT TRAPS (ST), INLET PROTECTION (IP), OUTLET PROTECTION (OP), CHECK DAMS (CD), SEDIMENT BASINS (SB), TEMPORARY/PERMANENT SEEDING AND MULCHING (MU), SOIL ROUGHENING, MAINTAINING EXISTING VEGETATION AND PROTECTION OF TREES. CM's MUST BE SELECTED, DESIGNED, ADEQUATELY SIZED, INSTALLED AND MAINTAINED IN ACCORDANCE WITH GOOD ENGINEERING, HYDROLOGIC AND POLLUTION CONTROL PRACTICES. CM's/BMP's INSTALLATION AND MAINTENANCE DETAILS SHALL CONFORM TO URBAN DRAINAGE FLOOD CONTROL CRITERIA MANUAL VOLUME 3, OR THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) ITEM CODE BOOK. CM's MUST FILTER, SETTLE, CONTAIN OR STRAIN POLLUTANTS FROM STORMWATER FLOWS IN ORDER TO PREVENT BYPASS OF FLOWS WITHOUT TREATMENT. CM's MUST BE APPROPRIATE TO TREAT THE RUNOFF FROM THE AMOUNT OF DISTURBED AREA, THE EXPECTED FLOW RATE, DURATION, AND FLOW CONDITIONS (I.E. SHEET OR CONCENTRATED FLOW). CM's/BMP's SHALL BE SPECIFIED IN THE SWMP (IF APPLICABLE), AND THE LOCATIONS SHOWN ON THE EC PLAN. 1) PRIOR TO CONSTRUCTION, PROJECTS DISTURBING 1 OR MORE ACRES OF LAND, OR ANY PROJECT BELONGING TO A COMMON PLAN OF DEVELOPMENT DISTURB 1 OR MORE ACRES, MUST OBTAIN: - A GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES, FROM THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, AND - AN ADAMS COUNTY STORMWATER QUALITY PERMIT WITHIN THE UNINCORPORATED ADAMS COUNTY MS4 AREA. 2) PERMITTED PROJECTS SHALL DEVELOP A STORMWATER MANAGEMENT PLAN (SWMP), AKA EROSION AND SEDIMENT CONTROL PLAN (ESCP), IN COMPLIANCE WITH CDPHE MINIMUM REQUIREMENTS. THE APPROVED SWMP, INCLUDING EROSION CONTROL (EC) PLAN (SITE MAP), SHALL BE KEPT ON-SITE AND UPDATED AT ALL TIMES. THE QUALIFIED STORMWATER MANAGER IS RESPONSIBLE FOR IMPLEMENTING THE SWMP AND CM's (AKA BMP's) DURING CONSTRUCTION. 3) PERMITTED PROJECTS SHALL PERFORM REGULAR STORMWATER INSPECTIONS EVERY 7 CALENDAR DAYS, OR EVERY 14 CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY PRECIPITATION OR SNOWMELT EVENT THAT CAUSES SURFACE EROSION. INSPECTION FREQUENCY CAN BE REDUCED FOR POST-STORM EVENT INSPECTIONS AT TEMPORARILY IDLE SITES AND ALSO FOR STORMWATER INSPECTIONS AT COMPLETED SITES WAITING FOR FINAL STABILIZATION. INSPECTION REPORTS MUST IDENTIFY ANY INCIDENTS OF NON-COMPLIANCE. 4) TRACKING OF DIRT ONTO PAVED PUBLIC OR PRIVATE PAVED ROADS IS NOT ALLOWED. THE USE OF DIRT RAMPS TO ENTER/EXIT FROM AN UNPAVED INTO A PAVED AREA IS PROHIBITED. VEHICLE TRACKING CONTROLS SHALL BE IMPLEMENTED, OTHERWISE ENTRANCE AREA MUST DRAIN THRU A CM TOWARDS THE PRIVATE SITE. 5) TRUCK LOADS OF FILL MATERIAL IMPORTED TO OR CUT MATERIAL EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORTATION ON PUBLIC RW. HAUL ROUTES MUST BE PERMITTED BY THE COUNTY. NO MATERIAL SHALL BE TRANSPORTED TO ANOTHER SITE WITHOUT APPLICABLE PERMITS. 6) CONTROL MEASURES DESIGNED FOR CONCRETE WASHOUT WASTE MUST BE IMPLEMENTED. THIS INCLUDES WASHOUT WASTE DISCHARGED TO THE GROUND AND WASHOUT WASTE FROM CONCRETE TRUCKS AND MASONRY OPERATIONS. 7) TEMPORARY CM's/BMP's SHALL BE REMOVED AFTER THE SITE HAS REACHED FINAL STABILIZATION. 8) DEWATERING OPERATIONS DISCHARGING OFF-SITE INTO ANY WATERS CONVEYANCE SYSTEMS INCLUDING WETLANDS, IRRIGATION DITCHES, CANALS, RIVERS, STREAMS, OR STORM SEWER SYSTEMS, REQUIRE A STATE CONSTRUCTION DEWATERING PERMIT. 9) PERMITTED PROJECTS SHALL KEEP THE CDPHE's STORMWATER DISCHARGE PERMIT, STORMWATER MANAGEMENT PLAN (SWMP) AND INSPECTION LOGS AVAILABLE ON-SITE THROUGHOUT THE DURATION OF THE PROJECT, AND FOR AN ADDITIONAL 3 YEARS AFTER PERMIT CLOSE-OUT. 10) PERMITTED LANDOWNER AND/OR CONTRACTOR SHALL CLOSE THE STATE AND CITY/COUNTY PERMIT ONCE FINAL STABILIZATION IS REACHED. STORMWATER INSPECTIONS SHALL CONTINUE UNTIL INACTIVATION NOTICE IS FILED WITH CDPHE.				PERFORMANCE STANDARD: 1. STORMWATER RUNOFF FROM DISTURBED AREAS MUST FLOW TO AT LEAST ONE (1) CM TO MINIMIZE SEDIMENT IN THE DISCHARGE. DO NOT ALLOW SEDIMENT TO LEAVE THE SITE. THE BEST WAY TO PREVENT SEDIMENT OR POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM IS TO STABILIZE THE SITE AS QUICKLY AS POSSIBLE, PREVENTING EROSION AND STOPPING SEDIMENT RUN-OFF AT ITS SOURCE. 2. PHASE CONSTRUCTION TO MINIMIZE DISTURBED AREAS, INCLUDING DISTURBANCE OF STEEP SLOPES (I.E. THE ENTIRE PROJECT SITE SHOULD NOT BE DISTURBED IF CONSTRUCTION WILL ONLY BE OCCURRING IN ONE PARTICULAR SECTION OF THE SITE). LIMIT SOIL EXPOSURE TO THE SHORTEST POSSIBLE PERIOD OF TIME. PROTECT NATURAL FEATURES AND EXISTING VEGETATION WHENEVER POSSIBLE. REMOVAL OF EXISTING VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATIONS. MAINTAIN PRE-EXISTING VEGETATION (OR EQUIVALENT CM's) FOR AREAS WITHIN 50 HORIZONTAL FEET OF RECEIVING WATERS. 3. SOIL COMPACTION MUST BE MINIMIZED FOR AREAS WHERE INFILTRATION CM's WILL OCCUR OR WHERE FINAL STABILIZATION WILL BE ACHIEVED THROUGH A VEGETATIVE COVER. 4. ALL SOIL IMPORTED TO OR EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT THE LOSS OF MATERIAL DURING TRANSPORT. 5. DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES OR WIND SHALL BE CONTROLLED. 6. INSTALL CONSTRUCTION FENCE (ORANGE) TO PROTECT WETLANDS AND OTHER SENSITIVE AREAS AND THE PREVENT ACCESS, AND TO DELINEATE THE LIMITS OF CONSTRUCTION. DO NOT USE SILT FENCE TO PROTECT WETLANDS SINCE TRENCHING MAY IMPACT THESE AREAS. 7. CM's INTENDED TO CAPTURE OVERLAND, LOW VELOCITY SHEET FLOW AT A FAIRLY LEVEL GRADE SHALL ONLY BE INSTALLED ALONG CONTOURS. 8. INSTALL CM's, SUCH AS CHECK DAMS, PERPENDICULAR TO THE CONCENTRATED FLOWS TO REDUCE FLOW VELOCITY. 9. STORM DRAIN INLETS WITHIN AND ADJACENT TO THE CONSTRUCTION SITE MUST BE PROTECTED. ANY PONDING OF STORMWATER AROUND INLET PROTECTION MUST NOT CAUSE EXCESSIVE FLOODING OR DAMAGE ADJACENT AREAS OR STRUCTURES. 10. INSTALL VEHICLE TRACKING CONTROL (VTC) TO ENTER/EXIT UNPAVED AREA. DO NOT USE RECYCLED CRUSHED CONCRETE OR ASPHALT MILLINGS FOR VEHICLE TRACKING PADS. 11. STRAW BALES SHALL NOT BE USED FOR PRIMARY EROSION OR SEDIMENT CONTROL (I.E. STRAW BALES MAY BE USED FOR REINFORCEMENT BEHIND ANOTHER BMP SUCH AS A SILT FENCE. 12. OUTLETS SYSTEMS (SUCH AS SKIMMER OR PERFORATED RISER PIPE) SHALL BE INSTALLED TO WITHDRAW WATER FROM OR NEAR THE SURFACE LEVEL WHEN DISCHARGING FROM BASINS. WATER CANNOT DRAIN FROM THE BOTTOM OF THE POND. 13. TEMPORARY STABILIZATION MUST BE IMPLEMENTED FOR EARTH DISTURBING ACTIVITIES ON ANY PORTION OF THE SITE WHERE LAND DISTURBING ACTIVITIES HAVE PERMANENTLY OR TEMPORARILY CEASED (FOR MORE THAN 14 CALENDAR DAYS). TEMPORARY STABILIZATION METHODS EXAMPLES: TARPS, SOIL TACKIFIER, AND HYDROSEED. TEMPORARY STABILIZATION REQUIREMENT MAY EXCEED THE 14-DAY SCHEDULE WHEN EITHER THE FUNCTION OF THE SPECIFIC AREA REQUIRES IT TO REMAIN DISTURBED, OR PHYSICAL CHARACTERISTICS OF THE TERRAIN AND CLIMATE PREVENT STABILIZATION AS LONG AS THE CONSTRAINTS AND ALTERNATIVE SCHEDULE IS DOCUMENTED ON THE SWMP, AND LOCATIONS ARE IDENTIFIED ON THE EC PLAN (SITE MAP). 14. RUNOFF FROM STOCKPILE AREA MUST BE CONTROLLED. SOILS THAT WILL BE STOCKPILED FOR MORE THAN 30 DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION. INSTALL CM's/BMP's 5 FEET AWAY FROM THE TOE OF THE STOCKPILE'S SLOPE. 15. WATER USED TO CLEAN CONCRETE TRUCKS SHALL BE DISCHARGED INTO A CONCRETE WASHOUT AREA (CWA). THE PREDEFINED CONTAINMENT AREA MUST BE IDENTIFIED WITH A SIGN, AND SHALL ALLOW THE LIQUIDS TO EVAPORATE OR DRY OUT. CWA DISCHARGES THAT MAY REACH GROUNDWATER MUST FLOW THROUGH SOIL THAT HAS BUFFERING CAPACITY PRIOR TO REACHING GROUNDWATER. THE CONCRETE WASHOUT LOCATION SHALL NOT BE LOCATED IN AN AREA WHERE SHALLOW GROUNDWATER MAY BE PRESENT AND WOULD RESULT IN BUFFERING CAPACITY NOT BEING ADEQUATE, SUCH AS NEAR NATURAL DRAINAGES, SPRINGS, OR WETLANDS. IN THIS CASE, A LINER UNDERNEATH IS NEEDED FOR AREAS WITH HIGH GROUNDWATER LEVELS. CWA SHALL NOT BE PLACED IN LOW AREAS, DITCHES OR ADJACENT TO STATE WATERS. PLACE CWA 50 FEET AWAY FROM STATE WATERS. 16. WASTE, SUCH AS BUILDING MATERIALS, WORKERS TRASH AND CONSTRUCTION DEBRIS, MUST BE PROPERLY MANAGED TO PREVENT STORMWATER POLLUTION. 17. INSTALL STABILIZED STAGING AREAS (SSA) TO STORE MATERIALS, CONSTRUCTION TRAILER, ETC. 18. IF CONDITIONS IN THE FIELD WARRANT ADDITIONAL CM's/BMP's TO THE ONES ORIGINALLY APPROVED ON THE SWMP OR EC PLAN (CIVIL DRAWING), THE LANDOWNER OR CONTRACTOR SHALL IMPLEMENT MEASURES DETERMINED NECESSARY, AS DIRECTED BY THE COUNTY. 19. PERMANENT CM's/BMP's FOR SLOPES, CHANNELS, DITCHES, OR DISTURBED LAND AREA SHALL BE PERFORMED IMMEDIATELY AFTER FINAL GRADING. CONSIDER THE USE OF EROSION CONTROL BLANKETS ON SLOPES 3:1 OR STEEPER AND AREAS WITH CONCENTRATED FLOWS SUCH AS SWALES, LONG CHANNELS AND ROADSIDE DITCHES. 20. THE DISCHARGE OF SANITARY WASTE INTO THE STORM SEWER SYSTEM IS PROHIBITED. PORTABLE TOILETS MUST BE PROVIDED, SECURED AND PLACED ON PERMEABLE SURFACES, AWAY FROM THE CURBSIDE, STORM INLETS AND/OR DRAINAGE WAYS. 21. REMOVE TEMPORARY CM's/BMP's ONCE FINAL STABILIZATION IS REACHED, UNLESS OTHERWISE AUTHORIZED. 22. FINAL STABILIZATION MUST BE IMPLEMENTED. FINAL STABILIZATION IS REACHED WHEN ALL SOIL DISTURBING ACTIVITIES HAVE BEEN COMPLETED, AND EITHER A UNIFORM VEGETATIVE COVER HAS BEEN ESTABLISHED WITH AN INDIVIDUAL PLANT DENSITY OF AT LEAST 70% OF PRE-DISTURBED LEVELS, OR EQUIVALENT PERMANENT ALTERNATIVE METHOD HAS BEEN IMPLEMENTED.				PERFORMANCE STANDARD (CONT): 23. PROVIDE SPILL PROTECTION AND CONTAINMENT MEASURES FOR CONSTRUCTION MATERIALS, WASTE AND FUEL STORAGE AREAS. BULK STORAGE (55 GALLONS OR GREATER) OF PETROLEUM PRODUCTS AND LIQUID CHEMICALS MUST HAVE SECONDARY CONTAINMENT, OR EQUIVALENT PROTECTION, IN ORDER TO CONTAIN SPILLS AND TO PREVENT SPILLED MATERIAL FROM ENTERING STATE WATERS. 24. REPORT SPILLS OR RELEASES OF CHEMICAL, OIL, PETROLEUM PRODUCT, SEWAGE, ETC., WHICH MAY REACH THE STORM SEWER OR ENTER STATE WATERS WITHIN 24-HOURS FROM TIME OF DISCOVERY. GUIDANCE AVAILABLE AT WWW.CDPHE.STATE.CO.US/EMP/SPILLSANDRELEASED.HTML: STATE OF COLORADO SPILL-LINE: 877-518-5608; ADAMS COUNTY STORMWATER HOTLINE: 720-523-6400; PUBLIC WORKS: 303-453-8787; AND THE TRI-COUNTY HEALTH DEPARTMENT AT 303-220-9200.			
												MAINTENANCE STANDARD: 1. MAINTAIN AND REPAIR CM's ACCORDING TO APPROVED EROSION CONTROL PLAN (CIVIL DRAWING) TO ASSURE THEY CONTINUE PERFORMING AS ORIGINALLY INTENDED. 2. CM's/BMP's REQUIRING MAINTENANCE OR ADJUSTMENT SHALL BE REPAIRED IMMEDIATELY AFTER OBSERVATION OF THE FAILING BMP. 3. CM's SHALL BE CLEANED WHEN SEDIMENT LEVELS ACCUMULATE TO HALF THE DESIGN UNLESS OTHERWISE SPECIFIED. 4. SWMP AND EC PLAN SHALL BE CONTINUOUSLY UPDATED TO REFLECT NEW OR REVISED CM's/BMP's DUE TO CHANGES IN DESIGN, CONSTRUCTION, OPERATION, OR MAINTENANCE, TO ACCURATELY REFLECT THE ACTUAL FIELD CONDITIONS. A NOTATION SHALL BE MADE IN THE SWMP, INCLUDING DATE OF CHANGES IN THE FIELD, IDENTIFICATION OF THE CM's REMOVED, MODIFIED OR ADDED, AND THE LOCATIONS OF THOSE CM's. UPDATES MUST BE MADE WITHIN 72-HOURS FOLLOWING THE CHANGE. 5. MAINTAIN VEHICLE TRACKING CONTROL (VTC), IF SEDIMENT TRACKING OCCURS. CLEAN-UP IMMEDIATELY. SWEEP BY HAND OR USE STREET SWEEPERS (WITH VACUUM SYSTEM). FLUSHING OFF PAVED SURFACES WITH WATER IS PROHIBITED. 6. CWA MUST BE CLEANED ONCE WASTE ACCUMULATION REACHES 2/3 OF THE WET STORAGE CAPACITY OF THE STRUCTURE. LEGALLY DISPOSE OF CONCRETE WASTE. DO NOT BURY ON-SITE. 7. CLEAN-UP SPILLS IMMEDIATELY AFTER DISCOVERY, OR CONTAIN UNTIL APPROPRIATE CLEANUP METHODS CAN BE EMPLOYED. FOLLOW MANUFACTURER'S RECOMMENDED METHODS FOR SPILL CLEANUP, ALONG WITH PROPER DISPOSAL METHODS. RECORDS OF SPILLS, LEAKS, OR OVERFLOWS THAT RESULT IN DISCHARGE OF POLLUTANTS MUST BE DOCUMENTED AND MAINTAINED. 8. REMOVE SEDIMENT FROM STORM SEWER INFRASTRUCTURE (PONDS, STORM PIPES, OUTLETS, INLETS, ROADSIDE DITCHES, ETC.), AND RESTORE VOLUME CAPACITY UPON COMPLETION OF PROJECT OR PRIOR TO INITIAL ACCEPTANCE OF PUBLIC IMPROVEMENTS (IF APPLICABLE). DO NOT FLUSH SEDIMENT OFF-SITE, CAPTURE ON-SITE AND DISPOSE OF AT AN APPROVED LOCATION.			
												THESE NOTES ARE NOT INTENDED TO BE ALL-INCLUSIVE, BUT TO HIGHLIGHT THE BASIC STORMWATER POLLUTION PREVENTION REQUIREMENTS FOR CONSTRUCTION ACTIVITIES TO COMPLY WITH CDP'S STORMWATER CONSTRUCTION PERMIT AND BE IN CONFORMANCE WITH COUNTY STANDARDS.			
												LEGEND CONSTRUCTION FENCE (CF) SILT FENCE SF SF (SF) VEHICLE TRACKING CONTROL (VTC) LIMITS OF CONSTRUCTION (LOC) EROSION CONTROL BLANKET (ECB) STABILIZED STAGING AREA* (SSA) SEDIMENT CONTROL LOG (SCL)			
												INLET PROTECTION (IP) CURB SOCK (CS) CONCRETE WASHOUT (CWA) DRAINAGE FLOW DIRECTION			
APPROVED City of Arvada, Colorado															
CITY ENGINEER DATE JOB NUMBER															
REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.															
SEP 2024 - 90% DESIGN															
NOT FOR CONSTRUCTION THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.															
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SC-5

Rock Sock (RS)

Rock Sock (RS)

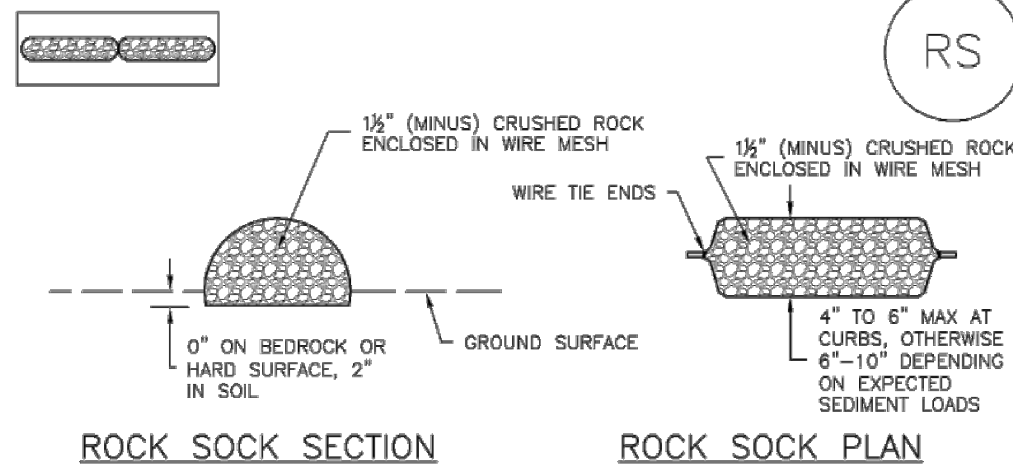
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Concrete Washout Area (CWA)

MM-1

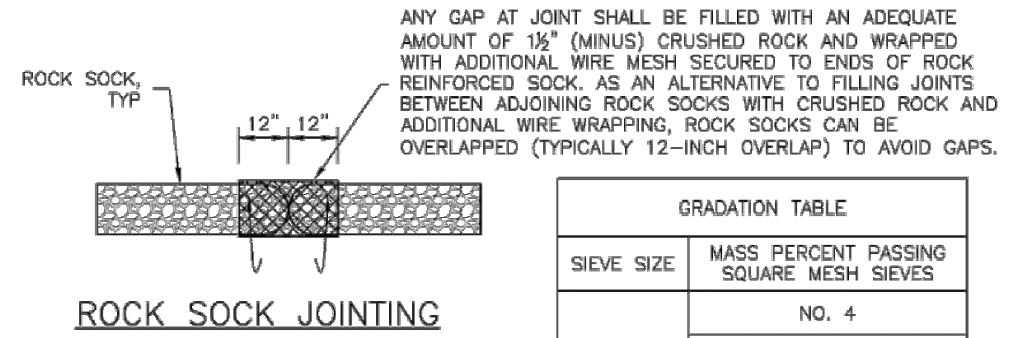
MM-1

Concrete Washout Area (CWA)



ROCK SOCK SECTION

ROCK SOCK PLAN



ROCK SOCK JOINTING

ROCK SOCK INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-LOCATION(S) OF ROCK SOCKS.
- CRUSHED ROCK SHALL BE 1/2" (MINUS) IN SIZE WITH A FRACTURED FACE (ALL SIDES) AND SHALL COMPLY WITH GRADATION SHOWN ON THIS SHEET (1/2" MINUS).
- WIRE MESH SHALL BE FABRICATED OF 10 GAGE POULTRY MESH, OR EQUIVALENT, WITH A MAXIMUM OPENING OF 1/4", RECOMMENDED MINIMUM ROLL WIDTH OF 48"
- WIRE MESH SHALL BE SECURED USING "HOG RINGS" OR WIRE TIES AT 6" CENTERS ALONG ALL JOINTS AND AT 2" CENTERS ON ENDS OF SOCKS.
- SOME MUNICIPALITIES MAY ALLOW THE USE OF FILTER FABRIC AS AN ALTERNATIVE TO WIRE MESH FOR THE ROCK ENCLOSURE.

RS-1. ROCK SOCK PERIMETER CONTROL

GRADATION TABLE		
SIEVE SIZE	MASS PERCENT PASSING	SQUARE MESH SIEVES
NO. 4		
2"	100	
1 1/2"	90 - 100	
1"	20 - 55	
3/4"	0 - 15	
3/8"	0 - 5	

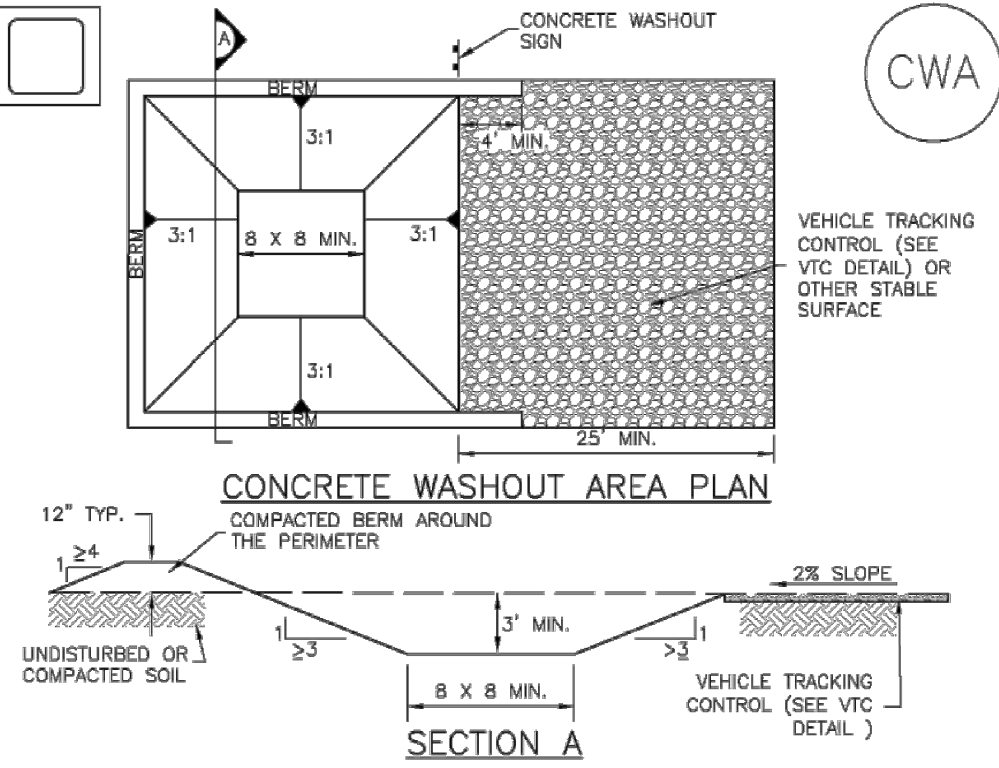
MATCHES SPECIFICATIONS FOR NO. 4 COARSE AGGREGATE FOR CONCRETE PER AASHTO M4.3. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES.

ROCK SOCK MAINTENANCE NOTES

- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
- FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
- WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
- ROCK SOCKS SHALL BE REPLACED IF THEY BECOME HEAVILY SOILED, OR DAMAGED BEYOND REPAIR.
- SEDIMENT ACCUMULATED UPSTREAM OF ROCK SOCKS SHALL BE REMOVED AS NEEDED TO MAINTAIN FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY 1/2 OF THE HEIGHT OF THE ROCK SOCK.
- ROCK SOCKS ARE TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND APPROVED BY THE LOCAL JURISDICTION.
- WHEN ROCK SOCKS ARE REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED AS APPROVED BY LOCAL JURISDICTION.

(DETAIL ADAPTED FROM TOWN OF PARKER, COLORADO AND CITY OF AURORA, COLORADO, NOT AVAILABLE IN AUTOCAD)

NOTE: THE DETAILS INCLUDED WITH THIS FACT SHEET SHOW COMMONLY USED, CONVENTIONAL METHODS OF ROCK SOCK INSTALLATION IN THE DENVER METROPOLITAN AREA. THERE ARE MANY OTHER SIMILAR PROPRIETARY PRODUCTS ON THE MARKET. UDFCD NEITHER INDORSES NOR DISCOURAGES USE OF PROPRIETARY PROTECTION PRODUCTS; HOWEVER, IN THE EVENT PROPRIETARY METHODS ARE USED, THE APPROPRIATE DETAIL FROM THE MANUFACTURER MUST BE INCLUDED IN THE SWMP AND THE BMP MUST BE INSTALLED AND MAINTAINED AS SHOWN IN THE MANUFACTURER'S DETAILS.



CONCRETE WASHOUT AREA PLAN

SECTION A

CWA-1. CONCRETE WASHOUT AREA

CWA INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-CWA INSTALLATION LOCATION.
- DO NOT LOCATE AN UNLINED CWA WITHIN 400' OF ANY NATURAL DRAINAGE PATHWAY OR WATERBODY. DO NOT LOCATE WITHIN 1,000' OF ANY WELLS OR DRINKING WATER SOURCES. IF SITE CONSTRAINTS MAKE THIS INFEASIBLE, OR IF HIGHLY PERMEABLE SOILS EXIST ON SITE, THE CWA MUST BE INSTALLED WITH AN IMPERMEABLE LINER (18 MIL MIN. THICKNESS) OR SURFACE STORAGE ALTERNATIVES USING PREFABRICATED CONCRETE WASHOUT DEVICES OR A LINED ABOVE GROUND STORAGE ARE SHOULD BE USED.
- THE CWA SHALL BE INSTALLED PRIOR TO CONCRETE PLACEMENT ON SITE.
- CWA SHALL INCLUDE A FLAT SUBSURFACE PIT THAT IS AT LEAST 8' BY 8' SLOPES LEADING OUT OF THE SUBSURFACE PIT SHALL BE 3:1 OR FLATTER. THE PIT SHALL BE AT LEAST 3' DEEP.
- BERM SURROUNDING SIDES AND BACK OF THE CWA SHALL HAVE MINIMUM HEIGHT OF 1'.
- VEHICLE TRACKING PAD SHALL BE SLOPED 2% TOWARDS THE CWA.
- SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE CWA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CWA TO OPERATORS OF CONCRETE TRUCKS AND PUMP TRUCKS.
- USE EXCAVATED MATERIAL FOR PERIMETER BERM CONSTRUCTION.

CONCRETE WASHOUT AREA

RS-2

Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

November 2010

November 2010

Urban Drainage and Flood Control District
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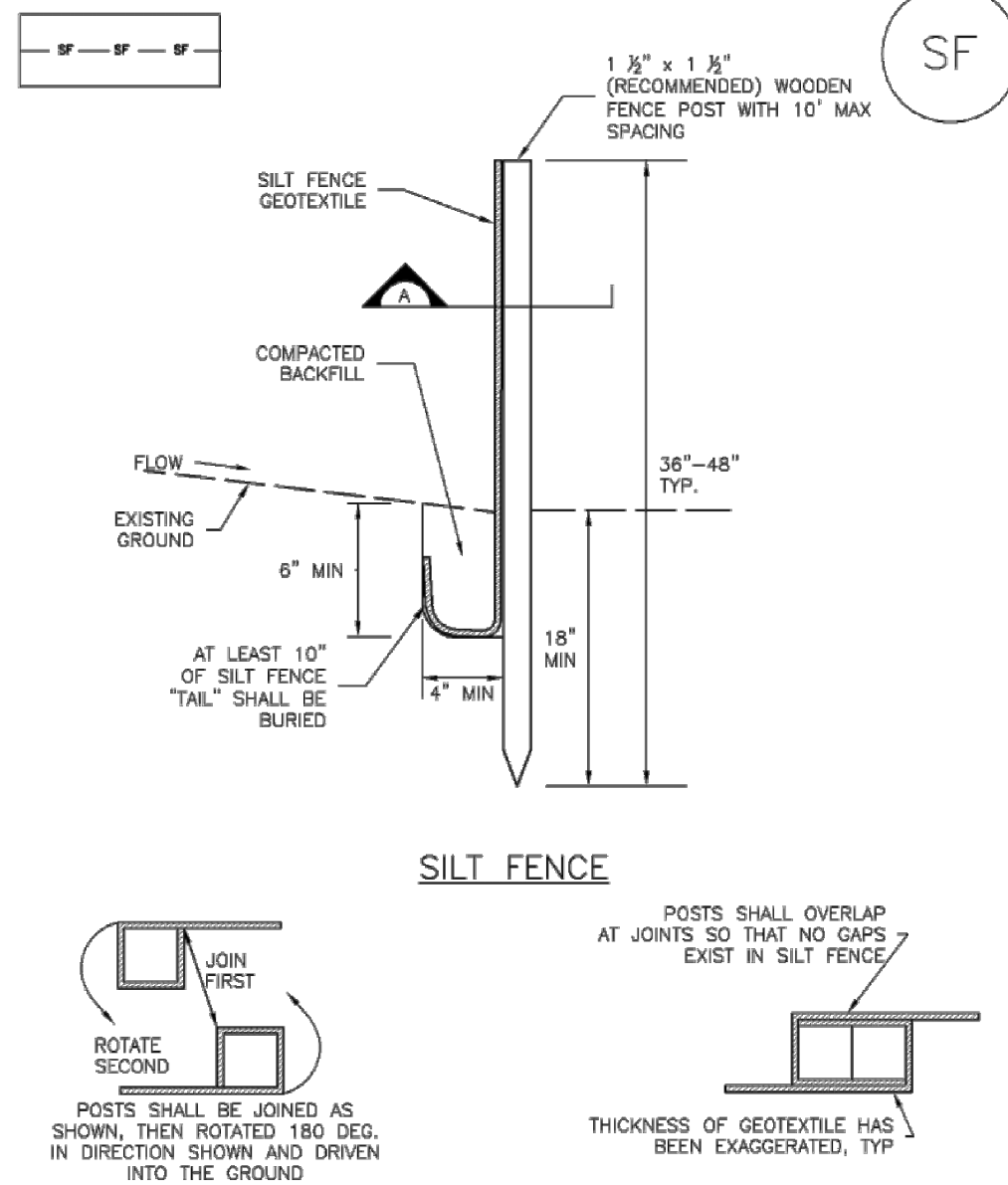
RS-3

Silt Fence (SF)

SC-1

SC-1

Silt Fence (SF)



SILT FENCE

SECTION A

SF-1. SILT FENCE

SILT FENCE INSTALLATION NOTES

- SILT FENCE MUST BE PLACED AWAY FROM THE TOE OF THE SLOPE TO ALLOW FOR WATER PONDING. SILT FENCE AT THE TOE OF A SLOPE SHOULD BE INSTALLED IN A FLAT LOCATION AT LEAST SEVERAL FEET (2-5 FT) FROM THE TOE OF THE SLOPE TO ALLOW ROOM FOR PONDING AND DEPOSITION.
- A UNIFORM 6" X 4" ANCHOR TRENCH SHALL BE EXCAVATED USING TRENCHER OR SILT FENCE INSTALLATION DEVICE. NO ROAD GRADERS, BACKHOES, OR SIMILAR EQUIPMENT SHALL BE USED.
- COMPACT ANCHOR TRENCH BY HAND WITH A "JUMPING JACK" OR BY WHEEL ROLLING. COMPACTION SHALL BE SUCH THAT SILT FENCE RESISTS BEING PULLED OUT OF ANCHOR TRENCH BY HAND.
- SILT FENCE SHALL BE PULLED TIGHT AS IT IS ANCHORED TO THE STAKES. THERE SHOULD BE NO NOTICEABLE SAG BETWEEN STAKES AFTER IT HAS BEEN ANCHORED TO THE STAKES.
- SILT FENCE FABRIC SHALL BE ANCHORED TO THE STAKES USING 1" HEAVY DUTY STAPLES OR NAILS WITH 1" HEADS. STAPLES AND NAILS SHOULD BE PLACED 3" ALONG THE FABRIC DOWN THE STAKE.
- AT THE END OF A RUN OF SILT FENCE ALONG A CONTOUR, THE SILT FENCE SHOULD BE TURNED PERPENDICULAR TO THE CONTOUR TO CREATE A "U-HOOK". THE "U-HOOK" EXTENDING PERPENDICULAR TO THE CONTOUR SHOULD BE OF SUFFICIENT LENGTH TO KEEP RUNOFF FROM FLOWING AROUND THE END OF THE SILT FENCE (TYPICALLY 10' - 20').
- SILT FENCE SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.

SILT FENCE MAINTENANCE NOTES

- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
- FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
- WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
- SEDIMENT ACCUMULATED UPSTREAM OF THE SILT FENCE SHALL BE REMOVED AS NEEDED TO MAINTAIN THE FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY 6".
- REPAIR OR REPLACE SILT FENCE WHEN THERE ARE SIGNS OF WEAR, SUCH AS SAGGING, TEARING, OR COLLAPSE.
- SILT FENCE IS TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND APPROVED BY THE LOCAL JURISDICTION, OR IS REPLACED BY AN EQUIVALENT PERIMETER SEDIMENT CONTROL BMP.
- WHEN SILT FENCE IS REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED AS APPROVED BY LOCAL JURISDICTION.

(DETAIL ADAPTED FROM TOWN OF PARKER, COLORADO AND CITY OF AURORA, NOT AVAILABLE IN AUTOCAD)

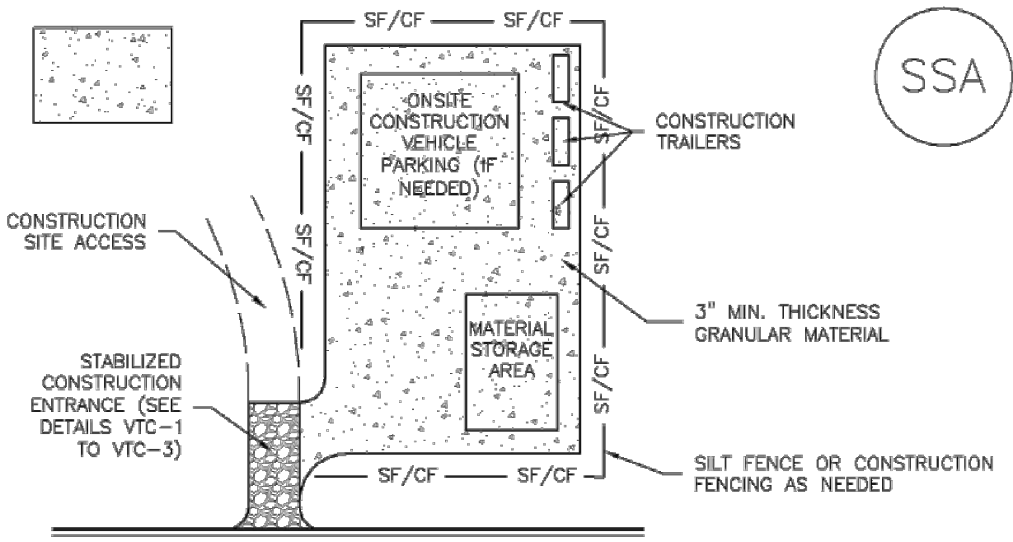
NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

Stabilized Staging Area (SSA)

SM-6

SM-6

Stabilized Staging Area (SSA)



SSA-1. STABILIZED STAGING AREA

STABILIZED STAGING AREA INSTALLATION NOTES

- SEE PLAN VIEW FOR:
-LOCATION OF STAGING AREA(S).
-CONTRACTOR MAY ADJUST LOCATION AND SIZE OF STAGING AREA WITH APPROVAL FROM THE LOCAL JURISDICTION.
 - STABILIZED STAGING AREA SHOULD BE APPROPRIATE FOR THE NEEDS OF THE SITE. OVERSIZING RESULTS IN A LARGER AREA TO STABILIZE FOLLOWING CONSTRUCTION.
 - STAGING AREA SHALL BE STABILIZED PRIOR TO OTHER OPERATIONS ON THE SITE.
 - THE STABILIZED STAGING AREA SHALL CONSIST OF A MINIMUM 3" THICK GRANULAR MATERIAL.
 - UNLESS OTHERWISE SPECIFIED BY LOCAL JURISDICTION, ROCK SHALL CONSIST OF DOT SECT. #703, AASHTO #3 COARSE AGGREGATE OR 6" (MINUS) ROCK.
 - ADDITIONAL PERIMETER BMPs MAY BE REQUIRED INCLUDING BUT NOT LIMITED TO SILT FENCE AND CONSTRUCTION FENCING.
- STABILIZED STAGING AREA MAINTENANCE NOTES
- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
 - FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
 - WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
 - ROCK SHALL BE REAPPLIED OR REGRADED AS NECESSARY IF RUTTING OCCURS OR UNDERLYING SUBGRADE BECOMES EXPOSED.

STABILIZED STAGING AREA MAINTENANCE NOTES

- STABILIZED STAGING AREA SHALL BE ENLARGED IF NECESSARY TO CONTAIN PARKING, STORAGE, AND UNLOADING/LOADING OPERATIONS.
 - THE STABILIZED STAGING AREA SHALL BE REMOVED AT THE END OF CONSTRUCTION. THE GRANULAR MATERIAL SHALL BE REMOVED OR, IF APPROVED BY THE LOCAL JURISDICTION, USED ON SITE, AND THE AREA COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY LOCAL JURISDICTION.
- NOTE: MANY MUNICIPALITIES PROHIBIT THE USE OF RECYCLED CONCRETE AS GRANULAR MATERIAL FOR STABILIZED STAGING AREAS DUE TO DIFFICULTIES WITH RE-ESTABLISHMENT OF VEGETATION IN AREAS WHERE RECYCLED CONCRETE WAS PLACED.
- NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

(DETAILS ADAPTED FROM DOUGLAS COUNTY, COLORADO, NOT AVAILABLE IN AUTOCAD)

APPROVED
City of Arvada, Colorado

CITY ENGINEER DATE JOB NUMBER

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November 2010 Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

SF-3

SF-4

Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

November 2010

SILT FENCE

November 2010 Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

SSA-3

SSA-4

Urban Drainage and Flood Control District
Urban Storm Drainage Criteria Manual Volume 3

November 2010

STABILIZED STAGING AREA

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CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

EROSION AND SEDIMENT
CONTROL DETAILS - I

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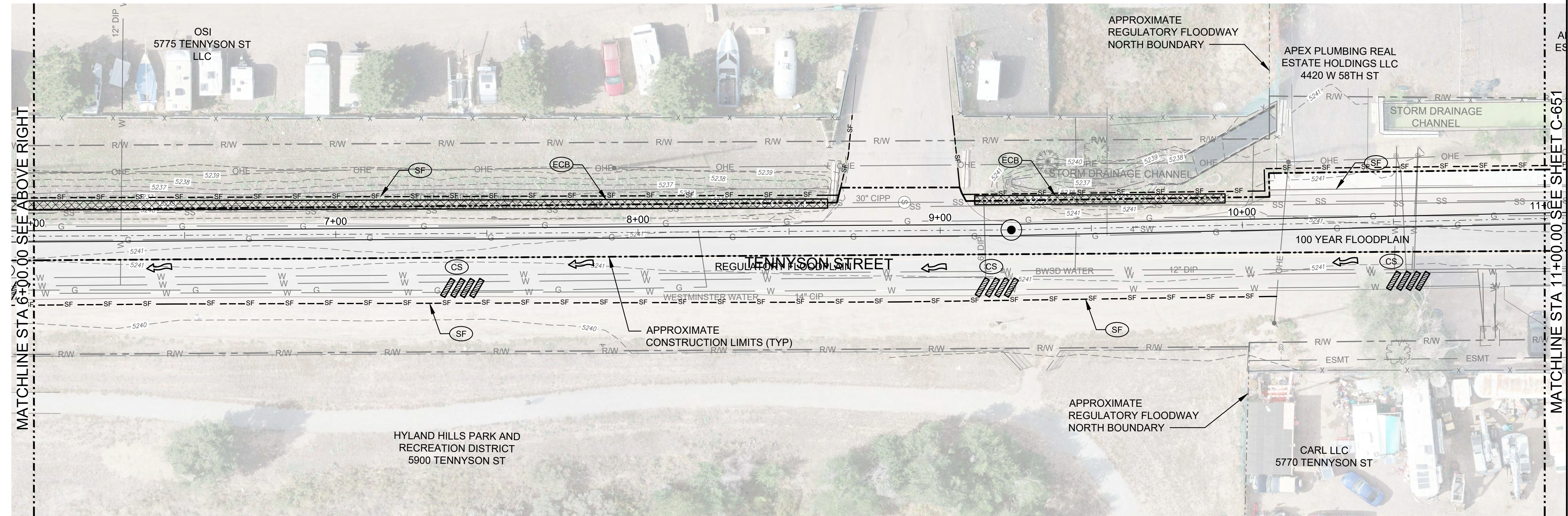
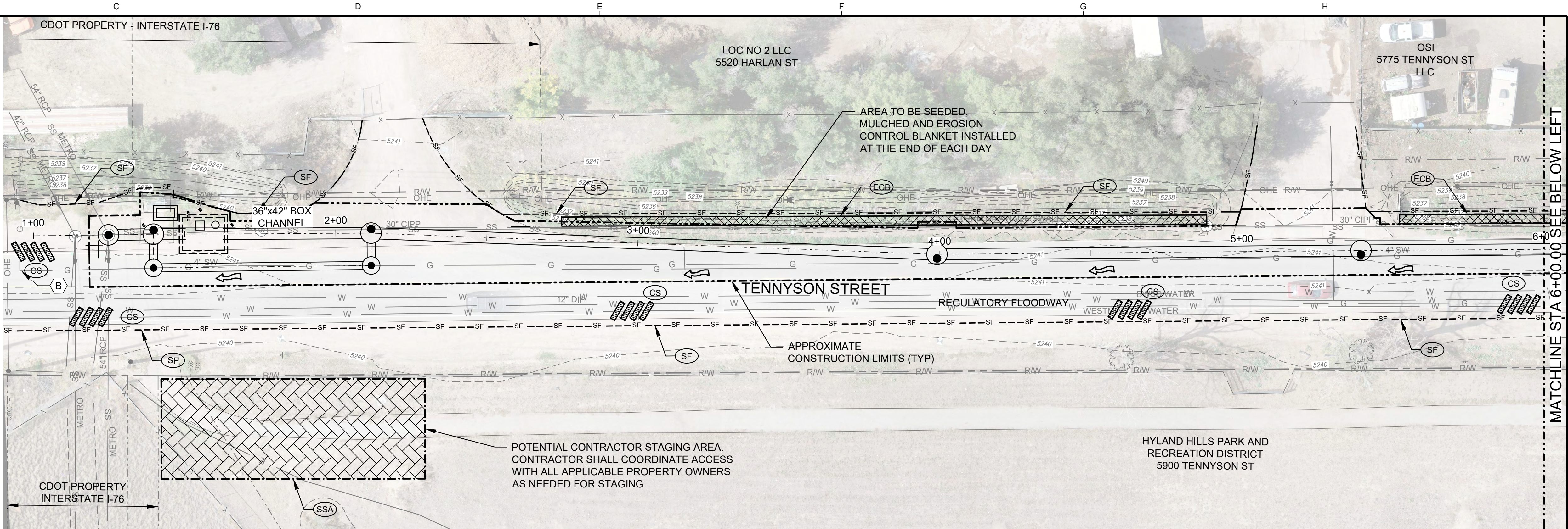
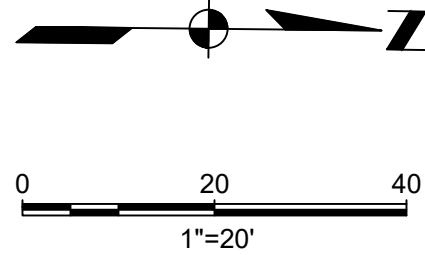
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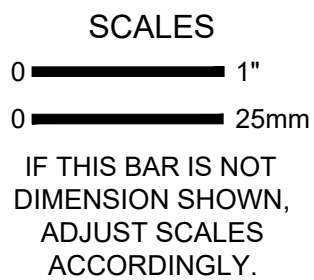
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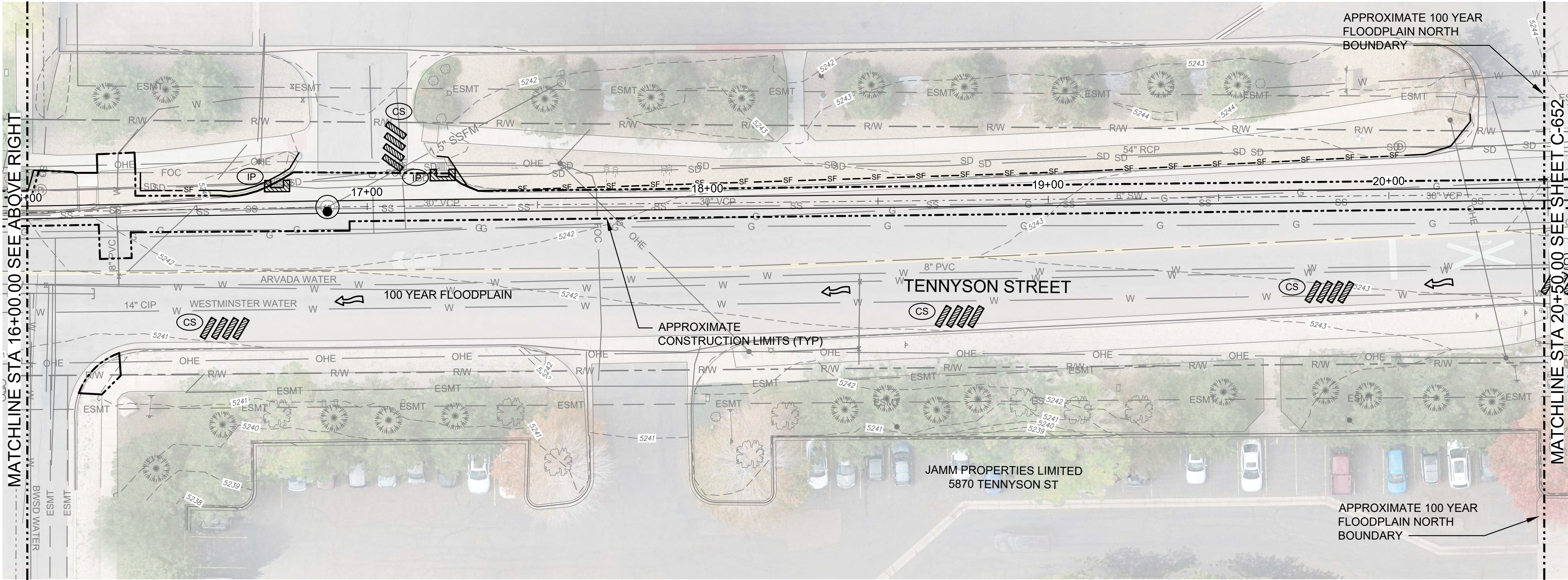
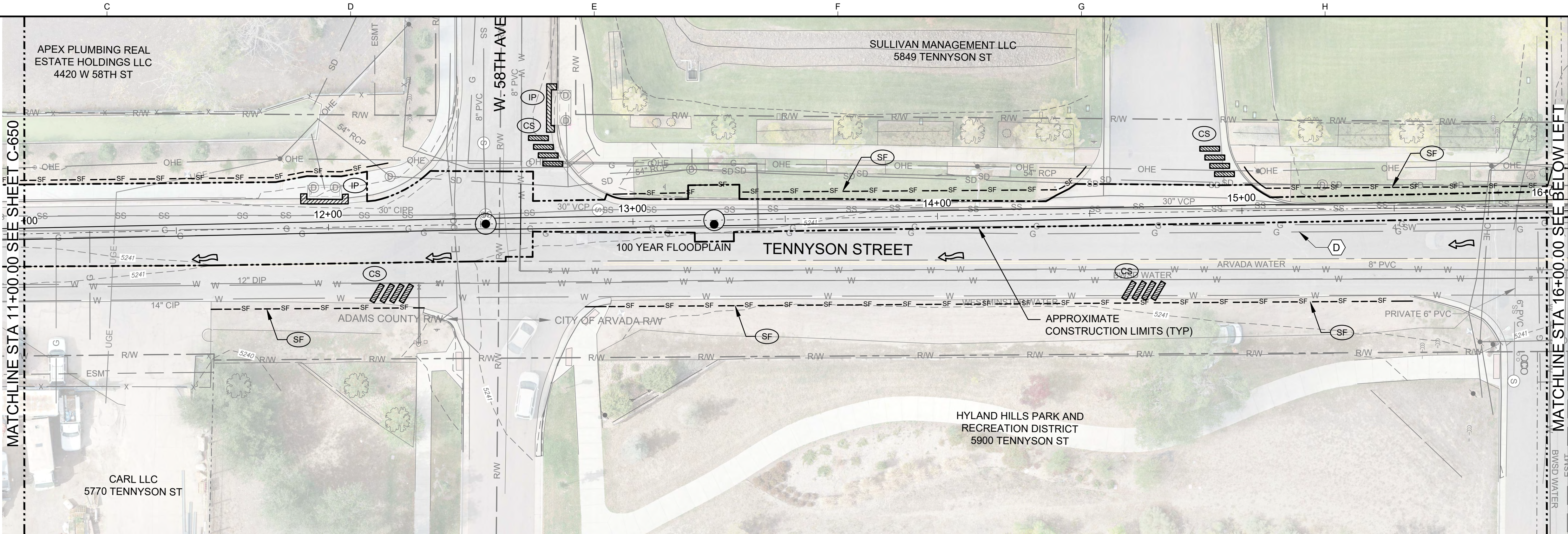
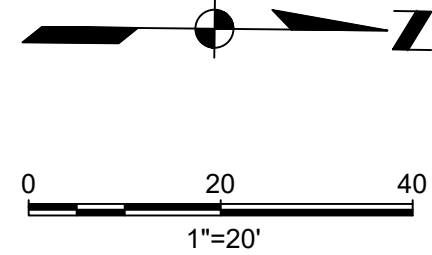


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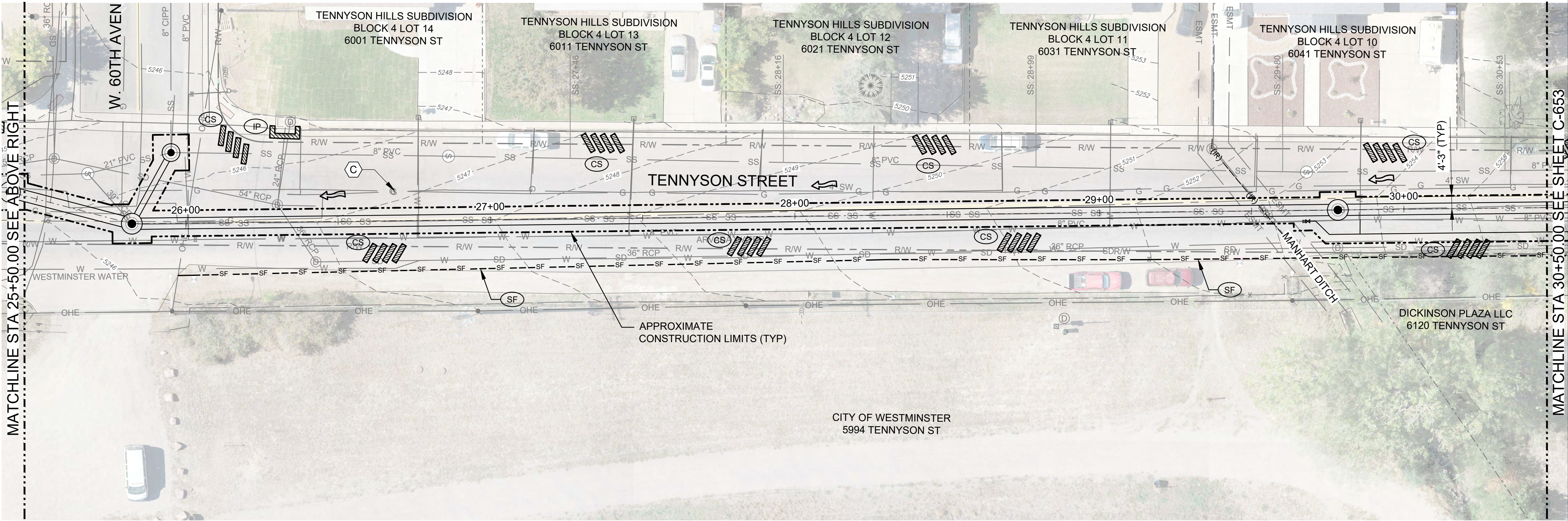
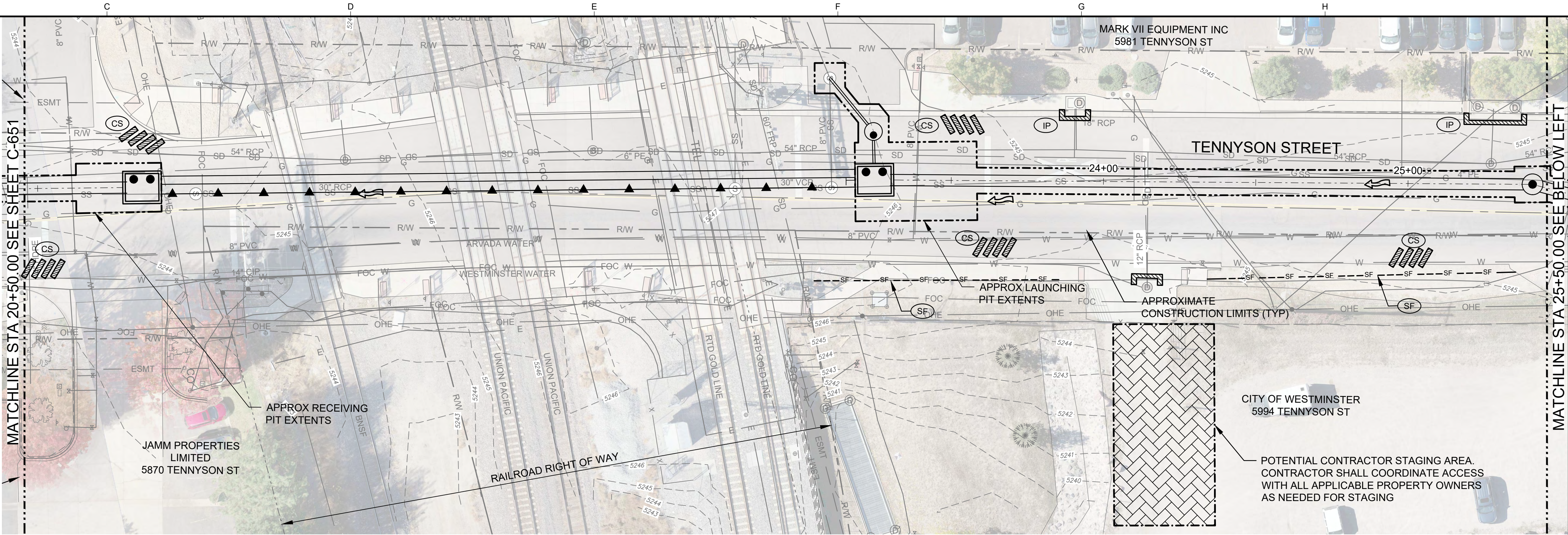
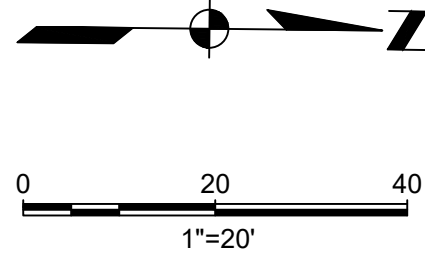
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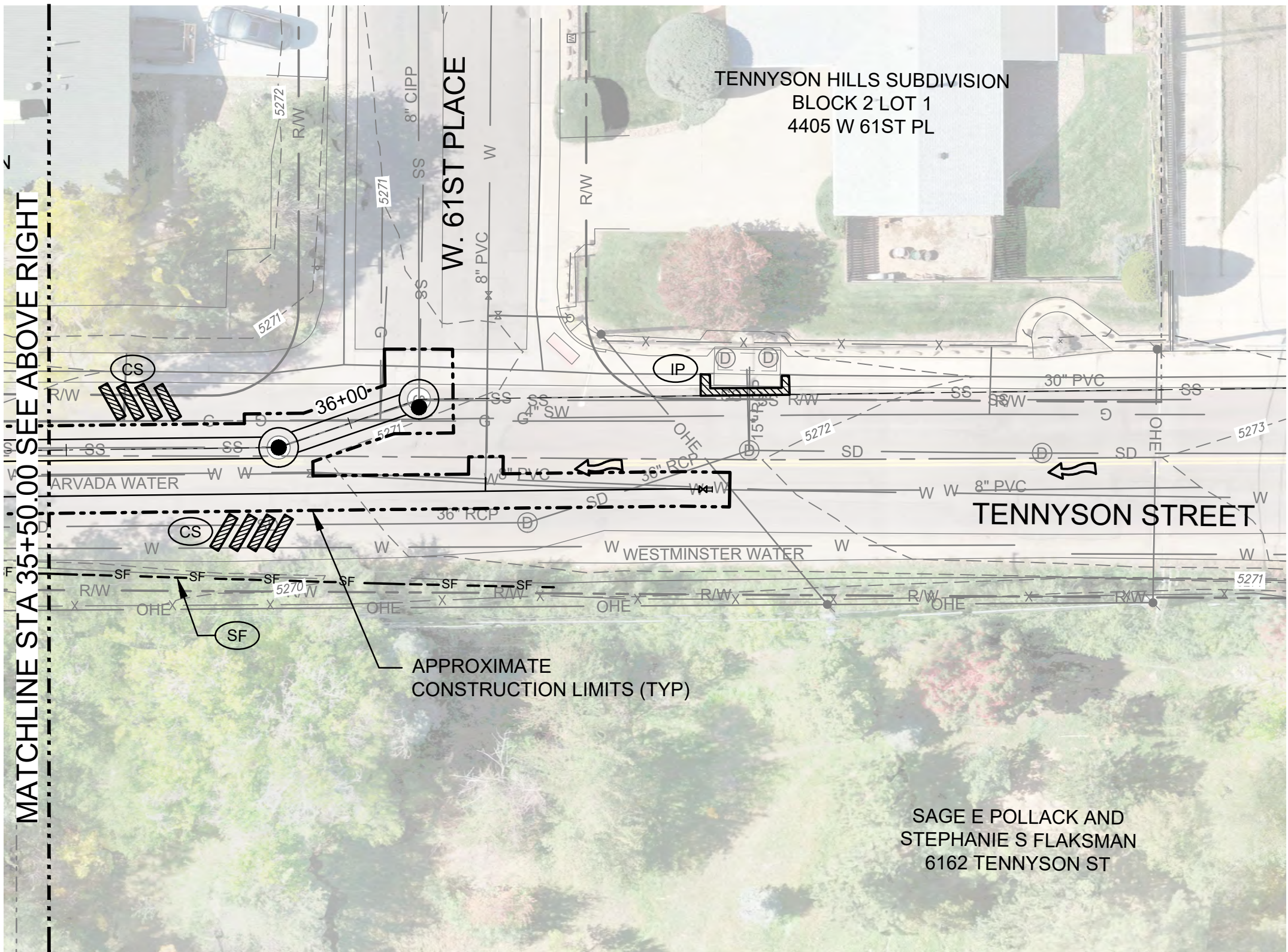
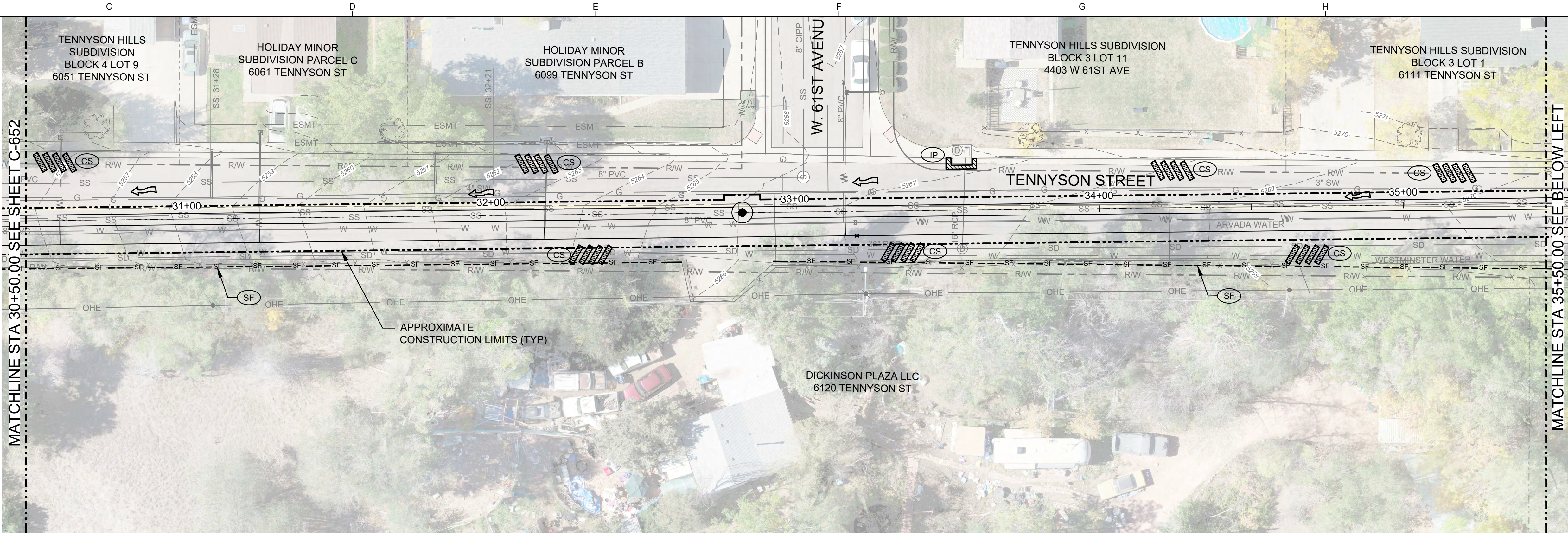
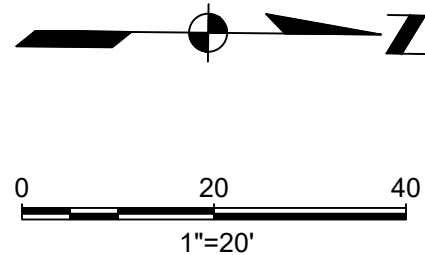
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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
 Kennedy Jenks

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GENERAL SHEET NOTES

- TOTAL AREA OF SITE DISTURBANCE IS APPROXIMATELY 1 ACRE, ALL PHASES.
- CONTRACTOR RESPONSIBLE FOR COORDINATING ALL NECESSARY SWMP AND STATE STORMWATER PERMIT CERTIFICATIONS. THIS IS TO INCLUDE PROVIDING THE POST-CONSTRUCTION WATER QUALITY EXCEPTION TO THE REQUIRED AGENCIES AS WELL AS A COPY TO THE OWNER.

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NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



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**EXHIBIT B -
WASTEWATER FLOW
MANAGEMENT PLAN SPEC**

SECTION 01 70 00

WASTEWATER FLOW MANAGEMENT PLAN

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Planning and implementation of wastewater flow diversions (Bypass Pumping).

1.2 RELATED SECTIONS

- A. Section 01 33 00 – Submittals.
- B. Section 01 73 00 – Discharge Emergency Response Plan.

1.3 SUBMITTALS

- A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. Wastewater Flow Management: Detailed implementation plan.

1.4 QUALIFICATIONS

- A. The Contractor shall retain the services of an experienced professional bypass pumping firm to plan, execute, maintain and remove bypass pumping systems needed to complete the Work. The firm or firms responsible for bypass pumping shall have at least three years of experience in bypass pumping in a sewage interceptor or collection application.

1.5 WASTEWATER FLOW MANAGEMENT PLAN (WFMP)

- A. The Contractor shall submit to the Engineer a WFMP for each location bypass pumping is required. The first plan shall be submitted thirty (30) working days prior to implementation of bypass pumping. Draft submittals shall be in electronic format to allow expedited review by Owner. All documents shall be in pdf format. Subsequent plans shall be submitted at least fifteen (15) working days in advance. The WFMP shall indicate the sequence of diversion operations, and all other operations the Contractor will establish to maintain wastewater service during the diversion/bypass period. The WFMP shall be reviewed and approved by the Engineer/Owner at least five (5) working days before flow can be diverted/bypassed. No deviation from the approved WFMP will be allowed without prior written approval from the Owner.
- B. The WFMP shall include a Discharge Emergency Response Plan indicating the procedures, personnel, equipment, and activities that will be implemented in the event of a discharge, spill or overflow to the environment, or bypass system failure. The Contractor shall be responsible for implementation of the Discharge Emergency Response Plan in accordance with Section 01 73 00.
- C. The Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing discharges, spills or overflows; containing discharges, spills or overflows; recovery and legal disposal of discharges, spills or overflows; any fines, penalties, claims and liability arising from negligent or willful discharge, spill or overflow, and violation of any law, ordinance, code, order, or regulation as a result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Owner or Engineer for such discharges, spills, or overflows, including any attorney fees and costs associated with defending any action against the Owner resulting from such discharges, spills or overflows.
- D. The Contractor shall not damage existing public and private improvements, interrupt existing services and/or facility operations which may cause a discharge, spill or overflow. Any utility and/or

improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.

- E. The Contractor will be charged for all costs associated with the Owner's Transmission Division's and other staff members' efforts if they are dispatched to the discharge, spill, overflow or diversion system failure.
- F. The Contractor is prohibited from discharging any groundwater, stormwater or hazardous waste encountered during the construction project to the sanitary sewer system without prior written approval of the Owner's Environmental Services Department.
- G. Contractor shall size the WFMP to handle the flows listed in Table 1 below.

Table 1 Average and Peak Flows per Bypass Location

Design Package	Flow Type	Bypass Location (STA)	Sheet Number	Connection	Average Flow (MGD) ⁽¹⁾	Peak Flow (MGD) ⁽¹⁾	Bypass Description
1	Gravel Pond Overflow	18+74.00	01C201 - 01C202	Storm Sewer (reservoir overflow) Relocation	0.14	0.14	From existing MH ST-10 to existing MH ST-3, settling pond, or the South Platte River
3	Wastewater	1383+90.28	03C401	Gateway Lift Station (Aurora Segment 1E) Connection	1.73	5.84	From existing Aurora SS manhole (EX MH 4)
3	Wastewater	1385+02.98	03C401	Gateway Lift Station (Aurora) Connection	0.50	1.96	From existing Aurora SS manhole (EX MH 3) to SD Interceptor
3	Wastewater	1501+74.94	03C401	Gateway Lift Station (Denver) Connection	0.46	1.83	From Existing Denver SS manhole to SD Interceptor
4	Wastewater	2031+84.66	04C128	DEN Lift Station 3 Connection	0.12	0.56	From existing DEN SS manholes to SD Interceptor
4	Wastewater	1861+57.49	04C125	Second Creek Lift	1.36	4.72	From existing Aurora SS

Design Package	Flow Type	Bypass Location (STA)	Sheet Number	Connection	Average Flow (MGD) ⁽¹⁾	Peak Flow (MGD) ⁽¹⁾	Bypass Description
				Station Connection			manholes to SD Interceptor
(1) Based on 2025 startup flows							

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 GRAVITY PIPING WITH BULKHEAD

- A. Contractor shall submit to Engineer and Owner as part of the WFMP, at minimum, the following: a plan and profile view drawing, design details for the bulkhead(s), stop logs or stop plates, and pipe sizing. The plan view shall be an aerial photo depicting the location of the piping system. Include a capacity analysis to verify pipe capacity vs. peak flow. The submittal shall also include a start date, time and duration of bypass pumping.
- B. After approval, install diversion system per plan.
- C. The Contractor shall inspect and maintain the bypass system daily. The Contractor shall submit with the WFMP all maintenance procedures and frequency. The Contractor shall maintain a log of all inspection, maintenance and repair records, and provide copies to the Engineer upon request in a manner acceptable to the Owner.
- D. Drain residual wastewater from piping system to the sanitary sewer prior to disassembly, taking care to avoid wastewater spills.

3.2 BYPASS PUMPING EQUIPMENT

- A. The Contractor shall submit to Engineer and Owner as part of the WFMP a detailed bypass design including, but not limited to, an aerial photo depicting pump/piping locations, bypass piping size(s), and a capacity analysis to verify pipe/pump capacity vs. design flows and procedures on inserting, securing and removing of plugs and “plug retrieval” devices, if used. Flows must be discharged back to the same Interceptor being worked on, unless alternate discharge Interceptors are indicated. The submittal shall also include a start date, time and duration of diversion. The submittal shall be in a form similar to the attached sample at the end of this section.
- B. The Contractor shall only use equipment (including plugs) inspected and found to be in good repair and fully functional and shall not leak during operation. Contractor shall use ¼” minimum steel cable for all plugs. Plugs shall be tied off to pumps or barriers. Plugs shall not be tied off to manholes or manhole steps.
- C. The Contractor shall provide a pumping system consisting of pumps, pipe and generators. Extra pumps and generators, if applicable, with a total capacity equal to 50% of the design flows must also be provided. A minimum of three pumps and generators, if applicable, shall be on site with no single pump and generator, if applicable, having less than 50% capacity of the design flows. The Contractor shall utilize the flow bypass system to perform the necessary maintenance and repairs on the flow bypass system, and exercise and ensure the operation of the backup pumps. The Contractor shall operate the backup pumps for a minimum of 25% of the total bypass time on a daily basis. All pumps shall be fully installed, operational, and ready for immediate use. Each pump shall include an isolation valve allowing

removal and replacement if necessary during pumping operations. If other agency flows must be managed, the Contractor will be responsible for determining design flows.

- D. The Contractor shall use pressure-rated piping materials in good working condition. Where five or more pipes will be used, provide one redundant, additional pipe of greater or equal size.
- E. The bypass system shall be hydrostatically pressure tested in the presence of the Owner using potable water prior to wastewater flow diversion. Test pressure shall be 50% greater than maximum operating pressures, or 10 psi above maximum operating pressures, whichever is greater. Pressure test shall be for minimum of one half hour. If any portion of the bypass piping is in a location that does not allow visual inspection for leaks, an air test shall be required prior to the hydrostatic test. The air test shall be performed in accordance with Uni-Bell Pipe Association UNI-B-6-98 and must pass. The Contractor shall demonstrate to the satisfaction of the Owner that both the primary and backup flow diversion systems are fully functional and adequate, and shall certify the same, in writing, to the Engineer in a manner acceptable to the Owner. Demonstration shall include test-pumping a minimum of one hour at the daily peak flow period, in the presence of the Owner.
- F. The Contractor shall submit as part of the WFMP the monitoring procedure and frequencies. The Contractor shall dedicate a minimum of one person at each pumping location whose sole function/responsibility is to continuously monitor the operation of the pumps and the water level in the suction structure or manhole to detect any possible failure that may cause a wastewater discharge, spill or overflow to the environment, or diversion system failure. A minimum of one additional person shall also be dedicated whose sole function/responsibility is to continuously monitor and inspect the bypass piping and any other monitoring manholes identified in the WFMP. The Contractor shall maintain a daily log of the monitoring and provide monthly copies to the Engineer in a manner acceptable to the Owner.
- G. After approval of the WFMP, install diversion systems per plan.
- H. The Contractor shall provide one dedicated fuel tank for every single pump/generator, if fuel/generator driven pumps are used. The Contractor shall provide a fuel level indicator outside each fuel tank. The Contractor shall continuously (while in use) monitor the fuel level in the tanks and ensure that the fuel level does not drop below a level equivalent of two hours of continuous flow diversion system operation. The Contractor shall take the necessary measures to ensure the fuel supply is protected against contamination. This could include but is not limited to fuel line water traps, fuel line filters, and protecting fuel stores from precipitation. The Contractor shall also monitor all hoses and repair leaks immediately.
- I. The Contractor shall inspect and maintain the bypass system daily, including the back-up system. The Contractor shall submit with their WFMP their maintenance procedures and frequency. The Contractor shall maintain a log of all inspection, maintenance and repair records, and provide copies to the Engineer upon request in a manner acceptable to the Owner.
- J. In addition to the requirements above, the flow bypass shall have the following general minimum requirements:
 - 1. Provide and install temporary pumps as needed. Also provide an additional spare unit.
 - 2. Provide and install pump controller panel.
 - 3. Provide and install floats for pump start/stop levels.
 - 4. Provide spare hoses at site.
 - 5. Provide an emergency generator at the site.
- K. Drain residual wastewater from piping system to an approved sanitary sewer prior to disassembly, taking care to avoid wastewater spills.

3.3 FLOW-THRU PLUGS

- A. Contractor shall submit to Engineer and Owner as part of the WFMP a detailed design including, but not limited to, the flow-thru pipe size(s), configuration and location, a capacity analysis to verify plug capacity vs. design flow and procedures on inserting, securing and removing of the plug and “plug retrieval” devices if used. The submittal shall also include a contingency plan, start date, time and

duration of flow-thru operations. The flow-thru plug shall be tethered or adequately braced during all diversion activities.

- B. If applicable, the Contractor shall size the flow-thru plug to handle the flows provided in Table 1 of Section 1.5 of this Specification.
- C. The Contractor shall submit as part of the WFMP the monitoring procedure and frequency, and shall continuously monitor the flow levels upstream of the flow diversion to detect any developing condition that may cause a wastewater discharge. The Contractor shall maintain a daily log of the monitoring and provide weekly copies to the Engineer in a manner acceptable to the Owner.
- D. After approval of the WFMP install system per plan.
- E. The Contractor shall install and operate the plug for a minimum of one hour at the daily peak flow period to demonstrate adequacy prior to use for actual diversion.
- F. The Contractor shall inspect and maintain the flow-thru plug daily. The Contractor shall submit with their WFMP their maintenance procedures. The Contractor shall maintain a log of all inspection, maintenance and repair records, and provide copies to the Engineer upon request in a manner acceptable to the Owner. Contractor shall use 1/4" minimum steel cable for all plugs. Plugs shall be tied off to pumps or barriers. Plugs shall not be tied off to manholes or manhole steps.

3.4 DISCHARGE/DIVERSION SYSTEM FAILURE

- A. In the event of a discharge, spill or overflow, or diversion/bypass system failure, immediately implement the Discharge Emergency Response Plan (See Section 01 73 00).

END OF SECTION

(SAMPLE – WASTEWATER FLOW MANAGEMENT PLAN)

PAR XXXX
XXXX XXXXXX REHABILITATION PROJECT
WASTEWATER FLOW MANAGEMENT PLAN

Contractor XXX will be rehabilitating pipe segment RC4 to RC5. In order to perform this work, a complete bypass of the flow will be necessary. The following is a detailed procedure for the bypass work.

Flow will be bypassed from MH RC 6 to MH RC 3. A base pumping system consisting of two 12-inch centrifugal pumps and discharge pipe and capable of providing a total capacity of 10 mgd will be installed. (See attached design calculations, pump literature, and sketch). One additional 12-inch centrifugal pump will be on site and fully connected to the system to provide 50% pump redundancy. All three pumps will connect to one common manifold. The discharge piping downstream of the manifold will be 18-inch diameter. The length of discharge pipe is approximately 1,500 feet. All suction and discharge piping will be HDPE with heat-welded joints.

In order to pump out of MH RC 6, the frame, cover and cone will need to be removed. A plug retrieval device (see attached sketch) will be installed at MH RC 2. A deflated plug will then be inserted into the downstream pipe of MH RC 6 prior to placement of the suction piping. The plug will be tethered with two cables to ensure it does not dislodge in the event of a sudden loss of pressure. Each cable will be rated at 2000 lbs tensile strength. One cable will be the primary “holdback” and will be anchored to the televising truck. Tension will remain tight on this cable at all times. The second cable will be anchored to a traffic bollard, and will be utilized in removing the plug. When the bypass is ready for operation the pumps will be turned on and then the plug will be inflated. Prior to live pumping, the system will be hydrostatically pressure tested at 30 psi.

During pumping operations, the pumping system will be continuously manned. This will include regular inspection of the pumps and walking the discharge line. Pump output will be monitored to ensure that water level in MH RC 6 does not exceed 3 feet above top of pipe. If one pump should fail, a call will be placed to the pump supplier and arrangements made for an immediate service call or pump replacement. In the event of a wastewater spill or diversion system failure, the Discharge Emergency Response Plan will be implemented.

When bypass operations are complete, the backup cable will be attached to a backhoe. Pressure will be released from the plug until fully deflated, and water pressure on the plug is minimized. The pumps will then be shut down. Suction piping will be removed as required. The plug will then be removed using the backhoe, and the plug retrieval device removed from MH RC 2.

Bypass pumping is anticipated to begin Nov 3, 2005 and continue around the clock for one week.

Plan Prepared by: _____ Date: _____
Contractor XXX

Plan Reviewed and Approved by: _____ Date: _____
Metro District DPM

Plan Reviewed and Approved by: _____ Date: _____
Metro District OIRC

(SAMPLE - WASTEWATER FLOW MANAGEMENT PLAN)

HDPE FRICTION LOSS

INPUTS		OUTPUTS	
FLUID FLOW RATE (GPM)	4900	AVERAGE PIPE ID (IN.)	15.755
LENGTH OF PIPELINE (FT)	1800	FRICTION LOSS (FT)	17.746281
SDR RATING OF PIPE (I.E. 17.0)	17	FRICTION LOSS (PSI)	7.68
NOMINAL PIPE SIZE (IN)	18	WATER VELOCITY (FT/SEC)	8.07
		PIPE PRESSURE RATING (PSI)	100

****NOTE: IF N/A APPEARS IN The AVERAGE PIPE ID BOX, THEN THAT COMBINATION OF SDR RATING AND NOMINAL PIPE SIZE IS UNAVAILABLE.**

The following are the Lift and TDH calculations:

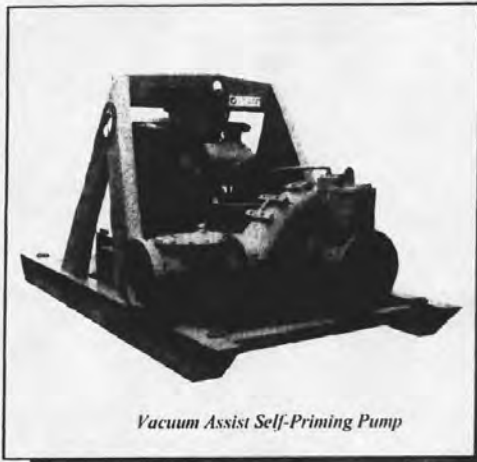
System 1:

<u>Total Suction Lift</u>	<u>Total Dynamic Head (TDH)</u>
12.5 Ft. lift, water =>ground level	29.3 Ft. Pipe Hf loss for 18"-1800' HDPE SDR 32.5
0.27 Ft. Pipe Hf for 20" HDPE SDR 17 pipe	2.74 Ft. Elbow Loss
1.29 Ft. Entrance Loss	0.19 Ft. Gate Elbow
0.47 Ft. Elbow Loss	2.83 Ft. Manifold Loss
1.61 Ft. 45 Deg. Elbow Loss	2.26 Ft. Check Valve
0.24 Ft. Reducer Loss	15.0 Ft. Elevation Change & Misc. Losses
2.00 Ft. Trailer Height	19.1 Ft. Suction Lift
<u>0.69 Ft.</u> Vapor Loss	
19.07 Ft.	<u>71.4 Ft.</u> Required Pump P

Altitude (Ft.): 5130
Atmosphere Adjuster (Ft.): 6.16 Ft.

Atmosphere = 27.344 – 19.07 Ft. == 8.28 NPSH
At 5000 GPM NPSHR = 5.50 Ft. < 8.28 Ft. NPSH **O.K.**

(SAMPLE - WASTEWATER FLOW MANAGEMENT PLAN)



Vacuum Assist Self-Priming Pump

SIZE 18" x 16"

- 16,000 GPM MAX
- 200 FT. HEAD MAX

FEATURES

- Solids handling capacities to 4-1/2" diameter
- Continuous self-priming
- Runs dry unattended
- Suction lift to 28 ft.
- Skid mounted
- Auto-start capable control panel
- Fast priming with no "Blow-By"

TECHNICAL

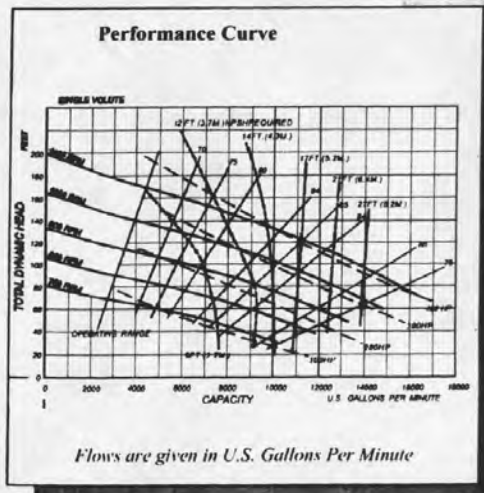
- Pedestal mounted pump end
- John Deere 6125H diesel-fueled engine, 12 volt, electric start
- Skid-mounted pump and engine with lifting bracket
- 100-gallon capacity fuel tank
- 60 CFM vacuum pump priming

MATERIAL SPECIFICATIONS

- **Standard Build**
 - Cast Iron open impeller
 - Replaceable wear rings
- **Pump Shaft**
 - 17-4PH Stainless Steel
- **Mechanical Seal**
 - Tungsten carbide vs. silicon carbide mating faces
 - Oil-bath lubrication for dry running
- **Flanges**
 - 18" suction; 16" discharge
 - ANSI 150# FF

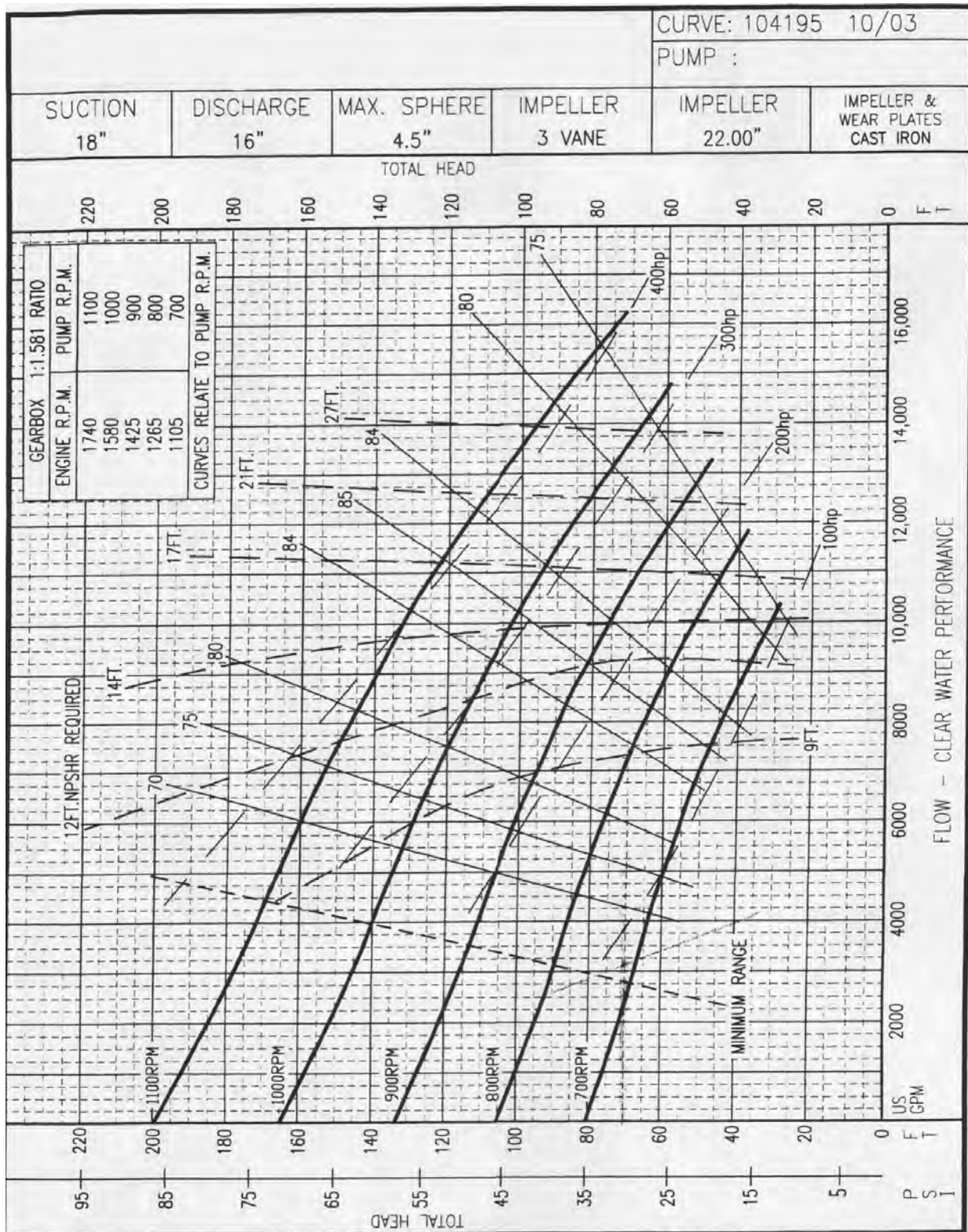
PUMP TO ENGINE RPM

<u>Pump RPM</u>	<u>Engine RPM</u>
1,100.....	1,740
1,000.....	1,580
900.....	1,425
800.....	1,265
700.....	1,105

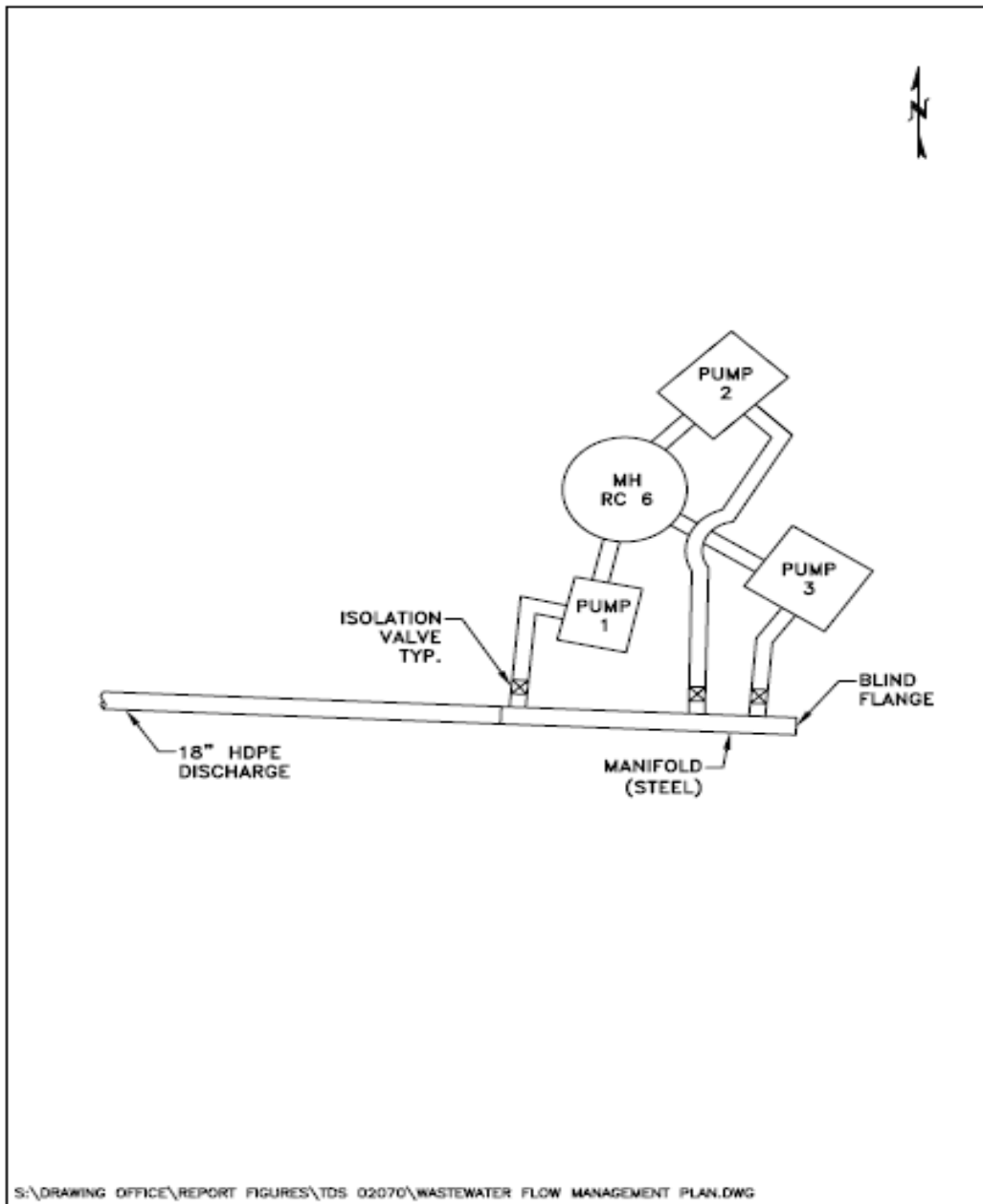


Fuel consumption:
13.9 GPH @ 1,700 RPM-John Deere 6125H

(SAMPLE - WASTEWATER FLOW MANAGEMENT PLAN)



(SAMPLE - WASTEWATER FLOW MANAGEMENT PLAN)



**EXHIBIT C -
QUITCLAIM DEED
FORM**

QUIT CLAIM DEED

THIS DEED, made this _____ day of _____, 202__, between _____ (“**Grantor**”), whose legal address is _____, and _____ (“**Grantee**”), whose legal address is _____;

WITNESSETH, that the Grantor, for and in consideration of the sum of TEN DOLLARS (\$10.00) and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, does hereby remise, release, sell, and **QUIT CLAIM**, unto the Grantee, and the Grantee’s heirs, successors and assigns, forever, all the right, title, interest, claim, and demand which the Grantor has in and to the real property, together with any improvements thereon, if any, lying and being in the County of Jefferson, State of Colorado, described as follows:

SEE EXHIBIT “A” attached hereto and incorporated herein by this reference.

TO HAVE AND TO HOLD the same, together with all and singular the appurtenances and privileges thereunto belonging or in anywise thereunto appertaining, and all the estate, right, title, interest and claim whatsoever, of the Grantor, either in law or equity, to the only proper use, benefit and behoof of the Grantee, its successors and assigns forever.

IN WITNESSETH WHEREOF, the Grantor executed this deed on the date set forth above.

GRANTOR:

(Name)
(Title)

STATE OF COLORADO)
) ss.
COUNTY OF JEFFERSON)

The foregoing instrument was acknowledged before me this _____ day of _____, 2024, by _____, as _____ (Title) of (Organization name)_____.

Witness my hand and official seal.

(SEAL)

My commission expires: _____.

Notary Public



REPORT TO CITY COUNCIL ORDINANCE FIRST READING

AGENDA ITEM
8.C.1.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: CB24-020, An Ordinance Authorizing an Additional Appropriation for Fiscal Year 2024 (Public Hearing to be set for December 16, 2024 at 6:15 p.m.)

Report in Brief

The attached ordinance is the final process to ensure that all Funds will end the year within their legally approved limits. The original budget of \$387,466,097 was approved by the City Council in October 2023.

The carryover ordinance approved by city Council in April 2024 increased the total appropriation by \$97,070,044, bringing the current budget to \$484,536,141. This ordinance requests that City Council approve a final clean-up ordinance that will add an additional \$26,597,998 to the budget, bringing the total appropriation to \$511,134,139.

The Arvada team recommends that the City Council approve CB24-020, An Ordinance Authorizing an Additional Appropriation for Fiscal Year 2024 on first reading, ordered published in full and a public hearing set for December 16, 2024 at 6:15 P.M.

Financial Impact

The overall increase in the 2024 appropriation is \$26,597,998 and will bring the total appropriation to \$511,134,139. Increased revenues or sufficient reserves exist to cover each of the budgeted items. The final modification to the budget will ensure each fund does not exceed its legally adopted appropriation

Background

The budget is an ongoing process throughout the year. It begins eight months prior to the beginning of the fiscal year. Throughout any given budget year, many things can change. Most of these changes can be accommodated within the appropriation that the City Council adopts. Other changes, such as grants and extraordinary expenditures, require City Council approval.

At the beginning of the year, there may be items that were not contemplated in the prior year and must be re-appropriated. This is referred to as the "Carry-Forward" ordinance. This usually comes to the City Council in the first quarter of the year and increases the total appropriation. Throughout the year, the City Council also adopts resolutions approving the acceptance of grants and other types of arrangements. Resolutions inform the City Council of changes. However, the budget may only be legally increased through the adoption of an ordinance. The final way to modify the budget is to adopt a final ordinance near the end of the year. This ordinance is often referred to as the "Clean-up" ordinance.

Discussion

This ordinance will increase the appropriation in 11 funds.

The attached table provides a summary of the history of the adjustments made to each fund in 2024. The following information summarizes the adjustments by Fund:

General Fund \$10,477,985

An increase of \$6,300,000 is needed for the purchase of the Early college of Arvada.

An increase of \$55,000 is needed for grants received by Public Safety for the purchase of equipment.

An increase of \$4,000,000 is needed for a loan to AURA for the Ralston Fields project area.

An increase of \$86,000 is needed for a Jeffco election invoice not carried forward from 2023.

An increase of \$36,985 is needed for increase in 2023 audit costs due to new Governmental accounting standards implemented.

Community Development Fund \$1,914,000

An increase of \$1,914,000 is needed for a Division of Housing ARPA grant received and not carried forward from 2023.

Housing Authority Fund \$2,905,000

An increase of \$360,000 is needed for the Mainstream Housing program for rental assistance. This request is funded by grant funds from the Housing and Urban Development Grant.

An increase of \$2,545,000 is needed for the Section 8 Housing program for rental assistance. This request is funded by grant funds from the Housing and Urban Development Grant.

Police Seizure Fund \$50,500

An increase of \$50,500 is needed for the purchase of a new K-9 Vehicle and additional equipment for tow other police vehicles.

Police Tax Increment .21 Fund \$240,942

An increase of \$226,164 is needed for grant funding received for employee wellness, automated license plate readers, personnel expenses, safety equipment and DUI enforcement.

An increase of \$14,778 is needed for Tshirts and crash reports, these items are funded by reimbursements from other agencies.

Capital Improvement Fund \$2,064,667

An increase of \$388,000 for electric vehicle charging infrastructure, this item is funded by grants received.

An increase of \$2,220 is needed for a traffic overage for the Ralston Raod concept, this is funded by a transfer from the General Fund.

An increase of \$1,674,447 is needed for a transfer to the aquatic center project, this is funded from interest received in the Capital Project Fund.

Construction Fund \$5,094,032

An increase of \$5,094,03 is needed for construction of the aquatic center. \$1,674,447 is funded from interest received in the Capital Improvement Fund during 2023, \$2,191,886 is funded from unallocated 98-101 funds in the Capital Improvement Fund and \$1,227,699 is funded from interest received from the proceeds of the 2021 COP issued for the aquatic center.

Golf Fund \$795,000

An increase of \$95,000 is needed for concrete repairs at the West Woods Golf Course. This is funded by a transfer from the Capital Improvement Fund.

An increase of \$700,000 is needed for increased expenses in the Golf Fund due to increased sales in both Golf and restaurant operations. This increase will be funded by increased revenue in the Golf Fund.

Insurance Fund \$501,000

An increase of \$322,000 is needed for property claims such as a Wadsworth overpass claim from a previous year, utility boring damage done to a property and for a tree that fell on a residents' roof. These increases will be funded by the fund balance in the

Insurance Fund.

An increase of \$179,000 is needed for vehicle damage to a dump truck and police vehicles. This increase will be funded by the fund balance in the Insurance Fund.

Computer Fund \$1,307,872

An increase of \$1,307,872 is needed for the computer replacement project, this will be funded by the computer fund balance.

Vehicle Fund \$958,000

An increase of \$80,000 is needed for the purchase of two Ford F-150 trucks. This is funded by a transfer from the Stormwater Fund.

An increase of \$450,000 is needed for the purchase of a Jet Vac truck. This is funded by a transfer from the Wastewater Fund.

An increase of \$40,000 is needed for the purchase of a Ford F-150 truck. This is funded by a transfer from the Wastewater Fund.

An increase of \$300,000 is needed for increased costs for maintenance parts. This is funded by the Vehicle Fund balance.

An increase of \$88,000 is needed for the purchase of a skid steer. This is funded by a transfer from the Water Fund.

Building Fund \$289,000

An increase of \$289,000 is needed for maintenance work at the Post Office. This is funded by the post office lease payments.

Public Contact

Posting of the City Council agenda.

Commission Recommendation

N/A

Strategic Alignment

The Ordinance supports the following principle within the Organizational and Service Effectiveness Priority area within the City Council Strategic Plan.

"Provides a well-managed, fiscally responsible government that operates effectively and efficiently while identifying revenue requirements to sustain current service levels and achieve future requested levels of service"

Alternative Courses of Action

N/A

Recommendation for Action

The Arvada team recommends that the City Council approve CB24-020, An Ordinance Authorizing an Additional Appropriation for Fiscal Year 2024 on first reading, ordered published in full and a public hearing scheduled for December 16, 2024 at 6:15 P.M.

Suggested Motion:

I move that CB24-020, An Ordinance Authorizing an Additional Appropriation for Fiscal Year 2024, be (approved on first reading, ordered published in full, and a public hearing set for December 16, 2024, at 6:15 p.m.) (rejected).

Prepared by:
Debra Nielson, Deputy Director of Finance

Reviewed by:

Approved by:

Jenna Belec, Executive Assistant	11/11/2024
Bryan Archer, Director of Finance	11/11/2024
Gail Walker, Legal Specialist-Contracts	11/11/2024
Laura Hemler, Assistant City Attorney	11/12/2024
Rachel Morris, City Attorney	11/19/2024
Linda Haley, Acting City Manager	11/19/2024

Enclosure, exhibits & attachments required to support the report

COUNCIL BILL NO. 24-020
ORDINANCE NO. _____

AN ORDINANCE AUTHORIZING AN ADDITIONAL APPROPRIATION
FOR FISCAL YEAR 2024

WHEREAS, the City Council of the City of Arvada adopted Ordinance No. 4860 (Council Bill No. 23-027), which authorized the annual appropriation for Fiscal Year 2024; and

WHEREAS, Section 10.8(a) of the Arvada Home Rule Charter provides that City Council may make additional appropriations by Ordinance during the fiscal year for unanticipated expenditures required of the City; and

WHEREAS, the City Council of the City of Arvada finds that an additional appropriation is necessary in order for the City to meet unanticipated expenditures; and

WHEREAS, the City Council of the City of Arvada further finds that such additional expenditures and budgeted expenses do not exceed budgeted revenues and reserves for Fiscal Year 2024.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF ARVADA, COLORADO:

Section 1. The following sums of money as may be needed or deemed necessary to defray the expenses and liabilities of the City of Arvada are hereby appropriated for Fiscal Year 2024.

City of Arvada Final Appropriation

Fund	Final Budget
General Fund	\$153,163,021
Conservation Trust Fund	\$190,016
Street Maintenance Fund	\$15,311,629
Community Development Fund	\$3,140,248
Housing Authority Fund	\$8,926,464
Emergency Fund	\$142,020
Parks Fund	\$17,236,113
Police Seizure	\$81,722
Police Tax Increment Fund .21	\$8,450,483
Police Tax Increment Fund .25	\$11,353,974
Debt Service	\$5,804,282
COP Debt Service Fund	\$3,277,484

Capital Improvement Projects Fund	\$14,560,115
Construction Fund	\$7,989,003
Water Fund	\$141,548,193
Wastewater Fund	\$73,995,416
Golf Course Fund	\$8,823,653
Stormwater Fund	\$8,321,794
Solid Waste Fund	\$4,737,907
Insurance Fund	\$4,120,203
Computer Replacement Fund	\$10,127,013
Print Shop	\$365,994
Vehicle Fund	\$8,702,330
Building Fund	\$765,062
Total Appropriation	\$511,134,139

Section 2. This Ordinance shall take effect five days after publication following final passage.

INTRODUCED, READ, AND ORDERED PUBLISHED this 2nd day of December, 2024.

PASSED, ADOPTED, AND APPROVED this _____ day of _____, 2024.

Lauren Simpson, Mayor

ATTEST:

City Clerk

APPROVED AS TO FORM:
Rachel A. Morris, City Attorney

By: _____

Publication Dates: December 5, 2024

City of Arvada 2024 Final Appropriation

Fund	Original Budget	Carryover Ordinance	Clean-Up Ordinance
General Fund	\$ 124,576,764	\$ 18,108,272	\$ 10,477,985
Conservation Trust Fund	\$ 190,016	\$ -	\$ -
Streets Maintenance Fund	\$ 12,824,973	\$ 2,486,656	\$ -
Community Development Fund	\$ 1,226,248	\$ -	\$ 1,914,000
Housing Authority Fund	\$ 6,021,464	\$ -	\$ 2,905,000
Emergency Fund	\$ -	\$ 142,020	\$ -
Parks Fund	\$ 14,337,478	\$ 2,898,635	\$ -
Police Seizure	\$ 31,222	\$ -	\$ 50,500
COP Series Debt Service Fund	\$ 3,277,484	\$ -	\$ -
Police Tax Increment Fund .21	\$ 7,591,419	\$ 618,122	\$ 240,942
Police Tax Increment Fund .25	\$ 8,269,420	\$ 3,084,554	\$ -
Debt Service Fund	\$ 5,804,282	\$ -	\$ -
Capital Improvement Projects Fund	\$ 8,249,512	\$ 4,245,936	\$ 2,064,667
Construction Fund	\$ -	\$ 2,894,971	\$ 5,094,032
Water Fund	\$ 101,037,278	\$ 40,510,915	\$ -
Wastewater Fund	\$ 55,971,929	\$ 18,023,487	\$ -
Golf Course Fund	\$ 8,010,198	\$ 18,455	\$ 795,000
Stormwater Fund	\$ 6,761,290	\$ 1,560,504	\$ -
Solid Waste Fund	\$ 4,737,907	\$ -	\$ -
Insurance Fund	\$ 3,548,316	\$ 70,887	\$ 501,000
Computer Replacement Fund	\$ 7,028,141	\$ 1,791,000	\$ 1,307,872
Print Shop	\$ 365,994	\$ -	\$ -
Vehicle Fund	\$ 7,128,700	\$ 615,630	\$ 958,000
Building Fund	\$ 476,062	\$ -	\$ 289,000
Total	\$ 387,466,097	\$ 97,070,044	\$ 26,597,998

Final Budget
\$ 153,163,021
\$ 190,016
\$ 15,311,629
\$ 3,140,248
\$ 8,926,464
\$ 142,020
\$ 17,236,113
\$ 81,722
\$ 3,277,484
\$ 8,450,483
\$ 11,353,974
\$ 5,804,282
\$ 14,560,115
\$ 7,989,003
\$ 141,548,193
\$ 73,995,416
\$ 8,823,653
\$ 8,321,794
\$ 4,737,907
\$ 4,120,203
\$ 10,127,013
\$ 365,994
\$ 8,702,330
\$ 765,062
\$ 511,134,139



REPORT FROM CITY COUNCIL

AGENDA ITEM
12.A.

DATE: December 2, 2024

SUBJECT: Council Committee Reports

Report in Brief

City Council members are appointed to various committees and boards as set out on the attached listing. As meetings are held, individual council members will report back to the full City Council any relevant discussions and issues that occurred.

Prepared by:
Chris Koch, CCO Admin

Lauren Simpson	Arvada City Attorney Committee Arvada Municipal Court/Judicial Committee Arvada Urban Renewal Authority Arvada Visitors Center Committee *Metro Mayors' Caucus Urban Drainage and Flood Control District West Connect Coalition E-470 Authority (Alternate) Olde Town Business Improvement (BID) (Alternate)
Shawna Ambrose	Adams County Regional Economic Partnership (ACREP) Arvada Audit Committee Bond Oversight Committee Jefferson County R-1 Schools Coordinating Committee Arvada Visitors Center Committee (Alternate)
Sharon Davis	Apex Coordinating Committee Arvada Municipal Court/Judicial Committee Arvada Parks Advisory Committee CML Policy Committee Jefferson Economic Development Council (JDEC) Denver Regional Council of Governments (DRCOG) (Alternate) E-470 Authority (Alternate) Jeffco Transportation Action & Advisory Group (JEFFTAAG) (Alternate)

	Jefferson County Community Corrections Board West Connect Coalition (Alternate)
Lisa Feret	Arvada Chamber of Commerce Government Affairs Committee Arvada Fire Protection District Coordinating Committee Denver Regional Council of Governments (DRCOG) Housing Advisory Committee Jeffco Transportation Action & Advisory Group (JEFFTAAG) Jefferson County Community Corrections Board Smart City Advisory Committee Adams County Regional Economic Partnership (ACREP) (Alternate)
Bob Fifer	Apex Coordinating Committee Arvada City Attorney Committee Arvada Fire Protection District Coordinating Committee Arvada Transportation Committee Jefferson County R-1 Schools Coordinating Committee Jefferson Parkway Public Highway Authority Smart City Advisory Committee Northwest Parkway Authority (Alternate)
John Marriott	Arvada Economic Development Association Board Bond Oversight Committee Olde Town Business Improvement (BID)
Randy Moorman	Arvada Audit Committee Arvada Center for the Arts and Humanities Arvada Sustainability Committee CML Policy Committee Jefferson Parkway Public Highway Authority Northwest Parkway Authority (Alternate)

*asterisked committees are not appointed by Council



REPORT TO CITY COUNCIL

AGENDA ITEM
13.A.

TO: THE HONORABLE CITY COUNCIL

DATE: December 2, 2024

SUBJECT: Review of Future Workshops and Presentations

Report in Brief

The City Manager's Office maintains a list of upcoming workshops and presentations to be scheduled for City Council meetings. During City Manager Reports, at the end of City Council business meetings, Interim City Manager, Linda Haley, will review with City Council the tentative schedule and make any adjustments necessary.

Prepared by:
Chris Koch, CCO Admin

Reviewed by:

Approved by:

Rachel Morris, City Attorney 11/19/2024

Linda Haley, Acting City Manager 11/19/2024

Enclosure, exhibits & attachments required to support the report

2024/2025 CITY COUNCIL WORKSHOPS, STUDY SESSIONS, PRESENTATIONS AND RETREATS (TENTATIVE)

WORKSHOPS	Date	Lead
Infrastructure Work System Annual Report - The Infrastructure Work System will share a status summary of progress towards City Council Strategic Results and 2024 metrics for work system services.	Dec 9	PW
Climate Action and Sustainability Plan Update. The City team and consultants will be providing an update on the draft Climate Action and Sustainability Plan. We will be seeking input from the Council on direction and priorities to include in the final plan we intend to bring forward for adoption in January.	Dec 9	Utilities
2025 Workshops		
Updated ADA Transition Plan The draft plan will be updated in a comprehensive document that outlines strategies and actions to ensure accessibility for individuals with disabilities, addressing areas of improvement and accommodating their needs.	Jan 13	PW
Short Term Rentals discussion	Mar 24	CED, PD
Municipal Court Update	Apr 14	
Building Code Update	April 14	CED
	April 28	
	May 12	
Legislative Update (Tentative)	June 9	CED
	Jul 14	
	Jul 28	
	Aug 11	
	Aug 25	
Certified Local Government (CLG) Discussion and Consideration (Tentative)	Sept 22	CED
	Oct 13	
	Oct 27	
	Dec 8	
PRESENTATIONS		
STUDY SESSIONS		
Homelessness Strategy	Dec 7 8-Noon	CMO
BID and Chamber funding	TBD	
City Expenditures	TBD (Nov or Dec)	Finance
WORKSHOP TBD's		
Stormwater 101	TBD	Utilities
Stormwater Master Plan	TBD	Utilities
New Water Tank @ Gross Reservoir (4th quarter)	TBD	CMO
Right of Way Acquisition	TBD	PW
Water Infrastructure for Fire Protection	TBD	Utilities
Smart Meters Update	TBD	Utilities
Capital Campaign Update and Strategy Discussion	TBD	CMO/Fin

Community Engagement	TBD	CMO
Fleet Electrification	TBD	Utilities
Pre-Sentencing/One Small Step	TBD	Courts
Financial Scenarios for Street Maintenance Deficit/Options for Increasing Maintenance Funds Engage City Council in a discussion around the current street maintenance needs and how the City might fund them. This will include revenue enhancements, future allocations and expenditure realignments.	TBD	PW/Fin/CMO
Fiber Master Plan The Fiber Master Plan which is also called Arvada Fiber Optic Network (AFON), was first presented to City Council 4/10/2017. City Councils had set a strategic goal to build a fiber network to enable high speed/real-time connectivity to city facilities and assets in order to enhance city operations. This workshop is intended to brief City Council as to the progress of the AFON build out. Updates are intended to cover conduit installation progress, fiber installation progress, current co-locate opportunities, IGA member updates, and connections to current assets (city buildings, traffic, signals, utilities, radio, etc.).	TBD	PW
Problem Properties	TBD	P.D.
Activation of Historical Assets	TBD	VCN
Customer Service Philosophy	TBD	CMO
Ask Arvada Update	TBD	CMO
COUNCIL JOINT MEETINGS/DINNERS:		
Denver Water Board Apex Board AURA Board Arvada Center Board—Per Coop Agreement - Annually after October 1 of each year Jefferson Parkway Meeting with Jeffco and Broomfield Council Annual Retreat	February	