

FORT PECK FISH HATCHERY WATER SUPPLY

TECHNICAL SPECIFICATIONS

THIS PAGE LEFT BLANK INTENTIONALLY

FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 02 EXISTING CONDITIONS

TABLE OF CONTENTS

DIVISION 02 – EXISTING CONDITIONS

SECTION	DOCUMENT
02 32 00	Geotechnical Investigation

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

02.1.01 DESCRIPTION

- A. The following report is provided to bidders for informational purposes only.
- B. The recommendations of this report shall be followed during the course of the work.
- C. Where the Drawings or Specifications require more stringent controls or quality of the work or higher compaction, the provisions of the Drawings or Specifications shall govern.
- D. The geotechnical report that is presented here has been prepared for the Owner. Neither the Owner nor the Engineer imply or warrant the correctness, completeness or applicability of this report and investigation as prepared by others.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

THIS PAGE LEFT BLANK INTENTIONALLY



AMERICAN
ENGINEERING
TESTING, INC.

CONSULTANTS
• ENVIRONMENTAL
• GEOTECHNICAL
• MATERIALS
• FORENSICS

REPORT OF GEOTECHNICAL EXPLORATION Fort Peck Fish Hatchery Transmission Main Fort Peck, Montana

AET No. 37-20591

Date:

February 24, 2021

Prepared for:



Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

www.amengtest.com



February 24, 2021

Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Attn: Mr. John Bach, P.E.

RE: Report of Geotechnical Exploration
Fort Peck Fish Hatchery Transmission Main
Fort Peck, Montana
AET No. 37-20591

Greetings Mr. Bach:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for your Fort Peck Fish Hatchery Transmission Main project in Fort Peck, Montana. These services were performed according to our proposal to you dated January 18, 2021.

We are submitting one electronic copy of the report to you. Additional copies can be sent out at your request.

Please contact me if you have any questions about the report. I can also be contacted for arranging construction observation and testing services during construction.

Sincerely,
American Engineering Testing, Inc.



Harvey T. Fitzgerald, P.E.
Geotechnical Engineer
Phone: (701) 572-3324
hfitzgerald@amengtest.com

Report of Geotechnical Exploration

Fort Peck Fish Hatchery Transmission Main; Fort Peck, Montana

February 24, 2021

Report No. 37-20591

AMERICAN
ENGINEERING
TESTING, INC.

SIGNATURE PAGE

Prepared for:

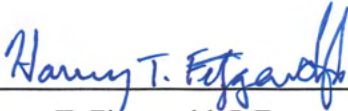
Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Attn: Mr. John Bach, P.E.

Prepared by:

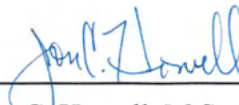
American Engineering Testing, Inc.
322 47th Street West
Williston, North Dakota 58801
(701) 572-3324/www.amengtest.com

Authored by:



Harvey T. Fitzgerald, P.E.
Geotechnical Engineer
Williston Manager

Reviewed by:



Jon C. Howell, M.S., P.E.
Senior Geotechnical Engineer
Gillette Manager



TABLE OF CONTENTS

Transmittal Letter.....	i
Signature Page	ii
TABLE OF CONTENTS.....	iii
1.0 INTRODUCTION	1
2.0 SCOPE OF SERVICES	1
3.0 PROJECT INFORMATION.....	1
4.0 SUBSURFACE EXPLORATION AND TESTING	2
4.1 Field Exploration Program	2
4.2 Laboratory Testing	2
5.0 SITE CONDITIONS.....	2
5.1 Surface Observations.....	2
5.2 Subsurface Soils/Geology.....	2
5.3 Groundwater	3
6.0 RECOMMENDATIONS.....	3
6.1 Approach Discussion.....	3
6.2 Utility Construction	4
6.3 Materials and Compaction.....	7
6.4 Testing Frequencies	8
7.0 CONSTRUCTION CONSIDERATIONS	9
7.1 Runoff Water in Excavation	9
7.2 Soil Chemistry Information	9
8.0 ASTM STANDARDS	9
9.0 LIMITATIONS.....	10

TABLE OF CONTENTS

STANDARD SHEETS

Earthwork Quality Control Information

APPENDIX A – Geotechnical Field Exploration and Testing

Boring Log Notes

Unified Soil Classification System

Site Vicinity Map

Boring Location Map

Subsurface Boring Logs

Sieve Analysis Tests

Atterberg Limit Tests

Unconfined Compression Tests

APPENDIX B – Geotechnical Report Limitations and Guidelines for Use

1.0 INTRODUCTION

Interstate Engineering, Inc. is proposing to construct a new waterline from the Fort Peck Dam Powerhouse to the Fort Peck Fish Hatchery in Fort Peck, Montana. To assist planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET performed their services according to our proposal, dated January 18, 2021, which you authorized on January 21, 2021. The authorized scope consists of the following.

- 12 penetration test borings to depths ranging from 16 to 24.5 feet below existing grade.
- Soil laboratory testing
- Geotechnical engineering review based on the data and preparation of this report

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination in the soil or groundwater.

3.0 PROJECT INFORMATION

The project site starts at the Fort Peck Dam Powerhouse, located approximately 1.75 miles east of Fort Peck and below the Fort Peck Dam, and runs parallel to Yellowstone Road, connecting to the existing fish hatchery water supply located north of Fort Peck, Montana. The elevation of the existing ground surface decreases from the Powerhouse (2,065 feet) to the fish hatchery water supply (2,055 feet).

The pipeline will be about 12,600 linear feet of 18.0-inch diameter PVC and will have a minimum depth of about 7 feet; however, the pipeline may extend up to 20 feet below existing grade to avoid disturbances of approaches, streams, and the Yellowstone Road. We understand the pipeline will be installed via horizontal directional boring or open-cut trenching methods. Horizontal directional drilling may include entry/exit excavations.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of twelve (12) penetration test borings. Interstate Engineering, Inc. (IEI) determined the number of borings and the locations. The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic origins, and moisture condition. A density description or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value) and the number of blows (uncorrected) for the Modified California sampler.

At the completion of each boring, we backfilled the borings with a 30% high solids bentonite grout, using the tremie method from the bottom of the boring. We checked the borings the following day to inspect for settlement of the grout. We re-grouted borings that settled more than 6 inches with 30% high solids bentonite and backfilled borings with less than 6 inches of settlement with bentonite chips. As requested by the United States Army Corps of Engineers (USACE), we transported the auger cuttings from boring located in landscaping areas (B-1, B-2, B-8, B-9, and B-10) off site for disposal. We covered each boring with native soils and walked through the site with a representative of the USACE on February 3, 2021.

4.2 Laboratory Testing

The laboratory testing program included natural moisture contents and densities, Atterberg limits, unconfined compression tests, sieve analysis, water soluble sulfates, resistivity, and pH. The test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed, or on the data sheets following the logs.

5.0 SITE CONDITIONS

5.1 Surface Observations

At the time of our subsurface exploration, the ground surface consisted of native prairie grasses, with a few locations with little to no vegetation. Borings B-1, B-2, B-8, B-9, and B-10 are located in landscape areas and the remaining borings are located in non-landscaped areas with thick native grasses. Topsoil typically extended 3 to 12 inches.

5.2 Subsurface Soils/Geology

The site geology consists primarily of coarse to fine alluvial deposits. The subsurface soils in Borings B-1 to B-7 primarily had varying layers of clays and sands. The subsurface soils in the borings along the toe of the Fort Peck Dam (B-8 to B-12) primarily consisted of clay overlying sands that extended beyond the depths explored. The sands at the toe of the dam ranged from very loose to medium dense. We encountered heaving sands in Borings B-7, and B-9 at 21 and 14 feet, respectfully. We added water to the auger column to add weight and control the heaving

sands.

5.3 Groundwater

We encountered groundwater in Borings B-7 to B-12 at the approximate depths below existing grade and elevations shown in the table below. We did not encounter groundwater in Borings B-1 to B-6 at the time of drilling.

Table 5.3-1 Groundwater Elevations

Boring	Depth Below Existing Grade (feet)	Elevation
B-7	14.5	2,043.6
B-8	9.5	2,039.8
B-9	7.0	2,043.3
B-10	14.5	2,039.6
B-11	19.5	2,036.7
B-12	19.5	2,042.1

We grouted each boring at the completion of drilling, therefore, borings were not left open to allow groundwater levels were not able to stabilize. Groundwater elevations may vary from the time of our exploration and construction. It should be noted our exploration occurred in February and groundwater levels fluctuate due to varying seasonal and annual rainfall and snow melt amounts, as well as other factors. The evaluation of these factors is beyond the scope of this report.

6.0 RECOMMENDATIONS

6.1 Approach Discussion

AET presents the following geotechnical recommendations to assist the planning, design, and construction of the waterline at Fort Peck Fish Hatchery in Fort Peck, Montana. Our recommendations are based on the results of our boring-based field exploration, field and laboratory testing, our experience in the area with similar soil conditions, and our understanding of the proposed construction. We specifically outline geotechnical design criteria, opinions, and recommendations regarding the soil conditions encountered. We also rely on a geotechnical continuity, communication between all project team members specific to risk- and cost-based decisions, and good construction practices to achieve the desired project outcome for IEI, and the Fort Peck Fish Hatchery. Therefore, our recommendations must be reviewed at the time civil design and construction plans are finalized to verify their applicability to the proposed project.

Exploration only allows observation of a small portion of the site subsurface conditions. Subsurface variations are possible between exploration locations and may not be apparent until construction. Where such variations exist, they may impact the opinions and recommendations presented in this report, as well as construction timing and costs. If design plans change, or if the subsurface conditions encountered during construction vary from those observed during our field

evaluation, we must be notified to be given the opportunity to review the report recommendations and make necessary revisions as warranted.

6.2 Utility Construction

6.2.1 Discussion

We understand the proposed pipeline will be installed by either horizontal directional drilling or by open cut trenching methods. Excavations for horizontal directional drilling (entry and exit pits) may be required for the proposed utility work. At the proposed elevation of the pipeline, we anticipate the utilities will be primarily in clay and sandy soils. We provide detailed subsurface soil conditions on the boring logs and on the fence diagram in Appendix A. We emphasize that conditions may vary between boring locations. We provide recommendations for utility construction in the subsequent sections.

6.2.2 Horizontal Directional Drilling

This project may include horizontal directional drilling along the entire route of the waterline. The diameter of the PVC pipeline will be 18 inches. As previously stated, the depth of the waterline will range from 7 up to 20 feet below existing grade. At the time of this report, the contractor has not been selected and the means and methods for drilling is not known. In addition, our scope of services did not include the evaluation of the potential for hydrofracturing during horizontal directional drilling based on the Delft Equation (Stahliet. al, 1998). The Delft Equation is used to estimate the maximum allowable pressure that can be developed in the annular space to prevent the potential for hydrofracture. Please contact us if this evaluation is needed and we can provide a cost proposal for these services.

ASTM F 1962 *Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings* provides guidance for the suitability of soils for horizontal directional drilling. The following table, taken from ASTM F 1962, classifies suitability based on soil type.

Table 6.2.2-1 Soil Types vs. Horizontal Directional Drilling Suitability

Soil Conditions	Generally Suitable	Difficulties May Occur	Substantial Problems
Soft to very soft clays, silts, and organic deposits		X	
Firm to very stiff clays and silts	X		
Hard clays and highly weathered shales	X		
Very loose to loose sands above and below the water table (not more than 30% gravel by weight)		X	
Medium to dense sands above and below	X		

Soil Conditions	Generally Suitable	Difficulties May Occur	Substantial Problems
the water table (not more than 30% gravel by weight)			
Very loose to dense gravelly sand (30% to 50% gravel by weight)		X	
Very loose to dense gravelly sand (50% to 85% gravel by weight)			X
Very loose to very dense gravel			X
Soils with significant cobbles, boulders, and obstructions			X
Weathered rocks, marls, chalks, and firmly cemented soils	X		
Slightly weathered to unweathered rocks		X	

The subsurface soil at the proposed elevation of the pipeline along the toe of the Fort Peck Dam (Borings B-7 to B-12) primarily consisted of very loose to medium dense sands and very soft clay (B-7). The pipeline will be below groundwater at Borings B-8 and B-9. Difficulties with horizontal directional drilling may occur in very loose to loose sands and soft to very soft clays due to the potential collapse of the boring. We anticipate substantial problems may occur near Borings B-8 and B-9 due to the very loose sands and the elevation of the groundwater.

The subsurface soil at the proposed elevation of the pipeline from the dam to the hatchery (Borings B-1 to B-6) primarily consisted of firm to stiff clay and loose clayey sand (B-2) and poorly-graded sand (B-5). We anticipate difficulties will likely occur in the loose sands, whereas the firm to stiff clayey soil is generally suitable for horizontal directional drilling. We provide a fence diagram with the approximate pipeline elevations in Appendix A.

When selecting the contractor, the contractor's experience horizontally directional drilling near USACE dams or levees, and experience with USACE regulations and requirements, should be considered. Experience with similar soil conditions is strongly recommended. The selected contractor shall adhere to all USACE rules and regulations regarding horizontal directional drilling.

6.2.3 Trench Excavation

Conventional construction equipment such as tracked excavators should be able to make the required trench excavations within the site soils along the proposed utility alignments. If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, surface runoff or water seepage due to the sandy soil can potentially induce side slope erosion or running which could

require slope maintenance. The contractor shall be prepared to address surface runoff and should be prepared to slope the excavation walls or provide trench shoring.

The site soil classifies as a Type C soil under the OSHA guidelines. Temporary excavation slopes may be required for utility trenches. Excavations less than 20 feet in depth shall have a maximum allowable slope of 1½H:1V. Deeper excavations and/or in saturated soils or below the groundwater table should be considered on an individual basis. Water levels, due to climatic conditions should be evaluated at the time of construction. We anticipate groundwater will likely be encountered within the excavations below the Fort Peck Dam. Construction vibrations can cause excavations to slough or cave. If the above trench layback recommendations are not feasible, due to space limitations or other factors, the OSHA rules should be consulted for alternative trench stabilization methods. Trench boxes or shoring in compliance with OSHA rules may be acceptable alternatives and is common practice in utility projects.

Due to the presence of very loose to loose sands near or below the water table near Borings B-7 to B-9, we anticipate excavations will be unstable unless trench boxes or shoring are used. We encountered heaving sands at 21 feet and 14 feet for B-7 and B-9, respectively. In this area, sand boils may develop in the excavation bottoms. The contractor must be prepared for dewatering the excavations and have equipment available that will lower and maintain the groundwater level at least 2 feet below the base of the excavations.

6.2.4 Utility Subgrade Preparation

Excavate soil to the proposed utility subgrade elevations with a smooth blade. Remove any unsuitable soils, including soft and/or organic soil, if encountered. Based on our subsurface exploration, the subsurface soil at the proposed subgrade elevations will likely be soft to firm clay and very loose to loose sands. Soil disturbance negatively impacts the soil's performance. Soft soil over-excavation criteria shall be determined during construction with AET, IEI, and the contractor.

6.2.5 Pipe Bedding and Backfill

The soil at the utility subgrade elevation primarily consists of very loose to loose sand, with soft to firm clay. The onsite sand may be used as pipe bedding material, provided it meets the requirements of Type 1 bedding, from Section 02221 – Trench Excavation and Backfill for Pipelines & Appurtenant Structures, of the Montana Public Works Standard Specifications, 2010 Edition (MPWSS). Pipe bedding below the water table should be non-plastic, free draining soil. In addition, we recommend the following:

- Place utility pipes on at least 12 inches of Type 1 bedding. Areas with very loose sands near or below the water table may require Type 2 bedding material. We recommend Type 2 bedding material be included in the bid documents and IEI and AET determine the need for Type 2 bedding during construction.

- Place Type 1 bedding and compact it from the pipe invert to 6 inches above the top of the pipe with tamping bars and/or plate compactors to render the backfill in a firm and unyielding conditions. Backfill and compact around each side of the pipe simultaneously to minimize lateral shifting.
- Thoroughly place and compact bedding below pipe haunches or the zone between the pipe invert and the spring line. To accomplish backfilling, the distance between the side of the pipe at the spring line and the trench wall should be at least 12 inches.

If soft or unstable soils are encountered, over-excavation may be required to provide a stable subgrade for the proposed sewer line. Soft soil over-excavation criteria shall be determined during construction with AET, IEI, and the contractor.

6.2.6 Utility Backfill Considerations

We anticipate that the site soil excavated for utility construction will be re-used for trench backfill. The subsurface soil generally consisted of sandy lean clay and sandy soils. Based on our experience with similar soils in the area, the excavated site soils for the new utility lines will require processing and moisture conditioning to bring the trench spoils close to the optimum moisture content before they reuse as trench backfill. Compact utility trenches in accordance with Table 6.3-1 Material Specifications and Compaction Specifications.

6.3 Materials and Compaction

The native soils can be reused during construction. We provide materials and compaction specifications in the table below.

Table 6.3-1 Materials and Compaction Specifications

Material	Allowable Use	Material Specifications	Minimum Compaction Requirements (ASTM D698)	Moisture Content (% of optimum)
Utility Trench Backfill	Utility Trench Backfill	• Soil classified as GM, GW, GC, SM, SC, SW, CL, or ML according to the USCS • May not contain particles larger than 6" in median diameter • Soil must be reasonably free from deleterious substances such as wood, metal, plastic, waste, etc.	95%	± 3%

Material	Allowable Use	Material Specifications	Minimum Compaction Requirements (ASTM D698)	Moisture Content (% of optimum)
Granular Structural Fill	Over-excavations and general structural fill	• Soil classified as GM or GW according to the USCS • May not contain particles larger than 4" in median diameter • Soil must contain less than 3% (by weight) of organics, vegetation, wood, metal, plastic, or other deleterious substances	98%	-4% to +2%
Type 1 Pipe Bedding	Pipe Bedding	Aggregate meeting the requirements for Type 1 Pipe Bedding in Section 02221, Trench Excavation and Backfill for Pipelines & Appurtenant Structures, of the <i>Montana Public Works Standard Specifications, 2010</i>	N/A	N/A
Type 2 Pipe Bedding	Excavation Subgrade Stabilization	Aggregate meeting the requirements for Type 2 Pipe Bedding in Section 02221, Trench Excavation and Backfill for Pipelines & Appurtenant Structures, of the <i>Montana Public Works Standard Specifications, 2010</i>	N/A	N/A

6.4 Testing Frequencies

We recommend performing the following tests at the recommended frequencies.

- **Entry/Exit Pit Backfill** – one (1) compaction test every other 8-inch lift of backfill.
- **Utility Trench Backfill Below Pavements & Structures** – one (1) compaction test every 150 linear feet, or 2 per trench, whichever results in the greater number of tests, per each 8-inch lift of backfill.
- **Utility Trench Backfill in Non-Structural Areas (Native Grass Areas)** – one (1) compaction test every 1,000 linear feet, per each 3 feet of backfill.

To verify that construction conforms to the intent of this report, we recommend American Engineering Testing, Inc. be retained to observe, test, and record the following.

- **Earthwork Observations** – including monitoring and recording deviations from subsurface soil conditions as presented in the Boring Logs in Appendix A.

- Observe and approve all excavations and over-excavations prior to placing backfill/fill materials
- Approve additional excavation, replacement, or stabilization if unsuitable soil as identified by the geotechnical engineer during excavation.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Runoff Water in Excavation

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the groundwater can be handled with conventional sump pumping.

7.2 Soil Chemistry Information

AET analyzed soil samples for soluble sulfates, resistivity, and pH. Sulfate attack is a deterioration resulting from chemical reactions occurring when concrete components react with sulfate ions (SO_4^{2-}) present in solution in contact with concrete. Table 7.2-1 below summarizes the soil chemistry information.

Table 7.2-1 Soil Chemistry Information

Boring # (depth)	Water Soluble Sulfates (ppm)	Resistivity (ohm-cm)	pH
B-2 (9.5-11')	430	550	8.1
B-6 (9.5-11')	780	260	8.5
B-10 (9.5-11')	1,420	6,270	8.5

Based on the results shown in the table above, concrete in contact with the on-site soil classifies as exposure class S1 according to the American Concrete Institute (ACI) publication ACI 318, Table 19.3.1.1. To achieve the required protection against sulfate related corrosion, we recommend specifying Type II cement, a maximum water-to-cement ration of 0.50 (by weight, normal weight concrete), and a minimum compressive strength, f'_c , of 4,000 pounds per square inch (psi). Details can be found in the above ACI reference and in the Portland Cement Association publication "Design and Control of Concrete Mixtures".

According to *Corrosion Life of Steel Foundation Products*, the soil at the site ranges from mildly corrosive to extremely corrosive to steel. We recommend buried metals be designed for corrosion.

8.0 ASTM STANDARDS

When we refer to an ASTM Standard in this report, we mean that our services were performed in general accordance with that standard. Compliance with any other standards referenced within

the specified standard is neither inferred nor implied.

9.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled “Geotechnical Report Limitations and Guidelines for Use.”

Standard Data Sheets

EARTHWORK QUALITY CONTROL INFORMATION

Excavation Base Evaluation

Judgments of supporting soils are based on soils exposed, and on local samples of soils retrieved by hand auguring and probing. Because conditions in the subsurface are hidden, it is not possible to fully characterize the subsurface conditions. Therefore, the client must accept that our judgments are limited to those soils which are directly observable to us.

As soil conditions may be variable at depth, it is best that excavation base observation be aided by deeper exploratory test borings (usually done prior to construction). Although these deeper borings may not totally reveal what is in the subsurface they greatly reduce the risk of deeper poor soils going undetected.

The presence of ground water within the excavation can also limit the supporting soil evaluation process. Also, if standing ground water is present, there is a risk to the client that soft or loose compressible soils may not be observed and that these soft or loose compressible may potentially remain beneath the water during excavation. The compressible materials can become trapped beneath or within the subsequently placed fill; thus, allowing adverse movements to occur in structures and fill materials placed over these materials.

Filling

Structural fill placement is commonly monitored by performing local compaction tests, which entails comparing a field density test to a laboratory Proctor test to arrive at a percent compaction. Field Density tests of fill only provide the compaction level of the fill at the location and elevation of the test. As many factors control compaction, such as fill lift thickness, moisture content, material type and compactive effort, compaction variation within fill materials can exist that may not be represented by the tests. Field Density (compaction) tests are considered representative when used in a conscientious program of controlled fill placement, where the factors influencing compaction are closely monitored. Conclusions about fill suitability to support structural loadings from the results of a limited number of compaction tests includes increased risk, unless the individual drawing the conclusions has complete knowledge of the afore-mentioned variables during placement. For this reason, part-time testing on a "trip" basis includes more risk to the client than "full-time" monitoring/testing.

Oversizing

Structural elements also exert loadings laterally; and because of this, the excavation and subsequent fill system needs to be oversized to accommodate these loadings. The extent of lateral oversizing is normally associated with the movement sensitivity of the structure and the strength/compressibility properties of the soils remaining along the excavation sidewalls. Oversizing on the order of 1H (horizontal):1V (vertical) is typically provided for foundations in "normal" conditions. However, oversizing on the order of 12H:1V or more is oftentimes needed in highly compressible situations such as swamp deposits.

AET does not practice in the field of surveying and must rely on location and elevation staking of proposed construction by the client or their representative. Our measurements in the field are made in relation to those stakes or other location and elevation information provided to us. The reliability of AET's opinions, conclusions and recommendations based on those measurements is dependent on the accuracy of the staking or information provided by the client or their representative.

Freezing Weather

Soils that are allowed to freeze will heave & lose density. Upon thawing, these soils will not regain their full original strength & density. The extent of heave and density/strength loss depends on the soil type and moisture condition; and is usually more pronounced in finer grained soils, and particularly silty soils. Foundations, slabs, and other improvements affected by such frost movements should be protected from frost intrusion during freezing weather. If filling takes place during freezing weather, all frozen soils, snow and ice should be stripped from all areas to be filled prior to new fill placement; and the new fill should not be allowed to freeze during or after placement. For this reason, it is usually more beneficial to perform excavate/refill operations during freezing weather in smaller plan areas where grade can be attained quickly rather than working larger areas where a large amount of frost stripping is needed.

Structural Support on Uncontrolled Fill

Risks are associated with supporting structures on fill which has not been placed in a controlled and well documented manner. Even where existing fill appears to be well compacted (including when soil borings have been performed), hidden poorer or looser soils can potentially exist below or within the fill; or previous excavation and extension of the compacted fill may have been provided with sufficient oversize in all directions to accommodate the new lateral loadings. Risks can be reduced by means of increasing the amount of testing and observations.

Appendix A

Geotechnical Field Exploration and Testing

Boring Log Notes

Unified Soil Classification System

Figure 1 – Boring Locations

Subsurface Boring Logs

Sieve Analysis Tests

Atterberg Limit Tests

Unconfined Compression Tests

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling of twelve (12) standard penetration test borings. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS)

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as “DS” or “SU” on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Modified California Samples (MC)

Sample types described as “MC” on the boring logs are obtained using a Modified California (MC) sampler, which is a large lined tube sampler. The sampler is thick-walled with an outside diameter of 2.5 inches and an inside diameter of 2 inches. The sampler is driven into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil.

A.2.4 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of “topsoil” layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under “Water Level Measurements” on the logs:

- ♦ Date and Time of measurement
- ♦ Sampled Depth: lowest depth of soil sampling at the time of measurement
- ♦ Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- ♦ Cave-in Depth: depth at which measuring tape stops in the borehole
- ♦ Water Level: depth in the borehole where free water is encountered

- ♦ **Drilling Fluid Level:** same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Atterberg Limits Tests

Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)

Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

A.5.4 Unconfined Compressive Strength of Cohesive Soil

Conducted per AET Procedure 01-LAB-080, which is performed in general accordance with ASTM: D2166 and AASHTO: T208.

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1d" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after falling through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q _p :	Pocket Penetrometer strength, tsf (approximate)
q _c :	Static cone bearing pressure, tsf
q _u :	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designator in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM

ASTM Designations: D 2487, D2488

**AMERICAN
ENGINEERING
TESTING, INC.**



Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name ^B
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well graded gravel ^F
			$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^F
		Gravels with Fines more than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}
			Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I
			$Cu < 6$ and $1 > Cc > 3$ ^E	SP	Poorly-graded sand ^I
		Sands with Fines more than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G,H,I}
			Fines classify as CL or CH	SC	Clayey sand ^{G,H,I}
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}
		organic	Liquid limit—oven dried < 0.75 Liquid limit – not dried	OL	Organic clay ^{K,L,M,N} Organic silt ^{K,L,M,O}
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}
		organic	Liquid limit—oven dried < 0.75 Liquid limit – not dried	OH	Organic clay ^{K,L,M,P} Organic silt ^{K,L,M,Q}
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat ^R

SIEVE ANALYSIS

Percent Passing vs. Particle Size in Millimeters

Curves shown for $D_{60} = 15\text{mm}$, $D_{30} = 2.5\text{mm}$, and $D_{10} = 0.075\text{mm}$.

Formulas for C_u and C_c :

$$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$$
$$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{2.5^2}{0.075 \times 15} = 5.6$$

PLASTICITY CHART

For classification of fine-grained soils and fine-grained fraction of coarse-grained soils.

Equation of "A"-line
Horizontal at $PI = 4$ to $LL = 25.5$,
then $PI = 0.73 (LL - 20)$

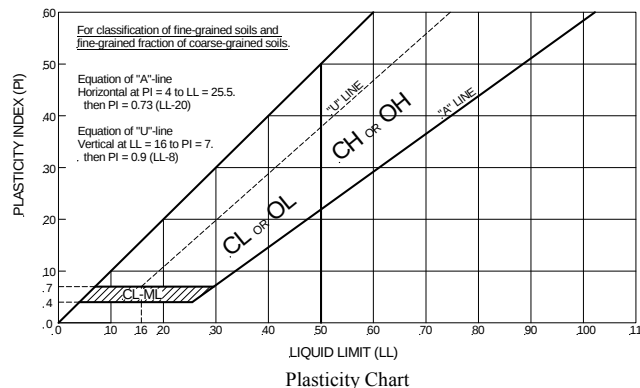
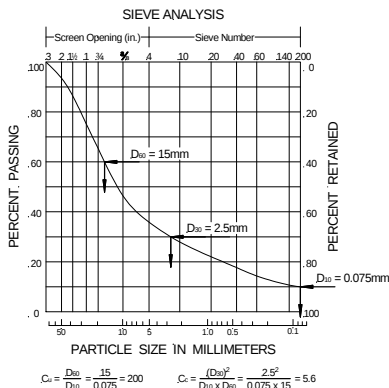
Equation of "U"-line
Vertical at $LL = 16$ to $PI = 7$,
then $PI = 0.9 (LL - 8)$

Regions: CL, CH, OH, OL

Plasticity Chart

Notes

- ^ABased on the material passing the 3-in (75-mm) sieve.
- ^BIf field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- ^CGravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
- ^DSands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
- ^E $Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
- ^FIf soil contains $\geq 15\%$ sand, add "with sand" to group name.
- ^GIf fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
- ^HIf fines are organic, add "with organic fines" to group name.
- ^IIf soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
- ^JIf Atterberg limits plot is hatched area, soils is a CL-ML silty clay.
- ^KIf soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
- ^LIf soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
- ^MIf soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.
- ^N $PI \geq 4$ and plots on or above "A" line.
- ^O $PI < 4$ or plots below "A" line.
- ^P PI plots on or above "A" line.
- ^Q PI plots below "A" line.
- ^RFiber Content description shown below.



ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size		Gravel Percentages		Consistency of Plastic Soils		Relative Density of Non-Plastic Soils	
Term	Particle Size	Term	Percent	Term	N-Value, BPF	Term	N-Value, BPF
Boulders	Over 12"	A Little Gravel	3% - 14%	Very Soft	less than 2	Very Loose	0 - 4
Cobbles	3" to 12"	With Gravel	15% - 29%	Soft	2 - 4	Loose	5 - 10
Gravel	#4 sieve to 3"	Gravelly	30% - 50%	Firm	5 - 8	Medium Dense	11 - 30
Sand	#200 to #4 sieve			Stiff	9 - 15	Dense	31 - 50
Fines (silt & clay)	Pass #200 sieve			Very Stiff	16 - 30	Very Dense	Greater than 50
				Hard	Greater than 30		
Moisture/Frost Condition		Layering Notes		Fiber Content of Peat		Organic/Roots Description (if no lab tests)	
(MC Column)		Laminations: Layers less than 1/2" thick of differing material or color.		Fiber Content (Visual Estimate)		Soils are described as <u>organic</u> , if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. <u>Slightly organic</u> used for borderline cases.	
D (Dry):	Absence of moisture, dusty, dry to touch.			Fibric Peat: Greater than 67%			
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").			Hemic Peat: 33 - 67%			
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.	Lenses: Pockets or layers greater than 1/2" thick of differing material or color.		Sapric Peat: Less than 33%		With roots: Judged to have sufficient quantity of roots to influence the soil properties.	
F (Frozen):	Soil frozen					Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.	



PROJECT: Fort Peck Fish Hatchery Transmission Main
Fort Peck, Montana

PROJ. NO. 37-20591

SUBJECT: Site Vicinity Map

DATE: February 9, 2021

SCALE: Approximate Scale 1"=2.8 miles

DRAWN BY: TT

REVIEWED BY: HTF





PROJECT: Fort Peck Fish Hatchery Transmission Main Fort Peck, Montana		PROJ. NO. 37-20591
SUBJECT: Boring Location Map		DATE: February 9, 2021
SCALE: Approximate Scale 1"=1184'	DRAWN BY: TT	REVIEWED BY: HTF



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-1 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2055.3		LATITUDE: 48.01836		LONGITUDE: -106.44771							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, brown, frozen to 4" (4 inches)	TOPSOIL	17	F/M	SS	8					
2	FAT CLAY, laminations of silt and sand, stiff, brown, moist (CH)	FINE ALLUVIUM									
3			11	M	SS	10	11				
4											
5			12	M	SS	16	22		59	21	89
6											
7											
8			6	M	SS	14	30				
9											
10	LEAN CLAY, trace iron oxide staining, firm, brown, moist (CL)		5	M	SS	14					
11											
12	SILTY SAND, trace iron oxide staining, loose, light brown, moist (SM)	COARSE ALLUVIUM	4	M	SS	18					
13											
14											
15											
16	SANDY LEAN CLAY, trace iron oxide staining, soft, brown, very moist (CL)	MIXED ALLUVIUM	3	M	SS	16					
	END OF BORING										

DEPTH: 0-14½' DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	16:15	16.0	14.5	-	-	None	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-2 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2056.2		LATITUDE: 48.01688		LONGITUDE: -106.44633							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, brown, frozen (6 inches)	TOPSOIL	15	F/M	SS	18					
	SANDY LEAN CLAY, trace roots, stiff, brown, moist (CL)	MIXED ALLUVIUM									
2	SILTY SAND, loose, brown, moist (SM)	COARSE ALLUVIUM	4	M	SS	18					
3											
4	SANDY LEAN CLAY, firm, brown, moist (CL)	MIXED ALLUVIUM	6	M	SS	8	27				
5											
6			4	M	SS	10					
7											
8			4	M	SS	10	29				
9											
10	CLAYEY SAND, laminations of clay, loose, brown, very moist (SC)		6	M	SS	18					
11											
12			8	M	SS	6					
13											
14	POORLY-GRADED SAND, loose, brown to red, moist (SP)	COARSE ALLUVIUM									
15											
16	END OF BORING										

DEPTH: 0-14½' DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	15:25	16.0	14.5	-	-	None	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-3 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2057.4		LATITUDE: 48.01375		LONGITUDE: -106.44486							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay with roots, dark brown, frozen (8 inches)	TOPSOIL									
2	LEAN CLAY, trace roots, a little gravel, stiff, brown to light brown, moist (CL)	MIXED ALLUVIUM	15	F/M	SS	18					
3			13	M	SS	10					
4											
5			14	M	SS	12	15				
6											
7											
8			17*	M	MC	14	21	99	45	23	99
9											
10			9	M	SS	20	25				
11											
12	SILTY SAND, loose, light brown, moist (SM)	COARSE ALLUVIUM	7	M	SS	18					
13											
14											
15	SANDY LEAN CLAY, trace iron oxide staining, soft, brown, very moist (CL)	MIXED ALLUVIUM	3	M	SS	16					
16	END OF BORING *Modified California Sample, N-value not corrected for sampler type										

DEPTH: 0-14½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	14:35	16.0	14.5	-	-	None	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012 J.G.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-4 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2059.1		LATITUDE: 48.01082		LONGITUDE: -106.44283							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, brown, frozen (8 inches)	TOPSOIL									
2	FAT CLAY, trace gypsum, lenses and laminations of sand, firm to stiff, brown, moist (CH)	MIXED ALLUVIUM	14	F/M	SS	18					
3			7	M	SS	4	21				
4											
5			13	M	SS	14	19				
6											
7											
8			17*	M	MC	14	18 28	98 93	71	23	97
9											
10											
11	SILTY SAND, very loose, brown, very moist (SM)	COARSE ALLUVIUM	9	M	SS	18					
12											
13			4	M	SS	16					
14											
15	laminations of clay and coarse sand at 14.5'		3	M	SS	12					
16	END OF BORING *Modified California Sample, N-value not corrected for sampler type										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-14½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	13:10	16.0	14.5	-	-	None	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-5 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2059.7		LATITUDE: 48.00865		LONGITUDE: -106.44015							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay with roots, brown, frozen (6 inches)	TOPSOIL									
	SANDY LEAN CLAY, stiff, brown, moist (CL)	MIXED ALLUVIUM	12	M	SS	14					
2											
3			19	M	SS	12					
4	iron oxide staining and trace gypsum at 4'										
5			19	M	SS	14	19				
6											
7											
8			8*	M	MC	10	28	95			
9	POORLY-GRADED SAND, loose, light brown to grey, very moist (SP)	COARSE ALLUVIUM									
10			4	M	SS	14	12				
11											
12	LEAN CLAY, laminations of sand, soft, brown, very moist (CL)	FINE ALLUVIUM	4	M	SS	18					
13											
14											
15			4	M	SS	2					
16	END OF BORING *Modified California Sample, N-value not corrected for sampler type										

DEPTH: 0-14½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	12:06	16.0	14.5	-	-	None	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-6 (p. 1 of 1)											
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT													
SURFACE ELEVATION: 2064.7		LATITUDE: 48.00687		LONGITUDE: -106.43651									
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS						
							WC	DEN	LL	PL	%-#200		
1	TOPSOIL, sandy lean clay, brown, frost extended to 12" (6 inches)	TOPSOIL											
2	SANDY LEAN CLAY, trace roots, stiff, light brown, moist (CL)	MIXED ALLUVIUM	21	F/M	SS	18							
3			13	M	SS	18							
4													
5	SILTY SAND, medium dense, light brown, moist (SM)	COARSE ALLUVIUM	12	M	SS	12	9						
6													
7													
8	SANDY LEAN CLAY, firm, brown, moist (CL)	MIXED ALLUVIUM	7	M	SS	14	26						
9													
10	lenses of coarse sand at 9.5'		8*	M	MC	12	25	93					
11													
12													
13			5	M	SS	14							
14													
15													
16	POORLY-GRADED SAND, loose, light brown, moist (SP)	COARSE ALLUVIUM	4	M	SS	18							
END OF BORING *Modified California Sample, N-value not corrected for sampler type													
DEPTH: 0-14½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG				
				DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH				DRILLING FLUID LEVEL	WATER LEVEL
				2/2/21	11:30	16.0	14.5	-				-	None
BORING COMPLETED: 2/2/21													
DR: TT LG: HTF Rig: 39													

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-7 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2058.1		LATITUDE: 48.00585		LONGITUDE: -106.4325							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay with roots, brown, frozen to 1' (12 inches)	TOPSOIL	18	F/M	SS	18					
2	SANDY LEAN CLAY, very stiff, brown, moist (CL)	MIXED ALLUVIUM									
3	SILTY SAND, medium dense, light brown, moist (SM)	COARSE ALLUVIUM	11	M	SS	16					
4	SANDY LEAN CLAY, stiff, light brown, moist (CL)	MIXED ALLUVIUM									
5	LEAN CLAY, stiff, brown, moist (CL)	FINE ALLUVIUM	10	M	SS	10	25				
6											
7	SILTY SAND, loose, light brown, moist (SM)	COARSE ALLUVIUM	6*	M	MC	18	31	90			
8	LEAN CLAY, firm to soft, brown, moist (CL)	FINE ALLUVIUM									
9											
10			3	M	SS	18	33				
11											
12	SILTY SAND, laminations of clay, loose to very loose, brown, moist to wet (SM)	COARSE ALLUVIUM	5*	NR	MC	NR					
13											
14											
15			2	W	SS	5					
16											
17											
18											
19											
20	POORLY-GRADED SAND, a little gravel, loose, light brown, wet (SP)		9	W	SS	24					
21	heaving sands at 21'										
22											
23											
24											
END OF BORING *Modified California Sample, N-value not corrected for sampler type											

DEPTH: 0-24½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL			
2/2/21	9:30	21.0	24.5	-	-	14.5			
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-8 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2049.3		LATITUDE: 48.00671		LONGITUDE: -106.42842							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay with roots, brown, frozen to 6" (6 inches)	TOPSOIL									
2	SANDY LEAN CLAY, a little gravel, very stiff, brown, frozen to 1', moist (CL)	MIXED ALLUVIUM	19	F/M	SS	18					
3	2" sand seam at 3'		4	M	SS	10					
4											
5	SILTY SAND, medium dense, brown to grey, moist, becomes wet at 9.5' (SM)	COARSE ALLUVIUM	20	M	SS	2	22				20
6											
7											
8			3	NR	SS	NR					
9											
10			2	W	SS	6	34				
11											
12											
13			1	W	SS	6					
14											
15			2	W	SS	24					
16	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-14½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/2/21	8:15	16.0	14.5	-	-	9.5	
BORING COMPLETED: 2/2/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-9 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2050.3		LATITUDE: 48.00795		LONGITUDE: -106.42411							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, brown, frozen to 12" (12 inches)	TOPSOIL	11	F/M	SS	16					
2	SILTY SAND, medium dense to loose, light brown, moist (SM)	COARSE ALLUVIUM									
3			6	M	SS	19					
4											
5			8	M	SS	17	6				
6											
7											
8	POORLY-GRADED SAND, laminations of clay, very loose, light brown to brown, wet (SP)		2	W	SS	12	29				
9											
10			3	W	SS	12					
11											
12											
13	POORLY-GRADED SAND with Silt, loose, brown, wet (SP-SM)		7	W	SS	24	27				8
14	heaving sands starting at 14'										
15			7	W	SS	24					
16											
17											
18											
19											
20	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-20'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/1/21	16:10	16.0	19.5	-	-	7.0	
BORING COMPLETED: 2/1/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-10 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2054.1		LATITUDE: 48.00904		LONGITUDE: -106.41993							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, trace gravel, brown, frozen (4 inches)	TOPSOIL	17	F	SS	18					
2	SANDY LEAN CLAY, firm, brown, frozen to 12", moist (CL)	MIXED ALLUVIUM									
3			8	M	SS	18					
4											
5	POORLY-GRADED SAND, loose, light brown, moist (SP)	COARSE ALLUVIUM	8	M	SS	18	9				
6											
7											
8			10	M	SS	16	10				
9											
10	trace gravel, iron oxide staining at 9.5'		10	M	SS	16	7				
11											
12											
13			7	M	SS	10					
14											
15			3	W	SS	2					
16	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-14½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/1/21	15:20	16.0	14.5	-	-	14.5	
BORING COMPLETED: 2/1/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-11 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2056.2		LATITUDE: 48.0103		LONGITUDE: -106.41589							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, sandy lean clay, dark brown, frozen (6 inches)	TOPSOIL	23	F	SS	18					
2	SANDY LEAN CLAY, a little gravel, dark brown, frozen to 12"	MIXED ALLUVIUM									
3			13	M	SS	20					
4	SILT, laminations of clay and sand, medium dense, moist (ML)	FINE ALLUVIUM									
5	SANDY LEAN CLAY, stiff, brown, moist (CL)	MIXED ALLUVIUM	10	M	SS	12					
6											
7	POORLY-GRADED SAND, loose to medium dense, brown, moist (SP)	COARSE ALLUVIUM	8*	M	MC	14	8				
8											
9			17	M	SS	18	5				
10											
11			12	M	SS	14					
12											
13			3	M	SS	8					
14	becomes loose at 14.5'										
15			4	W	SS	24					
16											
17											
18											
19											
20	becomes wet at 19.5'										
21	END OF BORING										
*Modified California Sample, N-value not corrected for sampler type											

DEPTH: 0-19½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/1/21	14:00	21.0	19.5	-	-	19.5	
BORING COMPLETED: 2/1/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21



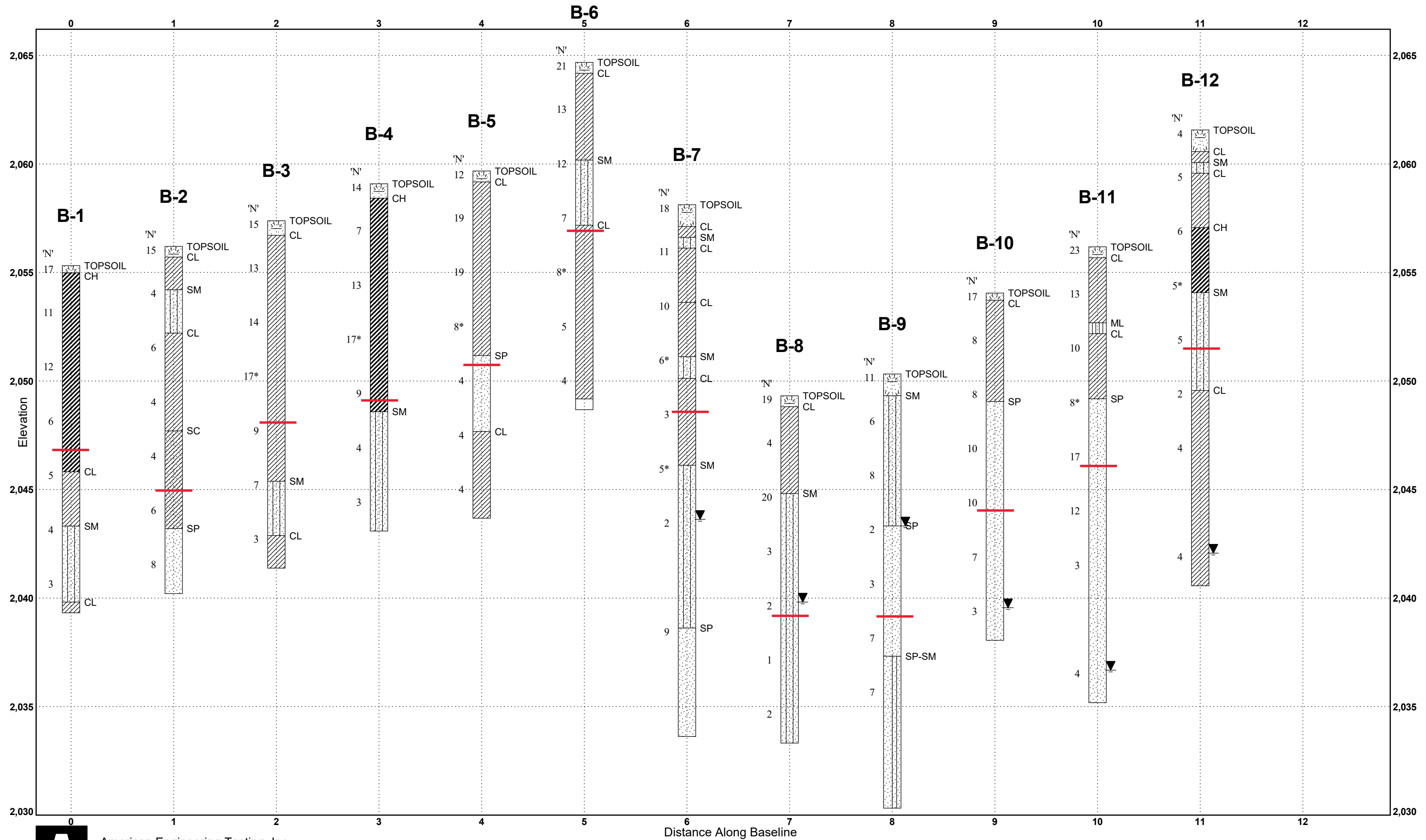
SUBSURFACE BORING LOG

AET JOB NO: 37-20591		LOG OF BORING NO. B-12 (p. 1 of 1)									
PROJECT: Fort Peck Fish Hatchery Transmission Main; Fort Peck, MT											
SURFACE ELEVATION: 2061.6		LATITUDE: 48.0113		LONGITUDE: -106.41197							
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, lean clay, dark brown, frozen (12 inches)	TOPSOIL	4	F/M	SS	24					
2	LEAN CLAY, soft, brown to dark brown, moist (CL)	FINE ALLUVIUM									
3	SILTY SAND, loose, brown, moist (SM)	COARSE ALLUVIUM	5	M	SS	20					
4	LEAN CLAY, laminations of sand, trace organics, firm, brown, moist (CL)	FINE ALLUVIUM									
5	FAT CLAY, firm, grey, moist (CH)		6	M	SS	18	36				
6											
7											
8	SILTY SAND, loose, brown, moist (SM)	COARSE ALLUVIUM	5*	M	MC	16	26	98			
9											
10			5	M	SS	12					
11											
12	SANDY LEAN CLAY, laminations of sand, soft, brown to light brown, wet (CL)	FINE ALLUVIUM	2	M	SS	8	30		35	23	68
13											
14											
15			4	WB	SS	16					
16											
17											
18											
19											
20			4	W	SS	NR					
21	END OF BORING *Modified California Sample, N-value not corrected for sampler type										

DEPTH: 0-19½'		DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS					NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		2/1/21	12:10	21.0	19.5	-	-	19.5	
BORING COMPLETED: 2/1/21									
DR: TT LG: HTF Rig: 39									

AET CORP W-LAT-LONG 37-20591 GINT.GPJ AET-CPT+WELL_20181012_JG.GDT 2/16/21

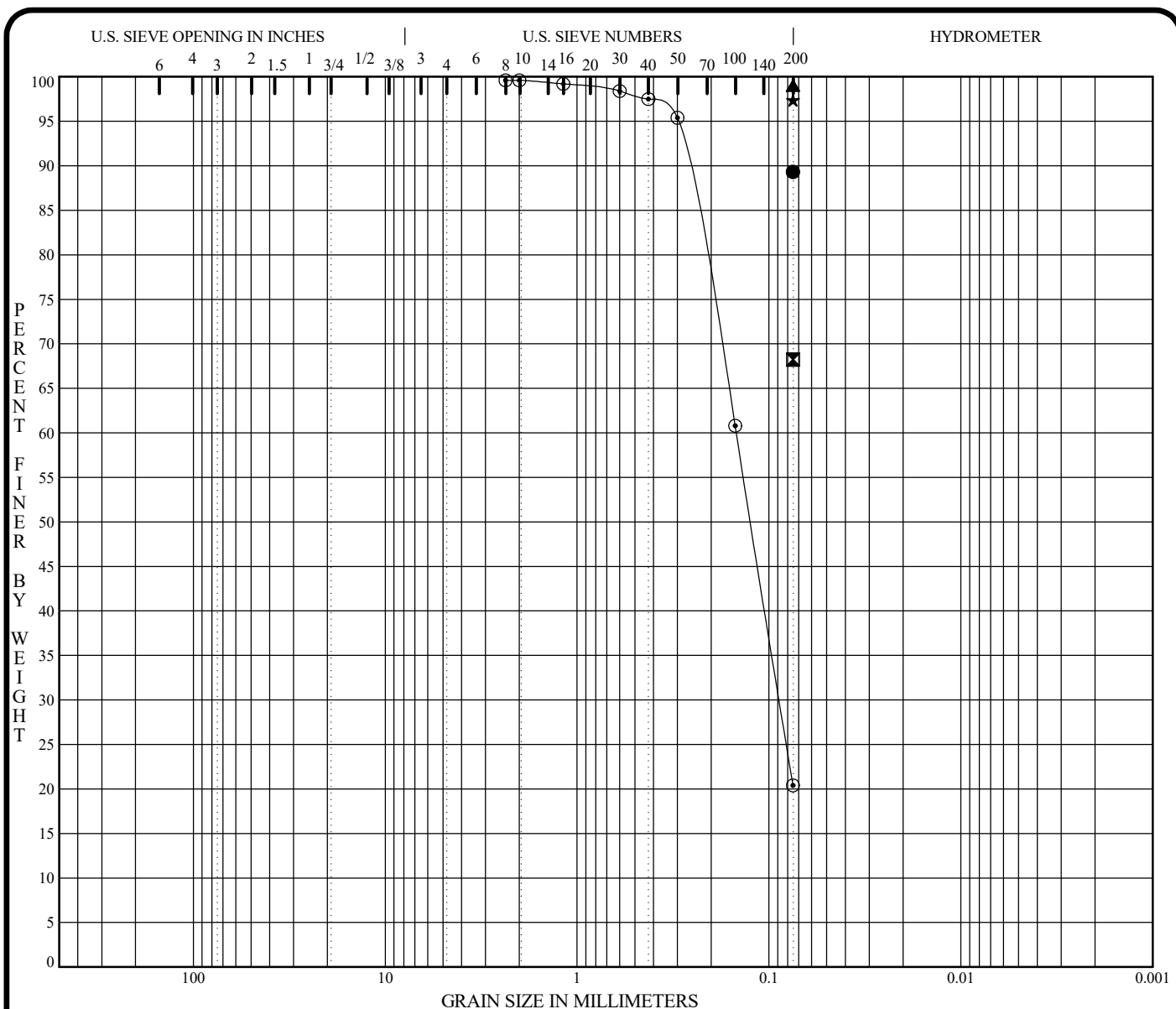
AET 11 X 17 N-VALUE & GEOLOGY 37-20591 GINT.GPJ AET+CPT+WELL_20181012_JG.GDT 2/16/21

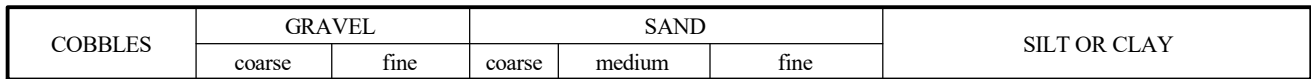


American Engineering Testing, Inc.
322 47th Street West
Williston, ND 58801
Telephone: (701) 572-3324

Fort Peck Fish Hatchery Transmission Main
Fort Peck, MT
AET No: 37-20591

— Approximate Elevation of Proposed Pipeline

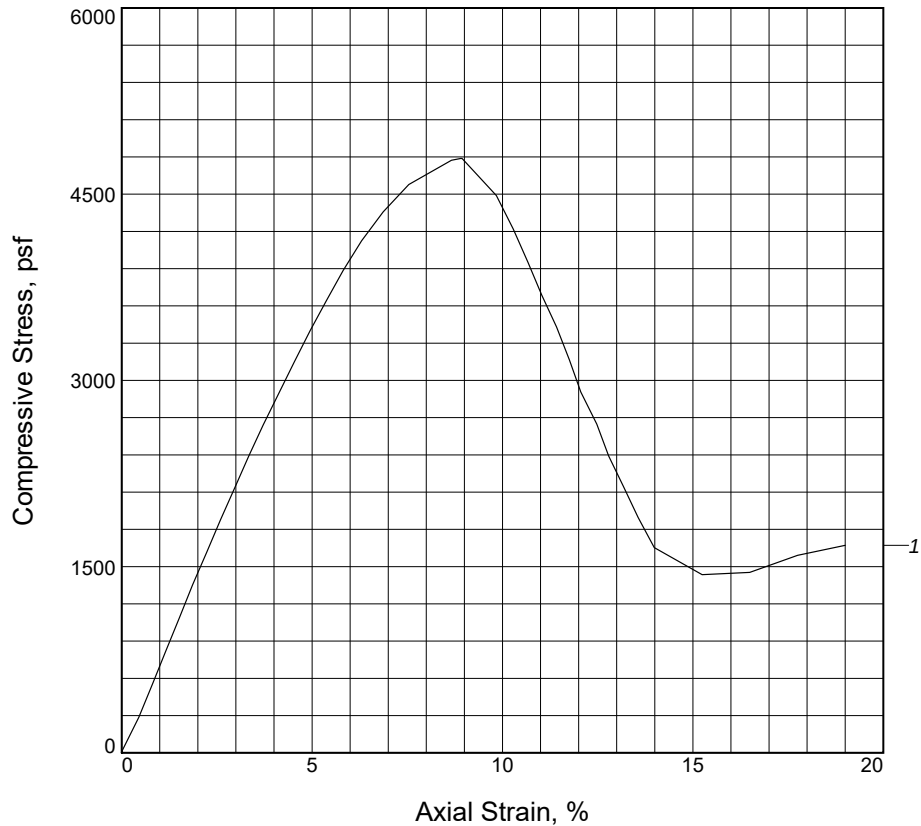


[illegible]

AET JOB NO. 37-20591
DATE 2/1/21



UNCONFINED COMPRESSION TEST



Speciman No.	1			
Unconfined strength, psf	4789			
Undrained shear strength, psf	2394			
Failure strain, %	8.9			
Strain rate, %/min.	1.00			
Water content, %	21.0			
Wet density, pcf	119.1			
Dry density, pcf	98.5			
Saturation, %	81.7			
Void ratio	0.6799			
Specimen diameter, in.	1.88			
Specimen height, in.	4.01			
Height/diameter ratio	2.13			

Description: Brown Lean Clay with Lignite Lenses

LL = 45 **PL** = 23 **PI** = 22 **Assumed GS**= 2.65 **Type:** California Ring

Project No.: 37-20591
Date Sampled: 1/29/2021
Remarks:
 ASTM D 2166

Client: Interstate Engineering

Project: Fort Peck Fish Hatchery Transmission Main

Source of Sample: B-3 **Depth:** 7

Sample Number: 3

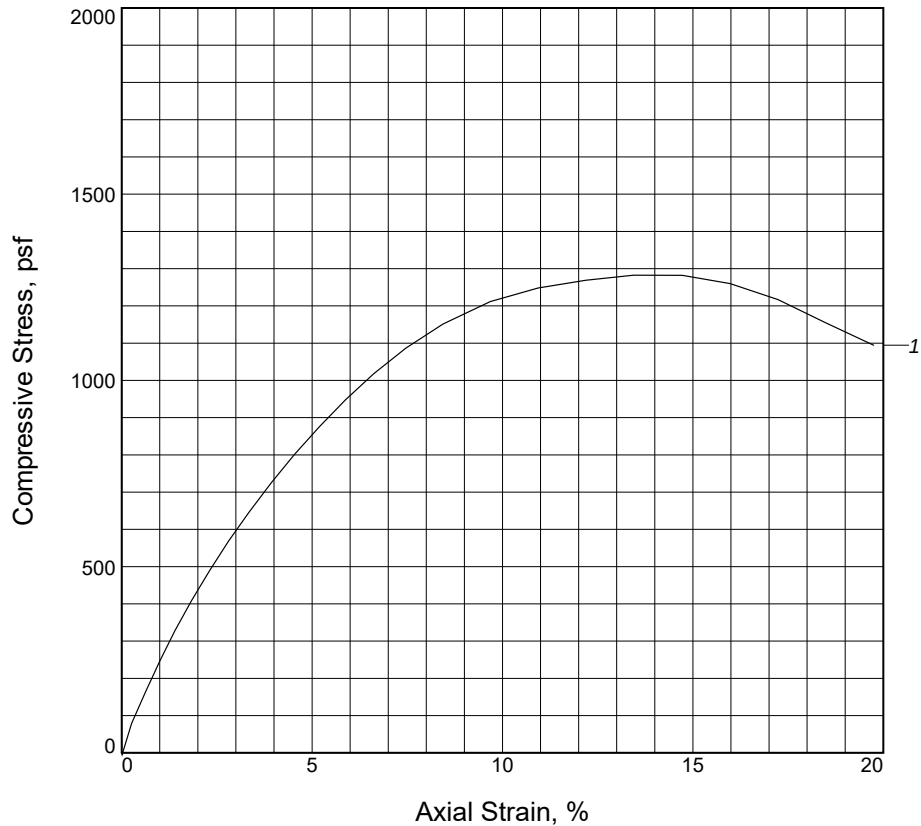
UNCONFINED COMPRESSION TEST
 American Engineering Testing, Inc.
 Gillette, WY

Figure _____

Tested By: Jim Frey

Checked By: *Harry Fitzgerald*

UNCONFINED COMPRESSION TEST



Speciman No.	1			
Unconfined strength, psf	1282			
Undrained shear strength, psf	641			
Failure strain, %	13.4			
Strain rate, %/min.	1.00			
Water content, %	27.5			
Wet density, pcf	120.7			
Dry density, pcf	94.6			
Saturation, %	97.4			
Void ratio	0.7479			
Specimen diameter, in.	1.91			
Specimen height, in.	4.02			
Height/diameter ratio	2.10			

Description: Brown Sandy Lean Clay

LL =	PL =	PI =	Assumed GS= 2.65	Type: California Ring
Project No.: 37-20591 Date Sampled: 1/29/2021 Remarks: ASTM D 2166			Client: Interstate Engineering Project: Fort Peck Fish Hatchery Transmission Main Source of Sample: B-5 Depth: 7 Sample Number: 3	
Figure _____			UNCONFINED COMPRESSION TEST American Engineering Testing, Inc. Gillette, WY	

Tested By: Jim Frey

Checked By:

Harry Fitzgerald

Appendix B

Geotechnical Report Limitations and Guidelines for Use

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by GBA¹, of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Understand the Geotechnical Engineering Services Provided for this Report

Geotechnical engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical engineering services is typically a geotechnical engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

B.2.2 Geotechnical Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client.

Likewise, geotechnical engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client.
- for a different project or purpose.
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it, e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

¹ Geoprofessional Business Association, 1300 Piccard Drive, LL14, Rockville, MD 20850
Telephone: 301/565-2733: www.geoprofessional.org, 2019

B.2.3 Read the Full Report

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. Read and refer to the report in full.

B.2.4 You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, always inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

B.2.5 Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

B.2.6 This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

B.2.7 This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

B.2.8 Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical engineering report, along with any attachments or appendices, with your contract documents, but be certain to note conspicuously that you've included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about

specific project requirements, including options selected from the report, only from the design drawings and specifications. Remind constructors that they may perform their own studies if they prefer and be sure to allow enough time to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

B.2.9 Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.10 Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical engineering study. For that reason, a geotechnical engineering report does not usually provide environmental findings, conclusions, or recommendations, e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated subsurface environmental problems have led to project failures. If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

B.2.11 Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. Geotechnical engineers are not building-envelope or mold specialists.

**Report of Geotechnical Engineering
Services
Fort Peck Fish Hatchery Transmission
Main Delft Equation Evaluation
Fort Peck, Montana**

AET Project No. P-0005142

Date:
September 24, 2021

Prepared for:



Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

September 24, 2021

Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Attn: Mr. John Bach, PE

RE: Report of Geotechnical Engineering Services
Fort Peck Fish Hatchery Transmission Main Delft Equation Evaluation
Fort Peck, Montana
AET Report No. P-0005142

Greetings Mr. Bach:

American Engineering Testing (AET) has completed the enclosed report of geotechnical engineering services for the Fort Peck Transmission Main project. This service was performed in accordance with our proposal to you dated July 30, 2021.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding the information presented in this report or if we can be of additional assistance, please contact us.

Sincerely,
American Engineering Testing



Harvey T. Fitzgerald, PE
Geotechnical Engineer
Williston Manager
hfitzgerald@amengtest.com
701.572.3324
605.209.6225



SIGNATURE PAGE

Prepared for:

Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Attn: Mr. John Bach, PE

Prepared by:

American Engineering Testing, Inc.
1225 Bean Drive
Williston, North Dakota 58801
(701) 572-3324/www.teamAET.com

Authored by:

A handwritten signature in blue ink, reading 'Harvey T. Fitzgerald', written over a horizontal line.

Harvey T. Fitzgerald, PE
Geotechnical Engineer
Williston Manager

Reviewed by:

A handwritten signature in blue ink, reading 'Jon C. Howell', written over a horizontal line.

Jon C. Howell, MS, PE
Senior Geotechnical Engineer
Gillette Manager



TABLE OF CONTENTS

Transmittal Letter	i
Signature Page	ii
TABLE OF CONTENTS	iii
1.0 INTRODUCTION	1
2.0 SCOPE OF SERVICES	1
3.0 PROJECT INFORMATION	1
4.0 DELFT EQUATION EVALUATION	2
4.1 Delft equation introduction	2
4.2 Initial Bore Diameter	3
4.3 Estimated Soil Parameters	3
4.4 Maximum HDD Pressures	4
4.5 Minimum HDD Pressures	5
4.6 Grouting Procedures and Mix Design Considerations	5
4.7 Summary	6
5.0 LIMITATIONS	6
6.0 References	6

APPENDIX A

Maximum Allowable Mud Pressure in Annular Space

Maximum and Minimum Allowable Mud Pressure in Annular Space

1.0 INTRODUCTION

The project consists of constructing a new transmission main from the Power House at the Fort Peck Dam to the Fort Peck Fish Hatchery in Fort Peck, Montana. American Engineering Testing, Inc. (AET) was authorized to perform a geotechnical exploration at the project site in order to provide geotechnical recommendations for utility construction, including trench excavations and horizontal directional drilling (HDD) considerations; however, our scope of services did not include a Delft Equation Evaluation in order to evaluate the risk of hydraulic fracturing of the soils along the proposed HDD path. To assist planning and design, you have authorized AET to perform a geotechnical engineering review for the project, specifically, the Delft Equation Evaluation. This report presents the results of the above services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET performed their services according to our proposal written for you dated July 30, 2021, which you authorized via Task Order 13 on the same day. The authorized scope consists of the following.

- Perform geotechnical review of the existing subsurface soils.
- Evaluate the risk of hydraulic fracturing of the soils along the proposed HDD boring profile by the “Delft method” and provide recommended maximum and minimum fluid pressures for HDD drilling operations and grouting.

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination in the soil or groundwater, the presence of abandoned mines, or any other services not explicitly mentioned above.

3.0 PROJECT INFORMATION

The proposed HDD borehole is planned along the toe of the Fort Peck Dam, north of the Yellowstone River. We understand the HDD borehole will run between Stations 71+64 and 127+10, and the depth of the borehole will typically be eight to ten feet below the existing ground surface and will be approximately 20 feet below the surface near Station 95+50. The pipeline will consist of a 14-inch diameter raw waterline cased with 18-inch diameter PVC casing. Based on the size of the PVC casing, we have assumed the HDD borehole to be 20 inches in diameter. We provide a detailed project information in our original geotechnical report, *Report of Geotechnical Exploration, Fort Peck Fish Hatchery Transmission Main*, dated February 24, 2021.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate. If any changes, such as alignment or otherwise, occur at any time, AET will require a reevaluation of the scope of services to see if additional exploration, field or laboratory testing, or other services will be necessary to revisit the evaluation.

4.0 DELFT EQUATION EVALUATION

4.1 DELFT EQUATION INTRODUCTION

The Report, *Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling* (Staheli, Bennett, O'Donnel, & Hurley, 1998) provides an equation to estimate the maximum allowable pressure that can be developed in the annular space to prevent the potential for hydrofracture. The Delft equation is shown below.

$$p_{max} = u + p'_{max} = u + (p'_f + c \cdot \cot \phi) \cdot \left\{ \left(\frac{R_0}{R_{p,max}} \right)^2 + Q \right\}^{\frac{-\sin \phi}{1 + \sin \phi}} - c \cdot \cot \phi$$

Where:

p_{max} = maximum allowable effective mud pressure in psf

u = initial pore pressure in psf

p'_f = fluid pressure at which the first plastic deformation takes place in psf

$$p'_f = \sigma' \cdot (1 + \sin \phi) + c \cdot \cos \phi$$

σ' = initial effective stress in psf

ϕ = angle of internal friction in degrees

c = cohesion in psf (in undrained situation $c = c_u$ and $\phi = 0$)

R_0 = initial radius of the bore hole in feet

$$Q = \frac{\sigma' \cdot \sin \phi + c \cdot \cos \phi}{G}$$

G = shear modulus in psf

$R_{p,max}$ = radius of the plastic zone

$$\text{In clayey and peat layers, } R_{p,max} = \frac{H}{2}$$

$$\text{In sand layers, } R_{p,max} = \frac{2}{3} H$$

where, H = height of the soil cover in feet

The Delft Equation is a mathematical function of the soil's friction angle, cohesion, shear modulus, the borehole diameter, effective stress, and an assumed plastic radius to calculate a maximum pressure above which hydraulic fracturing could occur.

4.2 INITIAL BORE DIAMETER

We understand that the proposed 14-inch diameter raw waterline will be installed by horizontal directional drilling along the toe of the Fort Peck Dam. We understand the waterline will be cased with an 18-inch diameter PVC casing. For calculating purposes, we have assumed the HDD bore to be 20-inches in diameter.

The Delft equation suggests using a plastic radius (R_p) of two-thirds the depth of the profile in sand soils and one-half the depth of the profile in clay soils as a means of applying a factor of safety to the results. In the Paper TA-T2-03, *Soil Mechanics and Calculating Hydraulic Fracture Risk* (Miller & Robison, 2019), the authors state "Recent discussions with the US Army Corps of Engineers (USACE) Risk Management Center (RMC) have suggested that limit the R_p value to something on the order of two- or three-hole diameters might be a reasonable way to limit plastic deformation of the formation surrounding the hole when completing HDD installations under critical facilities such as levees." Based on the conclusions from these discussions, we inputted a plastic radius of five feet into the Delft equation for purposes of this analysis.

4.3 ESTIMATED SOIL PARAMETERS

As stated previously, the soil profiles used to develop parameters for use in the Delft equation were based on subsoils encountered in the nearby boring locations. The soil parameters used were estimated from the field exploration data, limited laboratory testing, and generally accepted geotechnical correlations.

- At the time of our subsurface exploration, the groundwater elevation ranged from 2,040 feet to 2,072 feet. The elevation of the Fort Peck Reservoir was reported as 2,234.2 feet. It should be noted that the solution of the Delft equation is sensitive to groundwater elevation. The maximum allowable fluid pressures derived from the Delft equation may increase somewhat with deeper groundwater levels.
- For sands, ϕ (angle of internal friction) was estimated using the established correlations using the blow counts (N-values) (Peck, et al, 1974) and using our experience with similar soils.
- For cohesive soils, C (cohesion) was estimated from our experience with similar soils and from published typical values for the similar soils.
- G (shear modulus), was calculated using $G=E_s/2(1+\mu)$, where E_s is the correlated elastic modulus, and μ is Poisson's ratio.

- Poisson's ratio values for soils were obtained from the typical values provided in *Principles of Geotechnical Engineering* (Das, 2010) for similar soils, and the elastic modulus values for sands were obtained from the established correlation and using the typical values provided in (Das, 2010). Typical elastic modulus values provided in (Das, 2010) were used for cohesive soils.
- Soil parameters used in the analysis are presented in the table below:

Table 4.3-1 Soil Parameters

Soils	Consistency/RD	Frictional Angle	Elastic Modulus	Poisson's Ratio
		ϕ (degrees)	E_s (ksf)	μ (value)
Clay	Soft	0	100	0.30
Clay	Stiff	0	200	0.35
Sand	Very Loose	28	220	0.20
Sand	Loose	30	300	0.30
Sand	Medium Dense	32	400	0.35

4.4 MAXIMUM HDD PRESSURES

Based on the Delft Equation and the estimated soil parameters presented in the table above, the maximum effective mud pressure (P_{max}) was calculated in the annular space at six (6) station locations along the proposed HDD alignment. The locations were selected based on the boring locations (B-7 to B-12). Based on the proposed depth of the pipeline, we anticipate the HDD pipeline will primarily be in very loose to medium dense sands with varying amounts of fine-grained subsoil. Near Borings B-8 and B-9 (Stations 81+50 to 92+50), the HDD pipeline will be at or below the groundwater elevation. From Borings B-10 to B-12 (Stations 103+50 to 125+50), we anticipate the HDD alignment will be above the groundwater elevation in loose to medium dense sands. In saturated sands, creation of voids is unlikely to occur due to hydrostatic forces, however, loose dry sands and soft clays present a risk of hydraulically fracturing from pressure exceeding the recommended maximum effective mud pressures (P_{max}) presented in this report.

Based on the soil parameters above and our understanding of the proposed HDD pipeline, the maximum effective mud pressure will range from 13 to 23 pounds per square inch (psi). The spreadsheet in Appendix A shows the calculation of the maximum effective mud pressure at various locations in tabular format. Please note, the maximum effective mud pressure presented in Appendix A has a safety factor of 1.5 applied, as suggested by (Miller & Robison, 2019). We used soil information from the nearby borings in our evaluation. The applicable boring locations for each station are included in the spreadsheet.

4.5 MINIMUM HDD PRESSURES

An additional concern with fluid pressure is the minimum pressure required to stabilize the bore to prevent collapse. A guideline to determining a minimum required mud pressure is presented in Appendix A of the USACE publication “Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling”, ERDC/GSL TR-02-9, (Latorre, Wakeley, & Conroy, 2002). The publications states that the minimum required mud pressure can be estimated with the following equation:

$$P_1 = h * Y_{\text{mud}}$$

Where:

P_1 = component of minimum required annular pressure provided by weight

h = difference in elevation between the bore and the exit point of the mud flow

Y_{mud} = unit weight of mud

We used an estimated mud unit weight of 70 lb/ft³ in our evaluation. We provide a spreadsheet in Appendix A detailing the calculation of the minimum effective mud pressure (P_{min}) at various locations. We have not applied a factor of safety to the minimum effective mud pressure because the purpose is simply to maintain an open borehole.

4.6 GROUTING PROCEDURES AND MIX DESIGN CONSIDERATIONS

We recommend that the HDD bore be grouted at both the entry and exit pits after completion of the conduit pull. The grouting should be implemented by inserting a rigid 1 to 1.5-inch diameter grout tube into the bore hole as far as possible, up to 100 feet from the entry and exit points. The pipe should be sealed at the insertion end, and one-way ports should be included in the tremie pipe to be located at least 100 feet, or to the depth possible, from the entry and exit pits. The annulus should be grouted until grout returns are present at both the entry and exit pits.

The grout should be a stabilized non-shrink Portland cement-bentonite grout with a 28-day compressive strength of at least 100 psi. The grout should be of suitable fluidity (use of admixtures permissible) such that the grout will flow to the entry and exit points at a pressure that does not exceed the allowable mud pressure stated in this report. If the grout does not exit into both the entry and exit pits from the grouting process, then the end of the bore should be grouted again by extending solid tremie pipe as far as possible into the bore and pumping grout into the annulus until grout returns to the surface at an entry or exit of the pipeline. Grouting pressures should be carefully controlled to be maintained below the maximum allowable mud pressure to reduce the risk of hydrofracture.

4.7 SUMMARY

Based on our evaluation, the maximum effective grout pressure ranges from 13 to 23 psi and the minimum effective grout pressure ranges from 8 to 15 psi. The soil conditions at the site result in the relatively low maximum effective grout pressures which creates a narrow window between the maximum and minimum pressures and may be challenging for an HDD contractor to maintain pressures between the maximum and minimum pressures. Due to the challenging subsurface soil conditions, we recommend selecting an HDD contractor with experience with similar soil conditions and the ability to achieve the necessary pressures. Drilling fluid pressures should be monitored and documented by the HDD contractor continually while drilling to confirm that pressures fall between the recommended minimum and maximum values.

5.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use."

6.0 References

- Das, B. M. (2010). *Principles of Geotechnical Engineering 7th Edition*. Cengage Learning.
- Latorre, C. A., Wakeley, L. D., & Conroy, P. J. (2002). *Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling*. US Army Corps of Engineers - Engineer Research and Development Center.
- Miller, M. A., & Robison, J. L. (2019). Soil Mechanics and Calculating Hydraulic Fracture Risk. *North American Society for Trenchless Technology 2018 No-Dig Show*. Chicago, Illinois.
- Staheli, K., Bennett, D., O'Donnel, H. W., & Hurley, T. J. (1998). *Technical Report CPAR-GL-98-1 Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling*. US Army Corps of Engineers.

Appendix A

Maximum Allowable Mud Pressure in Annular Space
Maximum and Minimum Allowable Mud Pressure in Annular Space

Appendix A



Project: Fort Peck Fish Hatchery Transmission Main
Project No: P0005142
Calculation: Max Allow Mud Pressure in Annular Space
Calculated By: HTF
Reviewed By: JB/JCH
Date: 9/24/2021

Groundwater Highest Elevation 2044
Groundwater Lowest Elevation 2037
Factor of Safety 1.5

Atmospheric Pressure (psf) 2116
Clay unit weight (pcf) 118
Clay saturated unit weight (pcf) 120
Sand unit weight (pcf) 115
Sand saturated unit weight (pcf) 120

Water unit weight (pcf) 62.4

Boring	Station	Soil Class	Consist/RD	Top Layer (EL)	Bottom Layer (EL)	Pipe Elev	Groundwater (EL)	Thick (ft)	Depth (ft)	C (psf)	φ (deg)	E (ksf)	μ (value)	G (ksf)	u (psf)	σ' vo (psf)	p' f	R o (ft)	R p,max	Q (value)	(R o/R p,max)2+Q (value)	-sinφ/(1+sinφ)	c x cotφ	P max (psf)	P max (psi)
B-7	70+50	Clay	stiff	2058	2046	2048	2044	12.0	12.0	300	0	200	0.35	74	0	1416	1716	0.83	5.0	0.004	0.032	0.000	8594367	1835	13
		Sand	very loose	2046	2034	2048	2044	12.0	24.0	0	28	220	0.20	92	0	1186	1743	0.83	5.0	0.006	0.034	-0.319	0	3434	24
																								13	P max
B-8	81+50	Clay	soft	2049	2045	2042	2040	4.5	4.5	400	0	100	0.30	38	0	531	931	0.83	5.0	0.010	0.038	0.000	11459156	1493	10
		Sand	very loose	2045	2033	2042	2040	2.8	7.3	0	28	220	0.20	92	0	853	1253	0.83	5.0	0.004	0.032	-0.319	0	2511	17
																								17	P max
B-9	92+50	Sand	very loose	2050	2043	2044	2043	7.0	7.0	0	28	220	0.20	92	0	725	1065	0.83	5.0	0.004	0.031	-0.319	0	2147	15
		Sand	loose	2043	2030	2044	2043	-0.7	6.3	0	30	300	0.30	115	0	641	961	0.83	5.0	0.003	0.030	-0.333	0	2054	14
																								15	P max
B-10	103+50	Clay	stiff	2054	2049	2047	2040	5.0	5.0	800	0	200	0.35	74	0	590	1390	0.83	5.0	0.011	0.038	0.000	22918312	2666	19
		Sand	loose	2049	2038	2047	2040	11.0	16.0	0	30	300	0.30	115	0	831	1247	0.83	5.0	0.004	0.031	-0.333	0	2642	18
																								19	P max
B-11	114+50	Clay	stiff	2056	2049	2048	2037	7.0	7.0	1000	0	200	0.35	74	0	826	1826	0.83	5.0	0.014	0.041	0.000	28647890	3346	23
		Sand	medium dense	2049	2035	2048	2037	14.0	21.0	0	32	500	0.35	185	0	964	1475	0.83	5.0	0.003	0.030	-0.346	0	3300	23
																								23	P max
B-12	125+50	Clay	soft	2062	2054	2056	2042	5.6	5.6	500	0	100	0.30	38	0	661	1161	0.83	5.0	0.013	0.041	0.000	14323945	1842	13
		Sand	loose	2054	2050	2056	2042	4.5	10.1	0	30	220	0.20	92	0	442	663	0.83	5.0	0.002	0.030	-0.333	0	1424	10
		Clay	soft	2050	2041	2056	2042	9.0	19.1	420	0	100	0.30	38	0	-313	107	0.83	5.0	0.011	0.038	0.000	24064227	984	7
																								13	P max

Appendix A



Project: Fort Peck Fish Hatchery Transmission Main
Project No: P0005142
Calculation: Max & Min Allow Mud Pressure in Annular Space
Calculated By: HTF
Reviewed By: JB/JCH
Date: 9/24/2021

Groundwater Highest Elevation 2044
 Groundwater Lowest Elevation 2037
 HDD Entry Pit Elevation 2072

Atmospheric Pressure (psf) 2116
 Clay unit weight (pcf) 118
 Clay saturated unit weight (pcf) 120
 Sand unit weight (pcf) 115
 Sand saturated unit weight (pcf) 120
 Mud unit weight (pcf) 70
 Water unit weight (pcf) 62.4

Boring	Station	Pipe Elev	Groundwater (EL)	h (ft)	P _{min} (psf)	P _{min} (psi)	P _{max} (psi)
B-7	70+50	2048	2044	24	1680	12	13
B-8	81+50	2042	2040	30	2100	15	17
B-9	92+50	2044	2043	28	1960	14	15
B-10	103+50	2047	2040	25	1750	12	19
B-11	114+50	2048	2037	24	1680	12	23
B-12	125+50	2056	2042	16	1120	8	13



**AMERICAN
ENGINEERING
TESTING, INC.**

April 12, 2021

Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Attn: Mr. John Bach, P.E.

RE: Addendum #1
Fort Peck Fish Hatchery Transmission Main
Fort Peck, Montana
AET Project No. 37-20591

Greetings Mr. Bach:

American Engineering Testing, Inc. (AET) is pleased to provide Addendum #1 to our geotechnical evaluation for the Fort Peck Fish Hatchery Transmission Main project in Fort Peck, Montana. Based on your electronic mail correspondence on April 2, 2021 and our telephone conversation with you on April 8, 2021, we understand you and the United States Army Corps of Engineers (USACE) has requested we include the elevation of the water in Fort Peck Reservoir during the time of our subsurface exploration to our report.

Our subsurface exploration occurred on February 1st through the 3rd of 2021. Based on the information you provided in the electronic mail correspondence, the elevation of the reservoir ranged from 2,234.2 to 2,234.4 feet at the time of our subsurface exploration.

CLOSING

This addendum should be attached to and considered part of our geotechnical engineering evaluation. We appreciate the opportunity to continue our professional relationship with Interstate Engineering, Inc. If you have any questions regarding this addendum or need more information, please contact us at (701) 572-3324.

Respectfully,
American Engineering Testing, Inc.

Harvey T. Fitzgerald
Harvey T. Fitzgerald, P.E.
Geotechnical Engineer
Williston Manager



322 47th Street West | Williston, ND 58801

Phone (701) 572-3324 | Toll Free (800) 972-6364 | www.amengtest.com | AA/EEO

This document shall not be reproduced, except in full, without written approval from American Engineering Testing, Inc.



July 29, 2024

Mr. John Bach, PE
Interstate Engineering, Inc.
6066 Highway 24 South
Glasgow, Montana 59230

Subject: Additional Geotechnical Engineering Services
Fort Peck Fish Hatchery Transmission Main
IEI Project No. S1800053.01-Fort Peck, Montana
AET No. P-0032724

Greetings Mr. Bach,

This report documents AET's findings regarding additional geotechnical engineering services for the Fort Peck Fish Hatchery Transmission Main project (IEI Project No. S1800053.01) in Fort Peck, Montana. These services were performed in general accordance with AET's April 11, 2024 proposal and authorized through Task Order No. 25 dated May 13, 2024.

PROJECT BACKGROUND

As you know, AET has issued the following reports for Geotechnical services performed previously for the above-referenced project:

- Report of Geotechnical Exploration-Fort Peck Fish Hatchery Transmission Main- Fort Peck, Montana (AET No. 37-20591; February 24, 2021)
- Addendum #1- Fort Peck Fish Hatchery Transmission Main- Fort Peck, Montana (AET No. 37-20591; April 12, 2021)
- Report of Geotechnical Engineering Services-Fort Peck Fish Hatchery Transmission Main Delft Equation Evaluation- Fort Peck, Montana (AET No. P-0005142; September 24, 2021)

We understand the State of Montana is planning on constructing a water transmission line from the Power House at the Fort Peck Dam to the Fort Peck Fish Hatchery in Fort Peck, Montana. AET was authorized to perform a geotechnical exploration at the project site to provide geotechnical recommendations for utility construction, including trench excavations and horizontal directional drilling (HDD) considerations. AET issued a Geotechnical Report on February 24, 2021, and an Addendum on April 12, 2021, which presented and summarized our findings, results of field and laboratory testing, and geotechnical recommendations. In July 2021, you requested additional services to include a Delft Equation Evaluation as requested by the United States Corps of Engineers (USACE). As you know, the results of our

Delft Equation Evaluation were presented in our September 24, 2021 report. Based on the information you have provided (i.e. emails, portions of the USACE review document, etc.), we understand that the Delft Equation is inaccurate and is no longer recognized by the USACE. In a portion of the USACE review document, you provided (#10465884 Geotechnical), a reference was presented by USACE, as an acceptable substitute for calculating allowable drilling fluid pressures. USACE recommended using the “elastic equations (5.7-5.8) found in Manual EM 1110-2-2902.

You requested AET’s response for 6 comments (highlighted) in the USACE review document. Our responses are presented in the following paragraphs in the same order that they appear in the USACE review document.

RESPONSES

- USACE comment: ***“Concern – For the design and installation of waterline and casing, the guidance and mandatory requirements of EM 1110-2-2902 must be followed. Basis - EM 1110-2-2902 Conduits, Pipes, and Culverts Associated with Dams and Levee Systems. Significance – Critical. Due to USACE’s unique structures and their associated risks, criteria in this manual may exceed industry requirements. The criteria in this manual are minimum USACE requirements. Action – Follow USACE guidance and mandatory requirements of the engineering manual.”***

AET’s response:

It is clear that USACE requires compliance with the criteria presented in EM 1110-2-2902. The manual presents criteria as it applies to pipes/conduits of various material types. Once IEI selects the material type the appropriate Chapter can be selected and the criteria followed from the appropriate chapter in the manual. Moreover, the criteria presented in Chapter 1, which seems to be generally applicable to any material should also be followed as appropriate.

- USACE comment: ***“The pipeline elevations included in the AET Geotechnical Exploration (PDF Page 339) do not match the figures on C-1 through C-5. The exact waterline elevation must be determined and consistently identified in the submitted documentation in order to inform potential problematic construction conditions. The elevation of “Soil Bore #7” is shown at 2061’ on sheet C-3 but it is called out as 2058.1’ on the AET Geotechnical Exploration. Please reconcile and clearly state which coordinate system is being used for the elevations.”***

AET’s response:

We understand IEI “shifted” the alignment slightly after AET completed the field exploration and issued the Report dated February 7, 2024. The surface elevation discrepancy between what AET reported on “Soil Bore #7 and what IEI reported on Sheet C-3 is due to the alignment shift.

- USACE comment: ***“There is no citation or laboratory data to support some of the soil properties used for the HDD analysis. Please add table with each property used and reference for how that property was obtained.”***

AET’s response:

See response and table presented in the following section.

- USACE comment: ***“Concern – AET used the Delft equation to calculate the allowable mud pressures which is no longer appropriate for HDDs according to ER 1110-1-1807 date 1 June 2023 page 5 section g (1). Significance – Critical. USACE policy no longer allows for use of the Delft equation due to concerns of inaccuracy of such methods which could result in unsafe design. Action – Use the elastic equation (5.7 – 5.8) from EM 1110-2-2902.”***

AET's response:

Applicable excerpts from EM 1110-2-2902 (31 December 2020) are as follows:

“5.6.3. Drilling Fluid Pressures and Hydraulic Fracture.

5.6.3.1. General. The installation methods described in Table 5-3 require introduction of water-based lubricants within an annular “overcut” space between the pipe and the soil to facilitate pipe installation and remove drill cuttings. The annular space must be grouted as outlined in Section 5.6.4.7. The drilling fluids or grout that are introduced can cause the borehole to fail through uncontrolled expansion or hydraulic fracturing; therefore, the procedure discussed in this section must be followed.

5.6.3.2. Minimum Depth Requirements. Pipes installed within USACE dam or levee earthen embankments must have a minimum depth of cover below the lowest portion of the crest of at least nine feet, or a depth-to-crown to bore-diameter ratio equal to or greater than three; whichever is greater. Similarly, pipes installed beneath embankments must have a depth-to-crown to bore-diameter ratio of equal to or greater than three to prevent surface disturbances. In addition, the minimum depth of cover must accommodate short- and long-term loads imposed on the pipe. For all methods that use pressurized drilling fluid or grout, the minimum depth of cover is determined by establishing the depth required to maintain the required factor of safety against hydraulic fracture using the estimated operational drilling pressures.

5.6.3.3. Influence of Mud Pressures. The cavity expansion theory was first developed by Vesic (1972) and then further developed for use in horizontal directional drilling (HDD) projects by researchers at Delft Geotechnics, Luger and Hergarden (1988). The theory is that as the annular fluid pressure increases, the borehole radius will expand. Initially the deformation will be elastic, but as the pressure increases, the deformation will become plastic. As the zone of the plastic deformation increases to the ground surface, blowout will occur and drilling fluid will flow to the surface, creating a “frac out” or “inadvertent return.”

5.6.3.4. Hydraulic Fracture Capacity (Delft Equation). Equation 5-1 through Equation 5-5 were developed by Luger and Hergarden (1988) and have previously been recommended by USACE for estimating the maximum total mud pressure (CPAR, 1998).

$$\text{Equation 5-1} \\ p_{\max} = p'_{\max} + u$$

5.6.3.5.2. Maximum Plastic Radius, $R_{p,\max}$. The radius of the plastic zone $R_{p,\max}$ must be selected by the designer. Practitioners concerned about limiting fluid releases to the surface have used 1/2 the distance to the ground surface for clays and 2/3 the distance for sands. These values were selected assuming that no damage would occur outside the zone established by $R_{p,\max}$;

however, these $R_{p,max}$ values are meant to produce limiting pressures that will prevent drilling fluid surface release, but not necessarily localized hydraulic fracture. *Staheli (2010) and Rostami (2017) have both shown the calculation of P_{max} is not sensitive to $R_{p,max}$ beyond a few feet from the borehole and that there is no correlation to the actual fracture pressure.* Instead of assuming that plastic deformation is permissible, it is preferred that deformation be limited to the elastic range where specifying $R_{p,max}$ is not required.

5.6.3.5.3. Drained vs. Undrained Conditions. During drilling, the loading from the annular drilling fluid pressure will be drained for pervious materials and undrained for impervious material. The Delft equation includes both cohesion and friction angles which presents the potential to erroneously use both drained and undrained strengths together. For evaluating low permeability soil layers, $\phi'=0$ should be assumed and only the undrained strength (cohesion) should be used. For this condition, the equation for the maximum effective mud pressure reduces to Equation 5-7.

$$\begin{array}{c} \text{Equation 5-7} \\ P'_{max} = \sigma_0 + c \end{array}$$

For high permeability soil layers, $c = 0$ should be assumed and only the effective friction angle (ϕ') should be used. For this condition, the maximum effective mud pressure should be limited to equal p'_{tf} , where plastic deformation initiates according to Equation 5-8.

$$\begin{array}{c} \text{Equation 5-8} \\ P'_{max} = p'_{tf} = \sigma_0 \cdot (1 + \sin \phi) \end{array}$$

To get the maximum total pressure that can be compared to measured pressures, the pore pressure needs to be added, as shown in Equation 5-1.

Where:

P_{max} = maximum total mud pressure (psf)

P'_{max} = maximum effective mud pressure (psf)

σ_0 = effective confining stress (psf)

u = initial pore water pressure (psf)

c = cohesion (psf)

ϕ = angle of internal friction (degrees)"

Estimated Soil Parameters:

As stated in AET's September 24, 2021, Geotechnical Engineering Services Report, the soil profiles used to develop parameters for use in the Delft equation were based on subsoils encountered in the nearby boring locations. Similarly, the soil parameters used for the new

methodology (elastic equations 5-7 & 5-8) were estimated from the field exploration data, limited laboratory testing, and generally accepted geotechnical correlations.

1. At the time of our subsurface exploration, the groundwater elevation ranged from 2,040 feet to 2,072 feet. The elevation of the Fort Peck Reservoir was reported as 2,234.2 feet.
2. For sands, ϕ (angle of internal friction) was estimated using the established correlations using the blow counts (N-values) (Peck, et al, 1974) and using our experience with similar soils. γ (dry unit weight) was estimated from published data (Principles of Geotechnical Engineering, 7th edition, 2010, Braja M. Das)
3. For cohesive soils, c (cohesion) was estimated from our experience with similar soils and from published typical values (Peck, et al, 1974) for the similar soils.

Soil parameters used in the analysis are presented in the table below:

Estimated Soil Parameters

Soils	Consistency/RD	Frictional Angle	Cohesion	Dry Unit Weight
		ϕ (degrees)	c (psf)	γ (pcf)
Clay	Soft	0	375	83.0
Clay	Stiff	0	1500	108.0
Sand	Very Loose	28	NA	92.0
Sand	Loose	30	NA	102.0
Sand	Medium Dense	32	NA	115.0

- USACE comment: ***“Concern – Specifications for excavation are inadequate. Section Necessary excavation. Significance – Construction-related risk at fort Peck has the potential to increase to unacceptable levels depending on design and implementation of an adequate Excavation Plan. Long-term performance risk can be mitigated by ensuring appropriate execution of an approved excavation plan. Recommendations related to excavation are included in the AET report, but do not constitute a final, implementable excavation plan. Action – Submit an Excavation Plan for government review. This plan should include, but is not limited to, the following items:***
 - *Identify what OSHA soil type(s) are expected,*
 - *Identify maximum depth of excavation profile sheets,*
 - *Identify excavation limits on plan sheet,*
 - *Shoring/trench box/benching system information,*
 - *Equipment to be used for excavation and backfilling,*
 - *Compaction testing intervals,*
 - *Borrow source information,*
 - *Emergency Action Plan (EAP),*
 - *Daily monitoring reporting information,*

- **Haul plan,**
- **Spoils handling,**
- **Permits required, and**
- **Restoration Plan.”**

AET's response:

- See AET Report of Geotechnical Exploration, Fort Peck Fish Hatchery Transmission Main, Section 6.2.3 Trench Excavation (pages 5 & 6 of 11) dated February 24, 2021.
- Item addressed by IEI.
- Item addressed by IEI Earthwork Contractor to provide information.
- Earthwork Contractor to provide information.
- See AET Report of Geotechnical Exploration, Fort Peck Fish Hatchery Transmission Main, Section 6.3 Materials and Compaction (pages 7 & 8 of 11) & Section 6.4 Testing Frequencies (pages 8 & 9 of 11) dated February 24, 2021.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- IEI/Earthwork Contractor to provide information.
- USACE comment: ***“Concern – AET used a single assumed diameter borehole of 20” for HDD drilling calculations. USACE agrees that 20” is reasonable for the 18” pipe-in-pipe (PIP) sections, but there are 14” non-PIP sections that would likely have a smaller drilled borehole. Significance – Calculations for min and max drilling pressures require borehole diameter as a variable. Assuming 20” diameter borehole for 14” sections of pipe is likely not correct since borehole diameters should be minimized and could lead to unacceptable drilling pressures during construction. Action – Update HDD pressure analysis to include consideration for varying pipe diameters.”***

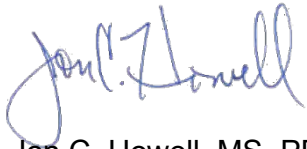
AET's response

Based on the USACE document IEI provided, use of the Delft Equation is not allowed ***“USACE policy no longer allows for use of the Delft equation due to concerns of inaccuracy of such methods which could result in unsafe design.”*** Moreover, according to Section 5.6.3.5.2. Maximum Plastic Radius, $R_{p,max}$, of EM 1110-2-2902 (31 December 2020) ***“the calculation of P_{max} is not sensitive to $R_{p,max}$ beyond a few feet from the borehole and that there is no correlation to the actual fracture pressure.”*** The approved method calculations (elastic equations 5-7 & 5-8) are not a function of borehole diameter.

CLOSING

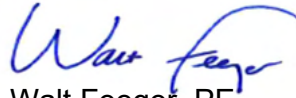
We appreciate the opportunity to respond to USACE's comments for this project. If you have questions regarding AET's responses, please contact the undersigned.

Sincerely,
American Engineering Testing, Inc.



Jon C. Howell, MS, PE
Principal Geotechnical Engineer
West Division

Reviewed by:



Walt Feeger, PE
Principal Geotechnical Engineer
West Division



FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 03 CONCRETE

TABLE OF CONTENTS

DIVISION 03 – CONCRETE

SECTION	DOCUMENT
03 00 00	Concrete
03 15 00	Concrete Accessories
03 20 00	Concrete Reinforcing
03 39 00	Concrete Curing

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

03.1.01 DESCRIPTION

- A. This section of the Contract Documents includes furnishing cast-in-place and structural concrete composed of portland cement, aggregates, and water meeting all specified requirements.

03.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|-------------|--|
| ASTM C33 | Concrete Aggregates |
| ASTM C94 | Ready-Mixed Concrete |
| ASTM D98 | Calcium Chloride |
| ASTM C138 | Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete |
| ASTM C143 | Slump of Hydraulic-Cement Concrete |
| ASTM C150 | Portland Cement |
| ASTM C173 | Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C231 | Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260 | Air-Entraining Admixtures for Concrete |
| ASTM C494 | Chemical Admixtures for Concrete |
| ASTM C595 | Blended Hydraulic Cements |
| ASTM C618 | Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C989 | Slag Cement for Use in Concrete and Mortars |
| ASTM C1017 | Chemical Admixtures for Use in Producing Flowing Concrete |
| ASTM C1116 | Fiber-Reinforced Concrete |
| ASTM C1157 | Hydraulic Cement |
| AASHTO T11 | Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing |
| AASHTO T21 | Organic Impurities in Fine Aggregates for Concrete |
| AASHTO T27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T71 | Effect of Organic Impurities in Fine Aggregate on Strength of Mortar |
| AASHTO T85 | Specific Gravity and Absorption of Coarse Aggregate |
| AASHTO T96 | Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| AASHTO T104 | Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate |
| AASHTO T260 | Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials |
| ACI 117 | Tolerances for Concrete Construction and Materials |
| ACI 214 | Guide to Evaluation of Strength Test Results of Concrete |
| ACI 301 | Structural Concrete |
| ACI 305 | Hot Weather Concreting |
| ACI 306 | Cold Weather Concreting |
| ACI 318 | Building Code Requirements for Structural Concrete and Commentary |

03.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 03 15 00	CONCRETE ACCESSORIES
SECTION 03 20 00	CONCRETE REINFORCING
SECTION 03 39 00	CONCRETE CURING
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

03.1.04 SUBMITTALS

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs.
- B. Mix designs for each class of concrete shall be submitted to the Engineer in accordance with the requirements of **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Submit written reports of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed and approved.
- D. Concrete producers are to allow access to their facilities by Engineer or their representatives for inspecting their facilities and/or sampling materials. All facilities should meet the requirements of the "National Ready-Mix Concrete Association" check list for concrete production facilities.
 - 1. Items directly affecting a facility's ability to properly proportion, transport and deliver concrete may be reason for disqualifying that facility as a source of supply until such deficiencies are corrected. Examples would include cement and aggregate scales that will not accurately weight materials or mixer units that will not thoroughly mix concrete materials.
- E. Submittals for a concrete mix design shall meet the mix proportions specified in ACI 301, Chapter 3, and include the following information.
 - 1. Cement in lbs (kgs) – Type and source of supply
 - 2. Coarse aggregate – Size and source of supply
 - 3. Fine aggregate – Source of supply
 - 4. Water, gallons(liters) – City or well
 - 5. Admixtures, Oz/yd3(g/M3) – Brand and description*
 - a. (*) Description as retarder, accelerator, air entraining, etc.
- F. Submittals for concrete constituent material as a source of supply shall include the following information at the stated frequencies.
 - 1. Aggregate gradations –With mix design / Updated monthly
 - 2. L.A. abrasions – With mix design
 - 3. Soundness – With mix design
 - 4. Deleterious substances – With mix design
 - 5. Water quality (if well) –With mix design / Updated twice yearly
 - 6. Cube strength and time of set – With mix design
 - 7. Cement mill certificates – With mix design / Updated monthly
 - 8. Organic impurities – With mix design
- G. Submittals for concrete constituent material as a source of supply shall include testing information and properties included in the following information.
 - 1. Current chemical analysis of mixing water (if well)
 - 2. Specific Gravity (Saturated Surface Dry) of coarse and fine aggregate
 - 3. ASTM C33 quality tests including the following:
 - a. Fine Aggregate
 - i. Gradation - AASHTO T27 and T11
 - ii. Deleterious substances soundness - AASHTO T104
 - iii. Organic impurities - AASHTO T21
 - iv. Mortar-making properties - AASHTO T71

- b. Course Aggregate
 - i. Gradation - AASHTO T27 and T11
 - ii. Deleterious substances soundness - AASHTO T104
 - iii. Percentage of wear - AASHTO T96
 - iv. Absorption of course aggregate - AASHTO T85
- H. Submittals for concrete mix designs shall include the following for field verification and compliance testing.
 - 1. Slump
 - 2. % Air
 - 3. Unit weight
 - 4. 7 and 28 day compressive strength
- I. The following variations will be cause for submittal of a new mix design:
 - 1. Change of aggregate source
 - 2. Change of cement content
 - 3. Addition or exclusion of certain admixtures including, but not limited to, pozzolans, accelerators, retarders and water reducers
 - 4. Change in aggregate size
 - 5. Change in type of cement
 - 6. Failure to attain strength requirements as outlined in ACI 214 or ASTM C94
- J. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- K. **Technical Provisions**
 - 1. Reserved
 - 2. Absorption of course aggregate as specified in part G.3.b.iv of this subsection, shall not exceed 1 – percent based on dry-rodded unit weight.
 - 3. A variation in any of the following will require "Informing the City Engineer" and possibly data indicating acceptability for use in existing mix designs.
 - a. Change of cement supplier
 - b. Change of admixture brands or dosages (not types)
 - c. Minor adjustments of aggregate proportions accompanying materials changes or to accommodate placement conditions (same w/c ratio)

03.1.05 TESTING

- A. Testing shall include; but not limited to, air content, slump, temperature, and cylinders for strength tests.
- B. Testing shall be performed as directed by the Engineer.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Testing and sampling of concrete shall be performed after all add mixtures have been included in the field. Testing and sampling of concrete absent the in-place material will not be allowed for acceptance.

PART 2 PRODUCTS

03.2.01 **GENERAL**

- A. Furnish Ready-mixed concrete meeting ASTM C94 unless otherwise specified.
 - 1. Use concrete mixing water and water to make ice meeting requirements of ASTM C94.
- B. The codes and standards referred to in this section are declared to be part of this Specification as if fully set forth herein. In addition, the following ACI Standards are incorporated in their entirety, unless specifically required otherwise:
 - 1. ACI Standard 301, "Specifications for Structural Concrete for Buildings," American Concrete Institute, Edition.
 - 2. ACI Standard 318, "Building Code Requirements for Reinforced Concrete", American Concrete Institute, current edition.
 - 3. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".
 - 4. International Building Code of I.C.B.O.
- C. Contractor shall provide a batch ticket for each batch of concrete discharged and used in the work, indicating project identification name and number, date, mix type, batch quantities, and amount of water introduced.
- D. Assure cementitious material used in concrete is the same brand and type and from the same plant of manufacture as the cementitious material used in the concrete represented by the submitted field test date or used in the trial mixtures.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Batch tickets as specified in part C of this subsection, shall included the amount of water included at the plant as well as the amount of water added at the construction site. Contractor shall be responsible for assuring concrete delivered and placed meets the requirements as specified herein.

03.2.02 PERFORMANCE & MIX REQUIREMENTS

A. General concrete mix requirements, unless otherwise specified.

- General concrete shall be used for curb and gutter, sidewalks, driveways, approaches, curb turn fillets, valley gutters, structural concrete, and slabs.

General Concrete Mix Requirements		
Concrete Classification / Compressive Strength	M4000	
Max Water / Cement Ratio (W / C)	0.45	
Target Slump (inches)	3	
Slump Tolerance (inches)	+ 2	
Freeze Thaw Exposure	Severe	
Air Content Required	See Table A	
Air Content Tolerance (%)	± 1 ½	
Specialty Add Mixture(s) Required (Y / N)	N	

B. Utility structure concrete mix requirements, unless otherwise specified.

- Utility structure concrete shall be used for manholes, storm drain inlets.

Utility Structure Mix Requirements		
Concrete Classification / Compressive Strength	M3000	

C. Slump Requirements:

- Furnish concrete at the point of delivery having a slump of 4 - inches (max) determined by ASTM C 143.
- Meet slump tolerances in ACI 117.
- When a plasticizing admixture is used meeting ASTM C 1017 or when a Type F or G high range water reducing admixture meeting ASTM C494 is approved to increase the concrete slump, assure the concrete has a slump of 2 to 4 - inches before the admixture is added and a maximum slump of 8 - inches at the point of delivery after the admixture is added.

D. Air Content Requirements:

- Concrete must be air entrained. Measure air content under ASTM C138, C173 or C231. Unless otherwise specified, ASTM C231 shall be used.

Total Air Content Required for Various Aggregate Size and Freeze Thaw Exposure Table 03 00 00 - A			
Nominal Max Aggregate Size	Total Air Content (%)		
	Severe Exposure	Moderate Exposure	Mild Exposure
Less Than 3/8"	9	7	8
3/8"	7.5	6	4.5
1/2"	7	5.5	4
3/4"	6	5	3.5
1"	6	4.5	3
1 1/2"	5.5	4.5	3
2"	5	3.5	1.5
3"	4.5	3.5	1.5
6"	4	3	1

E. **Technical Provisions**

- Reserved
- When high-early strength concrete is required by contract, higher cement contents may be submitted with the mix design for approval.

03.2.03 CONCRETE CLASSIFICATIONS

- A. Concrete is classified as set forth below. Place the specified class of concrete for each structure element as specified.
- B. Concrete with prefixes "C" contain 1 1/2 - inch size aggregate and those with "M" contain 3/4 - inch size aggregate.
 - 1. M-3000 is concrete with 3/4 - inch (19-05 mm) maximum aggregate and a 28-day compressive strength of 3000 pounds per square inch (psi) (20.7 Mpa).
 - 2. M-4000 is concrete with 3/4 - inch (19-05 mm) maximum aggregate and a 28-day compressive strength of 4000 pounds per square inch (psi) (27.6 Mpa).
 - 3. C-3000 is concrete with 1 1/2 - inch (38.1 mm) maximum aggregate and a 28-day compressive strength of 3000 psi (20.7 Mpa).
- C. If concrete strength or durability requirements established by design exceed the above strength classifications, the Engineer may specify additional concrete classifications to meet those requirements.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Concrete with prefixes "M" may be substituted for concrete with prefixes "C."

03.2.04 CEMENTITIOUS MATERIAL

- A. Cementitious material consists of Portland cement meeting ASTM C150, with or without the addition of cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989, or blended hydraulic cement meeting ASTM C595 or hydraulic cement meeting ASTM C1157.
 - 1. Portland cement used cementitious material shall be:
 - a. Type I or Type II, unless otherwise specified.
 - 2. Fly ash used as cementitious material shall be:
 - a. Class C or Class F, unless otherwise specified.
- B. Assure the cementitious material content is adequate to meet the specified requirements for strength, water-cement ratio and finishing requirements.
 - 1. For exterior concrete exposed to freezing and thawing or concrete exposed to deicers, assure a maximum water-cement ratio of 0.45.
 - 2. For concrete used in interior floors, assure the cement content is at least that indicated in Table B.

Minimum Cement Content for Interior Slabs Table 03 00 00 – B	
Nominal Maximum Aggregate Size	Minimum Cement Content LB/CY
1 1/2"	470
1"	520
3/4"	540
3/8"	641

- 3. If cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989 are used, the cement portion of the water-cement ratio must be the total weight of cementitious material.
 - a. The maximum weight of fly ash, pozzolan or ground granulated blast-furnace slag included in the calculation of water-cementitious material ratio cannot exceed the following percentages of the total weight of Portland cement plus fly ash, pozzolan and ground granulated blast-furnace slag:

- b. The combined weight of fly ash and pozzolan meeting ASTM C618 cannot exceed limits in ACI 318. The fly ash and pozzolan present in an ASTM Type IP or IPM blended cement meeting ASTM C595 must be included in the calculated percentage.
- c. The weight of ground granulated blast-furnace slag meeting ASTM C989 cannot exceed 50% of the total weight of cementitious material. The slag used in manufacture of a Type IS or ISM blended hydraulic cement meeting ASTM C595 must be included in the calculated percentage.
- d. If fly ash or pozzolan is used in concrete with ground granulated blast-furnace slag, the portland cement constituent meeting ASTM C150 cannot be less than 50% of the total weight of cementitious material. Fly ash or pozzolan must not constitute more than 25% of the total weight of cementitious material.

C. Technical Provisions

- 1. Reserved
- 2. Cementitious material as specified in part A.2 of this Subsection, shall be Type I-II-V.

03.2.05 AGGREGATES

- A. Assure aggregates meet ASTM C33. When a single size or a combination of two or more sizes of coarse aggregates are used, assure the final gradation meets the grading requirements of ASTM C33.
- B. Obtain concrete aggregates from the same source and use the same size ranges as the aggregates used in the concrete represented by submitted historical data, or used in trial mixtures.
- C. Assure the nominal maximum size of coarse aggregate does not exceed three fourths of the minimum clear spacing between reinforcing bars, one fifth of the narrowest dimension between sides of forms or one-third of the thickness of slabs or toppings.
- D. Fine Aggregate Gradation:

Fine Aggregate for Concrete (ASTM C33) Table 03 00 00 – C	
Sieve	Percent Passing (%)
3/8"	100
No. 4	95 - 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	10 – 30
No. 100	0 – 10

- E. Course Aggregate Gradation

Course Aggregate for Concrete (ASTM C33) Table 03 00 00 – D		
Sieve	Percent Passing (%)	
	#57 (1 1/2")	#67 (3/4")
1 1/2"	100	100
1"	95 – 100	100
3/4"		90 – 100
1/2"	25 – 60	
3/8"		20 – 55
No. 4	0 – 10	0 – 10
No. 8	0 – 5	0 – 5

F. Technical Provision

- 1. Reserved

03.2.06 CONSTRUCTION ADMIXTURES

- A. When admixtures are specified in the Contract Documents for particular parts of the work, use types specified.
- B. Use construction admixtures meeting the following requirements:
1. Air entraining, admixtures - ASTM C260
 2. Chemical admixtures - ASTM C494
 3. Chemical admixtures for use in producing, flowing concrete - ASTM C1017
 4. Calcium Chloride - ASTM D98
 5. Use admixtures in the concrete that are the same as those used in the concrete represented by submitted field test data or in trial mixtures.
- C. Use of calcium chloride or other admixtures containing chloride ions is subject to the limitations in Table 2.3 Chloride Ion Concentration. When approved, use calcium chloride in solution form only, when introduced into the mixture.
1. Assure the maximum water-soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days attributed to the ingredients including water, aggregates, cementitious materials and admixtures do not exceed the limits of Table E. Use tests to determine water soluble chloride ion content meeting AASHTO T260. The type of member described in Table E applies to the work as indicated in the Contract Documents.

Maximum Allowable Chloride Ion Content Table 03 00 00 – E	
Type of Member	Maximum Water-Soluble Chloride (Cl) Content in Concrete, Percent by Weight of Cement
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete exposed to chloride in service	1.00
Other reinforced concrete construction	0.30

D. **Technical Provisions**

1. Reserved

03.2.07 SPECIALTY ADMIXTURES

- A. When specialty admixtures are specified in the Contract Documents for particular parts of the work, use the types specified at the rate recommended by the manufacturer.
- B. Use specialty admixtures meeting the following requirements:
1. Synthetic micro-reinforcement fibers (fibrillated, monofilament, and multifilament) – ASTM C1116, Type III
 - a. Micro-reinforcement fibers shall be included at the dosage recommended by the manufacturer.
- C. **Technical Provisions**
1. Reserved

PART 3 EXECUTION

03.3.01 GENERAL

- A. Thoroughly compact concrete into its final position. Assure it is thoroughly consolidated around fittings and embedded items. Assure all reinforcement and embedded items are accurately placed as shown on the plans and are clean and free from coatings of dried mortar, detrimental rust, scale, oil or foreign matter.
- B. All concrete placed shall be cured in accordance with the provisions of **SECTION 03 39 00 CONCRETE CURING** of these Specifications.
- C. Cleanup
 - 1. As work progresses, remove debris, excess concrete, and complete to finish grade each portion of the work. Once the work is complete, clear debris and finish the entire site to smooth, uniform slopes presenting a neat and workmanlike appearance.
 - 2. Concrete waste material shall be disposed of at a suitable location designated by the Contractor. Contractor may furnish a concrete waste disposal container for onsite use at no expense to the Owner. Local, state, and federal regulations for disposal shall be upheld.
 - 3. Before final acceptance cleanup of the site shall be completed in accordance with the provisions of **SECTION 3.15 of the GENERAL CONDITIONS**.
 - 4. Cleanup shall include the removal and disposal of all unsuitable/excess materials.
 - 5. All equipment shall be removed from the site.
 - 6. The site shall be left in a manner so as to present a clean and neat appearance, in an equal or better state prior to construction.
- D. **Technical Provisions**
 - 1. Reserved

03.3.02 CONCRETE CONSISTENCY

- A. Assure concrete is of such consistency that it will flow around reinforcing steel, but individual particles of the coarse aggregate, when isolated, show a coating of mortar containing its proportionate quantity of sand. The consistency of the concrete will be gauged by the ability of the equipment to properly place the concrete in its final position and not by the difficulty in mixing or transporting. Use the minimum quantity of mixing water necessary to provide workability within the ranges of slump specified.
- B. **Technical Provisions**
 - 1. Reserved

03.3.03 CONCRETE MIXING

- A. For Ready-Mix Concrete, Comply with requirements of ASTM C94, and as herein specified.
- B. For Job-Site Concrete, mix materials for concrete in appropriate drum type batch match mixer. For mixers of one (1) CY, or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one (1) CY, increase minimum 1-1/2 minutes of mixing time by 2-1/2 minutes for each additional CY, or fraction thereof.
- C. Thoroughly mix concrete to assure a uniform distribution of the materials throughout the mass. Mix concrete only in quantities required for immediate use and place it within the time limits specified. Waste all concrete which initial set has begun. Retempering of concrete is prohibited. Aggregates, or bags of cement containing lumps or crusts of hardened material shall not be used. Mix concrete in an approved truck mixer meeting the requirements of ASTM C94 herein.
- D. The capacity of the plant and the transportation equipment must ensure delivery at a rate that will permit proper handling, placement and finishing at the point of delivery. Maintain the concrete

delivery rate to provide for the continuous operation of placing, handling and finishing concrete as is practical. Maintain the interval between delivery of loads so that layers or lifts of concrete in place do not harden before succeeding layers or lifts are placed. In general, no lift or layer of concrete can remain exposed for more than 20 minutes before being covered by fresh concrete.

- E. The volume of mixed concrete in the mixing drum shall not exceed the manufacturer's rating, on the capacity plate.
- F. During freezing weather, other approved methods of measuring water will be permitted.
- G. A recording water metering device is always required at the primary point of the batching operation.
- H. Do not add water to concrete in transit. Water may be introduced into the mixer at the job site if the specified water-cement ratio is not exceeded. Water shall be added in accordance with ASTM C94. Assure the drum revolves continuously after the introduction of the cement and water until the concrete is discharged.
- I. Begin mixing immediately after introduction of the cement and water and continue for at least 70 revolutions of the drum at mixing speed. This minimum revolution count will be waived when the concrete is produced at a central mixing plant. Not more than 100 drum revolutions can exceed 6 revolutions per minute. All other revolutions must be at agitating speed of not less than 2 or more than 6 revolutions per minute.
- J. Discharge the concrete at the job and place in its final position within 1-1/2 hours after the introduction of the mixing water and cement. When the air temperature is 90°F or above, place the concrete in its final position within 1 hour after the introduction of the mixing, water and cement. Concrete mixes with an approved set retarding admixture may be held an additional 1/2 hour beyond limits specified above.
- K. No mixed or agitated concrete that has remained in the drum of the truck mixer more than 10 minutes without agitation can be used.
- L. Provide a revolution counter on each truck that registers the number of revolutions of the drum.
- M. Mount the counter so it can be easily read by both the operator and the Engineer.

N. **Technical Provisions**

- 1. Reserved
- 2. Concrete that has remained in the drum longer than 10-minutes without agitation as specified in part K of this subsection, the Engineer may all allow it to be used after remixing for a minimum of 20 revolutions of the drum at mixing speed, if it can be placed in the forms within the specified time limits and did not suffer any detrimental effects.

03.3.04 CONCRETE CONSOLIDATION

- A. This section reserved.

03.3.05 VISIBILITY LIMITATIONS

- A. Stop concreting operations when darkness prevents obtaining the specified placing, and finishing work. Night operations may be conducted with written approval and when approved artificial lighting is provided.

B. **Technical Provisions**

- 1. Reserved

03.3.06 HOT WEATHER CONCRETING

- A. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ANSI/ASTM C94 may be required.
- B. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.
- C. Hot weather concreting shall be performed in accordance with ACI 305.

D. **Technical Provisions**

1. Reserved

03.3.07 COLD WEATHER CONCRETING

- A. Cold weather concreting shall be performed in accordance with ACI 306.
- B. Except by specific written authorization, stop concreting operations when a descending air temperature in the shade and away from artificial heat falls below 40°F, or do not resume until an ascending air temperature in the shade and away from artificial heat reaches frozen foundation course or subgrade.
- C. Assume all risk of placing concrete in cold weather. Placing concrete during cold weather does not relieve the Contractor of the responsibility for obtaining the specified results. Remove and replace all concrete injured by frost at Contractor expense.
- D. Before any concrete is placed, remove all ice, snow and frost completely from the formwork receiving the concrete.
- E. Heating and Placing Concrete
- F. When concreting is authorized during cold weather, assure concrete temperature meets ASTM C94.
- G. Protection of Concrete
 1. During the curing period, if the air temperature is anticipated to fall below 32°F, provide an approved blanket type insulating material along the work for covering all concrete that has been in place for 7 days or less. If, at any time, the ambient temperature drops to 32°F or less, protect the concrete using a method approved by the Engineer. The minimum method of protection under such conditions is as follows: between two layers of plastic sheeting, the insulating materials, with the exception of commercial blankets, must be spread loosely to a minimum depth of 6 - inches, but in all cases, to the depth required to prevent freezing of, or frost damage to, the concrete. Maintain the blanketing material at least until the end of the regular specified curing, period which is not less than 7 days. The Engineer may direct leaving the blanketing material in place for an additional period if the recorded temperatures indicate that additional curing may be necessary. If during the construction period the mean daily temperature is expected to fall below 40°F for 3 consecutive days, furnish approved heating enclosures and devices capable of maintaining the surface temperature of the concrete in place between 55°F and 80°F. The curing, period under these conditions is 7 days when Type I-II-V cement is used and 5 days when a pre-approved "high early strength" mix is used. At the close of the curing period, the heat may be reduced so that the temperature inside the housing does not decrease faster than 15° per hour until the temperature inside the housing is the same as outside.
 2. A Contractor may, at their own expense, field cure concrete cylinders with their in-place concrete and discontinue protection when those field cylinders reach 70 percent of design strength as indicated by the 28-day requirement of these Specifications.
 3. Perform all concrete protection using methods consistent with ACI 306 and approved by the Engineer.

H. **Technical Provisions**

1. Reserved

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

03.1.01 DESCRIPTION

- A. This Specification includes common accessories used for placing various forms of concrete.

03.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|-------------|---|
| ASTM C920 | Elastomeric Joint Sealants |
| ASTM C1028 | Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces |
| ASTM D695 | Compressive Properties of Rigid Plastics |
| ASTM D790 | Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| AASHTO M213 | Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction |

03.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 0 00	CONCRETE
SECTION 32 16 13	CURBS AND GUTTERS
SECTION 32 16 43	SIDEWALKS, DRIVEWAYS, AND VALLEY GUTTERS

03.1.04 SUBMITTALS

- A. Refer to Related Work sections for applicable submittals required in these Contract Documents if not included herein.
- B. Shop drawings and product data shall be submitted for pertinent items in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- D. Technical Provisions
- Reserved

03.1.05 TESTING

- A. This section reserved.

PART 2 PRODUCTS

03.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. Technical Provisions
- Reserved

03.2.02 PRE-FORMED CONTRACTION JOINT

- A. Pre-formed contraction joint material shall be a "T" shaped strip with a removable top portion.
- B. Furnish joint depths compatible with the concrete cross section being placed.

Contraction Joint Depth Table 03 15 00 – A	
Slab Thickness	Joint Depth
3" to 6"	1"
6" to 8"	1 1/2"
Greater than 8"	2"

C. **Technical Provisions**

1. Reserved
2. Pre-formed contraction joints shall be as manufactured by:
 - a. W.R. Meadows Speed-E-Joint, Superior Profiles ZIPSTRIP, or approved equal.

03.2.03 PRE-FORMED EXPANSION JOINT

- A. Furnish joint material meeting the requirements of AASHTO M213.
- B. Expansion joint material shall be 1/2" thick.

C. **Technical Provisions**

1. Reserved
2. Pre-formed expansion joints shall be as manufactured by:
 - a. W.R. Meadows Fibre Expansion Joint, or approved equal.

03.2.04 JOINT SEALANT

- A. Furnish joint sealant meeting the requirements of ASTM C920-11.
- B. Joint sealants for vertical faces shall be a shall be a non-sag polyurethane material.
- C. Joint sealants for horizontal faces shall be either a self-leveling or non-sag polyurethane material.

D. **Technical Provisions**

1. Reserved
2. Joint sealant shall be as manufactured by:
 - a. W.R. Meadows Pourthane, or approved equal.

03.2.05 DETECTABLE WARNING PANELS

- A. Detectable warning panels "ADA Panel" or "Truncated Domes" shall comply with the American's with Disabilities Act.
- B. Detectable warning panels placed in new concrete shall be a Type I construction and directly embedded into the concrete.
 1. Cast-in-place warning panels may be either permanently affixed or replaceable as specified by the Owner/Engineer.
- C. Detectable warning panels retrofitted to existing concrete shall be a Type II construction and surface applied to the concrete.
- D. Detectable warning panels shall be a corrosion resistant composite material with the following minimum physical characteristics:
 1. 26,900 PSI Min. – Compressive Strength – ASTM D695
 2. 29,300 PSI Min. – Flexural Strength – ASTM D790
 3. 1.18 Dry, 0.88 Wet – Slip Resistance – ASTM C1028
- E. Detectable warning panels shall be furnished with truncated domes meeting the requirements of the ADA Accessibility Guidelines (ADAAG).

1. Detectable warnings shall consist of a surface of truncated domes aligned in a square or radial grid pattern.
 2. Truncated domes in a detectable warning surface shall have a base diameter of 0.9 – inch minimum to 1.4 - inch maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 - inches
 3. Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 - inch minimum and 2.4 - inch maximum, and a base-to-base spacing of 0.65 - inch minimum, measured between the most adjacent domes.
- F. Detectable warning surfaces shall contrast visually with the adjacent gutter, street or highway, or walkway surface, either light-on-dark or dark-on-light.
1. Detectable warning panels shall be Federal Yellow unless otherwise specified.
- G. **Technical Provisions**
1. Reserved
 2. Detectable warning panels are not required for this project.

PART 3 EXECUTION

03.3.01 GENERAL

- A. Refer to related work sections for installation requirements if not included herein.
- B. All materials shall be furnished and installed in accordance with the manufacturer's recommendations unless otherwise specified.
- C. **Technical Provisions**
1. Reserved

03.3.02 PRE-FORMED CONTRACTION JOINTS

- A. Where green-saw cutting is prohibited and freshly poured concrete and not be hand-tooled, the Contractor shall install pre-formed contraction joint material capable of producing a straight line.
- B. Contraction joints shall be placed at the locations shown on the Drawings or as Specified in the Related Item of Work.
- C. **Technical Provisions**
1. Reserved

03.3.03 PRE-FORMED EXPANSION / ISOLATION JOINTS

- A. Expansion and isolation joints shall be placed at the locations shown on the Drawings or as specified for the Related Item of Work.
- B. Extend expansion and isolation joints the full depth of the concrete.
- C. All expansion and isolation joints shall be sealed with a polyurethane joint sealant.
1. Sealant shall be minimum 1/4 – inch and maximum 1/2 – inch in depth.
- D. **Technical Provisions**
1. Reserved

03.3.04 DETECTABLE WARNING PANELS

- A. Detectable warning panels shall be installed to meet the requirements of the American's with Disabilities Act.
- B. Detectable warning surfaces shall extend 24 - inches minimum in the direction of travel and the full width of the curb ramp (exclusive of flares), the landing, or the blended transition.
- C. Trim precast detectable warning devices panels to fit on private approach sidewalk curb ramp.

- D. Install the dome panel adjacent to the back of the curb. If the panel is offset, locate the edge of the panel as close as practicable to the back of curb.
- E. If the detectable warning device is embedded in concrete, install so the top of the panel is flush with the adjacent concrete and the domes will protrude above the adjacent surface.
- F. Ensure a uniform grade on the detectable warning devices free of sags and irregularities.
- G. Ensure the alignment and pattern of the domes is continued across any joints between detectable warning device panels.
- H. **Technical Provision**
 - 1. None

END OF SECTION

PART 1 GENERAL

03.1.01 DESCRIPTION

- A. This Specification includes work for furnishing and placing reinforcing steel or wire fabric meeting the quality, type and size specified in the Contract Documents.

03.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|-------------|---|
| ASTM A615 | Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A705 | Age-Hardening Stainless Steel |
| AASHTO M31 | Deformed and Plain Billet-Steel Bars for Concrete Reinforcement |
| AASHTO M32 | Cold Drawn Steel Wire for Concrete Reinforcement |
| AASHTO M55 | Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement |
| AASHTO M54 | Fabric Deformed Steel Bar or Rod Mats for Concrete Reinforcement |
| AASHTO M254 | Standard Specifications For Corrosion-Resistant Coated Dowel Bars |
| ACI | American Concrete Institute |

03.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS

03.1.04 SUBMITTALS

- A. Shop drawings and product data for concrete reinforcement shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Furnish four copies of shop details and placing drawings for all structural concrete reinforcing steel to the Engineer for approval. Once checked, the Engineer will return two marked up sets of prints or drawings for correction. The Engineer's review is only for general conformity with the plans. Checking the detailed dimensions is the Contractor's responsibility. The Engineer's review does not relieve the Contractor's responsibility to furnish all material meeting the Contract requirements. Detail Reinforcing, steel meeting the ACI "Standard Details and Detailing of Concrete Structures" and the "Manual of Engineering and Placing Drawings for Reinforced Concrete Structures" published by the American Concrete Institute (ACI 315).
- D. Technical Provisions
- Reserved

03.1.05 TESTING

- A. This section reserved.

PART 2 PRODUCTS

03.2.01 GENERAL

- A. This section reserved.

03.2.02 REBAR REINFORCEMENT – STRUCTURAL CONCRETE

- A. Structural concrete rebar reinforcement shall be in reference to rebar reinforcement used for, but not limited to, foundations, footings, abutments, stairs, and other vertical concrete construction.

- B. Furnish deformed reinforcement steel meeting ASTM A615, (AASHTO M31) or ASTM A705, Grade 40 or Grade 60.
 - 1. Small quantities purchased from warehouses may, at the Engineer's direction, be accepted if bend tested under ASTM A615 or AASHTO M31.
 - 2. The test specimen must cold bend around a pin without cracking on the outside of the bent portion.
- C. Assure all bars are bent cold. Do not field bend any bar partially imbedded in concrete except as specified on the plans.
- D. Ship bar reinforcement in standard bundles, tagged and marked meeting the "Details and Detailing of Concrete Structures" (ACI 315) requirements.
- E. **Technical Provisions**
 - 1. Reserved

03.2.03 REBAR REINFORCEMENT – SITEWORK CONCRETE

- A. Sitework concrete rebar reinforcements shall be in reference to rebar reinforcement used for, but not limited to, concrete paving, curb and gutter, valley gutter, sidewalks, driveways, and other miscellaneous sitework concrete.
- B. Furnish deformed reinforcement steel meeting ASTM A615, (AASHTO M31) or ASTM A705, Grade 40 or Grade 60.
- C. Rebar reinforcement shall be a #4 (1/2 – inch) rebar, unless otherwise specified, and placed at the locations shown on the Drawings.
- D. **Technical Provisions**
 - 1. Reserved

03.2.04 WIRE AND WIRE MESH

- A. Furnish wire meeting cold-drawn steel wire AASHTO M32 (ASTM A82) requirements.
- B. Furnish wire mesh for concrete reinforcement meeting AASHTO M55 (ASTMA A85).
- C. Furnish bar mats meeting AASHTO M54 (ASTM A184).
- D. **Technical Provisions**
 - 1. Reserved

03.2.05 DOWEL BAR

- A. Furnish round smooth dowel bar meeting ASTM A615, (AASHTO M31) or ASTM A705, Grade 40 or Grade 60.
- B. Dowels shall be a minimum #5 (5/8 – inch) dowel and 12 – inches in length, unless otherwise specified, and placed at the locations shown on the Drawings.
- C. Dowels shall be furnished with a min. 10 mill fusion bonded epoxy coating meeting AASHTO M254.
- D. Dowels shall be free of burs or other deformities that would restrict slipping in the concrete.
- E. Dowels placed in fresh concrete shall be furnished with a manufacturer certified bond breaker lubricant or dowel sleeve, unless otherwise approved.
- F. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

03.3.01 GENERAL

- A. Concrete reinforcement shall be furnished and installed at the locations shown on the Drawings and as specified in the Contract Documents.
- B. Concrete reinforcement and accessory details, not covered herein or on the drawings, must meet “Details and Detailing of Concrete Structures” and the “Manual of Engineering and Placing Drawings for Reinforced Concrete Structures” (ACI 315 and 315R) requirements.
- C. Protect steel reinforcement from damage at all times. Place steel free from dirt, detrimental scale, paint, oil and other foreign substance. Clean steel reinforcement having easily removed rust, loose scale, and dust using an approved method.
- D. Accurately place and hold firm all steel reinforcement in the plan locations as concrete is being placed.
- E. Support and fasten together all reinforcement to prevent displacement due to construction loads. It is permissible to use on ground, where necessary, concrete support blocks having a minimum 4 - square inches (2580 MM²) bearing area and having a compressive strength equal to the concrete being placed.
- F. **Technical Provisions**
 - 1. Reserved

03.3.02 MINIMUM COVER FOR REINFORCEMENT

- A. Follow the minimum concrete protective covering for reinforcement below.
 - 1. Concrete deposited against ground 3 – inches
 - 2. Formed surfaces exposed to weather or in contact with the ground:
 - a. #6 bars or larger 2 – inches
 - b. Smaller than #6 1 1/2 – inches
 - 3. Interior surfaces:
 - a. Beams, girders and columns 1 1/2 – inches
 - b. Slabs, walls and joists:
 - i. #11 bars or smaller 3/4 – inches
 - ii. #14 and #18 bars 1 1/2 – inches
- B. Use approved bar chairs and spacers with formwork to assure proper concrete cover and placement locations. Do not use pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe, or wooden block to position the reinforcement.
- C. For concrete surfaces exposed to the weather in the finished structure, assure the portions of all accessories within 1/2 - inch of the concrete surface are noncorrosive or protected against corrosion.
- D. For corrosive atmospheres or fire protection, see special provisions for minimum covering requirements.
- E. **Technical Provisions**
 - 1. Reserved

03.3.03 PLACING AND FASTENING STRUCTURAL CONCRETE REINFORCEMENT

- A. Obtain Engineer approval of reinforcement placement before placing concrete. Remove and replace concrete placed without Engineer approval of reinforcing.
- B. Obtain Engineer approval for all splices not shown on the plans. Mechanical connectors for reinforcing bars may be used if approved.
- C. Offset vertical bars in columns at least one bar diameter at lap splices. Furnish templates for all column dowels.

- D. When specified or approved, weld reinforcing steel meeting “Reinforcing Steel Welding Code” (AWS D 1.1). Do not weld at bends in bars. Do not tack weld crossbars without Engineer approval.

- E. **Technical Provisions**

- 1. Reserved

03.3.04 PLACING AND FASTENING WIRE MESH REINFORCEMENT

- A. Overlap welded wire fabric for successive mats or rolls providing an overlap measured between outermost cross wires of each fabric sheet at least 2 - inches. Extend the fabric across supporting beams and walls to within 4 - inches of concrete edges. It may extend through contraction joints. Adequately support the fabric during concrete placement to maintain its position in the slab using the methods previously described or by laying the fabric on a concrete layer of the required depth before placing the upper slab layer.

- B. Straighten fabric reinforcement shipped in rolls into flat sheets before placing it.

- C. **Technical Provisions**

- 1. Reserved

END OF SECTION

PART 1 GENERAL

03.1.01 DESCRIPTION

- A. This Specification includes work for furnishing and applying concrete cure and protection for cast-in-place, slip formed and other concrete construction as specified in the Contract Documents.

03.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- AASHTO M148 Standard Specification for Liquid-Forming Compounds for Curing Concrete

03.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS

03.1.04 SUBMITTALS

- A. Shop drawings and product data for curing and protective compounds shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS** of these Specifications.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Technical Provisions
1. Reserved

03.1.05 TESTING

- A. This section reserved.

PART 2 PRODUCTS

03.2.01 GENERAL

- A. This section reserved.
- B. Technical Provisions
1. All exterior concrete placed shall be furnished with an approved curing compound and sealant.

03.2.02 LIQUID MEMBRANE-FORMING COMPOUNDS FOR CURING CONCRETE

- A. Furnish liquid membrane-forming compound meeting the requirements of AASHTO M148, Type 1, clear or translucent.
- B. Technical Provisions
1. Reserved
2. Curing compound shall be as manufactured by:
- a. Dayton J11W, or approved equal.

03.2.03 EMULSIFIED LINSEED OIL COMPOUND

- A. Assure it meets all requirements of AASHTO M148 and contains at least 2.7 pounds of linseed oil per gallon. Furnish a manufacturer's certification showing that the formulated weight of linseed oil per gallon equals or exceeds this limit.

B. Technical Provisions

1. Reserved
2. Linseed oil compound will not be allowed for this project.

03.2.04 CONCRETE SELANT

- A. Sealant shall be compatible with curing compound used and installed per the manufacturer's recommendations.

B. Technical Provisions

1. Reserved
2. Sealant shall be as manufactured by:
 - a. Dayton J17, or approved equal.

PART 3 EXECUTION

03.3.01 GENERAL

- A. Thoroughly cure concrete surfaces subject to premature drying by covering as soon as possible with canvas, plastic sheets with sealed joints, burlap and sand or other satisfactory materials and keep concrete moist. If the concrete surfaces are not covered, keep them moist by flushing or sprinkling. Continue curing for at least 7 days after placing the concrete. Concrete surfaces placed against forms may be cured by leaving the forms in place for at least 7 days, when approved.
- B. Protect concrete against freezing or other conditions detrimental to strength development meeting the applicable requirements of this Specification.
- C. To aid finishing, side forms on ornamental work, curbs and sidewalks, railing and parapets may be removed after 12 hours, not to exceed 48 hours, depending on weather conditions. Continue moist curing during the concrete finishing operation.
- D. Untreated forms and existing concrete must be kept continuously wet for at least 1 hour before any concrete is placed. Keep wet until covered with concrete except that adequately treated forms must be thoroughly washed with a water spray immediately before placing the concrete.
- E. The curing of concrete, by either water curing or membrane curing, must be as included herein unless otherwise approved by the Engineer.
- F. Technical Provisions**
1. Reserved

03.3.02 WATER CURING

- A. Keep all concrete top surfaces continuously moist after finishing, with a fine water spray, until the concrete has set. Cover the moist concrete with water or an approved curing covering.
- B. Cure concrete deck slabs and concrete floors for at least 7 days. Cure by placing burlap, cotton mats or other absorptive material as close behind the finishing operation as possible without marring the finished surface. Keep the absorptive material continuously moist for the full time it is used. The absorptive material may be kept in place for the entire curing period or it may be removed as soon as practical and the entire surface covered with approximately 1-1/2 inches of sand, kept continuously moist for the entire curing period.
- C. Remove forms and repair surface irregularities without interfering with any of the curing requirements. As soon as the vertical forms have been removed and the surface irregularities repaired, cover the concrete with absorptive material, kept continuously wet for the balance of the curing period.
- D. Technical Provisions**
1. Reserved

03.3.03 IMPERVIOUS MEMBRANE CURING

- A. Assure membrane curing compounds are delivered to the job in the manufacturer's original container, clearly labeled to show the name of the manufacturer and the contents. The clear curing compound must be sufficiently transparent and free from permanent color that would change the color of the natural concrete. Use clear compound containing a fugitive dye having color sufficient to render the film visible on the concrete for at least 4 hours after application. The concrete surface must maintain its natural color after curing.
- B. Use a compound ready for use as shipped by the manufacturer. Dilute following the manufacturer's recommendations. Use curing compound only with written approval. Sampling will not be required if manufacturer's certification is available. Apply the curing compound under pressure with a spray nozzle to cover the entire exposed surface thoroughly and completely with a uniform film not exceeding manufacturer's Specifications. Maintain the required pressure in the spray machine to force the material to leave the nozzle in a fine mist. Keep all concrete surfaces moist with a fine water spray or with wetted burlap until the sealing compound is applied. Keep the curing compound application close to the finishers of the top surface of concrete at all times. Seal the concrete immediately after the finishing operations have been completed, to the satisfaction of the Engineer.
- C. If it is necessary to allow workers or equipment on the surface before the 7 day curing period is completed, cover the top surface of sealed concrete with a protective cushion for runways. Use a cushion consisting of a moist, 1 – inch minimum thick layer of fine sand, or layers of moist burlap that will prevent damage to the finished concrete. Cover the approved cushion with four by eight foot sheets of 3/4 - inch plywood laid over the cushion. Do not place the cushion material for at least 8 hours after the final application of the curing compound. Obtain the Engineer's written approval for any other proposed cushion material before use. Layers of plastic, visqueen or canvas are not an acceptable cushion material.
- D. Keep concrete, which has not completed its curing period, continuously moist during the stripping and surface repair operations. Remove all surface irregularities, repair all depressions, voids or holes, including those formed by trapped air, to the satisfaction of the Engineer. Immediately apply the curing compound before the surface has had an opportunity to dry out. Keep concrete, from which forms have been stripped, continuously moist until surface repair and finishing are completed and the impervious membrane curing has been applied.
- E. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 31 EARTHWORK

TABLE OF CONTENTS

DIVISION 31 – EARTHWORK

SECTION	DOCUMENT
31 05 00	Common Work Results for Earthwork
31 11 00	Clearing and Grubbing
31 23 00	Excavation and Fill
31 23 19	Dewatering
31 23 23.23	Compaction
31 23 23.33	Flowable Fill
31 23 33	Trenching and Backfilling
31 23 36	Structural Excavation and Fill
31 25 00	Erosion and Sedimentation Controls
31 50 00	Excavation Support and Protection

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes work common to earthwork, grading, excavation and fill and all appurtenances thereto as shown on the Drawings and specified herein.

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|------------|--|
| AASHTO T99 | Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop |
| ASTM D698 | Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ or 600 kN-m/m ³) |
| ASTM D1556 | Standard Test Method for Density and Unit Weight of Soil In-Place by the Sand-Cone Method |
| ASTM D4318 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | Standard Test Method for In-Place density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other Sections of these Specifications:

SECTION 02 32 00	GEOTECHNICAL INVESTIGATION
SECTION 31 11 00	CLEARING AND GRUBBING
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 31 23 13	SUBGRADE PREPARATION
SECTION 31 23 19	DEWATERING
SECTION 31 23 23.23	FLOWABLE FILL
SECTION 31 23 33	TRENCHING AND BACKFILLING
SECTION 31 23 36	STRUCTURAL EXCAVATION AND FILL
SECTION 31 25 00	EROSION AND SEDIMENT CONTROLS
SECTION 31 50 00	EXCAVATION SUPPORT AND PROTECTION
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

31.1.04 SUBMITTALS

1. Contractor shall submit an excavation plan for Engineer and USACE review and approval, this plan shall include the following.
 - a. Identify what OSHA soil types are expected.
 - b. Identify maximum depth of excavation on profile sheets.
 - c. Excavation limits.
 - d. Shoring and or trench box information.
 - e. Equipment to be used for excavation and backfilling.
 - f. Compaction testing intervals.
 - g. Borrow source information.
 - h. Emergency action plan.
 - i. Daily monitoring reporting information.
 - j. Haul plan.
 - k. Spoils handling.

- l. Any required permits.
 - m. Restoration plan.
 - B. Refer to Related Work sections for applicable submittals required in these Contract Documents if not included herein.

PART 2 PRODUCTS

31.2.01 TYPE 1 BEDDING

- A. Type 1 Bedding shall consist of sand, sandy gravel, or gravel having a maximum $\frac{3}{4}$ -inch size, and shall be placed from four (4) inches below the bottom of the pipe, around the pipe, and six (6) inches above the top of the pipe for flexible pipe systems. If the pipe system is rigid (i.e., concrete), the bedding shall be brought up to the springline of the pipe. Type 1 bedding shall have a maximum plasticity index of 6, as determined by ASTM D 4318.

31.2.02 TYPE 2 BEDDING

- A. Type 2 Bedding shall be used as directed by the Engineer to replace unsuitable material encountered in the trench bottom. Type 2 bedding shall be placed from the bottom of the Type 1 bedding material to a depth required to adequately support the pipe. Type 2 bedding shall be supplied and meet the following gradations:

<u>Sieve Opening</u>	<u>% Passing</u>
3"	100
No. 4	0-25
No. 8	0-10

31.2.03 ON-SITE EMBANKMENT

- A. Fill and backfill materials are to consist of natural soils free from organic matter, frozen material, refuse, construction debris, or other man-made items. The Contractor shall obtain approval of the Engineer for all fill before placing and use only the fill from designated borrow areas.

31.2.04 STRUCTURAL BACKFILL

- A. Structural backfill shall be in accordance with **SECTION 02 32 00 – GEOTECHNICAL INVESTIGATION** included within these Specifications.

PART 3 EXECUTION

31.3.01 GENERAL

- A. These general construction requirements apply to all site grading, structure excavation, utility excavation and earthwork.
- B. Until expiration of the guarantee period, the Contractor shall assume full responsibility and expense for all backfill settlement and shall refill and restore the work as directed to maintain an acceptable surface condition, regardless of location.

Where the provisions contained within **SECTION 02 32 00 – GEOTECHNICAL INVESTIGATION** are more stringent than those contained in this Section, the provisions of **SECTION 02 32 00 – GEOTECHNICAL INVESTIGATION** shall govern.

31.3.02 REMOVALS

- A. All surface objects, trees, stumps, roots and other obstructions that are not designated to remain shall be cleared and disposed of in accordance with **SECTION 31 11 00 – CLEARING AND GRUBBING** of these Specifications.
- B. The removal of surface improvements (pavement, curb and gutter, walks) shall be held to a minimum, and shall be in accordance with **SECTION 32 05 05 – SELECTIVE DEMOLITION FOR EXTERIOR IMPROVEMENTS** of these Specifications. All materials to be removed and means of

replacement shall be subject to the approval of the Owner's Representative where said removals are not detailed on the Drawings.

1. Any surface or sub-surface objects not designated for removal including irrigation systems, landscaping, and structures that are damaged or destroyed shall be replaced by the Contractor.

31.3.03 LIMITS OF CONSTRUCTION

- A. The Contractor shall limit the operation of their equipment to those areas shown on the Drawings or as directed by the Owner's Representative to be construction areas.
- B. The indiscriminate operation of equipment outside of designated construction areas will not be permitted.

31.3.04 CONTINUITY OF EXISTING TRAFFIC

- A. The Contractor shall not interrupt or change existing traffic, delivery, or parking without prior written approval from the Owner's Representative. When interruption is required, coordinate schedule with the Owner agency to minimize disruptions. When working in public right-of-way, obtain all necessary approvals and permits from applicable agency.
- B. When Contractor's activities impede or obstruct traffic flow, Contractor shall provide traffic control devices, signs, and flaggers in accordance with other Contract Documents and the current version of the MUTCD, or as shown on the Drawings. A Traffic Control Plan shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**

31.3.05 PROTECTION AND CONTINUITY OF EXISTING UTILITIES

- A. The Contractor shall protect and maintain continuity of existing utilities per the **GENERAL CONDITIONS.**
- B. The Contractor shall verify the locations of any water, drainage, gas, sewer, electric, telephone/communication, fuel, steam lines or other utilities and site features which may be encountered in any excavations or other sitework. All lines shall be properly underpinned and supported in a manner approved by the utility owner to avoid disruption of service.
- C. The Contractor shall not interrupt or change existing utilities without prior written approval from the Owner's Representative, affected utilities, and users. Notify all users impacted by outages a minimum of 48 hours in advance of outage. Notification shall be provided in writing and describe the nature and duration of outages and provide the name and number of Contractor's foreman or other contact.
- D. Any service connections encountered which are to be removed shall be cut off at the limits of the excavation and capped in accordance with the requirements of applicable codes and any specifications governing such removals.

31.3.06 DUST CONTROL

- A. Contractor shall be responsible for dust control, providing all equipment and personnel for the work. Furnish Engineer name(s) and telephone number(s) of the person(s) responsible for dust control during evenings and weekends. If this person cannot be contacted, Owner may at Contractor expense, perform the work or contract the work out.
- B. The Contractor shall maintain temporary site roadways, the Owner's existing roads, and public roads used during construction operations in clean, dust free condition.
- C. The Contractor shall comply with local environmental regulations for dust control and directions of the Owner. If the Contractor's dust control measures are considered inadequate by the Owner, the Owner will require the Contractor to take additional dust control measures.
- D. Providing Dust Control shall be included in the price bid for the work that requires dust control, and no additional compensation will be made therefor.

E. Technical Provisions

1. Reserved

2. In the event that the Contractor's contact, or a responsible person thus associated, cannot be contacted and/or respond to the request for dust control within 4 hours, the Owner may take action as specified in part A of this subsection.
3. Cost incurred by Owner for maintenance specified in this subsection shall be the responsibility of the Contractor. Payment shall be withheld as a Set-off on the Contractor's next application for payment.
4. Construction water required for dust control or other construction related work can be purchased from the Town of Fort Peck at the bulk fill station located at the water treatment plant.

31.3.07 STORMWATER/EXCAVATION WATER MANAGEMENT

- A. The Contractor shall be responsible for control measures to prevent damage from flooding, erosion, and sedimentation to on-site and off-site areas, and follow all requirements described in **SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROLS** of these Specifications.
- B. The Contractor shall control grading around structures, pitch ground to prevent water running into excavated areas. Pits, trenches within building lines, and other excavations shall be maintained free of water. Contractor shall provide trenching, pumping, and other facilities required.
- C. The Contractor shall notify Engineer if springs or running water are encountered in excavation and provide discharge by trenches, drains, or pumping to a point outside of excavation. The Contractor shall provide information to Engineer of points and areas that water will be discharged and method of discharge.

31.3.08 BLASTING

- A. It is not anticipated that blasting will be required for the Project. Should the Contractor exhaust conventional equipment and methods for rock excavation and removal and desire to use explosives to accomplish this Work, the Contractor shall comply with the following:
 1. The Owner's Representative shall be notified of any need for blasting to remove materials which cannot be broken up mechanically, and there shall be no blasting operations conducted until the Owner's Representative has been properly notified.
 2. Blasting will be allowed only when proper precautions are taken to protect life and property, and then shall be restricted as the Owner's Representative directs.
 3. The Contractor shall assume full responsibility for any damages caused by blasting, regardless of the requirements for notification and approval.
 4. The Contractor shall secure any required permits for blasting and shall conduct blasting operations in conformance with all applicable federal, state, and local laws, regulations, and ordinances.

31.3.09 SURPLUS MATERIAL AND BORROW

- A. The Contractor shall inform and satisfy themselves as to the character, quantity, and distribution of material to be excavated.
- B. Material in excess of that required for permanent work and/or materials deemed by the Owner's Representative to be unsuitable for use, with the exception of topsoil, shall be disposed of off-site at a location provided by the Contractor unless a disposal site is noted on the Drawings.
- C. Borrow material, if required, shall be provided by the Contractor at no additional expense to the Owner.
 1. The Contractor shall notify the Owner's Representative sufficiently in advance of opening any borrow areas so that the borrow material can be tested by the Contractor's Quality Control laboratory before being used.
 2. Sufficient time for testing the borrow material shall be allowed.
- D. Borrow sites shall be obtained by the Contractor unless an Owner-provided borrow site is shown on the Drawings.

- E. Borrow sites and excess soil disposal sites, where shown on the Drawings, must be graded to drain, must not impede an existing drainage, and must be re-seeded unless written agreements with the borrow site owner are obtained stating otherwise.
- F. Private or off site borrow and excess soil disposal sites shall be restored to the satisfaction of the landowner.

31.3.10 UNDERCUTTING

- A. Undercutting shall be performed where rock or soft, spongy, unstable, or other similarly unsuitable material is encountered in the excavation.
- B. Where such materials are encountered, they shall be removed to a depth as directed by the Owner's Representative.
- C. Rock shall be removed to a depth of no less than 6 inches below the plan shown grade established for the excavation.
- D. Undercut areas shall be backfilled with granular fill or low strength concrete as directed by the Owner's Representative.

31.3.11 COMPACTION

- A. Compaction of backfill and embankments shall be obtained by means of tamping rollers, sheepfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers.
- B. All such equipment shall be of a size and type sufficient to meet the minimum requirements specified herein.
- C. Flooding shall not be considered an acceptable means of obtaining compaction nor shall the use of a backhoe bucket.
- D. Permission on the part of the Owner or Owner's Representative to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the contract or that the equipment will achieve the required compaction.
- E. The Contractor shall be responsible for any damage caused by compaction equipment.
- F. Material for mechanically compacted backfill and embankments must be placed in lifts which, prior to compaction, do not exceed the thickness as specified in the Related Work sections herein.
 - 1. Lifts to be compacted with hand-directed mechanical tampers must not exceed a thickness of four (4) inches prior to compaction.
- G. A minimum of six (6) inches of backfill material must be placed over the top of a pipe before operating vibratory or sheepfoot type compaction equipment.
 - 1. This material must be compacted using hand-directed mechanical tampers.
- H. Mechanical equipment must be compatible with the material being placed.
- I. Each layer shall be evenly spread, moistened, or dried, if necessary, and then tamped or rolled until the specified relative compaction has been attained.
- J. Compaction adjacent to all foundations, footings, manholes, catch basins, valve boxes, curb boxes, end of sewer services and similar structures shall be performed by the use of hand-directed mechanical tampers with lifts not exceeding that specified above.
- K. Each layer of backfill or embankment shall be compacted to the density specified below.
 - 1. The material shall be compacted at a moisture content of no less than 3 percentage points above or below the optimum moisture of the Standard Proctor as defined by ASTM D698.

The locations below shall refer to future as well as present uses. Requirements for minimum density may also be contained in **SECTION 02 32 00 – GEOTECHNICAL INVESTIGATION**. If there is a discrepancy, the more restrictive shall apply.

MINIMUM DENSITY EXPRESSED AS A PERCENTAGE OF STANDARD PROCTOR

LOCATION	PROCTOR (ASTM D698)
Unimproved areas (eg. Lawns, etc.)	90%
Surface Improved Areas (parking lots, streets, walks)	95%
Embankments	95%
Structures (buildings, manholes, floors, basins, etc.)	100%
Lagoon and earthen basin floors (lined and unlined)	98%

31.3.12 TESTING

- A. The Contractor's Quality Control testing shall be in accordance with **SECTION 02 32 00 – GEOTECHNICAL INVESTIGATION**.
- B. The Contractor shall be responsible for obtaining and providing to the Engineer, test results showing the moisture-density relationships (Standard Proctor) of representative samples of the materials to be used in all embankment and backfill construction including excavated material, engineered fill, and borrow material. The Contractor will provide additional Proctor analysis when so directed by the Engineer or at the Contractor sole discretion when soil conditions appear to have changed. The Proctor analysis must be completed prior to compaction testing being accepted. The Contractor, at the Contractor's sole risk may test the compaction of trenches, streets, and roads prior to the completion of a Proctor analysis, realizing that the Engineer has the right to reject the work and require that compaction efforts be re-done until the compaction meets the requirements of the specification.
- C. Testing shall be performed by an independent testing laboratory in accordance with the requirements of ASTM D698.
- D. The following Quality Control tests shall be made by the Contractor to determine the Contractor's compliance with the specifications: *(Some tests may not apply to the work to be completed during this project)*.
 1. Proctor analysis and in-place density tests for trench compaction for all underground utilities installed by the Contractor.
 2. In-place density test of sub-grade backfill, sub-base, base, and asphalt paving courses.
 3. Gradation, liquid limit, and plasticity index tests of sub-base, base and surfacing aggregates. Tests of sub-base and base course materials shall be made from material in place. Tests of plant mix aggregates shall be made from samples obtained from the hot bins of the hot plant. Tests of concrete aggregates shall be made from samples at the mixer site.
 4. Stripping tests, volume swell tests, fracture tests, wear tests, and soundness tests shall be made prior to or during the Contractor's crushing operations.
- E. Acceptance and rejection of materials will be determined from tests made of the various courses complete and in-place in the field. While the Engineer may, during the course of construction, make tests at the source or point of production; it is the responsibility of the Contractor to conduct Quality Control Testing with an independent third-party testing firm to control and test his production operations in such a manner that the materials produced will meet the specification requirements. The Owner reserves the right to reject a third-party testing firm for previous substandard work or inexperienced staff.
- F. The Contractor will be reimbursed for the costs of independent testing services if provisions for such reimbursement are included in and the Bid Form. If no allowance is made for reimbursement, the testing shall be incidental to the other bid items, per **SECTION 31 23 23.23 COMPACTION** testing costs are incidental.

31.3.13 CLEANUP

- A. Cleanup of the site shall be completed before final acceptance of the work can be made. Final cleanup of the site shall be completed in accordance with the provisions of **SECTION 3.15 of the GENERAL CONDITIONS**.
- B. Cleanup shall include the removal and disposal of all unsuitable materials.

- C. All equipment shall be removed from the site.
- D. The site shall be left in a manner so as to present a clean and neat appearance.
- E. Utility Cleanup:
 - 1. All surplus waste materials remaining after completion of the backfilling operations shall be disposed of in an acceptable manner within 24 hours after completing the backfill work on each particular pipeline section.
 - 2. Disposal at any location within the project limits shall be as specified, or as approved by the Owner's Representative; otherwise, disposal shall be accomplished outside the project limits at a location provided by the Contractor.
 - 3. The backfilling and surplus or waste disposal operations shall be a part of the work required under the utility installation items, not as work that may be delayed until final cleanup.
 - 4. Utility lines and trench backfill shall be tested in accordance with the provisions of **DIVISION 33 – UTILITIES** and **SECTION 31 23 33 – TRENCHING AND BACKFILL**.

31.3.14 **GUARANTEE**

- A. The Contractor shall repair or replace as necessary any damage to the work caused by settlement that occurs within the time established in the **GENERAL CONDITIONS**.
- B. Said repairs shall be made at no cost to the Owner.

31.3.15 **SAFETY**

- A. Contractor must follow and adhere to safety requirements laid out within USACE safety standard EM 385-1-1 at all times, during the duration of this project.

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes clearing and grubbing including the disposal of materials for all areas within the limits required for the construction shown on the Drawings, specified herein or as directed by the Owner's Representative.

31.1.02 REFERENCES

- A. Reserved

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 02 32 00 GEOTECHNICAL INVESTIGATION

SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK

31.1.04 SUBMITTALS

- A. Should trees need removal within USACE Jurisdiction the Contractor is to prepare a tree removal plan that accounts for Endangered Species Act compliance.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

31.3.01 GENERAL

- A. Clearing and grubbing shall consist of clearing the surface of the ground of the designated areas of all trees, stumps, down timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences, structures, debris, and rubbish of any nature, natural obstructions or such material which in the opinion of the Owner's Representative is unsuitable to remain exposed in the construction areas.
- B. The materials cleared from the site shall be disposed of by the Contractor off site at their own expense.
- C. The areas to be cleared shall include all areas within construction limits and where otherwise designated on the Drawings.
- D. All spoil materials removed by clearing and grubbing shall be disposed of at a landfill or site that accepts such material.
1. Burning will be at the Contractor's discretion and must be in compliance with all Federal and State and Local laws and regulations relative to building fires at the site.
 2. If burning of the trees, brush and burnable debris is used as a method of disposal, the Contractor shall dispose of the remaining ash material off site at their own expense.
 3. The material left over after burning, waste concrete, asphalt, stones, rocks and other non-organic material may not be buried on the site.
 4. The Contractor shall be required to locate a disposal area outside the property limits at their own expense.
 5. The Contractor shall obtain and file with the Owner's Representative, permission in writing from the property owner for use of private property for this purpose.

6. All off-site disposals shall be in compliance with all Federal, State and Local laws.
 7. No blasting shall be permitted.
 8. The removal of existing utilities required to permit orderly progress of work shall be accomplished by local agencies, unless otherwise shown on the Drawings.
- E. Whenever a telephone or telegraph pole, gas pipeline, conduit, roadway, or other utility is encountered and must be removed or relocated, the Contractor shall notify the proper local authority or owner and attempt to secure prompt action.
- F. The Contractor shall clear the staked or indicated area of all objectionable materials.
- G. Trees unavoidably falling outside the specified limits must be cut up, removed, and disposed of in a satisfactory manner.
- H. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of areas being cleared.
- I. The Contractor shall preserve and protect from injury all trees and plants not to be removed.
- J. **Technical Provisions**
1. Reserved
 2. Clearing limits have not been provided for the project and will be based on Contractor's means and methods. Contractor shall keep all clearing, grubbing, stripping, and stockpiling operations within designated easements and right-of-way unless otherwise approved
 3. Should trees need removal within USACE Jurisdiction the Contractor is to prepare a tree removal plan that accounts for Endangered Species Act compliance, to include conservation conditions for the Northern Long Eared Bat (*Myotis septentrionalis*). For example: no trimming or grubbing of trees between 01-June to 15-August unless trees are surveyed by a certified biologist for the Northern Long Eared Bat and the species is found to not be present in any trees within the area of disturbance.

31.3.02 STRIPPING OF TOPSOIL

- A. Stripped topsoil shall be preserved and replaced after the completion of final grading as required. Topsoil shall be removed to a depth as included herein. Strip topsoil full depth to clearing limits, or as required.
- B. Stockpile all topsoil material where identified on the plans, or at a location approved by the Engineer.
1. Contractor shall separate and stockpile topsoil material from all other excavated materials.
- C. Stockpiles shall be constructed in a safe manner, minimizing slope gradients, erosion, and to eliminate sedimentation of adjacent areas. Contractor shall utilize industry accepted best management practices (BMP) for erosion and sedimentation control measures. If the project is required to have a SWPPP, the Contractor must adhere to the requirements of MDEQ, obtain an MPDES permit, and comply with the conditions outlined in the project's SWPPP.
- D. The Contractor may obtain written permission from a property owner for use of private property for stockpiling and/or disposal of topsoil material. Contractor is to provide a copy of the agreement for stockpiling or disposal of material to the Owner or Owner's Representative prior to disposing of materials under this section. The Contractor shall comply with all Federal, State and Local regulations for stockpiling and disposal of materials on private properties.
- E. The Contractor shall utilize stockpiled topsoil for the restoration and reclamation of disturbed areas as identified on the plans, profile sheets, and details, or as identified by the Engineer. Topsoil shall be placed to a depth equal to the adjacent in-situ topsoil depths, or at a minimum of 6", whichever is greater, or as otherwise specified. Grade to match existing contours, prevent ponding water and

to promote sheet flows. Final soil stabilization measures are to be completed immediately after final grading of restored areas.

- F. The Contractor shall restore all soil stockpile areas to their original condition once material removal has been completed. Final stabilization measures are to be done immediately after final grading and restoration of the area as specified.
- G. Any excess topsoil remaining after final grading of restored areas shall be hauled off site and disposed of at the Contractor's expense.
- H. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes work for excavation and filling or backfilling to the specified lines, grades and cross sections as shown in the Contract Documents.

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|------------|--|
| AASHTO T99 | Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop |
| ASTM D698 | Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ or 600 kN-m/m ³) |

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 02 32 00	GEOTECHNICAL INVESTIGATION
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK

31.1.04 SUBMITTALS

- A. Laboratory test results of fill materials must be submitted to the Engineer.
- B. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

31.2.01 ON-SITE EMBANKMENT

- A. Fill and backfill materials are to consist of natural soils free from organic matter, frozen material, refuse, construction debris or other man-made items. Obtain approval of the Engineer for all fill before placing and use only the fill from designated borrow areas.

31.2.02 IMPORTED BORROW MATERIALS (FOR EMBANKMENTS IN-PLACE)

- A. If required, the Contractor shall obtain borrow soil for embankments from areas off the project site. Imported borrow shall be furnished at Contractor expense unless otherwise specified. Engineer approval of borrow areas is required. Imported borrow is to meet the requirements of On-Site Embankment as included herein.

PART 3 EXECUTION

31.3.01 EXCAVATION

- A. Excavations shall be made to the specified lines and grades without causing rutting, pumping or other disturbance to underlying materials.
- B. Excavation made outside the specified grade limits is not measured for payment in the Excavation or Embankment In-Place quantities.
1. The Contractor shall restore sub-excavated areas as directed by the Engineer. The Contractor shall correct subgrade disturbance by removing the disturbed soil and replacing

- and compacting to reach at least 95% of the maximum laboratory dry density determined by AASHTO T99 or ASTM D698.
2. The Contractor shall correct subgrade disturbance before placing overlying fill, backfill, base course or other courses. Disturbed soils may be replaced with imported material approved by the Engineer and compacted to 95% of maximum laboratory dry density determined by AASHTO T99 or ASTM D698.
- C. The subgrade shall be maintained to drain at all times. Side ditches or gutters from cuts to embankments shall be constructed to prevent erosion damage to embankments.
 - D. The Contractor shall construct and maintain temporary drainage where existing surface drainage, sewers, or under-drainage are disturbed during the work until permanent drainage facilities are completed. The Contractor shall protect and preserve all existing drains, sewers, subsurface drains, conduits, gas lines, and other underground structures which may be affected by the work. All damage to these facilities or structures resulting from the work shall be repaired to the satisfaction of the Engineer.
 - E. The Contractor shall excavate to minimize foundation soil and/or subgrade soil exposure to erosion, drying or infiltrating moisture. The Contractor shall excavate to provide drainage away from foundation/subgrade soils and minimize the potential for surface runoff to enter the foundation/subgrade soils.
 - F. The Contractor shall grade all intersecting streets and approaches within the project limits as specified or as directed using suitable materials on the surfaces to produce smooth riding and satisfactory approaches to the intersections.

31.3.02 EMBANKMENT PLACEMENT

- A. General
 1. The Contractor shall place fill materials (embankment) to the specified lines and grade in uniform layers not exceeding 8 inches in loose thickness. Once placed, each layer shall be moistened or aerated, mixed, and compacted as specified. Clay soils shall be worked to maximum 2-inch nominal size before compacting. Fill placement shall not begin until the subgrade construction has been approved by the Engineer. Fill shall not be placed on wet or frozen areas. Heavy equipment for spreading or compacting fill shall not be operated within 4 feet of structures.
 2. If grading operations are suspended due to weather, the entire area shall be bladed until it is smooth, free of depressions and ruts, and crowned to drain water.
- B. Rocks in Embankment
 1. Individual rocks up to 24 inches in its longest dimension may be placed in the embankment when they are evenly distributed and are spaced to allow placing and compacting of soil between the rocks.
 2. Rocks exceeding 4 inches in its longest dimension must not be placed in the top 1 foot of the finished grade.
- C. Compaction
 1. Compaction shall be performed in accordance with **SECTION 31 05 00 – GENERAL WORK RESULTS FOR EARTHWORK** of these Specifications.

31.3.03 SUB-EXCAVATION/REPLACEMENT BELOW SUBGRADE

- A. Sub-excavation/replacement below subgrade shall be performed as directed by the Engineer to ensure a suitable subgrade is achieved.

31.3.04 TESTING

- A. Testing shall include but not be limited to, Field Density Testing and Laboratory Maximum Density and Optimum Moisture.

- B. Testing shall be performed in accordance with the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.
- C. Testing frequency and other related quality control criteria shall be performed in accordance with the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes dewatering for earthwork, utility, and structural excavations and all associated work included thereto, and shown on the Plan and Profile sheets and as specified herein.

31.1.02 REFERENCES

- A. This section reserved.

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other Sections of these Specifications:

SECTION 31 23 50	EXCAVATION AND EMBANKMENT
SECTION 31 23 33	TRENCHING AND BACKFILL
SECTION 31 25 00	EROSION AND SEDIMENTATION COTROLS

31.1.04 SUBMITTALS

- A. Submittals submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Contractor shall submit a Dewatering Control Plan to the Owner or the Owners Representative, which must be approved prior to any dewatering activities.
1. A complete dewatering plan must include
- Expected water levels (per TM-5-818-5 dewatering is required at least 2' below excavation)
 - Method for dewatering each area including design information
 - Manufacturer information for dewatering system
 - Drilling and Invasive Program Plan (DIPP) for well point installation (if applicable)
 - Drawings showing location and arrangement of dewatering equipment
 - Discharge Points
 - Contacts for employees who will be responsible for dewatering
 - Abandonment details
- C. **Technical Provisions**
1. Reserved

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

31.3.01 GENERAL

- A. Unless otherwise specified, all work associated with dewatering will be included in the price of the Project. All required construction dewatering shall be the responsibility of the Contractor.
- B. At all times the Contractor will comply with all requirements of the U.S. Environmental Protection Agency (EPA) for dewatering, under the Clean Water Act Section 402. The National Pollutant Discharge Elimination System (NPDES) program controls direct discharges into navigable waters of the United States.

- C. The Contractor shall verify if the project is subject to the Montana Pollution Discharge Elimination System permit requirements. If applicable, the Contractor is responsible for acquiring any necessary MPDES permits.
- D. The Contractor shall be responsible for investigating and becoming familiar with all site conditions that may affect the Work including surface water, potential flooding conditions, level of groundwater, and time of year the work is to be done.
- E. The Contractor shall maintain the site in a fashion that will provide positive surface drainage to basins utilized for permanent/temporary water detention, or to other appropriate BMP's, and at all times prevent surface water from flowing into excavations.
- F. Surface flows shall be directed in a manner to minimize the flow across soils which, when exposed, may be eroded, and carried into storm sewers or wetlands or other protected waters. No untreated discharges are allowed to enter into existing storm systems, drainages, wetlands or beyond the project limits.
- G. At no time during construction shall the Contractor affect existing surface or subsurface drainage patterns of adjacent property. Any damage to adjacent property resulting from the Contractor's alteration of surface or subsurface drainage patterns shall be repaired by the Contractor at no additional cost to the Owner.
- H. Ample equipment for dewatering shall be provided by the Contractor at all times during the course of the work. Pumps and equipment must be of the size and type for the efficient removal and disposal of all subsurface water, and/or for the prevention of surface water entering excavations. Contractor shall keep adequate standby equipment available at all times to insure continuous and efficient dewatering and maintenance.
- I. Dewatering shall not cease until such time the backfilling has progressed to where buoyancy of the fill, any structure, or pipe will not affect the alignment or integrity of the work.
- J. The Contractor shall be responsible for any damage arising from the disposal of water.
- K. Excavations for utilities and structures shall be dewatered to an elevation below the bottom of the trench and/or excavation.
- L. Water removed from excavations may not be disposed of into sanitary sewer systems.
- M. The Contractor shall remove all temporary water control facilities when they are no longer needed or at the completion of the Project, at no expense to the Owner.
- N. The costs of dewatering and all costs associated with discharging to surface waters, including permit fees shall be included in the bid price for the work requiring the dewatering, and is incidental to that work unless otherwise specified.
- O. **Technical Provisions**
 - 1. Reserved
 - 2. Soil moisture and ground water levels will fluctuate due to seasonal changes, weather, irrigation, and other variations in conditions. Methods and procedures related to differing soils could include adjusting the means and methods of excavation, installation or removal of soils encountered. The Contractor is responsible to determine construction methods and include these costs in the bid unit prices.
 - 3. If dewatering is deemed necessary at the time of construction, the Contractor shall consult a licensed professional engineer or geologist familiar with the local geologic, hydrogeologic, and geotechnical conditions as well as the construction practices pertaining to the Contractor's means and methods of dewatering.
 - 4. Contractor is responsible for controlling discharge rate and effect of the dewatering system. Contractor shall establish, observe, and record reference points at frequent intervals to detect any settlement of structures adjacent to areas of proposed dewatering. The Contractor is responsible for protecting adjacent structures. Any costs associated with the repair, restoration, or replacement of damaged structures or surfaces shall be the responsibility of the Contractor.

5. Contractor shall dispose of groundwater in a suitable manner without damage to adjacent property, as approved by Owner/Engineer. Contractor shall not direct groundwater into Work area and shall filter groundwater using appropriate methods to remove sand and fine-sized soil particles before disposal into any drainage system.
6. If dewatering is deemed necessary by Contractor, Contractor shall submit a detailed plan, operation, maintenance, and removal schedule for dewatering to Owner and Engineer for Owner's/Engineer's record.
 - a. Contractor shall consult a licensed professional engineer or geologist familiar with the local geologic, hydrogeologic, and geotechnical conditions as well as the construction practices pertaining to the Contractor's means and methods of dewatering.
7. Contractor shall conform with all local, state, and federal requirements and obtain permits for the control and discharge of groundwater from dewatering operations.
8. Contractor shall provide dewatering systems with sufficient pumping equipment and machinery in good working condition and provide at all times, competent personnel for the operation of the systems. Contractor shall keep adequate standby equipment available at all times to insure continuous and efficient dewatering and maintenance.

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes work for general compaction requirements of backfill and embankment.

31.1.02 REFERENCES

- A. This section reserved.

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other Sections of these Specifications.

SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 31 23 33	TRENCHING AND BACKFILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

31.1.04 SUBMITTALS

- A. This section reserved.

31.1.05 TESTING

- A. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION**.
- B. **Technical Provisions**
1. Reserved

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

31.3.01 GENERAL

- A. Compaction of backfill and embankments shall be obtained by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers.
- B. All such equipment shall be of a size and type approved by the Owner's Representative.
1. Flooding shall not be considered an acceptable means of obtaining compaction nor shall the use of a backhoe bucket.
- C. Permission on the part of the Owner or Owner's Representative to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the contract.
- D. The Contractor shall be responsible for costs and corrections for any damage caused by compaction equipment.
- E. Material for mechanically compacted backfill and embankments shall be placed in lifts which, prior to compaction, shall not exceed the thickness specified below for the various types of equipment:
1. Vibratory equipment, including vibratory plates, vibratory smooth-wheel rollers, and vibratory pneumatic-tired roller:
 - a. Maximum lift thickness 6 - inches.

2. Rolling equipment including sheepsfoot (both vibratory and non-vibratory), grid, smooth-wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheels:
 - a. Maximum lift thickness of 6 - inches.
3. Hand-directed mechanical tampers:
 - a. Maximum lift thickness of 4 - inches.
4. Refer to related work sections for maximum lift heights allowed for placement and compaction of applicable material.
- F. Mechanically compacted backfill and embankment shall be placed in horizontal layers of thickness not exceeding those specified above compatible to the material being placed and the type of equipment being used.
- G. Compaction adjacent to all foundations, footings, manholes, catch basins, valve boxes, curb boxes, end of sewer services and similar structures shall be performed by the use of hand-directed mechanical tampers with lifts not exceeding that specified above.
- H. A minimum of 1 – foot of backfill material shall be placed over the top of a pipe before operating vibratory or sheep's foot type compaction equipment. This material shall be compacted using hand-directed mechanical tampers with lifts not exceeding that specified above.
- I. Each layer shall be evenly spread, moistened or dried, if necessary, and then tamped or rolled until the specified compaction has been attained.
 1. Apply uncontaminated water, when required, at the locations and in the amounts required to compact the backfill material to the specified requirements.
 2. Water required for compacting trench backfill may be obtained from the municipal system if approved by the Owner, or from other sources.
 3. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
 4. Do not place backfill or embankment when moisture content prevents effective compaction or causes rutting. Dry all embankments and fill having excessive moisture by scarifying and blading and/or mixing the affected areas before compacting or placing succeeding layers.
- J. Proof roll and/or perform field density testing of subgrade material prior to placement of backfill or embankment as applicable. Compact all soft, yielding or otherwise unstable areas. Or, remove and replace any unstable or otherwise unsuitable subgrade approved by the Engineer.
- K. Refer to **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** for additional requirements.
- L. **Technical Provisions**
 1. Reserved
 2. The costs for all proctor analysis's and density testing shall be paid for by the Contractor and shall be incidental to the respective bid item.

END OF SECTION

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification consists of furnishing and placing Flowable Fill to the lines and grades shown on the plans as backfill in trenches and/or at other locations. Flowable Fill is a self-compacting cementitious material using mineral aggregates (sand and/or gravel), native or processed materials, fly ash/cement, water, air entraining solution and (optionally) other admixtures. Flowable Fill is also known as Controlled Low-Strength Material (CLSM) and Controlled Density Fill (CDF). Flowable Fill is only permitted when specifically called out in the Contract Documents or approved by Engineer.

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|------------|---|
| ASTM D4832 | Preparation/Testing of Soil-Cement Slurry Test Cylinders |
| ASTM C39 | Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM D6023 | Standard Test Method for Unit Weight |
| ASTM C150 | Specification for Portland Cement |
| ASTM C618 | Specification for Fly Ash |
| ASTM C494 | Specification for Chemical Admixture for Concrete |
| ASTM E329 | Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction |
| ASTM C1064 | Temperature of Freshly Mixed Portland Cement Concrete |
| ASTM C117 | Materials Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C136 | Sieve Analysis of Fine & Coarse Aggregate |
| ASTM C117 | Materials Finer Than No. 200 (0.075 mm) Sieve in Mineral Aggregates by Washing |
| ASTM D4318 | Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils |
| ASTM D6103 | Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM) |
| ASTM C94 | Ready Mix Concrete |
| ACI 301 | Standard Specifications for Structural Concrete for Buildings |
| ACI 304 | Guide for Measuring, Mixing, Transporting and Placing Concrete |

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 31 23 33	TRENCHING AND BACKFILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

31.1.04 SUBMITTALS

- A. The Contractor is to provide the Engineer with a mix design by either trial batch or field experience methods to verify the required compressive strength of the flowable fill at the 28-day age. Mix

design requirements are included herein, Proportions, and Compressive Strength. Proportions shall be selected on the basis of unconfined, air cured compressive strength test specimens.

- B. Measured compressive strength, air content and yield for the mix design trial batch, or for the field experience-based mix design, shall be submitted.
- C. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- D. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS..**
- E. **Technical Provisions**
 - 1. Reserved

31.1.05 TESTING

- A. Testing shall include; but not limited to, air content, slump, temperature, and cylinders for strength tests.
- B. Testing shall be performed as directed by the Engineer.
- C. **Technical Provisions**
 - 1. Reserved

PART 2 PRODUCTS

31.2.01 GENERAL

- A. Provide a mixture of the materials described below to produce a self-compacting cementitious material batched on a per cubic yard basis.
- B. Adjustments of the proportions of constituents may be made to achieve proper solid suspension and optimum flowability. However, strength requirements and proper yield shall be maintained for the actual batch weights.
- C. The Contractor shall submit, to the Engineer, a mix design based upon a trial batch or field experience, including the proportions and sources of all constituent materials, air entraining and (optionally) other admixtures, expressed as cubic yard batch weights.
- D. Consistency of the fresh mixture shall be such that the mixture produces a self-leveling product free of segregation determined by ASTM D6103.
- E. Water used in mixing shall be free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.
- F. **Technical Provisions**
 - 1. Reserved

31.2.02 CEMENTITIOUS MATERIAL

- A. Cementitious material consists of Portland cement meeting ASTM C150, with or without the addition of cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989, or blended hydraulic cement meeting ASTM C595 or hydraulic cement meeting ASTM C1157.
 - 1. Portland cement used cementitious material shall be:
 - a. Type I or Type II, unless otherwise specified.
 - 2. Fly ash used as cementitious material shall be:
 - a. Class C or Class F, unless otherwise specified.
- B. **Technical Provisions**

1. Reserved

31.2.03 **CHEMICAL ADMIXTURES**

- A. Chemical Admixtures shall conform to the requirements of ASTM C494.

B. **Technical Provisions**

1. Reserved

31.2.04 **FLOWABLE FILL (MPW STANDARD)**

- A. Proportions:

1. The mix shall contain a minimum of 50 pounds of cement and up to 250 pounds fly ash per cubic yard, with the remainder of the volumes composed of aggregates, water, and any approved admixtures.

- B. Flowable Fill Aggregates:

1. Any aggregate gradation which produces performance characteristics of the flowable fill specified herein will be accepted, except as follows:
 - a. The amount of material passing the #200 sieve shall not exceed 20 percent.
 - b. Liquid limit and plasticity index shall not exceed 25 and 5, respectively, when tested in accordance with AASHTO T89 and AASHTO T90.

- C. Unconfined Compressive Strength:

1. Flowable fill shall be designed to achieve a 28-day compressive strength of 30 psi to 500 psi when tested in accordance with ASTM D4832.
2. Excavatable flowable fill shall be designed to achieve a 28-day compressive strength of 30 psi to 150 psi when tested in accordance with ASTM D4832.

D. **Technical Provisions**

1. Reserved
2. The mix for flowable fill shall also be designed to produce a high flowability material generally having a slump greater than 8 – inches. As an alternative to slump testing, desired consistency may be approximated by filling an open-ended 3 - inch diameter cylinder, 6 - inches high, with the mixture and cylinder immediately pulled straight up. The correct consistency of the mixture will produce an approximate 8 - inch diameter circular type spread without segregation.

31.2.05 **EXCAVATABLE CONTROLLED LOW STRENGTH MATERIAL (CLSM)**

- A. Proportions:

1. Proportions for excavatable CLSM shall produce a unit weight of 80 pcf to 110 pcf when tested in accordance with ASTM D6023.
2. The requirements unit weight is for laboratory mix designs only and are not intended for jobsite acceptance requirements.

- B. Excavatable CLSM Aggregates:

1. Do not use coarse aggregate in excavatable CLSM. Aggregate shall have a max nominal aggregate size of 3/8 – inch.
2. 3/8 – inch minus aggregate shall meet the grading requirements for fine aggregates provided in **SECTION 03 00 00 CONCRETE** as determined by ASTM C33.
3. Do not use materials in CLSM with a plasticity index over 4 according to AASHTO T89 and AASHTO T90.

- C. Air Content Requirements:

1. Air content shall be between 5% and 40% as determined by ASTM D6023.
 2. The requirements for percent air are for laboratory mix designs only and are not intended for jobsite acceptance requirements.
- D. Unconfined Compressive Strength:
1. Excavatable CLSM shall be designed to achieve a 28-day unconfined compressive strength of 35 psi to 150 psi when tested in accordance with ASTM D4832.
- E. **Technical Provisions**
1. Reserved
 2. All flowable fill used on the project shall be excavatable.

31.2.06 NON-EXCAVATABLE CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Proportions:
1. Proportions for non-excavatable CLSM shall produce a unit weight of 100 pcf to 130 pcf when tested in accordance with ASTM D6023.
 2. The requirements unit weight is for laboratory mix designs only and are not intended for jobsite acceptance requirements.
- B. Non-Excavatable CLSM Aggregates:
1. Aggregate shall have a max nominal size of 3/4 – inch.
 2. Aggregates shall meet the gradings requirements of fine aggregates provided in **SECTION 03 00 00 CONCRETE** as determined by ASTM C33 or meeting the gradation provided in the following table.

CLSM Aggregate Gradation (Max 3/4 – inch) Table 31 23 23.33 - A	
Sieve	Percent Passing (%)
3/4"	100
No. 4	65 - 100
No. 30	40 – 80
No. 200	0 – 30

3. Do not use materials in CLSM with a plasticity index over 4 according to AASHTO T89 and AASHTO T90.
- C. Air Content Requirements:
1. Air content shall be between 5% and 30% as determined by ASTM D6023.
 2. The requirements for percent air are for laboratory mix designs only and are not intended for jobsite acceptance requirements.
- D. Unconfined Compressive Strength:
1. Non-excavatable CLSM shall be designed to achieve a 28-day unconfined compressive strength greater than 150 psi when tested in accordance with ASTM D4832.
- E. **Technical Provisions**
1. Reserved
 2. Non-excavatable controlled low strength material (CLSM) will not be required for this project.

31.2.07 ALTERNATIVE FLOWABLE FILL OR CLSM

- A. Project requirements may require alternative project specific mix designs and proportions for flowable fill or controlled low strength materials as specified in this section. If so, the proportions and mix requirements will be provided in part B, Technical Provisions, of this subsection.

B. **Technical Provisions**

1. Reserved
2. Proportions for flowable fill formula specified in in this subsection, shall have the following formula, or approved equal for all work performed within Montana Department of Transportation rights-of-way, including all small non-shrink backfill road patches, utility locates “pot-holes”, and excavation.

<u>Material</u>	<u>Metric (kg/m³)</u>	<u>US Customary (lbs/yd³)</u>
Cement – 0.45 sack	25	42
Water – 39 gal (148 L)	193	325
Air (entrained)		
1.5% course aggregate – 1 in. max	1010	1700
Sand (ASTM C33)	1095	1845
Total	2323	3912

- a. *Note: Start with 30 gal (114 L) of water or less and add more if necessary.
- b. The 28-day compressive strength shall show a strength of 30 to 150 psi and be designed to attain initial set within 4 hours of batching. Contractor shall submit test results based upon a trial batch to the Engineer verifying this property before use.

PART 3 EXECUTION

31.3.01 GENERAL

- A. Comply with ACI 304 and ASTM C94 for Measuring, Mixing, Transporting, and Placing the Flowable Fill, and as herein specified.

B. **Technical Provisions**

1. Reserved

31.3.02 LIMITATIONS OF PLACEMENT

- A. Do not place flowable fill or CLSM on frozen ground. Mix and place only when the air temperature is at least 35 degrees F and rising. At the time of placement, Flowable Fill shall be at least 40 degrees F. Stop mixing and placement when the air temperature is 40 degrees F and falling.
- B. Flowable backfill shall be placed by methods that preserve the quality of the material in terms of compressive strength, flow, homogeneity, plasticity and workability. The material shall be transported, placed, and/or consolidated so that it flows easily around, adjacent to and under structures. It shall have the flow, consistency, and workability such that the material is self-compacting.
- C. Protect freshly placed Flowable Fill from premature drying, excessive cold, or hot temperatures. The air in contact with the backfill surface shall be maintained at temperatures above freezing. Begin curing, immediately following placement before the backfill has dried. Continue with curing until the backfill has attained the 28-day strength requirement. This strength is to be determined prior to any load applications or construction activity, unless otherwise directed by an Engineer.
- D. **Technical Provisions**
1. Reserved

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes work for the excavation, trenching and backfilling for pipelines and appurtenances. It includes all clearing, grubbing, site preparation, removal, and disposal of debris from the excavation, handling and storing materials for fill and backfill, all bracing, shoring and trench protection, construction dewatering, all backfill, subgrade preparation, final grading, site dressing and cleanup.

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|---------------------------|--|
| AASHTO T89 | Determining the Liquid Limit of Soils |
| AASHTO T90 | Determining the Plastic Limit and Plasticity Index of Soils |
| ASTM D4318 | Determining Liquid Limit, Plastic Limit and Plasticity Index of Soils |
| ASTM D4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table |
| ASTM D4254 | Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density |
| AASHTO T11/ASTM C117 | Materials Finer Than 0.075µm (No. 200) Sieve in Mineral Aggregates by Washing |
| AASHTO T27/ASTM C136/136M | Sieve Analysis of Fine and Coarse Aggregate |

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	COMMON WORK RESULTS FOR CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 19	DEWATERING
SECTION 31 23 23.23	COMPACTION
SECTION 31 23 23.33	FLOWABLE FILL
SECTION 31 50 00	EXCAVATION SUPPORT AND PROTECTION
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

31.1.04 SUBMITTALS

- A. Submit to the Engineer material quality test results including Type 1 Bedding gradation and plasticity index: and Type 2 Bedding gradation.
- B. Submit to the Engineer samples of on-site and off-site borrow soils used for imported backfill for laboratory moisture-density relationship testing by the Engineer.
- C. If applicable, submit a blasting plan to the Engineer. (NOT REQUIRED)
- D. Shop drawings and product data shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- E. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- F. Technical Provisions
1. Reserved

31.1.05 TESTING

- A. Testing shall include; but not limited to, field density testing and laboratory maximum density and optimum moisture.
- B. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00 GOETECHNICAL INVESTIGATION.**
- C. **Technical Provisions**
 - 1. Reserved

PART 2 PRODUCTS

31.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. **Technical Provisions**
 - 1. Reserved

31.2.02 TYPE I PIPE BEDDING

- A. Type 1 Pipe Bedding includes the material placed from 4-inches below the bottom of the pipe, around the pipe, and up to the spring line of the pipe.
- B. Provide Type 1 Bedding consisting of sand, sandy gravel, or gravel having a maximum 3/4 - inch size and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.
- C. Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be free draining and non-plastic.
- D. Refer to Plan Detail sheets for requirements.
- E. **Technical Provisions**
 - 1. Reserved

31.2.03 SELECT TYPE I PIPE BEDDING

- A. Select Type 1 Bedding includes the material placed from the spring line of the pipe to 6 inches over the pipe.
- B. Select Type 1 Bedding shall consist of soil, sand or fine gravel, free from clods, lumps of frozen material, or rock exceeding 1-1/2 - inches in its greatest dimension.
- C. Excavated trench material may be screened or sorted for use as backfill subject to approval of the Engineer.
- D. Where trench excavation encounters wet or unstable material, Select Type 1 Bedding must be free draining and non-plastic.
- E. **Technical Provisions**
 - 1. Reserved

31.2.04 TYPE II PIPE BEDDING

- 1. Type 2 Pipe Bedding is used as directed by the Engineer to replace unsuitable material encountered in the trench bottom.
- 2. Place Type 2 Pipe Bedding from the bottom of the Type 2 Bedding material to the depth required to adequately support the pipe.
- 3. Type 2 Bedding shall consist of granular material meeting the following gradation.

<u>Sieve Opening</u>	<u>% Passing</u>
3 inches	100

No. 4	0 - 25
No. 8	0 - 10
No. 200	0 - 5

B. **Technical Provisions**

1. Reserved

31.2.05 TRENCH BACKFILL MATERIAL

- A. Backfill material obtained from trench excavations must be free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials.
- B. Backfill materials are subject to the performance type and provisions lined out in the Execution of this Specification.

C. **Technical Provisions**

1. Reserved

31.2.06 IMPORTED TRENCH BACKFILL MATERIAL

- A. Imported backfill material is from borrow source(s) outside the project limits and is used when, in the opinion of the Engineer, an adequate volume of suitable backfill material is not available within the project limits.
- B. Imported backfill material shall be free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials and subject to Engineer's approval prior to arrival onsite, and subject to the performance type and provisions lined out in Execution this Specification.

C. **Technical Provisions**

1. Reserved

PART 3 EXECUTION

31.3.01 GENERAL

- A. Clearing and grubbing prior to trenching, if required, shall be performed in accordance with **SECTION 31 11 00 CLEARING AND GRUBBING** of these Specifications.
- B. Trench dewatering efforts shall be performed in accordance with the provisions of **SECTION 31 23 19 DEWATERING** of these Specifications.

C. **Technical Provisions**

1. Reserved

31.3.02 PROTECTION OF EXISITING PROPERTIES

A. General

1. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Restore or replace all disturbed or damaged facilities to its original condition at Contractor's expense.
2. Contact utility Owners using the Montana One Call System for utility locates before starting work. Protect the utilities exposed during the work and prevent damaging underground

utilities adjacent to excavations. Immediately notify the utility Owner of any construction damage. Repairs of damage to marked utilities are at the expense of the Contractor.

3. Re-locate existing water mains, sanitary sewers and storm drains shown on the plans that conflict with new pipelines or structures as indicated in the Contract Documents. No separate payment will be made for this work unless shown as a payment item. If the Owner authorizes the relocation of mains or sewers which are not indicated in the bid documents, and the Engineer determines the work was not included in the original contract, payment will be made under the applicable sections of the General Conditions.
 4. Cut and replace existing service lines interfering with trenching operations only with the Engineer's permission and at the Contractor's expense. Show all repaired and/or adjusted water and sewer lines on the As-Built Plans.
 5. Protect existing water and sewer mains and water and sewer services from freezing at all times during construction.
- B. Privately Owned Utilities
1. If any existing private utility interferes with the work in either alignment or grade, and must be moved, the work will be performed by the appropriate Utility Owner, unless otherwise specified in the Contract Documents. Such private utilities may include gas mains, underground electrical and telephone cables, telephone poles, light poles, etc.
- C. Existing Structures
1. Prevent damage to existing buildings or structures in the work area. Repair all construction related damage to the satisfaction of the Owner.
- D. Existing Overhead Utilities
1. Use extreme caution to avoid conflict, contact or damage to overhead utilities during the work.
 2. In the event utilities need to be moved, the work shall be performed in accordance with the provisions of **SECTION 31 05 00 COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS** of these Specifications.
- E. Exploratory Excavation
1. The location of existing buried public utilities may need to be verified by exploratory excavation before construction.
 2. Exercise care to prevent damaging all utilities and repair any utility damage caused by exploratory excavation.
- F. Pavement Removal and Stripping
1. Where trench excavation or appurtenant structure excavation requires removing curb and gutter, concrete sidewalks, asphalt concrete pavement, or Portland cement concrete pavement, cut the concrete or pavement in a straight line parallel to the excavations edge using a spade-bitted air hammer, concrete saw or other suitable equipment to produce a straight, square and clean break. Re-cut edges broken during construction, before concrete or paving operations.
 2. For trenches passing through existing pavement, cut the pavement along a neat vertical line at least 12 inches from the trench edge. Where the neat line cut is less than 3-feet from the edge of the existing pavement, remove and replace the entire pavement section between trench and edge of pavement.
 3. Dispose of the asphalt concrete and/or Portland cement concrete debris off-site according to applicable state and local regulations.
 - a. Pavement Removal shall also be performed in accordance with the provisions of **SECTION 32 05 00 COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS** of these Specifications.

4. When excavating across existing gravel streets or other developed surfaces, remove the surfacing material full depth and stockpile for inclusion as trench backfill or legally dispose of the surfacing material.
5. When excavating across cultivated or sodded areas, remove topsoil full depth to a maximum 12 – inch depth, whichever is less, and stockpile for possible project use.

G. **Technical Provisions**

1. Reserved

31.3.03 MAINTENANCE OF FLOWS

- A. Maintain the flow of sewers, drains and water courses encountered during construction. Restore culverts, ditches, fences, crosswalks and structures disturbed by construction to their original condition upon completion of the work.

B. **Technical Provisions**

1. Reserved

31.3.04 TIME AND DISTANCE OF OPEN TRENCHES

- A. Perform the work so that trenches will remain open the minimum time required to accomplish the work.
- B. Do not begin trench excavating until appropriate compaction equipment is at the excavation site.
- C. Where interference with existing structures is possible or in any way indicated, and where necessary to establish elevation or direction for connections to in-place structures, the excavating shall be done at those locations in advance of the main operation so actual conditions will be exposed in sufficient time to make adjustments without resorting to extra work or unnecessary delay.
- D. The maximum permissible distance between backfilling/compaction operations and the end of newly installed pipe is 200 - feet in existing streets (and/or alleys) and 500 - feet in all other areas unless otherwise approved by Owner/Engineer.
- E. The maximum distance between the newly installed pipe and the excavator is to be 100 - feet in existing streets (and/or alleys) and 200 - feet in all other areas unless otherwise approved by Owner/Engineer.
- F. For each work group consisting of a trench excavator, a pipe laying crew, and a backfilling/compacting crew, the maximum allowable open trench at any time is 350 - feet in existing streets (and/or alleys) and 700 - feet in all other areas, unless otherwise approved by Owner/Engineer.
- G. The maximum distance behind the end of the new pipe is 1,500 - feet for final gravel surfacing, base, or pavement replacement, unless otherwise approved by Owner/Engineer.

H. **Technical Provisions**

1. Reserved

31.3.05 TRENCH EXCAVATION

A. General

1. Meet current OSHA Safety and Health Standards for all excavation, trenching, shoring, and Related Work.
 - a. Excavation protection shall be in accordance with **SECTION 31 50 00 EXCAVATION SUPPORT AND PROTECTION** of these Specifications.
2. Excavate at the specified locations for pipeline installations and appurtenant structures.

3. Crossings under sidewalks or curbs may be made by tunneling, if approved by the Engineer. If a portion of a sidewalk or curb is removed, use a concrete saw to make joints, compact the backfill as specified, and replace the removed section with new concrete sidewalk or curb.
 4. During excavation, stockpile backfill materials away from the trench banks to assure trench wall stability. Stockpile excavated materials on only one side of the trench without obstructing existing fire hydrants, valves, manholes and other appurtenances. Assure surface drainage of adjoining areas is unobstructed.
 5. Remove and dispose of all excess or unsuitable excavated materials.
 6. Prevent surface water from flowing into excavations. Promptly remove all water accumulating in trench excavations. Do not permit water to accumulate in any open trench. Remove and re-lay all pipe out of alignment or grade caused by trench flooding.
 7. Grade the trench bottoms to the specified lines and grades. Assure bedding material provides uniform bearing and support for each pipe section along its entire length. Excavate for bell and joints after the trench bedding is graded, limiting the excavation to the required length, depth and width for making the particular type of joint used. Backfill over excavations with Type 2 Bedding Material.
 8. No differentiation between common and rock trench excavation is made, except when listed as separate bid items on the bid proposal or bid form. Excavation includes removing and subsequent handling of all earth, gravel, bedrock or other material encountered regardless of the type, character, composition or condition of the material.
 9. The use of trench digging machinery is permitted, except in places where its operation is likely to cause damage to existing structures or features, in which case hand methods are to be employed.
- B. Trench Dimensions
1. Excavate to the trench dimensions specified below.
 2. Width
 - a. Excavate to provide room to install and join the pipe as specified. The minimum trench width is 3.5 - feet, for outside pipe diameters of 18 - inches or less. The minimum trench width is 2 - feet plus the outside pipe diameter, for pipe sizes exceeding 18 - inches. Maximum trench width may be specified in the Contract Documents.
 3. Depth
 - a. Excavate the trench as required for the invert grade or pipe bury as specified in the Contract Documents, plus 4 - inches for the Type 1 Pipe Bedding. If bedrock, boulders, or large stones are encountered at the bottom of the trench, excavate at least 6 - inches below the bottom of the pipe for backfilling with Type 1 Pipe Bedding.
- C. Soft or Unsuitable Trench Subgrade
1. When soft or unstable material is encountered at the trench subgrade which will not uniformly support the pipe, excavate the material to the depth directed by the Engineer and backfill to trench subgrade elevation with Type 2 Pipe Bedding.
 - a. Trench subgrade shall be considered the spring line of the pipe.
- D. Blasting
1. Blasting will not be permitted for this project.
- E. Pavement damaged caused by equipment
1. Equip all track mounted equipment operated on pavement surfacing with pads to prevent pavement damage.
 2. Restore all pavement damaged by construction to its original condition.

- F. Shoring, Bracing, and Sheeting
 - 1. Protection of excavations for utilities and appurtenances shall be performed in accordance with the provisions of **SECTION 31 50 00 EXCAVATION SUPPORT AND PROTECTION** of these Specifications.
- G. Excavation for Appurtenances
 - 1. Make excavations for manholes, hydrants, structures and other appurtenances of the size and depth to permit compacting of backfill on all sides to the specified density. The requirements for removing water and other applicable portions of these Specifications apply to excavation for appurtenances.
- H. **Technical Provisions**
 - 1. Reserved
 - 2. Pavement damage caused by equipment as specified in part E.2, included herein, shall be replaced in accordance with the provisions of **SECTION 32 12 16 ASPHALT PAVING** of these Specifications.

31.3.06 TRENCH BACKFILLING

- A. General
 - 1. Backfill all trenches as specified immediately after grade, alignment and pipe jointing has been inspected and approved by the Engineer. Conduct any pipe testing as specified in the respective water distribution, sewerage/drainage sections. Correct all defects discovered by tests prior to backfilling.
- B. Pipe Bedding Placement
 - 1. Type 1 Bedding:
 - a. Place Type 1 Pipe Bedding material 4 - inches under the pipe, around the pipe, and up to the spring line of the pipe. Place in maximum lifts of 6 - inches, using hand operated or other compaction methods without damaging or disturbing the pipe. Thoroughly compact each layer. Use special care to assure compaction under the pipe haunches.
 - b. Place backfill material in equal lifts on both sides of the pipe for the full trench width. Take care to prevent migration of Type 1 Bedding into surrounding soils during placement and compaction
 - 2. Select Type 1 Bedding:
 - a. Place Select Type 1 Bedding material from the spring line to 6 - inches over the pipe. Where wet or unstable material exists, assure the material is free draining and non-plastic.
 - b. Place in maximum lifts of 6 - inches using hand or other compaction methods without damaging or disturbing the pipe. Thoroughly compact each layer.
 - c. Place backfill in equal lifts on both sides of the pipe for the full trench width. Take care to prevent migration of Select Type 1 Bedding into surrounding soils during placement and compaction.
 - 3. Type 2 Pipe Bedding:
 - a. Use Type 2 Pipe Bedding described in Products Section as specified or as directed by the Engineer to replace unsuitable material encountered in the trench bottom, placing it from the bottom of the Type 1 Bedding material to the depth required to adequately support the pipe.
- C. Trench Backfill
 - 1. After the pipe bedding materials are placed and compacted as specified, backfill the trench. Use backfill material free of cinders, ash, refuse, organic or frozen material, boulders, or

other deleterious materials from the top of the Select Type 1 Pipe Bedding to 6 - inches below the ground surface, or to the subgrade elevation, material containing rock up to 8 - inches in the greatest dimension may be used.

2. Unless otherwise indicated or directed, rock shall be removed to an elevation at least 6 - inches below the bottom surface of the pipe barrel and below the lowest projection of joint hubs.
3. Rock shall be removed to such additional horizontal dimensions as will provide a minimum clearance of six inches on all sides of pipe and appurtenant structures such as valves, housings, access structures, etc.

D. Compaction

1. Trench backfill from the top of the pipe bedding to ground surface or to the street subgrade shall be compacted in accordance with the provisions of **SECTION 31 23.23 COMPACTION** and meet the requirements included in **SECTION 02 32 00 GEOTHECNICAL INVESTIGATION** of these Specifications.
2. Remove, replace, and re-compact backfill in trenches where settlement has occurred as directed by the Engineer at the Contractor's expense.

E. Replacement of Unsuitable Backfill Material

1. Remove and dispose of excavated soils that are saturated, contain deleterious materials or have characteristics that, in the opinion of the Engineer, render the soils unsuitable as backfill.
2. Replace unsuitable soils with material obtained from trench excavations within the project limits at the expense of the Contractor. If suitable replacement material is not available within project limits, obtain material from an approved borrow source, to be paid for as Imported Backfill Material.
3. Place and compact all imported material according to the applicable backfill Specification requirements.

F. Backfill Appurtenances

1. Place and compact backfill for appurtenances to finished grade around manholes, inlets, valve boxes and other underground items without disturbing appurtenance alignments.
2. Use backfill methods that shall eliminate the possibilities for appurtenance damage.
3. Meet the backfill material, placement, and compaction requirements specified for the adjoining trench.

G. Technical Provisions

1. Reserved

END OF SECTION

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes excavation and backfill necessary for the construction of structures and all work included thereto as shown on the Drawings and as specified herein.

31.1.02 REFERENCES

- A. Reserved.

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other Sections of these Specifications:

SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 11 00 CLEARING AND GRUBBING
SECTION 31 50 00 EXCAVATION SUPPORT AND PROTECTION

31.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

31.2.01 GENERAL

- A. Structure backfill shall be constructed of the materials as shown on the Drawings. The respective materials shall conform to the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.

PART 3 EXECUTION

31.3.01 GENERAL

- A. The work shall be constructed to the lines, grades, and cross sections as shown on the Drawings or as directed by the Owner's Representative.
- B. Excavations and backfill shall be finished to provide a smooth, uniform surface.
- C. Surfaces shall be sloped to drain away from the structure and slope rounding shall be employed to provide a gentle transition between the backfill and natural grade.
- D. Dewatering shall not be conducted by pumping from inside footings, structural floorslabs, or other structure foundation limits without written approval by the Engineer.
- E. Care shall be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal may be required in excavating the last few inches of material to obtain the subgrade of any item.
- F. Any over-excavated subgrades shall be brought back to subgrade elevations, as indicated on the Drawings, by the Contractor at the Contractor's expense in the following manner:
- G. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials, backfill with one-half (1/2) inch crushed rock, or fill with concrete at the time of the appurtenant structure concrete pour.
- H. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.
- I. Excavation shall be unclassified and shall consist of the removal of whatever substance or material is encountered.

31.3.02 UNSUITABLE MATERIAL

- A. Poor foundation material for any of the Work shall be removed by the Contractor with no additional cost to the Owner.
- B. Unsuitable foundation materials include the following:
 - 1. Saturated by either surface or subsurface flows
 - 2. Frozen for any reason
 - 3. Disturbed by the Contractor's work or caused to become unacceptable for foundation material purposes by means of Contractor's equipment, manpower, or methods of work.

31.3.03 TOPSOIL

- A. Topsoil shall be stripped and stockpiled in accordance with the provisions of **SECTION 31 11 00 CLEARING AND GRUBBING** of these Specifications.
- B. Topsoil shall be spread and finish graded as directed by the Engineer.

31.3.04 SURPLUS MATERIAL AND BORROW

- A. Surplus Material shall be disposed of in accordance with the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.
- B. Borrow shall be obtained for the sources and be of the quality specified in **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.

31.3.05 UNDERCUTTING

- A. Undercutting of structure excavation shall not be allowed unless rock or unsuitable materials are encountered.
- B. Undercutting shall be performed in accordance with the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.

31.3.06 COMPACTION

- A. Compaction of embankments shall be performed in accordance with the provisions of **SECTION 31 05 00 – COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.

31.3.07 CLEARANCE

- A. The excavation for structures shall be of sufficient size so as to leave at least 12 inches of clearance between the outer surface of the structure or footing and the embankment or sheathing or shoring.
 - 1. Where the structure bears on granular fill material that has been placed above the subgrade, the bottom of the excavation shall be oversized laterally one foot in each direction for each foot of granular fill material beneath the bearing elevation of the foundation.

31.3.08 EQUIPMENT

- A. Structure excavation shall be performed with a backhoe or similar piece of equipment to minimize construction traffic over the foundation soils.

31.3.09 GEOTECHNICAL TESTING AND INSPECTION

- A. The Contractor shall provide 48 hours' notice of when an area will be ready for geotechnical testing.
- B. Geotechnical testing shall be under the direct supervision of a professional geotechnical engineer licensed in the state in which the work is being performed.
- C. The geotechnical engineer shall inspect and test the subgrade.
- D. Fill material shall be tested every vertical foot of backfill with one test per 200 square feet of area.
- E. Structure backfill shall be compacted to 100% percent of standard proctor maximum density as determined by ASTM D698 unless noted otherwise.
- F. All areas with inadequate compaction shall be corrected at the Contractor's expense.

1. The Contractor shall have the areas retested to demonstrate that adequate compaction has been obtained.
2. The Contractor shall bear the cost of retesting and no reimbursement shall be made therefor.

31.3.10 **PROTECTION**

- A. The Contractor shall protect the subgrade and placed fill materials from frost and other damage at no additional cost to the Owner.
 1. The Contractor shall cover the subgrade and bearing fill materials with insulation any time there is a possibility of frost.
- B. Dewatering
 1. Dewatering shall be performed in accordance with the provisions of **SECTION 31 23 19 DEWATERING** of these Specifications.
- C. All sub-drainage, damp-proofing, waterproofing, foundation insulation and other similar work shall be installed by the Contractor and accepted by the Owner's Representative prior to backfilling.
 1. The Contractor shall expose any areas where work has been covered by backfilling but not witnessed by the Owner's Representative prior to backfilling as directed by the Owner's Representative.
 2. The cost of excavation and backfilling to expose covered work for which the Contractor did not provide an opportunity for review by the Owner's Representative shall be borne by the Contractor
- D. Contractor is responsible to protect adjacent structures, utilities, and other improvements at no additional cost to the Owner.
- E. Any damage resulting from the Contractor's performance of the work shall be corrected at no additional expense to the Owner.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. The work under this Specification shall include measures for the prevention of soil erosion and sedimentation due to construction related activities, including sub surface dewatering.
- B. The work shall include furnishing all materials, labor, and equipment required for the construction and maintenance of erosion and sediment control devices as specified in the Contract Documents.
- C. Contractor shall produce and implement an Erosion Control Plan (ECP).
- D. If required, Contractor shall and prepare and administer a Stormwater Pollution Prevention Plan (SWPPP).
- E. **Technical Provisions**
 - 1. Reserved

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - MDEQ Storm Water Management During Construction Field Guide for BMP's
 - MDOT Erosion and Sediment Control BMP Manual (Latest Edition)

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 11 01	CLEARING AND GRUBBING
SECTION 31 23 19	DEWATERING
SECTION 31 23 33	TRENCHING AND BACKFILL

31.1.04 SUBMITTALS

- A. Submittals for shop drawings, product data, and construction plans shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Contractor shall submit an Erosion Control Plan to the Owner or Owners Representative prior to the start of construction.
 - 1. The ECP must be approved by the Engineer prior to any construction related activity.
 - 2. Contractor shall submit to the Owner or Owners Representative the qualification(s) of the entity(s) that produced the ECP.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. The Erosion and Sediment Control Plan (ECP) as specified in part B of this subsection shall be submitted no later than seven (7) days following the Owner issuance of the Notice of Award for the project.

PART 2 PRODUCTS

31.2.01 GENERAL

- A. References to silt fences and other erosion control devices or measures, if any, in the Contract Documents are intended to illustrate typical erosion control measures to be implemented by Contractor. It is at the Contractors discretion what BMP's to use, unless otherwise specified, contingent

upon devices meeting the requirements included herein or as required and identified under the MPDES Storm Water Permit and SWPPP when applicable.

1. Other BMP's may be required for compliance with the CGP (2018) and may not be listed below.
- B. In the event erosion control measures or devices are not indicated on the plans or in the specifications does not waive Contractor responsibilities associated with the MPDES Storm Water permit nor the SWPPP.
- C. **Technical Provisions**
 1. Reserved

31.2.02 SILT FENCE

- A. Silt fence shall be machine sliced, and manufactured from Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest possible roll lengths, fabric including seams with the following minimum average roll lengths:
 1. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D4751.
 2. Permittivity: 0.1 sec^{-1} , minimum, when tested in accordance with ASTM D4491.
 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 after 500 hours exposure.
 4. Tensile Strength: 100 lb-f (450 N), minimum, in cross-machine direction; 124 lb-f (550 N), minimum, in machine direction, when tested in accordance with ASTM D4632.
 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632.
 6. Tear Strength: 55 lb-f (245 N), minimum, when tested in accordance with ASTM D4533.
 7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
 8. Suggested Regional Manufacturers Below:
 - a. WINFAB; www.winfabusa.com,
 - b. North American Green; www.nagreen.com.
 - c. Hanes Geo Components www.hanesgeo.com
 - d. Propex Geosynthetics; www.geotextile.com,
 - e. Any manufacturer producing materials meeting the required specifications may be substituted for the listed manufacturers above if approved by the Engineer.
 9. Wire backing if required, shall be a woven wire, and a minimum of 14.5-gauge grade 60 wire, with a maximum 6" mesh spacing.
 10. Lap all joints to the next support post and fasten as required. Overlaps are not included in the overall measurement for payment and is considered incidental to the item.
- B. The geotextile fabric shall be free of flaws such as tears or other defects. Any geotextile fabric which becomes damaged shall be replaced at no cost to the Owner. The geotextile fabric shall meet or exceed the following requirements:
 1. Type: Woven Monofilament
 2. Width: 36 inches
 3. Water Flow Rate of $<9 \text{ gpm/sf}$ when tested in accordance with ASTM D4491
- C. Posts
 1. Posts shall be a Steel.
 2. Posts shall be no less than 4 feet long.
 3. Steel posts shall be a minimum weight of 1.25 lbs./ft.

D. **Technical Provisions**

1. Reserved

31.2.03 EROSION CONTROL BLANKETS

A. Rolled Erosion Control Blanket (RECB)

1. RECB shall have a minimum shear stress of 1.75lbs/sf
2. RCEB shall have a functional longevity at or greater than 18 months.
3. Install RECB as shown on the plan and detail sheets. Overlap joints and seams as required by the manufacturer. Overlapped material is not subject to payment and is considered incidental to the item.
4. RECB shall be constructed of biodegradable mulch material, constructed using a combination of coconut and straw, coconut, or wood excelsior fibers.
 - a. Blended coconut-straw blankets shall consist of 70% minimum coconut fibers by weight, with remaining fibers consisting of straw. Straw shall be 100% weed free and certified as such by an accredited agency. All fibers shall have a minimum length of 3-inches.
 - b. Wood excelsior blankets shall have a minimum of 80% wood fibers to be 6-inches or longer, and fire resistant.
 - c. RECB shall have a net backing constructed of biodegradable polypropylene netting, or natural mechanically bound jute yarns or twines woven into a continuous matrix, with a functional longevity at least that of the fiber materials.
 - d. A minimum RUSLE "C" factor of .15 or greater.
5. Suggested Regional Manufacturers Below:
 - a. Tencate; www.tencategeo.com
 - b. WINFAB; www.winfabusa.com,
 - c. North American Green; www.nagreen.com.
 - d. Hanes Geo Components www.hanesgeo.com
 - e. Propex Geosynthetics; www.geotextile.com,
 - f. Any manufacturer producing materials meeting the required specifications may be substituted for the listed manufacturers above if approved by the Engineer.
6. Staples shall be a minimum length of 4-inches and be 100% biodegradable.

B. Hydraulic Erosion Control Blankets (HECB)

1. Spray on erosion control blanket shall produce a high-performance flexible growth medium (FGM), consisting of 100% biodegradable thermally refined wood fibers, coconut fibers, or a combination of both, crimped interlocking fibers, micro-pore granules, cross linked biopolymers and water absorbent. The FGM shall be photo-sanitized, 100% weed free, and on application form an intimate bond with soil surfaces, forming a flexible erosion control blanket.
 - a. Use Flexterra HP-FGM, or CocoFlex ET-FGM flexible erosion control blanket manufactured by Profile, or an approved equivalent.
 - b. Functional longevity must be a minimum of 18 months.
 - c. Slurry must be applied hydraulically, mixed, and applied as specified by the manufacturer.

C. **Technical Provisions**

1. Reserved

31.2.04 SEDIMENT CONTROL WATTLES

A. Fiber Rolls

1. Fiber rolls shall be constructed of 100% certified weed-free materials, consisting of straw, flax, coconut, wood fibers, a combination thereof, or other approved fiber materials bound into tight circular rolls encased in natural fiber such as hemp, jute, or a UV-degradable polypropylene netting.
 2. Fasten rolls to surface using pointed wood staking or other approved material, as specified on the plans and detail sheets, creating an intimate contact with soils. Overlap rolls as specified at joints and ends. Overlaps are not included in the overall measurement for payment and is considered incidental to the item.
 3. Contractor shall submit certification verifying materials to be 100% weed-free and certified as such by an accredited agency.
- B. Synthetic Wattles, Filter Socks
1. Install approved devices for sediment containment where applicable.
 2. Use synthetic log wattles such as Gator Guard, DuraWattle, Erosion Eel, or filter socks such as UltraTech, Filtrexx, Ultra, or approved equivalents for sediment control where applicable.
 3. Install as specified by the manufacturer, located as shown on the erosion control plan. Overlap wattles and filter socks as specified at joints and ends. Overlaps are not included in the overall measurement for payment and is considered incidental to the item.
- C. **Technical Provisions**
1. Reserved

PART 3 EXECUTION

31.3.01 GENERAL

- A. Unless otherwise specified, all work associated with sediment and erosion control will be included in the price of the Project.
- B. At all times the Contractor will comply with all requirements of the U.S. Environmental Protection Agency (EPA) for erosion and sedimentation control, under the Clean Water Act Section 402. The National Pollutant Discharge Elimination System (NPDES) program controls direct discharges into navigable waters of the United States.
- C. The Contractor shall verify if the project is subject to the Montana Pollution Discharge Elimination System permit requirements. If applicable, the Contractor is responsible for acquiring any necessary MPDES permits.
- D. Contractor is required to use established industry standards and practices for erosion and sedimentation control. Contractor is responsible to take actions to reduce erosion and contain sediments associated with construction activities, using appropriate BMP's identified in the ECP and SWPPP, and all remediation measures, costs, and fines for non-permitted discharges.
 1. Example references for local agency BMP's are published and located at:
 - a. MDEQ, <http://deq.mt.gov/Portals/112/Water/WPB/MPDES/pdfs/montfieldguide.revised4-4-14.pdf>
 - b. MDOT, <https://www.mdt.mt.gov/publications/docs/manuals/env/bmp-manual-dec16.PDF>
- E. No earth moving disturbances, or any other site work, excluding equipment and materials necessary for BMP installations will be permitted until all necessary temporary erosion control measures are completed and in place, preventing soil erosion and sedimentation.
- F. Contractor shall provide functional BMP's, and at no time allow sediments to enter wetlands, streams or sanitary or storm sewers.
- G. Contractor shall schedule work so that soil surfaces are left exposed for the minimum amount of time.
- H. Contractor shall incorporate natural buffers zones into the storm water management plan in conjunction with BMP's installed by the Contractor. All areas of native vegetation identified to be protected, or areas outside of the construction limits shall be protected from damage due to

construction related activities. Any vegetation, trees, shrubs etc. not planned for removal and/or damaged, shall be repaired or replaced at the expense of the Contractor.

- I. Contractor shall inspect all BMP's daily to identify maintenance and repairs needed, and if necessary, replace any damaged BMP's. Contractor shall maintain all erosion control devices for the duration of the project unless otherwise identified in the SWPPP, if required.
- J. If any storm water control device(s) is deemed inadequate, fails, or does not meet the requirements for controlling storm waters, the BMP shall be replaced with a more effective device.
- K. The construction of erosion control measures shall not relieve the Contractor of the responsibility, or requirements of the MPDES for preventing or minimizing the potential for erosion or siltation.
- L. The Contractor shall be responsible for all damages and clean up and the costs therefore, resulting from erosion of the soils and any siltation which may occur, regardless of the temporary erosion control measures taken.
- M. The cost of maintenance, repair, and replacement of temporary erosion control shall be included in the bid price for the work for which erosion control is required.
- N. **Technical Provisions**
 - 1. Reserved

31.3.02 PREVENTATIVE MEASURES

- A. **Erosion On Site:**
 - 1. Contractor shall minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 - a. Control movement of sediment and soil from temporary stockpiles of soil.
 - b. Prevent development of ruts due to equipment and vehicular traffic that may channel or pond storm water.
 - c. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- B. **Erosion Off Site:**
 - 1. Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 - a. Prevent windblown soil from leaving the project site.
 - b. Prevent tracking of mud onto public and private roads outside of the project site.
 - c. Prevent mud and sediment from flowing onto sidewalks and pavements.
 - d. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- C. **Sedimentation of Waterways Off Site:**
 - 1. No sedimentation of offsite waterways will be permitted from activities associated with this project. Sedimentation of waterways off the project site, including but not limited to, rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers will not be permitted.
 - a. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

D. Sedimentation of Waterways On-Site:

1. No sedimentation of onsite waterways will be permitted on this project site, including but not limited to, rivers, streams, lakes, ponds, open drainage ways, storm sewers and sanitary sewers. Construct on site measures to prevent any sedimentation of waterways.
 - a. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - b. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm. Pumping sediment basins is considered incidental to related work.

E. Storm Water Runoff:

1. Control increased storm water runoff due to disturbance of surface cover due to construction activities.
 - a. Prevent runoff into storm and sanitary sewer systems, open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
 - b. Contractor is to anticipate runoff volume due to the most extreme short term and 24-hour rainfall events for the project area and/or any forecasted events. SWPPP administrator is to secure the site prior to forecasted rain events in preparation for possible storm water runoff.

F. Technical Provisions

1. Reserved

31.3.03 **SILT FENCE**

- A. Silt fence shall be installed as shown on the Drawings and as required by the SWPPP and ECP, as applicable.
- B. Install posts and space as shown on the Drawings.
- C. The geotextile fabric for silt fencing shall be secured to the upstream face of the posts.
- D. The geotextile fabric shall be embedded in an anchor trench along the upstream side of the silt fence.
- E. The anchor trench shall be backfilled with the excavated material which shall be firmly compacted into place.
- F. Technical Provisions
 1. Reserved

31.3.04 **EROSION CONTROL BLANKETS**

- A. Rolled erosion control blankets shall be installed on all slopes 3:1(H:V) or steeper, at culvert ends, upstream and downstream, and as shown on the Drawings and as required by the SWPPP and ECP, as applicable.
- B. Rolled or hydraulically applied erosion control blankets shall be installed within 24 hours after seeding, fertilizing and mulching has been completed.
- C. RECB shall be rolled vertically down the slope.
- D. The blankets shall be spread out without stretching.
- E. Trench in and anchor trench at the top of slopes, pin, backfill, and secure blanket as specified on. Use specified staples and anchor RECB as specified.
- F. Along channels construct anchor trenches measuring one foot deep by one foot wide or as specified in the detail sheets.
- G. Technical Provisions

1. Reserved

31.3.05 STORMWATER & SEDIMENT CHECKS

- A. Check dams shall be countersunk or entrenched into the soil to a minimum depth of 4 inches below the surrounding soil as shown on the Drawings.
- B. Check bales if approved, shall be anchored to the ground with two 2-inch by 2-inch wood stakes or reinforcing bars, embedded in the soil at least 10 inches. Check bales shall be installed at locations shown on the Drawings and as required by the SWPPP and ECP, as applicable.
- C. **Technical Provisions**
 1. Reserved

31.3.06 SURFACE ROUGHENING

- A. Surface roughening is required for all exposed slopes where construction activities have ceased, due to construction phasing, delays, suspension or unforeseen reasons, for timelines greater than 21 days, or as approved by the Engineer.
- B. Prior to applying final stabilization measures and BMP's, Contractor shall surface roughen all finished surfaces. Roughen areas utilizing hand tools or by mechanical means for small areas. For large areas such as lawns, fields, embankments etc., roughen the surface by mechanical means using disks, ripping, scarifying or track walking the surface.
- C. All surfaces roughening shall be perpendicular to the flow of water.
- D. **Technical Provisions**
 1. Reserved

31.3.07 STORM DRAIN INLET SEDIMENT TRAPS

- A. Protect each curb inlet/catch basin from sediments entering systems, and as defined by the following measures:
 1. No storm water or subsurface water from dewatering or any construction related discharging activity shall be allowed to enter any storm water sewer system untreated. Contractor shall install appropriate BMP's for diversion of such waters or install pre-treatment devices for sediment removal prior to waters entering storm water systems.
 2. Filter fabric wrapped around hollow concrete blocks which block the entire inlet face area may be used; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet. Wrap fabric around surface grate inlets, tuck under and reset grate, or utilize other approved methods or products such as.
 3. Geotextile fabrics, filter socks, fiber rolls, grate/inlet filters and protection products, synthetic wattles, or other approved equivalent, installed per manufacturers specifications for the prevention of sediments entering storm drain systems.
- B. **Technical Provisions**
 1. Reserved

31.3.08 INTERIM MULCH

- A. During the periods when seeding and sodding are not permitted, the Contractor shall shape exposed areas to eliminate erosion, promote sheet flows, and prepare soils as specified and for;
 1. areas where site construction is phased with no construction related activities expected or planned for 21 days and exposed soils are present and subject to erosion;
 2. the project has been granted a winter shutdown; all exposed soils subject to erosion;
 3. or for any other project delays of 21 days or more, in which soils are exposed to weather and subject to soil erosion, the Contractor is required to apply an interim mulch and anchor/crimp the mulch as required or directed by the Engineer.

- B. Where the item(s) identified on the Bid Schedule includes separate pay items for mulching, disk and anchoring, the work, equipment, and materials for furnishing and anchoring of interim mulch shall be paid for at the unit bid price for the respective items.
- C. Contractor shall submit certification verifying materials used for interim mulching to be 100% weed-free and certified as such by an accredited agency.
- D. **Technical Provisions**
 - 1. Reserved

31.3.09 REMOVAL OF TEMPORARY EROSION CONTROL

- A. Temporary erosion control devices shall remain in place until final grading has been completed, all permanent erosion and sediment control devices have been installed, and final stabilization has been achieved, as defined in Section 5 of the MPDES, CGP (2018), unless otherwise specified in the SWPPP, if required.
- B. The Engineer may require temporary devices to remain in place up until the date of final completion for the project.
- C. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PART 1 GENERAL

31.1.01 DESCRIPTION

- A. This Specification includes shoring and protection of excavations and all work included thereto as shown on the Drawings and as specified herein.

31.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|-------|--|
| OSHA | Occupational Safety and Health Act Requirements |
| MUTCD | Federal Highway Administration Manual on Uniform Traffic Control Devices |

31.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other Sections of these Specifications:

SECTION 02 32 00	GEOTECHNICAL INVESTIGATION
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 31 23 33	TRENCHING AND BACKFILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

31.3.01 PROTECTION

- A. The Contractor shall take all necessary precautions for the protection of the work and the safety of the public.
1. All barricades and obstructions shall be illuminated at night by flashing signal lights which shall be kept burning from sunset to sunrise.
 2. Barricades shall be painted to increase their visibility.
 3. Suitable signs shall be so placed as to show in advance where construction, barricades or detours exist.
 4. All barricades and traffic control shall conform to the Federal Highway Administration Manual on Uniform Traffic Control Devices.
- B. The Contractor shall at all times conduct his work as to insure the least possible obstruction to traffic and inconvenience to the general public and to insure the protection of persons and property.
- C. No road or street shall be closed to the public except with the permission of the proper authority.
- D. Any police or other traffic control shall be arranged for by the Contractor and be at their expense.
- E. Fire hydrants on or adjacent to the work shall be kept accessible to fire-fighting equipment at all times.
- F. No valves on existing utilities shall be operated without permission from the proper authority.
- G. Temporary provisions shall be made by the Contractor to insure the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches, which shall not be obstructed.
- H. All costs of furnishing, placing, maintaining, and removing barricades, fences, and appurtenances shall be included in the unit price bid for Traffic Control which the protection is being provided and no separate compensation will be made therefor.

31.3.02 SHORING AND EXCAVATION SUPPORT

- A. All excavations shall be sheeted, shored, and braced as will meet all requirements of the applicable safety codes and regulations; comply with any specific requirements of the Contract; and prevent disturbance or settlement of adjacent surfaces, foundations, structures, utilities, and other properties.
- B. Any damage to the work under contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other causes due to failure or lack of sheeting, shoring, or bracing or through negligence of fault of the Contractor in any manner shall be repaired at the Contractor's expense and without delay.
- C. It shall be the Contractor's responsibility to provide for safe working conditions for all excavations in strict conformance with safety regulations.
 - 1. Damages or injury resulting from settlement, slides, cave-ins, water pressure, pedestrian, or vehicular involvement shall be the responsibility of the Contractor and all damages shall be repaired at the Contractor's expense.
 - 2. Where the depth of an excavation requires the slopes or shoring system to be designed by an Engineer retained by the Contractor, the Contractor shall furnish a copy of the Engineer's design to the Owner.
 - 3. The Contractor shall bear all costs for shoring and slope design.
- D. The Contractor shall assume full responsibility for proper and adequate placement of sheeting, shoring and bracing, wherever and to such depths that soil stability may dictate the need for support to prevent displacement.
- E. Bracing shall be so arranged as to provide ample working space and so as not to place stress or strain on the in place structures to any extent that may cause damage.
- F. Sheeting, shoring and bracing materials shall be removed only when and in such manner as will assure adequate protection of the in-place structures and prevent displacement of supported grounds.
 - 1. Sheeting and bracing shall be left in place only as required by the Drawings or Specifications or ordered by the Owner's Representative.
 - 2. Otherwise, sheeting and bracing shall be removed as the backfilling reaches the level of respective support.
 - 3. Wherever sheeting and bracing is left in place, the upper portions shall be cut and removed to an elevation of three feet or more below the established surface grade as the Owner's Representative may direct.
- G. All costs of furnishing, placing, removing sheeting, shoring, and bracing materials, including the value of materials left in place as required by the Contract, shall be included in the prices bid for which the protection is being provided and no separate compensation will be made therefor.
- H. When any sheeting, shoring, or bracing materials are left in place by written order of the Owner's Representative, in the absence of specific requirements of the Contract to do so, payment will be made for those materials as an Extra Work item, including waste material resulting from upper cut-off requirements.

END OF SECTION

FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 32 EXTERIOR IMPROVEMENTS

TABLE OF CONTENTS

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION	DOCUMENT
32 05 00	Common Work Results for Exterior Improvements
32 05 05	Selective Demolition for Exterior Improvements
32 11 16	Subbase Courses
32 11 23	Aggregate Base Courses
32 12 16	Asphalt Paving
32 16 13	Curbs and Gutters
32 16 43	Sidewalks, Driveways, and Valley Gutters
32 92 19	Seeding

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes work common to exterior improvements including but not limited to; retaining walls, concrete, pavement, and all work included thereto as shown on the Drawings and specified herein.

32.1.02 REFERENCES

- A. This section reserved.

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 03 05 00	COMMON WORK RESULTS FOR CONCRETE
SECTION 03 20 00	CONCRETE REINFORCING
SECTION 03 39 00	CONCRETE CURING
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 16	SUBBASE COURSE
SECTION 32 11 23	AGGREGATE BASE COURSE
SECTION 32 12 16	ASPHALT PAVING
SECTION 32 16 13	CURBS AND GUTTERS
SECTION 32 16 43	SIDEWALKS, DRIVEWAYS, AND VALLEY GUTTERS
SECTION 32 92 19	SEEDING
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

32.1.04 SUBMITTALS

- A. Refer to Related Work sections for applicable submittals required in these Contract Documents if not included herein.
- B. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS..**
- D. **Technical Provisions**
1. Reserved

32.1.05 TESTING

- A. Testing shall include; but not limited to, field density testing and laboratory maximum density and optimum moisture.
- B. Moisture density curves will be provided by the Contractor for each material supplied including but not limited to; aggregates, embankment, backfill, excavated material, engineered fill, and borrow material.
- C. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- D. **Technical Provisions**
1. Reserved

PART 2 PRODUCTS

32.2.01 **GENERAL**

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. **Technical Provisions**
 - 1. Reserved

PART 3 **EXECUTION**

32.3.01 **GENERAL**

- A. These general construction requirements apply to all work common to exterior improvements including but not limited to, retaining walls, concrete, pavement, and all work included thereto as shown on the Drawings and specified herein.
- B. Cleanup
 - 1. Cleanup of the site shall be completed before final acceptance of the work in accordance with the provisions of **SECTION 3.15 of the GENERAL CONDITIONS**.
 - 2. Cleanup shall include the removal and disposal of all unsuitable materials.
 - 3. All equipment shall be removed from the site. The site shall be left in a manner so as to present a clean and neat appearance.
 - 4. All surplus and waste materials remaining after completion of the exterior improvements shall be disposed of in an acceptable manner within 24 hours after completing the work on each area of the site.
 - a. Disposal at any location within the project limits shall be as specified, or as approved by the Owner's Representative; otherwise, disposal shall be accomplished outside the project limits at a location provided by the Contractor.
 - b. The waste disposal operations shall be a part of the work required under the exterior site improvement work, not as work that may be delayed until final cleanup.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. The Contractor shall be responsible for all damage to streets, roads, curb, sidewalk, valley gutters, highways, railways, ditches, shoulders, embankments, culverts, bridges or other public or private property or facility that may be damaged by moving, hauling or otherwise transporting equipment, materials or men to or from the work. The Contractor shall make, without delay, satisfactory and acceptable arrangements with the Owner of, or the land owner of the damaged property concerning its repair or replacement or payment of costs incurred in connection with said damage.

32.3.02 **CONSTRUCTION LIMITS FOR EXTERIOR IMPROVEMENTS**

- A. These general construction requirements apply to all exterior site improvement work.
- B. The limits of construction are shown on the Drawings or shall be established by the Owner's Representative.
 - 1. The Contractor shall confine construction operations within these limits.
 - 2. All surface objects, trees, stumps, roots and other obstructions that are not designated to remain shall be cleared and disposed of as specified.
- C. **Technical Provisions**
 - 1. Reserved

32.3.03 REMOVAL OF EXISTING PAVEMENT, CONCRETE CURB, SIDEWALK, DRIVEWAY AND/OR STRUCTURES

- A. The work consists of removing and disposing of existing pavement, concrete curb, combined curb and gutter, sidewalk, private driveways, and crosswalks, along with any structures designated for removal in the Contract Documents. Details of removals are specified in the Contract Documents.
- B. Dispose of all existing pavement, concrete curb, crosswalk and/or combined curb and gutter specified for removal in the Contract Documents or directed by the Engineer. Exercise care in such removal to assure that remaining nearby facilities and/or structures are not disturbed. Restore to original condition any such existing facilities or structures damaged by construction activities.
- C. All materials to be removed and means of replacement shall be subject to the approval of the Owner's Representative where said removals are not detailed on the Drawings.
- D. All materials that are removed shall be disposed of off-site at a location provided by the Contractor.
- E. Cut, remove and dispose of designated existing pavement to the lines indicated on the Contract Documents, or directed by the Engineer. Make straight and approximately vertical cuts of edges along which new pavement is to be placed.
- F. Remove and dispose of existing private concrete driveways and/or sidewalks which interfere with construction of street improvements or which do not match new grade as shown on the Contract Documents or as directed by the Engineer.
- G. All pavements, walks or curb and gutter that are to be removed shall be sawn full depth to provide a neat and true edge.
- H. **Technical Provisions**
 - 1. Reserved

32.3.04 RELOCATING OR REMOVING UTILITY POLES, STREET SIGNS AND MAILBOXES

- A. This item consists of relocating or removing existing street lights, signs, power poles, telephone poles and mailboxes as shown in the Contract Documents.
- B. Power, Street Light and Telephone Poles
 - 1. Affected utility companies are to move power, street light, and telephone poles, unless they are designated in the Contract Documents to be removed or relocated by the Contractor.
 - 2. When relocating or removing power poles, street light poles and telephone poles, comply with any applicable requirements of the Contract Documents.
- C. Street and Traffic Control Signs
 - 1. Remove and reinstall all street, stop and other traffic control/direction signs designated to be relocated by the Contractor as shown in the Contract Documents, or as designated by the Engineer. Include removing, temporarily installing, storing, and permanently installing the signs.
 - 2. The locations shown in the Contract Documents for street lights, street signs, power poles, telephone poles and private mailboxes to be relocated are approximate only. The specific locations are to be designated by the Engineer.
 - 3. Relocate all signs within the staked grading limits whose existing locations do not conform to final plan locations. Also relocate signs outside the staked grading limits to conform to final plan locations.
 - 4. Preserve all street, stop and other traffic control and direction signs that are to remain in place. Should any such signs be moved for the Contractor's convenience, permanently reinstall the signs after construction of curb and gutter is complete. Assume responsibility for any damage to such signs. No extra compensation will be allowed for preserving, removing or replacing stop and traffic control and direction signs designated to remain in place, since this work is considered incidental to the contract unit prices for the various items of the contract.

5. Where stop signs and traffic direction or control signs are temporarily removed, but are needed for traffic reasons during construction, temporarily install a similar stop sign or traffic direction sign in locations acceptable to the Engineer. Assure that the temporary signs remain in place until the permanent stop or traffic control signs are in place.
6. Do not install street signs temporarily.
7. Store signs which are not used for temporary installation.
8. Set all permanent signs in fresh concrete, the pole supporting the sign being vertical, and the bottom of the sign being 7 - feet above the top of the curb or sidewalk. Replace all signs which are damaged during removal with new signs.
9. Assure that all sign locations conform to the latest issue of the Manual on Uniform Traffic Control Devices.
10. Remove all signs designated for removal without damaging the signs. Salvage and deliver all such damaged signs to the Owner.

D. Mailboxes

1. Mailboxes within the staked grading limits generally are not shown in the Contract Documents. Remove mailboxes within the staked grading limits designated for relocation by the Engineer and place the mailboxes on temporary posts outside, but immediately adjacent to, the construction limits. Ensure that the location designated for temporary use shall provide uninterrupted service.
2. Upon completion of construction, reinstall mailboxes and posts in permanent location in accordance with current U.S. Post Office regulations and applicable City standards. Contractor shall contact property owner if existing mailbox support is of a condition rendering it unsuitable for reuse.

E. Technical Provisions

1. Reserved

END OF SECTION

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification specifies fusible polyvinylchloride pipe, including standards for dimensionality, testing, quality, and acceptable fusion practice.

33.1.02 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those other standards are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of design, bid, or construction, whichever is earliest. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
- C. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

<u>REFERENCE</u>	<u>TITLE</u>
ANSI/AWWA C110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
ANSI/AWWA C111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C153/A21.53	AWWA Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C605	Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	Standard for Disinfecting Water Mains
AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100mm Through 1,500mm), for Water Distribution
AWWA M23	AWWA Manual of Supply Practices PVC Pipe—Design and Installation, Second Edition
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2152	Test Method for Degree of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F1057	Standard Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique
NSF-14	Plastics Piping System Components and Related Materials
NSF-61	Drinking Water System Components--Health Effects
PPI TR-2	PVC Range Composition Listing of Qualified Ingredients

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES
SECTION 33 05 07.13	UTILITY DIRECTIONAL DRILLING
SECTION 33 14 13	PUBLIC WATER UTILITY DISTRIBUTION PIPING
SECTION 33 05 97.26	UTILITY DETECTABLE MARKINGS

33.1.04 PRE-CONSTRUCTION SUBMITTALS

- A. Shop drawings and product data shall be submitted for Piping, Fittings, and Appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
1. A manufacturer's certification shall be included, certifying that all materials furnished meet applicable standards as specified herein.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. The following PRODUCT DATA is required from the pipe supplier and/or fusion provider:
1. Pipe Size
 2. Dimensionality
 3. Pressure Class per applicable standard
 4. Color
 5. Recommended Minimum Bending Radius
 6. Recommended Maximum Safe Pull Force
 7. Fusion technician qualification indicating conformance with this specification
 8. Pipe fusion and fusion services warranty information
 9. Written procedural documentation for piping products including proper handling and storage, installation, tapping, and testing

33.1.05 POST-CONSTRUCTION SUBMITTALS

- A. The following AS-RECORDED DATA is required from the contractor and/or fusion provider to the owner or pipe supplier upon request:
1. Fusion report for each fusion joint performed on the project, including joints that were rejected. Specific requirements of the fusion technician's joint report shall include:
 - a. Pipe Size and Temperature
 - b. Machine Size
 - c. Fusion Technician Identification
 - d. Job Identification
 - e. Fusion Joint Number
 - f. Fusion, Heating, and Drag Pressure Settings
 - g. Heat Plate Temperature
 - h. Time Stamp
 - i. Heating and Cool Down Time of Fusion
 - j. Ambient Temperature

2. Approved datalogger device report
3. As-recorded Information
 - a. The as-recorded plan and profile will reflect the actual installed alignment, and reflect the horizontal offset from the baseline and depth of cover.
 - b. All fittings, valves, or other appurtenances will also be referenced and shown.

33.1.06 MANUFACTURER REQUIREMENTS

- A. All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784.

33.1.07 FUSION TECHNICIAN REQUIREMENTS

- A. Fusion Technician shall be fully qualified by the pipe supplier to install fusible polyvinylchloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.
- B. A minimum of 10,000 feet of documented pipe fusion experience is required and shall be supplied to the Engineer.

33.1.08 WARRANTY

- A. The pipe shall be warranted for one year from the date of substantial completion.
- B. In addition to the standard pipe warranty, the fusion services shall be warranted for one year from the date of substantial completion.

PART 2 PRODUCTS

33.2.01 FUSIBLE POLYVINYL CHLORIDE PRESSURE PIPE

- A. Fusible polyvinyl chloride pipe shall conform to AWWA C900, ASTM D2241 or ASTM D1785 for standard dimensions, as applicable. Testing shall be in accordance with the referenced AWWA standards for all pipe types. **14" DR21, 200 psi, shall be used for the Carrier Pipe and 18" DR21, 200 psi, shall be used for the Casing pipe where shown on the drawings.**
- B. Fusible polyvinyl chloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- C. Fusible polyvinyl chloride pipe shall be manufactured in a standard 40' nominal length, or custom lengths as specified.
- D. Fusible polyvinyl chloride pipe shall be blue in color for potable water use, and shall be green for sanitary sewer use.
- E. Pipe shall be marked as follows:
 1. Nominal pipe size
 2. PVC
 3. Dimension Ratio, Standard Dimension Ratio, or Schedule
 4. AWWA pressure class, or standard pressure rating for non-AWWA pipe, as applicable
 5. AWWA standard designation number, or pipe type for non-AWWA pipe, as applicable
 6. NSF-61 mark verifying suitability, if used for potable water service
 7. Extrusion production-record code
 8. Trademark or trade name
 9. Cell Classification 12454 and/or PVC material code 1120 may also be included

- F. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

33.2.02 FUSION JOINTS

- A. Unless otherwise specified, fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written guidelines for this procedure. All fusion joints shall be completed as described in this specification.
- B. All butt fusion joints on interior of casing shall be field trimmed to flush with the ID of the casing pipe and to allow casing spacers to be installed without damage to the runners.

33.2.03 CONNECTIONS AND FITTINGS FOR PRESSURE APPLICATIONS

- A. Connections shall be defined in conjunction with the coupling of project piping, as well as the tie-ins to other piping systems.
- B. Ductile Iron mechanical and flanged fittings:
- Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard ductile iron fittings conforming to AWWA/ANSI C110/A21.10, or AWWA/ANSI C153/A21.53 and AWWA/ANSI C111/A21.11
1. Connections to fusible polyvinylchloride pipe may be made using a restrained or non-restrained retainer gland product for PVC pipe, as well as for MJ or flanged fittings.
 2. Bends, tees and other ductile iron fittings shall be restrained with the use of thrust blocking or other means as indicated in the construction documents.
 3. Ductile iron fittings and glands must be installed per the manufacturer's guidelines.
- C. PVC gasketed, push-on fittings:
- Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard PVC pressure fittings conforming to AWWA C900.
1. Acceptable fittings for use joining fusible polyvinylchloride pipe other sections of fusible polyvinylchloride pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings as shown in the drawings.
 2. Bends, tees and other PVC fittings shall be restrained with the use of thrust blocking or other restraint products as indicated in the construction documents.
 3. PVC gasketed, push-on fittings and mechanical restraints, if used, must be installed per the manufacturer's guidelines.
- D. Fusible polyvinyl chloride sweeps or bends:
1. Fusible polyvinyl chloride sweeps or bends shall conform to the same sizing convention, diameter, dimensional tolerances and pressure class of the pipe being joined using the sweep or bend.
 2. Fusible polyvinyl chloride sweeps or bends shall be manufactured from the same fusible polyvinyl chloride pipe being used for the installation, and shall have at least 2 feet of straight section on either end of the sweep or bend to allow for fusion of the sweep to the pipe installation. There shall be no gasketed connections utilized with a fusible polyvinyl chloride sweep.
 3. Standard fusible polyvinyl chloride sweep or bend angles shall not be greater than 22.5 degrees, and shall be used in nominal diameters ranging from 4 inch through 16 inch.
- E. Sleeve-type couplings:
1. Sleeve-type mechanical couplings shall be manufactured for use with PVC pressure pipe, and may be restrained or unrestrained as indicated in the construction documents.
 2. Sleeve-type couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.

- F. Expansion and flexible couplings:
 - 1. Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated in the construction documents.
 - 2. Expansion-type mechanical couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.
- G. Connection hardware:

All bolts and nuts for buried service mains and fittings shall be made of stainless steel.

PART 3 EXECUTION

33.3.01 GENERAL

- A. Refer to **SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES** of these Specifications for provisions common to utility construction including water lines.
- B. Excavation and backfilling of utility trenches shall be in conformance with the provisions of **SECTION 31 23 33 – TRENCHING AND BACKFILLING** of these Specifications.
- C. Installation by horizontal directional drilling shall be in conformance with the provisions of **SECTION 33 05 07.13 – UTILITY DIRECTIONAL DRILLING**.

33.3.02 DELIVERY AND OFF-LOADING

- A. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Owner or Owner's Representative.
- B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify Owner or Owner's Representative immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.
- C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's guidelines shall be followed.
- D. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- E. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- F. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.

33.3.03 HANDLING PIPE

- A. Store pipe in a manner that will not result in damage or deformation to the pipe. If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- B. Prepare pipe on a relatively smooth surface, free of sharp rocks, sticks or debris. Utilize cribbing, pipe stands, rollers or other equipment as necessary to support the pipe. Pipe shall be stored and stacked per the pipe supplier's guidelines.
- C. Lift and move piping using ropes, slings or straps. Do not use unprotected chains, hooks or clamps to lift pipe.
- D. When lifting and moving pipe, provide a minimum of two points of support. Do not support pipes at butt-fused joints.

- E. Sections of pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and rejoined at the Contractor's expense.
- F. Plug all pipes at end of each workday. Provide a watertight plug to prevent entry of foreign materials into the pipe.
- G. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the Owner or Owner's Representative.

33.3.04 JOINING PIPE

- A. At start of each day, the Contractor shall complete fusion weld tests in accordance with manufacturer's recommendations to verify that fusion equipment is operating properly.
- B. Pipe ends shall be joined using butt fusion methods. Join pipe and fittings using butt fusion or socket or saddle fusion methods. Fusion methods shall comply with both pipe and fusion equipment manufacturers requirements.
- C. Join pipe and mechanical joint or flanged fittings in accordance with both fitting and pipe manufacturer requirements. Provide pipe stiffeners, wedge type retainer glands and clamp type joint restraint system
- D. Pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
- E. Pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.
- F. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
- G. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:
 - 1. HEAT PLATE - Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
 - 2. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - 3. GENERAL MACHINE - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion
 - 4. DATA LOGGING DEVICE – An approved datalogging device with the current version of the pipe supplier's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
- H. Other equipment specifically required for the fusion process shall include the following:
 - 1. Pipe rollers shall be used for support of pipe to either side of the machine.
 - 2. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 - 3. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
 - 4. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

5. Facing blades specifically designed for cutting the pipe material shall be used.
- I. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of the pipe material used. The software shall register and/or record the parameters required by the pipe supplier and these Specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes work for constructing a subbase course of either crushed or uncrushed materials meeting the specified gradations and other quality criteria specified herein.

32.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|--------------------------|--|
| AASHTO T11 | Amount of Material Finer Than No. 200 (0.075 mm) Sieve in Aggregate |
| AASHTO T27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T89 | Determining Liquid Limit of Soils |
| AASHTO T90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T176 | Sand Equivalent Value of Soils and Fine Aggregate |
| AASHTO T96 | Resistance to Degradation By Abrasion and Impact in the Los Angeles Machine |
| ASTM D5821 | Determining the Percentage of Fractured Particles in Coarse Aggregate |
| AASHTO T99/(ASTM D698) | Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5 kg) Rammer and 12-Inch (305 mm) Drop |
| AASHTO T191/(ASTM D1556) | Density of Soil in-Place By Sand Cone Method |
| AASHTO T310/(ASTM D6938) | In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth) |

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.
- | | |
|-------------------------|--|
| SECTION 03 00 00 | CONCRETE |
| SECTION 31 05 00 | COMMON WORK RESULTS FOR EARTHWORK |
| SECTION 32 05 00 | COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS |
| SECTION 33 05 00 | COMMON WORK RESULTS FOR UTILITIES |

32.1.04 SUBMITTALS

- A. Submit to the Engineer gradations, moisture density curves and other preliminary test results for sources to be used for base materials prior to delivery to the site for approval by the Engineer.
- B. If recycled materials are proposed, CBR test data must be submitted to the Engineer to assure consistency with design requirements.
- C. Shop drawings and product data shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- D. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- E. Technical Provisions
1. Reserved

32.1.05 TESTING

- A. Testing shall include; but not limited to, field density testing and laboratory maximum density and optimum moisture.
- B. Moisture density curves shall be provided by the Contractor for each subbase material supplied.
- C. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.

D. **Technical Provisions**

1. Reserved

PART 2 PRODUCTS

32.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.

B. **Technical Provisions**

1. Reserved

32.2.02 UNCRUSHED SUBBASE

- A. Furnish material consisting of hard, durable stone, gravel or other similar materials mixed or blended with sand, stone dust, recycled concrete and/or asphalt or other binding or filler materials produced from approved sources, providing a uniform mixture meeting these Specifications and compacted into a dense and well- bonded sub base. Oversize material of acceptable quality may be crushed and used in the base material, if the blend meets the specified gradations.

- B. Assure the material retained on the No.4 sieve has a wear not exceeding 50 percent at 500 revolutions as determined by AASHTO T96.

C. **Technical Provisions**

1. Reserved

32.2.03 CRUSHED SUBBASE

- A. Furnish material having both fine and coarse crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with soil, sand, screenings, recycled concrete and/or asphalt or other materials.

- B. Furnish crushed gravel or stone consisting of hard, durable particles, not containing excessive flat, elongated, soft or disintegrated rock, dirt, or other deleterious matter, and having a wear not exceeding 50 percent at 500 revolutions as determined by AASHTO T96.

- C. Use production methods that produce a percent of fractured rock in the finished product that is constant and uniform. Crush aggregate so that at least 25% of the material is retained on the No.4 sieve and has one or more mechanically fractured faces.

D. **Technical Provisions**

1. Reserved

32.2.04 GRADATION

- A. Produce material, including any added binder or filler, meeting the following Table of Gradations as determined by AASHTO Methods T11 and T27:

TABLE OF GRADATIONS

PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVES

<u>Passing</u>	<u>4" Minus</u>	<u>3" Minus</u>	<u>2" Minus</u>	<u>1 1/2" Minus</u>	<u>1" Minus</u>
4 Inch	100				
3 Inch	---	100			
2Inch	---	---	100		
1 1/2 Inch	---	---	---	100	
1 Inch	---	---	---	---	100
No.4	25-60	25-60	25-60	25-60	25-70
No.40	10-30	10-30	10-30	10-30	10-30
No.200	2-10	2-10	2-10	2-10	2-10

- B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.
- C. Suitability of the aggregate is determined by the gradation testing of material placed in the project as required in the Contract Documents, within the allowable limits described by the Table of Gradations for the particular grading specified.
- D. Assure the liquid limit for the aggregate fraction passing a No.40 sieve does not exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.
- E. Where crushed subbase is specified, produce a product with at least 25% of the material retained on the No.4 sieve having one or more fractured faces.
- F. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

32.3.01 GENERAL

- A. Before placing the subbase course, blade smooth and shape the underlying subgrade and/or embankment to the cross sections shown on the Drawings before placing the subbase and base courses.
- B. Furnish and install subbase courses to the thicknesses shown on the Drawings.
- C. Do not place subbase course on wet or muddy subgrade or subbase course.
- D. Maintain at least one completed area of finished and accepted subgrade or embankments in advance of placing subbase course.
- E. Use uncontaminated water for watering operations.
- F. **Technical Provisions**
 - 1. Reserved

32.3.02 PLACEMENT AND SPREADING

- A. Mix and place the material in maximum 6 - inch horizontal layers loose thickness layers. Deposit and spread each load of material on the prepared subgrade, or on a completed subbase course layer continuously without breaks. Assure hauling over the subgrade or over any completed sub base course does not damage the subgrade, subbase or base course.
- B. Spread using dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer or a windrow. Place and spread the material in a uniform layer to the specified depth without causing segregation. Once the base course is spread, blade-mix it the full depth by alternately blading the entire layer to the centerline and back to the roadway edge.
- C. For multiple layers, mix each layer as specified above. Blade smooth and compact each layer before placing the succeeding layer.
- D. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
- E. Apply water during the work to control dust and to maintain the base course in a damp condition.
- F. Water required for compacting base gravel may be obtained from the municipal system if approved by the Owner, or from other sources.

- G. Compact the material using appropriate tamping equipment or power rollers. Correct all irregularities or depressions that develop under rolling by scarifying the material and adding or removing material, as required, until the surface meets specifications.
 - 1. Subbases shall meet compaction requirements established in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- H. Blade and compact alternately, as required to produce the specified surface until final inspection. Tamp the material along curbs, headers, manholes, and similar structures and all places inaccessible to rollers using approved mechanical tampers or hand tampers meet field density requirements.
- I. **Technical Provisions**
 - 1. Reserved

32.3.03 SURFACE TOLERANCES

- A. Finish the subbase course so that when tested using a 10 - foot straight edge placed on the surface with its center line parallel to the street center, the maximum surface deviation from the straight edge does not exceed 1/2 - inch.
- B. Additionally, the finished subbase grade cannot deviate more than 0.1 - foot at any point from the staked elevation and the sum of the deviations from two points not more than 30 - feet apart cannot exceed 0.1 - feet.
- C. Perform all subbase course corrections to meet the above tolerances using approved methods and materials.
- D. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes work for the placing of one or more base courses composed of crushed gravel, stone or other similar materials meeting the gradation and other quality criteria specified herein.

32.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|--------------------------|--|
| AASHTO T11 | Amount of Material Finer Than No. 200 (0.075 mm) Sieve in Aggregate |
| AASHTO T27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T89 | Determining Liquid Limit of Soils |
| AASHTO T90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T176 | Sand Equivalent Value of Soils and Fine Aggregate |
| AASHTO T96 | Resistance to Degradation By Abrasion and Impact in the Los Angeles Machine |
| ASTM D5821 | Determining the Percentage of Fractured Particles in Coarse Aggregate |
| AASHTO T99/(ASTM D698) | Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5 kg) Rammer and 12-Inch (305 mm) Drop |
| AASHTO T191/(ASTM D1556) | Density of Soil in-Place By Sand Cone Method |
| AASHTO T310/(ASTM D6938) | In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth) |

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 31 50 00	EXCAVATION SUPPORT AND PROTECTION
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 16	SUBBASE COURSE
SECTION 32 12 16	ASPHALT PAVING
SECTION 32 16 13	CURBS AND GUTTERS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

32.1.04 SUBMITTALS

- A. Submit to the Engineer gradations, moisture density curves and other preliminary test results for sources to be used for base materials prior to delivery to the site for approval by the Engineer. If recycled materials are proposed, CBR test data must be submitted to the Engineer to assure consistency with design requirements.
- B. Shop drawings and product data shall be in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- D. Technical Provisions
1. Reserved

32.1.05 TESTING

- A. Testing shall include; but not limited to, field density testing and laboratory maximum density and optimum moisture.
- B. Moisture density curves shall be provided by the Contractor for each base material supplied.
- C. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- D. **Technical Provisions**
 - 1. Reserved

PART 2 PRODUCTS

32.2.01 GENERAL

- A. This section reserved.

32.2.02 CRUSHED BASE

- A. Consists of both fine and coarse fragments of crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with sand, finely crushed stone, crusher screenings, recycled concrete and/or asphalt or other similar materials.
- B. Use crushed stone or gravel consisting of hard, durable particles of fragments of stone, free of excess of flat, elongated, soft or disintegrated pieces, dirt, or other deleterious matter, and having a percent of wear not exceeding 50 at 500 revolutions when tested under AASHTO T96.
- C. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 35 percent of the material retained on the No. 4 sieve has at least one fractured face.
- D. Incorporate all material produced in the crushing operation and passing the No. 4 mesh sieve into the base material necessary to meet the gradation requirements.
- E. **Technical Provisions**
 - 1. Reserved

32.2.03 GRADATION

- A. As determined by AASHTO Methods T11 and T27, furnish material for the grading specified in the Contract Documents including binder or filler, which may have been added at the plant or at the site, meeting the requirements of that grading in the Table of Gradations below:

TABLE OF GRADATIONS
PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVE

<u>Passing</u>	<u>1 ½" Minus</u>	<u>1" Minus</u>	<u>¾" Minus</u>
1 1/2 Inch	100		
1 Inch	—	100	
3/4 Inch	—	—	100
1/2 Inch	—	—	—
No. 4 Sieve	25 - 60	40 - 70	40 - 70
No. 10 Sieve	—	25 - 55	25 - 55
No. 200 Sieve	0 - 8	2 - 10	2 - 10

- B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The produced material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.
- C. Suitability of the aggregate is determined by the gradation testing of material placed in the project as required in the Contract Documents, within the allowable limits described by the Table of Gradations for the particular grading specified.

- D. That portion of the fine aggregate passing the No. 200 sieve must be less than 60 percent of that portion passing the No. 40 sieve.
- E. Assure the liquid limit for that portion of the fine aggregate passing a No. 40 sieve cannot exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.
- F. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

32.3.01 GENERAL

- A. Before placing the base course, smooth and shape the surface of the underlying subgrade, sub-base, and/or embankments to the cross section shown on the Drawings before placing the base course.
- B. Furnish and install base courses to the thicknesses shown on the Drawings.
- C. Do not place base course on wet, muddy, or frozen subgrade or sub-base course.
- D. Assure the underlying subgrade is natural soil free of topsoil, organic material or refuse.
- E. Complete at least one area of finished and accepted subgrade, sub-base or underlying base before the placing of any base course.
- F. Place base courses for pavements, curb and gutters, sidewalk, etc. over the prepared subgrade as soon as practical.
- G. **Technical Provisions**
 - 1. Reserved

32.3.02 PLACEMENT AND SPREADING

- A. Mix and place the material in maximum 8 - inch horizontal layers loose thickness. Deposit and spread each load of material on the prepared subgrade, or on a completed sub-base course layer continuously without breaks. Assure hauling over the subgrade or over any completed subbase course does not damage the subgrade, subbase or base course.
- B. Deposit and spread the material in a uniform layer, without segregation, to a loose depth so that when compacted, and making allowance for any filler to be blended on the underlying surface, the layer has the specified thickness.
- C. Spread using dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer or a windrow. Place and spread the material in a uniform layer to the specified depth without causing segregation.
- D. Construct each layer meeting these requirements. Blade smooth and thoroughly compact each layer as specified before placing the succeeding layer.
- E. If segregation or moisture problems exist, or if the material was placed on the road in windrows, thoroughly blade-mix it the full depth by alternately blading the entire layer to the centerline and back to the roadway edge.
- F. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
- G. Apply water during the work to control dust and to maintain the base course in a damp condition.
- H. Water required for compacting base gravel may be obtained from the municipal system if approved by the Owner, or from other sources.

- I. Compact the material using appropriate tamping equipment or power rollers. Correct all irregularities or depressions that develop under rolling by scarifying the material and adding or removing material, as required, until the surface meets specifications.
 - 1. Subbases shall meet compaction requirements established in **SECTION 01 45 16 FIELD QUALITY CONTROL PROCEDURES** of these Specifications.
- J. Perform blading and compacting alternately, as required to produce the specified surface until final inspection. Tamp the material along curbs, headers, manholes, and similar structures and all places inaccessible to rollers using approved mechanical tampers or hand tampers meet field density requirements.
- K. **Technical Provisions**
 - 1. Reserved
 - 2. Placement and spreading of aggregate base course as specified in this subsection shall not be performed until subgrade and/or subbase has met the requirements for compaction, moisture, grade and other applicable parameters as contained within these Contract Documents.

32.3.03 SURFACE TOLERANCES

- A. The base course surface when finished and tested with a 10 - foot straight edge placed on the surface with its center line parallel to the center line of the street, will not have a surface deviation from the straight edge exceeding 0.03 – feet (3/8 – inch).
- B. Additionally, the finished grade cannot deviate more than 0.05 – feet at any point from the staked elevation, and further, the sum of the deviations from two points not more than 30 - feet apart cannot exceed 0.05 - feet.
- C. For base course receiving asphalt concrete surfacing, the finished grade cannot deviate more than 0.02 - feet at any point from the staked elevations, and the sum of the deviations from two points not more than 30 - feet apart cannot exceed 0.02 - feet.
- D. If patching of the base course is necessary to meet the tolerances, perform patching using methods and aggregates approved by the Engineer.
- E. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes the work for the production and placement of plant mix asphalt concrete pavement including new asphalt paving, asphalt overlays, and asphalt patching.
- B. Hot plant mix asphalt concrete is a mineral aggregate and asphalt material mixed at a central hot plant meeting these Specifications and placed in one or more courses on a newly prepared or existing street roadway in accordance with the Contract Documents.

32.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - ASTM D5361 Standard Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing
 - ASTM D2041 Theoretical Maximum Specific Gravity and Density of Bituminous Mixtures
 - ASTM C1097 Hydrated Lime for Use in Asphaltic Concrete Mixtures
 - ASTM D3666 Evaluating and Qualifying Agencies Testing and Inspecting
 - ASTM D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate
 - ASTM C123 Lightweight Particles in Aggregate
 - ASTM D6307 Asphalt Content of Hot Mix Asphalt by Ignition Method
 - STM C142 Clay Lumps and Friable Particles in Aggregates
 - MS-2 Asphalt Institute – Mix Design Methods
 - AASHTO T11/(ASTM D1140) Amount of Material Finer than No. 200 (0.075 mm) Sieve in Aggregate
 - AASHTO T27/(ASTM C136) Sieve Analysis of Fine and Coarse Aggregate
 - AASHTO T89/(ASTM D4318) Determining Liquid Limit of Soils
 - AASHTO T90/(ASTM D4318) Determining the Plastic Limit and Plasticity Index of Soils
 - AASHTO T283/(ASTM D4867) Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
 - AASHTO T176/(ASTM D2419) Sand Equivalent Value of Soils and Fine Aggregate
 - AASHTO T96/(ASTM C131) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - AASHTO T245/(ASTM D6926, D6927) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified, and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 00	EXCAVATION AND FILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 16	SUBBASE COURSE
SECTION 32 11 23	AGGREGATE BASE COURSE

32.1.04 SUBMITTALS

- A. Submit to the Engineer for approval a mix design for each mix required on the project. Assure the job-mix formula is within the gradation limits Products section of this Specification.
- B. Have the job-mix formula prepared by an independent testing laboratory approved by the Engineer. The requirements of ASTM D-3666 are the guidelines for testing laboratory approval. The cost of the job-mix formula(s) is at Contractor expense.
- C. Keep the job mix formula current and contain the following minimum information:

1. Gradation of all constituent aggregates.
 2. Specific gravity of constituent aggregates and asphalt cement.
 3. Source of supply of all materials and grade of Asphalt Cement.
 4. Marshall design curves for stability, unit weight, flow and volumetric requirements (VMA and total voids) at asphalt contents below and above optimum (four points minimum).
 5. Measured voidless (Rice's) specific gravity used in voids computations.
 6. Composite aggregate grading.
 7. Recommended asphalt cement content.
 8. Marshall compactive effort (50 blows).
 9. Date of mix design (job mix formula).
 10. Index of retained strength.
- D. In addition to the job mix formula, all asphalt concrete surfacing mix submittals will have laboratory tests indicating that the Tensile Strength Ratio (TSR) as determined by AASHTO T-283, is at least 70%. Test shall be performed at 7.0 +/- 1% air voids and shall include the freeze cycle.
- E. Obtain Engineer approval of the asphalt material source before shipments are made to any project. The source of supply cannot change after work is started unless approved in writing by the Engineer. The Engineer is not liable for the quantity shipped.
- F. Samples of asphalt binder material may be taken, as directed by the Engineer, and placed in uncontaminated one-quart containers. When sampled, these shall be taken from the tanker car or truck at the point of delivery on the project and submitted to the Engineer.
- G. The material supplier shall issue, in duplicate, a certificate showing full compliance with the Specifications for the designated grade of material, together with the following information. Project number, date of shipment, source of the material, car or truck initial and number, destination, gross quantity loaded, loading temperature, and net quantity in gallons at 60° F or tons, whichever unit of measurement is stipulated. Assure the certificate of compliance accompanies the shipment and is furnished to the Engineer. The certificate, signed by the supplier representative, must also certify that the conveyance vessel was inspected and found to be free of contaminating material.
- H. The certificate of compliance is the basis for tentative acceptance and use of the material. Samples taken according to applicable sampling methods and retained by the Engineer may be tested at the Engineer's discretion. Failure of the asphalt material to meet these Specifications may result in rejection of the entire, associated work. If rejected, removed and replace rejected work.
- I. Upon request by the Engineer, furnish the Engineer and/or laboratory (responsible for completing the mix design) with data or a report showing the temperature viscosity relationship of each asphalt binder used on the project. Assure this data covers the range of temperatures used for mixing and compaction. In addition, the Engineer may request a complete set of test results from Table 3, included herein, for each grade used on the project.
- J. Shop drawings and product data shall be in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- K. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- L. **Technical Provisions**
1. Reserved

32.1.05 TESTING

- A. Testing shall include; but not limited to, field density testing and laboratory maximum density, thickness, asphalt content, aggregates and constituent material verifications.
- B. Testing shall be performed in accordance with the provisions lined out in **SECTION 02 32 00** of these Specifications.
- C. **Technical Provisions**
1. Reserved

PART 2 PRODUCTS

32.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. The Asphalt Concrete Surface Course must have at least a 3-bin separation, when continuous flow mixing types of plants are used. When a drum dryer is used with a weight batching system from dry bins, separate and stockpile the crushed aggregate into two sizes.
- C. The specific type and grading of aggregate shall be as indicated on the plans or in the Contract Documents. The types and grades are described in this Specification.
- D. The furnishing of asphalt materials for use in asphaltic concrete mixes shall meet the requirements for the particular grade specified in the Contract Documents. The types and grades are described in this Specification.
- E. Prepare pavement course to conform to the lines, grades, thickness and typical cross sections shown on the Drawings, and shall be rolled, finished, and approved by the Engineer before the placement of the next course.
- F. **Technical Provisions**
 - 1. Reserved
 - 2. All asphalt installed shall be (Type B Asphalt), unless otherwise specified.

32.2.02 PLANT MIX AGGREGATES

- A. Furnish aggregates from acceptable sources approved by the Engineer.
- B. Furnish test data as outlined in this section on each source to be used for acceptance by the Engineer.
- C. Designation of the source of supply and the acceptability of the material there from, does not extend to the grading of the material as it may naturally come from the pit or crusher. Adjust the crusher and screens to remove certain portions of the material as may be necessary to furnish gravel that will comply with the Specifications in the contract. No additional compensation will be allowed for such adjustment of the equipment or the rejection of waste. It is understood that the Engineer may order procurement of material from any portion of any area designated as a pit site and may reject portions of the deposit as unacceptable.
- D. Aggregate materials shall not contain more than 1.5% by weight of clay lumps, shale, or coal, nor shall light weight particles exceed 3.5% by weight. No combination of clay, shale, coal, or lightweight particles shall exceed 3.5% by weight. Do not use Scoria (fired clay). Aggregate materials shall conform to the grading stipulated in the Contract Documents. Use reasonable care in the selection of material in a pit so that uniform product will be produced at all times. No compensation will be allowed for such stripping of the pit as may be required in order that satisfactory material may be secured.
- E. Aggregate used shall consist of gravel, crushed to the specified size, crushed stone, composed of hard durable pebbles or stone fragments, reclaimed asphalt pavement, and finely crushed stone filler, sand or natural clean material, or other fine mineral material. The portion of the material retained on the No. 4 sieve (4.74 mm) will be called coarse aggregate and that passing the No. 4 sieve (4.74 mm) and retained on the #200 sieve (0.075 mm) will be call fine aggregate. The material Passing the #200 (0.075 mm) will be called mineral filler. The reclaimed asphalt pavement shall be removed from its original location and reduced by suitable means to such particle size as may be required for use in hot plant mix asphalt concrete.
- F. For all gradings of fine aggregate, including any blended fine aggregate and mineral filler, passing a No 40 sieve (0.425 mm), shall have a liquid limit not exceeding 25 and a plasticity index of not more than 6.

- G. Produce coarse aggregate retained on the No. 4 sieve (4.75 mm) having a minimum of 50% by weight of particles with at least one mechanically fractured face. The coarse aggregate shall not exceed 40% wear at 500 revolutions.
- H. Preliminary acceptance of aggregates proposed for use may be made at the point of production. Final acceptance will be made only after tests of the aggregates are complete and in place.
- I. Surface Course Asphalt Plant Mix Aggregate:

TABLE 1

REQUIREMENTS FOR GRADING OF SURFACE COURSE AGGREGATE

Percentage by Weight Passing Job Mix Target Bands						
Sieve Size	Type A	Type B		Type C		Job Mix Tolerances
1" (25.0 mm)	100	---		---		---
¾" (19.0 mm)	91-93	100		---		+/- 7
½" (12.5 mm)	76-89	83-93		100		+/- 7
3/8" (9.5 mm)	61-79	73-87		91-93		+/- 7
No 4 (4.75 mm)	41-54	47-63		51-71		+/- 6
No 10 (2.00 mm)	31-39	32-43		34-46		+/- 6
No 40 (0.425 mm)	16-27	15-25		16-26		+/- 5
No 200 (0.075 mm)	4-7	5-7		5-9		+/- 2

1. The above gradation bands represent the job mix target limits, which determine the suitability of aggregate for use. The final job mix target gradation must be within the specified bands and uniformly graded from coarse to fine and not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa. The final job mix gradation limits are established by applying the job mix tolerances to the job mix targets.
2. The job mix formula establishes target values. During production of the mix, the gradations shall lie within the job mix gradation limits specified in Table 1. For example, "Type A, No. 200" band is "4-7". QA job mix target of 5 has been selected for the final mix. The job mix gradation limits is 5, plus and minus 2. Therefore, the job mix gradation limits for production is "3-7".

J. Technical Provisions

1. Reserved

32.2.03 TYPE B – MODIFIED ASPHALT

- A. Where designated, place a high-density hot mix asphalt surface course in accordance with the requirements of this Section.
- B. Grading requirements for surface course aggregate shall be as follows:

<u>Sieve Opening</u>	<u>% Passing</u>	<u>Job Mix Tolerance</u>
¾ – inch	100	-
½ – inch	82-95	±7
3/8 – inch	70-90	±7
No. 4	45-65	±6
No. 10	32-45	±6
No. 40	15-25	±5
No. 80	8-16	±2
No. 200	4-8	±2
Asphalt Cement		4 - 6.5%

- C. Provide crushed aggregate with at least 75% of the aggregate retained on the No. 4 sieve having at least two mechanically fractured faces. When two fractures are contiguous, the angle between the fracture planes shall be at least 30 degrees to count as two fractured faces.
- D. All Type B-Modified asphaltic concrete surfacing shall meet the following Marshall Design criteria as determined by ASTM D1559:

- | | | |
|----|--------------------------------------|----------|
| 1. | Number of Blows per Face | 75 |
| 2. | Stability, minimum | 1500 lbf |
| 3. | Flow | 8 – 16 |
| 4. | Percent Air Void | 3 - 5 |
| 5. | Percent Air Void Filled with Bitumen | 65 -75 |

E. **Technical Provisions**

1. Reserved

32.2.04 ASPHALT BINDER MATERIAL

- A. Furnish Asphalt binder material to be used as specified in the Contract Documents that meet the type and grade specified requirements in this section in Table 3.
 1. Grades
 - a. PGAB) PG 58-22
 - b. (PGAB) PG 58-28
 - c. (PGAB) PG 64-22
 - d. (PGAB) PG 64-28 (Polymer Modified)
- B. The percentage of asphalt by weight, to be added to the aggregate will be, generally, between 4 and 8 percent of the weight of the total mix. The mix design will establish the exact percentage of asphalt in the mix, based upon preliminary laboratory tests, sieve analysis and grading and character of the aggregate furnished within the Specification limits. No claim is allowed for the payment for rejecting any batch or load of mixture containing an excess or deficient amount of asphalt binder varying more than 0.4 of a percent from the fixed mix design percentage.
- C. All transport vehicles must be equipped with a spigot or gate valve installed in either: (1) the unloading line, (2) in the tanker at the centerline on the tank, (3) in the pressure line from the unloading pump, or other locations approved by the Engineer. Assure the spigot or gate valve has a diameter of between 3/8 - inch and 3/4 - inch. The spigot valve must be located to prevent contamination from plant dust or other contaminants.
- D. The supplier furnishing the asphalt binder material shall inspect each tanker car or truck before it is loaded and ship only in clean, uncontaminated, fully insulated cars or trucks, sealed after loading by the supplier.
- E. Apply asphalt material at temperatures that assure uniform mixing or spreading. Application temperature ranges for each grade of material should be accompanied with the mix design. Application temperature for mixing applications will be in accordance with the mix design.

TABLE 3
PERFORMANCE GRADED ASPHALT BINDER (PGAB)

Performance Grade	PG 58		PG 64		Test Methods
	-22	-28	-22	-28	
Average 7-day Maximum Pavement Design Temperature, °C	<58		<64		
Minimum Pavement Design Temperature, °C	>-22	>-28	>-22	>-28	
Original Binder					
Flash Point Temp.: Minimum °C	230				AASHTO T48
Viscosity: Maximum, 3 Pa ·s (3000 CP), Test Temp, °C	135				ASTM D4402
Dynamic Shear: G* / sin delta, Minimum, 1.00 kPa Test Temp @ 10 rad / s, °C	58		64		AASHTO TP5
Rolling Thin Film Oven (AASHTO T240) or Thin Film Oven (T179) Residue					
Mass Loss, Maximum, %	1.0				AASHTO T240
Dynamic Shear: G* / sin delta, Minimum, 2.20 kPa Test Temp @ 10 rad / s, °C	58		64		AASHTO TP5
Pressure Aging Vessel Residue (AASHTO PP1)					
PAV Aging Temp, °C	100		100		AASHTO PP1
Dynamic Shear: G* / sin delta, Maximum, 5000 kPa Test Temp @ 10 rad / s, °C	22	19	25	22	AASHTO TP5
Creep Stiffness *: S, Minimum, 300 MPa m-value, Minimum, 0.300 Test Temp, @ 60 sec, °C	-12	-18	-12	-18	AASHTO TP1
Direct Tension *: Failure Strain, Minimum, 1.0%, Test Temp @ 1.0 mm/min, °C	-12	-18	-12	-18	AASHTO TP3

- a. If creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

F. Technical Provisions

- Reserved
- The Asphalt binder shall be either PG58-28 or PG64-22 as specified in this subsection.

32.2.05 HYDRATED LIME FOR ASPHALT

- A. Mineral filler may be incorporated in the asphalt concrete mixture. Furnish hydrated lime as filler when specified. Assure it is free of lumps and extraneous material and meets the following gradation requirements as per ASTM D242:

<u>Sieve</u>	<u>Percent Passing</u>
No. 30 (0.60 mm) Sieve	100
No. 80 (0.180 mm) Sieve	95-100
No. 200 (0.075 mm) Sieve	70-100

- B. Assure the hydrated lime meets paragraph 2 (chemical composition) and paragraph 7 (a) requirements (chemical analysis) of ASTM C1097.
- C. Where required, the mineral filler will be effectively mixed with the hot plant mix asphaltic concrete.
- D. **Technical Provisions**
- Reserved
 - Hydrated lime will not be required for this project.

32.2.06 COMPOSITIONS OF MIXES

- A. The maximum permissible variation from the job-mix formula within the Specification limits is as follows:
- Aggregate Gradation Within Job Mix Tolerances
 - Asphalt ± 0.4 percent*
 - Temperature of Mix $\pm 20^{\circ}\text{F}$.
 - (*) This tolerance will be permitted only if the job mix parameter curves indicate that the corresponding Marshall design limits are not exceeded.
- B. Produce Hot Plant Mix Asphalt Concrete Surface courses having the following characteristics as measured by AASHTO T245, ASTM D6726 & D6927 "Resistance to Plastic Flow of Bituminous Mixtures by Means of the Marshall Apparatus":
- Number of compaction blows, each end of specimen 50.
 - Stability, minimum 1200.
 - Flow 8 – 18.
 - Air voids, percent 3-5.
 - Percent voids in mineral aggregate (minimum). See Table 4.

TABLE 4	
REQUIRED VOIDS IN MINERAL AGGREGATE (VMA)	
Nominal particle size (table 2)	Voids in Mineral Aggregate, Min.
3/8 – inch (9.5 mm)	14
1/2 – inch (12.5 mm)	13
3/4 – inch (19.0 mm)	12
1 – inch (25.0 mm)	11
1 1/2 – inch (37.5 mm)	10
Nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent.	

- C. **Technical Provisions**
- Reserved

PART 3 EXECUTION

32.3.01 **GENERAL**

- A. Before placing asphalt, smooth and shape the surface of the underlying subgrade, sub-base, base course and/or embankments to the cross section shown on the Drawings.
- B. Excess material shall be disposed of at a legal disposal area chosen by the Contractor, unless otherwise specified.
- C. Assure the area to be paved is true to line and grade and has a dry and properly prepared surface before starting paving operations. Assure the surface is free from all loose screenings and other loose or foreign material.
- D. Furnish and install asphalt to the thicknesses shown on the Drawings.
- E. **Technical Provisions**
 - 1. Reserved

32.3.02 **CRUSHING**

- A. Crushing Equipment
 - 1. Fit crushing plant-screening equipment, when required, with blowers or other devices capable of removing excess and undesirable fines.
- B. Screening Plants
 - 1. Screening plants consist of a revolving trommel screen, shaker screen, vibrating screen, or other devices capable of removing oversize material, excess and undesirable fines.
- C. Scales
 - 1. Furnish scales, when required, satisfactory to the Engineer. Test and certify scales prior to their use on the project and as often thereafter as the Engineer may consider necessary to insure their accuracy. Have on hand not less than ten, 50-pound weights for testing scales.
 - 2. House the recording devices of the scales in a suitable manner. Place the scales in a location suitable to facilitate accurate weighing of loads. The scales shall be accurate to one-half of one percent at any weight. Alternate methods or devices for weighing may be acceptable, provided that these methods or devices produce the same degree of accuracy as required of platform scales.
- D. **Technical Provisions**
 - 1. Reserved

32.3.03 **MATERIAL HANDLING**

- A. All work involved in clearing and stripping pits and quarries, including handling unsuitable material encountered, are performed with no additional compensation being allowed for this work. The pits as utilized shall immediately be opened so as to expose the vertical faces of the various strata of acceptable material and, unless otherwise directed, the material shall be secured in successive vertical cuts extending through all the exposed strata.
- B. Provide, unless otherwise specified, material containing as large a proportion as possible of crushed aggregate. Combine the crushed material with the screened material to obtain a uniform product.
- C. No material will be accepted which is loaded into hauling units in a segregated condition or which does not meet the required grading. In case the material deposit contains sand or other material in excess of the Specification gradation requirements, or of an unacceptable quality, such excess or undesirable material shall be removed and disposed of prior to crushing, or during screening operations, if crushing is not required.
- D. Provide a storage bin of ample capacity to insure uniform quality and delivery of material. Loading of trucks directly from the conveyor belt, from the crusher or screening plant will not be permitted.

E. **Technical Provisions**

1. Reserved

32.3.04 STOCKPILES

- A. Grub and clean sites for aggregate stockpiles prior to storing aggregates. Assure the site is firm, smooth and well drained. Maintain a bed of aggregate suitable to avoid the inclusion of soil or foreign material.
- B. Build up coarse aggregate stockpiles in tiers of not more than 4 - feet in thickness. Assure each tier is completely in place before the next tier is placed. Do not allow material to “cone” down over the next lower tier.
- C. Dumping, casting or pushing over the sides of stockpiles will be prohibited, except in the case of fine aggregate stockpiles.
- D. Space stockpiles of different gradations of aggregate far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.
- E. Any method of stockpiling aggregate, which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate, will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated and failure of such samples to meet all grading requirements for the aggregate discontinuance of such stockpiling procedures.
- F. Transfer the aggregate from the stockpiles in such a manner that uniform grading of the material is preserved.

G. **Technical Provisions**

1. Reserved

32.3.05 CONVEYOR STOCKPILING

- A. Materials stockpiled by conveyors shall be deposited in a succession of merging cone piles. Do not drop material over 12 - feet nor allow cones to exceed 12 - feet in height. Cones should be leveled to a thickness of approximately 4 - feet prior to starting another tier.

B. **Technical Provisions**

1. Reserved

32.3.06 TRUCK STOCKPILING

- A. Materials stockpiled by trucks shall construct the stockpile in tiers approximately 4 - feet in thickness. Complete each tier before the next tier is started.

B. **Technical Provisions**

1. Reserved

32.3.07 ASPHALT MIXING PLANTS

- A. Use mixing plants of either the weight batching type, the continuous flow mixing type, or drum dryer type. Use drum dryer mixers specifically designed and constructed for producing hot mix.
- B. Equip all plants with approved conveyors, power units, aggregate handling equipment, aggregate screens and bins that are coordinated and operated to produce a uniform mixture within the specified job mix tolerances.
- C. Use batch-type plants having a minimum batch production capacity of 2,000 pounds. Use continuous flow or drum dryer plants having a minimum production capacity of 60 tons per hour. These capacity requirements may be modified if specified in the Contract Documents.
- D. Stop production and remove from the project mixing plants that fail to continuously produce a mixture meeting requirements as specified.
- E. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mixes, the Engineer or his authorized representative will, at

all times, have access to all portions of the mixing plant, aggregate plant, storage yards and other facilities for producing and processing the materials for the work. All sampling and testing of processed and unprocessed material is performed in accordance with the provisions of the Contract Documents.

F. **Technical Provisions**

1. Reserved

32.3.08 WEATHER LIMITATIONS

- A. Weather Limitations shall apply to all asphalt operations included herein, unless otherwise specified.
- B. Ambient air temperature in the shade shall be 35°F and rising.
- C. Do not place asphalt when any and/or all of the following conditions are observed:
1. The moisture in the stockpiled aggregate or the dryer adversely effects the quality of mix production, normal plant operations.
 2. Snow, rain, and/or standing water is present.
 3. Weather conditions would cause rapid unpredictable cooling of asphalt mat. Including high winds and low ambient air temperatures.
 4. Surface temperature of underlying material is frozen and/or does not meet the minimum surface temperatures specified in the table below for the respective compacted lift thickness to be placed.

Surface Temperature Placement Limits			
Lift Thickness	T < 2"	2" ≤ T ≤ 3"	3" < T
Min. Surface Temp.	50°F	40°F	35°F

D. **Technical Provisions**

1. Reserved

32.3.09 NEW ASPHALT PAVING

- A. For new work, meet the surface preparation requirements for the underlying material as specified in the Specifications. Prime prepared soil or aggregate bases as applicable.
- B. Before paving, proof-roll the base with equipment having at least one 18 kip single axle load or equivalent. Excavate and replace areas that yield or crack under these wheel loads as directed. This does not replace or relax the base or subgrade compaction requirements.
1. The underlying surface(s) and materials shall be compacted to minimum requirements established in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- C. Paint the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in contact with asphalt mixes with a thin coating of asphaltic material to provide a water-tight joint. Asphaltic material shall be furnished in accordance with the provisions of Montana Public Works Standards Specifications (MPWSS) 2021 Edition.

D. **Technical Provisions**

1. Reserved

32.3.10 ASPHALT OVERLAYS

- A. Where a base is rough or uneven, place a leveling course using a paver or motor grader and compact before the placing of subsequent courses.
1. The underlying surface(s) and materials shall be compacted to minimum requirements established in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATIONS** of these Specifications.

- B. When a leveling course is not specified, patch or correct all depressions and other irregularities, subject to the Engineer's approval, before starting other paving operations. Remove all rich and unsuitable patches, excess crack or joint filler, and all surplus bitumen from the area to be paved. Do not blot excessive deposits of asphalt with sand or stone.
- C. Apply a tack coat when the surface to be paved is an existing portland cement concrete, brick or asphalt pavement. When a tack coat is required, use the asphalt material indicated, at the rate specified in Montana Public Works Standards Specifications (MPWSS) 2021 Edition.
- D. Coat the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes with a thin, complete coating of asphalt material to provide a water-tight joint.
- E. **Technical Provisions**
 - 1. Reserved

32.3.11 ASPHALT PATCHING

- A. Assure the area to be paved is true to line and grade, is dry and properly prepared surface before starting paving operations. Clean the surface of all loose screenings and other loose or foreign material.
- B. Before paving, proof roll the base. Areas that yield excessively or crack under such wheel loads will be excavated and replaced, to correct yielding and cracking problems. This does not replace the base or subgrade compaction requirements.
 - 1. The underlying surface(s) and materials shall be compacted to minimum requirements established in **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- C. Cut the edge of existing pavements against which additional pavement is to be placed straight and vertical.
- D. Neatly cut all asphalt edges using a asphalt saw.
- E. Cut asphalt edges to form as regular a patch shape as practical and should, in general, approximate a rectangle.
- F. Cut asphalt edges at least 12 - inches wider than the trench width, or as directed by the Engineer, on each side of trench excavations; and, in general, be cut parallel to the street centerline for mainline construction and perpendicular to the street centerline for service lateral construction.
- G. Remove and replace asphalt surface widths of less than 3 - feet.
- H. **Technical Provisions**
 - 1. Reserved
 - 2. Skin patching shall not generally be considered a satisfactory method of repair.
 - 3. All pavement damaged during construction by the Contractor's equipment or the use thereof shall be removed to at least depth of 2 – inches and replaced. Removal and replacement shall be over an area that is continuous with the asphalt restoration and as otherwise required by the Engineer to provide a smooth and durable patch. No compensation will be allowed for removal and replacement of damaged pavement outside of the pay limits for pavement restoration. Patches less than 2 – inches in thickness will not be allowed.
 - 4. More stringent repair standards shall apply to all patches in new pavement. Owner shall establish pavement repair standards.

32.3.12 TRANSPORTATION OF MIX

- A. Transport the mix in vehicles cleaned of all foreign material which may affect the mix. The truck beds must be painted, or sprayed with a lime-water, soap or detergent solution at least once a day or as often as required. After this operation elevate the truck bed and thoroughly drain it, with no excess solution being permitted. Dispatch the vehicles so that all material delivered is placed in

daylight, unless the Engineer approves artificial light. Deliver material to the paver at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

B. **Technical Provisions**

1. Reserved

32.3.13 SPREADING AND FINISHING

- A. Maximum lift thickness is 2 1/2 – inches for surface courses and 5 – inches for base courses.
- B. Rollers and equipment used for spreading and finishing shall meet the requirements as included herein.

C. **Technical Provisions**

1. Reserved

32.3.14 MECHANICAL PAVERS

- A. Spread and strike off the base and surface courses with a mechanical paving machine. Operate the paving machine so that material does not accumulate and remain along the sides of the receiving hopper.
- B. Do not use equipment, which leaves tracks or indented areas, which cannot be corrected in normal operation, produces flushing or other permanent blemishes, or fails to produce a satisfactory surface.
- C. Construct longitudinal joints and edges to true line markings. Establish lines for the paver to follow in placing individual lanes parallel to the centerline of the proposed roadway. Position and operate the paver to follow closely the established lines.
- D. When using pavers in echelon, assure the first paver follows the marks or lines with the second paver following the edge of the material placed by the first paver. To assure a hot joint and obtain proper compaction, assure the pavers work as close together as possible not exceeding 100 - feet apart. In backing trucks against the paver, take care not to jar the paver out of its proper alignment.
- E. As soon as the first load of material has been spread, check the texture of the unrolled surface to determine its uniformity. Segregation of materials is not permitted. If segregation occurs, suspend spreading operation until the cause is determined and corrected.
- F. Offset transverse joints in succeeding courses at least 2 - feet. Offset longitudinal joints at least 6 - inches.
- G. Correct all irregularities in alignment left by the paver by trimming directly behind the machine. Immediately after trimming, thoroughly compact the edges of the course by tamping. Avoid distorting the pavement during this operation.
- H. Assure edges against which additional pavement is to be placed is straight and approximately vertical. Use a lute or covered rake immediately behind the paver, when required, to obtain a true line and vertical edge. Correct all irregularities in the surface of the pavement course directly behind the paver. Remove excess material forming high spots by a shovel or lute. Fill low areas with hot mix and smooth it with the back of a shovel being pulled over the surface. Fanning of material over such areas is not permitted.
- I. **Technical Provisions**
 1. Reserved
 2. Mechanical pavers specified in this subsection shall also meet the following requirements.
 - a. Mechanical pavers shall be furnished with a heated, free-floating screed.
 - b. Use self-propelled pavers that spread, shape, and finish the combined plant mix material to the specified profile and cross slope.
 - c. Immediately stop paving if the paver tears, shoves, segregates or otherwise damages the plant mix, and repair or replace the paver before resuming paving operations.

- d. Equip the paver with a mobile grade reference system that provides a uniform pavement profile.
- e. Equip the paver with the necessary components to create a rolled/compacted tapered sluff or safety edge if required.
- f. Ensure the paver maintains the transverse slope at all times and is able to adjust the slope throughout super- elevated curves.
- g. Ensure auger extensions are used to match the screed width.

32.3.15 **MOTOR GRADERS**

- A. When motor graders are used for the spreading of leveling courses, place the material on the roadbed so that the proper amount of material is available.
- B. Spread the mix to the required thickness, line and grade, with a uniform surface texture, while at a workable temperature.
- C. **Technical Provisions**
 - 1. Reserved

32.3.16 **HAND SPREADING**

- A. In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Engineer. Wood or steel forms, approved by the Engineer, rigidly supported to assure correct grade and cross section, may be used. In such instances, measuring blocks and intermediate strips must be used to obtain the required cross-section. Perform hand placing carefully. Uniformly distribute the material to avoid segregation of the coarse and fine aggregate. Broadcasting of material is not permitted. During the spreading operation, loosen and uniformly distribute all material using lutes or covered rakes. Reject material that has formed into lumps and does not break down readily. Following placing and before rolling, check the surface with templates and straightedges and correct all irregularities.
- B. Maintain on the project heating equipment for keeping hand tools free from asphalt. Exercise caution to prevent heating that may burn the material. Assure the temperature of the tools when used is not greater than the temperature of the mix being placed. Use heat only to clean hand tools; petroleum oils or solvents are not permitted.
- C. **Technical Provisions**
 - 1. Reserved

32.3.17 **ASPHALT COMPACTION**

- A. Furnish the number of rollers necessary to provide the specified pavement density. During rolling, keep the roller wheels moist to avoid picking up the material.
- B. After the longitudinal joints and edges have been compacted, start rolling longitudinally at the sides and progress toward the center of the pavement. For transverse graded streets, begin rolling on the low side and progress to the high side, overlapping passes by at least one-half the width of rollers and uniformly lapping each preceding pass. Operate the rollers at a slow, uniform speed with the drive roll or wheel nearest the paver. Do not exceed 3 miles per hours.
- C. Do not quickly change the line of rolling reversing direction suddenly. If rolling displaces the material, re-work the area using lutes or shovels and restore it the original grade of the loose material before re-rolling. Do not permit heavy equipment or rollers to stand on the finished surface before it has been compacted and has thoroughly cooled.
- D. When paving in single width, roll the first lane placed as follows:
 - 1. Transverse joints
 - 2. Outside edge
 - 3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side
 - 4. Second rolling, same procedure as 3
 - 5. Finish rolling

- E. When paving in echelon, or abutting a previously placed lane, perform the longitudinal joint rolling the same as transverse joint rolling.
- F. When paving in echelon, leave 2 or 3 - inches of the edge unrolled, which the second paver can match unrolled. Then the joint between the lanes can be rolled together. Do not leave edges exposed more than 15 minutes without being rolled.
- G. In laying a surface mix adjacent to any finished area, place it high enough so that, when compacted, the finished surface is true and uniform.
- H. On slight grades, check gutters with a straightedge and test with running water to assure drainage to the planned outlet.
- I. The average mat density shall meet the minimum compaction requirements established in provisions of Montana Public Works Standards Specifications (MPWSS) 2021 Edition.
- J. **Technical Provisions**
 - 1. Reserved
 - 2. For laying of mix next to adjacent finished areas as specified in part G of this subsection, assure that finished compacted plant mix asphalt material is 1/4 – inch above the lip-of-gutter, and/or valley gutters, and shall be flush with the surface of the existing asphalt surface.

32.3.18 **BREAKDOWN / COMPACTION ROLLING**

- A. Immediately begin breakdown rolling following the rolling of the longitudinal joint and edges. Operate rollers as close to the paver as required to obtain density without causing undue displacement.
- B. Operate the breakdown roller with the drive roll or wheel nearest the finishing machine. The Engineer may make exceptions when working on steep slopes or super-elevated curves.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Complete compaction rolling within the temperature range recommended by the asphalt cement manufacturer included in the mix design or before the mat temperature falls below 175°F. Compaction rolling after the temperature is below 175 °F may be cause to suspend paving operations. Compaction rolling is rolling in the vibratory mode. The Engineer may adjust the minimum 175 °F temperature if compaction rolling damages the new pavement or has received written approval from the asphalt cement manufacturer.

32.3.19 **SECOND ROLLING**

- A. Assure the second rolling follows the breakdown rolling as close as possible while the paving mix is still at a temperature that will provide the specified density.
- B. **Technical Provisions**
 - 1. Reserved

32.3.20 **FINISH ROLLING**

- A. Perform the finish rolling while the material is still warm enough to remove roll marks. If necessary, the Engineer may require using pneumatic-tired rollers. Complete finish rolling the same day the mixture is placed.
- B. In places inaccessible to standard rollers, perform compaction using trench rollers or others to meet the specified compaction requirements. Operate the trench roller as directed until the course is compacted.
- C. Hand, manual or mechanical tamping, may be used in such areas if it is proved to the Engineer that the operation will provide the specified density.
- D. **Technical Provisions**

1. Reserved

32.3.21 TRANSVERSE JOINTS

- A. Construct and compact transverse joints to provide a smooth riding surface. Joints will be straight edged and string lined to assure smoothness and true alignment.
- B. Joint formed with bulkheads to provide a straight line and vertical face will be checked with a straightedge before fresh material is placed against it to complete the joint. If bulkheads are not used to form the joint and the roller is permitted to roll over the edge of the new material, locate the joint line in back of the rounded edge the distance required to provide a true surface and cross-section. If a joint has been distorted by traffic or by other causes, trim it to line. Paint the joint face with a thin coating of asphalt before the fresh material is placed against it.
- C. Place the material against the joints vertical face with the paving machine positioned so that the material overlaps the edge of the joint 1 to 2 - inches. Maintain a uniform depth of the overlapped material . Remove and dispose of the coarse aggregate in the overlapped material that dislodged during raking.
- D. Position rollers on the previously compacted material transversely so that no more than 6 - inches of the rolling wheel rides on the edge of the joint. Operate the roller to pinch and press the mix into place at the transverse joint. Continue rolling along this line, shifting position gradually across the joint, in 6 to 8-inch increments, until the joint has been rolled by entire width of the roller wheel.
- E. Keep the number of transverse joints to a minimum. When paving single width and maintaining traffic, pave one lane no farther than one block. Complete all lanes to the same station at the end of each paving day. When paving in echelon, bring the lanes up even as is practical.

F. Technical Provisions

1. Reserved

32.3.22 LONGITUDINAL JOINTS

- A. Roll longitudinal joints directly behind the paving operation. Assure the first lane placed is true to line and grade and has a vertical face. Place the material in the lane being paved up firmly against the face of the previously placed lane. Position the paver during spreading to assure the material overlaps the edge of the lane previously placed by 1 to 2 - inches. Uniformly maintain the width and depth of the overlapped material at all times. Keep the paver aligned with the line or markings placed along the joint for alignment purposes. Before rolling, remove and dispose of the coarse aggregate in the material overlapping the joint.
- B. Shift rollers onto the previously placed lane so that not more than 6 - inches of the roller wheel rides on the edge of the fine material left by brooming. Operate the rollers to compact the fines gradually across the joint. Continue rolling until a compacted, neat joint is obtained. When the abutting lane is not placed in the same day, paint the joint with a very thin coating of asphalt before placing the abutting lane. If the joint is distorted during the day's work by traffic or by other causes, carefully trim the edge of the lane to a neat line.

C. Technical Provisions

1. Reserved

32.3.23 EDGES

- A. Roll the pavement edges concurrently with or immediately after rolling the longitudinal joint.
- B. Exercise care in consolidating the course along the entire length of the edges. In rolling pavement edges, extend the roller wheels 2 to 4 – inches beyond the pavement edge.

C. Technical Provisions

1. Reserved

32.3.24 SHOULDERS

- A. Where paved shoulders or curbs are not specified, do not place the shoulder material against the pavement edges until the surface course rolling is completed. Take care to prevent distortion of

the pavement edge from specified line and grade. When shoulders are paved (except in conjunction with the traveled way paving), cold joint construction procedure is required to assure a tight bond at the joint.

- B. When the rolling of the surface course has been completed and the edges have been thoroughly compacted, immediately place shoulder material against the edges and roll it.

- C. **Technical Provisions**

- 1. Reserved

32.3.25 SURFACE TOLERANCES

- A. Produce a final surface that is uniform in texture and meets the line and grade specified. Before final acceptance of the Project or during the progress of the work, the Engineer will determine the thickness of all courses. Repair or replace all unsatisfactory work.
- B. During compaction, preliminary tests to aid in controlling the thickness, may be performed by inserting a flat blade, correctly graduated, through the material to the top of the previously placed base, or by other approved methods.
- C. For testing the surface on all courses, a 10 - foot straightedge will be used with the centerline of the straightedge placed parallel to the roadway centerline.
- D. Any variations that exceed 5/16 - inch in 10 - feet for base course and 1/4 - inch in 10 - feet for surface course must be corrected.
- E. Correct irregularities that may develop before the completion of rolling by loosening the surface mix and removing or adding materials as is required. If any irregularities or defects remain after the final compaction; such as alligator cracking, block cracking, edge cracking, rough or uneven joints, potholes, trench settlement, raveling, segregation, heaving, sinking, separation from curb and gutter, ponding, and settlement along curb and gutter, approaches, or valley gutters, remove the surface course and place and compact new material to a true and even surface. All minor surface projections, joints and minor honeycombed surfaces must be rolled smooth to grade, as directed.
- F. Remove and replace areas of new pavement requiring patching as directed. Patching material will be tested for meeting Specifications. The cost of testing is at Contractor expense.

- G. **Technical Provisions**

- 1. Reserved

END OF SECTION

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes work for constructing combined curb and gutter using structural concrete and meeting the lines, dimensions, and grades shown on the plans and these Specifications.

32.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- ACI American Concrete Institute

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 03 20 00	CONCRETE REINFORCING
SECTION 03 39 00	CONCRETE CURING
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 23	AGGREGATE BASE COURSE
SECTION 32 92 19	SEEDING

32.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for concrete, reinforcing bars, expansion material, and other pertinent items in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Technical Provisions
1. Reserved

32.1.05 TESTING

- A. Testing shall be performed in accordance with the provisions lined out in Montana Public Works Standard Specifications (MPWSS), 2021 EDITION.
- B. Technical Provisions
1. Reserved

PART 2 PRODUCTS

32.2.01 GENERAL

- A. Concrete shall be furnished in accordance with the provisions of **SECTION 03 00 00 CONCRETE** of these Specifications.
- B. Gravel base material shall be furnished and installed in accordance with the provisions of **SECTION 32 11 23 AGGREGATE BASE COURSE** of these Specifications, and meeting the gradation requirements for 1 – inch minus material.

- C. Pre-formed Expansion material shall be furnished in accordance with the provisions of **SECTION 03 05 00 COMMON WORK RESULTS FOR CONCRETE** of these Specifications.
- D. Concrete reinforcement as specified in accordance with the provisions of **SECTION 03 20 00 CONCRETE REINFORCING** of these Specifications.
- E. Concrete cure shall be furnished and installed in accordance with the provisions of **SECTION 03 39 00 CONCRETE CURING** of these Specifications.
- F. Refer to Related Work sections for applicable product details if not included herein.
- G. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

32.3.01 GENERAL

- A. Concrete curb and gutter may be machine-laid or hand-formed.
- B. **Technical Provisions**
 - 1. Reserved
 - 2. Concrete curb and gutter to be replaced and/or installed adjacent to road sections scheduled to receive new asphalt paving or asphalt patching shall be poured and allowed to reach design compressive strength prior to paving/patching efforts, unless otherwise approved.
 - 3. All exterior concrete placed shall be furnished with an approved curing compound and sealant. Refer to **SECTION 03 39 00 CONCRETE CURING** for additional information.

32.3.02 CURB FOUNDATION PREPARATION

- A. Complete excavation to the lines shown in the Contract Documents.
- B. Gravel base sections for curb and gutter shall conform to the thickness shown on the Drawings, but at no time be less than 3 – inches.
- C. For new street construction or street reconstruction, place gravel base course for the street to the back of the curb.
- D. Assure the subgrade or base course for the concrete has a firm and even surface and is compacted accordance with the provisions of **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. The depth of gravel base course as specified in part B of this subsection, shall be furnished to a minimum depth of 6 - inches.

32.3.03 CONCRETE CURB FORMS

- A. Use metal forms unless otherwise approved of the depth equal to the face of the item being constructed. Obtain Engineer approval of in-place forms before placing concrete.
- B. Assure forms produce the shape, lines, and dimensions shown on the plans and/or drawings. Assure forms prevent leakage of mortar and maintain position and alignment. Thoroughly clean and oil before placing and do not remove forms until the concrete has hardened sufficiently to prevent damage.
- C. Where the curb and gutter is to abut an existing sidewalk, use an approved face of- gutter form secured to maintain an established gutter grade. Vary the curb height to assure the top of curb matches as nearly as possible the standard curb and gutter cross section. Obtain Engineer approval to hand form lengths not exceeding 10 - feet.

- D. Form radii using flexible or curved metal forms set to fit the specified curvature. Obtain Engineer approval before using wood forms. Radii may be formed by using segments of straight forms if the length of the straight segment does not exceed one-tenth of the length of the radius.
- E. Place reinforcement as required. Place and hold in position before placing concrete.
 - 1. Refer to **SECTION 03 20 00 CONCRETE REINFORCING** for additional information.
- F. **Technical Provisions**
 - 1. Reserved

32.3.04 PLACING CONCRETE CURB

- A. Place and compact the subgrade to the specified grade before placing concrete. Dampen the subgrade just before placing the concrete. Spade and tamp the concrete thoroughly into the forms to provide a dense, compacted concrete free of rock pockets. Float, finish, and broom the exposed surfaces. Each placing/finishing crew shall have at least one ACI Flatwork Finishing Technician level or above, on site at all times.
- B. Do not place concrete at a rate that exceeds the finishing operation's ability to meet these Specifications.
- C. Machines or equipment that extrude curb and gutter may be used when approved, provided they produce a finished product matching that obtained by the set-form method. Use slip-form machines that are automatically controlled for longitudinal grade, alignment, and transverse slope by sensing devices operating from string lines set from construction stakes placed by the Engineer.
- D. **Technical Provisions**
 - 1. Reserved

32.3.05 STRIPPING CONCRETE CURB FORMS

- A. Remove forms when the concrete is sufficiently set to prevent chipping or spalling. When forms are removed before the curing period has expired, protect the concrete edges with moist earth or spray edges with curing compound. Clean, oil, and examine all forms for defects before they are used again.
- B. **Technical Provisions**
 - 1. Reserved

32.3.06 FINISHING CONCRETE CURB

- A. Finish the surface of concrete curbs and gutters true to the lines and grades shown on the plans.
- B. Fill honeycomb or other blemishes in formed surfaces with grout to the specified finish. Tool all edges to a 1/4 - inch radius. Float the surface using a magnesium float to a smooth and uniform surface. When the concrete in the curb and gutter has hardened sufficiently, give the surface a broom finish. Obtain Engineer approval of the broom before use. Broom the surface without tearing the concrete. Broom to produce regular corrugations not exceeding 1/8 - inch deep.
- C. Do not apply additional surface water. The Engineer may permit adding water, but it must be applied by fog spray only. Use of an evaporation retardant, Confilm, or equal, following the manufacturer's directions is permitted.
 - 1. Refer to **SECTION 03 39 00 CONCRETE CURING** for additional information.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Isolation joints as specified in part C of this subsection, shall be spaced no farther than 100 - feet apart.

32.3.07 JOINTS FOR CONCRETE CURB

- A. Place curb and gutter monolithically with no construction joints permitted, except at planned expansion joints.
- B. Form or cut contraction joints 1/8 - inch wide to one-fourth the depth of the concrete being placed. Construct the joints to coincide with the joints in adjacent concrete or in uniform sections 10 - feet in length. Where required to make a closure, sections less than 10 - feet in length will be permitted with the minimum length being 4 - feet. When contraction joints are made by approved forming or grooving before the concrete has set, tool the edges to the approved radius.
- C. Construct expansion joints at radius points, construction joints, junctions with existing concrete, opposite to or at expansion joints in adjacent concrete, and at maximum 300 - foot intervals, in a continuous run of concrete being placed.
 - 1. Form expansion joints using 1/2 - inch thick, pre-formed expansion joint filler, as specified in **SECTION 03 00 00 CONCRETE** of these Specifications.
- D. **Technical Provisions**
 - 1. Reserved

32.3.08 CURB BACKFILL

- A. Complete the curb backfill to 4 - inches below the top of curb before final grading of the subgrade and placing the base course.
- B. Backfill using impervious dirt up to 4 - inches below top of curb. Do not use sand or gravel backfill in this area.
- C. In areas of existing lawns, use black loam or approved topsoil for the top 4 - inches of backfill. Place it out from the curb and in the amount required to replace the turf or lawn removed during installation. Place the backfill to a point level with the top of the curb, immediately adjacent to the curb, and grade and blend to match the existing undisturbed lawn area.
 - 1. Seeding shall then be furnished in accordance with the provisions of **SECTION 32 92 19 SEEDING** of these provisions.
- D. Where lawns do not exist, place the top 4 - inches of backfill using impervious dirt and conforming to the typical sections shown on the plans.
- E. Compact backfill to prevent settlement and level the surface to be free draining.
- F. **Technical Provisions**
 - 1. Reserved

32.3.09 TOLERANCES

- A. Perform the work to produce a curb and gutter meeting the specified line and grade uniform in appearance and structurally sound. Remove and replace at Contractor expense curb and gutter having unsightly bulges, ridges, and/or low spots in the gutter, or other defects as directed. Grade cannot deviate more than 1/8 - inch, and alignment not vary more than 1/4 - inch from plan elevation, grade or alignment. Tolerances may be checked using survey instruments, straight edges, or water puddling. Puddled water cannot exceed 1/4 - inch in depth.
- B. **Technical Provisions**
 - 1. Reserved

END OF SECTION

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes work for the construction of concrete sidewalk and driveway approaches, curb turn fillets, valley gutters, new street monuments, and all other miscellaneous new concrete construction complete in place.
- B. The construction of the items described above may be in reference to Flatwork Concrete included within this Specification.

32.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
ACI American Concrete Institute

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 03 05 00	COMMON WORK RESULTS FOR CONCRETE
SECTION 03 20 00	CONCRETE REINFORCING
SECTION 03 39 00	CONCRETE CURING
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 23	AGGREGATE BASE COURSE

32.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for concrete, reinforcing bars, expansion material, and other pertinent items in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Technical Provisions
 - 1. Reserved

32.1.05 TESTING

- A. Testing shall be performed in accordance with the provisions lined out in Montana Public Works Standard Specifications (MPWSS), 2021 EDITION.
- B. Technical Provisions
 - 1. Reserved

PART 2 PRODUCTS

32.2.01 GENERAL

- A. Concrete shall be furnished in accordance with the provisions of **SECTION 03 00 00 CONCRETE** of these Specifications.

- B. Gravel base material shall be furnished and installed in accordance with the provisions of **SECTION 32 11 23 AGGREGATE BASE COURSE** of these Specifications, and meeting the gradation requirements for 1 – inch minus material.
- C. Pre-formed Expansion material shall be furnished in accordance with the provisions of **SECTION 03 05 00 COMMON WORK RESULTS FOR CONCRETE** of these Specifications.
- D. Concrete reinforcement as specified in accordance with the provisions of **SECTION 03 20 00 CONCRETE REINFORCING** of these Specifications.
- E. Concrete cure shall be furnished and installed in accordance with the provisions of **SECTION 03 39 00 CONCRETE CURING** of these Specifications.
- F. Refer to Related Work sections for applicable product details if not included herein.
- G. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

32.3.01 GENERAL

- A. Construct sidewalks, driveway approaches, valley gutters, curb returns, either new or replacement, at the locations shown on the Drawings or as directed by the Engineer meeting the specifications included herein.
- B. The use of slip form machines is prohibited for items in this section unless otherwise specified.
- C. **Technical Provisions**
 - 1. Reserved

32.3.02 FLATWORK CONCRETE FOUNDATION PREPARATION

- A. Complete excavation to the lines shown in the Contract Documents.
- B. Gravel base sections for concrete flatwork shall conform to the thickness shown on the Drawings, but at no time be less than 3 – inches.
- C. Assure the subgrade or base course for the concrete has a firm and even surface and is compacted accordance with the provisions of **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** of these Specifications.
- D. **Technical Provisions**
 - 1. Reserved

32.3.03 FLATWORK CONCRETE FORMS

- A. Assure forms produce the shape, lines, and dimensions shown on the plans and/or drawings. Assure forms prevent leakage of mortar and maintain position and alignment. Thoroughly clean and oil before placing and do not remove forms until the concrete has hardened sufficiently to prevent damage.
- B. Form radii using flexible or curved metal forms set to fit the specified curvature. Obtain Engineer approval before using wood forms. Radii may be formed by using segments of straight forms if the length of the straight segment does not exceed one-tenth of the length of the radius.
- C. Use 6 - inch forms and 6 - inch pre-formed expansion joint material for concrete 6 - inches in depth.
- D. Place reinforcement as required. Place and hold in position before placing concrete.
 - 1. Refer to **SECTION 03 20 00 CONCRETE REINFORCING** for additional information.
- E. **Technical Provisions**
 - 1. Reserved

32.3.04 **FLATWORK CONCRETE PLACEMENT**

- A. Place and compact the subgrade to the specified grade before placing concrete. Dampen the subgrade just before placing the concrete. Spade and tamp the concrete thoroughly into the forms to provide a dense, compacted concrete free of rock pockets. Float, finish, and broom the exposed surfaces. Each placing/finishing crew shall have at least one ACI Flatwork Finishing Technician level or above, on site at all times.
- B. Do not place concrete at a rate that exceeds the finishing operation's ability to meet these Specifications.
- C. **Technical Provisions**
 - 1. Reserved

32.3.05 **STRIPPING FLATWORK CONCRETE FORMS**

- A. Remove forms when the concrete is sufficiently set to prevent chipping or spalling. When forms are removed before the curing period has expired, protect the concrete edges with moist earth or spray edges with curing compound. Clean, oil, and examine all forms for defects before they are used again.
- B. **Technical Provisions**
 - 1. Reserved

32.3.06 **FINISHING FLATWORK CONCRETE**

- A. Finish the concrete surface true to the lines and grades shown on the plans. Float the concrete surface using a magnesium float to a smooth and uniform surface. Plastering of the surface is prohibited. Edge all outside edges of the slab and all joints using a 1/4 - inch radius-edging tool. After concrete has hardened sufficiently, give the surface a broom finish. Assure the broom strokes are square across the concrete from edge to edge, overlapping adjacent strokes. Broom without tearing the concrete. Assure the broomed finish produces regular corrugations not exceeding 1/8 - inch in depth.
- B. Do not apply additional surface water. The Engineer may permit adding water, but it must be applied by fog spray only. Use of an evaporation retardant, Confilm, or equal, following the manufacturer's directions is permitted.
 - 1. Refer to **SECTION 03 39 00 CONCRETE CURING** for additional information.
- C. **Technical Provisions**
 - 1. Reserved

32.3.07 **JOINTS FOR FLATWORK CONCRETE**

- A. Divide sidewalk into sections using contraction joints formed by a jointing tool or other approved methods. Extend the contraction joints into the concrete for at least one-fourth of its depth and be approximately 1/8 - inch wide.
- B. Unless otherwise directed, space contraction joints at maximum 10 - foot intervals or at a distance equal to the sidewalk width, whichever is less.
- C. In continuous sidewalk runs, install isolation joints at the location of a regular contraction joint if the distance between isolation joints does not exceed 300 - feet.
- D. Place isolation joints at radius points, junctions with existing concrete, and opposite to or at expansion joints in adjacent concrete.
- E. Place isolation joints where new concrete abuts existing concrete. Form isolation joints around all appurtenances, such as manholes, utility poles, etc. extending into and through the concrete.
- F. Extend isolation joints the full depth of the concrete.

1. Form expansion joints using 1/2 - inch (12 mm) thick, pre-formed joint filler as specified in **SECTION 03 05 00 COMMON WORK RESULTS FOR CONCRETE** of these Specifications.
- G. Install pre-formed joint filler between concrete and any fixed structure, such as a building or bridge. Assure all expansion joint materials extend the full depth of the concrete.
- H. Form cold joints at unions of consecutive pours as shown on the plans or directed by the Engineer. Assure the cold joint is vertical, the full depth of the concrete, and tooled to a 1/4 - inch radius.
- I. **Technical Provisions**
 1. Reserved
 2. Isolation joints as specified in part C of this subsection, shall be spaced no farther than 100 – feet apart.
 3. Contraction joints as specified in part B of this subsection, shall be placed so that the maximum panel size for concrete driveways/pavement does not exceed 10' x 10'.
 4. No green saw cutting of concrete will be allowed for contraction joints. All contraction joints shall be hand tooled in a neat line or furnished with pre-formed contraction joint material as specified in **SECTION 03 15 00 CONCRETE ACCESSORIES** of these Specifications unless otherwise approved.
 5. Isolation or cold joints between sidewalk and adjacent concrete driveway / concrete pavement shall NOT be furnished with dowels.

32.3.08 **FLATWORK CONCRETE BACKFILL**

- A. In areas of existing lawns, use black loam or approved topsoil for the top 4 - inches of backfill. Place it out from the edge of concrete flatwork and in the amount required to replace the turf or lawn removed during installation. Place the backfill to a point level with the top of flatwork concrete, and grade and blend to match the existing undisturbed lawn area.
- B. Seeding shall then be furnished in accordance with the provisions of **SECTION 32 92 19 SEEDING** of these provisions.
- C. Where lawns do not exist, place the top 4 - inches of backfill using impervious dirt and conforming to the typical sections shown on the plans.
- D. Compact backfill to prevent settlement and level the surface to be free draining.
- E. **Technical Provisions**
 1. Reserved

32.3.09 **TOLERANCES**

- A. Assure all items of construction covered by this section present clean, uniform surfaces and lines free of irregularities and distortions. Plane surfaces and vertical tangent lines are tested with a 10-foot straightedge and cannot deviate more than 1/4 - inch.
- B. **Technical Provisions**
 1. Reserved

32.3.10 **MISCELLANEOUS FLATWORK CONCRETE CONSTRUCTION**

- A. Construct new street monuments, new street light bases, and other miscellaneous concrete construction in accordance with detail drawings.
- B. **Technical Provisions**
 1. Reserved

END OF SECTION

PART 1 GENERAL

32.1.01 DESCRIPTION

- A. This Specification includes ground surface preparation; furnishing and applying fertilizer; and furnishing and planting seed in areas described in the Contract Documents or directed by the Engineer.

32.1.02 REFERENCES

- A. This section reserved.

32.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR SITE IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

32.1.04 SUBMITTALS

- A. Submit to the Engineer applicable seed mixture certifications, fertilizer descriptions and mulch certifications. Furnish duplicate signed copies of the vendors statement certifying that each seed lot has been tested by a recognized seed testing laboratory within 6 months of date of delivery. Assure the statement includes: Name and address of laboratory, date of test, lot number for each seed species and the test results including name, percentages of purity and of germination, percentage of weed content for each kind of seed furnished and, for seed mixes, the proportions of each kind of seed.
- B. Contractor is to submit a Re-vegetation plan for disturbed areas within USACE jurisdiction to the USACE in accordance with the Fort Peck Dam Re-Vegetation Specifications
- C. In the event that construction activities proceed in MDT rights-of-way the Contractor shall submit a seed mix and plan to Montana Department of Transportation (MDT) for approval within right-of-way.
- D. Product data shall be submitted for applicable seed mix, fertilizers and mulch, in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- E. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**

32.1.05 TESTING

- A. This section reserved.

PART 2 PRODUCTS

32.2.01 GENERAL

- A. This section reserved.

32.2.02 SEED

- A. Furnish seed and seed mixture, free of all prohibited noxious weed seed or any other weed seed prohibited by state or local ordinance.

- B. Seal and label all seed containers to comply with Montana Seed Law and Regulations or meeting U.S. Department of Agriculture and Regulations under the Federal Seed Act, if shipped in interstate commerce.
- C. Do not use wet, moldy, or otherwise damaged seed in the work.
- D. Furnish seed mixture of the species described in the Contract Documents. Furnish seed in standard containers labeled with the seed name, lot number, net weight, percentages of purity, germination, hard seed, and percentage of maximum weed seed content for each seed species.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Seed mix shall match the disturbed area. Seed mix to be approved by property owner.
 - 3. Contractor is to submit a Re-vegetation plan for disturbed areas within USACE jurisdiction in accordance with the following Fort Peck Dam Re-Vegetation Specifications.
 - a. All disturbed soil surfaces will be graded and smoothed and all brush piles must be removed from Government property.
 - b. Seeding shall be completed in the spring from April 15-June 15 or in the fall from October 15-November 15. No seeding shall take place if snow cover exists on the ground.
 - c. Any weeds that exist in seeding area prior to planting shall be removed.
 - d. Seed shall be planted using a drill equipped with a depth regulator to ensure proper depth of planting where drilling is possible. The seed mixture shall be evenly and uniformly planted over the disturbed area. Where drilling is not possible, seed shall be broadcast and the area shall be raked or chained to cover the seed. When broadcasting the seed, the pounds per acre are to be doubled.
 - e. Disturbed areas will be considered restored when planted species have established at a minimum of 95%. This will be determined by an on-site inspection by Project Natural Resource personnel after the second growing season following re-seeding.
 - f. Any species listed by the State of Montana as a noxious weed found growing on disturbed areas will be removed by hand or by herbicide pre-approved by the project office. All seed shall conform to the latest seed law of the State of Montana including those governing labeling and weed seed tolerances.
 - g. Inert matter shall not exceed 15%.
 - h. Labels shall also include the following information for each species in the mixture; the % of mixture for each species, PLS lbs. And bulk lbs (contained in the bag), date of seed test, lot number, common name, scientific name, variety, origin, % purity, % inert matter, % weed seed, % germination, % viability (from tz test) and % PLS for each species. The label will also indicate how many acres that bag of seed will cover based on the specified PLS seeding rate for the mixture. A copy of the label must be provided to Project Natural Resource personnel prior to seeding.
 - i. Substitutions are discouraged, however in cases where they are necessary due to supply shortages substitutions may be made with written approval by the Fort Peck Project. All substitutions shall serve the same function or similar niches as the species being substituted.
 - j. All disturbed vegetation will be re-seeded with a native seed mix. A minimum of (3) cool season grass species, (1) warm season grass species, (6) perennial flower species, (1) annual flower species must be chosen for the mix from the below list:

Species	Plant Type	PLS Lbs / A
Bluebunch Wheatgrass	Perennial cool season grass	6.0
Green Needlegrass	Perennial cool season grass	6.0
Needle and Thread	Perennial cool season grass	9.0
Indian Ricegrass	Perennial cool season grass	5.0
Prairie junegrass	Perennial cool season grass	1.0
Western Wheatgrass	Perennial cool season grass	9.0
Canada Wild Rye	Perennial cool season grass	6.0
Sideoats Grama	Perennial warm season grass	2.0
Blue Grama	Perennial warm season grass	2.0
Switchgrass	Perennial warm season grass	5.0
Blue Flax	Perennial flower	3.0
Hairy Golden Aster	Perennial flower	3.0
Prairie Aster	Perennial flower	3.0
American Vetch	Perennial flower	3.0
Purple Coneflower	Perennial flower	3.0
Maximilian Sunflower	Perennial flower	3.0
Purple Prairie Clover	Perennial flower	3.0
Scarlet Globemallow	Perennial flower	2.0
Palmer Penstemon	Perennial flower	2.5
Dotted Gayfeather	Perennial flower	3.5
Scarlet Globemallow	Perennial flower	2.0
Blanket flower	Perennial flower	3.0
Lacy Phacelia	Annual flower	4.0
Rocky Mt. Beeplant	Annual flower	4.0

32.2.03 SOD

- A. This section reserved.
- B. **Technical Provisions**
 - 1. Sod will not be required for this project.

32.2.04 TOPSOIL

- A. Use topsoil that is loose, friable, loamy soil, free of excess acid and alkali. Assure topsoil does not contain objectionable amounts of sod, hard lumps, gravel, sub-soil or other undesirable material that would form a poor seedbed. Before stripping topsoil, assure it has supported the growth of healthy crops, grass or other vegetable growth.
- B. **Technical Provisions**
 - 1. Reserved
 - 2. This subsection applies to both salvaged topsoil and imported “black dirt”, or approved material, required for disturbed areas to be seeded and/or landscaped as included herein.

32.2.05 LIME

- A. Furnish ground limestone or other material deemed suitable by the Engineer containing a minimum 85 percent of total carbonate equivalent ground so that 90 percent will pass through a No. 100 mesh sieve. Coarser material may be acceptable, if the application rates are increased to provide at least the minimum quantities and depth specified using an approved Dolomitic lime or a high magnesium lime containing at least 10 percent magnesium oxide.
- B. **Technical Provisions**
 - 1. Reserved

32.2.06 FERTILIZER

- A. Furnish standard commercial fertilizers supplied separately or in mixtures containing the specified percentages of total nitrogen, available phosphoric acid, and water soluble potash. Apply fertilizer at the specified rate and depth meeting the applicable State and Federal laws. Furnish fertilizer in standard containers clearly labeled with name, weight, and guaranteed analysis of contents. No cyanamide compounds of hydrated lime are permitted in mixed fertilizers.
- B. Fertilizers may be supplied in one of the following forms:
- C. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- D. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- E. A granular or pellet form suitable for application by blower equipment.
- F. **Technical Provisions**
 - 1. Reserved

32.2.07 SOILS FOR REPAIRS

- A. Use soil for filling and topsoiling repair areas of equal quality to the existing topsoil being repaired. Assure the soil is free of large stones, roots, stumps, or other materials that interfere with sowing, compacting, and establishing turf. Obtain approval from the Engineer before placing topsoil.
- B. **Technical Provisions**
 - 1. Reserved

PART 3 EXECUTION

32.3.01 GENERAL

- A. This section reserved.

B. Technical Provisions

1. Reserved
2. Seeding and topsoil salvage and placement of disturbed areas shall be performed in accordance with Section 610, 2014 MDT Standard Specifications within MDT rights-of-way, with the exceptions noted in this section.
3. Contractor shall mulch all areas to be seeded. The Contractor shall coordinate with all private land owners whose property is disturbed by construction to determine if seeding shall be done in those areas (especially areas utilized for agricultural purposes).

32.3.02 TOPSOIL

- A. Place at least 6 - inches of topsoil in all areas to be seeded. Import topsoil if sufficient topsoil is not available from excavated areas of the project.

B. Technical Provisions

1. Reserved
2. Contractor may salvage a portion of topsoil for replacement, but a minimum 3 – inches of imported “black dirt” or approved material shall be placed back on all disturbed areas to be seeded and/or landscaped as applicable.
3. When excavating across cultivated or sodded areas, remove topsoil full depth or to a maximum 12- inch depth, whichever is less, and stockpile for possible project use.

32.3.03 ALLOWABLE SEEDING MONTHS

- A. Perform seeding when the temperature and moisture are favorable to germination and plant growth. Seed preferably before June 1st and after October 1st of each year. Seeding dates must be approved by the Engineer.

B. Technical Provisions

1. Reserved
2. Date for seeding as specified in part B of this subsection, shall occur before the end of May, or after the beginning of September.

32.3.04 SEEDBED PREPARATION AND SOWING

- A. Clear the areas to be seeded of all debris, rocks, vegetation, and other material determined by the Engineer to be detrimental to the preparation of a seedbed. Once the area is cleared, disc, harrow, rake, or work the area by other suitable methods, into a smooth, even seedbed. Assure the prepared seedbed surface is firm enough to prevent seed loss from high winds or normal rainfall. If rolling is required, perform rolling before seeding using a suitable roller, of a weight appropriate to the soil conditions.
- B. Sow seed in the areas described in the Contract Documents at the specified application rates.
- C. Sow seed using a force feed drill having a grass seed attachment, except of slopes steeper than three to one or on areas too small to be seeded with a force feed drill. In these areas, seed may be sown by power sprayers, blowers or other effective methods. Use equipment in good working order.
- D. Seed Kentucky Bluegrass at a depth of one-quarter inch or less and cultipack the seed.
- E. Do not sow seed in winds that prevent proper embedment into the surface.
- F. **Technical Provisions**
1. Reserved
 2. Seed shall be applied at a rate of no less than 8 lbs. per 1,000 SF.

32.3.05 FERTILIZER

- A. Spread and work fertilizer into the soil during the final seedbed preparation. Apply fertilizer at the rate described in the Contract Documents.

- B. **Technical Provisions**

- 1. Reserved

32.3.06 CARE OF SEEDED AREAS

- A. Keep the seeded area moist until it has germinated and its continued growth is assured. Prevent erosion during watering. Water is incidental to the item "Seeding".
- B. Protect all seeded areas from traffic or pedestrian use with warning barricades or other Engineer approved methods.
- C. Maintain the seeded area, performing any required watering and mowing until the seed is firmly established. Prevent weeds and other undesirable vegetation from establishing in the seeded area. Mow weeds and rake and remove the clippings from the areas.
- D. Replace any seeded areas failing to germinate which have died or been damaged by construction activities. Replace such areas to meet the contract requirements. The contract warranty period applies to this item.

- E. **Technical Provisions**

- 1. Reserved

END OF SECTION

FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 33 UTILITIES

TABLE OF CONTENTS

DIVISION 33 – UTILITIES

SECTION	DOCUMENT
33 01 12	Inspecting and Testing of Water Utilities
33 05 00	Common Work Results for Utilities
33 05 07.13	Utility Directional Drilling
33 05 31.19	Fusible Polyvinyl Chloride Pipe
33 05 61	Concrete Manholes
33 05 97.26	Utility Detectable Markings
33 14 13	Public Water Utility Distribution Piping
33 14 19	Valves and Hydrants for Water Utility Service

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

PART 2 DESCRIPTION

- A. This Specification includes the testing, cleaning, and disinfecting of water utility piping, valves, fittings, and all work included thereto as shown on the Drawings and specified herein.
- B. References made to ASTM, ANSI, NSF AWWA, USASI or AASHTO designations shall be the latest revision at the time of call for bids; all specified material included herein shall conform to these standards where such standards exist.

33.2.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - AWWA B300 Hypochlorite for Disinfecting
 - AWWA B301 Liquid Chlorine for Disinfecting
 - AWWA C600 Installation of Ductile-Iron Mains and Their Appurtenances
 - AWWA C651 Disinfecting Water Mains

33.2.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections these Specifications.
 - SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES**
 - SECTION 33 14 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING**
 - SECTION 33 14 19 VALVES AND HYDRANTS FOR WATER SERVICE UTILITY**

33.2.04 SUBMITTALS

- A. Submittals shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Contractor shall submit a testing schedule and sequence plan with sufficient detail to verify conformance with the applicable testing standards.
- C. The submittal shall include as a minimum the following information as applicable:
 - 1. Chlorine product data
 - 2. Location of blow off, testing, injection, and sampling ports
 - 3. Flushing, pressure testing, chlorinating, and sampling sequence and zones
 - 4. Additional information may be required by the Engineer.
- D. Technical Provisions
 - 1. Reserved
 - 2. Water utility testing schedule and sequence plan shall be submitted to the Engineer prior to commencing the work.

PART 3 PRODUCTS

33.3.01 **LIQUID CHLORINE**

- A. Liquid chlorine shall contain 100 percent available chlorine under pressure in steel containers.
- B. Liquid chlorine shall meet AWWA B301 and NSF 61 requirements and use only in combination with appropriate gas-flow chlorinators and ejectors.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Chlorination will not be necessary.

33.3.02 **SODIUM HYPOCHLORITE**

- A. Sodium hypochlorite in liquid form shall contain approximately 5 to 15 percent available chlorine.
- B. Sodium hypochlorite shall meet AWWA B300 and NSF 61 requirements.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Chlorination will not be necessary.

33.3.03 **CALCIUM HYPOCHLORITE**

- A. Calcium hypochlorite in granular form or in 5g tablets containing approximately 65 percent available chlorine by weight.
- B. Calcium hypochlorite shall meet AWWA B300 and NSF 61 requirements.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Chlorination will not be necessary.

PART 4 **EXECUTION**

33.4.01 **GENERAL**

- A. Testing, Cleaning and Disinfecting shall be performed as specified herein for **SECTION 33 14 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING** and **SECTION 33 14 19 VALVES AND HYDRANTS FOR WATER UTILITY SERVICE**, and where specified within these Specifications.
- B. Costs of said testing shall be borne by the Contractor.
- C. Contractor is reminded that State permits may be required for de-chlorination and discharge of chlorinated disinfection water.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Following completion of all tests, remove corporation stops used for testing purposes, install brass plugs, and assure plugs do not leak after main has been charged. The Engineer must witness this work.

33.4.02 **WATER SERVICE TESTING**

- A. Water service lines and appurtenances shall be tested in a manner acceptable to the Engineer.
- B. When specified on the Drawings, new curb stops shall be installed prior to pressure testing of new water mains.
- C. **Technical Provisions**
 - 1. Reserved

33.4.03 **HYDROSTATIC AND LEAKAGE TESTING FOR PRESSURE PIPE**

- A. Perform hydrostatic and leakage testing in accordance with AWWA C600. Once the pipe is laid and backfilled, test for at least 2 hours, all newly laid pipe, or any valved section, to a hydrostatic pressure of at least 1.5 times the normal operating pressure at the test point or 1.25 times the normal operating pressure at the highest point along the test section.
- B. Conduct the pressure and leakage tests with the Engineer present.
- C. Slowly fill the pipe with water, purging all air, and apply the test pressure using a pump hooked up so that the pressure and leakage can be measured. To purge the pipe of air during the test, it is necessary to tap the pipe at its highest points if permanent air vents, water services, hydrants, etc. are not located at the high points. Use corporation stops for this purpose. Furnish the pump connections, gauges, stops, and all necessary apparatus for testing.
- D. Disassemble and reassemble all joints showing leakage after thorough cleaning. Remove and replace all cracked or defective pipes or fittings discovered in during the pressure test with sound material and repeat the test.
- E. Conduct the leakage test concurrently with the pressure test for 2 hours. Leakage is defined as the quantity of water supplied into the pipe, or any valved section thereof, necessary to maintain pressure within 5 PSI of the pressure test after the pipe has been filled with water and purged of air.
- F. The pipe installation will be rejected if the leakage exceeds that determined by the following formula:

$$L = \frac{S \times D \times \sqrt{P}}{148,000}$$

- 1. In which L equals the allowable leakage in gallons per hour;
 - 2. S is the length of pipe tested, in feet;
 - 3. D is the nominal diameter of the pipe, in inches;
 - 4. P is the average test pressure during the leakage test, in pounds per square inch gauge.
- G. Should any test of pipe laid disclose leakage exceeding that specified above, locate and repair the defective joints until the leakage is within the specified allowance.
- H. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gallon per hour per inch of nominal valve size is allowed. Repair all visible leaks regardless of the amount of leakage.
- I. Pressure test tapping sleeves after installation and before tapping.
- J. **Technical Provisions**
 - 1. Reserved
 - 2. Hydrostatic leak testing as specified in part A of this subsection, shall be hydrostatic tested to 150 psig.
 - 3. Leakage as defined in part D of this subsection, shall be restated to and defined as follows. Leakage is defined as (1) the quantity of water supplied into the pipe, or any valved section thereof, necessary to maintain pressure within 5 PSI of the specified test pressure (after the pipe has been filled with water and purged of air) for the duration of the 2 hour test period, and (2) the quantity of water supplied into the pipe, or any valved section thereof, required to return the pressure to the specified test pressure at the end of the 2 hour test period.

33.4.04 **CLEANING WATER MAINS**

- A. Before line is put in service, flush the mains thoroughly after the pressure and leakage test are completed.

- B. It is understood that such flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. Use a minimum flushing velocity in the main of 2.5 feet per second. If no hydrant is installed at the end of the main, provide a tap of the size to produce a velocity in the main of at least 2.5 feet per second. Table 1 shows the rates of flow required to produce a velocity of 2.5 feet per second in various size pipes.

TABLE 1
REQUIRED FLOW AND OPENINGS TO FLUSH PIPELINES^{1/}
(40 psi (276 kPa) Residual Pressure in Water Main)

<u>Pipe Diam.</u> <u>Inches (cm)</u>	Flow Required To Produce 2.5 fps (approx.) Velocity in Main, <u>gpm (epm)</u>	Size of Tap (inch)(mm) 1(25)1-1/2(38)2(51) number of taps <u>on pipe₂</u>		<u>Hydrant Outlet</u> Size <u>Number</u> <u>in. (mm)</u>	
4 (10)	100 (380)	1		1	2-1/2 (63)
6 (15)	200 (760)		1	1	2-1/2 (63)
8 (20)	400 (1510)		2	1	2-1/2 (63)
10 (25)	600 (2270)		3	2	2-1/2 (63)
12 (30)	900 (3400)			2	2-1/2 (63)
16 (41)	1600 (6060)			4	2-1/2 (63)

1. With a 40 psi (267 kPa) pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch (63mm) hydrant outlet will discharge approximately 1000 gpm(3786 epm) and a 4-1/2-inch (114mm) hydrant nozzle will discharge approximately 2500 gpm (9463 epm).
2. Number of taps on pipe based on discharge through 5 feet (1.5 meters) of galvanized iron (GI) pipe with one 90° elbow.

- C. Exercise extreme care and conduct a thorough inspection during the water main laying to prevent and detect small stones, pieces of concrete, particles of material, or other foreign material that may have entered the mains. To remove this material, flush and inspect all hydrants on the lines to assure that the entire valve operating mechanism of each hydrant is in good condition.
- D. In 24-inch (61 cm) or larger diameter mains, in addition to flushing, broom-sweep the main, removing all sweepings before chlorinating the main.
- E. **Technical Provisions**
1. Reserved
 2. Prior to any main flushing, the Engineer shall be notified and provided with a flushing schedule and plan a minimum of 24 hours in advance of any main flushing.

33.4.05 DISINFECTING WATER MAINS

- A. Disinfect the water mains subject to the Engineer's approval in accordance with AWWA C651, "Disinfecting Water Mains", and these Specifications, before placing the main in service.
- B. Keep the interior of all pipe, fittings and appurtenances free from dirt, heavy and foreign particles.
- C. **Technical Provisions**
1. Reserved
 2. Disinfection of the new raw water supply line will not be required.

33.4.06 METHODS OF CHLORINATION

- A. ~~Three (3) methods of chlorination may be used. The tablet method gives an average chlorine dose of approximately 25 ppm; the continuous feed method gives a 24-hour chlorine residual of not less than 10 ppm; and the slug method provides a three-hour exposure of not less than 50 ppm free chlorine.~~
1. ~~Tablet Method~~
 - a. ~~This method may be used if the pipes and appurtenances are kept clean and dry during construction.~~

- b. During construction, place calcium hypochlorite granules at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500-foot intervals. Use the quantity of granules shown in Table 2.
- c. ~~Warning: Do not use this procedure on solvent welded plastic or on screwed joint steel pipe because of fire or explosion hazard from the reaction of the joint compounds with the calcium hypochlorite.~~

TABLE 2
OUNCES OF CALCIUM HYPOCHLORITE GRANULES TO BE PLACED AT
BEGINNING OF MAIN AND AT EACH 500-FOOT (150 METER) INTERVAL

Pipe Diameter		Calcium Hypochlorite
Inches	(cm)	Granules
4	(10)	oz
6	(15)	0.5
8	(20)	1.0
12	(30)	2.0
16 and larger	(41)	4.0
		8.0

- d. ~~During construction, place 5g calcium hypochlorite tablets in each section of pipe and also place one tablet in each hydrant, hydrant branch and other appurtenance. Use the number of 5g tablets for each pipe section required to provide a minimum chlorine concentration of 25 ppm. The Calculating Quantities of Chlorine for Disinfecting Water Mains subsection of this Specification provides information on the number of 5g tablets for each pipe section required to provide a minimum chlorine concentration. Attach tablets to the inside of the pipe using an adhesive such as Permatex No.1 or equal. Assure no adhesive is on the tablet except on the broad side attached to the surface of the pipe. Attach all the tablets at the inside top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, mark their position on the section so it can be readily determined that the pipe is installed with the tablets at the top.~~
 - e. ~~When installation has been completed, fill the main with water at a velocity not exceeding 1 fps (0.3 mps). Take precautions to assure that air pockets are eliminated. Leave this water in the pipe for at least 24 hours. If the water temperature is less than 41° F (5°C), leave the water in the pipe for at least 48 hours. Position valves so that the chlorine solution in the main being treated will not flow into water mains in active service.~~
2. Continuous Feed Method
- a. ~~Before chlorinating, fill the main with water to eliminate air pockets and flush as specified above.~~
 - b. ~~Use water from the existing distribution system or other approved source of supply to flow at a constant, measured rate into the newly laid water main. At a point not more than 10 feet (3 meters) downstream from the beginning of the new main, assure water entering the new main receives chlorine fed at a minimum 25 ppm free chlorine. To assure that this concentration is provided, measure the chlorine concentration at regular intervals.~~
 - c. ~~The Calculating Quantities of Chlorine for Disinfecting Water Mains subsection of this Specification provides information on the approximate amounts of chlorine compound required for various pipe sizes.~~
 - d. ~~During chlorine application, position valves so that the chlorine solution in the main being treated does not flow into water mains in active service. Do not stop chlorine application until the entire main is filled with chlorinated water. Retain the chlorinated water in the main for at least 24 hours, operating all valves and hydrants in the section treated to disinfect the appurtenances. At the end of the 24 hour period, the treated water in all portions of the main must have a minimum free chlorine residual of 10 ppm free chlorine.~~

- e. ~~The preferred equipment for applying liquid chlorine is a solution feed vacuum operated chlorinator to mix the chlorine gas in solution water, in combination with a booster pump for injecting the chlorine gas solution water into the main to be disinfected. It is recommended that direct feed chlorinators not be used. Hypochlorite solutions may be applied to the water main with a chemical feed pump designed for feeding chlorine solutions.~~
- f. ~~If approved, an optional continuous feed method utilizing calcium hypochlorite granules may be used. Place the granules in the pipe sections as specified under the Tablet Method.~~
- 3. **Slug Method**
 - a. ~~Before chlorinating, preliminary flush the main as specified herein.~~
 - b. ~~Use water from the existing distribution system or other approved source of supply to flow at a constant measured rate into the newly laid water main.~~
 - c. ~~Not more than 10 feet (3 meters) downstream from the beginning of the new main, add chlorine to the water entering the new main at a constant rate that the water will have a minimum 100 ppm free chlorine. Measure this concentration at regular intervals. Apply the chlorine continuously and for the time required to develop a solid column or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a 100 ppm for at least 3 hours.~~
 - d. ~~Measure the free chlorine residual in the slug as it moves through the main. If at any time it drops below 50 ppm stop the flow and relocate the chlorination equipment at the head of the slug, and as flow is resumed, add chlorine to restore the free chlorine in the slug to not less than 100 ppm.~~
 - e. ~~As the chlorinated water flows past fittings and valves, operate related valves and hydrants to disinfect appurtenances and pipe branches.~~
- 4. **Final Flushing**
 - a. ~~After the retention period, flush the chlorinated water from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that in the system, or is acceptable for domestic use.~~

B. Technical Provisions

- 1. **Reserved**
- 2. ~~Disinfection of the new raw water supply line will not be required.~~

33.4.07 BACTERIOLOGICAL TESTS

- A. After final flushing and before the water main is placed in service, two (2) consecutive passing samples taken a minimum 16 – hours apart, shall be collected for every 1200 – feet of main(s) plus an additional sample from the end of the line and at least one set of samples from each branch greater than one pipe length, in accordance with AWWA C651.
- B. **Re-disinfection**
 - 1. If the initial disinfection fails to produce approved bacteriological, re-flush and resample the main.
 - 2. If check samples show bacterial contamination, re-chlorinate the main until approved results are obtained.
- C. **Swabbing**
 - 1. Where connections are made to existing piping and the connections are not disinfected along with the newly installed main, swab or spray the interior of all pipe and fittings used in making the connections with a 1 percent hypochlorite solution before installation.
- D. **Technical Provisions**

1. None
2. Bacteriological testing of the new raw water supply line will not be required.

33.4.08 CALCULATING QUANTITIES OF CHLORINE FOR DISINFECTING WATER MAINS

- A. ~~The amount or weight of chlorine required to disinfect a particular segment of water line is directly related to the volume of water contained in that particular segment of water main.~~

- B. ~~Volume of Water in Pipe~~

$$\begin{aligned}\text{Volume of Water (Gallons)} &= \text{Area of Pipe (ft}^2\text{)} \times \text{Length (ft)} \times 7.48 \\ &= \pi \times R^2 \times L \times 7.48\end{aligned}$$

$$\text{Where: } \pi = 3.1416$$

$$R = \text{Inside Radius of Pipe in Feet}$$

$$L = \text{Length of Pipe to be Disinfected, in Feet}$$

$$7.48 = \text{Gallons per Cubic Foot}$$

- C. ~~Formula to Determine Lbs. of Chlorine Required~~

$$\text{Lbs. of Chlorine} = \text{ppm} \times \text{MG} \times 8.34$$

$$\text{Where: Lbs. of Chlorine} = 100\% \text{ Effective Chlorine}$$

$$\text{Ppm} = \text{Chlorine Dosage in Parts per Million}$$

$$\text{MG} = \text{Million Gallons of Water}$$

$$8.34 = 8.34 \text{ Lbs. of Water per Gallon}$$

- D. ~~Sample Calculations~~

1. ~~Example: 4,500 lineal feet of 8" water main to be disinfected at a chlorine concentration of 25 ppm.~~

$$\text{Volume of Water} = \pi \times R^2 \times L \times 7.48$$

$$R = 4" = 4/12 \text{ Ft} = 0.333 \text{ Ft}$$

$$L = 4,500 \text{ Ft}$$

$$\text{Volume of Water} = 3.1416 \times (.333)^2 \times 4,500 \times 7.48$$

$$= 11,726 \text{ Gallons}$$

$$= 0.011726 \text{ MG}$$

$$\text{Lbs. of Chlorine} = \text{ppm} \times \text{MG} \times 8.34$$

$$\text{ppm} = 25$$

$$\text{Lbs. of Chlorine} = 25 \times 0.011726 \times 8.34$$

$$= 2.44 \text{ Lbs. of 100\% Effective Chlorine}$$

- E. ~~Using Chlorine Compounds or Solutions Less Than 100% Effective Chlorine~~

1. ~~Most dry chlorine compounds or chlorine solutions on the market do not contain 100% effective chlorine. Normally the containers of the compound or solution will state the amount of effective chlorine as a percentage.~~
2. ~~Example: Determine how much Clorox (Sodium Hypochlorite) solution is required to provide 2.44 lbs. of 100% effective chlorine. Clorox container is labeled at 5.25% effective chlorine.~~

$$\text{Effective Chlorine Per Gallon Clorox} = 5.25\% \times 8.34 \text{ lbs./gal.} = 0.44 \text{ Lbs.}$$

$$\text{Gallons of Clorox Required} = 2.44 \text{ lbs} \div 0.44 \text{ lbs./gal.} = 5.55 \text{ gallons Clorox}^{\text{®}}$$

Chlorine Dosage Table

3. ~~Table 1 following presents the chlorine required to produce a 25 ppm concentration in 100 feet of pipe. Also shown are the gallons required for a solution containing 1 percent effective chlorine.~~

TABLE 1
Chlorine Required to Produce 25 mg/L
Concentration in 100 ft. of Pipe -- by Diameter

Pipe Diameter Inches	100% Effective Chlorine Lbs.	1 Percent Chlorine Solutions Gallons
4	0.013	0.16
6	0.030	0.36
8	0.085	1.02
10	0.120	1.02
12	0.22	1.44
16	0.27	2.60
18	0.34	3.30
20	0.49	4.07
24	0.76	5.87
30	1.10	9.17
36	1.96	13.19
48		23.50

F. Dosage Table for Hypochlorite Tablets

1. ~~The number of 5-g tablets required for each pipe section to provide a chlorine dosage of 25 ppm is equal to $0.0012 \times d^2 \times L$, where d is the inside pipe diameter in inches and L is the length of the pipe section in feet. Table 2 shows the number of tablets required for commonly used sizes of pipe.~~

TABLE 2
Number of a5-g Hypochlorite Tablets
Required for Dose of 25 mg/L^a

Pipe Diameter	Length of Pipe Section, ft.				
	13 or Less	18	20	30	40
4	1	1	1	1	1
6	1	1	1	2	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	7
16	4	6	7	10	13
18	5	7	8	12	16
20	7	9	10	15	20
24	9	13	14	21	28

^a Based on 3.25 g available chlorine per tablet. Any portion of tablet rounded to next higher number.

G. Technical Provisions

1. ~~None~~

END OF SECTION

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes work common to water, sanitary sewer and storm water utilities and all work included thereto as shown on the Drawings and specified herein.

33.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
- | | |
|-------------|---|
| AWWA C105 | Polyethylene Encasement for Ductile-Iron Pipe Systems |
| AWWA C600 | Installation of Ductile-Iron Mains and Their Appurtenances |
| AWWA C900 | Polyvinyl Chloride (PVC) Pressure Pipe and Fabrication Fittings, 4 In. Through 60 In. |
| AASHTO T99 | Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop |
| ASTM A536 | Standard Specification for Ductile Iron Castings ASTM C547 Mineral Fiber Pipe Insulation |
| ASTM C1338 | Test Method for Determining Fungi Resistance of Insulation Materials and Facing |
| ASTM D698 | Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ or 600 kN-m/m ³) |
| ANSI/NSF 61 | Municipal Drinking Water System Components |
| ASTM F1674 | Standard Test Method for Joint Restraint Products for Use with PVC Pipe |

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 05 23.23	COMPACTION
SECTION 31 23 23.33	FLOWABLE FILL
SECTION 31 23 33	TRENCHING AND BACKFILL
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 32 11 23	AGGREGATE BASE COURSE
SECTION 32 92 19	SEEDING
SECTION 33 01 12	INSPECTION AND TESTING OF WATER UTILITIES
SECTION 33 05 07.13	UTILITY DIRECTIONAL DRILLING
SECTION 33 05 97.26	UTILITY DETECTABLE MARKINGS
SECTION 33 14 13	PUBLIC WATER UTILITY DISTRIBUTION PIPING
SECTION 33 14 19	VALVES AND HYDRANTS FOR WATER UTILITY SERVICE

33.1.04 SUBMITTALS

- A. Refer to Related Work sections for applicable submittals required in these Contract Documents if not included herein.
- B. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- D. Technical Provisions
- Reserved

33.1.05 **TESTING**

- A. Refer to Related Work sections for applicable tests required in these Contract Documents if not included herein.
- B. **Technical Provisions**
 - 1. Reserved

PART 2 **PRODUCTS**

33.2.01 **GENERAL**

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. **Technical Provisions**
 - 1. Reserved

33.2.02 **POLYETHYLENE ENCASEMENT**

- A. Furnish polyethylene encasement in accordance with AWWA C105, "Polyethylene Encasement for Fray and Ductile Cast – Iron Pipe for Water and other Liquids".
- B. **Technical Provisions**
 - 1. Reserved
 - 2. Polyethylene encasement as specified in this subsection shall have the following minimum thickness based on material selected. Linear low-density polyethylene (LLDPE) shall have a minimum film thickness of 8 mils. High density cross-laminated polyethylene (HDCLPE) shall have a minimum film thickness of 4 mils.

33.2.03 **UTILITY INSULATED CASING (IC)**

- A. If called for in the Drawings or directed by the Engineer, utilities susceptible to freezing shall be placed inside an insulated casing.
- B. Casing material shall be HDPE DR-11 PE4710, having a minimum inside diameter that will not damage the pipe insulation wrap during installation.
 - 1. Casings shall be furnished with concentric neoprene end seals restrained with stainless steel bands, or approved equals.
- C. Pipe wrap insulation shall meet the requirements of ASTM C547 and ASTM C1338 and meet or exceed the following requirements:
 - 1. Minimum 4-inches thick and capable of fully encasing the pipe
 - 2. Have a water vapor sorption rate of less than 5% by weight.
- D. Casing spacers shall be made of 304 stainless steel and equipped with glass filled polymer runners. Casing spacers shall be lined with PVC to prevent electrical contact between carrier pipe and spacer, be of centered and restrained type construction, and have a minimum width of 8-inches.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Insulated utility casing/pipe wrap insulation will not be required for this project.

PART 3 **EXECUTION**

33.3.01 **GENERAL**

- A. These general construction requirements apply to all water, sanitary sewer and storm water utilities and all work included hereto.

- B. The Contractor shall install pipe and appurtenances following the manufacturer's recommendations and instructions. The Contractor shall provide all tools and equipment required to install each type of pipe used.
- C. The Contractor is responsible for all Contractor furnished material. Replace all defective material or material damaged by handling after delivery by the manufacturer. This includes the furnishing of all materials and labor required to replace installed material discovered damaged or defective before final acceptance of the work, or during the guarantee period.
- D. All materials shall be stored safely to prevent damage. Pipe interiors and other accessories shall be kept free from dirt and foreign matter at all times.
- E. The Contractor shall load and unload delivered pipe, fittings, valves, and accessories in a manner that will prevent damage.
- F. The Contractor shall distribute material to the work site, such that each piece is laid adjacent to its installation point for Contractor inspection prior to installation.
- G. All water must be removed from the trench during installation. A dry trench shall be maintained until the pipe ends are sealed and the trench is backfilled.
- H. Excavation and backfilling of utility trenches shall be in conformance with the provisions of **SECTION 31 23 33 TRENCHING AND BACKFILLING** of these Specifications.
- I. Installation by horizontal directional drilling shall be in conformance with the provisions of **SECTION 33 05 07.13 UTILITY DIRECTIONAL DRILLING** of these Specifications.
- J. Cleanup
 - 1. As work progresses, remove debris, excess pipe, and complete to finish grade each portion of the work. Once the work is complete, clear debris and finish the entire site to smooth, uniform slopes presenting a neat and workmanlike appearance. Remove and dispose of all rocks brought to the surface during excavation or backfilling.
 - 2. Before final acceptance cleanup of the site shall be completed in accordance with the provisions of **SECTION 3.15 of the GENERAL CONDITIONS**.
 - 3. Cleanup shall include the removal and disposal of all unsuitable/excess materials.
 - 4. All equipment shall be removed from the site.
 - 5. The site shall be left in a manner so as to present a clean and neat appearance, in an equal or better state prior to construction.
- K. **Technical Provisions**
 - 1. Reserved
 - 2. All salvageable materials shall become the property of the Owner. Excess excavated material including pipe, stumps, roots, and any other items the Owner does not wish to salvage shall become the Contractor's property and shall be removed from the site and disposed of properly, in accordance with any local, state, and federal regulations, and considered incidental to the contract with no additional compensation awarded as such.
 - 3. It shall be the Contractor's responsibility to schedule his/her work so that water and sewer service, drainage through site, and access to the site shall be maintained to community utility users and property owners, unless otherwise approved by the Owner and Engineer. In the event that temporary services shall be necessary, they shall be furnished and installed in accordance with their respective sections and approved by Owner and Engineer.

33.3.02 CONSTRUCTION LIMITS FOR UTILITIES

- A. The Contractor shall confine all construction activities to within the MDT, or County/City right-of-way or properties where Owner has acquired an easement. Any damage to adjacent property must be restored to equal or better condition. The Contractor shall not enter for delivery of materials or occupy for any purpose any private property outside the designated easements or

MDT or County/City right-of-way without written permission from the Owner, Owner/Tenant of the property, or MDT.

- B. Construction on private property shall be limited to a 20 - foot corridor centered along the center of utility mains/services. All damage to private property must be restored to equal or better condition, as approved by the private property owner and Engineer.

C. **Technical Provisions**

- 1. Reserved

33.3.03

SEPARATIONS

- A. The following requirements are based on Montana Department of Environmental Quality (MDEQ) standards. In the event field conditions prove that the standard vertical and/or horizontal separations cannot be met, the Contractor shall notify the Engineer/Owner prior to proceeding with installation of utilities.
- B. Water mains must be laid at least 10 - feet horizontally and 18 – inches vertically, whether above or below, from any existing or proposed gravity sanitary or storm sewer, force main, septic tank, sewer manhole, or subsoil treatment system.
 - 1. The distance must be measured edge to edge.
- C. If the minimum horizontal separation as described above cannot be obtained, the sewer must be designed and constructed with the following minimum conditions:
 - 1. Sewers must be constructed of slip-on or mechanical joint pipe complying with public water supply design standards and be pressure tested to a minimum of 150 psi to assume water tightness.
 - 2. Sewer services utilizing in-line fittings and extending to the property lines, or beyond, must be installed and tested in the area of the encroachment. Saddles are not acceptable.
- D. Vertical crossings meeting the minimum separation described above must be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints.
 - 1. Where a water main crosses under a sewer, adequate structural support must be provided for the sewer to maintain line and grade and to prevent damage to the water and/or sewer main.
- E. If the proper vertical separation as described above cannot be obtained, the water main shall be installed to comply with the following:
 - 1. At crossings, one standard length of new pipe must be centered at approximately a 90-degree angle in respect to the existing pipe.
 - 2. Vertical separation at crossings between water and sewer mains must be at least 6 – inches and meet one of the following criteria:
 - a. Option 1: Either the water or sewer main must be encased in a watertight carrier pipe which extends 10 feet on both sides of the crossing.
 - b. Option 2: Sewers must be constructed of slip-on or mechanical joint pipe complying with public water supply design standards and be pressure tested to a minimum of 150 psi to assume water tightness.
 - i. Sewer services utilizing in-line fittings and extending to property lines, or beyond, must be installed and tested within 10 feet of the crossing. Saddles are not acceptable.
 - c. Option 3: Water and sewer main must be encased in a minimum of six inches of flowable fill for a minimum of 10 feet each side of the crossing pipes.
 - 3. If the minimum 6 - inch separation is not viable, the water line must be relocated and vertical separation at crossings between water and sewer mains must be at least 18 inches.

- a. If the vertical separation is less than 12 – inches the water main shall be lowered via 45° bends at a point 25 – feet from the crossing to achieve the minimum 18" separation, then transition back up to the required depth without the use of bends, unless otherwise approved by Owner/Engineer.
- b. If the vertical separation is greater than 12 – inches the water main shall be lowered via 45° bends at a point 15 – feet from the crossing to achieve the minimum 18 – inch separation then transition back up to the required depth with the use of 45° bends, unless otherwise by Owner/Engineer.
- c. All fittings used shall be mechanical joint and restrained along the entirety of the crossing.
- d. The water main shall be fully restrained through the extent of the crossing and 42 – feet beyond the location of the outside bend either side of said crossing.

F. Technical Provisions

1. Reserved

33.3.04 UTILITY LINE DEPTH OF COVER

- A. The depth of cover over all utility lines shall at all times be a minimum of 7 – feet measured from top of pipe to finish grade elevation, unless called out elsewhere in the Drawings or established in the Technical Provision included herein.

B. Technical Provisions

1. Reserved

33.3.05 POLYETHYLENE ENCASEMENT

- A. All ductile iron and gray iron pipe, valves, valve boxes, curb boxes, hydrants, fittings and appurtenances, shall be fully encased in polyethylene film.
 1. The film shall be furnished in tube form for installation on pipe and all pipe-shaped appurtenances such as bends, reducers, off-sets, etc.
 2. Sheet film shall be provided and used for encasing all odd-shaped appurtenances such as valves, tees, crosses, etc.
- B. The polyethylene tubing shall be installed on the pipe prior to being lowered into the trench.
 1. Tubing length shall be sufficient to provide a minimum overlap at all joints of one foot or more. After completing the pipe jointing and positioning the overlap material, the overlap shall be secured in place with adhesive tape wrapped circumferentially around the pipe not less than three turns.
- C. After encasement, the circumferential slack in the tubing film shall be folded over at the top of the pipe to provide a snug fit along the barrel of the pipe.
 1. The fold shall be held in place with adhesive tape applied at intervals of approximately three feet along the pipe length.
 2. Any rips, punctures, or other damage to the tubing shall be repaired as they are detected. These repairs shall be made with adhesive tape and overlapping patches cut from sheet or tubing material.
- D. At odd-shaped appurtenances such as gate valves, the tubing shall overlap the joint and be secured with tape, after which the appurtenant piece shall be wrapped with a flat film sheet or split length of tubing by passing the sheet under the appurtenance and bringing it up around the body.
 1. Seams shall be made by bringing the edges together, folding over twice, and taping down. Wherever encasement is terminated, it shall extend for at least two feet beyond the joint area.

- E. Openings in the tubing for branches, service taps, air valves and similar appurtenances shall be made by cutting an X-shaped slit and temporarily folding back the film.
 - 1. After installing the appurtenance, the cut tabs shall be secured with tape and the encasement shall be completed as necessary for an odd-shaped appurtenance.
- F. Polyethylene encasement shall not be installed below a point 6 inches above the drain outlet of hydrants.
 - 1. The foundation material at the base of the hydrant shall be placed against the polyethylene to secure it in place.
- G. **Technical Provisions**
 - 1. Reserved
 - 2. Wrapping shall be 1 – layer of polyethylene encasement for all direct bury cast iron or ductile iron pipe and appurtenances having an epoxy coating.
 - 3. Wrapping shall be 2 – layers of polyethylene encasement for all direct bury cast iron or ductile iron pipe and appurtenances not having an epoxy coating.

33.3.06 UTILITY INSULATION BOARD (IB)

- A. Insulation board will not be used on this project.
- B. **Technical Provisions**
 - 1. Reserved

33.3.07 UTILITY INSULATED CASING (IC)

- A. Insulated casing shall be extended a minimum of 2 – feet either side of storm sewer and be placed to allow a minimum 3 1/2 – feet of cover between top of water/sewer main and bottom of said overhead storm sewer unless otherwise approved by the Owner/Engineer.
- B. Carrier pipe joints located inside insulated casing shall be restrained.
- C. Pipe wrap insulation shall be furnished and installed per the manufacturers recommendations.
- D. The cost to furnish and install all required material specified for insulated casing of mains and/or services shall be considered included in the price of bid for that item.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Insulation insulated casing/pipe wrap insulation will not be required for this project.

33.3.08 THRUST BLOCKING

- A. Construct reaction or thrust blocks at all tees, plugs, valves, reducers, caps and at bends deflecting 22-1/2 degrees or more.
- B. Construct thrust blocks at tapping sleeves where the outlet diameter exceeds one-half the diameter of the main being tapped. Limit using metal rods or straps for thrust restraint to those specified on the plans, or where the use of concrete thrust blocks would be impractical. Do not use metal rods or straps without the Engineer's approval.
- C. Construct reaction blocks from concrete having a minimum compressive strength of 2,000 pounds per square inch at 28 days.
- D. Concrete thrust blocking shall be poured against firm, undisturbed ground and shall be formed in such a way that the joints will be kept free of concrete and remain accessible for repairs.
 - 1. Thrust blocking dimensions shall be installed per the plan drawings for the respective fitting.
- E. Restraining devices shall be accompanied in tandem with appropriately sized thrust blocking unless otherwise approved by the Engineer.

F. Technical Provisions

1. Reserved
2. In lieu of poured-in-place thrust blocks as specified in part D of this subsection, dry thrust blocks may be used in addition to mechanical joint restraints, subject to Engineer's approval. Dry thrust blocks must meet or exceed the same criteria specified for poured-in-place thrust blocks.
3. Use thrust blocks with all fittings, whether push-on, mechanical joint, or restrained joint, unless restraint joint system is designed to provide proper soil loading to provide sufficient restraint to the first non-restrained joint and approved by the Engineer.

33.3.09

ADJUSTING EXISTING UTILITIES AND APPURTENANCES TO GRADE

- A. The work consists of locating and adjusting to grade existing manholes, lampholes, inlets, water valve boxes or services, and fire hydrants as shown in the Contract Documents, staked in the field or as required in the Contract Documents.
- B. Provide all materials including concrete, brick and mortar, complying with the Specification section for the particular material involved, or if the material is not covered in these Specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure. If extensions for water valve boxes or services and fire hydrants are required beyond the length found to exist, provide items comparable to those in the existing structure.
- C. Bring to required grade all existing manholes, inlets, lampholes and water valve boxes by either lowering or raising in accordance with the details shown in the Contract Documents. Do not lower manholes, lampholes or inlets by removal of portions of the cones or barrel sections. Accomplish downward adjustments by replacement of existing sections with shorter sections. Assure that all structures have a minimum of one 2 - inch concrete adjusting ring and a maximum of 12 - inches of rings under the casting. Do not use brick and/or mortar for adjustment of castings.
- D. On manholes requiring steps, assure that maximum spacing between steps is 16 - inches and that 10 - inches is the maximum distance from the top of the manhole cone section to the first step.
- E. Excavate water valve boxes and services to readily determine whether height adjustment can be made without substituting a longer section. Adjust water valve boxes and services laterally so the valve stems can be operated by the extension. Adjust water services by raising or lowering the curb key stop and extension box.
- F. Adjust manholes, lampholes and water valve boxes to final grade before placing the final pavement surface. If required, make preliminary adjustment to allow placement of base courses and paving adjacent to the manhole, lamphole or water valve.
- G. Provide backfill material conforming to provisions of **SECTION 32 11 23 AGGREGATE BASE COURSE**, 1 - inch Minus Crushed Base Course compacted to the minimum densities specified in **SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.
- H. If required, make minor adjustments 5 - feet to 10 - feet in the horizontal location of existing fire hydrants to insure that they are the required minimum distance behind the back of curb. At the time of construction staking, any hydrants which require horizontal adjustment will be located by the Owner/Engineer and the adjusted location will be staked by the Contract Documents.
- I. Make any minor adjustments required as dimensioned in the Contract Documents to the height of existing fire hydrants to insure that they are at a reasonable height above the back of curb. At the time of construction staking, any hydrants which require vertical adjustment will be located by the Engineer and the adjusted height will be staked by the Engineer. Accomplish extension of fire hydrant height only by the use of standard extension spools provided by the hydrant manufacturer.
- J. Before final acceptance, clean all manholes, lampholes, inlets and water valve boxes/services. Assure that all water valve boxes, services and fire hydrants are operational.

- K. All requirements of this section shall apply to new, as well as to existing, manholes, lampholes, valve boxes, water services and fire hydrants.

- L. **Technical Provisions**

- 1. Reserved

33.3.10

ABANDONING EXISTING UTILITIES AND APPURTENANCES

- A. The following utilities and appurtenances no longer required for the operation of their respective systems and not removed in their entirety during construction shall be abandoned in a manner acceptable to the Owner/Engineer.

- 1. Water mains

- a. Abandoned in a manner that prevents cross-connection and must be entirely or partially removed to prevent future connections to the abandoned main.

- 2. Fire hydrants

- 3. Gate Valves

- 4. Sewer mains

- 5. Septic / Dosing Tanks

- 6. Manholes

- a. Abandoned in accordance with the provisions of **SECTION 33 05 61 CONCRETE MANHOLES** of these Specifications.

- B. Asbestos containing pipe and structures shall be handled and disposed of in accordance with the provisions of these Specifications.

- C. **Technical Provisions**

- 1. Reserved

- 2. Abandoning existing utilities is not anticipated for this project.

33.3.11

RECORDS

- A. The Contractor shall prepare and maintain an accurate record of underground utility locations and depths.

- B. Depths of installed utilities shall be recorded every 40 – feet to the top of pipe as compared to finish ground elevation along with location of said measurement.

- C. Depths and separations of installed utilities at existing and/or future utility crossings, as applicable, shall be recorded when encountered in addition to measurements every 40 – feet as specified herein.

- 1. A table has been provided in **SCHEDULE 33 05 00 – A** at the end of this section for convenience. Contractor is responsible to supply necessary data as specified in this section.

- D. The Contractor shall use references such as lot corners, building corners, manholes and other similar surface improvements or monuments.

- E. Said records shall be submitted to the Owner's Representative upon completion of the work.

- F. **Technical Provisions**

- 1. Reserved

CONTINUED

SCHEDULE 33 05 00 - A

[illegible]

END OF SECTION

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes work associated with utility installations by the horizontal directional drilling method and all work incidental thereto, as shown on the Drawings and as specified herein.

33.1.02 REFERENCES

- A. The current publications listed below form part of this Specification.
- B. Standard
NSF 60 Drinking Water Treatment Chemicals – Health Effects

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES
SECTION 33 05 31.19	FUSIBLE POLYVINYLE CHLORIDE PIPE
SECTION 33 05 97.26	UTILITY DETECTABLE MARKINGS
SECTION 33 14 13	PUBLIC WATER UTILITY DISTRIBUTION PIPING

33.1.04 QUALIFICATIONS

- A. All directional drilling operations shall be performed by a qualified directional drilling Contractor with at least five (5) years of continuous experience involving work of a similar size, length and configuration to the work required of this project. The contractor must adhere to the rules and regulations set forth in ER1110-1-1807 as well as the requirements within these specifications.
1. The lead personnel including the superintendent, the foreman and the lead locator each must have a minimum of five (5) years of experience and must have demonstrated competency and experience to perform the scope of work contained in this contract.
 2. The name, experience of each lead individual performing work on this contract, and list of project references shall be submitted. Personnel replaced by the Contractor, on this contract, shall have similar, verifiable experience as the personnel originally submitted for the project.
- B. **Technical Provisions**
1. Reserved

33.1.05 SUBMITTALS

- A. Preconstruction submittal product data shall be furnished as follows:
1. The Contractor shall submit a HDD Drilling Plan to the US Army Corp of Engineers prior to the commencement of any work. Work shall not proceed until the Drilling Plan has been approved. Items required in the HDD Drilling Plan include but are not limited to:
 - a. Means and Methods.
 - b. Hydro fracture factor of Safety Calculations in graphical format with HDD Profile, showing estimated allowable formation pressures.
 - c. Recommended maximum allowable drilling fluid pressure with built in factor of safety.
 - d. Required Drilling Fluid Pressures
 2. The following work plan and information is required from the contractor and/or horizontal directional drilling Contractor. This work plan and information shall also be supplied to the pipe supplier, should it be requested:

- a. Work plan shall include for each HDD installation any excavation locations and dimensions, description of the sequence of operations, interfering utilities, bore dimensions and locations including bend radii used, and traffic control schematics.
 - b. A project safety and contingency plan which shall include but shall not be limited to drilling fluid containment and cleanup procedures, equipment and plan for compromised utility installations including electrical and power lines, water, pipelines, wastewater and any other subsurface utility in the area.
 - c. An environmental management and noise pollution management plan.
 - d. An HDD schedule identifying daily work hours and working dates for each installation.
3. The Contractor shall provide equipment data for the drill rig and proposed design of equipment anchoring system and anticipated resistant forces, method to pack-off end of hole, proposed rod size, bend radius, and tabulation of rod hours (date and American Petroleum Institute rating), down-hole tools including drilling tools, reamers, pulling device, and tracking system.
4. The Contractor shall provide information on drilling fluid generation and management.
5. The Contractor shall provide a fusion welding quality assurance plan.
6. The Contractor shall provide certifications of training by the pipe fusing equipment manufacturer(s) stating that the operators of fusing equipment have been fully trained in the use of the fusion equipment used on the Project.
 - a. Fusing technicians shall meet the criteria included in the Specifications for the specified type of pipe material.
- B. The following As-Recorded Data is required from the contractor and/or fusion provider to the owner or pipe supplier upon request:
 1. Fusion report as described in **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE**.
 2. The as-recorded plan and profile will reflect the actual installed alignment, and reflect the horizontal offset from the baseline and depth of cover.
 3. Borehole survey instrumentation shall be used to monitor line and grade of the pilot hole. The Contractor shall maintain records documenting the line and grade of the pilot hole. Data shall include, pitch, depth, timestamp, GPS location, downhole fluid pressure, and location where bore crosses other utilities.
 4. The Contractor shall provide "As-Built" data based on downhole survey data or a walkover location system that indicates x, y, and z coordinates of the pipe at least every twenty-five (25) feet along the alignment, midpoints if the bore length is less than twenty-five (25) feet, and at all existing and future utility crossing locations, where applicable.
 5. Data collected in accordance with "Location and Protection of Underground Facilities" subsection included herein shall be included with the "As-Built" information.
 - a. A table has been provided in **SCHEDULE 33 05 07.13 – A** at the end of this section for convenience. Contractor is responsible to supply necessary data as specified in this section.
 6. All fittings, valves, or other appurtenances shall be referenced and shown.
 7. A daily project log, along with tracking log sheets shall be provided. Tracking log sheet data shall include inclination, depth, and hydraulic pull-back and rotational force measured.
- C. Shop drawings and product data shall be submitted for Piping, Fittings, and Appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- D. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

E. **Technical Provisions**

1. Reserved

33.1.06 TESTING

- A. This section reserved.

PART 2 PRODUCTS

33.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein..
- B. Fusible Polyvinyl Chloride pipe and fittings, when specified for horizontal directional drilling, shall meet the requirements as specified in **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of these Specifications.
- C. **Technical Provisions**
1. Reserved

33.2.02 DRILLING FLUID

- A. Drilling fluid shall be ANSI/NSF 60 (Drinking Water Treatment Chemicals – Health Effects) certified, bentonite-based drilling fluid.
- B. **Technical Provisions**
1. Reserved

33.2.03 CASING PIPE

- A. Casing pipe shall be 20" DR21, 200 PSI, Fusible Polyvinyl Chloride (PVC) and shall conform to the requirements outlined in **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of the specifications.
- B. All butt fusion joints on interior of casing shall be field trimmed to flush with the ID of the casing pipe and to allow casing spacers to be installed without damage to the runners.

33.2.04 CARRIER PIPE

- A. Carrier pipe shall be 14" DR21, 200 PSI, Fusible Polyvinyl Chloride (PVC) and shall conform to the requirements outlined in **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of the specifications.
- B. **Technical Provisions**
1. Restrained Joint Integrated Bell (RJIB) PVC meeting the same specifications may be used for the carrier pipe if approved by the Engineer. The casing pipe may need upsized to accommodate the diameter of RJIB PVC.

33.2.05 CASING SPACERS

- A. Casing spacers shall be sized sufficiently to provide a minimum clearance of two (2) inches between outside of carrier pipe bells or couplings and inside of casing. The spacers shall consist of the following components:
1. Spacer Band Material: Minimum 14-gauge steel band of Type T-304 stainless steel.
 2. Spacer Liner Material: Ribbed liner of PVC or EPDM rubber designed to overlap the edges of the spacer band and prevent slippage. Liner shall have a minimum thickness of 0.090 inches and a hardness of 85-90 durometer "A".
 3. Spacer Width: As recommended by spacer manufacturer for the specific application. Minimum width shall be 8 inches. Manufacturer's approval in writing shall be required for

installations exceeding 300 feet in length, carrier pipes in excess of 48 inches in diameter or multiple carrier pipes in casing.

4. Spacer Risers and Runners must be:
 - a. Risers must be minimum 10-gauge steel risers of same material and requirements as spacer band. Risers shall be MIG welded to spacer band and prior to coating. Risers must be suitable for supporting the weight of carrier pipe.
 - b. Runners shall be manufactured of an abrasion resistant material having a low coefficient of friction (0.1 to 0.6) and designed to support the carrier pipe without damage or excessive wear. Runner material shall be of glass reinforced polyester or nylon and have a minimum compressive strength of 18,000 psi (ASTM D 695).
- B. Casing spacers shall be placed at ten (10) feet on center or as per manufacturer's recommendations, whichever is more stringent.
- C. All hardware and fasteners shall be stainless steel.
- D. Hardwood skids shall NOT be used in place of manufactured casing spacers.
- E. Fill material is not required in the annular space.

33.2.06 **CASING END SEALS**

- A. Casing end seals shall be made of synthetic rubber, conical shape, pull-on or wrap-around style with Type 304 stainless steel bands. For carrier pipe greater than 24 inches in nominal diameter the annular space between the carrier pipe and the casing pipe at the ends shall be bricked in conjunction with the end seals.
- B. Casing end seals shall not be required at locations where the casing terminates in a manhole as shown on the drawings. Casing pipe at manhole penetration shall be grouted in a watertight fashion.

PART 3 **EXECUTION**

33.3.01 **GENERAL**

- A. Refer to Related Work sections for applicable installation requirements for specified type(s) of materials, and general installation of utilities.
- B. The directional drilling equipment, as a minimum, shall consist of a directional drilling rig of sufficient capacity to perform the bore(s) and pull-back of the pipe(s), a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project. All required equipment shall be included in the project safety and contingency plan as submitted per these specifications.
- C. Bore path and alignment shall be designed by the Contractor or his qualified subcontractor. Entry and exit locations and control-point elevations shall be maintained as indicated in the work plan as approved per the submittal requirements of this Section.
- D. Bend radii shown shall adhere to the minimum allowable radii pursuant to the pipe manufacturer/supplier published literature which shall also be supplied in the work plan.
- E. The Contractor shall be responsible for complying with all local, county, state, and federal regulations and the requirements of these Specifications, and shall be fully responsible for all damages arising from the failure to comply.
- F. Where utilities and pipelines are involved the Contractor shall monitor ground settlement or heave directly above and 10 feet before and after the utility or pipeline intersection.
- G. The Contractor shall cease operations when monitoring points indicate any surface disruption. The Contractor shall propose immediate action for review and approval by the Owner's Representative to remedy the problem.

- H. The Contractor shall conduct any necessary field surveys, subsurface investigations and geotechnical investigations necessary to complete the work. Reports of subsurface investigations performed by the Owner are solely for the convenience of the Contractor and when provided can be found in **DIVISION 02 EXISTING CONDITIONS** of these Specifications. The Owner makes no guarantee as to the types of materials to be encountered.
- I. Directional drilling shall consist of the drilling of a small diameter pilot hole at grade and from the locations shown on the Plans. Once the pilot boring is in place and meets the tolerance requirements as specified, the Contractor shall enlarge the hole by push reaming or pull reaming as the Contractor deems appropriate. Upon completion of hole sized to a maximum of 150 percent of the nominal pipe diameter, the Contractor shall pull the pipeline back from the recovery area to the directional drill machine unless alternate methods are proposed by the Contractor and approved by the Owner's Representative.
- J. The Contractor shall utilize a drilling fluid cleaning/recycling system. Entry and exit pits shall be sized and constructed to completely contain the drilling fluid.
- K. The Contractor shall install boring to line and grade shown on plans, unless noted otherwise. Alignment shall be within tolerances specified.
- L. If a stoppage in the forward progress of the project is encountered, the cause of the stoppage shall be determined by the Contractor. When the cause has been identified, the installation method shall be modified to the satisfaction of the Owner's Representative to best suit the actual conditions encountered. Should the stoppage be a result of the Contractor's equipment, materials or method, then all remedial costs will be at the Contractor's expense.
- M. **Technical Provisions**
 - 1. Reserved
 - 2. Refer to **SECTION 02 32 00 GEOTECHNICAL INVESTIGATION** to become familiar with hydraulic fracturing pressures.

33.3.02 DRILLING RIG

- A. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull drill pipe while delivering a pressurized fluid mixture to a drill head. The machine shall be anchored to withstand the pulling, pushing and rotating forces required to complete the project.
- B. The drilling rig hydraulic system shall be of sufficient pressure and volume to power drilling operations. The hydraulic system shall be free from leaks.
- C. The drilling rig shall have a system to monitor pull-back hydraulic pressure during pull-back operations.
- D. **Technical Provisions**
 - 1. Reserved

33.3.03 DRILL HEAD

- A. The horizontal directional drilling equipment shall produce a stable fluid lined tunnel with the use of a steer-able drill head and any subsequent pre-reaming heads.
- B. The system must be able to control the depth and direction of the drilling operation.
- C. Drill head shall contain all necessary cutters and fluid jets for the operation, and shall be of the appropriate design for the ground medium being drilled. Contractor shall be responsible for determining the appropriate drill head design for the onsite ground conditions to efficiently and effectively perform the work.
- D. **Technical Provisions**
 - 1. Reserved

33.3.04 DRILLING FLUID SYSTEM

A. Drilling Fluid System:

1. Drilling fluid shall be composed of clean water and the appropriate additive(s) for the fluid to be used. Water shall be from a clean source and shall meet the mixing requirements of the mixture manufacturer(s).
2. The water and additives shall be mixed thoroughly to assure the absence of any clumps or clods. No hazardous additives may be used.
3. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall(s).
4. Drilling fluid shall be disposed of off-site in accordance with local, state and federal requirements and/or permit conditions.
5. No additional chemicals or polymer surfactants shall be allowed to be added to the drilling fluid unless they have been submitted per this specification.

B. Mixing System:

1. A drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid for the project.
2. The mixing system shall be able to ensure thorough mixing of the drilling fluid. The drilling fluid reservoir tank shall be sized for adequate storage of the fluid.
3. The mixing system shall continually agitate the drilling fluid during drilling operations.

C. Drilling Fluid Delivery and Recovery System:

1. The drilling fluid pumping system shall have a minimum capacity to supply drilling fluid in accordance with the drilling equipment pull-back rating at a constant required pressure.
2. The delivery system shall have filters or other appropriate in-line equipment to prevent solids from being pumped into the drill pipe.
3. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. The use of spill containment measures shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps, vacuum truck(s), and/or storage of sufficient size shall be in place to contain excess drilling fluid.
4. A closed-loop drilling fluid system and a drilling fluid cleaning system should be used to whatever extent practical, depending upon project size and conditions. Under no circumstances shall drilling fluid that has escaped containment be reused in the drilling system.

D. Drilling Control System:

1. Calibration of the electronic detection and control system shall be verified prior to the start of the bore.
2. The drilling head shall be remotely steer-able by means of an electronic or magnetic detection system. The drilling head location shall be monitored in three dimensions:
 - a. Offset from the baseline,
 - b. Distance along the baseline, and
 - c. Depth of cover.
3. Point of rotation of the head shall also be monitored.
4. For gravity application and on-grade drilling, sonde/beacon or approved equipment applicable for grade increments of 1/10th of one percent shall be used.

E. Vacuum Trucks:

1. Vacuum trucks of sufficient capacity to contain 150 percent of the drilling fluid volumes in use

F. **Technical Provisions**

1. Reserved

33.3.05 PIPE PULL HEADS

- A. Pipe pull heads shall be utilized that employ a positive through-bolt design assuring a smooth wall against the pipe cross-section at all times.
- B. Pipe pull heads shall be specifically designed for use with the pipe material used, and shall be as recommended by the pipe supplier.

C. **Technical Provisions**

1. Reserved

33.3.06 PIPE ROLLERS

- A. Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe during handling and pullback operations.
- B. A sufficient quantity of rollers and spacing, per the pipe supplier's guidelines shall be used to assure adequate support and excessive sagging of the product pipe.

C. **Technical Provisions**

1. Reserved

33.3.07 LOCATION AND PROTECTION OF UNDERGROUND UTILITIES

- A. Correct location of all underground utilities that may impact the HDD installation is the responsibility of the Contractor, regardless of any locations shown on the drawings or previous surveys completed.
- B. Utility location and notification services shall be contacted by the Contractor prior to the start of construction.
- C. All existing and future lines and underground utilities, where applicable, shall be positively identified, including exposing those facilities that are located within an envelope of possible impact of HDD installation as determined for the project specific site conditions. It is the Contractor and HDD system operator's responsibility to determine this envelope of safe offset from existing utilities. This will include, but is not limited to, soil conditions and layering, utility proximity and material, HDD system and equipment, and foreign subsurface material.
- D. The Contractor shall locate all known utilities located adjacent to or crossing the utility line being installed. Excavate to expose utilities prior to initiating drilling and verify applicable clearances. Clearance shall meet applicable code requirements and the requirements of the directional drilling process.
 1. Description, depth, size, and type of existing utilities crossed during HDD, and top of pipe elevation at said locations shall be indicated on "As-Built" drawings supplied by Contractor.
 2. A table has been provided in **SCHEDULE 33 05 07.13 – A** at the end of this section for convenience. Contractor shall still be responsible to supply necessary data as specified in this section.
- E. The Contractor shall locate and verify the clearance of known structures and foundations/footings located adjacent to or crossing the utility line being installed.

F. **Technical Provisions**

1. Reserved
2. Contractor shall positively verify "pot hole" locations of all future and existing utilities prior to and/or during pilot hole bore and record depth of drill head at said locations. This information

shall be submitted to Owner's Representative prior to commencing pipe pullback operations to check for general concurrence. **SCHEDULE 33 05 07.13 – A** included at the end of this section shall be completed and submitted to Owner's Representative for all future and existing utility crossings at the completion of pull back operations prior to commencing backfilling efforts, to check for general concurrence to the Contract Documents.

- a. Reserved
3. All utility locates "pot-holing" performed within non-traveled roadways, shall be filled with non-shrink backfill material requiring no tamping or vibrating material, approved by the Engineer.
 - a. Non-shrink backfill shall be furnished in accordance with the provisions of **SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK** of these Specifications.
4. All utility locates "pot-holing" performed within traveled roadways, shall be poured to the surface with flowable fill, unless otherwise specified. Flowable fill shall be of a consistency to fill the voids without excess water, and require no tamping or vibrating. Flowable fill shall be allowed a minimum of 3 hours cure time prior to vehicle traffic. The top 4 – inches shall be removed prior to patching/surfacing with specified materials.
 - a. Flowable fill shall be furnished in accordance with the provisions of **SECTION 32 23 23.33 FLOWABLE FILL** of these Specifications.
5. Positive verification of existing and future lines as specified in part C of this subsection, shall be recorded in **SCHEDULE 33 05 07.13 – A** or by other means to show depth and/or elevation of said lines or utilities. During the preliminary pilot bore the Contractor shall record the depth and/or elevation of the drill head at these same locations. This information shall be submitted to the Engineer prior to commencing pipe pullback operations to check for general concurrence to the Contract Documents.

33.3.08 SITE LOCATION PREPARATION

- A. Work site as indicated on drawings shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made.
- B. Contractor shall confine all activities to designated work areas.
- C. **Technical Provisions**
 1. Reserved

33.3.09 DRILLING LAYOUT AND TOLERANCES

- A. The drill path shall be accurately surveyed with entry and exit areas placed in the appropriate locations as indicated on drawings. If using a magnetic guidance system, drill path will be surveyed for any surface geomagnetic variations or anomalies.
- B. Instrumentation shall be provided and maintained at all times that accurately locates the pilot hole, measures drill-string axial and torsional loads and measures drilling fluid discharge rate and pressure. Near real time data shall be available to the Owner's Representative. Data shall include, pitch, depth, timestamp, GPS location, downhole fluid pressure, and location where bore crosses other utilities.
- C. Entry and Exit pit areas shall be constructed so as not to exceed the bending limitations of the pipe as recommended by the pipe supplier/manufacturer, or as controlled by installation method specified in subsection PIPE PULL BACK AND INSERTION included herein.

1. Entry and exit pits shall be constructed and properly braced/shored in accordance with the provisions of **DIVISION 31 EARTHWORK** of these Specification.
 2. Pay limits for horizontal directional drilling (considered a trenchless method), shall be in accordance with the provisions of **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- D. The piping shall be installed at the minimum depths as specified in **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES**, or on the Drawings, and shall deviate no more than 6 - inches along the vertical axis and 3 - feet along the horizontal alignment.
- E. **Technical Provisions**
1. Reserved

33.3.10 PILOT HOLE BORE

- A. Pilot hole shall be drilled along bore path, and electronically monitored. In the event that the pilot bore does deviate from the bore path, it may require Contractor to pull-back and re-drill from the location along bore path before the deviation. The Owner's Representative shall be notified of any deviations from the bore path.
 - B. The Contractor shall limit curvature in any direction to reduce force on the pipe during pull-back. The minimum radius of curvature shall be no less than that specified by the pipe manufacturer and as indicated on the drawings.
 - C. The Contractor shall notify the Owner's Representative upon completion of the pilot hole to observe alignment prior to reaming and pullback.
 - D. **Technical Provisions**
1. Reserved

33.3.11 REAMING

- A. After successfully completing the pilot hole, the bore hole shall be reamed to a diameter which meets the requirements of the pipe being installed. The following table is offered as an estimated guide:

<u>Nominal Pipe Diameter</u>	<u>Bore Hole Diameter</u>
< 8 – inches	Pipe Dia. +4 – inches
8 – inches to 24 – inches	Pipe Dia. X 1.5
> 24 - inches	Pipe Dia. +12 - inches
 - B. Multiple reaming passes shall be used at the discretion of the Contractor and shall conform to this specification.
 - C. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, the Contractor shall be responsible for restoring any damaged property to original condition and cleaning up the area in the vicinity of the damage or loss. The Contractor shall notify the Owner's Representative immediately of fluid losses.
 - D. **Technical Provisions**
1. Reserved

33.3.12 PIPE PULL-BACK AND INSERTION

- A. Contractor shall handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not bend past the pipe manufacturer's minimum allowable bend radius, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.
- B. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
 1. The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.

2. The pipe may be continuously or partially supported on rollers or other Owner's Representative approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.
 3. A swivel shall be used between the reaming head and the pipe to minimize torsion stress on the pipe assembly.
- C. Buoyancy modification shall be at the sole discretion of the Contractor, and shall not exceed the pipe supplier's guidelines in regards to maximum pull force or minimum bend radius of the pipe. Damage caused by buoyancy modifications shall be the responsibility of the Contractor.
 - D. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.
 - E. In the event that the pipe becomes stuck, the Contractor may choose to cease the pulling operations to allow any potential hydro-lock to subside. Then if on re-commencement of the pulling operations the pipe remains stuck, the Contractor shall immediately notify the Owner's Representative. The Contractor in consultation with the Owner's Representative will discuss the appropriate recovery plan to be implemented to allow the work to continue. The cost to perform said work shall be the responsibility of the Contractor.
 - F. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, or movement and distortion of surface features. Any damages caused by the Contractor's operations shall be corrected by the Contractor at the Contractor's expense.
 - G. Install tracer cable during pullback operations, if requested. Extend tracer cable to end of carrier pipe and secure. Test continuity of the tracer cable prior to demobilizing. Tracer wire installation shall be in accordance with **SECTION 33 05 97.26 UTILITY DETECTABLE MARKINGS** of these Specifications.
 - H. Prior to sealing the annulus space, restoring the access chambers, and backfilling the insertion pit, the installed pipe shall be allowed the manufacturer's recommended amount of time, but not less than four (4) hours for cooling and relaxation. Sufficient excess length of new pipe shall be allowed to protrude into the access chamber to allow for cooling and relaxation and the consequential contraction.
 - I. Prior to backfilling launching and exit pits, the Contractor shall ensure that new pipe is properly supported and on the required grade. Suitable material approved by the Owner's Representative shall be used immediately under the new pipe as support in order to avoid sagging after backfill and compaction.
 - J. **Technical Provisions**
 1. Reserved
 2. When fusible pipe (Fusible PVC and/or HDPE) is specified, Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous length.
 3. Pipe cooling and relaxation time as specified in part H of this subsection, shall be increased to a 24 – hour cooling and relaxation period when pipe material used for directional drilling is high density polyethylene (HDPE) pipe.
 4. Maximum allowable tensile force imposed to pull section of pipe is not to exceed [90] percent of the pipe manufacturer's safe pull (or tensile) strength. If the section of pipe being pulled is made up of multiple pipe sizes or materials, the lowest safe pull strength value governs and the maximum allowable tensile force is not to exceed [90] percent of this value.
 5. Pipe installation shall satisfy all requirements of **SECTION 33 14 13 PUBLIC UTILITY DISTRIBUTION PIPING**.

33.3.13

PIPE VERIFICATION

- A. Contractor shall field verify the location, depths, and separations to existing utilities of installed pipe at completion of pull-back procedures in the presence of the Owner's Representative.
 - 1. Contractor shall choose method of verification satisfactory to the Owner/Engineer.
- B. Data shall be collected at minimum 30 – foot intervals and all utility crossings, unless otherwise approved by Owner/Engineer.
- C. In the event field verifications show installed pipe does not meet minimum design tolerances and/or clearance, the Contractor shall correct all deficiencies by means approved by Owner/Engineer at their own expense.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Pre-approved methods of verification are as follows:
 - a. Positive verification via "pot-holes", Pipe verified in place via sonde/locator.

33.3.14 **INSTALLATION CLEANUP**

- A. Following the installation, the project site shall be returned to a condition equal to or better than the pre-construction condition of the site. All excavations will be backfilled and compacted per the construction documents and jurisdictional standards. All pavement and hardscape shall be repaired per applicable jurisdictional standards, excess materials shall be removed from the site, and disturbed areas shall be re-landscaped. All drilling fluid shall be properly disposed of per these specifications and all applicable jurisdictional laws.
- B. Contractor shall verify that all utilities, structures, and surface features in the project area are sound.
- C. **Technical Provisions**
 - 1. Reserved

REST OF PAGE LEFT BLANK INTENTIONALLY

SCHEDULE 33 05 07.13 - A

[illegible]

END OF SECTION

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification specifies fusible polyvinylchloride pipe, including standards for dimensionality, testing, quality, and acceptable fusion practice.

33.1.02 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those other standards are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of design, bid, or construction, whichever is earliest. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
- C. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

<u>REFERENCE</u>	<u>TITLE</u>
ANSI/AWWA C110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
ANSI/AWWA C111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C153/A21.53	AWWA Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C605	Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	Standard for Disinfecting Water Mains
AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100mm Through 1,500mm), for Water Distribution
AWWA M23	AWWA Manual of Supply Practices PVC Pipe—Design and Installation, Second Edition
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2152	Test Method for Degree of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F1057	Standard Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique
NSF-14	Plastics Piping System Components and Related Materials
NSF-61	Drinking Water System Components--Health Effects
PPI TR-2	PVC Range Composition Listing of Qualified Ingredients

33.1.03 **RELATED WORK SPECIFIED ELSEWHERE**

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES
SECTION 33 05 07.13	UTILITY DIRECTIONAL DRILLING
SECTION 33 14 13	PUBLIC WATER UTILITY DISTRIBUTION PIPING
SECTION 33 05 97.26	UTILITY DETECTABLE MARKINGS

33.1.04 **PRE-CONSTRUCTION SUBMITTALS**

- A. Shop drawings and product data shall be submitted for Piping, Fittings, and Appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
1. A manufacturer's certification shall be included, certifying that all materials furnished meet applicable standards as specified herein.
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. The following PRODUCT DATA is required from the pipe supplier and/or fusion provider:
1. Pipe Size
 2. Dimensionality
 3. Pressure Class per applicable standard
 4. Color
 5. Recommended Minimum Bending Radius
 6. Recommended Maximum Safe Pull Force
 7. Fusion technician qualification indicating conformance with this specification
 8. Pipe fusion and fusion services warranty information
 9. Written procedural documentation for piping products including proper handling and storage, installation, tapping, and testing

33.1.05 **POST-CONSTRUCTION SUBMITTALS**

- A. The following AS-RECORDED DATA is required from the contractor and/or fusion provider to the owner or pipe supplier upon request:
1. Fusion report for each fusion joint performed on the project, including joints that were rejected. Specific requirements of the fusion technician's joint report shall include:
 - a. Pipe Size and Temperature
 - b. Machine Size
 - c. Fusion Technician Identification
 - d. Job Identification
 - e. Fusion Joint Number
 - f. Fusion, Heating, and Drag Pressure Settings
 - g. Heat Plate Temperature
 - h. Time Stamp
 - i. Heating and Cool Down Time of Fusion
 - j. Ambient Temperature

2. Approved datalogger device report
3. As-recorded Information
 - a. The as-recorded plan and profile will reflect the actual installed alignment, and reflect the horizontal offset from the baseline and depth of cover.
 - b. All fittings, valves, or other appurtenances will also be referenced and shown.

33.1.06 **MANUFACTURER REQUIREMENTS**

- A. All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784.

33.1.07 **FUSION TECHNICIAN REQUIREMENTS**

- A. Fusion Technician shall be fully qualified by the pipe supplier to install fusible polyvinylchloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.
- B. A minimum of 10,000 feet of documented pipe fusion experience is required and shall be supplied to the Engineer.

33.1.08 **WARRANTY**

- A. The pipe shall be warranted for one year from the date of substantial completion.
- B. In addition to the standard pipe warranty, the fusion services shall be warranted for one year from the date of substantial completion.

PART 2 **PRODUCTS**

33.2.01 **FUSIBLE POLYVINYL CHLORIDE PRESSURE PIPE**

- A. Fusible polyvinyl chloride pipe shall conform to AWWA C900, ASTM D2241 or ASTM D1785 for standard dimensions, as applicable. Testing shall be in accordance with the referenced AWWA standards for all pipe types. **14" DR21, 200 psi, shall be used for the Carrier Pipe and 20" DR21, 200 psi, shall be used for the Casing pipe where shown on the drawings.**
- B. Fusible polyvinyl chloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- C. Fusible polyvinyl chloride pipe shall be manufactured in a standard 40' nominal length, or custom lengths as specified.
- D. Fusible polyvinyl chloride pipe shall be blue in color for potable water use, and shall be green for sanitary sewer use.
- E. Pipe shall be marked as follows:
 1. Nominal pipe size
 2. PVC
 3. Dimension Ratio, Standard Dimension Ratio, or Schedule
 4. AWWA pressure class, or standard pressure rating for non-AWWA pipe, as applicable
 5. AWWA standard designation number, or pipe type for non-AWWA pipe, as applicable
 6. NSF-61 mark verifying suitability, if used for potable water service
 7. Extrusion production-record code
 8. Trademark or trade name
 9. Cell Classification 12454 and/or PVC material code 1120 may also be included

- F. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

33.2.02 FUSION JOINTS

- A. Unless otherwise specified, fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written guidelines for this procedure. All fusion joints shall be completed as described in this specification.
- B. All butt fusion joints on interior of casing shall be field trimmed to flush with the ID of the casing pipe and to allow casing spacers to be installed without damage to the runners.

33.2.03 CONNECTIONS AND FITTINGS FOR PRESSURE APPLICATIONS

- A. Connections shall be defined in conjunction with the coupling of project piping, as well as the tie-ins to other piping systems.
- B. Ductile Iron mechanical and flanged fittings:

Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard ductile iron fittings conforming to AWWA/ANSI C110/A21.10, or AWWA/ANSI C153/A21.53 and AWWA/ANSI C111/A21.11

 - 1. Connections to fusible polyvinylchloride pipe may be made using a restrained or non-restrained retainer gland product for PVC pipe, as well as for MJ or flanged fittings.
 - 2. Bends, tees and other ductile iron fittings shall be restrained with the use of thrust blocking or other means as indicated in the construction documents.
 - 3. Ductile iron fittings and glands must be installed per the manufacturer's guidelines.
- C. PVC gasketed, push-on fittings:

Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard PVC pressure fittings conforming to AWWA C900.

 - 1. Acceptable fittings for use joining fusible polyvinylchloride pipe other sections of fusible polyvinylchloride pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings as shown in the drawings.
 - 2. Bends, tees and other PVC fittings shall be restrained with the use of thrust blocking or other restraint products as indicated in the construction documents.
 - 3. PVC gasketed, push-on fittings and mechanical restraints, if used, must be installed per the manufacturer's guidelines.
- D. Fusible polyvinyl chloride sweeps or bends:
 - 1. Fusible polyvinyl chloride sweeps or bends shall conform to the same sizing convention, diameter, dimensional tolerances and pressure class of the pipe being joined using the sweep or bend.
 - 2. Fusible polyvinyl chloride sweeps or bends shall be manufactured from the same fusible polyvinyl chloride pipe being used for the installation, and shall have at least 2 feet of straight section on either end of the sweep or bend to allow for fusion of the sweep to the pipe installation. There shall be no gasketed connections utilized with a fusible polyvinyl chloride sweep.
 - 3. Standard fusible polyvinyl chloride sweep or bend angles shall not be greater than 22.5 degrees, and shall be used in nominal diameters ranging from 4 inch through 16 inch.
- E. Sleeve-type couplings:
 - 1. Sleeve-type mechanical couplings shall be manufactured for use with PVC pressure pipe, and may be restrained or unrestrained as indicated in the construction documents.
 - 2. Sleeve-type couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.

- F. Expansion and flexible couplings:
1. Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated in the construction documents.
 2. Expansion-type mechanical couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.
- G. Connection hardware:
- All bolts and nuts for buried service mains and fittings shall be made of stainless steel.

PART 3 EXECUTION

33.3.01 GENERAL

- A. Refer to **SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES** of these Specifications for provisions common to utility construction including water lines.
- B. Excavation and backfilling of utility trenches shall be in conformance with the provisions of **SECTION 31 23 33 – TRENCHING AND BACKFILLING** of these Specifications.
- C. Installation by horizontal directional drilling shall be in conformance with the provisions of **SECTION 33 05 07.13 – UTILITY DIRECTIONAL DRILLING**.

33.3.02 DELIVERY AND OFF-LOADING

- A. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Owner or Owner's Representative.
- B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify Owner or Owner's Representative immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.
- C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's guidelines shall be followed.
- D. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- E. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- F. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.

33.3.03 HANDLING PIPE

- A. Store pipe in a manner that will not result in damage or deformation to the pipe. If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- B. Prepare pipe on a relatively smooth surface, free of sharp rocks, sticks or debris. Utilize cribbing, pipe stands, rollers or other equipment as necessary to support the pipe. Pipe shall be stored and stacked per the pipe supplier's guidelines.
- C. Lift and move piping using ropes, slings or straps. Do not use unprotected chains, hooks or clamps to lift pipe.
- D. When lifting and moving pipe, provide a minimum of two points of support. Do not support pipes at butt-fused joints.

- E. Sections of pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and rejoined at the Contractor's expense.
- F. Plug all pipes at end of each workday. Provide a watertight plug to prevent entry of foreign materials into the pipe.
- G. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the Owner or Owner's Representative.

33.3.04

JOINING PIPE

- A. At start of each day, the Contractor shall complete fusion weld tests in accordance with manufacturer's recommendations to verify that fusion equipment is operating properly.
- B. Pipe ends shall be joined using butt fusion methods. Join pipe and fittings using butt fusion or socket or saddle fusion methods. Fusion methods shall comply with both pipe and fusion equipment manufacturers requirements.
- C. Join pipe and mechanical joint or flanged fittings in accordance with both fitting and pipe manufacturer requirements. Provide pipe stiffeners, wedge type retainer glands and clamp type joint restraint system
- D. Pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
- E. Pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.
- F. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
- G. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:
 - 1. HEAT PLATE - Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
 - 2. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - 3. GENERAL MACHINE - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion
 - 4. DATA LOGGING DEVICE – An approved datalogging device with the current version of the pipe supplier's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
- H. Other equipment specifically required for the fusion process shall include the following:
 - 1. Pipe rollers shall be used for support of pipe to either side of the machine.
 - 2. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 - 3. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
 - 4. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

5. Facing blades specifically designed for cutting the pipe material shall be used.
- I. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of the pipe material used. The software shall register and/or record the parameters required by the pipe supplier and these Specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes the installation of concrete manholes for storm water and sanitary sewer applications specified in the Contract Documents and this Specification.
- B. Documents or references made to ASTM, ANSI, or AASHTO designations shall be the latest revision at the time of call for bids; all specified material included herein shall conform to these standards where such standards exist.

33.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - AASHTO H20 Load Rating
 - AASHTO M199 Precast Reinforced Concrete Manhole Sections
 - ASTM A615 Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
 - ASTM C443 Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - ASTM C478 Circular Precast Reinforced Concrete Manhole Sections
 - ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes
 - ASTM C1244 Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
 - ASTM D4101 Polypropylene Injection and Extrusion Materials

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.
 - SECTION 03 00 00 CONCRETE**
 - SECTION 03 20 00 CONCRETE REINFORCING**
 - SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK**
 - SECTION 31 23 33 TRENCHING AND BACKFILLING**
 - SECTION 32 05 00 COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS**
 - SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES**

33.1.04 SUBMITTALS

- A. Furnish a manufacturer's certification covering concrete manholes and castings certifying that the materials meet the applicable Specifications.
- B. Shop drawings and product data shall be submitted for concrete manholes in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- D. Technical Provisions
 - 1. Reserved

PART 2 PRODUCTS

33.2.01 GENERAL

- A. Refer to Related Work sections for applicable product information if not included herein.
- B. Concrete manholes shall be furnished meeting ASTM C478 for all applicable portions of construction material, specifically including mandatory rejection requirements.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. All concrete manholes shall be constructed using Type 'V' cement.
 - 3. Provide mounding or other diversion to assure that no stormwater may enter the sewer manhole either during or following construction.
 - 4. Refer to **SECTION 03 00 00 CONCRETE** for additional requirements on precast concrete manhole material.

33.2.02 **PRECAST REINFORCED MANHOLE**

- A. Construct manholes from precast concrete sections having frames, covers, and steps as shown in the Drawings.
- B. **Technical Provisions**
 - 1. Reserved

33.2.03 **CONCRETE MANHOLE BASE**

- A. Concrete bases may be precast or field-poured on undisturbed earth.
- B. **Technical Provisions**
 - 1. Reserved

33.2.04 **MANHOLE STEPS**

- A. Furnish non-corrosive steps, 12 - inches in width, of 1/2 - inch steel rod encased with polypropylene.
- B. Assure steps withstand 400 pound vertical loads and 1,000 pound pull-out resistance.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Polypropylene Manhole steps as specified in this subsection shall meet the requirements of ASTM C478 and AASHTO M199. Polypropylene shall conform to ASTM D4101. Steps shall be a Grade 60 deformed reinforcing bar and shall meet ASTM A615.

33.2.05 **CASTING AND COVERS**

- A. Furnish 2-hole type covers unless specified otherwise.
- B. Covers shall meet requirements set forth in ASTM C478 and be designed for AASHTO H20, unless otherwise specified.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. Manhole Castings and Covers specified in this subsection shall be grey cast iron with a minimum clear opening of 24 – inches and furnished with a 7 – inch casting ring.
 - 3. Insulated manhole covers are required on all manholes as shown on the drawings.

33.2.06 **MORTAR**

- A. Mortar (non-shrink) shall be a combination of one part Portland Cement to two parts of sand by volume to which lime can be added not to exceed ten (10%) percent of cement by weight.
- B. **Technical Provisions**
 - 1. Reserved

33.2.07 **JOINT SEALING**

- A. Joint all connections between manhole walls and base and between wall sections adjusting rings and frame making the manhole watertight.
- B. For all horizontal joints located below the established high groundwater elevation, install a preformed rubber gasket joint meeting the requirements of ASTM C443.
- C. **Technical Provisions**
 - 1. Reserved

33.2.08 **PIPE CONNECTIONS**

- A. For all connections, the voids between new and/or existing carrier pipe or casing pipe shall be firmly grouted with a non-shrink material to produce a watertight joint at the penetration.
 - a. .
- B. **Technical Provisions**
 - 1. Reserved

PART 3 **EXECUTION**

33.3.01 **GENERAL**

- A. Install connectors and structures following the manufacturer's Specifications and instructions. Provide all tools and equipment required to install each structure and make required connections.
- B. The Contractor is responsible for all Contractor furnished material. Replace all defective material or material damaged by handling after delivery by the manufacturer. This includes the furnishing of all materials and labor required to replace installed material discovered damaged or defective before final acceptance of the work, or during the guarantee period.
- C. The Contractor is responsible for the safe storage of material for the work until it has been incorporated in the completed project.
- D. Load and unload manholes to prevent damage using hoists or skids as necessary.
- E. Trenching and excavation of pipelines and appurtenances shall be performed in accordance with the provisions of **SECTION 31 23 33 TRENCHING AND BACKFILL** of these Specifications.
- F. Cleanup shall be performed in accordance with the provisions of **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- G. **Technical Provisions**
 - 1. Reserved
 - 2. The contractor will be required to install the manholes near the locations shown on the drawings, some field adjustment will be required as appropriate for constructability. Either an inspection manhole or an air release manhole will be placed within every 1000' LF of mainline installed.
 - 3. Air release manholes are to be located at "high spots" along the mainline and the location must be field verified and approved by the Engineer.

33.3.02 **CONCRETE MANHOLES**

- A. Construct manholes to the specified dimensions and elevations. Make invert channels smooth and semi circular in shape conforming to the inside of the adjacent sewer/stormwater section. Make changes in flow direction with a smooth curve of as large a radius as the manhole size will permit. Make changes in channel grade and size gradually and evenly.
- B. The invert channels may be formed directly in the manhole base concrete or by laying half-pipe in the concrete. Make the floor of the manhole outside the channel smooth and slope toward the channel at 1 - inch per foot.
- C. Joint all connections between manhole walls, base, between wall sections adjusting rings and frame making the manhole watertight.
- D. Keep manhole construction within one manhole distant behind sewer pipeline construction.
- E. Castings shall be set in full mortar beds. Castings shall be set accurately to correct elevation so that no subsequent adjustment will be needed. The maximum distance from the top of the precast reinforced concrete pipe manhole to the top of the casting shall be 1 1/2 - feet. Building up shall be done with precast concrete manhole rings.
- F. Install adjusting rings on each manhole to bring the manhole top elevation to match the existing or specified ground elevations. Furnish adjusting rings reinforced with the same percentage of steel as the riser and top.
- G. All manholes shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be free from such accumulations at the time of final inspection.
- H. **Technical Provisions**
 - 1. Reserved
 - 2. Manhole rings as specified in part F of this subsection shall be 2 - inch minimum and 12 - inch maximum height.

33.3.03 **CONNECTIONS TO NEW MANHOLES**

- A. All pipe to manhole connections shall be installed per the manufacturer's specifications.
- B. Pipe ports shall be blocked out or core-drilled at the point of manhole manufacture and shall be accurately located within 1/2 - inch of proposed sewer/stormwater centerline.
- C. **Technical Provisions**
 - 1. Reserved
 - 2. For all connections, the voids between new and/or existing carrier pipe or casing pipe shall be firmly grouted with a non-shrink material to produce a watertight joint at the penetration.

33.3.04 **CONNECTIONS TO EXISTING MANHOLES**

- A. When a sewer/stormwater line is connected to an existing manhole, a hole adequate to receive the new pipe shall be cut into the manhole.
- B. If the existing manhole is of brick construction, a single rowlock of brick shall be turned over the new pipe and the existing manhole brick work shall be cleaned, pointed and given a 1/2 - inch mortar coat on the outside surface.
- C. For connections to existing precast reinforced concrete manholes, a hole shall be cored into the concrete manhole wall to receive the pipe. Any voids in the concrete shall be firmly grouted with a non-shrink material to produce a water tight joint after the connection is made.
- D. The bottom of the existing manhole shall be reconstructed to meet the new conditions and continue proper flows.
- E. **Technical Provisions**
 - 1. Reserved

33.3.05 **ADJUSTING NEW RING FRAME AND CASTINGS**

- A. Adjusting Frames and Ring Castings in Paved Areas
 - 1. In areas with hard surfacing (pavement/concrete) castings shall be set within 1/4 to 1/2 - inch below the proposed finished grade of the street.
- B. Adjusting Frame and Ring Castings in Areas with Aggregate Surfacing or Turf
 - 1. In areas with aggregate surfacing, the top of casting shall be approximately 2 - inches below the top of the surface.
 - 2. In areas where there is turf around the casing, the casing shall be flush with the ground.
- C. Adjusting castings of new manholes shall be considered incidental and no additional compensation will be made therefor.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. For adjustments made in paved areas as specified in part A of this subsection, the frame and ring shall be set 1/4 – inch below finish grade and be furnished with a concrete collar as shown on Montana Department of Transportation (MDT) standard Drawing 621-05.

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes installation of detectable warning devices and signage for utilities and all work included thereto as shown on the Drawings and specified herein.

33.1.02 REFERENCES

- A. This section reserved.

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections these Specifications.

SECTION 03 05 00	COMMON WORK RESULTS FOR CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES

33.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- C. **Technical Provisions**
1. Reserved

33.1.05 TESTING

- A. **Continuity Testing**
1. The Contractor shall perform a continuity test on all trace wire in the presence of the Engineer or the Engineer's representative.
 2. The continuity test shall be conducted after all backfilling activities have been completed for the section(s) to be tested.
 3. To minimize traffic disruptions and pavement damage, the continuity test shall be conducted prior to the final lift in all paved areas.
 4. If the trace wire is found to be not continuous after testing, the Contractor shall repair or replace the failed segment of wire at their own expense.
- B. **Technical Provisions**
1. Reserved

PART 2 PRODUCTS

33.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. **Technical Provisions**
1. Reserved

33.2.02 **TRACER WIRE**

- A. The wire shall be designed in such a manner as to be able to properly trace all piping without loss or deterioration of signal and without the transmitted signal migrating off the tracer wire.
- B. Open cut installation:
 - 1. The trace wire shall be a minimum 12 AWG copper clad steel or reinforced copper wire.
 - 2. The trace wire shall include a 30 mil HDPE insulation jacket recommended for direct burial.
 - 3. The trace wire shall be rated for use at 30 volts.
 - 4. The trace wire shall meet the American Public Works Association (APWA) Color-Code Standard for Identification of Buried Utilities.
- C. Trenchless installation:
 - 1. The trace wire shall be a minimum 12 AWG copper clad steel or reinforced copper wire with rated break load of 1,330 lbs (260,000 psi).
 - 2. The trace wire shall include a 45 mil, high-density, high molecular weight polyethylene (HMW-HDPE) coating pursuant to ASTM D1248 standard.
 - 3. The trace wire shall be rated for use at 30 volts.
 - 4. The trace wire shall meet the American Public Works Association (APWA) Color-Code Standard for Identification of Buried Utilities.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. All tracer wire installed shall be as manufactured by:
 - a. PRO-TRACE HDD-CCS PE45 by Pro-Line Safety Products, Trace-Safe as manufactured by NEPTCO, or approved equal.
 - 3. Tracer wire for open-cut installation shall be as manufactured by:
 - a. Copperhead Industries, LLC SuperFlex Copper Clad Steel, or approved equal.
 - 4. Tracer wire for trenchless installation shall be as manufactured by:
 - a. Copperhead Industries, LLC SoloShot Reinforced Tracer Wire, or approved equal.

33.2.03 **TRACER WIRE ACCESS BOX**

- A. The tracer boxes shall be magnetized for ease of locating.
- B. The tracer boxes shall include corrosion-resistant brass wire lugs to prevent corrosion.
- C. The tracer boxes shall allow connection without the removal of the cover.
- D. The tracer box covers shall meet the APWA Color-Code Standard for Identification of Buried Utilities.
- E. **Technical Provision**
 - 1. Reserved
 - 2. Tracing wire access boxes shall be as manufactured by:
 - a. Copperhead Industries LLC (Snakepit Access Box), or approved equal.
 - 3. Tracing wire access boxes as specified in this subsection, shall be cast iron with a permanently attached 3" x 12" ABS tube with a flared end to secure it in the ground, complete with a cast-iron locking pentagon lid with stainless steel terminal connectors.
 - 4. Tracer wire access boxes shall be installed at 500' intervals or as directed by the Engineer.

33.2.04 **TRACE WIRE CONNECTORS**

- A. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity.
- B. Except for approved spliced-in connections, tracer wire shall be continuous and without splices from each trace wire access point.
- C. All recommendations of the manufacturer for the trace wire connectors shall be followed.
- D. Connectors shall be compatible with trace wire gauge approved for installation and be of a configuration to allow for "in-line" and/or "lateral" connections as applicable to complete the work.
- E. Connectors shall be rated for direct burial use and filled with silicone sealant to prevent corrosion at connection points and shall be watertight.
- F. The buried connectors shall meet the APWA Color-Code Standard for Identification of Buried Utilities.
- G. **Technical Provisions**
 - 1. Reserved
 - 2. Tracer wire connectors shall be as manufactured by:
 - a. Copperhead Industries, LLC SnakeBite Corrosion Proof Wire Connectors, or approved equal.

33.2.05 **DETECTABLE WARNING TAPE**

- A. Underground marking tape shall be a 6 – inch width, detectable marking tape with a minimum 5.0 - mil overall thickness.
- B. The tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 - mil solid aluminum foil core and then laminated to a 3.75 - mil clear virgin polyethylene film.
- C. The tape and markings shall be imperious to alkalis, chemical reagents, and solvents in the soil.
- D. The tape shall be solid colored or printed using a diagonally striped design for maximum visibility and shall meet the APWA Color-Code Standard for Identification of Buried Utilities.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Detectable Warning Tape shall be as manufactured by:
 - a. Pro-Line Safety Products, Reef Industries, or approved equal.

33.2.06 **UTILITY MARKERS (POSTS)**

- A. The utility marker shall be a single piece marker capable of simple, permanent installation by one person.
- B. The utility marker shall be of a square or rectangular design.
- C. The bottom end of the utility marker shall be pointed for ease of ground penetration.
- D. The utility marker shall resist displacement from wind and vehicle impact forces.
- E. The utility markers shall be carsonite.
- F. The utility marker shall be wide enough to accommodate a 3 - inch wide reflector or decal.
- G. Decals shall be self-adhesive, retroreflective, and manufactured from quality U.V. resistant materials.

- H. The utility marker shall have a nominal length to provide minimum embedment depth of 18 - inches and maintain the minimum exposed marker length approved by the Owner/Engineer.
- I. The utility marker shall meet USACE standard NWDR 1110-1-1.
- J. The utility marker shall meet the APWA Color-Code Standard for Identification of Buried Utilities.

K. **Technical Provisions**

- 1. Reserved
- 2. Utility Markers shall be furnished with decals that read "WATER MAIN", "WATER VALVE", or "AIR RELEASE MANHOLE" respectively, on two sides.
- 3. Utility Markers nominal length as specified in part H of this subsection, shall be 42 - inches (2 - foot exposed length).
- 4. Utility Markers shall be installed at all valves, fittings, changes in direction, every 500 feet, and manhole locations as shown on the drawings

33.2.07 UTILITY MARKERS (CONCRETE)

- A. The utility marker shall be a single piece marker capable of simple, permanent installation by one person.
- B. The utility marker shall be of a square design.
- C. The utility marker shall resist displacement from wind and vehicle impact forces.
- D. The utility markers shall be concrete.
- E. The utility marker shall be at least 24" square but not larger than 30" square.
- F. Markings shall be mechanically imprinted no "finger" imprinting will be acceptable.
- G. The utility marker shall be 4" thick and placed 3" into the ground, in locations approved by the Owner/Engineer.
- H. The utility marker shall meet USACE standard NWDR 1110-1-1.
- I. The utility marker shall be edged with a 1 ¼" radius tool..

J. **Technical Provisions**

- 1. Reserved
- 2. Utility Markers shall be furnished with decals that read "WATER MAIN", "WATER VALVE", or "AIR RELEASE MANHOLE" respectively, on two sides.
- 3. Utility Markers shall be installed at all valves, fittings, changes in direction, every 500 feet, and manhole locations as shown on the drawings

33.2.08 **METALLIC UTILITY LOCATOR**

- A. If providing a utility locator is required, the locator shall operate on a 60 Hz signal for passive power locating and frequencies of 512 Hz, 8 kHz, and 83 kHz for active locating.
- B. The locator shall be capable of locating ferrous metals.
- C. The locator shall come with a hard case with high density foam inserts.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Contractor will not be responsible for providing a utility locator for this project.

PART 3 **EXECUTION**

33.3.01 **GENERAL**

- A. These general construction requirements apply to the installation of detectable warning devices and signage for utilities.
- B. **Technical Provisions**
 - 1. Reserved

33.3.02 **TRACER WIRE**

- A. The trace wire shall be laid flat and securely affixed to the pipe at a minimum of 10' intervals to ensure that the wire remains adjacent to the pipe.
- B. The trace wire shall be protected from damage during the execution of the works. No breaks or cuts in the trace wire or insulation shall be permitted.
- C. At service saddles, the trace wire shall not be placed between the saddle and the main.
- D. Trace wire access points shall be within public right-of-way or public utility easements.
- E. Location of tracing wire access boxes and termination points shall be placed at the location shown on the Drawings and/or as specified herein.
- F. Trace wire access points shall be, in general, no more than 500' apart. Where the distance between suitable appurtenances exceeds 500', tracer boxes shall be installed equidistant between the adjacent appurtenances as approved by the Owner/Engineer.
- G. At the point of connection between cast iron or ductile iron mains with any non-iron main, the tracer wire shall be properly connected to the iron pipe with an exothermic weld or approved equivalent bonding device to maintain electrical continuity. Tracer wire welds or bonding clamps shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a coat a minimum of 2 inches thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
- H. **Technical Provisions**
 - 1. Reserved
 - 2. For directional drilling, auguring, boring, or pipe bursting installations two (2) tracer wires shall be pulled with each water main crossing. Tracer wires shall be attached to the pipe a minimum of 90° apart as measured radially around the circumference.
 - 3. The tracer wire shall be installed with the carrier pipe during the directional drill, auger, bore, or pipe bursting. Installing the tracer wire after the pipe has been installed shall not be acceptable.

4. Test tracer wire for continuity after pipe has been installed and prior to final surface restoration. Verify that tracer wire is locatable with electronic utility locating equipment and repair all breaks or separations as needed.
5. In open cut installations the tracer wire shall be attached to the pipe at 10' intervals and run continuously between manholes and terminate inside the manholes at each end of the pipe with a minimum of 3' of wire coiled and accessible in each manhole.

33.3.03 **DETECTABLE WARNING TAPE**

- A. Detectable warning tape shall be buried a maximum 18 - inches below finish surface grade.
- B. **Technical Provisions**
 1. Reserved

33.3.04 **UTILITY MARKERS (POSTS)**

- A. Location of utility markers shall be placed at the location shown on the Drawings and/or as specified herein.
- B. **Technical Provisions**
 1. Reserved
 2. Utility Markers shall be installed at all manholes and main-line valve locations, located outside of traveled roadways, as approved by the Engineer.
 3. Utility Markers shall be installed at all tracer box locations.

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes the installation of all water utilities, fittings, mains, and appurtenances, appurtenant equipment, and all work included thereto as shown on the Drawings and specified herein.
- B. References made to ASTM, ANSI, NSF, AWWA, USASI or AASHTO designations shall be the latest revision at the time of call for bids; all specified material included herein shall conform to these standards where such standards exist.

33.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - ASTM D2000 Rubber Products in Automotive Applications
 - ASTM A193 Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 - ASTM A536 Ductile Iron Castings
 - AWWA C104 Ductile Iron Cement-Mortar Lining
 - AWWA C110 Ductile Iron Fittings
 - AWWA C111 Ductile Iron Joints
 - AWWA C116 Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
 - AWWA C151 Ductile Iron Pipe
 - AWWA C153 Ductile Iron Compact Fittings
 - AWWA C213 Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Steel Water Pipelines
 - AWWA C219 Bolted, Sleeve-Type Couplings for Plain End Pipe
 - AWWA C301 Concrete Cylinder Pipe
 - AWWA C900 PVC Water Main Pipe
 - ANSI/NSF 61 Municipal Drinking Water System Components

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.

SECTION 03 00 00	CONCRETE
SECTION 31 05 00	COMMON WORK RESULTS FOR EARTHWORK
SECTION 31 23 33	TRENCHING AND BACKFILLING
SECTION 32 05 00	COMMON WORK RESULTS FOR EXTERIOR IMPROVEMENTS
SECTION 33 01 12	INSPECTING AND TESTING OF WATER UTILITIES
SECTION 33 05 00	COMMON WORK RESULTS FOR UTILITIES
SECTION 33 05 07.13	UTILITY DIRECTIONAL DRILLING
SECTION 33 05 31.19	FUSIBLE POLYVINYL CHLORIDE PIPE
SECTION 33 05 97.26	UTILITY DETECTABLE MARKINGS
SECTION 33 14 19	VALVES AND HYDRANTS FOR WATER SERVICE UTILITY SERVICE
SECTION 40 23 36	POTABLE WATER PROCESS PIPING

33.1.04 SUBMITTALS

- A. Furnish a manufacturer's certification covering all pipe and fittings furnished, certifying that the pipe and fittings meet applicable Specifications.
- B. Shop drawings and product data shall be submitted for Piping, Fittings, and Appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS..**

- D. **Technical Provisions**

- 1. Reserved

33.1.05 TESTING

- A. Testing, Filling, Flushing, and Disinfecting of all water mains and associated pipe and appurtenances shall be performed in accordance with the provisions of **SECTION 33 01 12 INSPECTING AND TESTING OF WATER UTILITIES** of these Specifications.

- B. **Technical Provisions**

- 1. Reserved

PART 2 PRODUCTS

33.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. Materials shall be of the type called for on the Plans or in the proposal and shall be in accordance with the following appropriate requirements. All materials shall meet the applicable ANSI/NSF Standards 60 or 61 including Annex G and be so certified by NSF, UL or other organizations accredited by ANSI to test and certify such materials.
- C. Assure all pipe is clearly marked showing type, class and/or thickness. Lettering must be legible and permanent under normal handling storage conditions.
- D. All ductile iron fittings shall be wrapped w/ polyethylene encasement as specified in **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- E. Contractor will be required to have on hand the necessary fittings, valves, adaptors, and other material required to complete the project. If the Contractor is required to return any fittings, valves, etc., the cost of restocking shall be considered incidental to the project.
- F. Fusible Polyvinyl Chloride water pipe, when specified shall conform to the provisions of **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of these Specifications.
- G. **Technical Provisions**
 - 1. Reserved
 - 2. All nuts and bolts used for buried application shall be Cor-Ten or Stainless Steel with a "manufacturer's standard" coating, unless otherwise approved by Owner/Engineer.

33.2.02 DUCTILE IRON PIPE

- A. Class 51 wall thickness meeting AWWA C151, American National Standard for Ductile Iron Pipe.
- B. Use underground pipe and fittings having mechanical joints meeting AWWA C111.
- C. Assure the pipe interior is cement mortar lined meeting AWWA C104 requirements. Assure the outside of the pipe surface for underground services is bituminous coal tar base coated 1 mil thick.
- D. Ductile Iron piping shall conform to the requirements as outlined in **SECTION 40 23 36 POTABLE WATER PROCESS PIPING.**
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Ductile Iron piping shall be pressure class 250.

33.2.03 **POLYVINYL CHLORIDE PIPE**

- A. Furnish PVC water main pipe meeting AWWA C900 requirements, made to ductile iron O.D.'s for "Push-On" joints. Assure pipe joints are bell and spigot having an elastomeric gasket.
- B. **Technical Provisions**
 - 1. Reserved
 - 2. Polyvinyl Chloride Pipe (PVC) installed open-cut methods carrier pipe and casing pipe shall be, DR21 200PSI as manufactured by:
 - a. NAPCO C900, Northern Pipe Products C900, or approved equal.
 - 3. Polyvinyl Chloride Pipe (PVC) installed via directional drilling methods, carrier pipe shall be DR21 200 PSI, casing pipe shall be DR21 200 PSI and meet all requirements as outlined in **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of these Specifications.
 - 4. Restrained Joint Integrated Bell (RJIB) PVC meeting the same specifications may be used for carrier pipe if approved by the Engineer. The Contractor may need to upsize the casing pipe to accommodate the RJIB PVC carrier pipe diameter.

33.2.04 **STEEL WATER PIPE**

- A. Steel pipe shall meet AWWA C200. Utilize welded or seamless pipe with plain, or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets.
- B. Ensure that the wall thickness of fittings is equal to or greater than that required for the pipe. Reinforce fittings in accordance with methods given in AWWA M11, Chapter 13, "Supplementary Design Data and Details" when necessary to meet the pressure test requirements.
- C. Welded Joints: Provide electrodes of the quality specified in AWWA C206.
- D. Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. All steel pipe and fittings shall have a minimum working pressure of 250 PSI.
 - 3. Fittings for steel pipe shall meet AWWA C208 and AWWA C200.
 - 4. Flanged joints shall meet AWWA C207.
 - 5. All steel pipe shall be joined by weld in accordance with AWWA C206.
 - 6. Steel Pipe and accompanying fittings shall be installed satisfying AWWA 604 and AWWA M11 respectively.
 - 7. ALL welded steel pipe and fittings shall comply with **SECTION 40 23 36 POTABLE WATER PROCESS PIPING**.

33.2.05 **MECHANICAL JOINT RESTRAINTS**

- A. Mechanical joint restraints shall be furnished for the type of pipe being installed, as recommended by the manufacturer.
- B. The devices shall have a pressure rating equal to that of the pipe being installed.

- C. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland.
 - 1. Gland body, backup rings, wedges and wedge actuating components shall be ductile iron meeting or exceeding ASTM A536 and be compatible with all mechanical joints that conform to AWWA C111.
 - 2. Mechanical joint restraints shall have a fusion bonded epoxy coating.
- D. Tie rods and nuts shall meet or exceed the requirements of AWWA C111, or ASTM A193.
- E. **Technical Provisions**
 - 1. Reserved
 - 2. Mechanical joint restraints shall be as manufactured by the following as it relates to the installation of PVC pipe:
 - a. EBAA Series 2000PV, Ford Series UFR1500, or approved equal.
 - 3. Mechanical joint restraints shall be fully wrapped in polyethylene encasement.
 - 4. Piping sections requiring mechanical joint restraints are shown on the plans.

33.2.06 MECHANICAL BELL RESTRAINTS

- A. Mechanical bell restraints shall be furnished for the type of pipe being installed, as recommended by the manufacturer.
- B. The devices shall have a pressure rating equal to that of the pipe being installed.
- C. Restraint device may consist to (2) split body serrated retainers/rings capable of gripping the plain end of the pipe being installed.
 - 1. Serrated retainers shall be ductile iron meeting or exceeding ASTM A536.
- D. Mechanical bell restraints shall have a fusion bonded epoxy coating.
- E. Tie rods and nuts shall meet or exceed the requirements of AWWA C111, or ASTM A193.
- F. **Technical Provisions**
 - 1. Reserved
 - 2. Mechanical bell restraints shall be as manufactured by the following as it relates to the installation of PVC pipe:
 - a. EBAA Series 1900 (14" diameter and smaller), EBAA Series 2800 (14" diameter and larger), or approved equal.
 - 3. Mechanical joint restraints shall be fully wrapped in polyethylene encasement.

33.2.07 PIPE FITTINGS

- A. Fittings shall be made of ductile iron having a minimum pressure rating of 250 psi.
- B. Fittings shall be mechanical joint fittings in accordance with either AWWA C153 (Compact) or AWWA C110 (Full Body).
- C. Flanged fittings shall not be used for underground installation unless otherwise specified.
- D. Fitting joints shall meet the applicable requirements of AWWA C111.
- E. Fittings shall be furnished with a cement mortar lined interior meeting the applicable requirements of AWWA C104.
- F. Exterior coating shall be 1 mil thick bituminous tar, unless otherwise specified.
- G. **Technical Provisions**
 - 1. Reserved

2. ALL welded steel pipe and fittings shall comply with **SECTION 40 23 36 POTABLE WATER PROCESS PIPING**.

33.2.08 **PIPE SLEEVES**

- A. Sleeves shall be made of cast or ductile iron having a minimum pressure rating of 250 psi.
- B. Sleeves shall be mechanical joint fittings in accordance with either AWWA C153 (Compact) or AWWA C110 (Full Body).
- C. Sleeve joints shall meet the applicable requirements of AWWA C111.
- D. Fittings shall be furnished with a cement mortar lined interior meeting the applicable requirements of AWWA C104.
- E. Exterior coating shall be 1 mil thick bituminous tar, unless otherwise specified.
- F. Sleeves shall be long body type, with a minimum length of 12".
- G. A mechanical restraint or mechanically restrained ductile iron sleeve shall be employed to restrain joints between pipes of dissimilar material (i.e. fusible PVC to HDPE), unless otherwise approved by the Engineer.
 1. Mechanical restraints for HDPE pipe require insert stiffeners.
- H. **Technical Provisions**
 1. Reserved

33.2.09 **PIPE COUPLINGS**

- A. Coupling components shall be ductile iron meeting or exceeding ASTM A536 and have a minimum pressure rating of 250 psi or be equivalent to the pipe being installed up to 350 psi.
- B. Couplings shall meet the applicable requirements of AWWA C219.
- C. Couplings shall be furnished with a fusion-bonded epoxy coating in accordance with AWWA C213.
- D. Gaskets for couplings shall be SBR or NBR compounded for water service per ASTM D2000.
- E. Provide couplings with manufacturer's recommended model for the types of pipe being joined.
- F. **Technical Provisions**
 1. Reserved
 2. Pipe Couplings shall be as manufactured by:
 - a. Smith-Blair (Series 461 - Quantum), Romac (Series XR501 or MACRO), Ford (Series FC2W), Romac, Rockwell, Dresser, or approved equal.

33.2.10 **FLEXIBLE CONNECTORS**

- A. Flexible connectors of the sizes shown on the Drawings shall be manufactured of ductile iron conforming to the material properties of ANSI/AWWA C153/A21.53.
- B. Each flexible expansion joint shall be factory tested against its own restraint to a minimum of 350 psi.
- C. The flexible expansion joints shall be of a double ball configuration and shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15 degrees of deflection per ball joint and 4 inches of expansion.
- D. All pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be holiday tested with a 1500 volt spark test conforming to said Specification.
- E. **Technical Provisions**

1. Reserved
2. Flexible connectors will not be required for this project.

PART 3 EXECUTION

33.3.01 GENERAL

- A. Install pipe following the manufacturer's Specifications and instructions. Provide all tools and equipment required to install each type of pipe used.
- B. The Contractor is responsible for all Contractor furnished material. Replace all defective material or material damaged by handling after delivery by the manufacturer. This includes the furnishing of all materials and labor required to replace installed material discovered damaged or defective before final acceptance of the work, or during the guarantee period.
- C. Store all material safely and to prevent damage. Keep pipe interior and other accessories free from dirt and foreign matter at all times.
- D. Deliver and distribute all Contractor furnished pipe at the site. Load and unload pipe, fittings, specials, valves and accessories to prevent damage. Do not permit pipe handled on skidways to skid or roll against pipe already on the ground.
- E. When distributing material at the work site, lay each piece adjacent to its installation point. Repair or replace all damaged pipe at Contractor's expense on the jobsite.
- F. Remove all water in the trench during pipe laying and maintain a dry trench until the pipe ends are sealed. Do not permit the pipe to float. Do not allow any trench water to enter the pipe at any time.
- G. Excavation and backfilling of utility trenches shall be in conformance with the provisions of **SECTION 31 23 33 TRENCHING AND BACKFILLING** of these Specifications.
- H. Installation by horizontal directional drilling shall be in conformance with the provisions of **SECTION 33 05 07.13 UTILITY DIRECTIONAL DRILLING** of these Specifications.
- I. .
- J. **Technical Provisions**
 1. Reserved

33.3.02 VALVE OPERATION

- A. The Owner shall operate all existing valves as necessary. The Contractor shall notify the Engineer's on-site representative that valves need to be operated and which valves need to be on and off. The notification shall be made in writing a minimum of 48 hours before the valves need to be operated excluding Saturdays, Sundays, and Holidays.
- B. The Contractor shall not operate any existing valves except for emergency situations.
- C. The Contractor shall operate all new valves until the date of substantial completion.
- D. **Technical Provisions**
 1. Reserved

33.3.03 CONNECTING TO EXISTING WATER MAINS

- A. Make all connections to existing water mains in use unless otherwise specified. Furnish the special fittings, as shown on the plans, and all other material required. Make all necessary excavations to assure gradual transition between the new and existing water main, and perform all necessary backfilling.
- B. Where the connection of new work to old requires a service interruption and customer notification, the Engineer and the Contractor are to mutually agree upon a date for connections to permit

adequate time to assemble labor and materials, and to notify all affected customers. All notifications are the Contractor's responsibility.

- C. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. All equipment, materials, and labor that the Contractor plans to have available shall be coordinated with the Owner and Engineer in order to ensure the work is done in the minimum amount of time.
- D. When the connection is made by using tapping sleeves and valves, the outside of the existing main and inside of the sleeve and valve shall be thoroughly cleaned with a solution of chlorinated lime and water. After installing tapping sleeve and valve and before tapping existing main, place calcium hypochlorite inside the sleeve and valve. When connection to existing fittings and the existing main has been opened, place calcium hypochlorite inside existing fitting.
- E. Existing valves or gates used to isolate certain structures may not be watertight and some leakage may occur. The Contractor shall provide the necessary temporary plugs and/or plumbing facilities to handle any leakage.
- F. All materials and equipment (including emergency equipment) necessary to expedite tie-ins shall be on hand prior to the shutdown or existing services or utilities.

G. **Technical Provisions**

- 1. Reserved

33.3.04 LAYING OF PIPE

- A. Inspect the pipe and pipe coating for damage or defects before installation. Lay pipe without damaging the pipe coating. Repair all pipe coating damage following the manufacturer's instructions before laying the pipe. When using belt slings to lower the pipe into the trench, remove the slings without damaging the pipe coating.
- B. Lay pipe to the specified lines and grades with fittings and valves at the required locations. Plumb all valve stems.
- C. Grade and alignment on un-graded streets will be provided using hubs set parallel to the pipe line, and on graded streets from established points on the existing curbs or sidewalks, when directed by the Engineer. Excavate pipe trenches to the lines and grades given or to the standard cover depth specified. Trenching and excavation for piping shall be performed in accordance with the provisions of **SECTION 31 23 33 TRENCHING AND BACKFILL** of these Specifications.
- D. Transfer lines and grades to the pipe from hubs or from existing concrete curbs or sidewalks as an incidental part of this work.
- E. Use implements, tools and facilities satisfactory to the Engineer for the safe and convenient prosecution of the work. Carefully lower all pipe, fittings and valves into the trench using a derrick, rope or other tools or equipment, without damaging pipe materials and protective coatings and linings. Do not drop or dump materials into the trench.
- F. Take every precaution to prevent foreign material from entering the pipe as it is placed in the line. During laying operations, do not permit debris, tools, clothing or other materials to be placed in the pipe. At times when pipe laying is not in progress, close the open ends of the pipe using a watertight plug or other approved methods to prevent material entering the pipe.
- G. Place pipe bedding in the bottom of the trench meeting provisions of **SECTION 31 23 33 TRENCHING AND BACKFILL**. Voids may be left in the bedding material to remove pipe slings and for pipe bells to allow support along the full length of the pipe barrel.
- H. Long radius curves, either horizontal or vertical, may be laid with standard pipe with deflections at the joints where approved. If the pipe is shown curved on the plans and no special fittings are shown, assume that the curves can be made by deflection of the joints with standard lengths of pipe. If shorter lengths are required, the plan will indicate maximum lengths that can be used.

- I. The Contractor shall determine the method of deflection or curving where required but not specified, methods shall not cause pipe to deflect in a manner that exceeds manufacturers recommendations. Additional payment will not be made for laying pipe on planned curves, nor for field changes involving standard pipe lengths deflected at the joints.
- J. Do not exceed the applicable material and joint Specifications of AWWA or the pipe manufacturer's recommendations at pipe joints for various types of pipe. When rubber gasketed pipe is laid on a curve, joint the pipe in a straight alignment and then deflect to the curved alignment. Excavate trenches to accommodate deflections and curves.
- K. Thrust blocking for tees, plugs, valves, reducers, caps and bends deflecting 22 1/2 - degree or more shall be furnished and installed in accordance with the provisions of **SECTION 31 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- L. Cut pipe for inserting valves, fittings or closure pieces in a neat and workmanlike manner without damaging the pipe or coating and leaving a smooth end at right angles to the pipe axis. Do not cut pipe using an oxyacetylene torch.
- M. **Technical Provisions**
 - 1. Reserved
 - 2. Reference **SECTION 33 05 07.13 UTILITY DIRECTIONAL DRILLING** for specifications on trenchless pipe installation.
 - 3. Steel Pipe and accompanying fittings shall be installed satisfying AWWA C604 and AWWA M11 respectively.

33.3.05 PIPE JOINTING

- A. Bell and Spigot Joints / Rubber Gasket "Push-On" Joints
 - 1. Follow the manufacturer's recommendations for jointing of pipe and fittings with a rubber gasket, "push-on" type. Wipe the rubber gasket and gasket seat inside the bell clean with a cloth. Wipe the plain end of the adjoining pipe clean, lubricate and insert into the bell to make contact with the gasket. Force the plain end "home" using a crow bar, fork tool, or jack assembly.
- B. Fusion Joints
 - 1. Fusion joints for fusible polyvinyl chloride pipe (FPVC), when specified, shall be in accordance with **SECTION 33 05 31.19 FUSIBLE POLYVINYL CHLORIDE PIPE** of these Specifications.
- C. Mechanical Joints
 - 1. Torque specifications for the mechanical joints shall be per the manufacturers recommendations as indicated on the data sheet.
 - 2. Apply the torque loads with torque measuring or indicating wrenches, or apply using regular socket wrenches, checked with torque wrenches.
 - 3. If the joint is not sealed using the maximum torque indicated above, disassemble and re assemble the joint after thorough cleaning. Do not over torque bolts. Anti-seize compound shall be applied to each bolt in accordance with the manufacturer's recommendations.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Pipe sections to be fitted with mechanical joint restraints shall be specified on the plans.
 - 3. Restrain all dead-end valves and/or caps to the last full section of pipe, or as shown on the Drawings.

4. For a water/sewer pressure main that is not part of a fully restrained system, joints found within the distances specified in the following table shall be fully restrained either side of the designated fitting, unless otherwise approved by the Owner/Engineer.
 - a. Joint restraints shall be installed per the manufacturer's recommendations based on Contractor verified field conditions.
 - b. All joints within the calculated length must be restrained.
 - c. If your distance between fittings is less than or equal to the calculated restraint length, restrain all joints between those fittings.

Pressure Main Nominal Diam. (IN)	Fitting Type							Restrained Length (FT)
	11.25°	22.5°	45°	90°	Tee	Valve	Cap	
14	3	6	12	28	32	60	60	
16	4	7	13	31	39	67	67	
18	4	7	15	35	46	74	74	

- a. Calculations are based on the following design criteria:
 - i. PVC pipe type, 7 – feet depth of bury, Safety Factor – 1, Soil Class – CL, trench type 3, 200 psi test pressure, and a horizontal alignment.
 - ii. Tee fitting calculations are assuming main branch and lateral are of the same nominal pipe size.
 - iii. <https://rlc.ebaa.com/calculator.php>
5. Flanged joints shall meet AWWA C207.
6. All steel pipe shall be joined by weld in accordance with AWWA C206.
7. Steel Pipe and accompanying fittings shall be installed satisfying AWWA 604 and AWWA M11 respectively.

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

PART 1 GENERAL

33.1.01 DESCRIPTION

- A. This Specification includes the installation of all water utility distribution valves, hydrants, and appurtenant equipment and all work included thereto as shown on the Drawings and specified herein.
- B. References made to ASTM, ANSI, AWWA, USASI or AASHTO designations shall be the latest revision at the time of call for bids; all specified material included herein shall conform to these standards where such standards exist.
- C. Furnish a manufacturer's certification covering all pipe and fittings furnished, certifying that the pipe and fittings meet applicable Specifications.

33.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 - AWWA C104 Ductile Iron Cement-Mortar Lining
 - AWWA C105 Polyethylene Encasement for Ductile-Iron Pipe Systems
 - AWWA C110 Ductile Iron Fittings
 - AWWA C111 Ductile Iron Joints
 - AWWA C151 Ductile Iron Pipe
 - AWWA C153 Ductile Iron Compact Fittings
 - AWWA C500 Gate Valves
 - AWWA C502 Fire Hydrants
 - AWWA C504 Butterfly Valves
 - AWWA C507 Ball Valves
 - AWWA C509 Gate Valves
 - AWWS C515 Reduced-Wall, Resilient Seated Gate Valves for Water Service
 - AWWA C550 Protective Interior Coatings for Valves and Hydrants
 - AWWA C900 PVC Water Main Pipe
 - ASTM A48 Gray Iron Castings
 - ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - ASTM A536 Ductile Iron Castings
 - ANSI/NSF 61 Municipal Drinking Water System Components

33.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of Related Work are specified and included in other sections of these Specifications.
 - SECTION 31 05 00 COMMON WORK RESULTS FOR EARTHWORK**
 - SECTION 31 23 33 TRENCHING AND BACKFILLING**
 - SECTION 33 01 12 INSPECTING AND TESTING OF WATER UTILITIES**
 - SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES**
 - SECTION 33 05 97.26 UTILITY DETECTABLE MARKINGS**
 - SECTION 33 14 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING**

33.1.04 SUBMITTALS

- A. Shop drawings shall be submitted for valves, hydrants and other appurtenances and shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS.**

C. **Technical Provisions**

1. Reserved

33.1.05 TESTING

- A. Testing, Filling, Flushing, and Disinfecting of all water mains/services and associated pipe and appurtenances shall be performed in accordance with the provisions of **SECTION 33 01 12 INSPECTION AND TESTING OF WATER UTILITIES** of these Specifications.

B. **Technical Provisions**

1. Reserved

PART 2 PRODUCTS

33.2.01 GENERAL

- A. Refer to Related Work sections for applicable product details if not included herein.
- B. Flanged pipe and fittings shall not be used for buried lines unless noted otherwise on the Drawings.

C. **Technical Provisions**

1. Reserved
2. All valves shall be equipped with thrust blocking in accordance with the provisions of **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications.

33.2.02 GATE VALVES

- A. Gate valves shall be iron body, resilient-seated or double disc conforming to pressure rating specified in AWWA Standard C509 or C500.
- B. Assure stem seals are double "O" ring seals capable or replacing the seal above the stem collar with the valve under pressure in full open position.
- C. All gate valves shall be flanged with 2-inch operating nut; or dimensions meeting the municipal body's current standards, and shall be opened by turning counter-clockwise.
- D. Gate valves shall have a non-rising stem and shall have a clear waterway opening equal to the full nominal diameter of the valve.
- E. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.
- F. Each valve shall have the maker's monogram or initials, pressure rating and year of manufacturer cast on the body.

G. **Technical Provisions**

1. Reserved
2. Gate Valves shall be as manufactured by:
 - a. Mueller, or approved equal
3. Gate valves shall have a fusion bonded epoxy (FBE) exterior coating and interior coating in accordance with AWWA C550.
4. Pressure rating for Gate Valves as specified in part A, of this subsection, shall be pressure rated per AWWA C509/C515.
5. Handwheels and visual position indicators shall be provided as indicated on the drawings.
6. The electronically actuated gate valve at the Fish Hatchery shall seamlessly integrate into the existing Fish Hatchery controls system operated and maintained by Johnson Controls. The contractor shall coordinate with Johnson Controls to ensure that the valve will integrate

with the existing system and that coordination shall be incidental to the installation of the valve.

33.2.03 BUTTERFLY VALVES

- A. All butterfly valves shall be manufactured in accordance with AWWA C504 for Class 250 service.
- B. Valve bodies shall be constructed of cast iron ASTM A-126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness.
- C. Furnish performance certification, leakage and hydrostatic tests as specified in AWWA C504. Manufacturer must have at least five (5) years' experience manufacturing waterworks and distribution valves.
- D. Butterfly valves shall have mechanical joint ends and lubricated screw type operators designed for underground bury.
- E. Valve seat rubber shall be replaceable without disassembling the valve and not interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping instead of bonding to the valve body.
- F. Valve shafts shall be 18-8 type 304 stainless steel conforming to ASTM A-276.
 - 1. Shaft seals shall be standard self-adjusting and permanent.
 - 2. Shaft seals shall be of a design allowing replacement without removing the valve shaft.
- G. All direct bury butterfly valves shall be furnished with valve actuators.
 - 1. Valve actuators shall be permanently lubricated, screw type, totally enclosed and watertight.
 - 2. The actuator shall have overload protection allowing 450 foot-lbs input torque at full-open and full-closed positions without damaging the operator or valve..
 - 3. The traveling nut shall engage alignment grooves in the housing.
 - 4. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.
- H. Valve bearings shall be sleeve type that are corrosion resistant and self-lubricating.
 - 1. Furnished with a 2 – inch operating nut and valve box for operating the valve. Valve shall be opened by turning counter-clockwise.
 - 2. The actuators shall be suitable for submerged or buried service.
- I. Valve discs shall be made from cast iron ASTM A-126 Class B or ASTM A-48 Class 40 in sizes 24 - inch and smaller.
 - 1. Sizes 30" and larger shall be built from ductile iron in conformance to ASTM A-536.
 - 2. Disc shall be furnished with 316 stainless steel seating edge to mate with the rubber seat on the body.
- J. **Technical Provisions**
 - 1. Reserved
 - 2. Butterfly valves shall be as manufactured by:
 - a. Lineseal XP as manufactured by Mueller or approved equal.
 - 3. Butterfly valves shall have a fusion bonded epoxy (FBE) exterior coating.
 - 4. Butterfly valves with electric operators shall be provided for the 14" butterfly valve in control building and 18" butterfly valve in the flattop manhole.

33.2.04 VALVE BOXES

- A. Valve boxes for gate valves and plug valves shall be three piece cast iron, adjustable screw type valve box, with a 5 1/4 - inch shaft diameter.
- B. The bottom part of the box shall have a bell conforming to the perimeter of the valve.
- C. Valve box shall be of sufficient length for the pipe bury.
- D. Valve box castings shall be hot coated inside and outside with a rust resisting coating.
- E. Covers shall be provided with slots for easy and quick removal, and have an arrow indicating the opening direction.
- F. Covers shall be unlabeled with the exception of valves on potable water lines which have the word "WATER" cast onto the lid.
- G. The valve box covers shall be extra deep and fit the valve box snugly to prevent rattles or tipping due to traffic.
- H. Assure that valve box and corresponding valve nut set true vertical and demonstrate to the Engineer's satisfaction that the key may be placed easily on the nut without interference from the valve box walls. If key does not easily fit to the nut, excavate, reset the box, and if necessary the valve, and repeat the test.
- I. **Technical Provisions**
 - 1. Reserved
 - 2. Valve Boxes shall be manufactured by:
 - a. Sigma, Tyler or approved equal
 - 3. All valve boxes as specified in this subsection shall be furnished with a 2" valve box riser as furnished by Trumbull, or approved equal.
 - 4. Valve box type as specified in part A of this subsection, shall be of the buffalo type (screw).
 - 5. Depth of cover and valve box length will vary along the project. Contractor shall have on hand variable lengths and extensions in order to complete the Work.

33.2.05 VALVED TAPPING SLEEVE

- A. Gray iron or ductile iron, split sleeve, mechanical joint type with end and side gaskets.
- B. Split-body type with circular gasket forming a seal around the circumference of the outlet.
 - 1. For the use of split- body sleeves assure that the body length of the sleeve meets the minimum requirement of the pipe manufacturer.
- C. Assure both types have a class 125, ANSI B16.1 outlet flange, are rated for a minimum 150 psi working pressure and contain a threaded test plug on the neck or body of the tapping sleeve. Assure gaskets are manufacturers' standard for use in potable water systems. Use Cor-Ten or stainless steel bolts and nuts. Assure mechanical joint type is fusion-bonded, 12 mil thick epoxy coated. Limit the use of mechanical joint type to metal pipe. Assure tapping valves meet the applicable requirements for gate valves, with flanged inlets compatible with the flange of the tapping sleeve and push-on or mechanical joint outlet.
- D. **Technical Provisions**
 - 1. Reserved
 - 2. Valved tapping sleeves will not be required for this project.

33.2.06 FIRE HYDRANTS

- A. Fire Hydrants shall meet or exceed ANSI/AWWA C502, "Standard Specifications for Fire Hydrants for Ordinary Water Works Service" latest revision.
- B. Rated working pressure shall be 250 psi, test pressure shall be 500 psi, and hydrants shall include the following specific design criteria: the nozzle section, upper and lower stand pipes, and hydrant base shall be ductile iron.

- C. The valve opening diameter shall be 5 ¼ -inches for all 6 inch pipe connections, and 6-inches for 8-inch pipe connections. The bronze seat shall be threaded into mating threads of bronze for easy field repair. Bolting below-grade shall be stainless steel.
- D. The hydrants shall be equipped with two (2) two and one-half (2 ½) inch inside diameter hose connections with seven and one-half (7 ½) threads per inch and one meeting ASA Specification B26 for National Standard Fire Hose Coupling Screws. (1) four and one-half (4 ½) inch inside diameter pumper connection with four (4) threads per inch, or threads matching the Owner's existing pattern. Hydrants shall have mechanical, flanged or push-on inlet, joint connections with stainless steel nuts and bolts. Hydrants shall include nozzle chains.
- E. Hydrants shall be furnished with a National Standard operating nut, opened by turning counter clockwise, and have an arrow on top of the hydrant designating the opening direction.
- F. The main valve closure shall be of the compression type; opening against the pressure and closing with the pressure, include both a safety flange and safety stem coupling designed so that the removal/replacement of all working parts can be accomplished without excavating or turning off the water. The safety flange bolts shall be located above the final grade per the manufacturer's recommendation and the bury line indicated on the stand pipe. Nozzle section to be designed for easy 360 degree rotation by the loosening of no more than four bolts.
- G. Hydrants shall be of the dry-top, dry-barrel design, two (2) or more "O"-rings shall be furnished to help keep operating mechanism lubricated and protected from line fluid and from the weather. Hydrant operating threads to be automatically lubricated, via a sealed self-contained lubricating reservoir.
- H. The draining system of the hydrant shall be bronze and be positively activated by the main operating rod. Hydrant to be furnished with a bronze drain valve. Drain valves made of rubber, plastic or leather will not be allowed. Hydrant must have an internal travel stop nut located in the top housing of the hydrant.
- I. External surfaces above grade shall be factory coated and catalyzed two-part epoxy primer and polyurethane top coating and painted per the Owner's standards. Below grade surfaces shall be wrapped in polyethylene encasement conforming to the requirements of AWWA C105.
- J. **Technical Provisions**
 - 1. Reserved
 - 2. Fire hydrants will not be required for this project.

33.2.07 FLUSHING & BLOW-OFF HYDRANTS

- A. Flushing and blow-off hydrants shall meet or exceed ANSI/AWWA C502 latest revision.
- B. Rated working pressure shall be 250 psi, test pressure shall be 500 psi, and flushing and blow-off hydrants shall include the following specific design criteria: the nozzle section, upper and lower barrel sections, and hydrant shoe shall be ductile iron.
- C. Hydrants shoes shall be mechanical joint, unless otherwise specified.
- D. The main valve closure shall be of the compression type; opening against the pressure and closing with the pressure.
 - 1. The main valve opening diameter shall be 5 ¼ -inches, unless otherwise specified.
- E. The hydrants shall be equipped with two (2) two and one-half (2 ½) inch inside diameter hose connections and one (1) four and one-half (4 ½) inch inside diameter pumper connection.
- F. Hydrants shall be of the flush-type, dry-barrel design, furnished with dual bronze drain valves for barrel drainage.
- G. Hydrants shall be furnished with a cast iron flush box and lid meeting or exceeding ASTM A126 CL.B.
- H. **Technical Provisions**
 - 1. Reserved

2. Flushing and/or blow-off hydrants will not be required for this project.

PART 3 EXECUTION

33.3.01 GENERAL

- A. Wrap all direct bury cast iron pipe and fittings including hydrants, valve boxes, and other metal parts and surfaces in polyethylene encasement.
- B. For related general pipe and appurtenance information, refer to the provisions of **SECTION 33 14 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING** of these Specifications.
- C. Trenching and Excavation shall be performed in accordance with the provisions of **SECTION 31 23 33 TRENCHING AND BACKFILL** of these Specifications.
- D. **Technical Provisions**
 - 1. None

33.3.02 VALVES

- A. Set and joint gate valves, butterfly valves, and plug valves to the pipe as specified for pipe laying and jointing. Set valves with operating nut vertical. Center and plumb valve boxes over the operating nut to prevent shock or stress being transmitted to the valve.
- B. Valve Boxes
 - 1. Center and plumb valve boxes over the valve operating nut. Set valve box tops flush with the ground surface or street surfacing.
 - 2. Place bedding gravel around all water main valves and under the valve box bottom to drain any water entering the valve box.
 - 3. When specified, install valves with thrust blocks and anchor rods meeting minimum requirements as lined out in **SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES** of these Specifications, verify with Engineer if rebar is required.
- C. **Technical Provisions**
 - 1. Reserved

33.3.03 FIRE, FLUSHING, AND BLOW-OFF HYDRANTS

- A. Set all hydrants plumb with the pumper nozzle facing the street. Set the hydrant with the ground line at the location indicated by the hydrant manufacturer.
- B. Provide drainage at the hydrant base by placing clean gravel as specified above. Brace the hydrant against unexcavated earth at the trench end with concrete backing as detailed on the plans. Furnish hydrants with the specified gate valves.
- C. All hydrants, flushing and/or fire hydrants shall be furnished with an auxiliary valve meeting the size of the hydrant lead specified.
- D. The depth of earth cover over the connecting pipe shall be not less than six and one-half (6 1/2) feet. The hydrant nozzle shall be no less than two and one-half (2 1/2) feet above the final grade. The Contractor shall supply necessary extensions which will be incidental to hydrant unit price. Hydrant drain area shall be surrounded by 10 cubic feet of washed gravel meeting the following Specifications.

<u>Sieve Opening</u>	<u>% Passing</u>
3 Inch	100
No. 4	0-25
No. 8	0-10

- E. Scoria will not be permitted for use as any aggregate material. Washed gravel shall be placed at least 6 - inches below, 1 foot on all sides of the hydrant, and 6 inches above the drain hole so that the hydrant will readily take up all water from the drip valves. Hydrants shall be set on a concrete

pad 6 - inches thick and 18 inches square. Weep holes shall be located above the seasonal ground water table.

F. **Technical Provisions**

1. Reserved

END OF SECTION

PAGE LEFT BLANK INTENTIONALLY

FORT PECK FISH HATCHERY WATER SUPPLY

FORT PECK, MONTANA

DIVISION 40 PROCESS INTERCONNECTIONS

TABLE OF CONTENTS

DIVISION 40 – PROCESS INTERCONNECTIONS

SECTION	DOCUMENT
40 05 00	Common Work Results for Process Interconnections
40 05 78.13	Air-Vacuum Valves for Water Service
40 23 36	Potable Water Process Piping
40 42 13	Process Piping Insulation
40 71 13	Magnetic Flow Meters
40 73 13	Pressure and Differential Pressure Gauges

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes work common to process piping and all work included thereto as shown on the Drawings and specified herein.

40.1.02 REFERENCES

- A. The current publications listed below form a part of this Specification.
- B. Standards
 AWWA C651 Disinfecting Water Mains

40.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 40 05 78.13	AIR-VACUUM VALVES FOR WATER SERVICE
SECTION 40 23 23	POTABLE WATER PROCESS PIPING
SECTION 40 42 13	POTABLE PIPING INSULATION
SECTION 40 71 13	MAGNETIC FLOW METERS
SECTION 40 73 13	PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 2 PRODUCTS

40.2.01 CHLORINE

- A. Any of the following forms of chlorine can be used for the disinfection of potable water and water treatment process lines subject to the approval of the Owner's Representative.
- Liquid Chlorine
 - Sodium Hypochlorite
 - Calcium Hypochlorite
- B. The chlorine compounds should be added to an amount that will produce a solution of 50 to 100 mg/L of available chlorine.
- C. The following table indicates the amount of calcium hypochlorite that should be added for the respective length of pipe shown to furnish a resulting solution of 50 to 100 parts per million of free chlorine.

Pipe Diameter Inches	Ounces of Granular Calcium Hypochlorite per 500 feet of pipe	No. of 5 gram Hypochlorite Tablets per 20 feet of pipe
4	0.5	1
6	1.0	1
8	2.0	2
10	3.0	3
12	4.0	4
16	8.0	7
20	8.0	10
24	8.0	14
30	8.0	22
36	8.0	32
42	8.0	43
48	8.0	56

PART 3 EXECUTION

40.3.01 GENERAL

- A. Alignment
 - 1. Process pipe, fittings and valves must be installed to the lines and grades shown on the Drawings and as specified herein.
- B. Inspection
 - 1. The Contractor shall inspect all pipe fittings and appurtenances for damage and defects when the materials are unloaded.
 - 2. The Contractor shall also inspect these materials when they are installed to detect any damage, which may have occurred due to handling.
 - 3. Particular attention shall be given to jointing surfaces.
 - 4. All defective or damaged materials must be promptly removed from the site by the Contractor.

40.3.02 INSTALLATION

- A. All foreign matter or dirt must be removed from the inside of the pipe and fittings before they are lowered into position, and they shall be kept clean by approved means during and after laying.
- B. The pipe materials must be carefully placed into position by the use of suitable restraining devices.
- C. At all times when pipe installation is not in progress, including lunch breaks and overnight periods, all open ends of the pipe line must be closed by watertight plugs or other means approved by the Owner's Representative.
- D. When connecting to existing pipes, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.
 - 1. All necessary work to make the connection will be included in the price bid for the pipe line and no additional compensation shall be made therefor.

40.3.03 ALIGNMENT AND LENGTHS

- A. The cutting of pipe for inserting valves, fittings or closure pieces must be done in a neat and workmanlike manner without damage to the pipe and so as to leave a smooth square-cut end.
 - 1. Pipe must be cut with approved mechanical cutters.
 - 2. The electric-arc cutting method, using carbon or steel rod, will be approved for use on larger size ductile or gray pipe where mechanical cutters are not available.
 - 3. Flame cutting will not be allowed under any conditions.
 - 4. All rough edges must be removed from the cut ends of pipe and, where rubber gasket joints are used; the outer edge must be rounded or beveled by grinding or filing to produce a smooth fit.
- B. Connection and assembly of joints must be accomplished during the setting, aligning, and fitting operations.

40.3.04 PIPE SUPPORTS

- A. The movement of all plugs, caps, tees, bends, and other thrust points must be prevented by attachment of suitable restraining devices, in accordance with the requirements of the Drawings or specified herein.

- B. Pipes, fittings and valves must be supported as shown on the Drawings subject to the minimum saddle sizes and support spacing as follows:

Pipe Size Inches	Maximum Support Spacing Feet	Minimum Saddle Length Parallel to Centerline of Pipe Inches
4	12	2
6	16	2
8	18.5	2 1/2
10	19.5	2 1/2
12	20	3
14	20	3
16	20	3 1/2
18	20	3 1/2
20	20	4
24	20	4 1/2
30	20	5 1/2
36	20	6 1/2
42	20	7 1/2
48	20	8 1/2

- C. Pipe supports must be furnished at the bottom of all pipe sections that are not horizontal.

40.3.05 PAINTING

- A. Pipe valves and fittings not required to be coated with fusion-bonded epoxy must be factory primed with a primer that is compatible with intermediate and topcoat specified herein.
- B. Pipe, fittings and valves must be field painted. Coating products and process to be approved by Engineer.

40.3.06 JOINTS

- A. Where connections are to be made to existing pipes, the Contractor shall verify the necessary dimensions required for all fittings and appurtenances.
- B. No pipeline shall be removed from service as may be necessary for making a connection until the proper measurements have been taken and the Contractor has verified that all necessary and properly sized fittings, valves and appurtenances are on hand.
- C. All surfaces of the joints, including gaskets, must be thoroughly cleaned to remove all oil, dirt, grit or other foreign matter before any joint lubricant is applied.

40.3.07 TESTING

- A. Each valved section will be subjected to the pressure and leakage tests prescribed herein.
- The Contractor shall furnish the pump, pipe connections, gauges, measuring equipment and shall perform the testing under the direct observation of the Owner's Representative.
 - Where permanent air vents are not provided, the Contractor shall provide and install corporation stops at the high points as needed for release of air as the line is filled with water.
- B. At the option of the Owner's Representative, the pressure and leakage tests may be conducted simultaneously.
- C. Any defective joints, and any defective pipe, fittings, valves or hydrants, revealed during the testing or before final acceptance of the work must be satisfactorily corrected and the tests must be repeated until the specified requirements have been met.
- D. General Requirements
- The Contractor shall fill the pipe and expel all air through connections, air release valves or Contractor furnished corporation stops installed at high points.

2. The working pressure is the maximum sustained operating pressure in the line being tested.
 3. In no event must the test pressure exceed the pressure rating of pipes, fittings, valves, thrust restraints or other appurtenances.
- E. Pressure Test
1. The section being tested must be slowly filled with water and the specified test pressure must be applied, after all the air has been expelled from the pipe.
 2. A hydrostatic pressure of not less than the greater of the value shown in **Schedule 40 05 00 – A** or 150% of the working pressure, measured at the point test, must be applied by means of a pump connected to the pipe in a satisfactory manner.
 3. The specified pressure must be held for the minimum duration shown in **Schedule 40 05 00 – A**.
 4. No drop in pressure will be allowed.
- F. Leakage Test
1. After satisfactory completion of the pressure test, a leakage test must be performed on each valved section of the pipe to determine the quantity of water that must be supplied into the section to maintain a test pressure of equal to the greater of the test pressure shown in **Schedule 40 05 00 – A** or 150% of the working pressure, after the air in the pipeline has been expelled and the pipe has been filled with water.
 2. After filling the pipe with water and expelling all air in the line, the specified pressure must be applied in the same manner as prescribed for the pressure test, and sufficient water must be measured and supplied into the pipe section to maintain the pressure for the test duration shown in **Schedule 40 05 00 – A**.
- G. The costs of furnishing all labor, materials, water, and equipment necessary for the testing of water lines will be included in the price bid for the pipeline and no additional compensation shall be made therefor.
- H. Process pipe tests may be conducted at the same time as adjacent utility pipes if the time and pressure requirements are the same.

40.3.08

DISINFECTION

- A. Acceptance
1. Each unit of completed potable water line must be disinfected with chlorine before acceptance.
 2. Each unit of completed potable water line or water treatment process line must be disinfected with chlorine before being placed into service as determined by the Owner's Representative.
- B. Standards
1. Disinfection must be accomplished as described in the system prescribed by the American Water Works Association Standard C651.
 - a. The Contractor shall provide a copy of AWWA standard C651 to the Owner's Representative if this system of disinfection is used.
 - b. The copy of the standard must be returned to the Contractor upon completion of the disinfection and testing.
 2. After the final flushing, the water must be tested for bacteriological quality to verify conformance with the standards prescribed by the State Department of Health.
- C. Cost
1. The cost of disinfection and bacteriological testing will be included in the price bid for the water line and no additional compensation will be made therefor.

D. Preliminary Flushing

1. The main must be flushed prior to disinfection except when dry chlorine compounds are placed in piping at the time of jointing.
2. If no hydrant is installed at the end of the main, a tap must be provided large enough to affect a velocity in the main of at least 2.5 fps.
3. Flushing at the outlet must be continued until the comparison of samples show no further improvements in color and turbidity.

40.3.09 **CLEANUP**

- A. The Contractor shall maintain the work in a clean and orderly condition at all times.
- B. All surplus materials, rubbish and debris must be removed from the site.

SCHEDULE 40 05 00 – A
PROCESS PIPE TESTING

DESCRIPTION	TEST PRESSURE (PSI)	TEST DURATION (HOURS)		
		PRESSURE	LEAKAGE	COMBINED
D.I.P. Wastewater	350	1	2	2
D.I.P Potable Water	350	1	2	2
Steel Potable Water	350	1	2	2

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes the installation of all air release/vacuum valves (combination air valves), appurtenant equipment and all work included thereto as shown on the Plans and specified herein. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.

40.1.02 REFERENCES

- A. Reserved.

40.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 31 23 33 TRENCHING AND BACKFILLING

SECTION 33 05 00 COMMON WORK RESULTS FOR UTILITIES

SECTION 40 05 00 COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS

40.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for the combination air valves, vaults, and other appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**. As applicable for each valve type, the shop drawings shall include:
1. Specific detail regarding valve construction
 2. Specific detail regarding operation
 3. Copies of the certified listings from the National Sanitation Foundation (NSF) stating that all materials in contact with potable water meet the latest version of the American National Standards Institute (ANSI) Additives Standard No. 61 for indirect additives including Annex G
- B. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

40.2.01 VAULT ENCLOSURE

- A. The vault enclosure shall be constructed and installed as detailed in the plans and in accordance with **SECTION 33 05 61 CONCRETE MANHOLES**.

40.2.02 COMBINATION AIR VALVES

- A. Combination air valves shall be installed at the locations marked on the plans.
- B. Combination air valves shall be designed for use in water systems to allow large quantities of air to escape out the orifice when filling a pipeline, to admit air on shut-down, and to release air continuously during operation.
- C. The combination air valve shall be of the float operated, simple lever or compound lever design and capable of automatically releasing accumulated air from a fluid system while the system is pressurized and operating.
- D. An adjustable designed orifice button shall be used to seal the valve discharge port with drip-tight shut-off. The orifice diameter shall be sized for use within a given operating pressure range to insure maximum air venting capacity.
- E. Unless otherwise specified, the combination air valve inlet shall be 3.0 inch, and the outlet shall be 3.0 inch. Unless otherwise specified, the small orifice size shall be 5/64 to 3/32 inches. The combination air valve shall be rated for use in systems up to 165 psi.

- F. The combination air valves shall be contained in one housing, made of the following materials:
 - 1. Body: Cast Iron
 - 2. Float: Stainless Steel
 - 3. Internal Parts: Stainless Steel
 - 4. Seal: Buna-N Rubber
- G. The combination air valves shall be:
 - 1. Cla-Val Series 36
 - 2. Val-Matic VMC-201C

40.2.03 **ISOLATION VALVES**

- A. An isolation valve shall be placed between the pipeline and each combination air valve to allow removal of the valve for maintenance or replacement without de-pressurizing the pipe.
- B. The isolation valve shall include a handle and shall be installed so that the handle can be operated without any tools.
- C. Each isolation valve shall be of the same nominal diameter as the combination air valve it is connected to. No reducers shall be allowed on the combination air valve assembly.
- D. Isolation valves shall be certified by NSF to meet ANSI Standard 61 including Annex G.

40.2.04 **TAPPING SADDLE**

- A. Tapping saddles shall be one piece, three inch (3") nominal size outlet, two bolt, stainless steel service saddle with female iron pipe (FIP) size outlet for AWWA C900 or AWWA C909 PVC pipe. Tapping saddles shall be Mueller SS Series Double Stud, Ford Series FS313, or approved equal.

40.2.05 **VENT PIPING**

- A. Vent piping shall be constructed of stainless steel and shall be installed as shown on the drawings and shall include an aluminum double outlet vent.

PART 3 **EXECUTION**

40.3.01 **GENERAL**

- A. Construction requirements shall be in accordance with the provisions of **SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- B. Before installation, the Contractor shall carefully clean valves of all foreign material, adjust stuffing boxes, and inspect valves.
- C. Combination air valves shall be mounted in the vertical position on top of the pipeline with an isolation valve installed between the pipeline and the valve.
- D. Installation practices shall conform to the manufacturer's recommendations.

40.3.02 **DELIVERY STORAGE AND HANDLING**

- A. The Contractor shall unload and handle material with equipment of adequate capacity.
- B. The materials shall be stored on-site in reasonably level, well drained areas free from dense or tall vegetation.
- C. The materials shall be stored in such a manner that they may be safely inspected.

40.3.03 **TESTING**

- A. Valves shall be pressure tested at the same time that the adjacent pipeline is tested. Joints shall be watertight at test pressures before acceptance. The Contractor will be responsible for any damage caused by testing.

- B. The valves shall be disinfected with the adjacent piping. They shall be installed and operable during the disinfection testing.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes all work for the complete and satisfactory installation of potable water process piping, pipe supports and appurtenances as shown on the drawings and specified herein.

40.1.02 REFERENCES

- A. Reserved.

40.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of the Specifications:

SECTION 03 15 00 CONCRETE ACCESSORIES
SECTION 40 05 00 COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS

40.1.04 SUBMITTALS

- A. Shop drawings and operation and maintenance manuals shall be submitted for the equipment furnished in accordance with the **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Certification of inspection and testing of pipe shall be provided by the manufacturer.

PART 2 PRODUCTS

40.2.01 GENERAL

- A. Process piping shall be of the size and materials as shown on the drawings and as specified herein

40.2.02 DUCTILE IRON PIPE

- A. Ductile iron pipe shall conform to the requirements of AWWA C150 and ANSI A21.51 (AWWA C151).
- B. Flanged ductile iron pipe shall conform to ANSI A21.15 (AWWA C115).
- C. Ductile iron piping shall be pressure class 250.
- D. Piping shall be prime coated and painted.
- E. All iron piping and fittings beneath concrete slabs shall be encased in minimum 6" concrete.
- F. Flanged and mechanical joint fittings for use on ductile iron pipe shall be cast iron and shall be rated for 250 psi working pressure.
- G. All nuts, bolts and washers shall be stainless steel.
- H. Pipe shall be cement-mortar lined except where used for process air piping.
- I. The interior of process air piping shall be coated with a bituminous coating.

40.2.03 WELDED STEEL PIPE

- A. Steel pipe shall be fabricated from steel sheets and plates and coated in accordance with these Specifications and Standard Specifications of the American Water Works Association, latest revision as follows:
- B. Sheets shall conform to ASTM A415
- C. Plates shall conform to ASTM A283, Grade B or C
- D. AWWA Standard C207 for "Steel Pipe Flanges"
- E. The Plans show size and general arrangements of pipe and appurtenances.

- F. Responsibility for furnishing exact length of various sizes of pipe for proper make-up rests with the Contractor.
- G. The pipe shall be shop fabricated.
- H. All field welding shall be done in accordance with AWWA C206.
- I. Pipe shall be of sufficient wall thickness as designated by the manufacturer to withstand all internal and external forces on the design procedures set forth in AWWA M11.
- J. All steel pipe, fittings, and couplings shall be painted unless specified to be stainless steel.
- K. Steel pipe specials and fittings shall be of the same material and thickness as the adjacent steel pipe and shall have the type of end shown on the Plans for ductile iron pipe or as approved by the Engineer.
- L. Bends shall be smooth and segmented.
- M. Specials and fittings shall conform to all applicable provisions of AWWA Standard C208 or dimensions shown on the Plans.
- N. Specials and fittings shall be clearly marked to identify the location of each item.
- O. Steel pipe connections shall be grooved, flanged, or sleeve type couplings as shown on the Plans.
- P. Grooved couplings shall be in conformance with Federal Specifications QQ-I-666C, Grade II and shall be similar and equal to Victaulic or Aeroquip.
- Q. Flanges shall conform to ASA B16.1 Class 125.
- R. Blind flanges shall be installed where shown on the Plans.
- S. Sleeve-type couplings shall be Dresser Style 38 or 40 and shall be installed where shown on the Plans or as approved by the Engineer.
- T. Joint harnesses for sleeve type couplings shall be provided at each sleeve type coupling. Harness lugs and bolts shall be stainless steel.
- U. Joint harnesses shall be sized per AWWA M11 steel pipe manual for the pressure encountered.
- V. Pipe supports shall be designed and spaced in accordance with the design procedures recommended in AWWA M11.
- W. The pipe shall be fabricated and prepared by a manufacturer with at least five (5) years experience in the fabrication and coating of pipe similar to that specified.
- X. All pipe and fittings shall be installed satisfying AWWA 604 and AWWA M11.

40.2.04

FLANGED FITTINGS

- A. Flanged fittings shall be ductile iron conforming to the requirements of ANSI/AWWA-C110-/A21.10.
- B. Flanges shall be furnished faced and drilled to 125 pounds template.
- C. Flanged fittings shall be cement mortar lined and shall be Class 125 with a water working pressure of 250 psi.
- D. Flanged fittings for air piping shall not be cement mortar lined but the interior shall be coated with a bitumastic coating.
- E. Bolts, nuts and washers for fittings shall be stainless steel.

40.2.05 **PIPE HANGERS AND SUPPORTS**

- A. Pipe supports of the adjustable type shall be as manufactured by Eaton.
- B. Pipe hangers shall be of the adjustable clevis type and shall be as manufactured by Eaton.
 - 1. The following models shall be used for construction.
 - a. Eaton Fig B3090 pipe support with U-bolt.
 - b. Eaton Fig B3080 base stand.
 - c. Eaton Fig B1344 standard double bolt pipe clamp.
 - d. Eaton Fig 99 all threaded rod.
 - e. Eaton Fig B3200 weldless eye nut.
 - f. Eaton Fig B3086 clevis concrete plate.

40.2.06 **FLANGE ADAPTERS**

- A. Flange adapters or union flanges shall be fabricated from ductile iron conforming to the requirements of ASTM A536. The gasket shall be suitable for use in a municipal wastewater treatment facility.
- B. The flange adapter shall have flange bolt circles that are compatible with ANSI/AWWA C115/A21.15.
- C. Restraint for the flange adapter shall consist of plurality of individually actuated gripping wedges to maximize restraint capability.
- D. Torque-limiting actuating screws shall be used to insure proper initial set of the gripping wedges.
- E. The flange adapters shall have a pressure rating of 350 psi when used on ductile iron pipe.
- F. All wetted portions shall be coated with fusion bonded epoxy conforming to the requirements of ANSI/AWWA C213.
- G. Flange adapters shall be Series 2100 Megaflange as manufactured by EBAA Iron, Inc. or equal.

40.2.07 **FLEXIBLE COUPLINGS**

- A. Non-metallic flexible couplings shall be fabricated from neoprene and nylon bodies.
- B. Flanges shall be fabricated from stainless steel.
- C. Flanges shall be faced and drilled to a 125 lbs. template.
- D. Wire beads fabricated from spring steel shall be embedded in the body of the fitting at each end.
- E. The body shall have 2 corrugations.
 - 1. Arches shall be rounded or filled.
- F. Flexible couplings shall be Series M-S-2 molded rubber flexible couplings as manufactured by Twin City Hose, Inc., Flexicraft Industries, or equal.

40.2.08 **ANTI SEIZE COMPOUND**

- A. Anti-seize compound for use on stainless steel bolts shall be pure nickel Never-Seez by Bostik, or equal.

40.2.09 **PVC PIPE**

- A. PVC pipe shall be Schedule 80 pipe meeting the standards and specifications of ASTM D1785 and ASTM D1784.
- B. The pipe joints and fittings shall be mechanical connections.

40.2.10 **SMALL DIAMETER FLEXIBLE CONNECTORS**

- A. Small diameter flexible connectors shall have neoprene and nylon bodies and shall have galvanized 150 pound unions at each end.
- B. The union fitting for connection to the piping shall be female N.P.T.
- C. The small diameter flexible connectors shall be Model M-FUS-2 as manufactured by Twin City Hose, Inc., Flexicraft Industries, or equal.

40.2.11 SLEEVE TYPE CONNECTORS

- A. Sleeve type couplings for joining pipes to allow for thermal expansion and contraction shall be furnished and installed at the locations shown on the Plans.
- B. Tie bolts shall be provided at all sleeve type couplings to prevent the pipes from separating under pressure.
- C. All bolts shall be stainless steel.
- D. Sleeve type couplings shall be as manufactured by Dresser Industries, R. H. Baker, or equal.

40.2.12 MODULAR MECHANICAL SEALS

- A. Rubber modular mechanical seals shall be used to seal pipes to sleeves where shown on the Drawings.
- B. The modular mechanical seals shall be furnished with stainless steel bolts.
- C. Cast-in-place non-corroding sleeves shall be furnished for each penetration which requires a modular mechanical seal in accordance with the provisions of **SECTION 03 15 00 – CONCRETE ACCESSORIES**.
- D. Where the penetration is in a wall, floor or roof of a liquid containing structure, the sleeve shall include an integral waterstop.
- E. Modular mechanical seals shall be Innerlynx as manufactured by Advance Products & Systems, Link Seal as manufactured by PSI, or equal.

40.2.13 FLEXIBLE TUBING

- A. Flexible tubing shall be flexible nylon tubing.
- B. The tubing shall have a minimum working pressure of 250 psi at 72°F and a minimum burst pressure of 1000 psi at 73°F.
- C. The tubing shall be suitable for indoor and outdoor exposure and continuous exposure to temperatures ranging from -65°F to 200°F.
- D. The flexible nylon tubing shall be Parflex Nylon Tubing as manufactured by Parlor Hannifin Corporation, or equal.

PART 3 EXECUTION

40.3.01 GENERAL

- A. The installation of process piping and appurtenances as specified herein shall be in strict accordance with the manufacturer's recommendations.
- B. Pipe shall be supported so as not to impart any load onto valves, pumps or other equipment to which it is connected.
- C. The drawings show size and general arrangements of the piping system.
- D. Responsibility for furnishing exact length of pipe for proper make-up rests with the Contractor.
- E. Thrust restraint and supports, if shown on the Drawings, are the minimum requirements.
- F. Additional supports, hangers and means of thrust restraint may be required by the Engineer or to provide proper support for equipment.
- G. All flanged fittings which utilize flange adapters shall be restrained with tie rods or thrust blocking or a combination of both.
- H. Tie rods, washers and nuts shall be stainless steel.
- I. All pipe supports and thrust restraints shall be installed so that they are independent of all other pipes other than the pipe they support.
- J. Pipe supports and thrust restraints shall not be supported by or tied to other pipes.

- K. Stainless steel bolts and tie rods shall be treated with anti-seizing compound to reduce the potential for galling and seizing of the nut on the bolt.
- L. Flexible couplings shall be installed between the piping and equipment (e.g. pumps, presses, etc.). Flanges for each pipe connected to the equipment whether or not such couplings are shown on the Plans.
- M. Tapped openings and plugs shall be installed where shown on the Plans and as directed by the Engineer.

40.3.02 **PVC PIPE**

- A. Pipe shall be cut square with the axis, using a fine tooth hand saw and a miter box or a fine toothed power saw with a suitable guide.
- B. All burrs shall be removed with a knife, file, or abrasive paper.
- C. Surfaces to be joined shall be clean and free of moisture.
- D. Clean surfaces with a clean, dry cloth and PVC solvent.

40.3.03 **TESTING**

- A. Contractor shall provide pressure leakage tests for all new process piping as directed by the Owner's Representative and specified herein in **SECTION 40 05 00 – COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS**.
- B. Gauges, test pumps, test plugs, temporary thrust restraint and fittings necessary for leakage testing shall be furnished and installed by the Contractor.
- C. All tests performed for each section to be tested shall be witnessed and approved by the Owner's Representative before acceptance.
- D. In the event the Contractor performs any test without witness by the Owner's Representative, the Contractor shall retest the section again in conformance with these Specifications at no additional cost to the Owner.
- E. Testing Procedure
 - 1. Each section of process piping to be tested shall be slowly filled with water and the specified test pressure shall be applied by means of a pump connected to the piping.
 - 2. All air shall be expelled from the section of piping being tested prior to the application of pressure.
 - 3. The test pressure shall be taken as 150% of the normal operating pressure of the line, not to exceed the water working pressure of the line.
 - 4. The test pressure shall be maintained for no less than 2 hours.
 - 5. Leakage shall be determined by measuring the quantity of water added to the tested pipe as necessary to maintain the specified test pressure.
- F. Leakage Allowance
 - 1. Buried or concealed process piping shall not be accepted unless the leakage is less than 11.6 gallons per inch diameter per mile of pipe per 24 hours unless noted otherwise on the Plans.
 - 2. Interior process piping shall not be accepted unless there is no leakage during the test period.

40.3.04 **DISINFECTION**

- A. All potable water process piping and potable water lines shall be disinfected in accordance with the provisions of **SECTION 40 05 00 – COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS** of these Specifications.

40.3.05 **PAINTING**

- A. All piping and supports shall be painted.
- B. Piping shall be color coded as per **SCHEDULE 40 23 23** at the end of this section.
- C. All piping shall have affixed to it identification and flow direction markers.
- D. Markers shall conform to ANSI and OSHA requirements for marker size, color, legend size and legend color.
- E. Each pipe shall be labeled with at least 2 markers in each room, crawl space or area.
- F. Chemical piping shall be marked at intervals not to exceed 8 feet in addition to the foregoing requirements.

SCHEDULE 40 23 23
PIPE COLOR SCHEDULE

MATERIAL CARRIED	COLOR	MATERIAL CARRIED	COLOR
Raw or Recycle Water	Olive Green	Fluoride	Yellow w/ Violet Band
Settled or Clarified Water	Aqua	Lime Slurry	Light Green
Finished or Potable Water	Dark Blue	Phosphate Compounds	Light Green w/ Red Band
Backwash Waste	Light Brown	Gas	Red
Sewer	Dark Gray		
Compressed Air	Dark Green		
Chlorine (Gas and Solution)	Yellow		

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes all work included to the complete and satisfactory installation and pipe insulation and appurtenance as shown on the Drawings and specified herein.

40.1.02 REFERENCES

- A. Reserved.

40.1.03 RELATED WORK SPECIFIED ELSEWHERE:

- A. The following items of related work are specified and included in other sections of the Specifications:

SECTION 40 05 00 COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS

40.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for the insulation furnished in accordance with the **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

40.2.01 BURIED PIPE: RIGID INSULATION

- A. Rigid insulation shall be Styrofoam SM as manufactured by the Dow Chemical Company, or equal.
- B. The insulation shall be a closed cell extruded polystyrene foam insulation.
- C. The insulation shall have a high-density smooth extruded surface with square edges.
- D. The minimum five-year aged Thermal Resistance (R-Value) of the rigid insulation shall be 5.0 per inch nominal thickness based on a mean temperature of 75 degrees Fahrenheit.
- E. The maximum water absorption shall be 0.3% by volume when tested in accordance with ASTM C272.
- F. The typical compressive strength will be 40 PSI with a minimum strength of 25 PSI when tested in the vertical direction in accordance with ASTM D1621.
- G. The maximum water vapor performance for 1.0-inch thickness shall be 1.0 perm when tested in accordance with ASTM E96.

40.2.02 ABOVE GRADE PIPE INSULATION

- A. 3" thick polyisocyanurate foam insulation exterior pipe.
- B. The insulation shall be covered with a 0.016 inch thick aluminum roll jacket with 3/16" corrugations.
- C. The insulation shall be
1. Trymer 2000 Polyisocyanurate Foam Insulation by Dow Chemical Company,
 2. Trymer 210 by Upjohn Company
 3. Or equal.
- D. Lengths, joint seals, and joining methods shall be per manufacturer's recommendations.
- E. The aluminum roll jacket shall be as manufactured by Childers, or equal.

PART 3 EXECUTION

40.3.01 GENERAL

- A. Rigid insulation shall be installed according to the manufacturer's recommendations around all buried pipe with less than 7 feet of cover.

- B. All steel piping and fittings shown on drawings shall be insulated in accordance with the insulation manufacturer's recommendations

40.3.02 **HEAT TAPE**

- A. NOT USED

END OF SECTION

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes flow meters and appurtenances.

40.1.02 REFERENCES

- A. Reserved.

40.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of the Specifications:

SECTION 40 05 00 COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS

40.1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted for the equipment furnished in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Operation and maintenance manuals shall be submitted for the equipment furnished in accordance with the **GENERAL CONDITIONS**.
- C. Copies of the certified listings for all potable water meters from the National Sanitation Foundation (NSF) stating that all materials in contact with potable water meet the latest version of the American National Standards Institute (ANSI) Additives Standard No. 61 for indirect additives including Annex G shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

40.1.05 QUALITY ASSURANCE

- A. Materials and equipment specified herein are intended to establish a standard for the necessary and desired type of flow meters.
- B. Products of another manufacturer will be considered if, in the opinion of the Engineer, these products meet or exceed the type and quality of the specified equipment and will meet the operational requirements of the system as a whole.
- C. Products of manufacturers not specified herein must be submitted for prior approval in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

40.2.01 GENERAL

- A. Flow meters shall be furnished and installed at the locations shown on the Drawings. The size of the meters shall be as shown in the Drawings.

40.2.02 MAGNETIC FLOW METER WITH MICROPROCESSOR CONVERTER

- A. The magnetic flow meter shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional to and linear with the liquid flow rate.
1. The meter shall be designed for operation on 120 VAC, +10%, 60 Hz, +5 watts per inch of diameter for larger sizes.
 2. The magnetic flow meters shall be Emerson Rosemount Model 8705 with an 8712 transmitter, Endress Hauser series 33, or approved equal.
- B. The metering tubes for sizes 1/10" through 12" shall be constructed of stainless steel.
1. For sizes 14" and larger, the tubes shall be constructed of steel.
 2. All magnetic flow meters shall be designed to mount directly in the pipe between ANSI Class 150 flanges through 24" and AWWA flanges in sizes 30" and larger.

3. Meters 1/10" through 4" shall be the wafer design. Sizes 6" and larger shall consist of a flanged pipe spool piece.
 4. Laying length of meters 14" and larger shall be 1½ times the nominal meter size.
 5. Meters 4" and smaller shall be lined with polyurethane liners and be supplied with 316 stainless steel electrodes. Meters 6" and larger shall have polyurethane liners and 316 stainless steel or zirconium electrodes.
- C. The signal converter portion of the magnetic flow meter shall include both a magnet driver to power the magnet coils and the signal converter electronics.
1. The signal converter shall be integrally or remotely mounted as specified in the Functional Description or as shown on the Drawings.
 2. It shall be housed in a NEMA 4 die cast aluminum case.
 3. When remotely mounted, the interconnecting cable shall be supplied with the meter.
 4. Signal converters shall be identical and interchangeable for all meter sizes.
 5. When integrally mounted, the converter shall include a separate customer connection section to isolate the electronics compartment and protect the electronics from the environment.
 6. A separate terminal strip for power connection shall be supplied.
- D. The electronics shall be of the solid state, feedback type, utilize integrated circuitry, and be microprocessor controlled.
1. All operational parameters shall be user configurable locally via an integral keypad or via a remote intelligent terminal.
 2. All changes to the database shall be by entry of numerical values, i.e. the range setting, or selectable from a menu, i.e. the range units.
 3. When in the configuration mode, normal meter output shall be maintained.
- E. The converter shall be provided with a back lighted, dot matrix-type, liquid crystal display for easy reading of flow and configuration data.
1. The display shall have two rows of 16 alpha-numeric characters.
 2. For operation, the top row shall indicate instantaneous flow rate in percent or direct engineering units, field selectable.
 3. The second row shall display accumulated total flow. For configuration adjustment and system monitoring, all data base parameters and error messages shall appear in the display in plain English language.
 4. Error messages shall announce incorrect entry values which will be rejected by the computer.
- F. Converter failure shall be announced in the display as an error message.
1. In addition, an alarm contact shall provide for an external indication of failure.
 2. The range setting of the signal converter shall be continuously adjustable between 5% and 100% of meter capacity.
 3. The range and other parameter adjustments shall be direct reading via the integral digital display.
- G. The converter shall have input impedance of 1012 ohms or greater and not be affected by quadrature noise.
1. It shall require no zero adjustment or special tools for start-up. Input and output signals shall be fully isolated.
 2. The converter output shall be 4 to 20 mAdc into 0 to 900 ohms.

3. The unit shall be capable of accommodating either unidirectional or bi-directional flow.
4. The converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure.
- H. When specified in the Functional Description, there shall be supplied a 24 VDC scaled pulse output for remote totalization.
 1. Pulse width between 0.032 and 2000 ms and weighting factors between 0.01 and 100 shall be software adjustable to match the requirements of the remote counter and to satisfy the process requirements, respectively.
 2. The entire data base of the converter shall be addressable and configurable through a remote intelligent terminal such as a Rosemount HART calibrator.
- I. The signal converter software shall include a noise reduction algorithm to minimize the effects of noise generating processes. The signal converter will be Rosemount 8712DR12NOM4 or approved equal.
- J. The signal converter shall have a 13-function self-test feature for checking operational modes and alarms.
 1. Continuous diagnostics shall also be performed, including but not limited to, the monitoring of electrode reference voltage to sense meter coil failure.
 2. Sensing of meter failure shall activate a user configurable of zero or 130% output signal and a failure alarm contact closure.
 3. The signal shall drive a final control element to a position appropriate to satisfy the needs of the process under a failed meter condition.
- K. The meter shall be hydraulically calibrated at a facility located in the United States, and the calibration shall be traceable to the National Bureau of Standards.
 1. A computer printout of the actual calibration data giving indicated versus actual flows at a minimum of three (3) flow rates shall be provided with the meter.
 2. The calibration factor for all meters of the same size shall be a constant.
 3. The accuracy of the metering system shall be $\frac{1}{2}\%$ of rate from 2 to 100% of flow for flow velocities of 0.6 to 31 feet per second.
- L. Complete zero stability shall be an inherent characteristic of the meter system.
 1. This shall eliminate the need to zero adjust the system with a full pipe at zero flow.
 2. Meter systems that require zero adjustment with a full pipe zero flow condition must be supplied with a full line size shutoff valve for installation on the downstream side of the meter.
 3. All costs for the changes necessary to accommodate such valves will be borne by the Contractor.
- M. The meter housing shall be NEMA 4.
 1. The meter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics or interruption of the flow measurement.
 2. The meter shall be protected by epoxy paint.

PART 3 EXECUTION

40.3.01 GENERAL

- A. The meters and appurtenances shall be installed at the locations shown on the Plans in strict accordance with the manufacturer's recommendations.

40.3.02 **TESTING**

- A. Meters shall be pressure tested at the same time that the adjacent pipeline is tested. Joints shall be watertight at test pressures before acceptance. The Contractor will be responsible for any damage caused by testing.
- B. The meters shall be disinfected with the adjacent piping. They shall be installed and operable during the disinfection testing.
- C. The meters shall be tested for functionality before acceptance.

40.3.03 **START-UP SERVICES**

- A. The Contractor shall provide the services of a factory authorized representative to check the installation and start-up of the meters. The Owner and Owner's Representative shall be present for the start up for training.

SCHEDULE 43 22 53
LIQUID PROCESS METERS

METER No.	TYPE	METER DIAMETER (Inches)	FLOW RANGE (GPM)	MEASURED FLOW
1	ELECTROMAGNETIC	14	0-4000	RAW WATER

END OF SECTION

PART 1 GENERAL

40.1.01 DESCRIPTION

- A. This Specification includes the installation of all water utility distribution pressure gauges, appurtenant equipment, and all work included thereto as shown on the Plans and specified herein.

40.1.02 REFERENCES

- A. Reserved.

40.1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:

SECTION 40 05 00 COMMON WORK RESULTS FOR PROCESS INTERCONNECTIONS

40.1.04 SUBMITTALS

- A. Shop drawings and product data for pressure gauges, connectors, ball valves, and other appurtenances in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- B. Copies of the certified listings from the National Sanitation Foundation (NSF) stating that all materials in contact with potable water meet the latest version of the American National Standards Institute (ANSI) Additives Standard No. 61 for indirect additives including Annex G shall also be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.
- C. Submittals for prior approval shall be submitted in accordance with **SECTION 3.12 of the GENERAL CONDITIONS**.

PART 2 PRODUCTS

40.2.01 MANUFACTURERS

- A. All liquid filled pressure gauges shall be manufactured by
1. Omega Model PGUF-20L
 2. Wika Type 111.10DW
 3. Or equal with prior approval by Engineer.

40.2.02 LIQUID FILLED PRESSURE GAUGE

- A. The pressure gauges shall be installed vertically and orientated for ease of reading from the nearest clear space unless otherwise noted on the plans.
- B. The pressure gauges shall have a minimum display of 2 inches diameter.
- C. The display shall consist of a white background with black markings and a black pointer.
- D. The gauges shall read from 0 psi to 150 psi with an accuracy of $\pm 2.5\%$ of span or better.
- E. Exterior gauges, or gauges inside structures without climate control, shall be rated for use in temperatures ranging from 40 degrees Fahrenheit below zero to 120 degrees Fahrenheit.
- F. The Pressure gauges shall be certified by NSF to meet ANSI Standard 61.
- G. The liquid filled pressure gauges shall be made of the following materials:
1. Case: Stainless Steel
 2. Solder: No-lead solder
 3. Window: Poly-Carbonate
 4. Movement: Brass

- 5. Wetted Parts: Lead-Free Brass
- 6. Bourdon Tube: Bronze

40.2.03 BALL VALVES

- A. A ball valve shall be placed between the pipe and each pressure gauge to allow removal of the gauge for maintenance or replacement without de-pressurizing the pipe.
- B. The ball valve shall include a handle and shall be installed so that the handle can be operated without any tools.
- C. Each ball valve shall be of the same nominal diameter as the pressure gauge it is connected to. No reducers shall be allowed on the pressure gauge assembly.
- D. Ball valves shall be certified by NSF to meet ANSI Standard 61 including Annex G.

40.2.04 THREADED CONNECTIONS

- A. Unless it is contrary to the manufacturer's recommendations, Teflon tape or other approved connection sealant shall be used.
- B. All connections must be watertight.

PART 3 EXECUTION

40.3.01 GENERAL

- A. Construction requirements shall be in accordance with the provisions of **SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES** of these Specifications.
- B. Connection to pipe: The gauge and ball valve shall be connected to each other and to the pipe with appropriate fittings. Connections to PVC pipe shall be with appropriately sized saddles. Connections to ductile iron pipes shall be made by drilling.
- C. All pressure gauges and associated piping shall be pressure tested at the same time that the adjacent pipeline is tested. Joints shall be watertight at test pressures before acceptance. The Contractor will be responsible for any damage caused by testing.

40.3.02 TESTING

- A. Pressure gauges and associated appurtenances shall be pressure tested at the same time that the adjacent pipeline is tested. Joints shall be watertight at test pressures before acceptance. The Contractor will be responsible for any damage caused by testing.
- B. The pressure gauges and associated appurtenances shall be disinfected with the adjacent piping. They shall be installed and operable during the disinfection testing.
- C. The ball valve shall be in the open position during all testing.

END OF SECTION