The Charter Township of Alpena
Construction Standards and Specifications
for
Sanitary Sewer and Water Distribution Systems

Revised August, 2019

The Charter Township of Alpena
4385 US-23 North
Alpena, Michigan 49707
(517) 356-4024

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Section V General Specifications

NOTES:

1. Throughout this document wherever a referenced standard, specified material or procedure, regulatory agency, referenced specification or guideline has been revised, updated, or replaced, the most current revision shall be used and enforced and shall be considered part of this document.

2. These Charter Township of Alpena Construction Standards and Specifications shall be used in conjunction with the Sanitary Sewer and Water Ordinance (Charter Township of Alpena Ordinance No. 140) and the Industrial Pretreatment Sewer Use and Discharge Ordinance.

A. Introduction

TO ALL PROSPECTIVE DEVELOPERS:

The MDOT Construction Standards and Specifications, 2012 Edition is hereby issued by the Charter Township of Alpena. The issuance of these Construction Standards and Specifications is made in an effort to ensure the use of uniform, adequate and acceptable construction standards, methods and materials. These Specifications should be utilized in conjunction with local zoning and subdivision ordinances, the State of Michigan Subdivision Control Act, and other applicable State and local regulations to produce residential, commercial, and industrial developments which conform to the Township Standards. The Charter Township of Alpena strives at all times to stay up to date with respect to construction requirements.

These specifications are adopted as standard requirements to apply to work and materials to be constructed after July 31st, 2019.

Nathan Skibbe
Supervisor

_____

Adopted by Township Board Date

B. Definitions

1. CONTRACTOR: The Owner or Developer or the person, firm, or corporation with whom the Owner or Developer has entered into an agreement with to construct the subdivision, land development, and/or Township improvement.

2. DESIGN ENGINEER - The Engineer engaged by the developer to prepare platting documents and plans and specifications for subdivisions or plans and specifications in unplatted land developments.

3. ENGINEER OR TOWNSHIP ENGINEER - The person, firm, or corporation empowered by the Township of Alpena to provide the required engineering review and inspection services.

4. EGLE - Michigan Department of Environment, Great Lakes and Energy or Michigan Department of Natural Resources and Environment (MDNRE) - The agency responsible for issuing construction permits for wastewater systems and water supply systems.

5. OWNER OR DEVELOPER - A natural person, firm, corporation, association, partnership, or other entity who proposes subdivision or other land development and/or Township improvements and who either has an ownership interest therein or is authorized to act as an agent with respect thereto for an entity having such ownership interest.

6. TOWNSHIP – Charter Township of Alpena.

7. TOWNSHIP STANDARDS - The minimum standards for design and construction for all work related to subdivisions and land development.

C. Regulatory Constraints

1. Subdivision Control Act of 1967

   The Subdivision Control Act (Act 288) gives the local units of government in Michigan the authority required to assure that new subdivisions conform to sound subdivision practices; retain their beauty and value; and remain an asset, not a liability, to the community.

   A Manual of Instructions for implementing Act 288 is available from the Michigan Department of Commerce, Subdivision Control Unit. The Manual of Instruction includes step by step regulations for preparation of the preliminary and final plats as well as the rules and regulations of the Departments of Commerce, Transportation, Environmental Quality, Natural Resources and Public Health.

2. Natural Resources and Environmental Protection Act (NREPA) of 1994

   The Natural Resources and Environmental Protection Act (Act 451) was enacted to regulate activities in floodplains (Part 31), inland lakes and streams (Part 301), wetlands (Part 303), shorelands (Part 323), and Great Lakes submerged lands (Part 325). A construction permit may be required and can be obtained from the Michigan Department of Environment, Great Lakes and Energy (EGLE). A joint permit with the US Army Corps of Engineers (USACE) is required if the activity is in navigable waters of the US and their adjacent wetlands. All associated permit fees shall be paid by the Developer unless otherwise approved by the Township.

3. NREPA (Part 91), Soil Erosion and Sedimentation Control

The Natural Resources and Environmental Protection Act (Act 451) was enacted to control soil erosion and sedimentation (Part 91) for all earth change activities which disturb one or more acres of land, or if the earth change is within 500 feet of a lake or stream. A Soil Erosion Permit is obtained from the Alpena Conservation District. Permit fees shall be paid by the Developer unless otherwise approved by the Township.

4. NREPA (Part 41), Sewerage Systems

Upon receipt of approved plans and specifications from the Developer, the Developer will assist the Township with making an application for permit to the EGLE for construction of new sanitary sewer facilities. All permit application costs and fees shall be paid for by the Developer, unless otherwise approved by the Township.

5. Michigan Safe Drinking Water Act of 1976

In accordance with Michigan Safe Drinking Water Act (Act 399) and upon receipt of approved plans and specifications from the Developer, the Developer will assist the Township with making an application for permit to the EGLE for construction of new water facilities. All permit application costs and fees shall be paid for by the Developer, unless otherwise approved by the Township.

6. State and Local Building Codes

The Township has adopted the State of Michigan code for basic building. The state code will be enforced by the State of Michigan for mechanical, plumbing, and electrical work. Applications for Building Permit shall be submitted to the Charter Township of Alpena Building Department. Mechanical, plumbing and electrical permits are handled by the State of Michigan, and shall be paid by the Developer.

7. Miscellaneous

Driveway-Culvert Permits need to be obtained from the Alpena County Road Commission or Michigan Department of Transportation (MDOT). All other required permits including all associated fees shall also be secured by the Developer prior to construction.

D. Administrative Procedures and Fees

1. General

All correspondence, verbal requests, submission of plans, and related information exchanges shall be directed to the Director of Public Works of The Charter Township of Alpena during normal business hours or by mail. Appropriate distribution of information, plans, etc., shall be made by the Township. This applies to information received from the Developer for the Engineer and information from the Engineer for the Developer. The intent of this section is to maintain, in the Township offices, a copy of all correspondence and related information for Township use.

2. Fees

The Township shall provide an estimate of plan review and field inspection charges at the time of street and utility plan approval. The estimated amount shall be deposited with the Township by the Developer prior to construction. The Township shall disburse the funds to the Engineer.

A. Sanitary Sewer System

1. Scope

These standards establish the minimum requirements for the design of sanitary facilities in the Township.

2. Plans and Specifications

a. The plans and specifications shall be prepared by a Professional Engineer registered in the State of Michigan.

b. Plans shall consist of a cover sheet showing a location map and site plan of the proposed project, plan and profile sheets covering all the proposed utilities and a standard detail sheet. Plan sheet(s) shall be 24” x 36”.

c. Elevations shall be based upon USGS datum.

d. Plan profiles shall indicate existing and proposed finished ground levels, USGS elevations, and stationing.

e. Four (4) sets of plans and specifications shall be submitted by the Developer to the Township for preliminary approval. All plans and specifications submitted for approval shall be sealed by the Registered Professional Engineer in charge of design. Modifications required to meet the Township standards, if any, will be noted on two sets, with one such set returned to the Developer for final corrections within 90 days of receipt.

f. Six (6) sets of final plans and specifications shall be submitted by the Developer to the Township for approval. All plans and specifications submitted for approval shall be signed and sealed by the Registered Professional Engineer in charge of design.

g. The Developer will complete the EGLE Permit Application for Wastewater Systems as required under NREPA Part 41. The Township will sign the application and submit it to the EGLE after Township review and approval. The Developer will be responsible for securing all other permits required for the sanitary sewer construction.

h. One (1) set of reproducible “as-built” tracings, on mylar or polyester film, three (3) sets of blue line drawings and two (2) digital copies of the drawings on CD shall be submitted to the Township upon completion of the utility construction. The location of all sanitary tees or wyes, and the intersection of the service lateral at the respective property line shall be witnessed from at least three permanent topographic features.

3. Minimum Grades and Velocities

Sanitary sewers shall be designed to maintain a minimum velocity of two feet per second; maximum velocity shall not exceed ten feet per second. Minimum grades for various size sanitary sewers are listed below:

6” (lateral)	1.00%
8”	0.40%
10”	0.30%
12”	0.22%
15”	0.15%
18”	0.12%
24”	0.10%

The minimum depth of cover for sanitary sewers located under a roadway or driveway shall not be less than 6 feet. Sanitary sewers located under other areas shall have a minimum of 5 feet of cover. Specific details must be provided for approval for those proposed areas with less than these minimum requirements.

4. Minimum Diameter

The Developer shall install the appropriately sized sanitary sewer system to serve the proposed development and shall submit supporting documentation and calculations to the Township to demonstrate adequacy.

The minimum diameter of collection sewers shall be eight inches and the minimum diameter of the service lateral shall be six inches. The Township may desire to increase the size of certain sewers for their own purposes, in which case, the Township may pay for the difference in sewer pipe and manhole construction materials costs over and above the Developer's proposed diameter sanitary sewer and manhole structures.

5. Sewer Pipe

Sanitary sewer pipe shall be PVC conforming to ASTM D3034. Minimum wall thickness shall be SDR-35. Joints shall be of the elastomeric gasket push-on type conforming to ASTM D3212.

6. Manholes

Manholes shall be constructed at all changes in grade, size and alignment of the sanitary sewer. The maximum run between manholes shall be 400 feet. All manholes shall be precast concrete with rubber "O" ring at joints; block or brick sanitary manholes will not be approved. All pipe openings shall be cast in the precast section or cored in the finished wall. Manhole pipe connections shall be furnished with an integrally cast seal system, equal to "Press Wedge II", "Kor-N-Seal", "Lock Joint Flexible Manhole Sleeve", or equal. Sanitary manholes shall have integral concrete manhole bottom. A drop pipe shall be constructed for all sewers entering a manhole at a height of 24 inches or greater above the proposed manhole invert. The minimum inside diameter of a sanitary sewer manhole for sewers through 21 inches in diameter shall be 48 inches. For sanitary sewer 24 to 36 inches in diameter, the minimum inside diameter of the sanitary manhole shall be 60 inches. A minimum of three rows and a maximum of six rows of concrete adjusting bricks or rings shall be constructed on top of the precast cone section. The interior and exterior of the adjusting bricks or rings shall receive a 1/2 inch coat of plaster. All manholes shall be provided with approved manhole steps.

7. Service Laterals

Connection of the service laterals to the collection sewer shall be by means of a sewer pipe wye or tee fitting. The service lateral shall be constructed to the property line of all lots and marked with 1/2" rebar 18" long and set 3 inches below finished grade. In addition, the Developer shall be required to furnish to the Township a map indicating the precise location of all sanitary sewer laterals at the property line intersection. The location should be witnessed from three recoverable reference points. All service laterals shall have a minimum 6" diameter cleanout pipe connected to the lateral with a wye fitting. The cleanout pipe shall be extended to the surface and equipped with a threaded cap set flush with the ground surface. The cleanout cap shall be located six inches (6") inside the right-of -way line. Where sanitary sewers are deeper than 15 feet, 6" diameter risers shall be constructed such that the service lateral is 6 feet below finish grade at the property line. All changes in direction, materials, or pipe size shall be done with proper fittings.

8. Subsurface Soil Conditions

The Developer shall provide sufficient soil borings along the sanitary sewer route to accurately describe the prevailing soil conditions. The borings shall be constructed to a depth of four feet below the proposed invert elevation of the sanitary sewer. The Developer should be responsible for all associated costs.

9. Manhole Casting

Refer to Section II-C Standard Castings, Valves and Hydrants for the Township standard for sanitary manhole castings.

10. Lift Stations

Unless otherwise approved, lift stations shall be submersible or suction lift type inside a fiberglass enclosure. Each station shall be equipped with an adequately sized wet-well, duplex pumps, suction and discharge plug valves, discharge check valves, high and low water level alarms, ventilation and heat. Stations shall have provisions for accepting portable emergency generator service compatible with the Township's generator. Pump stations shall be similar to the Township's existing stations and shall be subject to the approval of the Township. Lift station design shall conform to the guidelines contained in the Recommended Standards for Sewage Works, Great Lakes-Upper Mississippi River Board of State Sanitary Engineers (Ten-State Standards), latest version, unless otherwise noted or approved. All submersible pump lift stations shall be provided with intrinsically safe electrical control systems. Pumps and motors shall be explosion proof. All mechanical/electrical equipment (and installation methods) shall comply with the National Electrical Code (NEC) for the NEC hazard classification applicable to the location in which the equipment is installed. Wet wells are NEC Class I Division 1 Group D Hazardous locations. Lift station design shall be subject to the approval of the Township.

11. Inverted Siphons

Generally, the use of inverted siphons will not be approved unless specific conditions warrant their use.

12. Illegal Connections

The connections of footing drains, roof drains, sump pump discharge, or yard drains to the sanitary sewer are strictly prohibited.

13. Connection Elevations

Plans submitted for approval shall note the elevations of the sanitary sewer service lead at the building foundation line as well as the invert elevation of the service lead at the collection sewer in the street. Minimum cover over the service lateral shall be four feet.

14. Trench Loading Design

All sanitary sewers shall be designed so as to resist all trench backfill and construction load or anticipated superimposed loadings utilizing a factor of safety of 2.0 of the pipe's resistance to failure.

B. Water Distribution System

1. Scope

These standards establish the minimum requirements for the design of water distribution systems in the Township.

2. Plans and Specifications

a. The plans and specifications shall be prepared by a Professional Engineer registered in the State of Michigan.

b. Plans shall consist of a cover sheet showing a location map and site plan of the proposed project, plan and profile sheets covering all the proposed utilities and a standard detail sheet. Plan sheet shall be 24” x 36”.

c. Elevations shall be based upon USGS datum.

d. Plan profiles shall indicate existing and proposed finished ground levels, USGS elevations, and stationing.

e. Four (4) sets of plans and specifications shall be submitted by the Developer to the Township for preliminary approval. All plans and specifications submitted for approval shall be sealed by the Registered Professional Engineer in charge of design. Modifications required to meet the Township standards, if any, will be noted on two sets, with one such set returned to the Developer for final corrections within 90 days of receipt.

f. Six (6) sets of final plans and specifications shall be submitted by the Developer to the Township for approval. All plans and specifications submitted for approval shall be sealed by the Registered Professional Engineer in charge of design.

g. The Developer will complete the EGLE Permit Application for Water Supply Systems as required under Act 399. The Township will sign the application and submit it to the EGLE after Township review and approval. The Developer will be responsible for securing all other permits required for the water distribution system construction.

h. One (1) set of reproducible “as-built” tracings, on mylar or polyester film, three (3) sets of blue line drawings and two (2) digital copies of the drawings on CD shall be submitted to the Township upon completion of the utility construction. The location of all tees, manholes, and the intersection of the service lateral at the respective property line shall be witnessed from at least three permanent topographic features.

3. Minimum Size

The Developer shall install the appropriately sized water main to serve the proposed development and shall submit supporting documentation and calculations to the Township to demonstrate adequacy.

The minimum size of water main shall be 6” in diameter. The Township may desire to increase the size of certain mains for their own purposes in which case the Township may pay for the difference in water main and valve material costs over and above the Developer’s proposed diameter water main and valves.

4. Valves

AWWA approved gate valves shall be placed throughout the distribution system in accordance with the following regulations:

a. On straight runs, valves shall be spaced at maximum intervals of 800 feet.

b. At tees, a minimum of two valves are required.

c. At crosses, a minimum of three valves are required.

d. At the end of dead end mains, valves shall be constructed to facilitate future connections. Dead end valves shall be securely rodded with 6' of pipe extended past the valve with a cap for future development where appropriate.

e. A valve shall be installed at the intersection of water mains and easement lines. The Township intends to maintain water mains centered within legal easements.

5. Valve Boxes and Manholes

Valves shall be placed in valve manholes as directed by the Township. Generally, valve manholes will be required in State Highway right-of-ways, paved surfaces, berms, sidewalks, and any other location where re-excavation may be difficult. Valves not placed in valve manholes shall be provided with adjustable screw type valve boxes.

6. Valve Extension Stems

Where valves are used with valve boxes, the depth to the top of the valve operating nut shall not be greater than 5-1/2 feet. Where the water main is buried at a depth where the normal valve operating nut will be at a depth greater than 5-1/2 feet, a valve extension stem with operating nut shall be provided and mechanically attached to the valve to provide an operating nut at the 5-1/2 foot depth.

7. Water Mains

Water mains shall be constructed of ductile iron or PVC with a minimum cover of 6'. Any other pipe material shall be subject to the approval of the Township and Michigan Department of Natural Resources and Environment (MDNRE). The use of asbestos cement pipe will not be approved. In general, water mains shall be designed in a network with sufficient looping to eliminate "dead-end" runs.

8. Hydrants

The minimum size for fire hydrants shall be 5-inch diameter and the hydrant shall have connections and special construction as noted in Section II-C Standard Castings, Valves and Hydrants. Hydrants shall be spaced along the water main network such that all residential and commercial establishments are within 400 feet of a hydrant (measured along the street right-of-way). Threads on the connections shall be National Standard Threads (NST). The hydrants shall have plugged drains. The pumper connection shall face the street. Hydrants shall be constructed at all dead end mains. Hydrants shall be constructed from the main by use of a standard tee and gate valve. A concrete thrust block of sufficient area shall be constructed to resist the thrust and hydrant shall be rodded to hydrant valve and valve rodded to main.

9. Service Connections

Connection to the existing main shall be made with a corporation stop with a minimum diameter of one inch. Service lead shall be Type K annealed seamless copper water tubing. Service lead shall be constructed to within six inches of the property line and shall be terminated with a curb valve and box. The open end shall be capped and protected during backfill operations. An adjustable curb box shall be provided for each curb stop. The size of water service connection shall be approved by the Engineer. Each service connection shall be provided with a minimum of 6 feet of cover. Refer to Section II-C Standard Castings, Valves and Hydrants for acceptable makes and model numbers.

10. Water Meters

Water meters are to be furnished by the Township upon payment of the necessary fee as established by the Township (this fee is subject to change by the Township Board). The meter and appurtenances shall remain the property of the Township and shall be maintained by the Township. Installation shall be in accordance with Water Service Installation Policies section.

C. Standard Castings, Valves and Hydrants

1. Sewer System

Sanitary Manhole Castings EJIW 1040A

2. Water Distribution System

Fire Hydrants: EJIW 5BR250 or approved equal. All fire hydrants shall equal or exceed AWWA Standard C502 and its latest revisions. All hydrants shall have a main valve opening of 5-1/4" and a 6" inlet connection. Each hydrant shall have two 2-1/2" national standard hose connections, one 4-1/2" national standard pumper connection, and one 5" Storz pumper connection. Hydrants shall open counter clockwise with a 1-1/8" pentagon operating nut. All hydrants shall be breakaway flange type.

Each hydrant shall be furnished complete with one 6" auxiliary valve and box as indicated on the Standard Details.

Gate Valves: Mueller, or approved equal. Line gate valves shall be resilient wedge type constructed to AWWA C509 Specifications with non-rising stem and "O" ring seal. The valves shall be ANSI A21.11 mechanical joint and shall open counterclockwise.

Valves for hydrants shall meet the above specifications and shall be called auxiliary valves.

Valve Manhole Castings: EJIW 2010A or approved equal as required.

Corporation Stops: Mueller H-15008 or approved equal.

Curb Stop: Mueller H-15207 or approved equal. A bronze pin shall be utilized to connect the rod to the curb stop.

Curb Box: Mueller H-10314 or approved equal.

Service Lead: Type K annealed seamless copper.

Note: All curb stops and boxes shall be of the same manufacturer and model.

A. General Notes

1. The Contractor shall call “MISS DIG” at 1-800-482-7171 or 811 at least 72 hours (excluding holidays and weekends) prior to the start of construction. All underground utilities shall be located before the start of construction.

2. The Contractor shall furnish as-built drawings indicating all changes and deviation from approved drawings.

3. The Contractor/Developer shall obtain and pay for all permits necessary for construction.

4. All work within county road right-of-way shall also conform to Alpena County Road Commission Standards and Specifications.

5. All work within US 23 and M-32 right-of-way shall also conform to Michigan Department of Transportation Standards and Specifications.

6. All construction of the sanitary sewer system and/or water system shall be in accordance with the Construction Standards and Specifications herein.

7. In areas of rock, the minimum trench width for sewer and water main shall be 30” for future maintenance.

B. Water Service Notes

1. Depth and Separation

All service pipes, on either public or private property, as permitted in this article, shall be laid on solid ground not less than six (6) feet below the established finished grade of the street. Service pipe shall be laid at least ten (10) feet horizontally from any sanitary sewer, storm sewer or sewer manhole, measured from pipe edge to pipe edge. When conditions prevent a horizontal separation of ten (10) feet, service pipe may be laid closer to a storm or sanitary sewer provided that the bottom of the service pipe is at least 18 inches above the top of the sewer and/or there is at least 18 inches of vertical separation at crossings between water service pipes and sewers. Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling. In all cases, local ordinances and plumbing codes for required horizontal and vertical separation shall be met.

2. Installation Codes

That portion of the service pipe from the main to the water meter shall be of copper or some other material of like corrosion-resistant nature, not less than 1 inch in diameter, approved by the Township. All service pipe 2 inches and less in diameter shall be laid six (6) feet or more beneath the surface of the ground. All service pipe shall be brought to the required depth as soon as possible after leaving the tap. Service cocks shall be stop type and shall be placed at the property line. The stop box shall be set so that the cover is level with the surrounding sidewalk or lawn and must be set on a brick or concrete foundation to prevent settlement. The lid of the box shall be marked with the word “Water”. No service pipe shall be laid on a fill unless supported in such a manner that the settlement of such fill will not affect such pipe.

3. Meter Valves

A gate valve shall be placed on the service pipe just inside the building wall on both sides of the water meter. Isolation valves shall be equal in quality to the service valve.

4. Installation of Service Leads

The corporation stop, the service pipe from the main to the curb stop, and stop box will be maintained by the Township.

All service pipe on private property and all water piping in all premises shall be installed by a plumber licensed under state law, or may be installed by homeowner if properly inspected. Licensed plumbers shall not interfere in any way with service pipes installed by the water department and shall not be permitted to turn water on or off at the curb stop except for the purpose of testing their work, in which case, after the test is made, the curb stop shall be left in the same condition and position as they found it. Any plumber called upon to shut off water and drainpipes in any premises shall do so inside the building only.

C. Water Service Installation Policies

1. A contract with the Township must be signed and filled out prior to construction.

2. Inspection is needed at the time of connection to the stop box as well as a final inspection for the inside plumbing prior to water turn on. An appointment for inspection must be made at least 24 hours before connection. NO CONNECTIONS will be allowed after 4 p.m. or on weekends unless cleared with the Township Water Department.

3. You must have a four (4) foot severance from the well plumbing and ten (10) foot isolation from your septic tank and drain field.

4. 1 inch Type 'K' Copper with no soldered joints underground, or 200 psi rated plastic.

5. Service line must be installed six (6) feet underground. Where six (6) feet of depth is impossible, adequate insulation must be installed.

6. A gate valve shall be installed on each side of meter. A space of 9-1/4 inches between meter couplings is needed. Keep meter 6 inches from wall. Meter cannot be put in a crawl space.

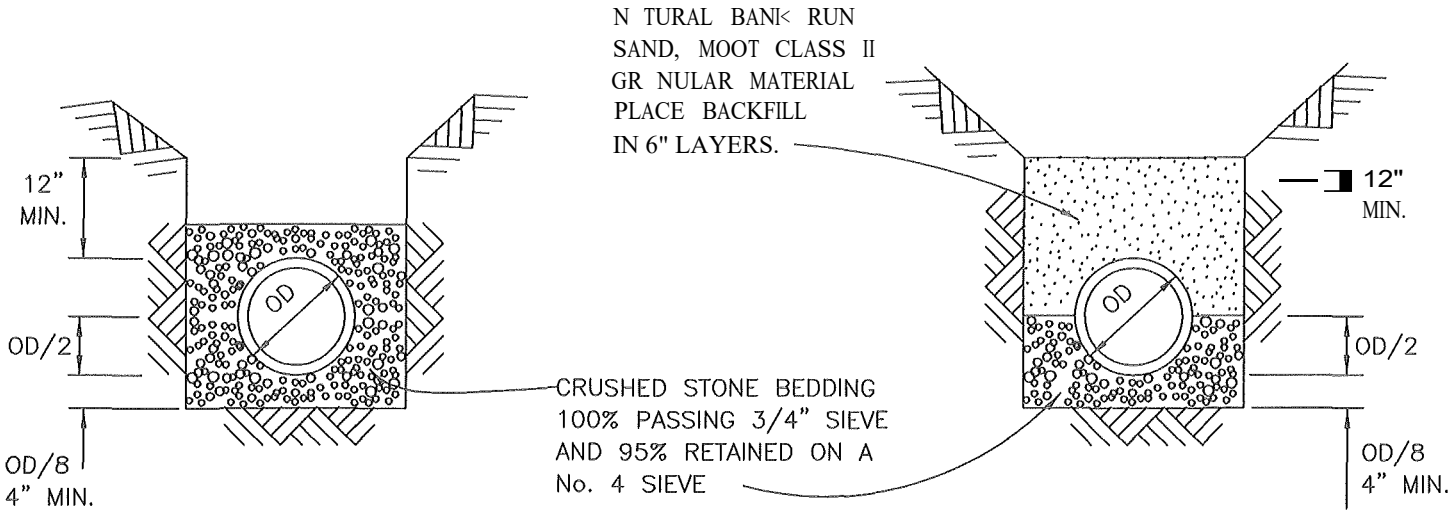
7. Curb box must be installed straight up and down with a concrete block underneath.

8. Call the Township Water Department for inspections, water turn-ons and placement of water meters (989-356-2851).

9. Action will be taken against all intentional violations.

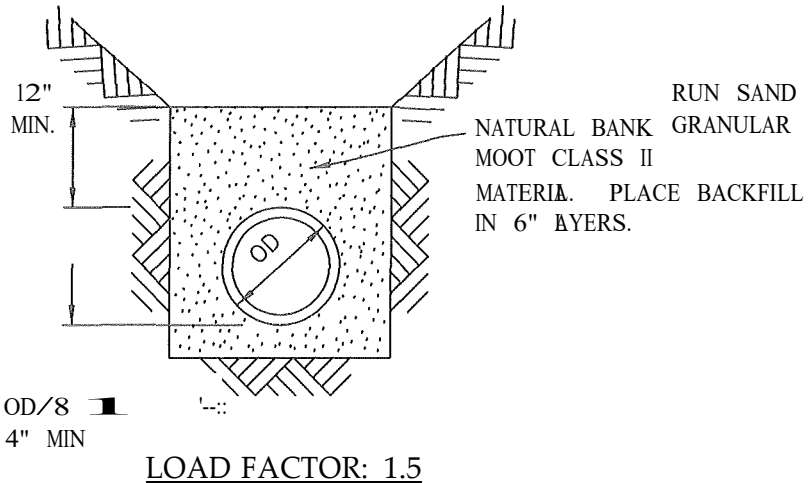
These rules are approved by the Township Board under Section 10, Article 2 of the Charter Township of Alpena Water Ordinances on the 7th day of July, 1980.

General Details



CLASS "I"

CLASS "II"



LOAD FACTOR: 1.5

CLASS "111"

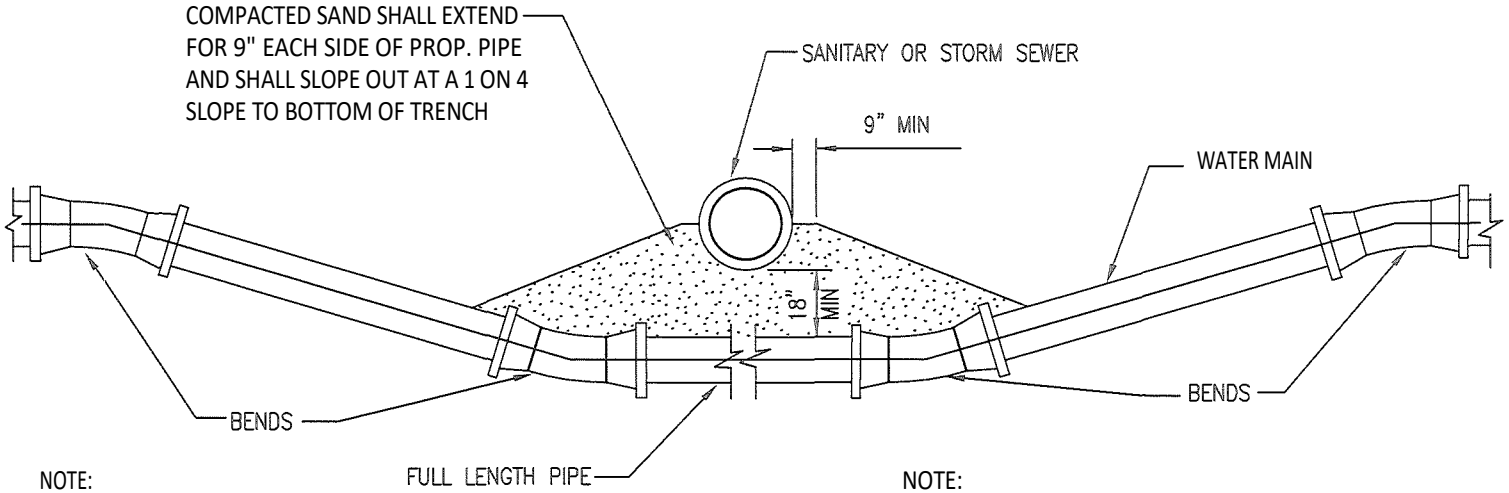
TRENCH WIDTHS AT 12" ABOVE TOP OF PIPE:

FLEXIBLE PIPE: THE MINIMUM WIDTH SHALL BE NOT LESS THAN THE GREATER OF EITHER THE PIPE OUTSIDE DIAMETER PLUS 16 IN. (400 MM) OR THE PIPE OUTSIDE DIAMETER TIMES 1.25, PLUS 12 IN. (300 MM). THE MAXIMUM TRENCH WIDTH FOR FLEXIBLE PIPE SHALL NOT EXCEED THE MINIMUM WIDTH BY MORE THAN 6-INCHES.

RIGID PIPE: TRENCH WIDTHS TO BE IN ACCORDANCE WITH AWWA C-600 LATEST EDITION.

PIPE BEDDING DETAILS

NO SCALE



NOTE:
FOR BEDDING OF WATER MAIN SEE PIPE BEDDING DETAILS.

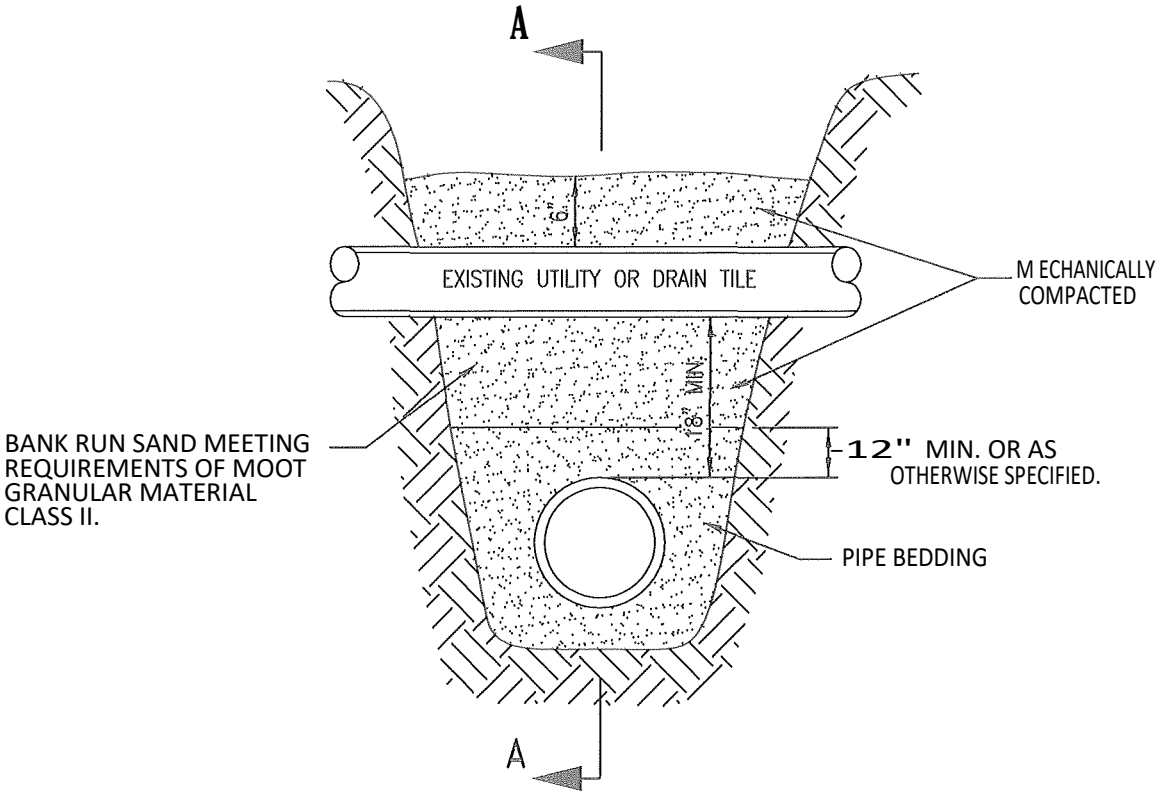
NOTE:
FOR ANCHORAGE AT BENDS SEE VERTICAL REACTION BLOCKING DETAIL.

WATERLSEWER CROSSING

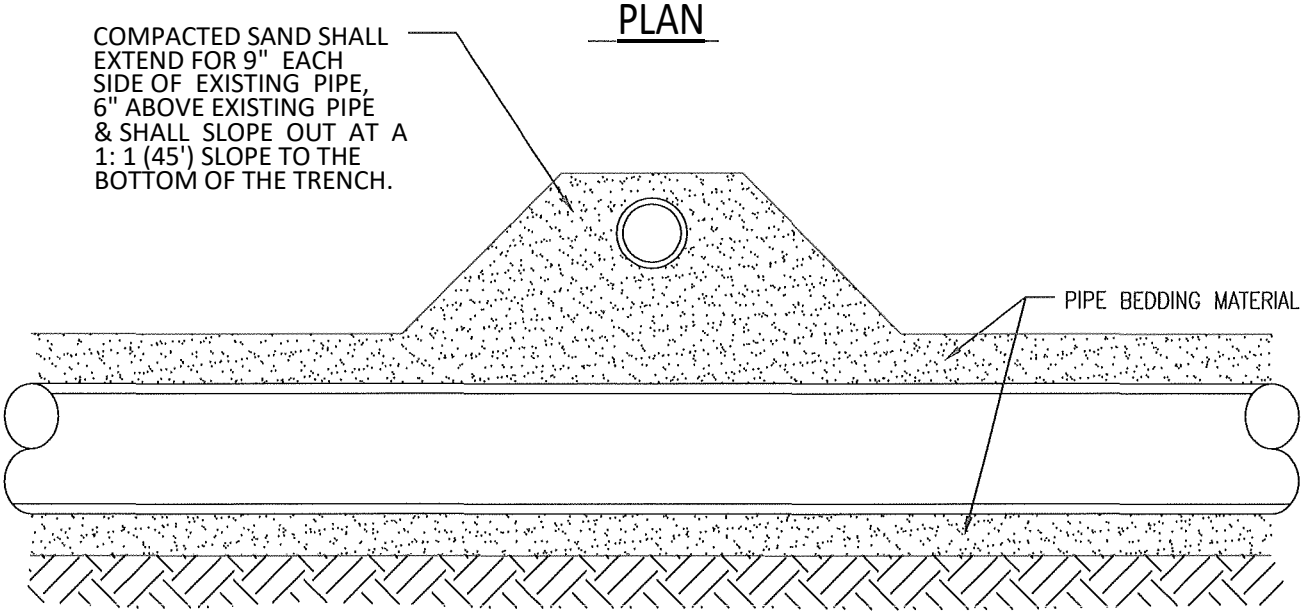
NO SCALE

C0-2

NOTE:
WHERE CONCRETE ENCASEMENT IS SPECIFIED FOR NEW UTILITY A 6" MINIMUM LAYER OF MECHANICALLY COMPACTED SAND SHALL BE MAINTAINED BETWEEN EXISTING UTILIT Y & TOP OF CONCRETE ENCASEMENT.



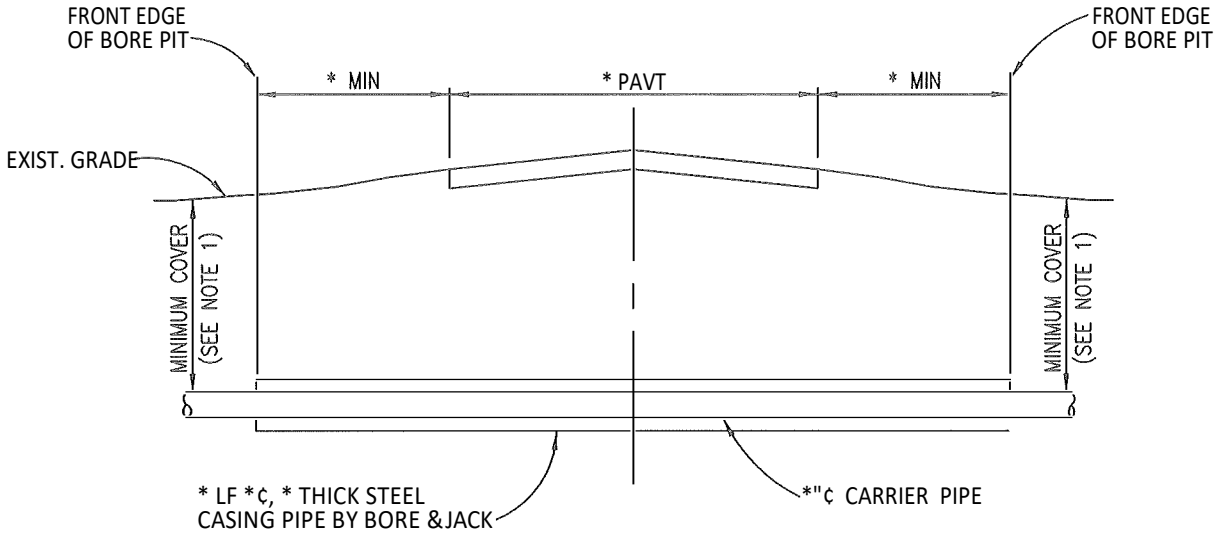
PLAN



SECTION A-A

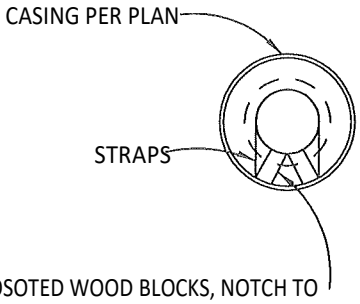
STANDARD PIPE SUPPORT

NO SCALE

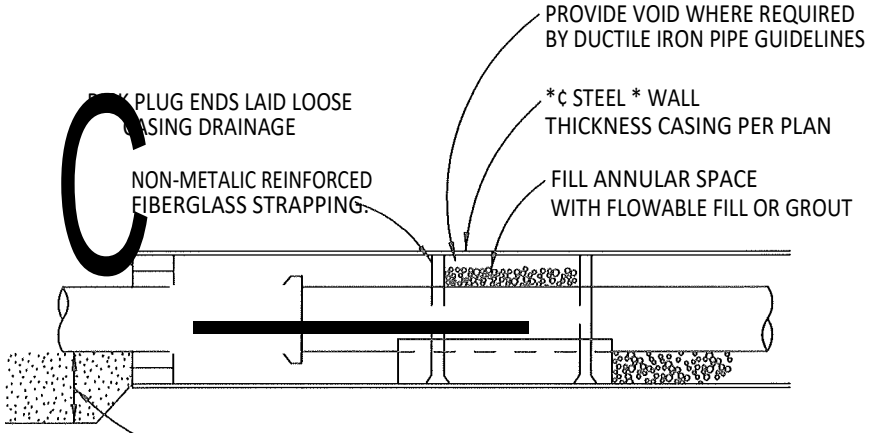


NOTES:

1. MINIMUM COVER FOR WATER MAIN SHALL BE 6-FEET. MINIMUM COVER FOR SANITARY SEWER AND FORCE MAIN SHALL BE 5-FEET.



CREOSOTED WOOD BLOCKS, NOTCH TO RECIEVE STRAPS, BLOCKS TO BE OF SUFFICIENT DEPTH TO PREVENT BELL FROM BEARING. MAX. UNSUPPORTED PIPE LENGTH 12"

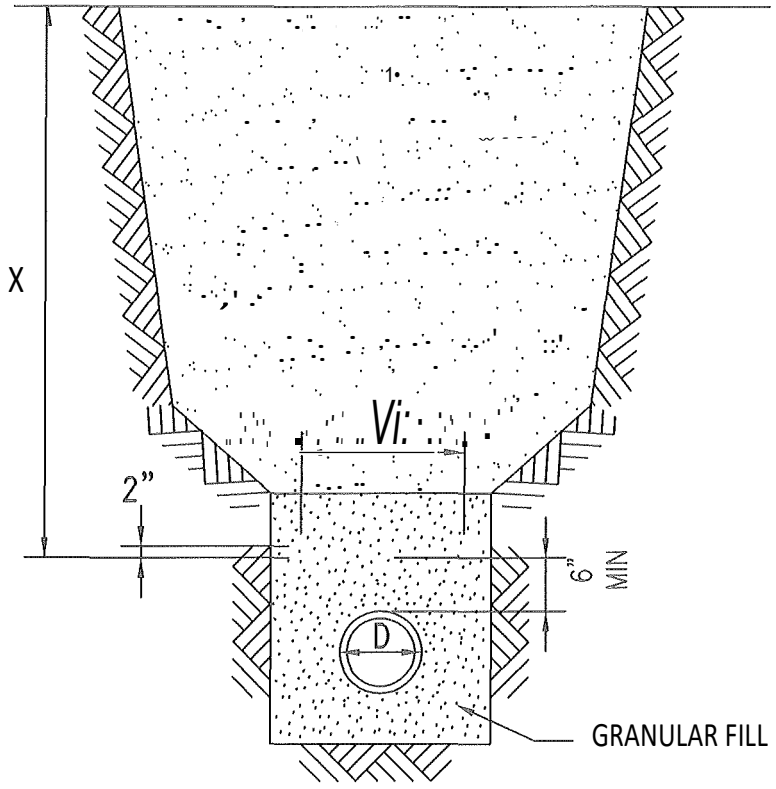


NOTE:
DO NOT COMPLETELY FILL PER
DUCTILE IRON INSTALLATION GUIDE

BORE AND JACK DETAILS

NO SCALE

REFER TO PIPE BEDDING DETAIL AND NOTES AND
SPECIFICATIONS FOR TRENCH BACKFILL REQUIREMENTS



HORIZONTAL LAYER INSULATION DETAIL

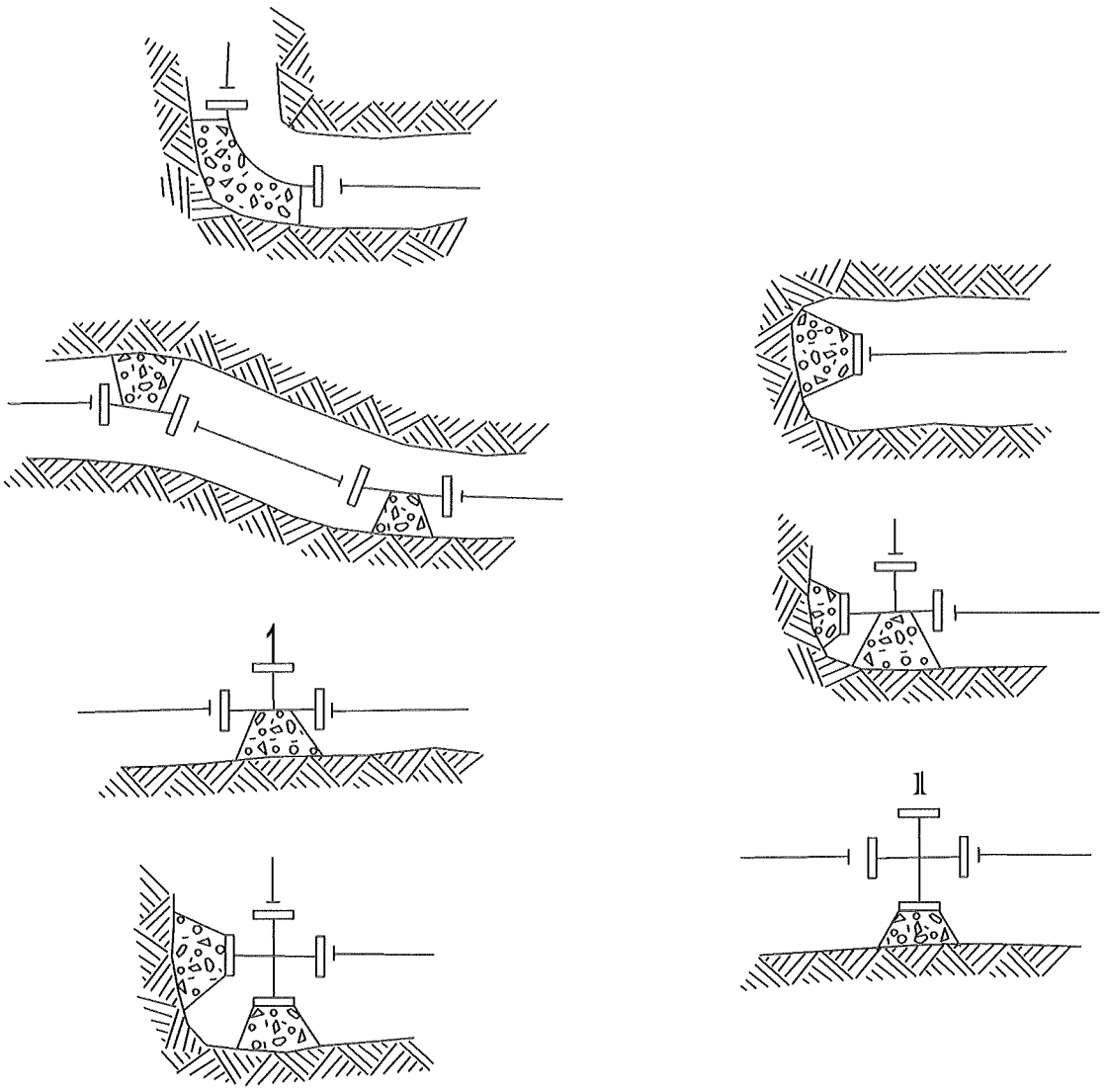
NO SCALE

HORIZONTAL LAYER INSULATION SCHEDULE

(1f-16" PIPE)

X, AMOUNT OF BACKFILL OVER INSULATION (FT)	W, WIDTH OF INSULATION REQUIRED (FT)
< 4.5	INSTALLATION NOT ALLOWABLE ABOVE THIS DEPTH
4.5	2+0
5.0	1+0, 2 MIN.
5.5	2
6.0	NO INSULATION NEEDED

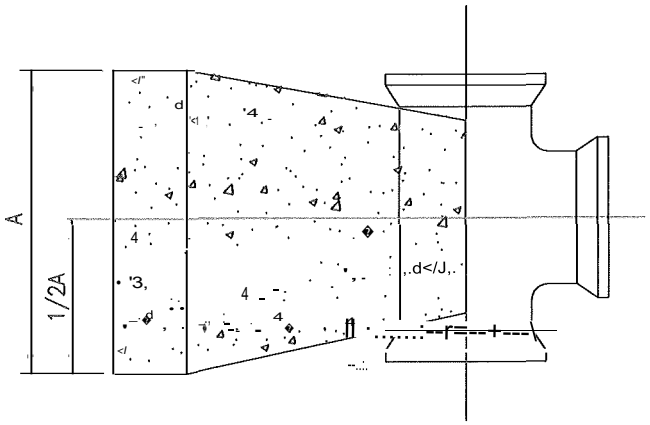
NOTE: INSULATION SHALL BE A MINIMUM OF 2'' BLUEBOARD WITH LAPED JOINTS. PRIOR TO PLACING INSULATION THE TRENCH SHALL BE PREPARED TO PROVIDE AN EVEN AND LEVEL SURFACE FOR THE INSULATION TO REST ON.



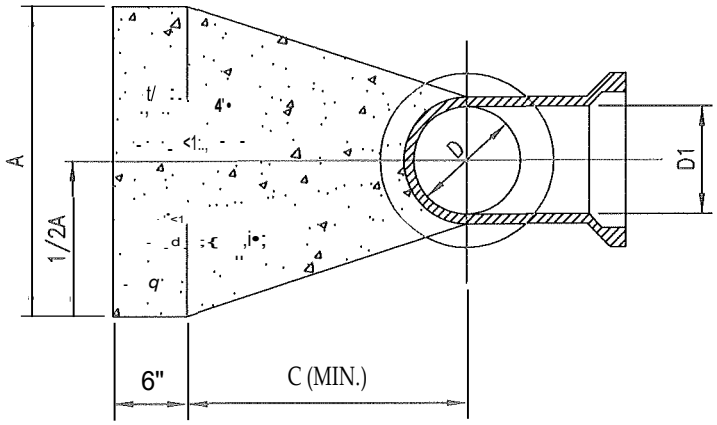
ALL THRUST BLOCKS SHALL EXTEND TO UNDISTURBED SOIL, CONCRETE SHALL BE 3500 P.S.I. (5 BAG WET MIX). COAT PIPE TO PREVENT BOND TO CONCRETE.

THRUST BLOCK LOCATIONS

NO SCALE

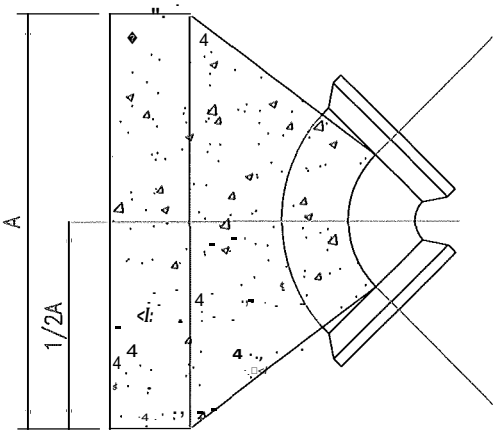


PLAN

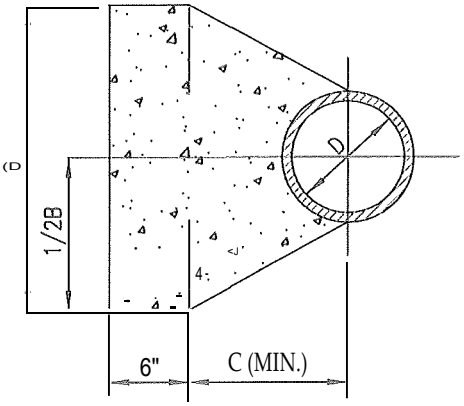


SECTION

TEE

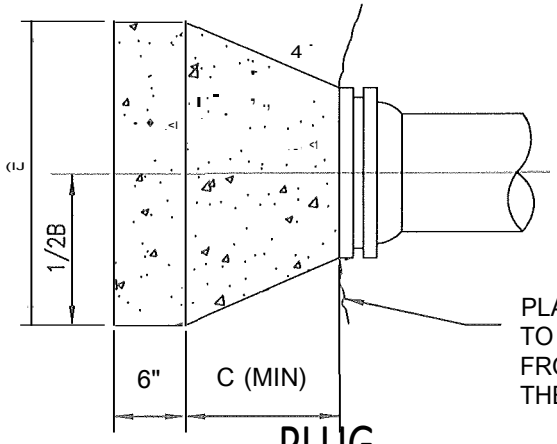


PLAN



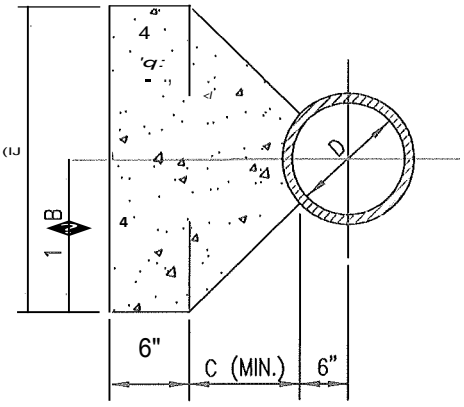
SECTION

BEND



PLACE VISQUEEN OR PLASTIC TO PROTECT BOLT AND PLUG FROM DIRECT CONTACT WITH THE CONCRETE.

PLUG



SECTION

11-1/4° BEND

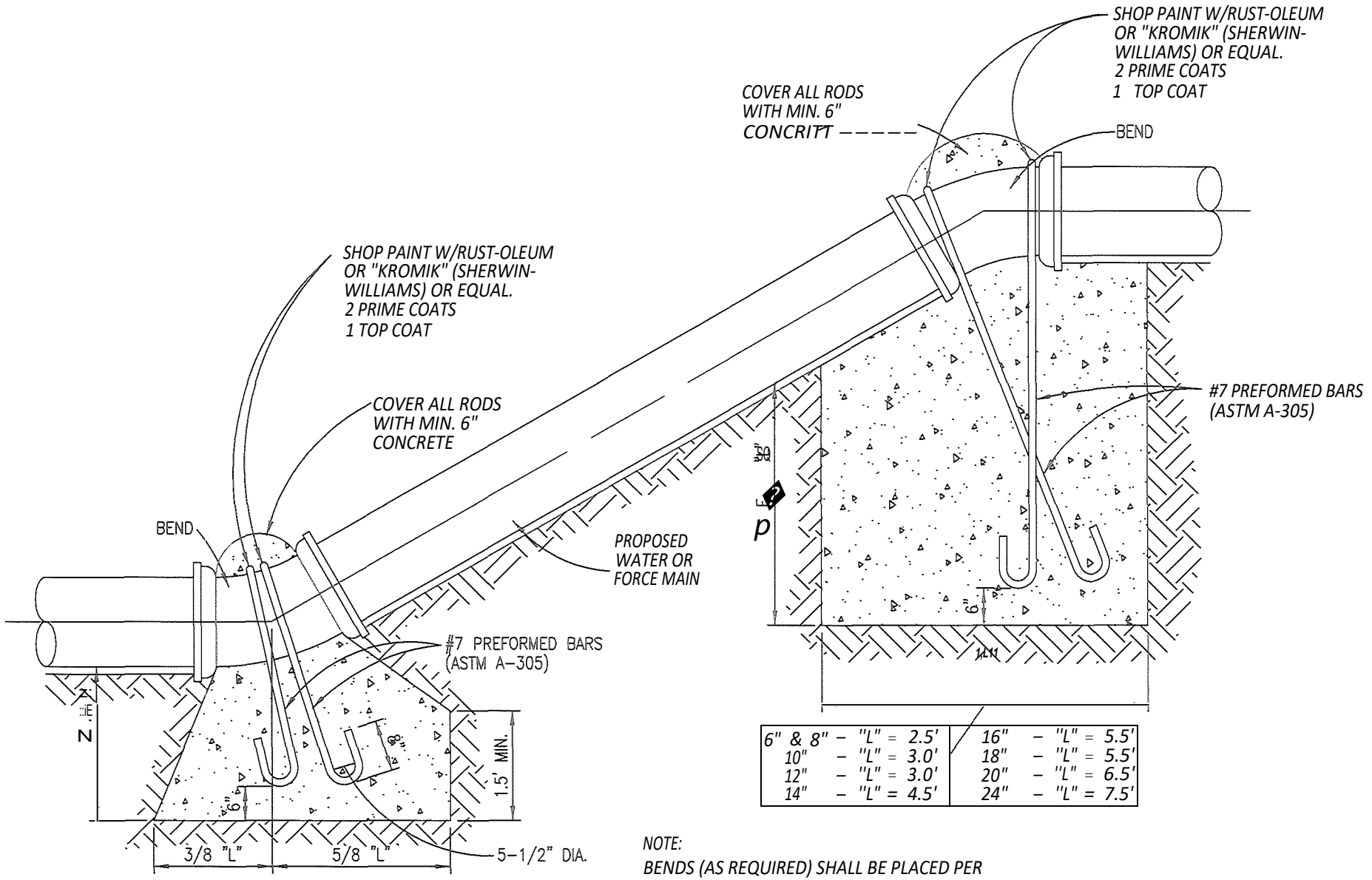
THRUST BLOCK DETAILS

NO SCALE

GD-7

DIAMETER OF PIPE D	90° BEND			45° BEND			22-1/2° BEND			11-1/4° BEND			PLUG			TEE			
																DIAMETER		T.B.	
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	D	DI	A	C
6"	2'0"	1'-1"	9"	18"	18"	1'-3"	1'-5"	21"	12"	12"	21"	12"	1'-1"	1'-3"	9"	8"	8"	2'0"	21"
8"	2'9"	2'0"	12"	2'0"	2'0"	15"	15"	21"	12"	12"	21"	12"	2'0"	2'0"	12"	12"	8"	2'0"	2'-1"
10" & 12"	4'-0"	3'0"	15"	3'-3"	3'0"	18"	2'0"	3'0"	15"	1'-5"	3'0"	1'-3"	3'0"	3'0"	15"	16"	8"	2'0"	21"
14"	5'-0"	3'-6"	18"	4'-6"	3'-6"	18"	2'6"	5'-6"	1'-0"	18"	5'-6"	18"	5'-6"	3'-6"	18"	12"	12"	3'0"	2'0"
16" & 18"	5'-6"	4'-0"	18"	4'0"	4'0"	21"	3'-0"	4'-0"	1'-6"	2'0"	4'0"	1'-6"	4'-0"	4'-0"	18"	16"	12"	3'-0"	2'0"
20"	7'0"	4'0"	21"	7'0"	4'0"	21"	3'-9"	4'0"	21"	2'-3"	4'0"	21"	3'-0"	4'0"	21"	20"	12"	3'-0"	2'0"
24"	8'0"	5'0"	24"	8'0"	5'0"	24"	4'-0"	5'0"	24"	2'9"	5'0"	2'-4"	7'0"	5'0"	24"	24"	12"	3'-0"	2'0"
																16"	16"	4'-0"	2'-5"
																20"	16"	4'-0"	2'-3"
																24"	16"	4'0"	2'-3"

STANDARD THRUST BLOCK DIMENSIONS



6" & 8"	– "L" =	2.5'	16"	– "L" =	5.5'
10"	– "L" =	3.0'	18"	– "L" =	5.5'
12"	– "L" =	3.0'	20"	– "L" =	6.5'
14"	– "L" =	4.5'	24"	– "L" =	7.5'

NOTE:

BENDS (AS REQUIRED) SHALL BE PLACED PER VERTICAL REACTION BLOCKING TO ENSURE MINIMUM COVER REQUIREMENTS ARE MET. CONCRETE TO BE 3500 P.S.I.

VERTICAL REACTION BLOCKING

NO SCALE

Sanitary Details

SANITARY GENERAL NOTES

1. ALL MANHOLE RIMS SHALL I:IE SET ro GRADE AS FURNISHED BY THE ENGINEER.

2. [◆ISERS ON SANITAI1Y SEWrns SHALL Bf:INSTALLED WHERE SEWER IS ovrn I 2' DEEP TO t\ DEPTH OF s' TO 1o· DEEP t\T THE PI◆OPERIY LINE.

3. ALL MANHOLES SHALL USE ECCENTRIC CONES PLACED TOWARD THE PROPERTY LINE UNLESS OTHERWISE NOTED.

4. NO FOOTING DRAINS SHALL BE CONNECTED TO THE BUILDING LEAD.

5. DIFFERENTIAL OF EXCAVATION AROUND EXISTING MANHOLES SHAU. NOT EXCEED 6'.

6. NO CONIJECTION RECEIVING STORM WATER, sur◆FACE WATER OR GROUNDWATER SHALL BE MADE TO SANITARY SEWERS.

7. ALL SEWERS SHALL BE SUBJECTED TO AIR, INFILTRATION OR EXFILTfWION TESTS, OR A COMBINATION OF SAME, BEFORE ACCEPTANCE.

8. WHEN CURB AND GUTTER RUNNING SUBSTANTIALLY PARALLEL TO THE NEW SEWEf◆ IS DAMAGED OR DISTUrmrn BY TH[CONTRACTOR'S OPEI◆ATIONS, IT WILL BE REPLACED BY THE CONTRACTOR AT HIS OWN EXPENSE, UNLESS THE PLANS INDICATE THAT THE CURB AND GUTTER IS TO BE REMOVED.

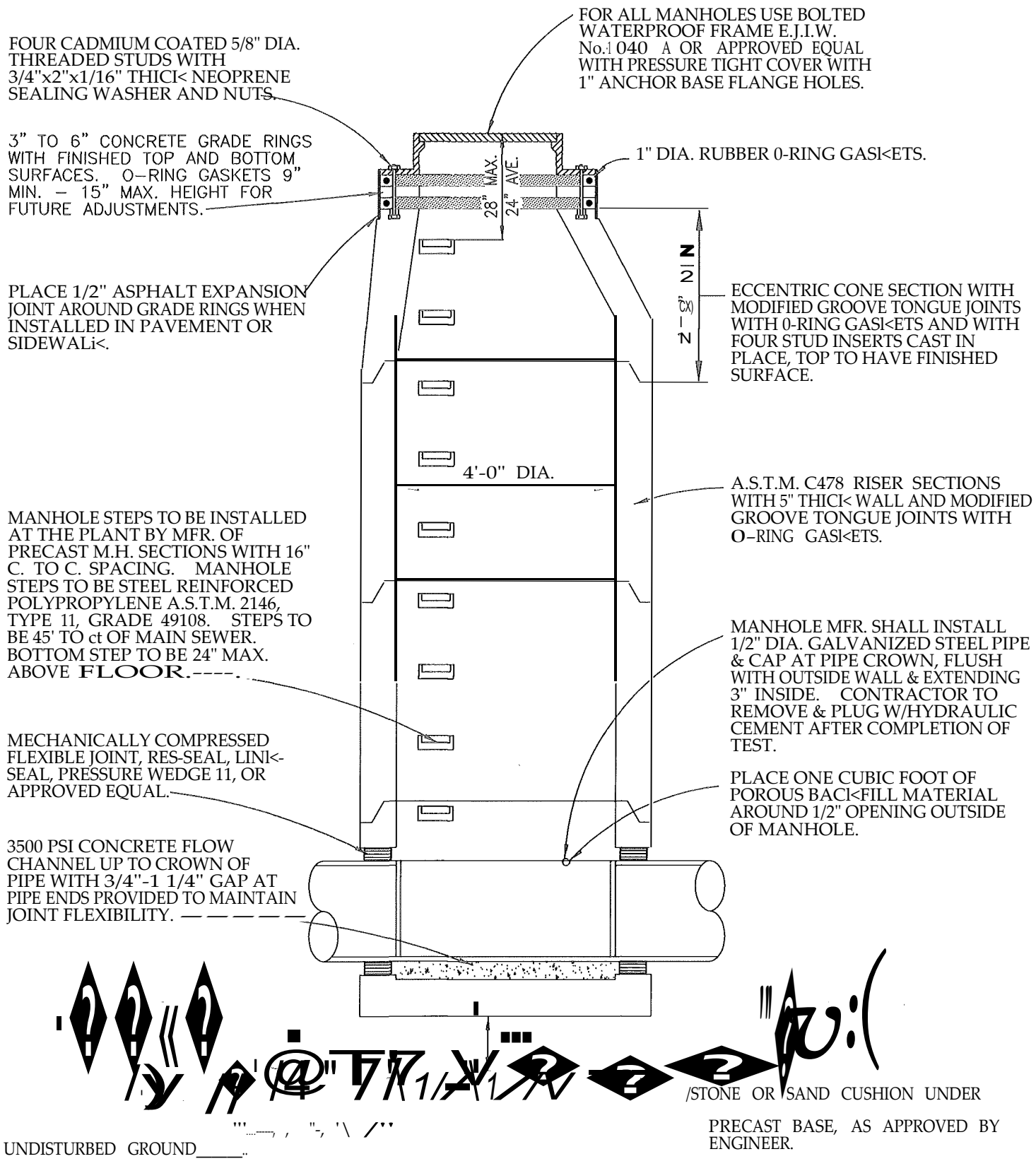
9. IN ROADWAYS, STREETS, DRIVES AND PARI<ING AREAS, THE BASE COUI◆SE SHALL BE REPLACED IMMEDIAITLY AFTER BACI<FILLING OF TI IE TRENCH.

10. NEW SANITARY SEWER BUILDING CONNECTIONS SHALL BE EXTENDED FROM SANITAI◆Y SEWER TO PI◆OPERIY UNI WHI:RE SHOWN ON THE PLANS. EXISTING SANITARY SEWER SHALL BE I<EPT IN SEI<VICE AT ALL TIMES DUf◆ING INSTALLATION OE NEW BUILDING CONNECTIONS.

11. ALL STUBS SHALL HAVE A WAIUTIGHT BULI<HEAD (PLUG).

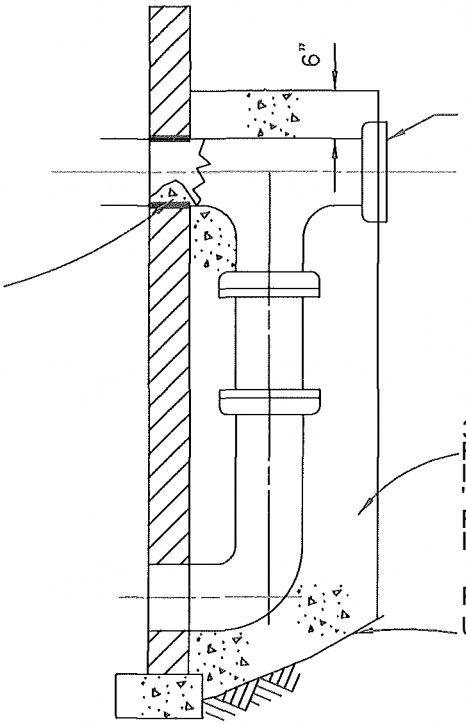
12. USE CIASS III B[])DING DETAIL UNLESS NOTED OTHrnWISE.

13. IN Af<EAS OF IWCK THE MINIMUM TRENCH WIDTH SHALL BE 30" FOf, FUTURE MAINTENANCE.



STANDARD SANITARY MANHOLE
FOR SEWERS 8" THRU 24"

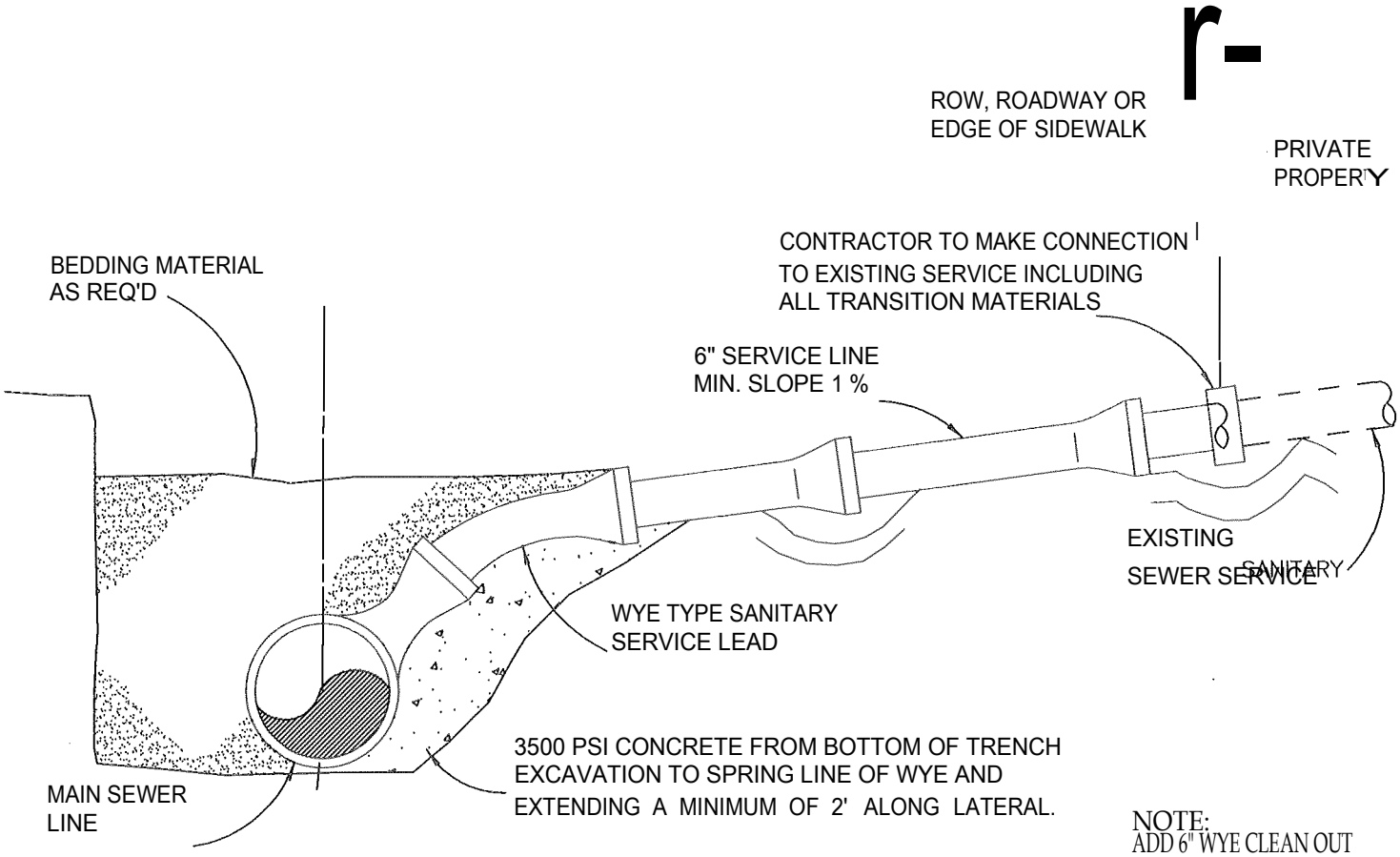
NO SCALE



DIA. OF SEWER	DIA. OF DROP CONNECTION
8" & 10"	8"
12",15" & 18"	12"
21",24", 27, & 30"	18"
36" & 42"	24"

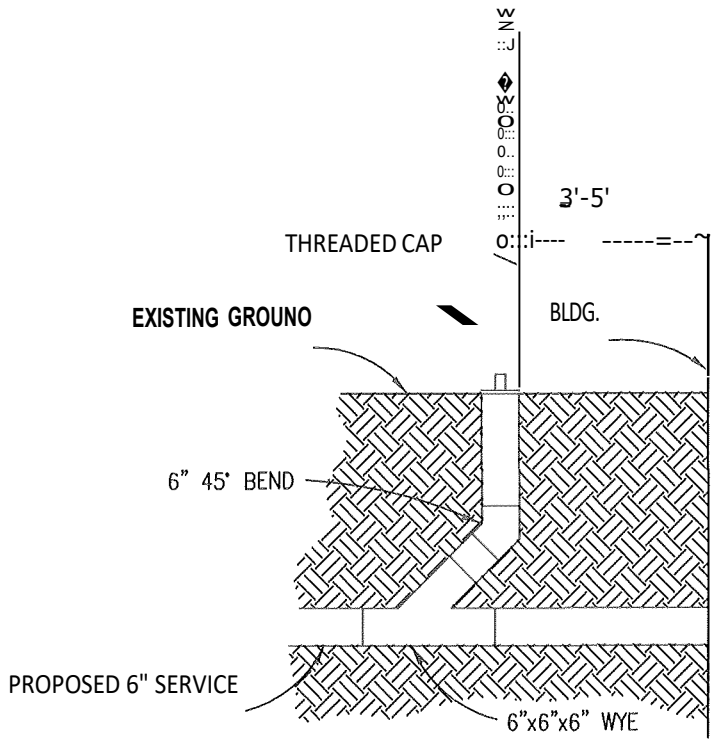
EXTERIOR DROP CONNECTION

NO SCALE



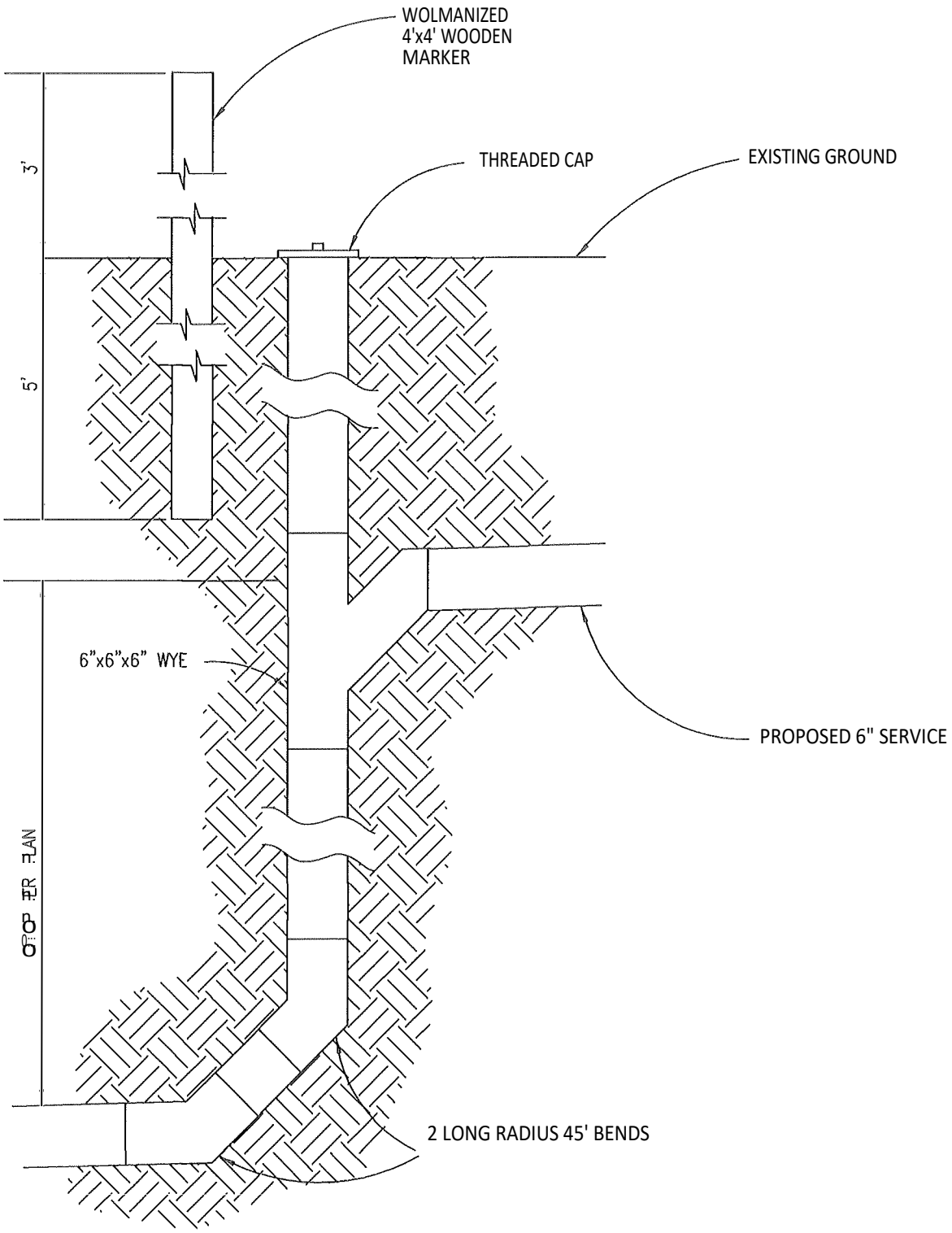
SANITARY SEWER SERVICE CONNECTION DETAIL

NO SCALE



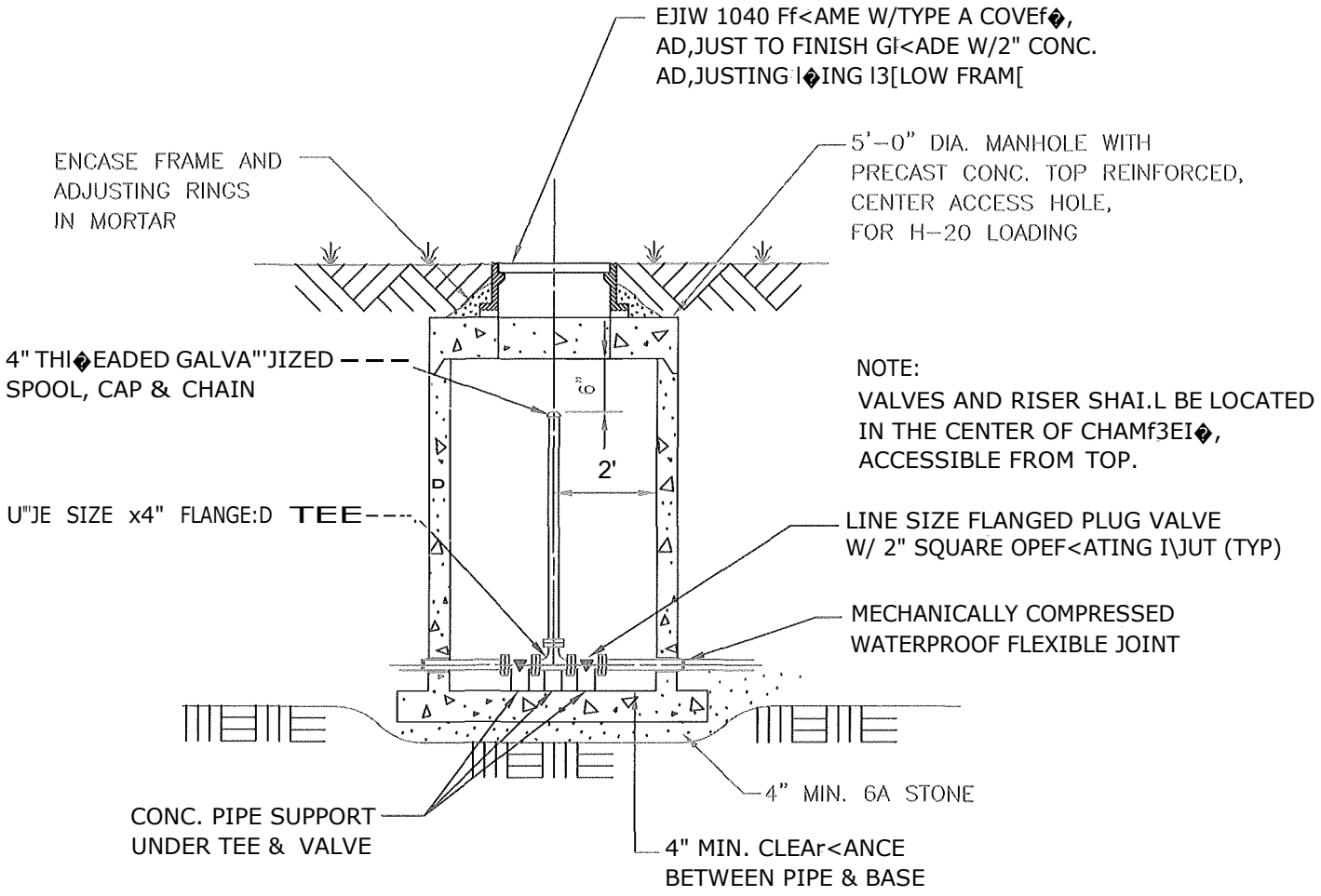
SANITARY SEWER SERVICE CLEANOUT DETAIL

NO SCALE



6" SERVICE DROP CLEANOUT DETAIL

NO SCALE



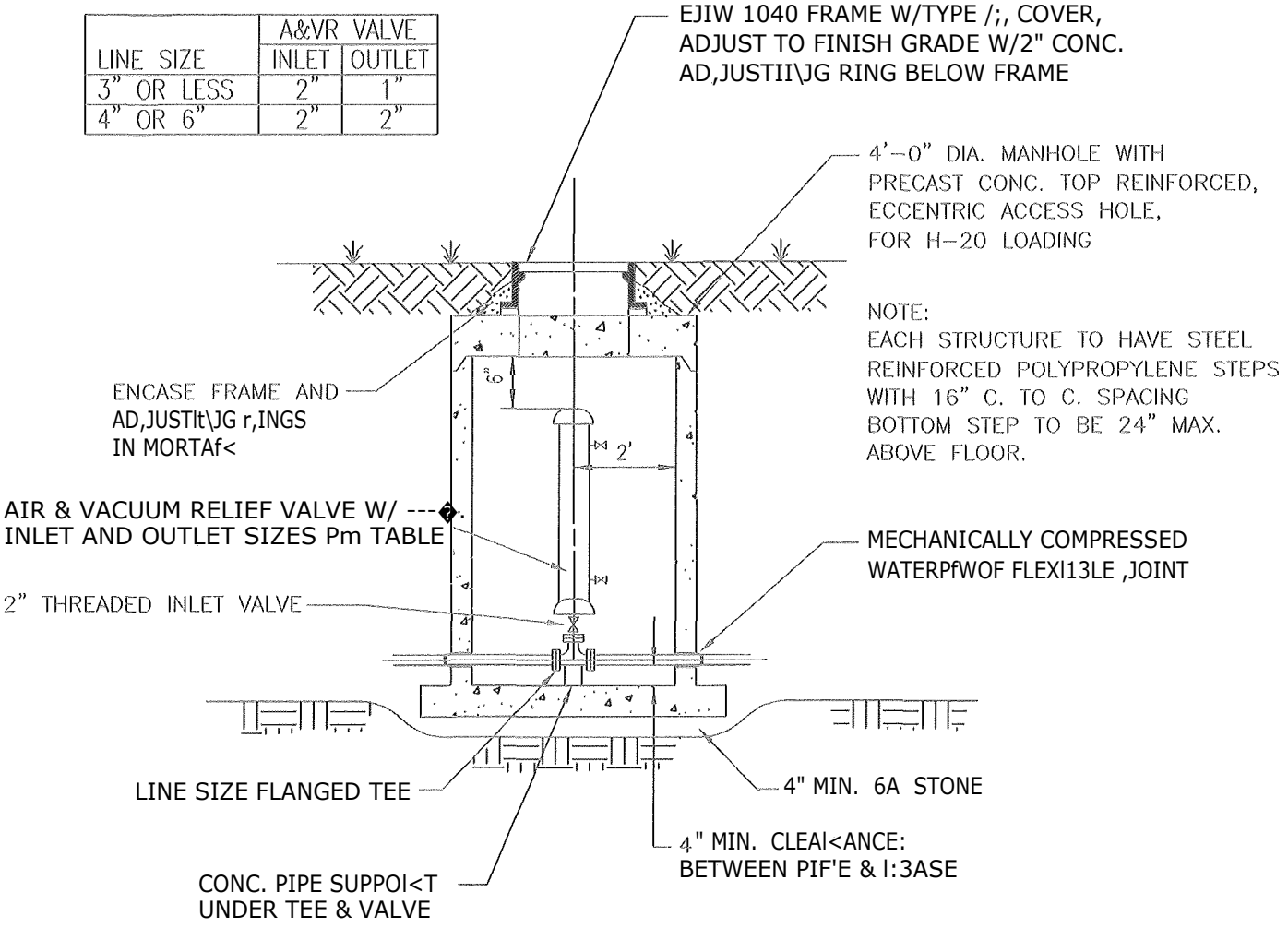
NOTE: REFER TO 11\J-LINE CLEANOUT DETAIL FOR LOW PRESSURE SEWEr●s.

NOTE: SEE VALVE / RISER PIPE SUPPORT
DETAIL PAGE S-10

FORCE MAIN CLEANOUT

NO SCALE

LINE SIZE	A&VR VALVE	
	INLET	OUTLET
3" OR LESS	2"	1"
4" OR 6"	2"	2"

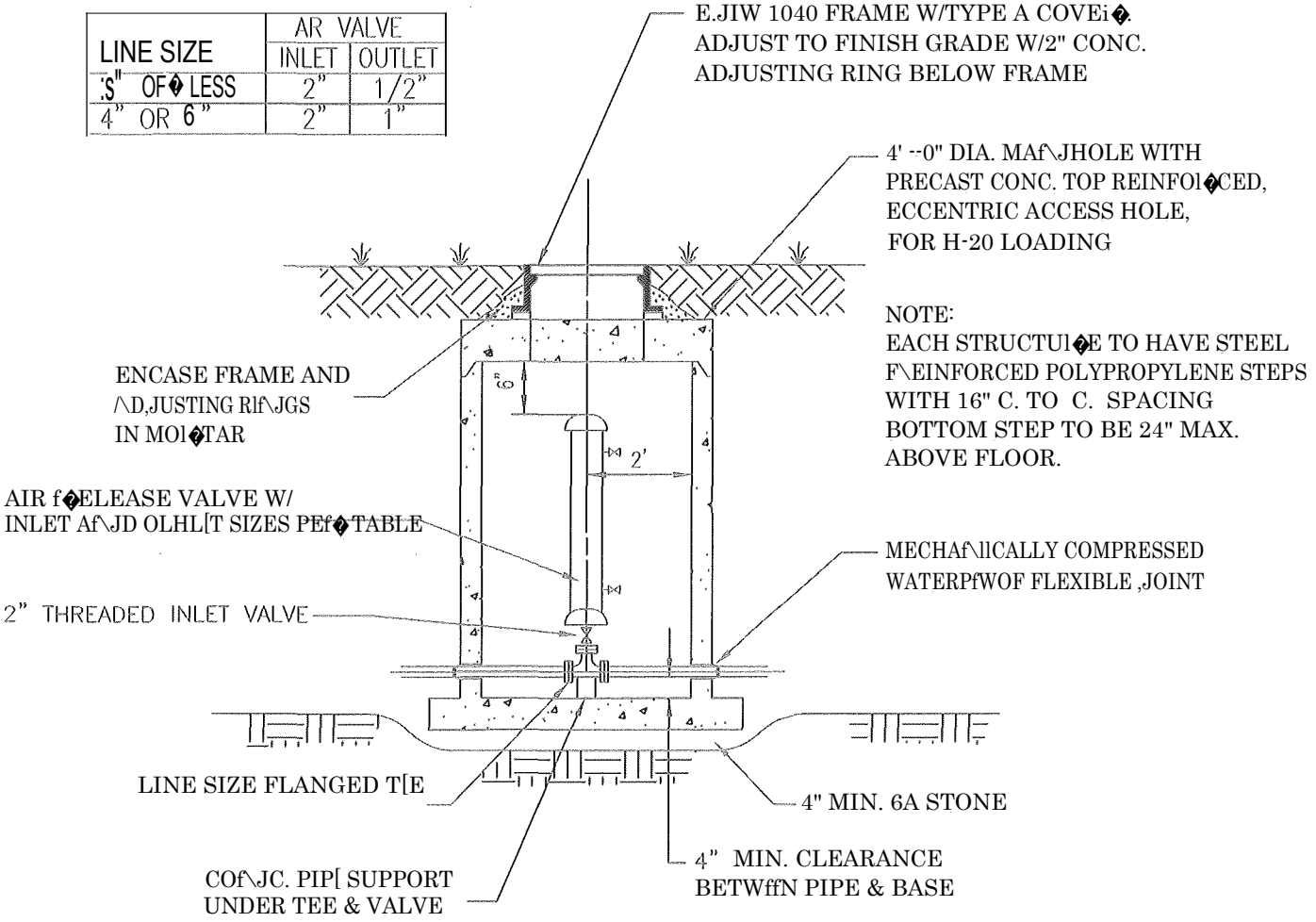


NOTE: SEE VALVE / RISEf< PIPE
SUPPORI DETAIL PAGE S-10

Alf & VACUUM RELIEF VALVE MANHOLE

NO SCALE

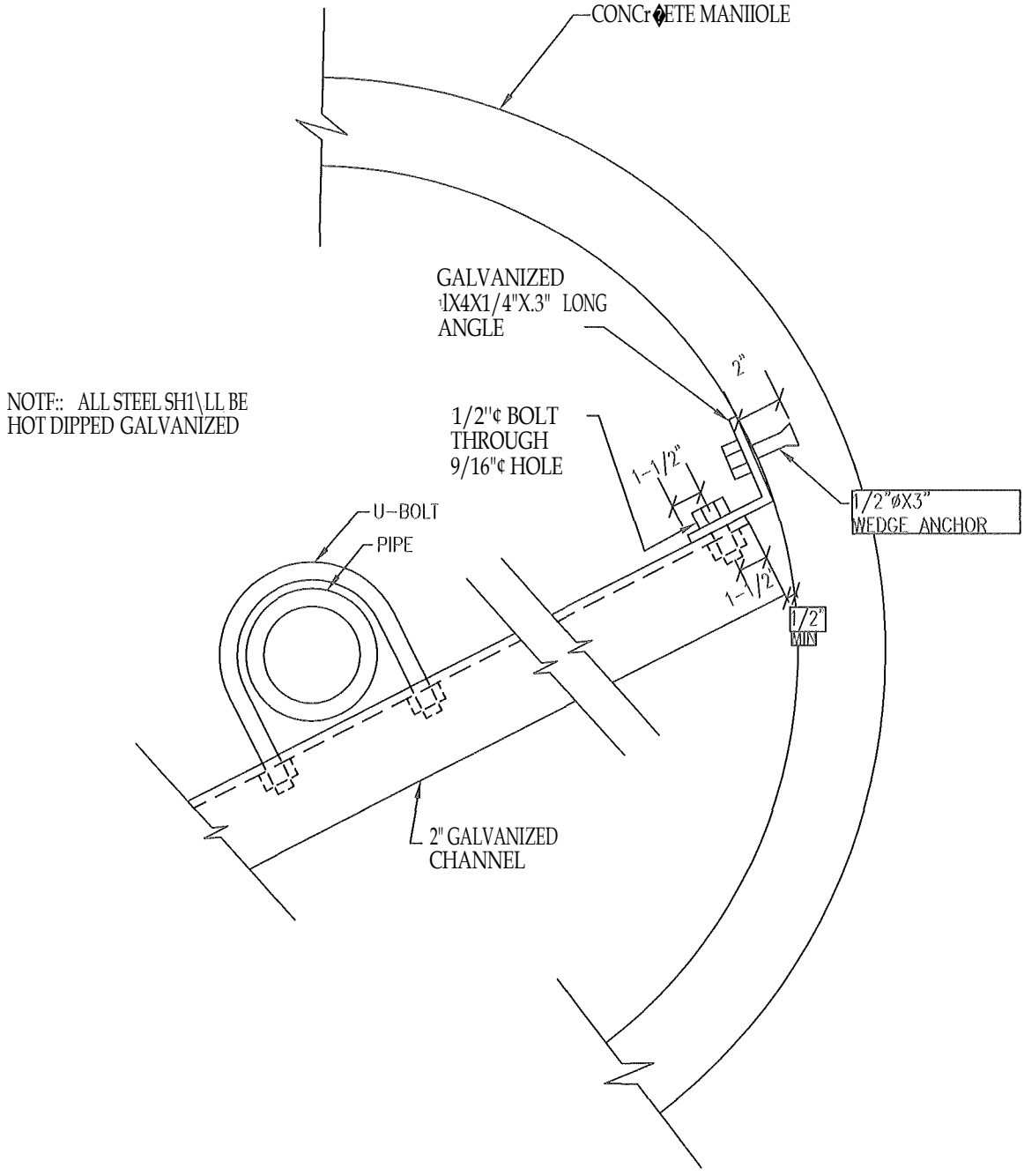
LINE SIZE	AR VALVE	
	INLET	OUTLET
3" OR LESS	2"	1/2"
4" OR 6"	2"	1"



NOTE: SEE VALVE / RISER PIPE SUPPORT DETAIL PAGE S-10

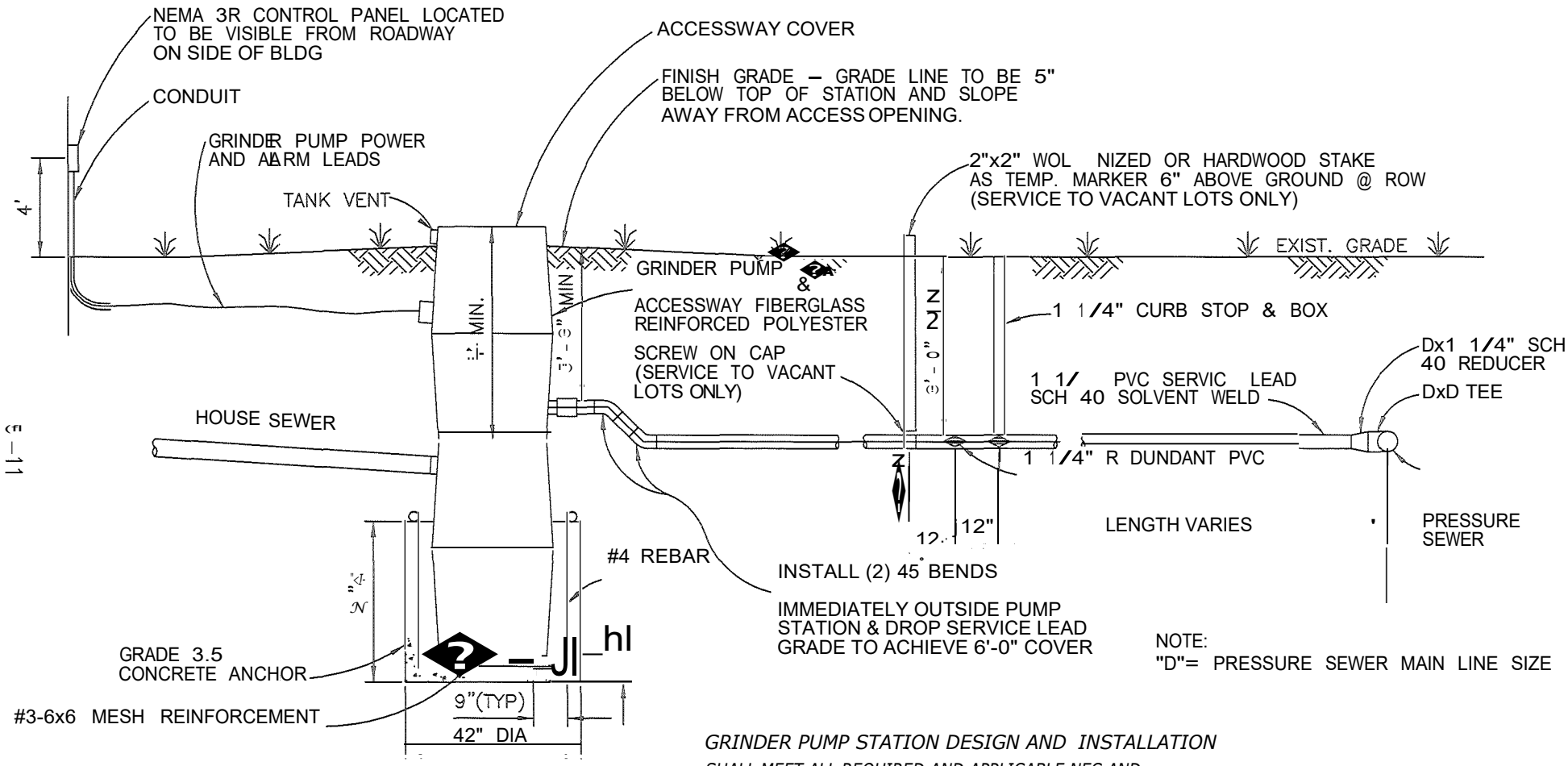
AIR RELEASE VALVE MANHOLE

NO SCALE



VALVE L RISER PIPE SUPPOF◆T

NO SCALE



NOTE:
"D"= PRESSURE SEWER MAIN LINE SIZE

GRINDER PUMP STATION DESIGN AND INSTALLATION SHALL MEET ALL REQUIRED AND APPLICABLE NEC AND NFPA 820 REQUIREMENTS FOR TIHE INTENDED APPLICATION AND USER IYPE.

PRESSURE SEWER SERVICE LATERAL AND GRINDER PUMP STATION

NO SCALE

Water Details

WATER - GENERAL NOTES

1. ALL SURF.ACE STRUCTUF◆ES, SUCH AS HYDRANTS, GATE WELLS, AND VAL.VE BOXES, SHALL BE SET TO GRADE AS FUF\NISHE:D BY THE ENGINEER.

2. ALL WATER SYSTEM COl'-JSTFWCTION SHALL CONFORM TO TI IE CURREf\JT STAl·JDARDS AND GENERAL SPECIFICATIONS OF THE AGENCWS HAVING JURISDICTION or· THE WATER SUPPLY SYSTEM AND CONSTRUCTION AREA.

3. PFWVIDE 6 FOOT MINIMUM COVER UNLESS OTHERWISE NOTED.

4. CLASS Ill BEDDlt\JG PEF\ STANDAFW DETAIL GD· 1 SH1\LL BE USED ON AI..L WATFR MAIN.

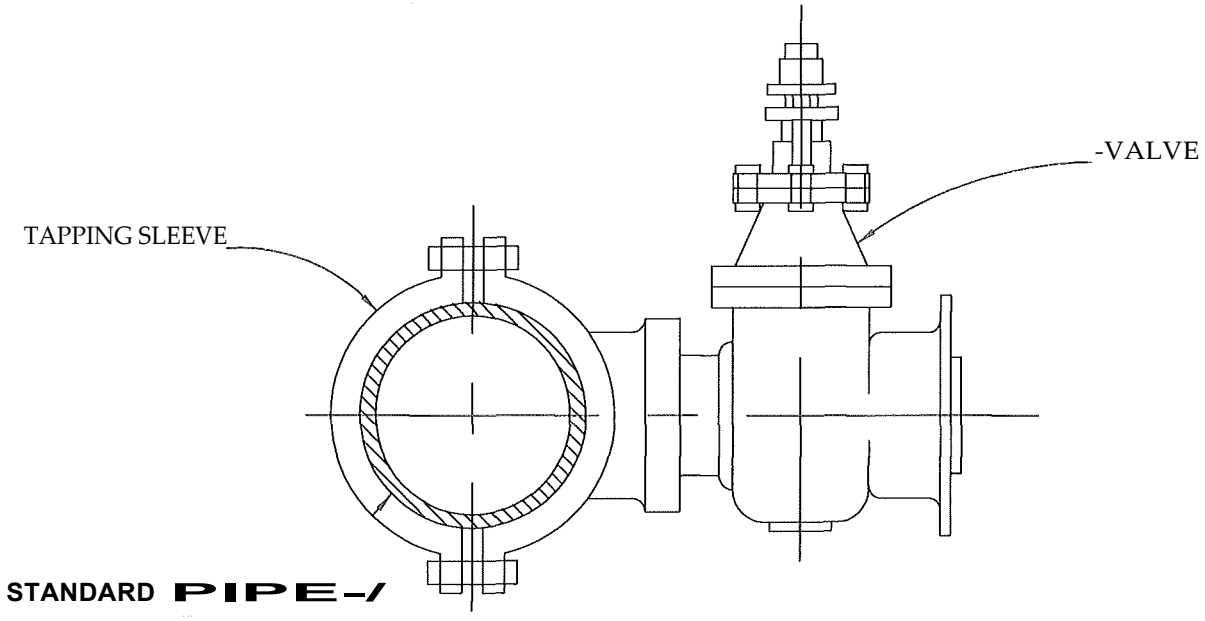
5. ALL HYDRAI'-JTS AND VALVES SHALL CONFORM TO rllE TYPE INDICATED li:l THE SPECIFICATIONS.

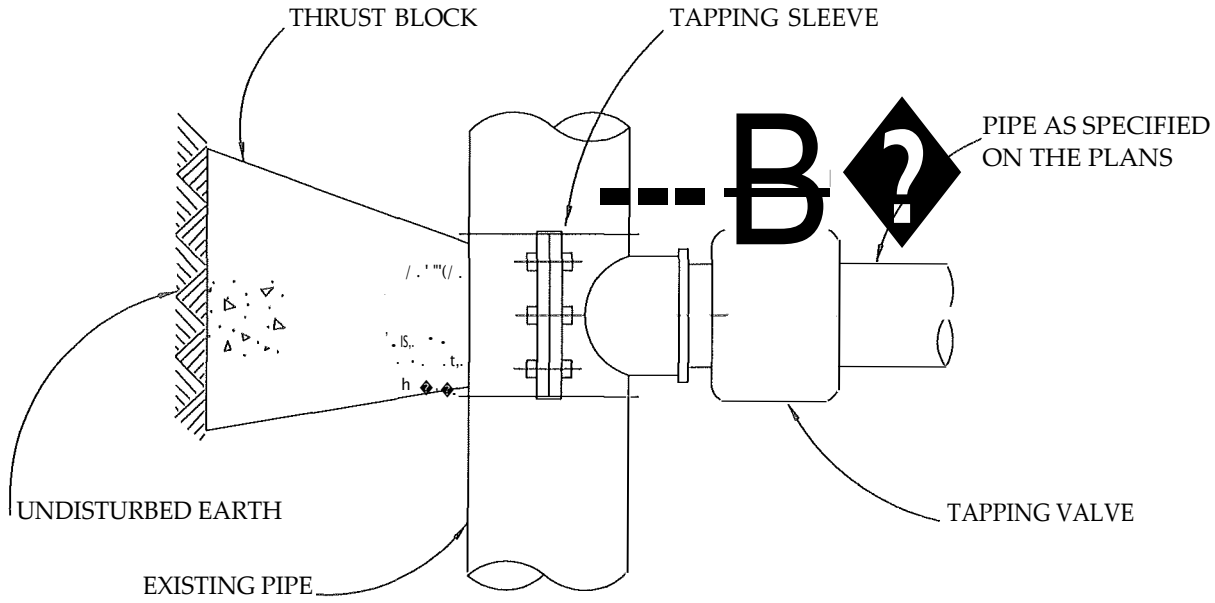
6. HYDI'<ANTS SHALL BE PLACED AS DIRECTED BY THE ENGINEEF<.

7. IN LOCATIOl·JS F\EQUIRING HORIZOI\JTAL THRUST BLOCK, A MECHANICAL ,JOINT f<ESTf<AINING DF:VICE MAY BE USED IN LIEU OF THE THRUST BLOCI<. THE DEVICE SHALL BE A MEGALUG BY EBBA IRON, li:JC. Of◆ EQUAi .

8. BACl<FILL OF rnENCHES ABOVE PIPE BEDDING SHALL MEET THE REQUIREMENTS OF GENEl'<AL SPECIFICATIONS SECTION 31 2333 AND AWWA C600 01'< C605.

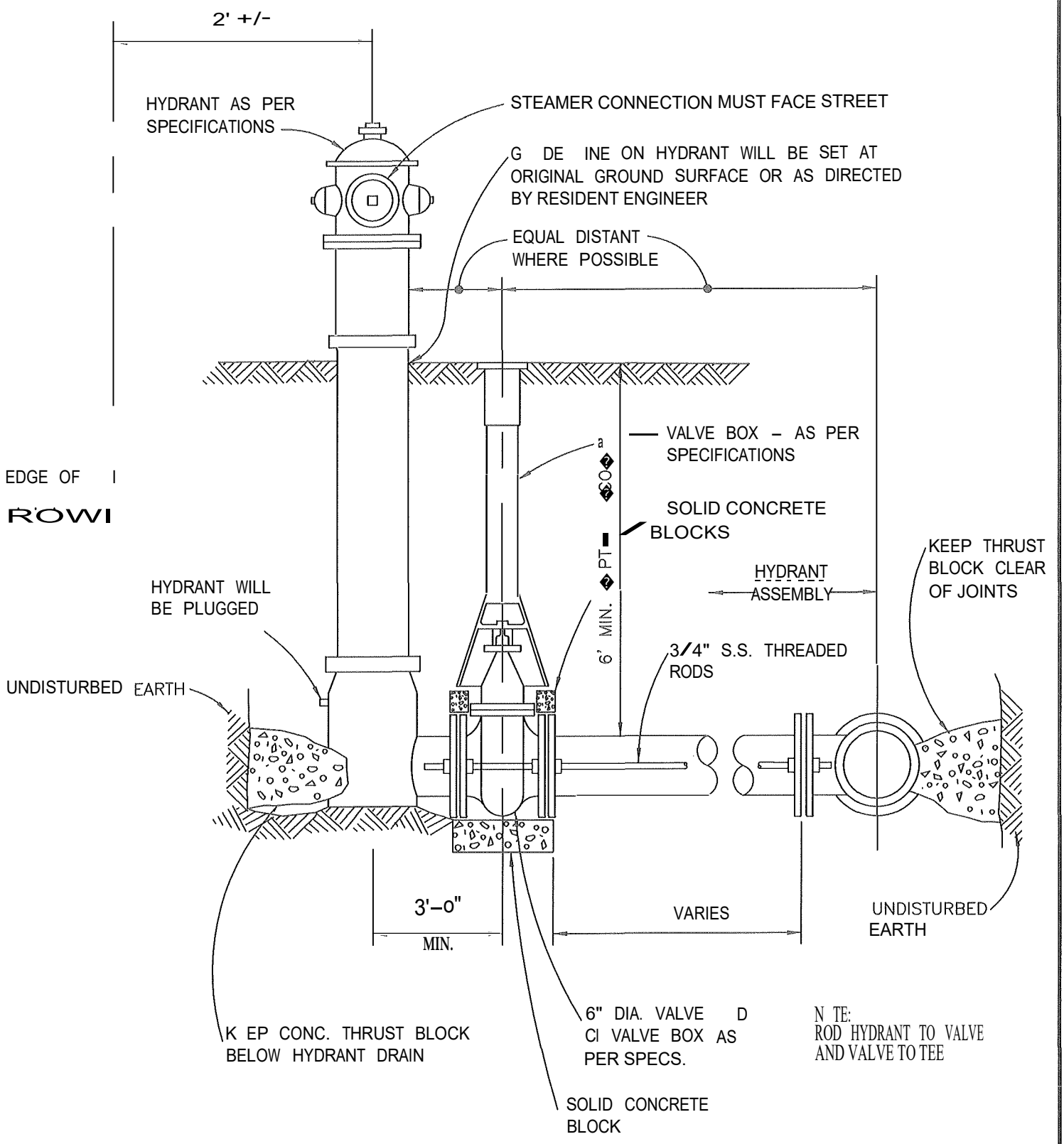
9. lf\J AREAS OF ROCK THE MINIMUM Tl'<[f\JCH WIDTH SHALL BE 30" FOR THE FUTURE MAINTENANCE.





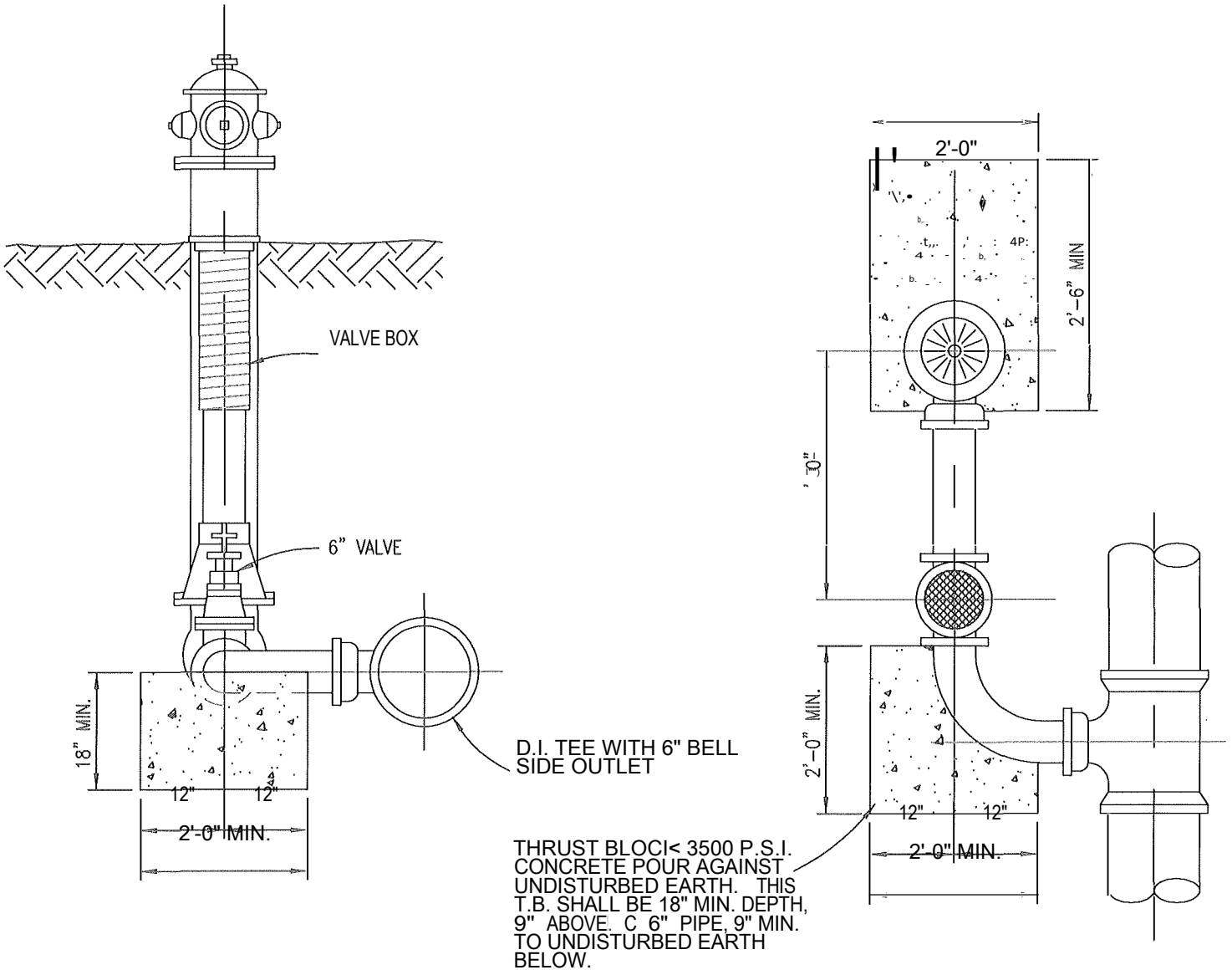
TAPPING SLEEVE AND VALVE ASSEMBLY

NO SCALE



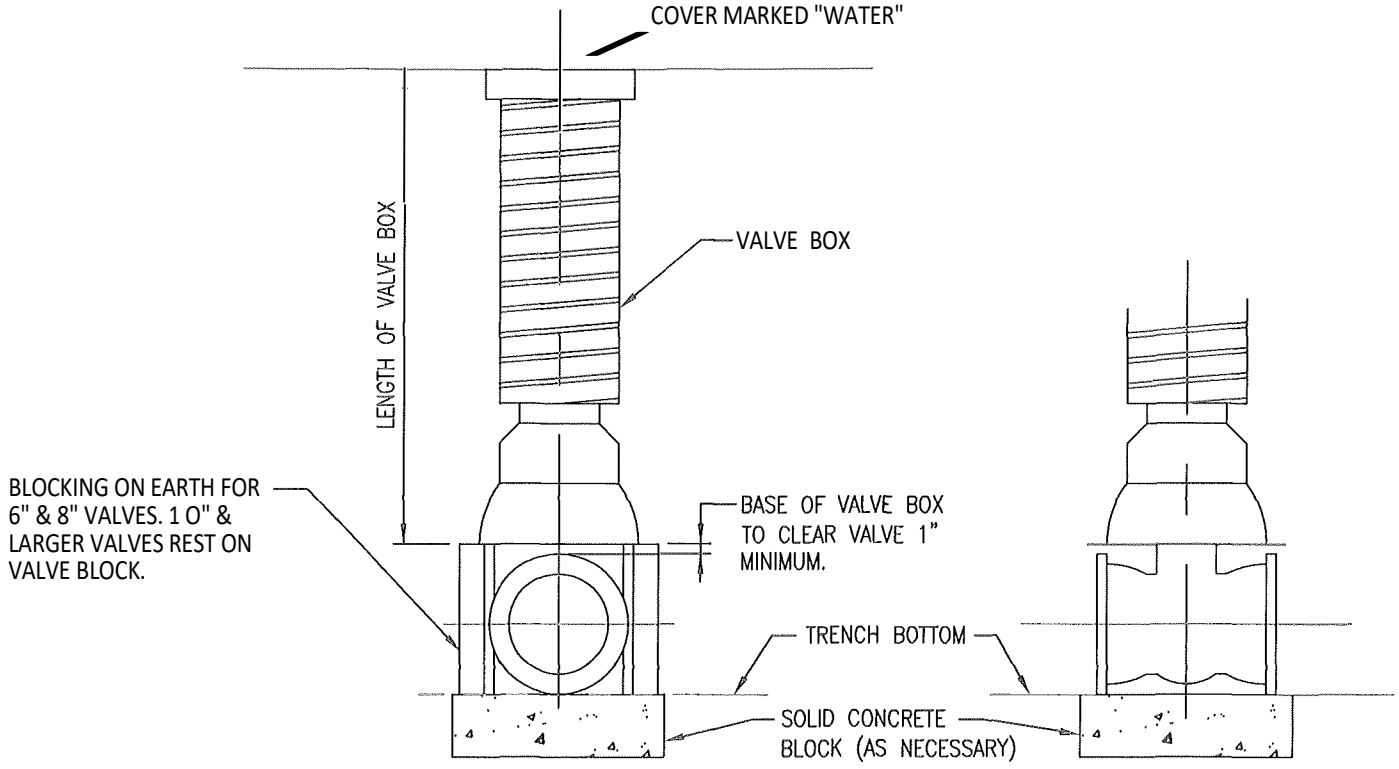
HYDRANT SECTION

NO SCALE



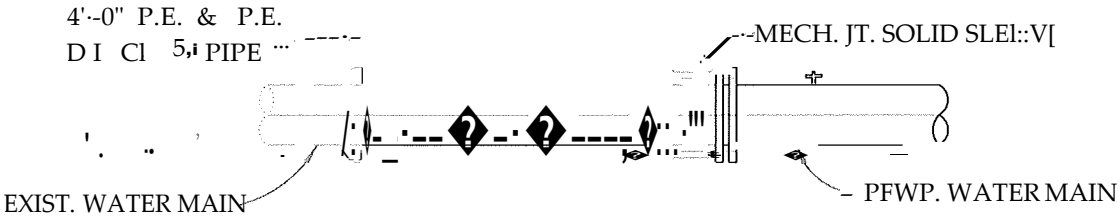
CLOSE COUPLED HYDRANT SETTING

NO SCALE



VALVE BLOCK AND BOX DETAIL

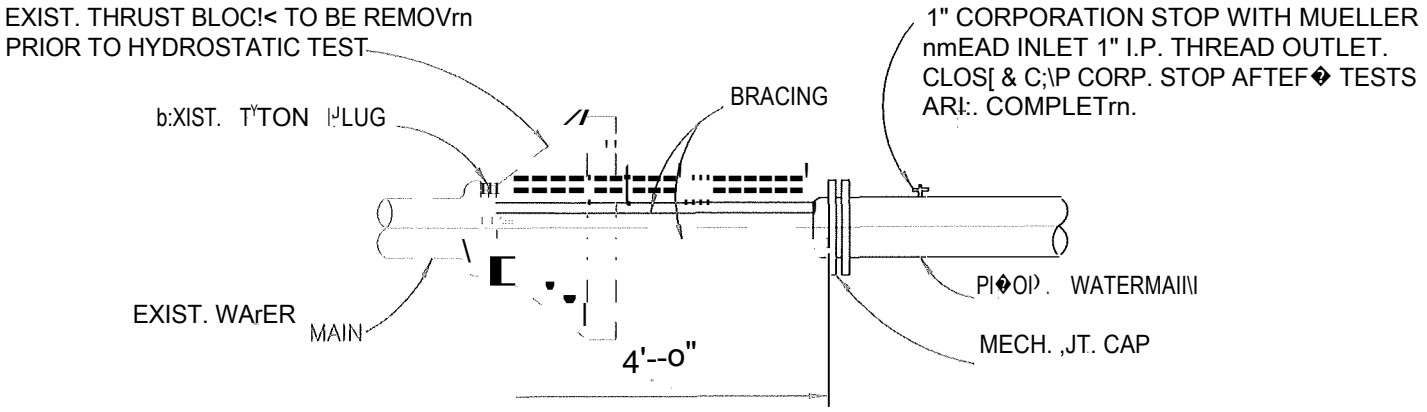
NO SCALE



NOTE:
ALL ,JOINTS NOT SUF3JI::CTED TO
HYDf◆OSTATIC TEST SHALL BE OBSEFMJJ
UNDER LINE PF<ESSURE TO ASSUF◆E
WATERTIGHTNESS.

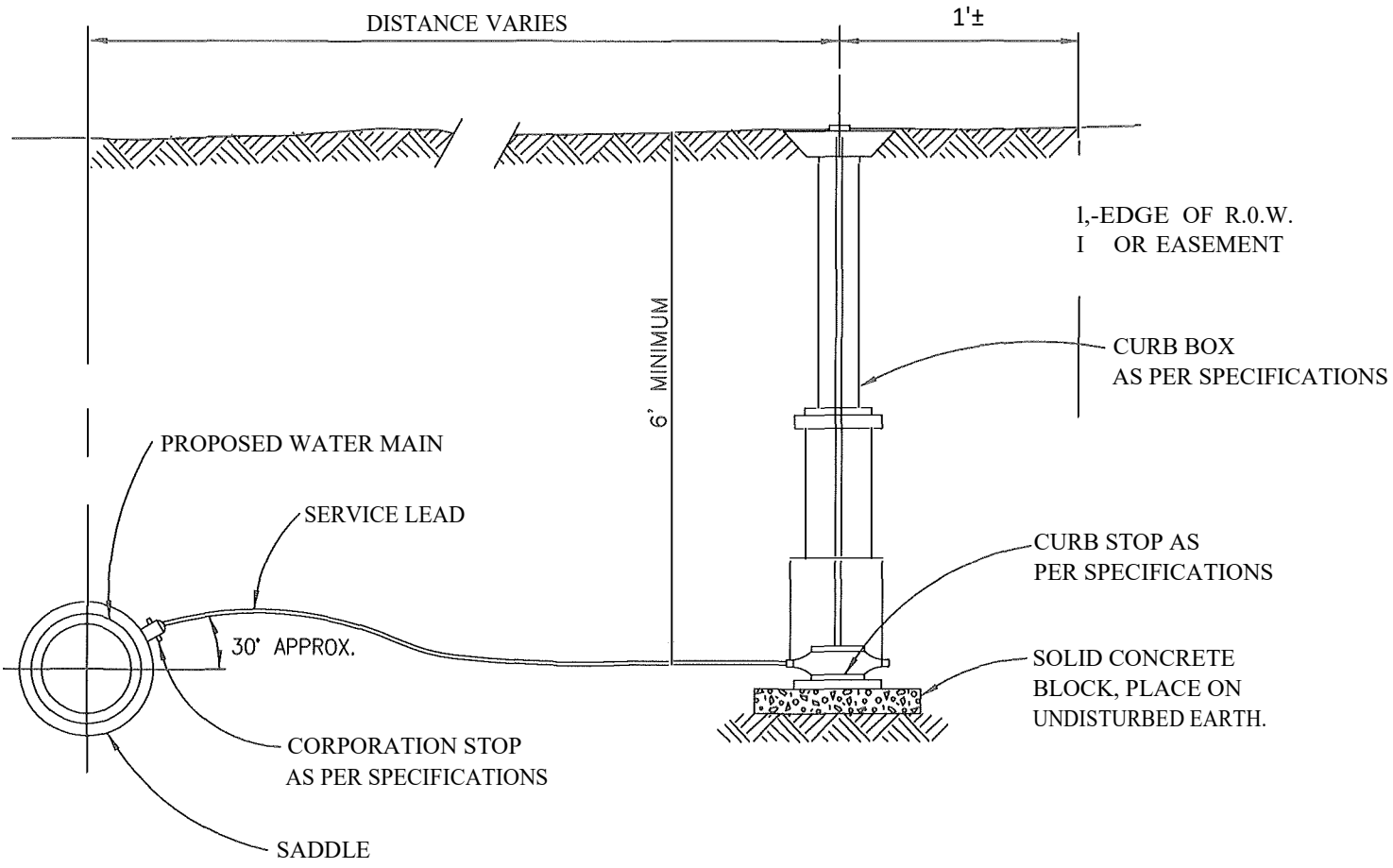
COMPLETED CONNECTION TO EXISTING WATER MAIN

NO SCALE



TEMPORARY ARRANGEMENT FOR HYDROSTATIC TEST

NO SCALE



WATER SERVICE CONNECTION

NO SCALE

General Specifications

Section 03 3000
Cast-in-Place Concrete

Part 1 General

1.01 Scope

This Section includes all monolithic cast-in-place concrete work complete with materials, mixes, installation and testing.

1.02 Related Work Specified Elsewhere

Dewatering: Section 31 2319

1.03 Reference Standards

Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:

ACI - American Concrete Institute
ASTM - ASTM International
MDOT - Michigan Department of Transportation, Standard Specifications for Construction, 2003

1.04 Reference Specifications

The latest or current ACI Standards and Code Requirements for "Concrete and Reinforced Concrete" shall govern all concrete Work except where otherwise specified herein.

1.05 Testing Agency

All inspections and tests required by this Section shall be performed by organizations acceptable to the TOWNSHIP.

1.06 Design Criteria

Mixes shall be designed and tested for each size and gradation of aggregates and for each consistency intended for use. Design quantities and test results of each mix shall be submitted for review.

1.07 Source Quality Control

Furnish tests of cement and aggregates. Material sampling shall conform to the following ASTM Standards:
Cement C183
Aggregates D75.

Testing shall be in accordance with applicable ASTM Standards to assure compliance with Specifications.

Make tests for the following quantities, or fraction thereof:

Cement	550 tons (500 metric ton)
Fine Aggregate	2,000 Tons (1800 metric ton)
Coarse Aggregate	2,000 Tons (1800 metric ton)

Use same brand cement for any given structure produced by a single mill unless otherwise provided by authorization of the ENGINEER.

1.08 Submittals

The CONTRACTOR shall submit test reports for cement and aggregates to assure compliance with the Specifications.

Concrete mixture designs and test data shall be submitted for review by the ENGINEER with a written request for approval. No concrete shall be placed until the CONTRACTOR has received such approval in writing.

Each mixture report shall include:

- Slump on which design is based.
- Total gallons of water per cubic yard (l/m^3).
- Brand, type, composition, and quantity of cement.
- Brand, type, composition, and quantity of pozzolan or other mineral admixtures.
- Brand, type, composition, and quantity of ground granulated blast furnace slag.
- Specific gravity and gradation of each aggregate.
- Ratio of fine to total aggregates.
- Weight (surface dry) of each aggregate, lbs./c.y. (kg/m^3).
- Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
- Air content.
- Compressive strength based on 7-day and 28-day compression tests.
- Time of initial set.

Submit a sample concrete delivery ticket for review by the ENGINEER.

Submit tickets collected at the site of concrete placement accompanying each load of concrete. A printout system for producing these tickets in connection with automatic batching will be permitted.

Each ticket shall be serially numbered, show the charging time, quantity and grade of concrete, location of delivery and the signatures of inspectors at the plant and site. Transit mixed concrete tickets shall also include revolution counter reading at charging and mixing completion.

Submit reports of the sampling and testing of slump, air content and strength performed.

1.09 Material Storage and Handling

Materials shall be stored and handled in accordance with ACI 304 and as specified below.

When permission is given to store cement in the open, a floor at least six (6) inches (150 mm) above the ground and a waterproof covering shall be provided and so placed as to insure runoff in case of rain. Cement sacks shall be thoroughly shaken when emptying sacks into the batch. Cement salvaged by the CONTRACTOR by cleaning sacks mechanically or otherwise, or from discarded sacks of cement, shall not be used in the Work. The use of a fractional sack of cement will not be permitted unless the fractional part is measured by weight. At the time of its use in the Work, the cement shall be free from lumps.

No aggregates which have become intermixed prior to proportioning shall be used. Sufficient aggregate shall be available at the site to preclude the possibility of damaging delays while placing the concrete.

Cars used for shipping aggregates shall be clean and in good repair. The use of straw, marsh, hay or other similar materials for closing cracks or holes in cars will not be tolerated.

Store and handle curing compound in a manner to prevent contamination.

1.10 Environmental Requirements

Environmental requirements shall be in accordance with ACI 305 for hot weather concreting, and ACI 306 for cold weather concreting. Specific temperature requirements are contained in Article 2.10 of this Section for mixing and Article 3.13 of this Section for placing.

Part 2 Products

2.01 Materials - General

The materials shall meet the requirements of ACI 301, ACI 318, and MDOT Specification, Division 9.

Concrete materials shall be tested and inspected as the Work progresses. The review and/or check-test of the proposed materials, securing of production samples of materials at plant stockpiles and/or review of the manufacturer's reports for compliance will be performed at no cost to the TOWNSHIP.

Testing and inspection required due to substitution or change of materials requested by the CONTRACTOR shall be at the CONTRACTOR's expense.

2.02 Cement

Cement shall be the type as indicated on the Plans or as specified.

- Type I and IA, conforming to ASTM C150, air-entraining Portland cement when special properties are not specified.
- Type III and IIIA, conforming to ASTM C150, air-entraining Portland cement for use when high-early strength is specified.

2.03 Aggregates

Washing will be required to eliminate the dust, clay, or silt coating. Aggregates which have been washed shall not be used sooner than 24 hours after washing, unless approved by the ENGINEER.

Coarse aggregate shall be gravel or crushed rock, conforming to MDOT Section 902.03, Class 17A for members eight (8) inches (200 mm) or less in thickness and Class 6AA for other construction.

Gravel shall consist of hard, clean, durable particles of rock or pebbles and shall be free from lumps of clay.

Crushed rock shall consist of angular fragments of crushed hard heads or boulders or crushed igneous rock free from weathered rock and of uniform quality.

All sieve and screen analyses determination of clay, silt, and dust content and percentages of objectionable particles will be based on dry weights and conform to MDOT Section 902.03, Table 902-1, "Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open Graded Aggregates" and Table 902-2, "Physical Requirements for Coarse Aggregate, Dense Graded Aggregates and Open Graded Aggregates."

Fine aggregate shall be sand size 2NS, MDOT, Section 902.09.

Fine aggregates shall consist of sharp sand which shall be composed of clean, hard, durable grains and shall be free from lumps of clay and organic deleterious substances.

Fine aggregates shall conform to MDOT Section 902.09 and Table 902-4, "Grading Requirements for Fine Aggregates."

2.04 Admixtures

Admixtures shall be used to achieve concrete as indicated on the Plans or specified herein. Calcium chloride shall not be used.

- Air-entraining, conforming to ASTM C260.
- Pozzolan and Fly Ash, conforming to ASTM C618, Class C or F.
- Water reducing, conforming to ASTM C494.
- Retarder, conforming to ASTM C494.
- Plasticizer, conforming to ASTM C494.
- Ground granulated blast furnace slag conforming to ASTM C989, grade 100.

2.05 Water

Water shall be free from oil, acid, alkali, organic matter, and any other deleterious substances. Water approved by the Local Board of Health may be used without testing. Water from other sources shall be tested before using.

2.06 Mixes

Concrete shall consist of a mixture of air-entraining Portland cement, coarse and fine aggregate, and water with admixtures if required. Admixtures shall not be used without the ENGINEER's review. The mixture, combined in proportions, shall meet the requirements of MDOT, Specification Section 701, and ACI 211.1.

Concrete shall be classified and proportioned on the basis of minimum compressive strength at 28 days when cured in a moist room at a temperature within the range of 65 degrees to 75 degrees F (18° to 24° C). The desired strength of the concrete shall be shown on either the Plans or in the Specifications.

Table 1 shows for each grade of concrete the minimum compressive strength, cement content, and the modulus of rupture. Concrete shall be 3,500 psi, Grade 3.5, unless otherwise shown on the plans.

Aggregates shall be proportioned by weight, except for small structures and for incidental Work requiring less than ten (10) cubic yards (7 m^3) of concrete, in which case they may be proportioned by volume when approved by the ENGINEER.

Cement in bulk, when permitted, shall be proportioned by weight.

When proportioned by volume, the amount of each aggregate required for a single batch shall be measured separately and accurately. Shovel methods of measuring will not be permitted. The unit of volumetric measurement shall be one (1) cubic foot or one (1) cubic meter.

When proportioned by weight, the amount of each aggregate required for a single batch shall be weighed in a separate container. The equipment for weighing shall be of an approved type, and of such accuracy that there shall not be an error of more than one (1) percent in any one (1) batch.

2.07 Batching Admixtures

The batching of admixtures to achieve and maintain production of the mix design of concrete shall be in accordance with ACI 212.

If the air content is found to be less or greater than the specified amount, the CONTRACTOR shall immediately discontinue Work and correct the air content.

Decreasing the air content may be accomplished by blending air-entraining Portland cement with Portland cement, manufactured at the same mill, in a ratio which will reduce the air content to a value within the specified limits, this blending shall be reviewed by the ENGINEER.

Increasing the air content may be accomplished by adding to each batch a sufficient amount of air-entraining admixture to bring the air content up to the designed amount.

Pozzolan and ground granulated blast furnace slag shall be proportioned based on the mix design approved by the ENGINEER per Article 1.09 of this Section to produce watertight concrete.

Water Reducer can be used to reduce the water requirement of concrete to obtain consistency of slump, modify workability, increase strength or any other approved use.

2.08 Temperature Limits of Mixture

The temperature of the cement, at the time of delivery to the mixer, shall not exceed 165 degrees F (74°C). It may be required that it be stored at the CONTRACTOR's expense until cooled to that temperature.

The temperature limits of aggregates and water entering the mixer shall be as follows:

LIMITS OF TEMPERATURES

	Minimum	Maximum
Water	75°F (24°C)	140°F (60°C)
Fine Aggregate	65°F (18 °C)	140°F (60°C)
Coarse Aggregate	65°F (18°C)	110°F (43°C)
Concrete (resulting)	60°F (15°C)	90°F(32°C)

2.09 Mixers and Mixing

Concrete mixing operations shall be in accordance with ACI 304 and MDOT, Section 701, and shall be subject to random inspection during the progress of the Work at no charge to the CONTRACTOR.

A. Central Mixed Concrete

Mixers shall be capable of quickly and completely discharging without segregation or loss. The efficiency of the mixers shall be maintained at all times through repair or replacement of worn parts when necessary. They shall be provided with readily adjustable, automatic devices which will measure the cement and water within one (1) percent and admixtures within three (3) percent. The drum of the mixer shall be kept free from hardened concrete and shall be completely emptied before recharging. Retempering or remixing concrete that has partially set will not be permitted. The mixer shall be cleaned thoroughly each time when out of operation for more than 1/2 hour.

Recommended mixing time is a minimum time of one (1) minute for one (1) cubic yard (or cubic meter), with an additional 15 seconds for each additional cubic yard (or cubic meter).

The concrete shall be delivered to the site in clean, tight truck bodies designed for this purpose and painted with paraffin if necessary for easy dumping. The concrete at the point of delivery shall have the proper consistency and shall be free from segregation. Mechanical agitators in the truck bodies will be required if the period of time from the mixing plant to the point of dumping exceeds 30 minutes.

No concrete shall be dumped if the elapsed time from the mixing plant to the point of dumping exceeds 60 minutes.

B. Transit Mixed Concrete

Transit-mix concrete shall be in accordance with ASTM C94. If transit-mix concrete is used, it shall meet all the foregoing requirements specified for central mixed concrete and, in addition, the following:

The batched materials shall be properly proportioned and in a dry state. The proper amount of water shall be added to the mixer on the trucks, and no additional water shall be added. No admixtures or accelerators shall be added except as herein noted, without the approval of the ENGINEER. Trucks shall not be loaded beyond their rated capacity and shall have mixing drums cleaned of all set-up materials at frequent intervals while in use. Trucks with leaking water valves shall not be used.

Recommended mixing speed should be no less than 12 revolutions per minute, with a minimum of 90 revolutions or until the mix is satisfactory.

Mixing shall be continuous after water is added to the mix in the drum, but no concrete shall be placed in the forms more than 90 minutes after water is added to the mix.

Truck-mixed concrete shall be delivered to the site of the Work and discharged from the mixer within the maximum period of 1-1/2 hours from the first introduction of water to the mix. Any concrete which remains in the mixer after this period and any concrete which appears too stiff to be properly workable or which appears to have begun to take its initial set shall be rejected and removed from the site of the Work.

The OWNER may employ an independent testing laboratory to provide a qualified inspector to be present at the plant where batching of concrete occurs. The inspector shall verify the compliance of the mix with the Specifications and shall sign a form indicating the quantity of concrete and the concrete mixture of each load.

2.10 Change of Mixture

If the CONTRACTOR requests a change or substitution of approved batch proportioning, mixing, or delivery operations additional testing and/or inspection shall be at the CONTRACTOR's expense.

Part 3 Execution

3.01 Verification of Formwork, Reinforcing, and Subgrades

The CONTRACTOR shall inspect formwork, reinforcement and subgrades to confirm compliance with the related Work specified elsewhere.

3.02 Embedded Items

The CONTRACTOR shall verify the location, from certified vendor or applicable engineering drawings, of all embedded items including anchor bolts, wall sleeves, wall casting, railing post sleeves and miscellaneous pipes and conduits and shall install the items accurately at the locations determined.

3.03 Building in Other Work

The CONTRACTOR shall make all necessary provisions in concrete Work for other Work installed by this or other contractors, and build in all required steel beams, frames, curbs, expansion joints, inserts, hangers, pipes, floor drains, pipe trench covers and frames, anchors, sleeves, floor ducts, fiber and steel conduit, pipe hanger sockets, and all other Work furnished by either this or other contractors.

The CONTRACTOR shall build in all anchors, ties, etc., specified under brick and other Work, in faces of concrete Work which are to be faced with masonry, and any other Work shown or noted to be built into concrete. In addition, the CONTRACTOR shall provide all openings and holes in concrete Work as shown or as needed to accommodate other Work.

3.04 Special Concrete

The CONTRACTOR shall verify the use and/or locations of watertight concrete and/or high-early strength concrete.

3.05 Preparation

The CONTRACTOR shall notify the TOWNSHIP and the ENGINEER two (2) working days prior to placement of concrete.

Before depositing new concrete on or against existing concrete the existing concrete shall be roughened, thoroughly cleaned of foreign matter and laitance and saturated with water. The cleaned and saturated surface of the hardened concrete, including vertical and inclined surfaces, shall be coated with a bonding agent or slushed with a minimum 2-inch (50 mm) thick coating of concrete without coarse aggregate grout against which the new concrete shall be placed before the mixture has attained its initial set.

Before concrete is placed in any unit, the forms and the placing and fixing of all steel and incidental items shall be complete, and the forms, steel and adjacent concrete shall be thoroughly cleaned and wetted down.

Where indicated on the Plans, the CONTRACTOR shall bridge the subgrade with at least 2,000 psi (13.8 MPa), 3-inch (75 mm) thick lean concrete before placing the reinforcement. This shall be at no extra cost.

No concrete shall be deposited in any unit until the area has been completely dewatered in accordance with Section 31 2319, Dewatering, and not until after the CONTRACTOR has made satisfactory provisions to eliminate all possibility of water entering or flowing through the concrete while it is being poured or is taking its set. No concrete shall be placed under or on water.

3.06 Conveying

The concrete handling equipment shall be of such a nature and shall be so located that the concrete after leaving the mixer will reach its destination with a minimum lapse of time, with no segregation, and loss of slump. The use of drop chutes, except at or in the forms, is prohibited.

The interior hopper slope of concrete buckets shall be not less than 60 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five (5) times the nominal maximum size aggregate and the area of the gate opening shall be not less than two (2) square feet (0.2 m^2). The maximum dimension shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically or hydraulically operated except for buckets larger than two (2) cubic yards (1.5 m^3) shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing.

Concrete may be conveyed by positive displacement pump when authorized by the ENGINEER. The pumping equipment shall be piston or squeeze pressure type. The pipeline shall be rigid steel pipe or heavy duty flexible rubber hose. The inside diameter of the pipe shall be at least three (3) times the nominal maximum size coarse aggregate in the concrete mixture to be pumped. The maximum size coarse aggregate shall not be reduced to accommodate the pumps.

The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

3.07 Placing

All concrete shall be so deposited as to maintain the top surface level, unless otherwise shown on the Plans, and also as to avoid any appreciable flow in the mass.

Where placing operations involve dropping the concrete more than three (3) feet (1 m) in the forms, it shall be deposited through sheet metal or other approved spouts or pipes. These spouts or pipes shall have suitable receiving hoppers at the upper ends, and the lower ends shall be kept within six (6) inches (150 mm) of the newly placed concrete so as to prevent segregation and avoid spattering the reinforcing steel with mortar. Under no circumstances shall concrete that has partly hardened be deposited in the Work.

Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than two (2) feet (600 mm) per hour. Concrete vibrators shall penetrate the initial layer when placing the following layer. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed six (6) feet (1.8 m) of vertical height. Concrete in walls or columns shall set at least two (2) hours before concrete is placed in the structural systems to be supported by such walls or columns.

Concrete shall be set when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

No concrete shall be placed in contact with frozen ground. Time between charging and placement of concrete shall not exceed 1-1/2 hours.

Concrete shall be compacted by continuous vibrating, tamping, spading or slicing. Care shall be taken to eliminate all voids and to provide full bond on reinforcing steel and embedded fixtures. Mechanical vibration shall be employed. Concrete shall be compacted and thoroughly worked with suitable tools combined with the use of vibrators applied internally and providing a frequency not less than 7,000 revolutions per minute. All such vibrating, including the methods and equipment, shall be subject to the review of the ENGINEER.

The time of vibrating in any area shall only be sufficient to get efficient compaction, but shall in no case be carried to the point where there is segregation of the fine and coarse materials of the mix. There shall be an absolute minimum of direct vibration of the steel or forms during the process of vibrating. Vibrators shall be inserted and withdrawn from the concrete at numerous locations, from 18 to 30 inches (450 to 750 mm) apart, but shall not be used to transport concrete within the forms. The CONTRACTOR shall have a stand by vibrator on the job site during all concrete pouring operations.

3.08 Finishing Unformed Surfaces

The unformed surfaces of all concrete shall be screeded and given an initial float finish followed by steel troweling.

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch (5 mm) as measured from a 10-foot (3 m) straightedge.

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface. Floating shall be performed with hand floats or suitable mechanical compactor floats.

Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks. The top surface of driveways, and sidewalks shall be given a broomed finish after troweling.

Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having 1/4 inch (5 mm) corner radius.

3.09 Concrete Curing

All concrete shall be cured for a period not less than seven (7) consecutive days. The CONTRACTOR shall have adequate equipment and curing material on the job site before concrete placement begins, and it shall be adequate to prevent checking and cracking and loss of moisture from all the surfaces of the concrete. The concrete shall be protected from rain, flowing water, wind and the direct rays of the sun. Openings in concrete shall be sealed to prevent drying of the concrete during the curing period.

Curing compounds shall not be used on surfaces to which additional concrete or other material are to be bonded.

Curing compounds when used shall be applied in strict accordance with the manufacturer's recommendations.

Concrete cured with water shall be kept wet by covering with ponded water or fog spraying to keep all surfaces continuously wet.

Horizontal construction joints and finished surfaces cured with sand shall be covered a minimum thickness of 1-inch (25 mm), uniformly, and kept saturated during the curing period.

Burlap used for curing shall be treated to resist rot and fire and free of sizing or any substances that are injurious to Portland cement or cause discoloration. Strips shall be lapped by half widths. The burlap shall be saturated with water after placement and during the curing period.

Straw or hay shall be in a layer no less than six (6) inches (150 mm) thick and held in place by screens, wire or other means to prevent dispersion by the wind. Care shall be observed to avoid discoloration of the concrete surface from the vegetable fibers and for the flammability of the material. The straw shall be saturated with water after placement and during the curing period.

3.10 Environmental Conditions

The CONTRACTOR shall provide cold or hot weather protection in accordance with ACI and as specified herein. There shall be no additional cost for hot or cold weather protection of the concrete.

A. Cold Weather Protection

When placing concrete in cold weather, the CONTRACTOR shall plan and prosecute his Work in a manner which shall assure results free from damage through freezing, contraction, and loss of concrete strength.

No concrete shall be poured when the surrounding temperature is below 40 degrees F (4° C), unless the aggregates and water are properly heated. Concrete which has been poured at higher temperatures but has not attained a strength equal to 75% of the required strength of the class of concrete involved, shall be housed and protected in accordance with the provisions of this Section whenever the surrounding temperature falls below 40 degrees F (4° C).

Application of heat to the materials shall be made in a manner which will keep these materials clean and free from injurious substances.

Aggregates may be heated only by steam coils or steam jets, except in the case of small quantities of concrete when other methods may be approved by the ENGINEER. A sufficient quantity of properly heated aggregates shall be on hand prior to starting the pouring of any unit.

Concrete shall be properly housed with canvas, burlap, or other windproof material in such a manner that any necessary removal of the forms or finishing of the concrete can proceed without undue damage to the concrete from the elements. Heating of the housing shall be done in a manner which will maintain a temperature between 50 degrees F and 70 degrees F (10° and 20° C), at all times for at least five (5) days after the pour is complete and 12 hours before the pour begins. All supplemental heating units shall have exhaust vented to the exterior and shall not cause deleterious reactions or deposits to occur to concrete.

B. Hot Weather Protection

Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90 degrees F (32° C).

In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays, or other devices shall be provided.

3.11 Addition of Water

To increase workability, adding water to the mix shall be limited to a one time addition of one (1) gallon of water per cubic yard of concrete (5 liters per cubic meter) and mixed with a minimum of 30 revolutions at a rate of 12 to 15 revolutions per minute. Addition of water shall be within the slump requirements.

3.12 Concrete Delivery Ticket

A ticket system shall be used for recording the transportation of concrete from the batching plant to point of delivery. This ticket shall be issued to the truck operator at the point of loading and given to the ENGINEER upon delivery. The ticket shall as a minimum indicate the time of mixer charging, quantity of concrete, type of mixture including amount of cement, and the plant where the concrete was batched.

3.13 Concrete Delivery Rejection

Concrete not permitted for inclusion in the Work by the TOWNSHIP or the ENGINEER shall be removed from the site. Rejection of concrete will be determined through concrete testing and elapsed time from mixer charging to delivery.

3.14 Concrete Testing at Placement

Tests shall be made of fresh concrete for each 50 cubic yards (40 m^3), or whenever consistency appears to vary. The sampling and testing of slump, air content and strength will be performed at no cost to the CONTRACTOR.

Composite samples shall be secured in accordance with the Method of Sampling Fresh Concrete, ASTM C172.

A. Slump Test

Slump Test shall be in accordance with ASTM C143. The CONTRACTOR shall use the least slump possible consistent with workability for proper placing of the various classifications of concrete.

A tolerance of up to 1-inch (25 mm) above the indicated maximum slump shall be allowed for individual batches provided the average for all batches or the most recent ten (10) batches tested, whichever is fewer, does not exceed the maximum limit.

B. Air Content

Air content of normal weight concrete will be determined in accordance with Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASTM C231.

C. Compressive Strength

A set of cylinders for compressive strength tests will consist of four cylinders per each set.

Molding and curing specimens from each set shall be in accordance with Method of Making and Curing Concrete Test Specimens in the Field, ASTM C31. Any deviations from the requirements of this Standard shall be recorded in the test report.

Testing specimens will be in accordance with Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. One (1) specimen shall be tested at seven (7) days for information and two (2) shall be tested at 28 days for acceptance. The acceptance test results shall be the average

of the strengths of the two (2) specimens tested at 28 days. If one (1) specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result.

The strength level of the concrete will be considered satisfactory so long as the averages of all 28 day strength test results equal or exceed the specified 28-day strength and no individual strength test result falls below the specified 28-day strength by more than 500 psi (3.4 MPa).

If the strength test is not acceptable, further testing shall be performed to qualify the concrete.

The temperature of concrete sample will be determined for each strength test.

3.15 Testing of Concrete in Place

Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements shall be at the expense of the CONTRACTOR.

Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by the ENGINEER to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.

When required by the ENGINEER, cores at least two (2) inches (50 mm) in diameter shall be obtained and tested in accordance with Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM C42. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 degrees to 80 degrees F (15° - 25° C), relative humidity less than 60%) for seven (7) days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C42.

At least three (3) representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the ENGINEER so as to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced.

Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85% of and if no single core is less than 75% of the specified 28-day strength.

Core holes shall be filled by low slump concrete or mortar.

Table 1 - Concrete Mixtures

Concrete Grade	Coarse Aggregate	Min Cement Content				Minimum Comprehensive Strength At 28 Days (PSI/MPa)	Minimum Modulus of Rupture At 28 Days (PSI/MPa)	Air Content %
		Type of Cement	Lbs. per C.Y.	Sacks per C.Y.	Kg per m^3			
4.5	6AA	I, IA, IS, IS-A	658	7.0	390	4,500 / 31.0	725 / 5.0	4 - 6
4.0	6AA or 17A	I, IA, IS, IS-A	611	6.5	362	4,000 / 28.0	700 / 4.8	4 - 6
3.5	6AA or 17A	IS, IS-A, IP, IP-A	564	6.0	335	3,500 / 24.0	650 / 4.5	4 - 6

Maximum water cement ration shall be 0.45

Structural concrete for walls and slabs shall be placed with a slump of four (4) inches (100 mm) maximum.

Ground granulated blast furnace slag (GGBFS) may be substituted for cement on a pound for pound basis from a minimum of 25% up to a maximum of 40% GGBFS and 60% cement

Fly ash may be substituted for cement on a pound for pound basis up to a maximum of 15% fly ash and 85% cement

End of Section

Section 31 2200
Grading

Part 1 General

1.01 Scope

This Section includes site grading as indicated on the Plans, complete with removing and salvaging topsoil, rough grading, finish grading, adjusting structures, and reconstructing structures.

1.02 Related Work Specified Elsewhere

Structural Excavation and Backfill: Section 31 2316

1.03 Soil Erosion and Sedimentation Control

The CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by the ENGINEER. The measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work. Also, the measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.

Part 2 Products (Not Used)

Part 3 Execution

3.01 Site Grading

Sites shall be graded as specified on the Plans or as determined by the ENGINEER. The CONTRACTOR shall carry out the grading operation to prevent standing water and soil saturation detrimental to structures and improvements. Provisions shall be made to preserve and protect trees and other vegetation specified on the Plans or determined by the ENGINEER as not to be removed.

3.02 Removing and Salvaging Topsoil

Topsoil encountered along the route of the construction shall be pushed back and preserved for use in restoration following completion of the construction. The topsoil must remain on each given parcel and lot throughout the Project including the existing road right-of-way adjoining the parcel or lot where it existed.

Removal of topsoil from the Project or movement of topsoil from one portion of the Project for use in another portion of the Project will not be allowed.

If there is insufficient working area, the topsoil may be removed, stockpiled and later replaced on the original lot or parcel. The CONTRACTOR shall furnish the TOWNSHIP and the ENGINEER with written permission obtained from the property owner of the property on which the topsoil is to be stockpiled, prior to commencing the stockpiling operation.

Topsoil shall be salvaged in an amount equivalent to the quantity required by the Plans. Topsoil salvaged in excess of that required by the Plans or as required by the ENGINEER will be disposed of by the CONTRACTOR at his expense.

Before removing topsoil, all vegetation shall be reduced to a height of approximately four inches (100 mm) and all such vegetation and all brush, stones, rocks, and any other objectionable litter or foreign material shall be removed and disposed of before the ground is broken for topsoil removal.

Equipment and methods of operations shall be such as to avoid the lifting of the subsoil. If soil or weather conditions are unsuitable, the CONTRACTOR shall cease stripping until stripping can resumed in a suitable manner.

Topsoil shall be removed within the grading limits for cuts and shall be removed to a width and depth specified on the Plans or as determined by the ENGINEER.

The topsoil shall be stockpiled within the limits of construction in areas designated on the Plans, or in areas out of the way of construction as determined by the CONTRACTOR. Stockpiles shall be located and shaped so as to avoid diversion of storm water runoff, either in or out of the limits of construction, towards buildings, creation of standing water or interference of controlled irrigation. The CONTRACTOR shall not place topsoil around trunks and root areas of trees to be preserved.

Topsoil shall be kept separate from other excavated materials that are to be used for embankment and shall be completely removed from any designated area prior to the beginning of regular excavation or placing embankment in the area.

The topsoil stockpiles shall be located as near the original location as possible and no payment will be made for overhaul.

After the completion of construction, the topsoil shall be screened through a 5/8-inch maximum size mesh screen, spread, graded, raked and prepared for seeding or sodding.

3.03 Existing Sand On-Site

In those instances where the construction takes place within private easements, the sand shall not be removed from each parcel or lot. Sand encountered in existing road right-of-way may be used for construction purposes throughout the Project providing it meets the requirements for the material it is intended to be used for.

Removal of sand from the Project will not be allowed, except for the volume displaced by the new construction.

If there is insufficient working area, the sand may be removed, stockpiled and replaced on the original lot or parcel. The CONTRACTOR shall furnish the TOWNSHIP and the ENGINEER with written permission obtained from the property owner of the property on which the sand is to be stockpiled, prior to commencing the stockpiling operations.

3.04 Rough Grading

The site shall be graded as necessary to comply with the Plans or as determined by the ENGINEER. The subgrade shall be roughly established by cut or fill, approximately parallel to proposed finished grades and to elevations which allow for thickness of topsoil and installation of site or roadway improvements.

In fill areas all debris shall be removed from the area to be filled. All material detrimental to site improvement shall be removed from the site and acceptably disposed of as specified in Section 01 8900 Site Construction Performance Requirements.

Original ground shall be scarified and benched or otherwise treated to provide adequate bond and to prevent slippage of fill.

Fill material shall be free of debris or other detrimental material and shall have a moisture content within 2 percent of optimum moisture when placed. All fill shall be compacted to a density not less than 95% of the maximum unit weight and placed in layers no less than nine inches (230 mm) and no greater than 15 inches (380 mm). The maximum unit weight shall be determined by ASTM D698, Method B.

If possible fills or embankments shall be constructed when the ground is frost-free and there is favorable weather. However if winter grading is necessary, all ice and snow shall be removed from the surface of the ground before the fill or embankment is placed. No frozen material will be allowed in the fill area or in the embankment being constructed. Any frozen material on a partially completed fill shall be removed before placing any more fill. This frozen material shall be stockpiled outside the grading limits until thawed. Thawed material from the stockpiled frozen material may be used in the fill and embankment areas.

3.05 Finish Grading

The subgrade shall be smoothed parallel to proposed finished grades and elevations specified on the Plans. The subgrade shall be scarified to assure bond with the topsoil prior to spreading of the topsoil.

The topsoil shall be spread uniformly to provide a smooth, even surface at a finish grade specified on the Plans or acceptable to the ENGINEER. After spreading, the topsoil shall be compacted lightly as necessary to minimize settlement. Final grades shall not vary more than one-tenth of a foot (30 mm) from the elevations indicated on the Plans.

Finished grading shall be done when the ground is frost-free and weather is favorable.

3.06 Adjust Structures

Structures to be adjusted shall be as called for on the Plans or as indicated by the ENGINEER. Adjustment of structures shall apply where the elevation of the casting is either raised 12 inches (300 mm) or less, or lowered six (6) inches (150 mm) or less.

A. For Rehabilitation/Resurfacing Projects

For structures in existing pavement, the pavement shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.

1. For structures in concrete pavement, the structure shall be adjusted, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.

    a. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.

    b. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans. The concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.

2. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed. The structure shall be adjusted, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

B. For Bituminous Reconstruction or New Construction Projects

The frame and cover on all new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses. All bituminous base and leveling courses shall be placed over the plated structures. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans. The structure shall be adjusted, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the adjusting the structure unless otherwise noted in the Contract Documents.

The existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure, unless a new frame and cover are called for on the Plans.

The brick courses or concrete adjustment rings shall be removed or installed as necessary to adjust the structure's frame and cover to the proper elevation.

The brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by the ENGINEER.

The outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 inch (10 mm) thick.

The structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of the ENGINEER.

The flow in the entire system shall be maintained, at the CONTRACTOR's expense, while performing any part of the Work. Also, the structure shall be cleaned and all unsuitable material shall be disposed of at the CONTRACTOR's expense.

3.07 Reconstruct Structures

Structures to be reconstructed shall be as called for on the Plans or as determined by the ENGINEER. Reconstruction of structures shall apply where the elevation of the casting must be raised in excess of 12 inches (300 mm), lowered in excess of six (6) inches (150 mm), or to rebuild portions of the existing structure which are deteriorated.

A. For Rehabilitation/Resurfacing Projects

For structures in existing pavement, the pavement shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.

1. For structures in concrete pavement, the structure shall be reconstructed, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.
   a. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.

   b. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans. The concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.
2. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed. The structure shall be reconstructed, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

B. For Bituminous Reconstruction or New Construction Projects

The frame and cover on all new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses. All bituminous base and leveling courses shall be placed over the plated structures. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans. The structure shall be reconstructed, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the reconstructing the structure unless otherwise noted in the Contract Documents.

The existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure unless a new frame and cover are called for on the Plans.

The existing corbel entrance sections or precast concrete chimney type entrance shall be removed along with any additional brick courses or precast concrete sections necessary to achieve the amount of reconstruction called for on the Plans or as determined by the ENGINEER.

The necessary brick work and precast concrete sections shall be installed to meet the design grade.

Manhole steps shall be furnished and shall be installed, as necessary, so that maximum spacing is 24-inches (600 mm). The brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by the ENGINEER.

The outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 (10 mm) inch thick. The structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of the ENGINEER.

The flow in the entire system shall be maintained, at the CONTRACTOR's expense, while performing any part of the Work. Also, the structure shall be cleaned and all unsuitable material shall be disposed of at the CONTRACTOR's expense.

End of Section

Section 31 2316
Structural Excavation and Backfill

Part 1 General

1.01 Scope

This Section includes excavation for structures, removal and disposal of excavated materials, backfilling, backfill materials and compaction.

1.02 Related Work Specified Elsewhere

Grading: Section 31 2200
Dewatering: Section 31 2319
Water Utility Distribution Piping Section 33 1100
Sanitary Utility Sewerage Piping: Section 33 3000
Sanitary Utility Force Mains: Section 33 3400

1.03 Reference Standards

Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:

ASTM - ASTM International
AASHTO - American Association of State Highway Transportation Officials
MDOT - Michigan Department of Transportation Standard Specifications for Construction, 2003

1.04 Submittals

The testing laboratory shall provide the ENGINEER with two (2) certified copies of the test results of the compaction of the backfill. The testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by the ENGINEER.

1.05 Soil Erosion and Sedimentation Control

The CONTRACTOR shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by the ENGINEER. The measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work. Also, the measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.

Part 2 Products

2.01 Granular Materials

The granular material gradation shall conform to the grading requirements for granular material, Classes I and II, as specified in MDOT, Section 902.08. The granular material shall be natural bank run sand.

2.02 Coarse Aggregate

The coarse aggregate gradation shall conform to coarse aggregate, 6A, as specified in MDOT, Section 902.03.

Part 3 Execution

3.01 Dewatering

The area within the vicinity of the new Work shall be dewatered in accordance with Section 31 2319, Dewatering prior to the excavation operation. The depth of the dewatering shall be sufficient to allow the excavation to remain in a dry condition during the construction of the structure, including the excavating, backfilling and compacting operations.

3.02 Sheeting, Shoring, and Bracing

The CONTRACTOR shall furnish, place and maintain at all times such sheeting, shoring, and bracing of the excavated area as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipelines and conduits next to, or crossing the excavated area, and for the protection and safety of pedestrian and vehicular traffic.

The CONTRACTOR shall be responsible for the complete design of all sheeting, shoring and bracing Work. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil. Prior to installing the sheeting, shoring or bracing, the CONTRACTOR shall submit Plans for this Work to the ENGINEER for informational purposes only.

Sheeting, shoring, and bracing, and excavation shall conform to current federal or state regulations for safety.

Where indicated on the Plans and where necessary in the Work, install and leave sheeting, shoring, and bracing in place. No extra compensation shall be paid to the CONTRACTOR for sheeting, shoring or bracing left in place unless otherwise indicated in the Proposal.

Supports for pipes, conduits, etc., crossing the excavated area shall conform to the requirements of the owners of such facilities and if necessary, shall be left in place.

The furnishing, placing, maintaining and removing of sheeting, shoring, and bracing materials shall be at the CONTRACTOR's expense unless otherwise indicated in the Proposal.

The CONTRACTOR shall not remove the sheeting, shoring or bracing until the structure has obtained sufficient strength to support the external loads. The sheeting, shoring and bracing material shall not come in contact with the structure, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the structure.

3.03 Cofferdams

A cofferdam shall consist of the maintenance, installation and removal of a substantially watertight enclosure or a well-point system or similar system, which will permit construction of the substructure, above seal or subfooting, in the dry and without damage to the Work. Alternate methods, where used in lieu of cofferdams, will be permitted by authorization only. Such authorization will be considered only

after receipt of a permit from all federal, local or State agencies with jurisdiction for the alternate method.

Stream diversion and earth dikes, where used in lieu of cofferdams or a well-point system will be permitted by authorization only. Such authorization will be considered only after receipt of a permit from all federal, local or State agencies with jurisdiction for such construction.

The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit dewatering outside of the forms.

Cofferdams, caissons or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

Cofferdams shall not be braced to substructure forms. They shall be constructed so as to protect the Work in place against damage from high water and to prevent injury to the foundation by erosion. No timber bracing shall extend into or remain in the finished concrete.

Cofferdams shall be removed in such a manner as not to disturb or mar the finished concrete. When called for on the Plans or where necessary in the Work, cofferdam sheeting shall be left in place.

The furnishing, construction, maintenance and removal of the cofferdams including pumping shall be at the CONTRACTOR's expense. If the CONTRACTOR elects to use a well-point system or similar system, he shall be responsible for any claims for damages resulting therefrom.

3.04 Excavation

Excavation shall include the site clearing and grubbing, the excavating and disposing of all materials encountered, the supporting and protecting of all structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site. Excavation shall also include the removal of existing structures, as shown on the Plans or as determined by the ENGINEER. Rock excavation, if applicable, shall be performed as a part of the excavation in accordance with specifications contained elsewhere.

The CONTRACTOR shall keep the limits of his excavation operations within a reasonable close conformity with the location and grade, of each structure.

The excavated materials shall be temporarily stored in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property or traffic. The excavated materials shall not be placed at such locations that will endanger the banks of the excavation by imposing loads thereon.

The excavation shall be of sufficient size to allow for the construction of the new Work, the placing and compacting of the backfill and for the dewatering operation.

When concrete is to bear on or against an excavated surface other than rock, special care shall be taken not to disturb the surface. The final removal of the foundation material to grade shall not be made until just prior to the placing of the concrete.

Concrete shall not be placed until the depth of the excavation has been checked and the suitability of foundation material has been reviewed by the ENGINEER.

Excavated material, determined by the ENGINEER as suitable for backfill may be used. All excess materials shall be disposed by the CONTRACTOR, at his expense, as specified in Section 01 8900, Site Construction Performance Requirements.

The elevations for the bottom of footings shall be subject to such changes as are necessary to insure a satisfactory foundation. Any changes required shall be reviewed by the ENGINEER prior to making the change.

The surface of all rock or other hard material upon which concrete is to be placed shall be free of all loose fragments, cleaned and cut to a firm surface. The surface shall be level, stepped or serrated, as shown on the Plans.

All unsound material underlying proposed structures shall be removed and replaced with granular material approved by the ENGINEER, in layers not exceeding six (6) inches (150 mm) in depth. Each layer shall be compacted to 95% of maximum unit weight unless indicated otherwise on the Plans, or within these specifications.

3.05 Backfill

Backfill material shall be placed only after the new Work and backfill material have been inspected by the ENGINEER.

Backfill shall not be placed against any portion of the new Work until the required curing, surface finishing and waterproofing of such portions have been completed. Backfill which will place an unequalized horizontal loading on the new Work shall not be placed until the concrete has attained at least 70% of its design strength. To equalize horizontal loadings, the required backfill around the new Work shall be placed on opposite sides at the same time.

Granular material shall be used for backfilling within three (3) feet (1 m) of all manholes, chambers, valve wells, valve boxes, other pipeline structures, footings, piers, abutments, columns, walls, foundations, etc., unless otherwise indicated in the Contract Documents.

All spaces excavated and not occupied by the new Work or by the specified backfill material, shall be backfilled with suitable material from the excavation.

After the backfill has been placed and compacted to the flow line elevation of any weep holes indicated on the Plans, the back end of each weep hole shall be covered with not less than two (2) cubic feet (0.5 m^3) of coarse aggregate.

Large stones, boulders, broken rocks, concrete, and masonry shall not be used in the backfill.

The backfill shall be carried up to the surface of the adjacent ground or to the elevation of the proposed earth grade, and its top surface shall be neatly graded. Fills around all new Work shall be trimmed to the lines shown on the Plans or as directed by the ENGINEER.

3.06 Compacting Backfill

All backfill behind and around the new Work shall be placed in layers, not more than nine (9) inches in depth, and shall be compacted to not less than 95% of the maximum unit weight.

Areas where the density does not affect the construction, as determined by the ENGINEER, shall be compacted to not less than 90% of maximum unit weight.

Backfill material shall be placed as specified in MDOT, Section 206.03.B, except for the following modifications. The backfill material shall have a moisture content not greater than three (3) percent above optimum, at the time of compaction. If the material contains an excess of moisture, it shall be dried to the required moisture content before being installed.

Each layer of material containing the required amount of moisture shall be compacted to not less than 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by the ENGINEER, before the succeeding layer is started.

Compaction of the backfill will not be paid for separately, but shall be considered incidental to the Work of backfilling and shall include all the Work of manipulating the soil to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.07 Cleanup

Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by the CONTRACTOR, at his expense.

The construction area shall be graded and left in a neat, workmanlike condition.

At a seasonally correct time, the disturbed area shall be raked, having topsoil placed thereon, fertilized and restored.

3.08 Testing

During the course of the Work, the ENGINEER may require testing for compaction or density of the backfill. The taking of samples and the testing required shall be performed by a testing laboratory approved by the ENGINEER. The cost for testing and sampling shall be at the expense of the OWNER.

The testing laboratory shall furnish the ENGINEER with two (2) certified copies of the results of all tests. Testing procedures shall conform to current MDOT, Standards for Construction.

The maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method A, for granular materials conforming to MDOT, Class I, and Method D, for granular materials and all other soils.

3.09 Defective Work

Any portion of the backfill which is deficient in the specified density shall be corrected by the methods meeting the approval of the ENGINEER. Any extra testing or sampling required because of apparent deficiencies shall be at the CONTRACTOR's expense.

End of Section

Section 31 2319
Dewatering

Part 1 General

1.01 Scope

This Section includes all dewatering work complete with design of dewatering systems, construction and operation of dewatering systems, abandonment of dewatering systems, protection of personnel and structures, environmental protection and restoration.

1.02 Related Work Specified Elsewhere

Structural Excavation and Backfill: Section 31 2316
Trenching and Backfilling: Section 31 2333
Cast-In-Place Concrete: Section 03 3000

1.03 Design of Dewatering Construction

Any Geotechnical Investigations made in relation to this Project are provided as reference documents. Interpretations of all data and reports, performing any additional investigations, and obtaining any additional data for construction purposes is the responsibility of the CONTRACTOR.

The CONTRACTOR shall be responsible for the complete design of all structures and methods proposed for dewatering the project site, including the implementation of all materials, tools and equipment proposed for use in the Work. Temporary wiring associated with the dewatering shall comply with applicable portions of the National Electrical Code.

Provide monitoring wells as necessary to determine the groundwater levels along the alignment and shaft locations.

1.04 Soil Erosion and Sedimentation Control

All dewatering systems design and construction shall conform to the provisions of Part 91 Soil Erosion and Sedimentation Control of "Natural Resources and Environmental Protection Act" PA 451 of 1994. Where applicable, the CONTRACTOR shall obtain and pay for all permits and inspections for dewatering construction in accordance with the provisions of PA 451, State of Michigan, 1994, and all local government agencies having jurisdiction. No additional claim for compensation shall be allowed because of the CONTRACTOR's failure to obtain or pay for such permits and inspections.

The CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by the ENGINEER. The measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work. Also, the measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.

1.05 Federal, State, and Local Regulations

Dewatering operations shall conform to the requirements of all federal, state, and local agencies having jurisdiction.

Dewatering water discharged to streams, drains or sewers may require permits from federal, state or local agencies having jurisdiction. The CONTRACTOR shall comply with all water quality requirements prior to discharging dewatering water. The CONTRACTOR shall be responsible for all testing and treatment required to meet water quality requirements prior to discharge, and shall contact MDEQ if water contamination is identified during dewatering operations. No discharges to sanitary sewers will be allowed without prior approval of local agencies with jurisdiction for the sanitary sewers.

1.06 Protection

Take all steps necessary, during the Work of this Section, to protect surrounding property and adjacent buildings, private water supplies, roads, drains, sewers, structures and appurtenances. Adequate measures shall be taken to protect such property and construction from the effects of the dewatering operations.

1.07 Submittals

Submit detailed plans indicating proposed type and location of dewatering wells, type and location of collection/conveyance piping, and point of disposal of pumped water. Do not begin any dewatering work until submittals and supporting data have been reviewed by ENGINEER.

Dewatering system shall be designed by a professional with a minimum of seven years documented experience in the installation and design of dewatering systems. Submittal shall be signed and sealed by a registered professional engineer, stating that the proposed dewatering method is adequate to perform the required tasks.

Part 2 Products (Not Used)

Part 3 Execution

3.01 General

Provide electrical power from local utility. Provide stand-by power and any other required auxiliary dewatering equipment to assure continuous dewatering capability. Dewatering, where required, shall be continuous. Dewatering will not be stopped during work stoppage without approval of the ENGINEER. Coordinate construction operations to minimize duration and extent of dewatering required.

Dewatering wells are to use properly designed filters to prevent the migration of soil fines into the well.

3.02 Monitoring and Control

During dewatering operations, monitor ground water level with piezometers to ensure the design or specified groundwater elevation is maintained. Install monitoring wells with screens below the excavation level as required. Install wells at minimum 200-foot intervals located between dewatering wells. Provide access to monitoring wells by ENGINEER.

Modify dewatering operation if geotechnical, instrumentation or survey measurements indicate movement of structures, sheeting or embankments, or inability to lower groundwater as specified.

Inspect wells and lines on a daily basis to ensure integrity and watertightness. Keep fittings and connections watertight to ensure release of sulfide to atmosphere from groundwater does not occur.

3.03 Existing Drainage Conditions

Prior to beginning any work, verify in the field the location, type and capacity of all existing drainage facilities and conditions which will affect the Work of this Section. No allowances shall be made for conditions found during the progress of the dewatering operations because of the CONTRACTOR'S failure to verify such conditions.

3.04 Existing Structures and Utilities

The CONTRACTOR shall make field verification of all existing structures and utilities at the site of the Work which are scheduled to remain and which may be affected by the Work of this Section. The CONTRACTOR shall be responsible for any damage to existing structures and/or utilities caused because of his Work and shall repair such damage at his expense to the satisfaction of the ENGINEER or utility owner.

3.05 Drainage of Excavations

The CONTRACTOR shall maintain all finished excavation Work free of water during the preparation of the subgrade and until the completion of the Work. No ground or surface water shall be discharged into any existing sanitary sewer. No unit of Work shall be constructed under water except as otherwise determined by the ENGINEER. Provide and maintain adequate dewatering equipment to remove and dispose of all surface or groundwater entering excavations, trenches or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the construction is complete.

All excavations which extend down to or below the static groundwater elevation shall be dewatered by lowering and maintaining the groundwater level beneath such excavations a distance of not less than 12 inches (300 mm) below the bottom of the excavation. Drainage system methods shall not cause any damage to wells or adjacent property. All outlet drainage piping and conduit shall be kept clean and free from sediment. The CONTRACTOR shall be held responsible for the condition of all existing pipes, conduits and structures which he may use for drainage.

3.06 Dewatering Sumps and Pump Wells

Sumps and pump wells used as a part of the dewatering system shall be strongly sheathed and braced to protect the construction while in use. Tops of well casings must be covered to prevent animals and debris from entering and shall be 2 to 3 feet (0.6 to 0.9 m) above ground. Sumps and wells, when abandoned, shall be backfilled and compacted to the satisfaction of the ENGINEER.

3.07 Drilling

Methods used in drilling wells associated with dewatering systems shall be the responsibility of the CONTRACTOR and shall be acceptable to the ENGINEER. Drilling methods shall insure proper placement of well materials and shall not involve displacement of earth formations. Drilling shall be done with first class equipment of proper type and in good condition, acceptable to the ENGINEER.

3.08 Pumping

Equipment for pumping and pumping methods associated with dewatering systems shall be the responsibility of the CONTRACTOR and shall be acceptable to the ENGINEER. The CONTRACTOR shall construct or furnish adequate discharge piping to conduct and dispose of the water so as to prevent damage to existing structures or property. Pumping equipment shall be first class, acceptable to the

ENGINEER, of proper type and size for the Work and in good condition. Provide all anchors and supports for pumping equipment.

3.09 Filling and Grading

Upon completion of dewatering Work for the Project, abandon and/or fill all holes, trenches, ditches and other earth excavations created by the Work of this Section and not scheduled to remain. Do all filling, backfilling and grading to restore excavations and earth banks to the lines and levels indicated on the Plans and as determined by the ENGINEER. All earth fills shall be compacted to a density equal to that of the surrounding undisturbed earth.

End of Section

Section 31 2333
Trenching and Backfilling

Part 1 General

1.01 Scope

This Section includes open trench construction for utility installation, complete with trenching, sheeting, bracing, bedding, bedding materials, backfilling, backfill materials, and compaction.

1.02 Related Work Specified Elsewhere

Grading: Section 31 2200
Structural Excavation and Backfill: Section 31 2316
Water Utility Distribution Piping: Section 33 1100
Sanitary Utility Sewerage Piping: Section 33 3000
Sanitary Utility Force Mains: Section 33 3400

1.03 Reference Standards

Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:

ASTM - ASTM International
AASHTO - American Association of State Highways and Transportation Officials
MDOT - Michigan Department of Transportation, 2012 Standard Specifications for Construction

1.04 Test Reports

The testing laboratory shall provide the ENGINEER with two (2) certified copies of the test results of the compaction of the backfill.

The testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by the ENGINEER.

1.05 Mix Design

Submit mix designs for any concrete or flowable fill mixtures to be used on the Project. Include certified test results for seven day and 28 day strengths, together with any technical information for admixtures.

1.06 Soil Erosion and Sedimentation Control

The CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by the ENGINEER.

The measures shall prevent surface runoff from carrying excavated materials into the drain, to reduce erosion of the slopes, and to prevent silting in of drain downstream of the Work.

The measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.

Part 2 Products

2.01 Class II Granular Materials

The Class II granular material gradation shall conform to the grading requirements for granular material Class II, as specified in MDOT, Section 902.08 except as follows. The Class II granular material shall be natural bank run sand with a maximum size of 1½-inches (38 mm).

2.02 Crushed Stone Bedding

Crushed, angular, natural stone material, meeting the requirements of MDOT 21AA. Crushed concrete and slag are not allowed.

2.03 Concrete

The concrete shall conform to MDOT, Section 701, use grade S3; 3,000 psi (21 MPa) strength; Type I-A cement; 5.5 sacks cement per cubic yard (307 kg/m^3); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's review.

2.04 Flowable Fill for Backfilling

A. Materials:

1. Fly Ash: Fly Ash shall have a maximum loss on ignition of 12% and meet the other requirements of ASTM C618 (Class F).
2. Water: Water shall meet the requirements of ASTM C94.
3. Cement: ASTM C150 or C595, Type I or IA.

B. Mixture (Strength 100 – 120 psi, (690 – 825 kPa)):

1. Fly Ash: 2000 lbs/c.y. (1190 kg/m^3) min
2. Cement: 70 lbs/c.y. (40 kg/m^3) min
3. Water: Sufficient water to produce desired flowability, 700 lbs/c.y. (415kg/m^3) ±

C. The temperature of the flowable fill mix as manufactured and delivered shall be at least 50° F (10° C). The flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.

Part 3 Execution

3.01 Dewatering

The area within the vicinity of the trenching operation shall be dewatered in accordance with Section 31 2319, Dewatering prior to the trenching operation.

The depth of the dewatering shall be sufficient to allow the trench excavating operation including backfilling and compacting to proceed in a dry condition.

3.02 Trench Excavation

Open cut trench excavation shall include the site clearing and grubbing, the excavating of all materials encountered, the supporting and protecting of all structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site.

The trenching operation shall commence at the downstream or outlet end of the new Work and proceed upstream, unless otherwise specified on the Plans or directed by the ENGINEER.

The trench shall be excavated in reasonably close conformity with the lines and grades specified on the Plans or as established by the ENGINEER.

The excavated materials shall be temporarily stored along the trench in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property, public property or traffic. The excavated materials shall not be placed at such locations that will endanger the trench banks by imposing loads thereon.

The trench shall be of sufficient width to provide adequate working space to permit the installation of the pipe and the compaction of the bedding material under and around the pipe.

For flexible pipe, the minimum width shall be not less than the greater of either the pipe outside diameter plus 16 in. (400 mm) or the pipe outside diameter times 1.25, plus 12 in. (300 mm). The maximum trench width for flexible pipe shall not exceed the minimum width by more than 6-inches.

To support the additional load of the backfill when the maximum trench width as specified for flexible or semi-rigid pipe is exceeded, the CONTRACTOR shall install, at his expense, crushed stone pipe bedding to the full width between undisturbed trench walls or at least 2.5 pipe diameters on each side of the pipe.

When, through the CONTRACTOR's construction procedure or because of unsuitable existing ground conditions, it becomes impossible to maintain alignment and grade properly, the CONTRACTOR, at his expense, shall excavate below the normal trench bottom grade and shall fill the void with a large size aggregate or 3,000 psi (21 MPa) concrete as approved by the ENGINEER to insure that the pipe when laid in the proper bedding will maintain correct alignment and proper grade.

All trench excavations, including those for shafts and structures, shall be adequately braced and/or sheeted where necessary to prevent caving or squeezing of the soil.

3.03 Rock Excavation

Where rock is encountered and required to be removed during excavating operations, the CONTRACTOR shall follow the provisions included in Standard Excavation above, plan details, and the following method shall also be paid for as rock excavation:

Rock excavation shall include removal of rock material in beds, ledges, un-stratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cubic yard in size. Rock excavating shall include removal of rock material on bed ledges un-stratified masses, conglomerate deposits, and boulders exceeding 1 cubic yard that requires excavating equipment equivalent to or larger than the following size and performance ratings noted herein.

Rock excavating equipment equivalent: late-model, track-mounted hydraulic excavator equipped with a 42-inch wide minimum, short-up-radius rock bucket, rated at not less than 138-hp flywheel power with bucket-curling force not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf, measured according to SAE J-1179.

Rock excavation by a smaller piece of equipment shall only be paid for as rock excavation if approved by the ENGINEER.

Blasting shall not be permitted without the expressed written consent of the OWNER, ENGINEER, and all agencies having jurisdiction. Should the CONTRACTOR elect to pursue the possibility of blasting, he shall bear the sole responsibility for preparing all necessary reports, permits, and applications and obtaining all necessary approvals. Pay limits for rock removal by blasting if approved shall not exceed rock excavation pay limits as described in the plans.

3.04 Sheeting, Shoring, and Bracing

The CONTRACTOR shall furnish, place and maintain at all times such sheeting, shoring, and bracing of the trench and/or shaft as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipe lines, conduits next to or crossing the trench, and the protection and safety of pedestrian and vehicular traffic.

The CONTRACTOR shall be responsible for the complete design of all sheeting, shoring and bracing Work. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil. Prior to installing the sheeting, shoring or bracing, the CONTRACTOR shall submit Plans for this Work to the ENGINEER for informational purposes only.

Sheeting, shoring, bracing, and excavation shall conform to the current federal or state regulations for safety.

Where indicated on the Plans and where necessary in the Work, install and leave sheeting, shoring, and bracing in place. No extra compensation shall be paid to CONTRACTOR for sheeting, shoring or bracing left in place.

Supports for pipes, conduits, etc., crossing the trench shall conform to the requirements of the owners of such facilities, and if necessary, shall be left in place.

The furnishing, placing, bracing, maintaining, and removing of sheeting, shoring, and trenching materials shall be at the CONTRACTOR's expense. The CONTRACTOR shall not remove the trench sheeting, shoring and bracing unless the pipe has been properly bedded, and the trench backfilled to sufficiently support the external loads. Also the sheeting, shoring, and bracing material shall not come in contact with the pipe, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the pipe.

3.05 Pipe Bedding

Install and compact in six inch layers. Particular care shall be taken to assure filling and tamping all spaces under, around, and above the top of the pipe. Work in and around pipe by hand to provide uniform support.

Flexible pipe bedding shall conform to ASTM D2321, except as noted. A continuous and uniform bedding shall be provided in the trench for all buried pipe.

Class I:

The pipe shall be bedded in crushed stone bedding material placed on the trench bottom. The bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), and shall extend up the sides of the pipe until the top of pipe is covered by a minimum thickness of 12 inches (300 mm).

Where allowable trench widths are exceeded, Class I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

Class II:

The pipe shall be bedded in crushed stone bedding material placed on the trench bottom. The bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the

horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 inches (300 mm) above the top of the pipe shall be Class II granular material. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

Where allowable trench widths are exceeded, Class I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

Class III:

The pipe shall be bedded in Class II granular material, placed on the trench bottom. The bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and the bedding shall extend to a level not less than 12 inches (300 mm) above the top of the pipe. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of the pipe.

Where allowable trench widths are exceeded, Class I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

3.06 Backfilling Trenches

Backfill material shall be placed on sections of bedded pipes only after such pipe bedding and backfill materials have been approved by the ENGINEER.

The trench backfilling shall follow the pipe laying as closely as possible. However, at no time shall the pipe laying in any trench precede backfilling of that trench by more than 100 feet (30 m), unless otherwise directed by the ENGINEER.

Backfilling shall not be done in freezing weather except by permission of the ENGINEER. Frozen materials shall not be used in trench backfilling.

The following trench backfill specifications are for use in that portion of the trench beyond the scope of the pipe bedding requirements which normally stops at a point 12 inches (300 mm) above the top of pipe.

Backfill material to be placed above pipe bedding shall be free of cinders, ashes, refuse, boulders, roots, stumps, trees, timbers, brush, debris, or other extraneous materials which in the opinion of the ENGINEER, are unsuitable.

Rocks or stones having a dimension larger than six (6) inches (150 mm) shall not be placed within three (3) feet (1 m) of the top of the pipe.

Large stones may be placed in the remainder of the trench backfill only if well separated and arranged so that no interference with backfill settlement will result.

The type and method of backfilling is dependent on its location and function and shall conform to the following requirements:

Trench "B":

Trenches under road surfaces, pavement, curb, driveway, sidewalk and where the trench edge is within three (3) feet (1m) of the pavement and as noted on the plans shall be backfilled with natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans. The material shall be placed in uniform layers that can be adequately compacted and tested from the surface of that layer and shall be compacted to 95% of the materials maximum unit weight. Trenches under pavement to be constructed in the near future, as noted or shown on the

Plans, shall be backfilled with natural bank run sand, meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, as herein provided.

Where a pipe is installed under an existing or proposed utility, the backfill between the two shall be natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, constructed as herein specified.

Trench "A":

All other trenches shall be backfilled with suitable excavated material placed in uniform layers that can be adequately compacted and tested from the surface of that layer. Each layer shall be thoroughly compacted by approved mechanical methods to a density equivalent to the undisturbed adjacent soil or 90% of its maximum unit weight which ever is less.

Unless otherwise specified on the Plans or as directed by the ENGINEER, the trench backfill shall be carried to the adjacent existing ground.

Where any backfill or bedding as shown on the plans or specified is to be flowable fill, care shall be used to avoid displacing any pipes or structures due to fluid pressure. Pipes in backfill areas may need to be secured to avoid the bouyancy effect.

3.07 Compacting Trench "B" Backfill

Trench "B" backfill shall be compacted to 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by the ENGINEER.

Compaction of the backfill will not be paid for separately, but shall be considered incidental to the Work of backfilling and shall include all the Work of manipulating the soil, to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.08 Cleanup

Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by the CONTRACTOR, at his expense. The construction area shall be leveled and left in a neat workmanlike condition.

At a seasonally correct time, approved by the ENGINEER, the disturbed area shall be raked, having topsoil placed thereon, fertilized and seeded.

3.09 Field Testing

During the course of the Work, the ENGINEER may require testing for compaction or density of the backfill. The taking of samples and the testing required shall be performed by a testing laboratory suitable to the TOWNSHIP and approved by the ENGINEER. The cost for testing and sampling shall be at the expense of the DEVELOPER/OWNER.

The maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method D.

3.10 Defective Work

Any portion of the trench backfill which is deficient in the specified density shall be corrected by methods meeting the approval of the ENGINEER.

Any extra testing or sampling required because of deficiencies shall be at the CONTRACTOR's expense.

End of Section

Section 33 0523
Utility Pipe Jacking

Part 1 General

1.01 Scope

CONTRACTOR shall furnish and install bored or jacked steel casing, complete and in place, all in accordance with the requirements of the Contract Documents. Carrier pipe installation within the steel casing shall be in accordance with the requirements contained within this Section.

In the performance of the work, CONTRACTOR shall comply with the lawful requirements of the affected railway companies, public agencies, and owners of public utilities or other facilities respecting the safeguarding of traffic and improvements which might be endangered by the boring and jacking operations. The approach trenches in public streets will not be permitted to remain open for extended periods of time.

If CONTRACTOR is not ready to place the pipe in the casing at the time of completion of boring and jacking operations, the ends shall be bulkheaded, and the approach trenches in public streets shall be backfilled, temporary surfacing placed thereon, and the affected portion of the street reopened to traffic.

CONTRACTOR shall be responsible for maintaining the specified line and grade, and for preventing settlement of overlying structures, or other damage due to the boring and jacking operations.

1.02 Related Work Specified Elsewhere

Dewatering: Section 31 2319
Trenching and Backfilling: Section 31 2333
Water Utility Distribution Piping: Section 33 1100
Sanitary Utility Force Mains: Section 33 3400

1.03 Reference Specifications, Codes, and Standards

AISC- American Institute of Steel Construction
ACI - American Concrete Institute
AREA - American Railroad Engineering Association
ASTM - ASTM International
MDOT - Michigan Department of Transportation, 2003 Standard Specifications for Construction

1.04 Submittals

CONTRACTOR shall submit shop drawings of pipe casing in accordance with the following requirements:

CONTRACTOR, prior to beginning any trench or structure excavation five (5) feet deep or over, shall submit to the ENGINEER and shall be in receipt of the ENGINEER's written acceptance of the CONTRACTOR's detailed plan showing design of shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation.

Casing installation schedules which include schedules of excavation, pipeline installation, and backfill operations.

Material list including diameter, thickness, and class of steel casing.

Detailed locations and sizes of all boring or jacking and receiving pits and the jacking head proposed to be used.

The method of transporting the pipe in the casing and the method of "tugging" the pipe into the joints.

Details of concrete support blocks and bracing to prevent the carrier pipe from shifting or floating during the installation of sand backfilling.

Permits associated with the boring or jacking operations.

Certifications: CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and the following supplemental requirements:

Physical and chemical properties of all steel.

Expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.05 Quality Assurance

Boring or jacking operations shall be done by a qualified CONTRACTOR with at least 5 years experience involving work of a similar nature.

CONTRACTOR shall give the TOWNSHIP, the ENGINEER and the INSPECTOR a minimum of 3 days advance notices of the start of an excavation or boring operations.

Work shall be performed in the presence of the ENGINEER and the INSPECTOR.

Welding Requirements: Welding procedures used to fabricate steel casings shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates and grout coupling connections.

Welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the type of materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the casing or pipeline. Machines and electrodes similar to those used in the work shall be used in qualification tests. CONTRACTOR shall furnish all material and bear the expense of qualifying welders.

1.06 Protection of Property, Utilities, and Structures

Take all steps necessary to protect surrounding public and private property, adjacent buildings, roads, drives, sidewalks, drains, sewers, utilities, structures, and appurtenances from damage because of any tunneling operations. Responsibility and payment for correction of any damage shall be the sole responsibility of the CONTRACTOR.

1.07 Soil Erosion and Sedimentation Control

CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and for permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by the ENGINEER.

The measures shall prevent surface runoff from carrying excavated materials into nearby rivers, creeks, catch basins or drains; to reduce erosion of the slopes; and to prevent silting in of drain

downstream of the Work. The measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.

1.08 Safety

CONTRACTOR shall have sole responsibility for the safety of the jacking and boring operations and for persons engaged in the work.

CONTRACTOR shall conform to the requirements in accordance with Standard Specification Item No. 509, "Trench Safety System" of the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29 FR 1926/1920) as published in U.S. Department of Labor publication OSHA 2207, latest revision, and shall provide an appropriate Trench Safety Plan.

Part 2 Products

2.01 General

Steel casings shall be welded steel pipe of the diameters and plate thicknesses shown, and shall conform to ANSI/AWWA C200, subject to the following supplemental requirements.

The casing shall be of the diameter and thickness shown and shall be furnished complete with welded joint ends and pressure grout couplings as shown.

CONTRACTOR shall be fully responsible for the sufficiency of the casing provided and may select a greater diameter or thickness for the method of work, loading characteristics, site conditions, or possible interferences at no additional cost to the OWNER.

2.02 Steel Casing Pipe

ASTM A252, Grade 2, welded and seamless steel pipe; ASTM A53, Type E or Type S, Grade B; or ASTM A139, Grade B, electric fusion (arc) welded type; of size and wall thickness shown on the Plans.

CONTRACTOR shall provide 2-inch grout connections regularly spaced at 5 feet on center alternating at 45 degrees from plumb each side of the vertical centerline.

Casing section joints shall be butt welded, lap welded, or welded using butt straps in the field. Each end of the casing for butt welding shall be prepared by providing .25-inch by 45-degree chamfer on the outside edges.

Provide smooth interior. Weld joints to form a leakproof continuous pipe. Provide cathodic protection or coating as indicated on the Plans.

2.03 Concrete

In accordance with MDOT Section 701, use Grade S3; 3,000 psi (21 MPa) strength; Type IA cement; 5.5 sacks cement per cubic yard (307 kg/m3); 6A coarse aggregate; 2NS fine aggregate; 6.5% + 1.5% air content; 3-inch (75 mm)maximum slump; no admixtures without ENGINEER approval.

2.04 Concrete Reinforcement

Use ASTM A615, Grade 60, for bars and ASTM A185 for welded wire fabric and meeting the requirements of MDOT Section 905.

2.05 Wales, Struts, Plates and Miscellaneous Steel

Carbon Steel: ASTM A36 except where otherwise noted on the Drawings or as approved by the ENGINEER.

2.06 Fasteners

High-Strength Carbon Steel Bolts: ASTM A325, Type 1 or 2.
Alloy Steel Nuts: ASTM A563, Grade C, Heavy Hex Style.
Hardened Steel Washers: ASTM F436

2.07 Wood Lagging

Wood lagging: Sound southern pine or mixed hardwoods free from shakes, large knots, and other defects that might impair its strength.

Bending strength shall be as required for the design.

2.08 Blocks and Shims

Blocks and shims: Sound hardwood or southern pine with a rectangular cross section.

Part 3 Execution

3.01 Verification of Grades, Lines, and Levels

Prior to performing any tunneling or jacking and boring operations, verify the grades, lines and levels to which the new Work is to be installed. Any operations required to adjust grades, lines and levels after Work has started will be at the expense of the CONTRACTOR.

3.02 Existing Structures and Utilities

Prior to beginning any tunneling or jacking and boring operations, verify in the field the location of existing structures and active utilities scheduled to remain and requiring protection from damage because of the Work. Notify the ENGINEER where such conditions directly affect the progress of the Work.

3.03 Location of Work

ENGINEER will establish on the surface of the ground, control points both as to line and grade. CONTRACTOR shall insure that these control points are properly protected and adequately locate the Work from the reference points established by ENGINEER.

3.04 Layout of the Work

CONTRACTOR shall stake, mark and layout the work using suitable stakes and markers to facilitate verification of grades, lines and levels and location of the Work to be performed in a manner acceptable to ENGINEER. In laying out the Work, consideration should be made for the rights of adjacent property Owners.

Provide pedestrian and vehicular access to such properties. Should sidewalk encroachment be necessary, provide and maintain suitably safe, protected pedestrian walkways, at least four (4) feet (1.2 m) in width.

3.05 Sheeting, Shoring and Bracing

Provide and maintain all sheeting, shoring, and bracing required in tunnels, shafts, pits, trenches and open cut excavations to insure protection and safety of personnel and to protect adjacent structures, property and Work in place.

Where indicated on the Plans and where necessary in the Work, install and leave in place, primary tunnel linings.

No extra compensation shall be paid to CONTRACTOR for sheeting, shoring, bracing left in place.

CONTRACTOR shall be responsible for the complete design of all sheeting, shoring, and bracing Work. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil.

Prior to installing the sheeting, shoring or bracing, the CONTRACTOR shall submit plans for this Work to the ENGINEER for informational purposes only.

Sheeting, shoring, and bracing shall conform to the current federal or state regulations for safety.

Furnishing, placing, bracing, maintaining, and removing of sheeting and shoring materials shall be at the CONTRACTOR'S expense unless otherwise indicated.

CONTRACTOR shall not remove the sheeting, shoring and bracing unless the pipe has been properly bedded and backfilled to sufficiently support the external loads.

Sheeting, shoring, and bracing material shall not come in contact with the pipe, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the pipe.

All bore pits within the 1 on 1 influence of the road or within railroad right-of-way shall be backfilled with flowable fill.

3.06 Work Under Existing Utilities

Where any excavation or Work is conducted under existing utilities which may constitute a hazard to either the utility, excavation or tunneling operations, perform all excavation or tunneling operations to prevent damage or rupture to conduits or piping.

When Work is being conducted near a utility under conditions which may result in rupture of such utility, notify the utility of the conditions and do not proceed with the Work until an authorized representative of the utility has examined the conditions. Proceed only after the utility has been adequately protected.

3.07 Installation of Steel Casing

Once the CONTRACTOR begins the jack and bore operation, he shall work as necessary to prevent "freeze-up" of the pipe, until the entire pipeline is complete.

> Operations between 8:00 p.m., and 8:00 a.m., shall be approved by the OWNER prior to beginning the work.
>
> CONTRACTOR shall endeavor, however, to limit the noise from this operation to the greatest extent possible between the hours of 8:00 p.m., to 8:00 a.m.

If necessary, use bentonite lubricant applied under pressure through fittings in the lead pipe to reduce pipe-soil friction.

Use no less than two (2) jacks of sufficient power to carefully and accurately install the pipe by pushing or jacking pressure.

Use a timber bearing pushing frame, built to fit and match the end of the pipe being jacked, to evenly distribute the jacking force over the end of the pipe.

Use reaction blocks or backstop supports, installed in the jacking pit, shaft or trench, of sufficient strength to handle the thrust of the jacks.

A steel jacking head shall be fitted to the lead section of the casing in such a manner that it extends around the entire outer surface of the steel casing and projects at least 18 inches beyond the driving end of the casing. The jacking head shall not protrude more than 0.5 inches outside of the outer casing surface. The head shall be securely anchored to prevent any wobble or alignment variation during the boring or jacking operations.

To minimize voids outside the casing, excavation shall be carried out entirely within the jacking head and not in advance of the head. Excavated materials shall be removed from the casing as the boring or jacking operation progresses and no accumulation of excavated materials within the casing shall be permitted.

The excavations for the boring or jacking operations shall be adequately shored to safeguard existing substructures and surface improvements and to ensure against ground movement in the vicinity of the jack supports.

Heavy guide timber, structural steel, or concrete cradles of sufficient length shall be provided to assure accurate control of boring or jacking alignment.

CONTRACTOR shall provide adequate space within the excavation to permit the insertion of the lengths of casing to be bored or jacked.

Timbers and structural steel sections shall be anchored to ensure action of the jacks is in line with the axis of the casing.

A bearing block, consisting of a timber or structural steel framework, shall be constructed between the jacks and the end of the casing to provide uniform end bearing over the perimeter of the casing and distribute the jacking pressure evenly.

CONTRACTOR shall control the application of the jacking pressure and excavation of materials ahead of the casing as it advances to prevent the casing from becoming earthbound or deviating from the required line and grade.

CONTRACTOR shall restrict the excavation of the materials to the least clearance necessary to prevent binding in order to avoid loss of ground and consequent settlement or possible damage to overlying structures.

Allowable grade deviations in horizontal and vertical alignments shall be no greater than 0.2 feet per 100 feet in any direction over the length of the jacking or boring to a maximum deviation of 0.5 feet.

Installation of the casing shall be in accordance with the Contract Documents and subject to the approval of the agency having jurisdiction over the area containing the boring or jacking operations.

3.08 Installation of Carrier Pipe

Use the types and sizes of pipe shown on the Plans. Place pipe to the lines and grades indicated on the Plans.

Use care to not damage pipe, joints or joint material.

Use plywood or other protective joint spacer material to distribute pushing or pulling loads evenly around joints.

The carrier pipe shall be braced or filled as shown on the drawings to prevent shifting or flotation during backfilling operations.

Completely fill voids between outside pipe wall and soil as specified

Joints of the carrier pipe within the casing shall be joined in accordance with the specification Sections for the type of pipe material installed.

Application of mortar to the interior and exterior joints shall be performed in accordance with the requirements of the specification Sections for the type of pipe materials installed and as provided for herein.

No exterior or interior joints of the carrier pipe shall have mortar grout applied over a seam until the seam has cooled.

Hydrostatic testing of the carrier pipe shall be completed prior to the filling of the annular space between the casing and carrier pipe with sand. Hydrostatic testing shall be performed in accordance with applicable Sections of these Standards.

CONTRACTOR shall furnish the necessary sand, equipment, hoses, valves, and fittings for backfilling the annular space in jacked casing. Sand shall be conveyed by air through a hose and deposited by air pressure in its final position. Sand shall be free of lumps to flow unimpeded and to completely fill all voids. In general, sand backfill will be considered completed when no more sand can be forced into the annular space.

CONTRACTOR shall protect and preserve the interior surfaces of the steel casing from damage.

3.09 Backfilling Voids

Excavations beyond the neat lines of the pipe shall be backfilled with a sand-cement or grout mixture. Any voids judged by the ENGINEER to exist behind such construction shall be grouted.

For tamped backfill, fill all voids with sand-cement mixture consisting of 1-part Portland cement to not more than ten (10) parts fine aggregate, by volume, tamped thoroughly in place.

For pressure grouted backfill, fill all voids with a grout mixture consisting of one (1) part Portland cement to three (3) parts fine aggregate, by volume, with sufficient water to flow through the grouting pipes. Install grout mixture under pressure from the pipe interior through threaded grout holes in pairs every 16 feet (5 m) piercing the pipe wall or from the ground surface through insertion pipes.

For all jacked pipe installations, use pressure grouted backfill.

3.10 Grouting Operations

Immediately after completion of the boring or jacking operations, the CONTRACTOR shall inject grout through the grout connections in such a manner as to completely fills all voids outside the casing pipe resulting from the boring or jacking operations.

Grouting shall be done so as not to damage the pipe, adjacent structures or existing utilities. Two (2) grout holes shall be provided for each 10-foot (3 m) of tunnel run.

A grout pipe at least 1-l/2 inches (40 mm) in diameter shall be inserted and securely caulked into the grout hole. The grout pipe shall be fitted with a control valve to control the flow of grout into the voids.

Grout holes not less than 1-l/2 inches (40 mm) in diameter shall be drilled on radial lines the inner lining of the pipe. The grout holes shall be extended through the outer lining to permit complete grouting outside the primary lining as well as between the linings.

Grout shall consist of a mixture of Portland cement thoroughly mixed with mortar sand with sufficient water to permit ready flow through the grout pipes. In general, the mix shall be 1-part of cement to 1-part of sand, but the proportions may be varied at the ENGINEER'S request to the extent of richening the mix to neat cement. If necessary to speed up the setting of the grout, approved admixtures or quick setting cement shall be used as approved by the ENGINEER.

Grout shall be pumped through the grout pipe at the prescribed pressures to completely fill all voids between the inner and outer lining as well as the void spaces between the outer lining and the earth banks.

If there is no visible escape of grout between interior and exterior surfaces of the tunnel liners, at bulkheads or through outlets, grouting may be considered complete when grout can no longer be pumped through the inlet pipe at the prescribed pressures.

Care shall be taken during the grouting operation to prevent the pumped grout from escaping into basements, adjacent sewers, manholes or other structures.

If it becomes evident that more grout is being used then is effectively necessary for the Work, operations shall be halted and the source of waste investigated.

Following satisfactory grouting operations acceptable to the ENGINEER and after initial set of the grout, remove the grout pipe from the grout hole and fill the space previously occupied by the pipe with stiff mortar and trowel smooth at the inner face of the sewer or conduit wall. The space from which the pipe was removed shall be at least three (3) inches (75 mm) deep before sealing. Chipping to that depth is required if necessary.

The CONTRACTOR shall do all re-grouting required to close unfilled spaces or voids, repair cracks and/or breaks in the tunnel linings and to make the installation watertight.

3.11 Closing of Pits

After jacking equipment and excavated materials from the boring or jacking operations have been removed from the jacking pit, CONTRACTOR shall prepare the bottom of the jacking pit as a pipe foundation.

CONTRACTOR shall remove loose and disturbed materials below pipe grade to undisturbed earth and re-compact the material in accordance with Section 31 2333.

Should appreciable loss of ground occur during the jacking operation, the voids shall be backpacked promptly to the extent practical with soil cement consisting of a slightly moistened mixture of one part cement to five parts granular material.

Where the soil is not suitable for this purpose, the CONTRACTOR shall import, at the CONTRACTOR'S expense, suitable material.

The soil cement shall be thoroughly mixed and rammed into place as soon as possible after the loss of ground.

3.12 Acceptance and Inspection

If unable to maintain line and grade or to maintain jacking operations due to pipe freeze-up, propose alternate methods of construction as specified under Article 1.10 of this Section to complete the Work.

Carrier and casing/camier pipe Work shall be inspected and accepted under the appropriate section of Related Work Specified Elsewhere.

Casing pipe shall be inspected for cracks, crushing, buckling or other structural damage.

Joints shall be inspected for structural damage and water-tightness. CONTRACTOR shall remove and replace any damaged or unacceptable Work. Repair Work shall be done to the satisfaction of the ENGINEER.

If any excavation or installation Work done by the CONTRACTOR is to be abandoned or not completed, the CONTRACTOR shall fill all voids and spaces of the abandoned Work, as determined by the ENGINEER.

3.13 Field Quality Control

Perform periodic tests of ventilation and compressed systems to insure that all equipment is in proper working order and providing minimum required air for personnel safety and tunneling operations.

Perform periodic inspection and test of air lock equipment and operation in accordance with the requirements of the regulatory agencies referenced herein.

End of Section

Section 33 0524
Utility Horizontal Directional Drilling

Part 1 General

1.01 Scope

The Work specified in this Section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.

1.02 Related Work Specified Elsewhere

Trenching and Backfilling: Section 31 2333
Water Utility Distribution Piping: Section 33 1100
Sanitary Utility Force Mains: Section 33 3400

1.03 Quality Assurance

The CONTRACTOR shall be responsible for the complete design of all methods used for directional boring including the implementation of all materials, tools, labor, and equipment proposed for use in the Work. The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Adherence to the specifications contained herein, or the ENGINEER's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the CONTRACTOR of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

Conform to the requirements of all federal, state, and local regulatory agencies having jurisdiction.

Where applicable, obtain and pay for permits and inspections for pipe directional boring operations as required by PA 451, State of Michigan, 1994, and all government and private agencies having jurisdiction. No additional compensation shall be allowed because of the CONTRACTOR's failure to obtain and pay for such permits and inspections. Be aware of and conform to all OWNER-obtained permits.

Conform to the requirements of the Michigan State Department of Labor, Construction Safety Standards Commission Construction Standard, Part 14; Tunnels, Shafts, Caissons and Cofferdams, and the Michigan State Department of Public Health, Occupational Health Standards Commission, Occupational Health Standards, Part 2; Tunnels, Shafts, Caissons and Cofferdams.

1.04 Reference Standards

ASTM - American Society for Testing and Material
AWWA - American Water Works Association
MDOT - Michigan Department of Transportation

1.05 Submittals

Prior to beginning any Work, prepare and submit to the ENGINEER for his information only detailed plans and shop drawings showing the limits of the proposed directional boring Work; the materials,

equipment and methods of construction proposed for use; the connection including all thrust blocking and bracing of the directionally bored carrier pipe to all other pipe; the location of shafts, pits and/or approach tunnels to be constructed; and methods to be implemented for protection of personnel, excavations and adjacent structures, property and utilities.

Prior to beginning any pipe directional boring operations, submit copies of all permits and inspection records obtained from state and local authorities having jurisdiction as described under Article 1.03.B of this Section.

1.06 Job Conditions

Where soil conditions or obstructions are encountered that prevent the completion of pipe directional boring Work started or in progress, develop and submit to the ENGINEER for review alternate methods of performing the Work as described under Article 1.03.A of this Section. Perform no additional Work until completion of review by the ENGINEER of the alternate method proposed.

Provide all structures, safety equipment and professional services required to provide for the health and safety of the general public and of personnel involved in pipe directional boring Work in accordance with the requirements of the regulatory agencies having jurisdiction.

Take all measures necessary to protect surrounding public and private property, adjacent buildings, roads, drives, sidewalks, drains, sewers, utilities, structures, and appurtenances from damage due to pipe directional boring Work. Responsibility and payment for correction of such damage shall be the sole responsibility of CONTRACTOR.

Part 2 Products

2.01 General

Horizontal directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing and 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.

2.02 Drilling Rig

The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during drilling and pull-back operations.

2.03 Drilling System

The drill head shall be steerable by changing it's rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

Mud motors (if required) shall be of adequate power to turn the required drilling tools.

Drill Pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

2.04 Guidance System

A Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to one hundred feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to +/-2% of the vertical depth of the borehole at sensing position at depths up to one hundred feet and accurate within 1.5 meters horizontally.

The Guidance System shall be of a proven type and shall be operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.

2.05 Drilling Fluid (Mud) System:

A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. Mixing system shall continually agitate the drilling fluid during drilling operations.

Drilling fluid shall be composed of clean water and appropriate additives including bentonite clay. Water shall be from an authorized source with a pH of 8.5 - 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No potentially hazardous material may be used in drilling fluid.

The mud pumping system shall be of an adequate capacity for delivering the drilling fluid at a constant pressure suitable for the Work. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, a minimum of 12" high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

The drilling fluid recycling system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

2.06 Pipe Rollers

Pipe rollers shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall used to prevent excess sagging of pipe.

2.07 Process Pipe

A. Water Main:

1. PVC - Conforms to AWWA C-900, DR 18 with Certa-Lock restrained joints or fused joints.

2. HDPE – Conforming to AWWA C-906, DIOD, DR11 and manufactured from high density

PE 3408 polyethylene resin.

B. Water Services: Copper per Section 33 1100.

2.08 Other Materials

Concrete shall be in accordance with MDOT 7.01, use Grade 30P; 3,000 psi strength; Type IA cement; 5.5 sacks cement per cubic yard; 6A coarse aggregate; 2NS fine aggregate; 6.5% + 1.5% air content; 3-inch maximum slump; no admixtures without ENGINEER review.

Concrete reinforcement shall be in accordance with MDOT 8.05, use ASTM A615, Grade 60, for bars and ASTM A185 for welded wire fabric.

Concrete block cast from Portland cement sand, gravel or crushed stone, of uniform and compact texture, free from cracks or warpage and with square corners conforming to ASTM C139.

Part 3 Execution

3.01 CONTRACTOR's Verification

Prior to performing any horizontal directional drilling operations, verify the grades, lines and levels to which the new Work is to be installed. Any directional boring Work required to adjust grades, lines and levels after Work has started will be at the expense of the CONTRACTOR performing the Work.

Prior to beginning any horizontal directional drilling Work, verify in the field the location of existing structures and active utilities scheduled to remain and requiring protection from damage because of the Work. Notify the ENGINEER where such conditions directly affect the progress of the Work.

3.02 Preparation

Stake, mark, and layout the Work in a manner acceptable to the ENGINEER using suitable stakes and markers to facilitate verification of grades, lines, levels, and locations of the Work to be performed.

From reference points established by the ENGINEER on the surface of the ground, carry line and grade down to the bottom of any shafts or boring pits. Perform the Work to the line and grades established using methods acceptable to the ENGINEER. Protect such reference points throughout the progress of the Work.

Prior to performing any horizontal directional drilling Work, examine all pipe for damage due to fabrication, shipment, or handling. Inspect pipe for cracks, breaks, bends, dents, broken ends, or other damage which might affect the structural integrity, performance requirements, or jointing as shown on the Plans, specified herein or as directed by the ENGINEER. Defective pipe shall be rejected by the ENGINEER and shall be removed from the Work and replaced with acceptable pipe at the expense of the CONTRACTOR.

Prior to performing any horizontal directional drilling Work, notify all applicable inspecting agencies under Article 1.02.B.2 of this Section, of Work Schedule with a minimum of two (2) working days' notice.

3.03 Performance

Furnish, install and maintaining throughout the progress of the Work, such sheeting, shoring, and bracing in tunnels, shafts, pits and trenches as may be required for safety of workmen, for protection of the Work and adjacent structures, and for issuance of applicable agency permits. All sheeting, shoring,

and bracing shall be removed after completion of the Work unless otherwise indicated on the Plans or directed by the ENGINEER. Design of earth supports shall be the responsibility of the CONTRACTOR and shall be as required by the nature of the soils encountered. Supports shall be dimensioned and spaced as to prevent caving, loss of earth or squeezing within the neat lines of the excavation. Supports shall effectively restrain movement of the adjacent soil.

The sheeting of pits along any road shall be required if the leading edge of the pits falls within the one-on-one zone of influence from the shoulder point or curb and gutter edge.

Excavate as required to perform all directional boring Work to the grades, lines and levels indicated on the Plans and as specified herein. Construct approach trenches, pits and shafts of sufficient length and width to accommodate the equipment being used, the pipe units to be placed and the manpower working. Provide guide timbers or rails in the bottom of the trenches, pits and shafts for keeping the Work on line and grade.

The CONTRACTOR shall join the pipe on the surface in the area indicated on the Plans. Use care to not damage pipe, joints or joint material. Pipe shall be joined per manufacturer's recommendations and in accordance with the requirements of Section 33 1100. Tracer wire shall be provided in accordance with Section 33 1100.

Directional drilled water main shall be hydrostatically tested twice for leakage, once after the pipe has been constructed on the surface, and once after the pipe has been installed in the drilled hole. The CONTRACTOR shall furnish the pump, pipe connection, hydrants, valves and any other necessary apparatus including gages and meters and all personnel necessary for conducting the test. Before applying the test pressure, all air shall be expelled from the pipe. If necessary to accomplish this, taps shall be made at points of higher elevation and afterwards plugged. The test shall be made at a pressure of 150 pounds per square inch gage. The full pressure shall be held for at least two (2) hours. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by the CONTRACTOR with sound material and the test shall be repeated until specified requirements are met. The maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed a rate of 10.5 U.S. gallons per inch diameter of main per mile of pipe in 24 hours for each section tested. Test sections will normally not exceed one (1) mile and in the event more than one (1) mile of pipeline is tested, the permissible leakage will remain at the amount determined for one (1) mile of pipe.

The CONTRACTOR shall install pipe with continuous pullback until the pipe is in place as indicated on the Plans. Following successful pull-back of pipe, CONTRACTOR shall perform leakage testing per the requirements of Section 33 1100. No connections to the pipe shall be made for a period of 24 hours after the continuous pullback has been completed.

3.04 Drill Path Survey

Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on Plans. If CONTRACTOR is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.

3.05 Drilling Procedure

Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100'. In the event that pilot does deviate from bore path more than 5% of depth in 100', CONTRACTOR will notify ENGINEER and ENGINEER may require CONTRACTOR to pull-back and re-drill from the location along bore path before the deviation.

In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole

drilling operations, CONTRACTOR shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and then wait another 30 minutes. If mud fracture or returns loss continues, CONTRACTOR will cease operations and notify ENGINEER. ENGINEER and CONTRACTOR will discuss additional options and work will then proceed accordingly.

Upon successful completion of pilot hole, CONTRACTOR will ream bore hole to the minimum amount necessary to accommodate outside diameter of pipe. CONTRACTOR will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.

After successfully reaming bore hole to the required diameter, CONTRACTOR will pull the pipe through the bore hole using a swivel in front of the pipe. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole. During pull-back operations CONTRACTOR will not apply more than the maximum safe pipe pull pressure at any time.

In the event that pipe becomes stuck, CONTRACTOR will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If pipe remains stuck, CONTRACTOR will notify ENGINEER. ENGINEER and CONTRACTOR will discuss options and then work will proceed accordingly.

3.06 Backfilling

After the pipe has been installed and approved by the ENGINEER, the CONTRACTOR shall backfill the entrance/exit pits, approach trenches or shafts. The entrance/exit pits, approach trenches or shafts shall be considered as open cut trench and where they exceed the maximum allowable trench width the carrier pipe shall be backfilled as specified in Section 31 2333.

3.07 Acceptance and Inspection

The CONTRACTOR shall maintain line and grade and shall provide the ENGINEER with as-built location at five-foot intervals. If unable to maintain line and grade or to maintain directional boring operations, propose alternate methods of construction as specified under Article 1.04.A of this Section to complete the Work.

If any excavation or installation Work done by the CONTRACTOR is to be abandoned or not completed, the CONTRACTOR shall fill all voids and spaces of the abandoned Work, as directed by the ENGINEER.

3.08 Recordkeeping, As-Builts

CONTRACTOR shall maintain a daily project log of drilling operations and a guidance system log with a copy given to ENGINEER at completion of project. As-built drawings shall be certified as to accuracy by CONTRACTOR.

End of Section

Section 33 1100
Water Utility Distribution Piping

Part 1 General

1.01 Scope

This Section includes all water main Work complete with water main piping, valves, hydrants, thrust blocks, valve wells, structures, fittings, joints, joint materials, nuts, bolts, glands, gaskets, plugs and accessories as shown and required. This Section also includes bedding and laying of water main piping, hydrostatic testing of new water main piping systems, and flushing and chlorination of water main piping systems.

1.02 Related Work Specified Elsewhere

Dewatering: Section 31 2319
Trenching and Backfilling: Section 31 2333
Utility Horizontal Directional Drilling: Section 33 0524

1.03 Requirements of Regulatory Agencies

Conform to the applicable requirements of State and local health authorities having jurisdiction for disinfection and testing of water mains.

1.04 Reference Standards

Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:

ANSI - American National Standards Institute
ASTM - ASTM International
AWWA - American Water Works Association
MDOT- Michigan Department of Transportation, 2012 Standard Specifications for Construction
NSF - National Sanitation Foundation

1.05 Submittals

Submit manufacturer affidavit showing butterfly valves comply with AWWA C504, where applicable.

Submit manufacturer's data for restrained joint pipe and fittings for ENGINEER's review.

1.06 Storage of Materials

Pipe shall be stored in a manner to minimize infiltration of dirt, debris and other extraneous materials.

Piping materials shall not be stacked higher than four (4) feet (1.2 m). Suitable racks, chairs and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground; alternate tiers; and chock tier ends.

Store all hydrants, valves, wells and prefabricated structures off the ground, drained and kept free of water to protect against damage from freezing. Hydrants, valves, wells, their accessories and appurtenances shall be kept in their original containers until ready for installation.

All gaskets, glands, joint and sealing materials subject to ultra-violet or ozone attack shall be protected from the sunlight, atmosphere and weather; and stored in suitable enclosures until ready for installation.

1.07 Handling of Materials

Load and unload piping using suitably approved hoists and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping shall be rejected by the CONTRACTOR.

Lifting devices shall be suited to the Work and shall protect surfaces from damage.

Part 2 Products

2.01 Scope

The intent of the Articles in Part 2 of this Section is to specify in detail the various types of pipe, joints, and fittings which have been indicated throughout the Plans and Specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Ductile Iron Pipe System

Ductile Iron Pipe shall be ANSI/AWWA C151/A21.51, and AWWA C150, with cement mortar lining inside, and 1-mil (25 μm) minimum thickness asphaltic coating outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans or specified in the Proposal. Minimum wall thickness shall be class 52 or minimum pressure class shall be 150.

Mechanical joints for ductile iron pipe shall be compression gasket type, conforming to ANSI/AWWA C111/A21.11 except that slots with the same width as the diameter of the bolt holes in mechanical joints shall not be allowed in the bell flange.

Push-on, compression gasket type joints shall conform to ANSI/AWWA C111/A21.11 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section.

Fittings and plugs shall be ductile iron compact fittings, mechanical joint, pressure rating of 350 psi (2.4 MPa), conforming to ANSI/AWWA C153/A21.53, and rubber gasket joints conforming to ANSI/AWWA C111/A21.11, with double thickness cement mortar lining and coal tar enamel coating on the outside of fittings.

Flexible ball and retainer type joints shall be ball and retainer type, boltless, locking, and capable of being deflected up to 15°.

Cement mortar linings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C104/A21.4 of the thickness specified and shall be permanently set prior to the application of any additional pipe coating.

2.03 Polyvinyl Chloride (PVC) Piping Systems

Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings, size four (4) inches (100 mm) and larger, shall conform to AWWA C900 or C909, pressure class 160, DR 18 unless otherwise indicated in the Contract Documents.

Molecularly oriented polyvinyl chloride (PVCO) pipe sizes 4-iches through 24-inches shall be AWWA C909, pressure class 200 unless otherwise indicated in the Contract Documents. PVCO pipe will only be allowed when specifically called for in the Contract Documents.

Compounds used for production of PVC pipe and components shall be suitable for potable water products as required in Sections 3 and 4 of NSF Standard 14. Spigot end of pipe shall be marked to visually determine when the spigot is fully seated in the bell of the adjoining pipe. All PVC pipe materials shall meet NSF Standard 14 for potable water and the "NSF-pw" identification must appear on pipe wall.

Joints for PVC pipe shall be push-on or mechanical elastomeric gasket type, conforming to ASTM D3139.

PVC fittings shall only be allowed when called for on the Plans. When allowed, 4-inch and larger PVC fittings and plugs shall be 200 pound (1380 kPa) Pressure Class conforming to AWWA C900 of types and sizes indicated on the Plans.

Fittings and plugs for PVC pipe, unless specified otherwise, shall be ductile iron and as specified in Article 2.02.

Gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477.

Pipe joint lubricants shall be manufacturers standard nontoxic conforming to AWWA C900.

2.04 High Density Polyethylene (HDPE) Piping Systems

HDPE pipe shall conform to AWWA C906, O.D. based DR11 for pipe 4" and larger. HDPE pipe and tubing shall conform to AWWA C901, O.D. based DR9 for pipe smaller than 4". All HDPE pipe and tubing shall bear the appropriate AWWA standard and "NSF-pw" identification on the exterior wall print line demonstrating compliance with NSF Standard 14. HDPE pipe shall be manufactured from high density PE 3408 polyethylene resin. Connections to other pipe types shall not be made until pipe has reached equilibrium temperature.

2.05 Restrained Joints

Where the Plans or Specifications call for restrained joints they shall be per the following.

Restrained joints for ductile iron pipe and fittings shall be designed for a working pressure of 350 psi (2.4 MPa). Joints shall be capable of being deflected after assembly. Restraints shall be by one of the following methods:

1) A positive axial lock between the bell interior surface and a retainer welded on the spigot end of the pipe.
2) A thrust restraint wedge which embeds in the pipe with twist off nuts to control wedge setting.

Restrained joints for PVC water main pipe shall be designed for a working pressure of 200 psi (1.4 MPa). Where the restrained portion of the pipe is connected to fittings, restraint shall be provided across the joint by a clamping ring and anchored to the fitting with T-head bolts or stainless steel rods. Restraining devices for PVC water main pipe shall incorporate clamping rings with serrations on the inside surface to provide positive restraint on the outside surface of the pipe and shall provide full support around the circumference of the pipe to maintain roundness.

Restrain HDPE connections to conventional water main or appurtenances using a mechanical-joint adapter with stainless steel stiffener or approved equal. A flange ring adapter may also be used for joining HDPE pipe to HDPE pipe or mechanical joint pipe. Other methods of joining HDPE pipe are available and should only be used after consulting with pipe and fitting manufacturers. Additional

restraint is necessary on each side of the connection point. This restraint may be provided in the form of an HDPE anchor ring encased in concrete or other methods as approved by the MDEQ. All proposed connection and restraint details shall be included with shop drawing submittals.

2.06 Polyethylene Encasement

Polyethylene material for encasement shall be either 4 mil high density, cross-laminated polyethylene film or 8 mil linear low-density polyethylene film per AWWA C105.

2.07 Valves and Hydrants

A. Gate Valves

Provide iron body, resilient seated, solid wedge type gate valves with non-rising stems and O-ring seals in accordance with AWWA C509. Furnish buried valves with mechanical joint ends, stainless steel hardware, and 2" square operating nut. Where the water main is buried at a depth where the normal valve operating nut will be at a depth greater than 5-1/2 feet, a valve extension stem with operating nut shall be provided and mechanically attached to the valve to provide an operating nut at the 5-1/2 foot depth. Furnish non-buried valves with flanged ends conforming to ANSI B16.1, 125 lb. and handwheel actuator. Valves shall open counterclockwise. Gate valves shall be as manufactured by Mueller, or approved equal.

B. Fire Hydrants

Fire hydrants must comply with AWWA C-502 and shall be traffic type. Hydrants shall have 6" mechanical joint inlet connection or 6" flanged connection directly to hydrant valve. Furnish each hydrant with a resilient seated gate valve with extension stem, 2" square operating nut, and valve box to grade. The hydrants shall be 5-1/4" size with one (1) 4-1/2" National Standard Thread (NST) pumper nozzle and two (2) 2-1/2" NST hose nozzles. Operating nut shall be 1-1/8" pentagon and shall open counterclockwise. Hydrants shall have 6'-6" depth of bury with drain plug. Hydrants shall be Model 5BR as manufactured by East Jordan Iron Works, or approved equal.

2.08 Tapping Sleeves

Tapping Sleeves shall be cast iron or ductile iron, pressure rating of 250 psi (1.7 MPa), mechanical joint sleeves conforming to AWWA C110, furnished complete with valve, stops, caps, plugs and joint accessories as indicated on the Plan. The sleeve shall be of a 2-section type.

2.09 Valve Boxes

Valve boxes shall be 3-piece, 5-1/4 inch (135 mm) diameter, screw type, gray iron castings conforming to ASTM A48, Class 20. Overall length shall be adjustable to meet grade.

2.10 Corporation Stops

Corporation stops, couplings and plugs shall be water service bronze of type and size detailed on the Plans.

2.11 Service Saddles

Water service saddles shall be compatible with the main and service lead, with straps of a ductile material to avoid crushing the main out-of-round. A molded gasket of rubber or neoprene shall

completely encircle the tapped opening to insure a watertight connection. The use of lead gaskets is not allowed. Water service saddles shall be bronze with AWWA tapped threads.

Service saddles used with PVC water main shall be double strap, full circular and provide uniform bearing around the circumference. U-bolt type straps are not allowed.

2.12 Curb Stops

Water service bronze of types and sizes detailed on the Plans. Curb stops shall include an extension type, 3-piece curb box with extension type base, foot piece, one piece lid and a 3-foot stationary rod, unless otherwise specified.

2.13 Threaded Fittings

Where indicated on the Plans, threads for water main service fittings shall conform to the requirements of AWWA C800 and AWWA C800 "Appendix for Materials."

2.14 Water Service Pipe

Soft Copper shall be Type "K" conforming to ASTM B-88, with flared fittings.

2.15 Restraints, Clamps, Rods, and Ties

High strength low alloy steel or stainless steel conforming to ANSI/AWWA C111/A21.11. Balls and fittings shall be bronze alloy or corrosion protected steel.

2.16 Structures

Material for water main structures shall conform to the details on the plans and the requirements listed below:

Precast concrete structures shall conform to ASTM C478, circular with circular reinforcement as detailed. Provide lifting holes in precast units where indicated.

2.17 Manhole Steps

Cast iron manhole steps shall be ASTM A48, Class 30, with a minimum cross section dimension of 1-inch (25 mm) in any direction.

Steel reinforced plastic manhole steps shall be suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60.

Manhole steps shall be of types and sizes indicated on the Plans and shall comply with applicable state and federal occupational and safety standards.

2.18 Covers and Frames

Structure frame and covers shall be of the types and sizes as detailed on the Plans. Covers shall be Class 30, ASTM A48 gray iron castings. The castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of castings shall be ground to assure proper fit and to prevent rocking. Units shall be frost proof and shall be provided with tapping screws and anchors where indicated on the Plans.

2.19 Bolts, Studs, and Nuts

Bolts, studs, and nuts shall be as specified on the Plans and shall conform to the requirements of AWWA C500 and the ASTM standards listed below:

Bronze ASTM B98
Steel ASTM A307, Grade B
Cadmium Plating ASTM B766, Grade NS
Zinc Coating ASTM A153 or B633, Type GS

Tee head bolts and nuts shall be high strength, low alloy steel conforming to ANSI/AWWA C111/A 21.11.

2.20 Flowable Fill

Flowable Fill for filling abandoned water mains.

A. Materials

Cement: Cement shall conform to ASTM C150 or ASTM C595

Fly Ash: Fly ash shall have a maximum loss on ignition of 12 percent and meeting the other requirements of ASTM C618 (Class F)

Water: The water shall meet the requirements of ASTM C94

B. Mixture (Strength 50-100 psi) (345 to 690 kPa)

Fly Ash: 2,000 lbs/cyd (1190 kg/m^3) (min)

Cement: 100 lbs/cyd (60 kg/m^3)(minimum)

Water Sufficient water to produce the desired flowability (approximately 700 lbs/cyd)(415 kg/m^3)

The temperature of the flowable fill mixture as manufactured and delivered shall be at least 50°F (10° C).

The flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.

CONTRACTOR shall submit a history of the mix design for seven (7) day and 28 day strengths, together with any other technical information. The design mix shall also be included as part of the CONTRACTOR's submittals for project.

2.21 Tracer Wire

Copper clad steel wire with 30 mil High Density Polyethylene insulation. Concentric copper cladding metallurgically bonded to a steel core through a continuous solid cladding process. Copper cladding to measure 3% minimum of the overall wire diameter. Wire to be 12 AWG, .0808 in. diameter, .00242 inch nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength. Wire to be Copperweld ® or equal.

2.22 Acceptable Manufacturers

A. Flexible Joint Pipe: "F141," Clow, "Usiflex," U.S. Pipe, or approved equal.

B. Restrained Joints for ductile iron pipe: Griffin Pipe Products Company, “Snap-Lok” or “Bolt-Lok”; American Cast Iron Pipe Company, “Lok-Ring” or “Lok-Fast”; United States Pipe and Foundry Company, “TR Flex”; Ebaa Iron “Megalug” or approved equal.

C. Valve Boxes: "A-295 Three Piece Screw Type," Traverse City Iron Works; "F2450," Clow, "Series 6860, Tyler," or approved equal.

D. Corporation Stops: Mueller or approved equal.

E. Service Saddles: "Twin Seal," Clow, "Hays Seal," Hays, "Service Saddles," Mueller, or approved equal.

F. Curb Stops: Mueller or approved equal.

Part 3 Execution

3.01 CONTRACTOR's Verification

Prior to the installation of any water main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that all excavation bottoms, compacted subgrades and pipe bedding are adequate to receive water main materials to be installed. Correct all defects and deficiencies before proceeding with the work.

Expose the existing water main piping and structures to which the new Work is to be connected and notify the ENGINEER of the same. The ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform the CONTRACTOR as to the necessary adjustments required to align the new water main work with the existing system.

3.02 Preparation

Remove all lumps, blisters and excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of all plain ends and the inside surfaces of all socket ends before installation. Any pipe or fitting which has acquired a coating of mud or other foreign material shall be scrubbed clean with heavily chlorinated water.

All pipe fittings, valves, hydrants, accessories and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be rejected and removed from the Project by the CONTRACTOR.

3.03 Installation - General

Foreign matter shall be prevented from entering the pipe while it is being placed in the trench. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe.

Proposed water main shall be separated from existing or proposed sanitary or storm sewers as follows:

1. Parallel Installation. Water mains shall be laid at least 10 feet horizontally from existing or proposed sanitary or storm sewers, measured from pipe edge to pipe edge.

2. Crossings. Water mains crossing existing or proposed sanitary or storm sewers shall be laid to provide the minimum vertical distance of 18 inches between water main and sewer, measured from pipe edge to pipe edge.

During the progress of all water main Work, watertight plugs shall be carried along and inserted in the end of each pipe as it is laid to prevent foreign matter or rodents from entering the pipe. This watertight plug shall be fastened in the end of the water main in such a manner as to prevent it from floating or being otherwise displaced whenever construction operations are temporarily halted, such as at noon or at the end of the days Work.

Pipe shall have minimum depth of bury of 6 feet.

Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes.

Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles, shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer for the type of pipe materials being cut and according to the best trade practices.

When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.

Where pipe using a resilient gasket to effect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burrs which might damage the gasket.

Where soil or groundwater is contaminated, appropriate contaminant restraint gaskets are required per the direction of the ENGINEER or as noted on the Plans.

Unless otherwise specified, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell end of the adjacent pipe section, the pipe shoved into position and brought to true alignment and secured with sand tamped under and on both sides of the pipe except at bell holes. Adequate support shall be provided for all water main pipe.

After the bottom of trench has been excavated the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. The pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.

A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.

Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.

Install bolts, studs, and nuts of the type specified per the manufacturer's installation and torquing requirements. All steel bolts, studs, and nuts shall be painted with bituminous paint after installation.

3.04 Installation of Ductile Iron Pipe

Ductile Iron pipe shall be installed per AWWA C600.

Push-on-joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be prelubricated before installation using a lubricant recommended by the pipe manufacturer. The seated joint shall be identified by the visible mark on the spigot of the installed pipe section.

Mechanical joints shall be made with bolts, molded resilient gasket and cast iron follower gland. All nuts shall be screwed up finger tight before using a wrench. The gland and rubber gasket shall be brought up evenly at all points around the bell flange and then torqued per the manufacturer's recommendations.

Exposed portions of bolts shall be covered with mastic.

Flexible joint pipe shall be assembled, handled and installed in accordance with the printed recommendations which accompanies the pipe and is provided by the manufacturer of the piping materials being installed. Methods of handling and installation shall be acceptable to the ENGINEER.

3.05 Installation of Polyvinyl Chloride Pipe

PVC pipe shall be installed in accordance with AWWA C605. Polyvinyl chloride pipe shall be laid with gasketed joints in complete accordance with AWWA C605 and the pipe manufacturers published instructions. The joints shall be sufficiently lubricated using the pipe manufacturers recommended lubricant.

Gaskets for pipe joints shall be inserted with the painted edge facing the end of the bell. Each length of pipe shall be pushed home individually. The pipe shall be positioned so that the reference mark on the spigot end is in line with the bell end.

Tracer wire is to be installed along with PVC water mains. Tracer wire is to be continuous from end to end and terminate at each structure in such a way and with a sufficient length of wire to allow for easy connection to utility tracing equipment. Wire shall be continuity tested after installation. Any wire which fails the continuity test shall be replaced.

3.06 Installation of High Density Polyethylene (HDPE) Pipe

HDPE pipe may be installed by conventional methods, or in special application, by the horizontal boring method. Special applications may include: surface water crossings, highway crossings, wetlands, unstable soils or areas that would require high restoration costs due to conventional construction. Critical crossings, such as surface water crossings, require valving on each side of the crossing so that the section of piping may be isolated. In addition, a valve manhole with corporation stops on each side of the valve shall be installed for purposes of future chlorination, sampling, and leak testing.

HDPE joints shall be fusion welded in accordance with the procedures and techniques in ASTM D2657 or ASTM D3261, as applicable.

Connections to HDPE pipe shall not be made immediately after the pipe has been installed. It is recommended to wait overnight so that the pipe can approach an equilibrium temperature with its surrounding environment. Linear dimensions will vary with temperature change.

In addition, HDPE pipe must be properly aligned at all transitions to conventional or HDPE water main and appurtenances.

Otherwise install HDPE pipe per AWWA C605. Tracer wire shall be required with HDPE pipe.

3.07 Installation of Restrained Joints

Restrained joints shall be provided where indicated on the plans. Joints shall be assembled in strict accordance with manufacturer's directions. All joints shall be fully extended after assembly.

3.08 Fittings, Strapping, and Lugged Pipe

Install all fittings to the lines, levels and locations indicated on the Plans. Fittings shall be provided with restraints as specified herein, as indicated on the Plans, or as required for a functional installation.

Where indicated on the Plans or as determined by the ENGINEER, bends in water main piping and piping runs subject to impact reaction shall be secured by means of metal strapping. Install all necessary bands, tie rods, nuts, and washers required. No metal strapping shall be used in direct contact with polyvinyl chloride pipe.

Where lugged pipe and special fittings are indicated on the Plans, furnish and install all necessary tie rods, nuts, and washers.

3.09 Polyethylene Encasement

Where called for on the plans, ductile iron water main, fittings and hydrants shall be encased in a polyethylene film tube. The polyethylene film tube shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Method A consists of cutting the polyethylene tube two feet longer than the pipe to provide an overlap at the joints. The cost of the polyethylene encasement shall be incidental to the water main. Service taps, bends, tees and other connections shall be made to polyethylene encased pipe in accordance with section 4.4.6 of AWWA C105.

3.10 Valves

All valves shall be installed to the grade, lines, levels and locations indicated on the Plans.

Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.

Where required, valves shall be supported with special supports as indicated on the Plans and as approved by the ENGINEER. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.

3.11 Water Main Structures

Construct water main valve wells and structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment rings, etc. as shown and as required for a complete installation. Construction of water main structures shall conform to the type of construction and dimensions indicated on the Plans and as described below.

Construct precast concrete structures as detailed on the Plans. Provide mortar joints struck smooth. Provide two (2) to four (4) courses of 8-inch (200 mm) brick at top of structure for future adjustment.

Cement mortar plaster coat shall be applied to the exterior surfaces of all brick or block gate wells and other water main structures indicated on the Plans. Plaster coat shall be 1/2 inch (10 mm) thick and shall be applied to the outer surfaces of the structures.

Provide and install to the elevations shown all cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 1/2 inch (10 mm) thick minimum. Mortar joints shall be struck smooth.

Install steps for structures of types and in locations indicated on the Plans. Steps shall be installed on 16-inch (400 mm) centers minimum, unless shown otherwise on the plans.

Pipe placed in structures for inlet or outlet connections shall extend through the walls and beyond the outside wall surfaces a sufficient distance to allow for complete connections. Openings between pipes and walls shall be sealed with a full bed of cement mortar. Pipe shall be supported by concrete supports.

3.12 Valve Boxes

Install valve boxes to the grade, lines, levels and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.13 Hydrants

All hydrants shall be installed plumb to the lines, levels, grades and locations indicated on the Plans. Hydrants shall be set to the established grade, shall have their nozzles parallel to or at right angles to and facing the grade or curb.

Where necessary to adjust for proper hydrant location, the CONTRACTOR shall install additional pipe between the water main and road box. Hydrant extensions shall be installed to adjust hydrant to proper grade.

The CONTRACTOR shall plumb all hydrants at the time they are set with a plumb line or other means acceptable to the ENGINEER. Upon substantial completion of cleanup, the CONTRACTOR shall recheck all hydrants for plumb and grade and shall make all adjustments as necessary at this time. The Work of constructing fire hydrants shall not be considered complete until these final adjustments for plumb and grade have been made.

3.14 Fire Hydrant Approaches

Fire hydrant approaches shall consist of culvert pipe with end protection and a gravel approach. The culvert pipe shall be of the size and type shown on the Plans. The culvert pipe shall be installed to the existing or proposed grade of the drain or ditch with pipe bedding and backfill from a point four (4) inches (100 mm) below the pipe to a point 12 inches (300 mm) above the top of the pipe, consisting of bank run sand meeting the requirements of MDOT Class II granular material and compacted to 95% of maximum unit weight. Each end of the culvert pipe shall be protected against erosion, as shown on the Plans. The gravel approach shall extend from the edge of the traveled portion of the road to the fire hydrant and shall be a minimum of ten feet (3 m) wide. The gravel approach shall consist of a minimum of six (6) inches (150 mm) of compacted 22A or 23A aggregate, with calcium chloride applied at a rate of six (6) pounds per Ton (3 kg per metric ton) of aggregate.

3.15 Air Release Assembly

Provide all materials and construct air release assemblies where indicated on the Plans. Install all valves, fittings, caps, plugs and piping as required. Fittings and joint materials used for air release assemblies shall be as specified herein for the water main piping materials used. Air release manholes ans details shall meet all requirements of Recommended Standards for Water Works and all cross connection guidance and rules.

3.16 Blow-Off Assembly

Provide all materials and construct blow-off assemblies where indicated on the Plans. Blow-off assemblies and pipe shall be installed to the lines, levels and elevations shown. Install all valves, fittings, reducers, piping, plugs, joints, etc., as detailed. Blow-off assemblies shall be installed on stable, undisturbed earth materials with changes in directions and returns provided with bedding and restraints as indicated on the Plans, as specified herein and as required for a complete installation. Blow-off assemblies shall include valve boxes as detailed.

3.17 Tapping Valve Assembly

Install all tapping valve assemblies of sizes and to the lines, elevations, locations and details indicated on the Plans. The tapping sleeve shall be assembled around the main, and the tapping performed in strict accordance with the manufacturer's recommendations. Tapping shall be accomplished without interruption of service.

3.18 Anchors, Encasements, and Restraints

Plugs, tees, sleeves, bends, caps, straps and lug piping shall be provided with suitable anchors, encasements and restraints as indicated on the Plans. Anchoring, encasement and restraint methods shall be as detailed. All bearings shall be as shown. Anchors, encasements and restraints shall rest on firm, stable, compacted subgrade and shall be provided for all standard and special fittings.

3.19 Water Service Lines

When so indicated in the Proposal, or on the Plans, the CONTRACTOR shall provide water service lines in accordance with this Section. Otherwise, water service lines are not required.

Water service lines shall be installed after the water main has been successfully tested and put into service, including the installation of fire hydrants. The service lines shall be of the type indicated on the Plans, and shall be 1 inch (25mm) diameter unless otherwise indicated on the Plans or Proposal.

Water service lines shall be provided for all lots or parcels at the locations indicated on the Plans, within these Contract Documents or as designated by the ENGINEER. Service lines shall extend from the water main to within 1-foot (300 mm) of the limits of a right-of-way or easement at a minimum 5-foot (1.5 m) depth terminating with a curb stop and curb box as specified herein.

Water service lines under concrete or asphalt pavements shall be installed by boring or tunneling, unless otherwise indicated on the Plans or approved by the ENGINEER.

Backfilling of open cut construction for water services shall be in accordance with Section 31 2333, Trenching and Backfilling, after the service line, including curb stop, has been laid and approved by the ENGINEER. Prior to backfilling the service line the CONTRACTOR shall request an inspection by the ENGINEER and obtain approval of the service line.

Alternative methods such as hydraulic jacking; air jetting; piston mole; etc, may be used to install water service lines if approved by the ENGINEER. The proposed method must be approved by the governmental agency having jurisdiction over the work area and the CONTRACTOR must demonstrate that, in the opinion of the ENGINEER, the method is suitable for local soil and ground conditions. To be found suitable for local conditions, the method must be demonstrated to perform within acceptable horizontal and vertical accuracy limits, must not compress soil beyond acceptable limits, and must not leave voids in the soil. Water jetting shall not be permitted. Final installation of the service pipe must be

in accordance with manufacturer's recommendations and no joints or fittings shall be allowed under roadway surfaces.

Existing water mains shall be kept in service until all water services have been connected to the new mains. The CONTRACTOR shall repair all water services damaged during the installation of the new water mains. Only after the new mains have been accepted and put into service, will service connections be made to the new mains.

A. Reconnection of Water Services

The connection of existing service lines to the new mains shall be made within the street rights-of-way or within the easements, utilizing the existing curb stops. All existing lead water service lines shall be abandoned and new water service lines installed from the new water main to the existing curb stops.

Backfill, method of construction under pavements, and new water service lines shall be as specified in this Section.

3.20 Corporation Stops

Corporation stops shall be located on water main piping where indicated on the Plans, or as determined by the ENGINEER.

All corporation stops on PVC water mains shall be made with service saddles.

Install a minimum of two (2) corporation stops in each valve well.

3.21 Service Saddles

Where service saddles are to be installed, the entire circumference of the main shall be free of all loose material. Installation of the saddle and tapping of the main shall be in accordance with manufacturer's recommendations.

3.22 Curb Stops

Install curb stops of the types and sizes indicated on the Plans. Curb stops shall include furnishing and installing a curb box.

3.23 Abandoning Water Main

Install cap with a minimum 2-inch (50 mm) diameter threaded opening at one end of water main to be abandoned and solid cap at opposite end.

Install a minimum 2-inch (50 mm) diameter stand pipe no farther than 1-foot (0.3 m) from the end with the solid cap in the top of the water main to be abandoned. The stand pipe should be installed such that it can be removed after use and the hole sealed.

Install a minimum 2-inch (50 mm) diameter drain pipe in threaded opening. The drain pipe shall be installed in the opposite end of the water main from the stand pipe. The drain pipe should bend up to a 90 degree angle with the end of the pipe being a minimum of six (6) inches (150 mm) above the top of the water main.

Using the stand pipe, fill the water main to be abandoned with flowable fill material. The material shall be placed in the water main until free water flows from the drain pipe at the opposite end. Continue

filling water main until the material released at the drain pipe is representative of the flowable fill being introduced at the fill end of the water main, at which time the drain pipe will be sealed with a threaded cap and the filling terminated.

Remove the stand pipe and cap the filling hole.

3.24 Relocate Water Main

Relocate water main shall consist of removing and relaying and existing water main to go under or over a proposed utility. Existing pipe shall be removed and disposed of. Bends and vertical anchors shall be installed as shown on the plans. Verticals anchors and thrust blocks shall be sufficient to resist thrust forces.

3.25 Abandon Existing Gate Valve and Well

Gate valve and well and other water main structures on the existing water main shall be abandoned and the structures shall be abandoned in accordance with the following: The abandonment of existing structures shall consist of removing and salvaging the existing frame and cover. The valve shall be opened. Masonry shall be broken down to an elevation at least 3-feet (1 m) below the subgrade. The abandoned structure shall be backfilled with flowable fill to 1-foot (300 mm) above the pipes and the remainder of the structure with sand-cement mixture at a 10 to 1 ratio to subgrade elevation or to 1-foot (300 mm) below finished grade.

3.26 Remove Gate Valve and Well

Gate valve and well and other water main structures on the existing water main shall be removed in accordance with the following: The removal of existing structures shall consist of removing and salvaging the existing frame and cover, and valve. The ends of the existing water main shall be plugged and braced. The complete structure shall be removed entirely and disposed of. The excavation shall be backfilled with sand and compacted to 95 percent of its maximum unit weight.

3.27 Remove Existing Fire Hydrants

Fire hydrants on the existing water main shall be removed by excavating and removing the existing fire hydrant, gate valve, and valve box. The existing hydrant lead shall be capped and blocked. The fire hydrant, valve, and box shall be salvaged and delivered to a location as designated by the OWNER. The excavation shall be backfilled with sand and compacted to 95 percent of its maximum unit weight.

3.28 Relocation of Fire Hydrants

Relocation of hydrants shall include the provision of new hydrant shoes, frost jacket and restraints. Provide all new materials required for hydrant relocation. Reinstall hydrants at the new locations to the lines and levels shown. Make all joint connections to new or existing water mains, joints, couplings, etc., as shown and as required. Provide all anchorage and restraint for a complete installation.

3.29 Hydrostatic Testing

After the pipe has been laid and backfilled, the pipe shall be hydrostatically tested for leakage. The CONTRACTOR shall furnish the pump, pipe connection, hydrants, valves and any other necessary apparatus including gages and meters and all personnel necessary for conducting the test. Before applying the test pressure, all air shall be expelled from the pipe. If necessary to accomplish this, taps shall be made at points of higher elevation and afterwards plugged.

Test sections will normally not exceed one (1) mile (1.6 km) and in the event more than one (1) mile (1.6 km) of water main is tested, the permissible leakage will remain at the amount determined for one (1) mile (1.6 km) of pipe.

A. Testing Ductile Iron Water Main

The test shall be made at a pressure of 150 pounds per square inch (1 MPa) gage minimum. The full pressure shall be held for at least two (2) hours. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by the CONTRACTOR with sound material and the test shall be repeated until specified requirements are met. The maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed that given under Allowable Leakage as noted in Article 3.29D. Hydrostatic testing shall conform to AWWA C600.

B. Testing PVC Water Main

The test shall be made at a pressure of 150 pounds per square inch (1 MPa) gage minimum per AWWA C605. The full pressure shall be held for at least two (2) hours. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by the CONTRACTOR with sound material and the test shall be repeated until specified requirements are met. The maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed that given under Allowable Leakage as noted in Article 3.29D for each section tested.

C. For HDPE pressure testing also reference AWWA C605, the Plastic Pipe Institute's Handbook for Polyethylene Pipe, AWWA Manual M55 and manufacturer's recommendations. HDPE pipe pressure test must include an initial expansion phase and be conducted for 2 hours at 150 psi minimum.

D. Allowable Leakage rates per AWWA C600-05 and C605-05:
D = diameter of pipe - inches
L = testing allowance, gph
S = length of pipe, feet
P = ave. test pressure, psi (guage)
For 150 psi test pressure this results in:

Nominal diameter	Hydrostatic testing allowance	
4 inch	0.33 gph	Per 1,000 feet of pipe
6 inch	0.5 gph	Per 1,000 feet of pipe
8 inch	0.66 gph	Per 1,000 feet of pipe
10 inch	0.83 gph	Per 1,000 feet of pipe
12 inch	0.99 gph	Per 1,000 feet of pipe

3.30 Flushing

After completion of water main installation, flush the new mains, valves, hydrants and appurtenances completely and as acceptable to the ENGINEER. Heavily chlorinated water discharged from a disinfected system shall be controlled adequately to protect any surface water resource or adjacent property from potential environmental damage, or from creation of a hazard to traffic.

Remove and dispose of all temporary installations at completion of the flushing operation. After flushing, and prior to final approval of the system, the CONTRACTOR shall pump down all fire hydrants and verify that the hydrant valve is properly seated to prevent the hydrant standpipe from filling with water.

3.31 Disinfection

CONTRACTOR shall disinfect water main before making any connections to existing water mains. After satisfactory hydrostatic testing and flushing of the new water main, disinfect the complete system in accordance with AWWA C651 by introduction of a chlorine-water solution throughout the water main piping. The liquid mixture shall be applied by means of a solution-feed chlorinating device. The CONTRACTOR shall install corporation stop and feed chlorine solution through the corporation stop at the beginning of the main or valved section. A slow flow of water shall be let into the main approximately at the point of injection of the chlorine solution, at a rate such that the chlorine dosage of the entering water shall be at least 50 parts per million. An open discharge shall be maintained at the far end of the section of main being chlorinated, and the introduction of chlorine solution and water shall continue until the water discharging at the far end shall carry the required dosage of chlorine.

As the main is filled with chlorinated water, each outlet from the main shall be opened and sufficient water drawn off to assure that the full dosage of chlorine reaches each outlet.

Back pressure causing a reversal of flow in the main being chlorinated shall be prevented, and pressure in the main shall be held down to a point which will make it impossible for chlorinated water to be forced into other sections of the main or water system.

The chlorine treated water shall remain in the main at least 24 hours, and at the end of that time the chlorine residual at pipe extremities and other representative points shall be at least 25 ppm. If the chlorine residual shall be less than 25 ppm at the end of 24 hours, further application of chlorine shall be made and the retention period repeated until the required 25 ppm residual is obtained.

Should the initial treatment of all or any section of the mains, in the opinion of the ENGINEER, prove ineffective, the chlorination procedure shall be repeated until confirmed tests show that water sampled from the new mains conforms to the foregoing requirements.

The CONTRACTOR shall collect water samples per AWWA C651 and cause analyses to be made at his own expense. Testing laboratory and sample collection shall meet the approval of public health authorities having jurisdiction.

3.32 Water for Cleaning, Testing and Disinfection

The CONTRACTOR shall make all necessary arrangements with the authority which controls the source of water system and shall be governed in his use of water by all rules and regulations imposed thereon by said authority.

The CONTRACTOR shall provide and remove temporary connections between the source water system and the mains constructed under this contract. All temporary connections shall meet the approval of the ENGINEER, the authority controlling the source water system, and Public Health authorities having jurisdiction. Cross connection control including suitable backflow preventers shall be utilized per the requirements of the potable water source.

3.33 Bacteriological Analysis

Prior to bacteriological analysis samples being taken, the heavily Chlorinated water shall be flushed from the main and replaced with potable water with chlorine concentrations that are no higher than generally prevailing in the distribution system or that is acceptable for domestic use.
Prior to placing a water main in service, not less than two (2) consecutive water samples taken 24 hours apart for bacteriological analysis shall be collected and each analysis shall show results meeting state and local drinking water standards.

The CONTRACTOR shall collect water samples and cause analyses to be made at his own expense. Samples shall be collected in accordance with AWWA C651. Testing laboratory and sample collection shall meet the approval of public agency having jurisdiction.

Safe or acceptable test results are negative for bacteria and otherwise in accordance with AWWA C651 and MDNRE requirements.

3.34 Cleaning (Pigging)

Flushing shall be performed using foam "poly-pig" swabs to ensure that no debris and grit remain in the line prior to disinfection and placing water main in service. Cleaning shall be with a metal bodied, mandrel type solid plug (pig) with scrapers. The pig shall be pulled or otherwise propelled through the entire line prior to testing or connecting to any existing water main.

End of Section

Section 33 3000
Sanitary Utility Sewerage Piping

Part 1 General

1.01 Scope

This Section includes sanitary sewer Work indicated on the Plans complete with pipe, joints, structures, pipe bedding, installation, television inspection and testing.

1.02 Related Work Specified Elsewhere

Structural Excavation and Backfill: Section 31 2316
Dewatering: Section 31 2319
Trenching and Backfilling: Section 31 2333

1.03 Requirements of Regulatory Agencies

Testing shall conform to the applicable requirements of State and local authorities having jurisdiction, and shall include such tests as: deflection, air, exfiltration and infiltration.

1.04 Reference Standards

Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:

ANSI - American National Standard Institute
ASTM - ASTM International
MDOT - Michigan Department of Transportation, 2012, Standard Specifications for Construction
NCPI - National Clay Pipe Institute

1.05 Source Quality Control

Laboratory test not less than one (1) percent, with a minimum of three (3) pieces, each size, material and class of gravity pipe required in the Work.

1.06 Tolerances

The actual grade of the invert of the sewer shall not deviate from plan grade by more than 0.1 feet/100 feet (0.03 m/30 m), and not more than 0.2 ft. (60 mm) in total for a sewer run from manhole to manhole.

Alignment of sewer shall be within 0.2 feet/100 feet (0.06 m/30 m) and within 0.5 feet (150 mm) in total for a sewer run from manhole to manhole.

1.07 Submittals

Submit independent grade checks in accordance with Article 3.06 of this section.

Submit manufacturer's data for pipe bulkheading devices in accordance with Article 3.13 of this Section.

A complete field report of the location of all wyes, risers and building leads shall be submitted to the ENGINEER at the end of each sewer section of the Project or on the last day of each week, whichever occurs first.

The complete field report shall include witnessing by the CONTRACTOR of the ends of all building leads placed. Witnessing shall consist of recording three (3) horizontal distances to the nearest foot (0.3 m) with the lines of measurement at minimum angles of 45 degrees with respect to one another. Witnessing shall also include recording of the depth to nearest 1/2 foot (0.1 m) from the invert at the end of the lead to the finish ground above the end of the lead. No payment will be made for un-witnessed installation or for improperly witnessed installations.

As part of the television inspection, a wye location report shall be submitted to the ENGINEER. The report shall contain the precise location of each wye, notes, photographs, and other pertinent information.

Submit two (2) copies of the laboratory test reports required per Article 1.05 of this Section to the ENGINEER.

Shop Drawings shall be provided on all manhole tees.

1.08 Storage of Materials

Piping material shall not be stacked higher than four (4) feet (1.2 m). Suitable racks, chairs, and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground; alternate tiers; and chock tier ends.

All joint and sealing materials used in the sanitary sewer system shall be protected from sunlight and stored in cool and clean place until ready for installation.

1.09 Handling of Material

Load and unload piping using suitably approved hoists, skids, etc. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping not be used by the CONTRACTOR.

Lifting devices shall be suited to the Work and shall protect surfaces from damage.

Part 2 Products

2.01 Scope

The intent of the Articles in Part 2 of this Section is to specify in detail the various types of sewer pipe, joints, manholes, etc. which have been indicated throughout the Plans and Specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 PVC Solid Wall Pipe

PVC Solid Wall Pipe in sizes 6-inch through 15-inch (150 mm through 375 mm) shall be ASTM D3034, SDR 35, and in sizes 18-inch through 27-inch (450 mm through 675 mm) shall be ASTM F679 SDR35, polyvinyl chloride pipe (PVC).

Joints for polyvinyl chloride pipe (PVC) shall be ASTM D3212, push-on type, in which an elastomeric ring gasket is compressed in the annular space between a bell end or socket and a spigot end of pipe.

Wyes or tees shall be a molded wye or tee fitting per ASTM D2680, with gasketed joints on each end suitable for directly inserting in the mainline pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner

surface of the pipe. Branch connection fitting shall be a gasketed joint suitable for the house lead pipe specified. Saddle connections are not allowed.

2.03 Structures

Material for sanitary sewer structures shall conform to the requirements as indicated on the Plans and as specified below. Precast concrete structures are required except when constructing a structure over an existing sewer may require limited use of concrete block or brick as approved by the ENGINEER.

A. Concrete Brick:
Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.

B. Concrete Block:
Block shall conform to ASTM C139, Portland cement conforming to ASTM C150, Type II. Blocks shall be solid curved blocks with the inside and outside surfaces parallel and curved to the required radii. The blocks shall have a groove or other approved type of joint at the ends.

C. Precast Concrete:
Precast concrete manhole, riser, cone and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement. The wall thickness shall be five (5) inches (125 mm) for manhole depths up to 32 feet (10 m). Base slab shall be eight (8) inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).

Precast doghouse sections shall be used for connections to existing sewer 15 inches (375 mm) and smaller on straight through runs for a depth up to 20 feet (6 m) and on right angle runs, with a maximum of four cutouts for depths up to 12 feet (3.5 m). Openings in precast doghouse sections shall be cast in the pipe before curing and no breaking or chipping of sections will be allowed after the manhole section has cured. The size of the opening shall be cast as indicated on the Plans.

Precast bottom sections shall be cast with the bottom end flat to provide bearing of the full wall thickness. The openings for sewer pipe shall be cast in the manhole and the bottom section by the manufacturer.

6-inch through 24-inch (150 mm through 600 mm) connections to manholes shall use a mechanically compressible flexible joint, as indicated on the Plans. 27-inch (675 mm) and larger connections to manholes shall be grouted, as indicated on the Plans.

Riser sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets or a tongue and groove joint with a Butyl Rubber based gasket type sealant meeting the requirements of AASHTO M-198 and having a nominal size of 1-inch (25 mm).

Eccentric cone sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets and be provided with 4-stud inserts cast in the top. The top shall have a smooth finished surface.

Concrete grade rings shall have smooth finished top and bottom surfaces. Grade rings shall be provided with "O" ring gaskets.

Precast manhole tees will be allowed on straight through runs with no angle at the manhole and where stubs or openings in manhole are above the tee section.

Precast concrete manhole tee units shall conform to ASTM C76, Class IV and shall be circular with circular reinforcement. The precast tees must be a monolithic pour with wire cage inspection prior to concrete placement. Joints for tee shall be the same as the joints on the sanitary sewer.

D. Manhole Steps:
Cast iron manhole steps shall conform to ASTM A48, Class 30, gray iron with a minimum cross section dimension of 1-inch (25 mm) in any direction.

Steel reinforced plastic manhole steps shall be of suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60 and shall be in accordance with ASTM C478.

Manhole steps shall be of the types and sizes indicated on the Plans and shall comply with applicable Michigan Occupational Safety and Health Standards (MIOSHA).

E. Manhole Frames and Covers:
Manhole frames and covers shall conform to ASTM A48, Class 30, gray iron and shall be of the types and sizes as indicated on the Plans. The castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of casting shall be ground to assure proper fit and to prevent rocking.

For all manholes, use a bolted waterproof frame with a pressure tight cover. Bolted down frame and cover shall be installed as indicated on the Plans.

Bolts, studs, and nuts shall conform to the following ASTM Standards:

Cadmium Plating: ASTM B766, Grade N.S.
Zinc Coating: ASTM A153 or B663, Type G.S.

2.04 Concrete

In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m^3); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without the ENGINEER's approval.

2.05 Concrete Reinforcement

In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.06 Flowable Fill

Flowable fill shall be used for filling abandoned sanitary sewers.

A. Materials:
Cement: Cement shall conform to ASTM C150 or ASTM C595

Fly Ash: Fly ash shall have a maximum loss on ignition of 12 percent and meeting the other requirements of ASTM C618 (Class F)

Water: The water shall meet the requirements of ASTM C94

B. Mixture (Strength 50 – 100 psi) (345 to 690 kPa)

Fly Ash (Class F): Minimum 2,000 lbs/cyd (1185 kg/m3)

Cement: Minimum 100 lbs/cyd (60 kg/m3)

Water: Sufficient water to produce the desired flowability (approximately 700 lbs/cyd) (415 kg/m3)

The temperature of the flowable fill mixture as manufactured and delivered shall be at least 50° F (10° C).

The flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.

CONTRACTOR shall submit a history of the mix design for seven day and 28 day strengths, together with any other technical information. The design mix shall also be included as part of the CONTRACTOR's submittals for project.

Part 3 Execution

3.01 Verification of Excavation and Bedding

Prior to the installation of any sanitary sewer piping, structures, or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that all excavation bottoms, compacted subgrades and piping bedding are adequate to receive the sanitary sewer materials to be installed. Correct all defects and deficiencies before proceeding with the Work.

3.02 Existing Sanitary Sewers

The CONTRACTOR shall expose the existing sanitary sewer and structures to which the new Work is to be connected and notify the ENGINEER of same. The ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform the CONTRACTOR as to the necessary adjustments required to align the new sanitary sewer work with the existing system. Connecting to an existing manhole requires removing the existing flow channel and constructing a new flow channel as necessary.

Where the pipe joints are not compatible when connecting a new sewer to an existing sewer or a new building lead to an existing building lead, use a "Fernco" rubber adapter. When connecting clay to clay, concrete to concrete or plastic to plastic, use stainless steel shear ring type couplers.

3.03 Verification of Pipe Class and Joints

Prior to the installation of any sanitary sewer piping, ascertain that the class of pipe, joint material and bedding are as specified herein and as indicated on the Plans.

3.04 Preparation of Pipe Ends

The outside surface of the spigot end and the inside surface of the bell end shall be cleaned and free of any foreign material, other than sealant recommended by the manufacturer, prior to installation.

3.05 Examination of Material

All pipe, frames, covers, accessories, and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged material shall be rejected and removed from the Project by the CONTRACTOR.

3.06 Installation - General

Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length.

All pipe shall be laid to the line and grade called for on the Plans. Each pipe as laid shall be checked by the CONTRACTOR with line and grade pole or laser system to insure proper result is obtained. When employing a laser system, the CONTRACTOR shall have an alternate and independent means of checking the line and grade. CONTRACTOR shall check line and grade every 100-feet minimum. The finished work shall be straight and shall be sighted through between manholes.

Construction shall begin at the outlet end and proceed upstream with spigot ends pointing in direction of flow. Bell holes shall be excavated so that the full length of the barrel will bear uniformly on the bedding.

Mechanical means shall be used for pulling home all pipe where manual means will not result in pushing and holding the pipe home. Mechanical means shall consist of a cable placed inside of the pipe with a suitable winch, jack, or come along for pulling the pipe home and holding the pipe in position.

After laying of pipe, care shall be taken so as not to disturb its line and grade. Any pipe found off grade or out of line shall be re-laid.

Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer of the type of pipe materials being cut and according to the best trade practices. When cutting of pipe or fittings, care shall be taken to prevent damage to the lining and the exterior surface. Damage to either shall be cause for rejection of complete section.

During the preparation of the pipe bedding and until the trench has been satisfactorily backfilled, the trench shall be kept free of water and sewage. A dewatering system, in accordance with Section 31 2319, Dewatering, shall be provided and maintained by the CONTRACTOR. The dewatering system shall remain in operation until the trench is backfilled.

Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.

3.07 Pipe Laying

A. Rigid Pipe:
Installation of rigid pipe shall conform to ASTM C12. All pipe shall be jointed by means of a resilient gasket. The resilient gasket shall be lubricated and installed to form a watertight joint between the bell and spigot of the pipe. The bell of the pipe in place shall be cleaned and properly lubricated prior to the installation of the next pipe spigot. The pipe shall be centered in the bell or groove. After the spigot is well entered into the bell and the gasket is fully compressed and brought to final shape, check the gasket for proper position around the full circumference of the joint. Complete installation by pushing the pipe tightly together to form a smooth and continuous invert.

When adapters are required to properly connect the new pipe to an existing pipe of other materials or manufacture, the nominal inside diameter of adapters shall be the same size as the nominal pipe diameter to which it is to be connected.

B. Flexible Pipe:
Installation of flexible pipe shall conform to ASTM D2321.

Except as otherwise specified herein, installation of PVC piping shall be made in complete accordance with the published installation guide of the pipe manufacturer.

Joints for PVC pipe shall be made by using a lubricant immediately before joining. Apply lubricant on the bell and spigot, coating the entire circumference of the bell and spigot bevel plus 1-inch (25

mm) behind the taper. Insert lubricated spigot into the bell, and using normal force insert spigot until insertion stripe mark is flush with the bell entrance.

When jointing PVC pipe, rotate the pipe when inserting it approximately 1/4 to 1/2 turns.

Taps to previously installed ABS and PVC pipes, where in-line fittings are not provided, shall be made with chemically welded saddle fittings unless otherwise indicated on the Plans. Holes for saddle connections shall be by mechanical hole cutters, or by keyhole saw or saber saw. Holes for saddles shall be laid out with a template and shall be deburred and beveled to provide a smooth hole shaped to conform precisely to the fitting. After the cemented saddle has been fixed to the pipe surface, quickly install band clamps each side of the saddle and tighten.

3.08 Pipe Bedding

After the bottom of trench has been excavated the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. The pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.

A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.

3.09 Manhole Structures

Construct sanitary sewer manhole and other sanitary structures to the grades, lines and levels indicated on the Plans, or as specified herein. Structures shall be precast concrete, complete with concrete bases, reinforcing, frames, covers, and adjustment rings, as shown and as required for a complete installation. Sanitary manholes as called for on the Plans shall carry a stub opening as specified herein. Wye openings in manholes are prohibited unless indicated on Plans. Sanitary sewer structures shall conform to the type of material and dimensions indicated on the Plans.

Manholes shall be completed and ready for final inspection either before 600 feet (180 m) of additional sewer construction is completed or within one (1) week after the manhole is constructed, whichever comes first.

Sanitary manholes may only be constructed with block where specifically shown on the plans or where approved by the ENGINEER. The first course of concrete block shall be placed on the prepared base in a full bed of mortar. Mortar joints shall be full and closed in all courses. Courses shall be level throughout. Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable. Joints shall be uniform in thickness throughout the structure. Strike all joints and properly point to provide true, smooth surfaces.

Prior to applying plaster coat, block shall be thoroughly wetted with water and the surface allowed to dry sufficiently to effect proper bonding.

Where precast doghouse sections cannot be used, the manhole shall be brick or block to eight (8) inches (200 mm) above top of highest pipe. Above that point manholes shall be precast concrete as shown on the plans.

Cement mortar plaster coat shall be applied to the exterior surfaces of all brick and/or concrete block sections of all manholes. Plaster coat shall be 1/2 inch (10 mm) thick.

Provide and install all cast iron covers, frames, adjusting rings, and anchors to the elevation indicated on the Plans, or as specified herein. Castings shall be set on 1-inch (25 mm) diameter rubber "O" ring

gasket, resting on adjustment rings. The casting shall be anchored to the precast concrete cone section as indicated on the Plans.

Steps are to be installed at the plant by the manufacturer of precast units. Field install steps in other than precast structures of the types and in the locations indicated on the Plans.

Pipe, 6-inch through 24-inch (150 mm through 600 mm) diameters, shall be connected to manholes using an approved mechanically compressible flexible joint as indicated on the Plans. The pipe shall be properly supported with compacted pipe bedding material from undisturbed ground so that any settlement will not disturb the connection.

Pipe, 27-inch through 42-inch (675 mm through 1050 mm) diameters, or pipe in brick or block manholes, shall be connected to manholes using a grouted joint as indicated on the Plans. The pipe shall be properly supported with 3,500 psi (24 MPa) concrete from undisturbed ground so that any settlement will not disturb the connection.

The joint for existing pipe, six (6) inches (150mm) in diameter and larger, over which the sanitary manhole will be constructed, shall be a grouted joint as indicated on the Plans.

Pipe, 48 inches (1200 mm) in diameter or larger, shall be installed as an integral part of the manhole which shall be constructed of 3,500 psi (24 MPa) concrete placed in one continuous pour to 1-foot (300 mm) above the top of pipe as indicated on the Plans.

Concrete flow channels shall be constructed in each manhole, as indicated on the Plans. For manholes with outlet pipe diameter of 24 inches (600 mm) or less, construct concrete flow channel straight through a manhole to conform as closely as possible in shape, and slope to that of the connecting sewers. The channel walls shall be formed or shaped to the full height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers. The concrete flow channel shall be constructed with a 3/4 inch to 1-1/4 inch (20 mm to 30 mm) gap provided at the pipe ends to maintain joint flexibility.

For manholes with outlet pipe diameters from 27 inches to 42 inches (675 mm to 1050 mm) or for manholes constructed over existing sewers to 42 inches (1050 mm) in diameter, the channel shall be constructed by filling around the pipe to the spring line and splitting the pipe at the spring line and removing the top half after the manhole is constructed.

3.10 Sanitary Sewer Stub Opening

Stub openings shall be at least two (2) pipe lengths, with a minimum length of ten (10) feet (3 m) (unless otherwise indicated on the Plan), and the first joint located approximately 18 inches (450 mm) from the outside manhole wall. The end of the stub shall have a manufactured bell, which shall be plugged with a watertight manufacturer plug that is blocked to prevent movement.

3.11 Drop Connection Assembly

Provide all materials and construct drop connection assembly where indicated on the Plans. Install all piping, fittings, joints, etc., as detailed.

Tapping of existing manholes for drop connections shall be made by drilling holes through the wall of the manhole at 4-inch (100 mm) centers along the periphery of the opening, to create a plane of weakness joint, before breaking out section. Nonshrink grout shall be used to seal the opening and a 3,500 psi (24 MPa) concrete collar 12 inches (300 mm) thick shall be poured around the pipe. Drop connections to existing or new manholes shall be made as indicated on the Plans.

3.12 Bulkheads

A solid masonry or approved water and airtight bulkhead shall be placed at each point of beginning and at each stub that is constructed or as indicated on the Plans.

At the completion of construction and testing, all the bulkheads shall be removed, unless otherwise indicated on the Plans or as directed by the ENGINEER.

3.13 Wyes

One 6-inch (150 mm) wye or tee branch shall be provided for each lot or parcel 100 feet (30 m) or less in width that is served by the sewer or every hundred feet (30 m) for lots or parcels in excess of 100 feet (30 m) in width that is served by the sewer, unless otherwise indicated on the Plans or specified.

In all cases, unless otherwise indicated, wyes shall be placed as near as practical to the lower 1/3 point of vacant lots or parcels to be served, and it shall be the responsibility of the CONTRACTOR to see that the wyes are so placed. Wyes to developed lots or parcels shall be placed at the location nearest the existing sanitary service lead.

If the CONTRACTOR fails to place any wyes as herein outlined he shall return to the site and place additional wyes, in an approved manner, at his expense.

If a concrete pipe with an inset opening is being used, a compression type joint shall be cast into bell end of the opening. Wye openings shall be closed with a 6-inch (150 mm) stopper, as recommended by the manufacturer, to make a watertight closure.

3.14 Risers

Risers shall be installed where the sewer is more than 12 feet (3.5 m) below the established grade or future grade, and carried to between nine (9) and ten (10) feet (2.5 m to 3.0 m) of the established grade or future grade, as indicated on the Plans. Six (6) inch (150 mm) pipe with approved compression type joints, shall be installed in the manner indicated on the Plans.

Riser openings shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.

3.15 Building Leads

All building leads shall be 6-inch (150 mm) diameter pipe and shall be laid on a uniform slope of 1/8 inch per foot (10 millimeters per meter) unless greater slope will provide depth considered adequate by the ENGINEER.

Building leads shall be provided to within 1-foot (300 mm) of property line for all lots or parcels on both sides of the street, unless otherwise indicated on the Plans. If in an easement, the lead shall be provided to within 1-foot (300 mm) of the easement line.

Building lead depth, four-(4) feet (1.2 m) horizontal from property line or permanent easement line, shall be between eight (8) and nine (9) feet (2.5 m to 3.0 m). From this point, a 45-degree bend shall be placed and a short length of pipe such that the end depth will be between five (5) and six (6) feet (1.5 m to 1.8 m).

Building leads under or within five (5) feet (1.5 m) of concrete or asphalt pavements shall be installed by boring or tunneling.

Each building lead shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.

3.16 Wye, Riser or Building Lead Marker

Unless otherwise indicated in the Plans or Specifications, prior to the backfilling of a wye, riser or building lead, a 2" x 2" (50 mm x 50 mm) (minimum cross section) wooden marker shall be placed from a point immediately in front of the service connection to 1-foot (0.3 m) below the finish ground surface. Do not rest the marker on any portion of the service connection or stopper.

3.17 Abandoning Sanitary Sewer with Flowable Fill

Install a bulkhead in each end of the sanitary sewer to be abandoned leaving a small opening in the very top of each bulkhead

Install a minimum 2-inch (50 mm) diameter stand pipe in the top of the bulkhead of the sanitary sewer to be abandoned. The stand pipe should be installed such that it can be removed after use and the hole sealed.

Install a minimum 2-inch (50 mm) air release pipe in the bulkhead in the opposite end of the sanitary sewer from the stand pipe. The air release pipe should bend up to a 90 degree angle with the end of the pipe being a minimum of six inches (150 mm) above the top of the sanitary sewer.

Using the stand pipe, pump flowable fill into the sanitary sewer to be abandoned. The flowable fill shall be pumped into the sanitary sewer until free water flows from the air release pipe at the opposite end. Continue filling the sanitary sewer until the material released at the air release pipe is representative of the flowable fill being introduced at the fill end of the sanitary sewer.

Remove the stand pipe and air release pipe and plug the hole in both bulkheads.

3.18 Abandon Existing Manholes

Manholes on the existing sanitary sewer shall be abandoned and the structures shall be removed in accordance with the following: The removal of existing structures shall consist of removing and salvaging the existing frame and cover. The ends of the existing sanitary sewer shall be bulkheaded. Masonry shall be broken down to an elevation at least 30-inches (750 mm) below the proposed subgrade or finished grade. The abandoned structure shall be backfilled with flowable fill to 1-foot (0.3 m) above the pipes and the remainder of the structure with sand-cement mixture at a 10 to 1 ratio to subgrade elevation.

3.19 Field Quality Control

After all the pipe, structures, and leads have been laid, constructed and backfilled, the system shall be final inspected and tested. The inspection and testing shall consist of the following parts: first inspection, television inspection and testing.

The first inspection shall be completed and all repairs made in ample time so that the television inspection of the underground portion of the system, can be completed within four (4) weeks of the completion of the construction. Television inspection shall be considered completed when the necessary construction repairs have been made and the installation re-televised when required, and the system is acceptable for the testing phase. When re-television is necessary, an additional two (2) weeks will be allowed for completion. Testing of the system shall immediately follow the television inspection and shall be completed within a 2-week period.

Failure to maintain a schedule in compliance with this specification will automatically cause the stoppage of other work at the particular site in question until such time as the final inspection of the completed underground portion of the system has progressed to within acceptable limits.

A. First Inspection
The CONTRACTOR shall have the underground portion of the sewer system ready for the first inspection within two (2) weeks after the completion of each 2,000-foot (600 m) section of sewer installed.

The first inspection shall consist of a visible and audible check of the sewers and manholes to ascertain that the manhole steps have been placed, all lift holes jointed, the channeling of the manhole bottoms completed, all visible or audible leaks stopped, all pipe has been placed straight and true to the proper grades and elevation, the required adjusting rings and frame and cover properly installed, all trenches and structures backfilled in a workmanlike manner and that the system has been thoroughly cleaned.

The first inspection shall be considered completed when all the repairs have been made and the system is ready for television inspection.

B. Television Inspection
The CONTRACTOR shall provide for television inspection of the various sanitary sewer lines installed under this Contract.

The CONTRACTOR shall arrange for, engage and pay all expenses involved for the services of a competent company to perform this television inspection.

The television inspection shall observed by representatives of the OWNER, ENGINEER, and the CONTRACTOR. Any television viewing performed in the absence of the ENGINEER will not be considered as a part of the final inspection.

The inspection shall involve the visual observation by closed-circuit television of all sanitary sewer, eight (8) inches (200 mm) in diameter to 30 inches (750 mm) in diameter inclusive, installed as a part of this Contract.

The inspection shall be performed at a maximum rate of speed of 30-feet per minute, which will allow examination of all points of infiltration, cracked or crushed pipe, defective joints, misalignment in line or grade, location of all wye openings and any defects or items of poor workmanship which may appear. Prior to television inspection, the CONTRACTOR shall run water down the line to show any dips or high spots in the line. Water shall be run continuously during television inspection if necessary to determine changes in grade in the line.

Any items which, in the opinion of the ENGINEER, require repair shall be precisely located and photographed along with a detailed statement of the condition.

The CONTRACTOR shall take immediate action to repair all such defects including excessive infiltration at any specific location, even though the infiltration limits as herein specified have not been exceeded for the entire length of sewer being inspected. Following completion of the repair, the OWNER or the ENGINEER, at their discretion, may require a second television inspection of any repaired areas. The CONTRACTOR shall arrange for and pay all costs involved in performing this re-inspection.

As a part of the television inspection, the precise location of each wye shall be noted in relation to the downstream manhole. These locations shall be entered on the Wye Location Sheet as supplied by the ENGINEER and verified by comparison with the locations as established at the time of construction. Any discrepancies in location between the field location record and the television inspection record

shall be reconciled and the proper location of the wye determined as a part of the television inspection. Two (2) copies of all notes, photographs, wye locations and other pertinent information shall be made as a part of the television inspection. One (1) set of this information shall be turned over to the representative of the ENGINEER upon the completion of the inspection of each line. The second copy of the information shall be held by the television inspection company until completion of the project, at which time it shall be neatly assembled and turned over to the ENGINEER as a complete, comprehensive report on the television inspection of the project.

Television inspection shall be recorded and shall be submitted in the format(s) as specified by the ENGINEER.

1. DVD Disk shall meet the following specifications:
   Media: DVD-R or DVD+R, 4.7GB, single layer
   Format: DVD – Video
   Video Encoding: Highest available bit rate (6-9 Megabit), 60 fields per second interlaced video
   Audio Encoding: Uncompressed stereo wave or stereo Dolby Digital (256 kilobit or better)
   Aspect Ratio: 4x3 (720x480 pixels)
   No Macrovision or other copy protection encoding. No region code or region code 1.

2. VHS Video Cassette Tape: ½-inch VHS format cassette tape suitable for play-back on video color equipment. All recording must be made on continuous running audio/video tapes

Television inspection shall be considered completed when the necessary construction repairs have been made and the installation retelevised when required, and the system is acceptable for the testing phase.

C. Testing

The CONTRACTOR shall provide the necessary supervision, labor, tools, equipment and the materials necessary for the tests which shall be conducted in the presence of the ENGINEER. The ENGINEER shall be notified two (2) working days in advance of all testing. The following tests shall be performed and approved prior to placing any system in service:

Leakage tests shall be conducted on all new sewer lines and existing lines which have not been previously approved. All sewers shall be subjected to air, exfiltration or infiltration tests, or a combination of same, prior to acceptance. All sewers over 24-inch (600 mm) diameter shall be subjected to infiltration tests. All sewers of 24-inch (600 mm) diameter or smaller, where the groundwater level above the top of the sewer is over seven (7) feet (2m), shall be subjected to infiltration tests. All sewers of 24-inch (600 mm) diameter or less, where the groundwater level above the top of the sewer is seven (7) feet (2 m) or less, shall be subjected to air tests or exfiltration tests.

1. Exfiltration/Infiltration Test:

   Exfiltration and Infiltration testing will be performed in accordance with ASTM C1091 except as specified herein. If an exfiltration test is performed, the maximum exfiltration rate shall be the same as the permitted from infiltration. For the purposes of exfiltration testing, the internal water level shall be equal to the external water level plus seven (7) feet (2 m) as measured from the top of pipe, and the elevation must be at least as high as the highest house service.

   Maximum allowable infiltration shall not exceed 100 gallons per inch of diameter per mile of pipe between manholes per 24 hours (18.5 L/mm diameter/km length/24 hours) for any section of the system and shall include the infiltration from all manholes and other appurtenances.

2. Air Test:

   The procedure for air testing of sewers shall be in accordance with ASTM F1417 for Plastic Pipe except as follows:

   All house leads shall be properly plugged and blocked to withstand the air pressure. The sewer line shall be tested in increments between manholes. The line shall be cleaned and plugged at each manhole. Such plugs shall be designed to hold against the test pressure and shall provide an airtight seal. One (1) of the plugs shall have an orifice through which air can be introduced into the sewer. An air supply line shall be connected to the orifice. The air supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the air pressure in the sewer. The pressure gauge shall have a minimum diameter of 3-1/2 inches (90 mm)and range of 0 - 10 psig (0 to 70 kPa). The gauge shall have minimum divisions of 0.10 psig (0.5 kPa) and an accuracy of ± 0.04 psig (0.2 kPa).

   The sewer shall be pressurized to an initial test pressure of 4.0 psig (27.5 kPa) greater than the greatest back pressure caused by groundwater over the top of the sewer pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize. If necessary, air shall be added to the sewer to maintain a pressure within 1.0 psig (7 kPa) of the initial test pressure.

   After the stabilization period, the air supply control valve shall be closed so that no more air will enter the sewer. The sewer air pressure shall be noted and timing for the test begun. The test shall not begin if the air pressure is not within 1.0 psig (7 kPa) of the initial test pressure.

   The time required for the air pressure to decrease 1.0 psig (7 kPa) during the Test shall not be less than the time calculated from Table 1 and the Appendices of the applicable ASTM standard as noted above.

   Manholes on sewers to be subjected to air tests shall be equipped with a 1/2 inch (10 mm) diameter galvanized capped pipe nipple extending through the manhole wall, three (3) inches (75 mm) into the manhole and at an elevation equal to the top of the sewer pipe. Prior to the air test, the groundwater elevation shall be determined by blowing air through the pipe nipple to clear it and then connecting a clear plastic tube to the pipe nipple. The tube shall be suspended vertically in the manhole and the groundwater elevation determined by observing the water level in the tube. The air test pressure shall be adjusted to compensate for the maximum groundwater level above the top of the sewer pipe to be tested. After all tests are performed and the sewer is ready for final acceptance, the pipe nipple shall be removed and the hole in the manhole wall shall be plugged with hydraulic cement.

If a sewer fails to pass any of the previously described tests, the CONTRACTOR shall determine the location of the leaks, repair them and retest the sewer. The tests shall be repeated until satisfactory results are obtained.

3.20 Deflection Test for Plastic Pipe

Plastic pipe shall be tested for deflection, but no sooner than 30 days following the backfilling of the pipe. Maximum allowable deflection (reduction in vertical inside diameter) shall be five (5) percent. Locations with excessive deflection shall be excavated and repaired by re-bedding and/or replacement of the pipe. Optional devices for testing include a deflectometer, calibrated television or photography, or a properly sized "go, no-go" mandrel or sewer ball. Mandrel shall have a minimum of nine (9) legs.

End of Section

Section 33 3400
Sanitary Utility Force Mains

Part 1 General

1.01 Scope

This Section includes underground force main work complete with piping, valves, force main manholes, fittings, thrust blocks, retainers, plugs and accessories required for installation as indicated on the Plans and specified herein. This Section also includes hydrostatic testing of completed portions of new force main.

1.02 Related Work Specified Elsewhere

Structural Excavation and Backfill: Section 31 2316
Dewatering: Section 31 2319
Trenching and Backfilling: Section 31 2333

1.03 Reference Standards

Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:

ANSI- American National Standards Institute
ASTM- ASTM International
AWWA- American Water Works Association
MDOT- Michigan Department of Transportation, Standard Specifications for Construction, 2012

1.04 Submittals

Submit certified copies of hydrostatic test results of completed force main sections as specified in Article 3.14.

Submit manufacturer affidavit showing compliance with AWWA Standards for valves.

Submit manufacturer's data for restrained joint connections, valves or special fittings.

1.05 Delivery of Materials

Provide two (2) percent of pipe lengths to be delivered as short pieces with a length ten (10) feet (3 m) or less.

1.06 Storage of Materials

Pipe shall be stored in a manner to minimize infiltration of dirt, debris, and other extraneous materials.

Piping materials shall not be stacked higher than four (4) feet (1.2 m). Suitable racks, chairs, and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground; alternate tiers; and chock tier ends.

All joint and sealing materials subject to ultraviolet or ozone attack and used in the force main system shall be protected from the sunlight, atmosphere and weather, and stored in suitable enclosures until ready for installation.

1.07 Handling of Materials

Load and unload piping using suitable hoists and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping shall not be used by the CONTRACTOR.

Lifting devices shall be suited to the Work and shall protect surfaces from damage.

1.08 Environmental Requirements

Cast iron or ductile iron pipe joints shall comply with the requirements due to outside ambient air temperatures specified under Article 3.05 of this Section.

Part 2 Products

2.01 Scope

The intent of the Articles in Part 2 of this Section is to specify in detail the various types of pipe, joints, and fittings which have been indicated throughout the Plans and Specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Ductile Iron Pipe

Ductile iron pipe shall be ANSI A21.51, with double thickness cement mortar lining inside and 1-mil (25 μm) minimum thickness asphaltic coating outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.

Mechanical joints for ductile iron pipe shall be compression gasket type, conforming to ANSI A21.11 except that slots with the same width as the diameter of the bolt holes in mechanical joints shall not be allowed in the bell flange.

Push-on joints for ductile iron pipe shall be compression gasket type conforming to ANSI A21.11 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section.

Fittings and plugs shall be ductile iron, mechanical joint, pressure rating of 350 psi (2.4 MPa), conforming to ANSI/AWWA C153/A21.53, and ANSI/AWWA C111/A21.11, with double thickness cement mortar lining and coal tar enamel coating on the outside of fittings.

Nuts and bolts shall be high strength low-alloy steel conforming to ANSI A21.11.

Flexible ball and retainer type joints shall be ball and retainer type, boltless, locking, and capable of being deflected up to 15°.

Flange joints shall have full face neoprene gaskets, 1/8" thick and conform to ANSI B16.1. Carbon steel bolts shall conform to ASTM A449 with nuts conforming to ASTM A563 Grade B. Stainless steel bolts and nuts shall conform to ASTM A320. Bolt head and nuts shall be hex. All piping connection bolts and nuts used on this Project including piping in the wet areas shall be cadmium plated. Flange joints shall not be buried.

Cement mortar linings for cast iron and ductile iron pipe shall conform to the requirements of ANSI A21.4 of the thicknesses specified and shall be permanently set prior to the application of any additional pipe coating.

2.03 Polyvinyl Chloride (PVC) Piping Systems

Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings conforming to ASTM D2241, SDR 21, pressure class 200, unless indicated otherwise in the Contract Documents. Spigot end of pipe shall be marked to visually determine when the spigot is fully seated in the bell of the adjoining pipe.

Joints for PVC pipe shall be Push-on, elastomeric gasket type, conforming to ASTM D3139.

PVC fittings shall only be allowed when called for on the plans. When allowed, PVC fittings shall be SDR-21, conforming to ASTM D2241, D3139 and F477.

Fittings for PVC pipe, unless specified otherwise, shall be Class 250 psi, manufactured of ductile iron, grade 80-55-06 in accordance with ASTM A536. Fittings shall have mechanical joints with gaskets meeting ASTM F477. Fittings shall have radii of curvatures conforming to AWWA C110 and shall be cement lined in accordance with AWWA C104.

Gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477.

Pipe joint lubricant shall be manufacturers standard nontoxic.

2.04 Subaqueous Pipe

Pipe shall be ductile iron, ANSI A21.51, with double thickness cement mortar lining and 1-mil (25 μm) thickness minimum of coal tar enamel inside and outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.

Bell assembly shall conform to AWWA C110, threaded onto pipe in accordance with ANSI B2.1. Spigot shall have raised bead cast with the pipe and machined to form shoulder.

The joint shall be made by a retaining ring and gasket assembly compressed between an outer ring and the shouldered spigot. Steel retaining rings shall seat the gasket inside the spherical bell and provide a positive stop for the spigot. The gasket shall be a high quality molded rubber and duck tipped. Tee head bolts and hexagonal nuts shall be stainless steel.

2.05 Restrained Joints

Where the plans or specifications call for restrained joints they shall be per the following.

Restrained joints for ductile iron pipe and fittings shall be designed for a working pressure of 350 psi (2.4 MPa). Joints shall be capable of being deflected after assembly. Restraints shall be by a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe.

Restrained joints for PVC force main pipe shall be designed for a working pressure of 200 psi (1.4 MPa). Where the restrained portion of the pipe is connected to fittings, restraint shall be provided across the joint by a clamping ring and anchored to the fitting with T-head bolts or stainless steel rods. Restraining devices for PVC water main pipe shall incorporate clamping rings with serrations on the inside surface to provide positive restraint on the outside surface of the pipe and shall provide full support around the circumference of the pipe to maintain roundness.

2.06 Polyethylene Encasement

Polyethylene material for encasement shall be either 4 mil high density, cross-laminated polyethylene film or 8 mil linear low-density polyethylene film per AWWA C105.

2.07 Gate Valves

Provide iron body, resilient seated, solid wedge type gate valves with non-rising stems and O-ring seals in accordance with AWWA C509. Furnish buried valves with mechanical joint ends, stainless steel hardware, and 2" square operating nut. Where the water main is buried at a depth where the normal valve operating nut will be at a depth greater than 5-1/2 feet, a valve extension stem with operating nut shall be provided and mechanically attached to the valve to provide an operating nut at the 5-1/2 foot depth. Furnish non-buried valves with flanged ends conforming to ANSI B16.1, 125 lb. and handwheel actuator. Valves shall open counterclockwise. Gate valves shall be as manufactured by Mueller, or approved equal.

2.08 Eccentric Plug Valves

Valve body shall be full ported, cast iron and comply with AWWA C504. Inlet and outlet connections shall be compatible with the pipe joints used.

Body seats shall be synthetic rubber reinforced by a nickel alloy conforming to ASTM B127. Seats shall be adequately reinforced and secured to the body to prevent the seat from becoming inflated by the pressure from behind.

Bearings shall be replaceable sleeve-type with one set being thrust resistant to hold the plug securely in the center of the seat. Self-lubricated bearings shall have proven record of durable service.

Shaft seals shall conform to AWWA C504 and C507.

2.09 Air Release Valves

Air Release valves shall have an ASTM A126 Class B cast iron body and cover with a threaded inlet connection of the size shown on the plans or listed in the schedule and a 1/2 in. NPT outlet connection. Valve body shall have a 2 in. NPT plugged port near the base to facilitate cleanout of large solids as well as a 1/2 in. NPT connection near the top and 1 in. NPT port near the bottom to permit the installation of flushing attachments.

Valves shall have an 18-8 stainless steel float and a replaceable seat of Buna-N or other suitable material. Internal linkage mechanism shall be 18-8 stainless steel, plastic or bronze is not acceptable. The linkage mechanism shall be capable of being removed from the cover without disassembly of the mechanism. Valves shall have 3/16 in. diameter stainless steel orifice for working pressures up to 150 PSI.

Provide flushing attachments to include 1/2 in. flushing valve, 1 in. blowoff valve, 5 feet of rubber hose and quick disconnect couplings.

The valve shall automatically exhaust accumulated air from a fluid system while the system is pressurized and operational.

2.10 Combination Sewage Air Release and Vacuum Valves

Wastewater combination air valves shall be constructed of cast iron body and cover, stainless steel plug, guide shaft, bushings and float, Buna-N seat. Valves shall be automatic float operated valve designed to releases air, gas or vapor during filling of a force main and close upon liquid entry, and allow air to re-enter when draining or under a negative pressure. The valve shall also release accumulated air from a force main while the system is in operation and under pressure. The valves shall have working pressure of 150 psi (1000kPa). Provide a backwash system to be included with the valves consisting of an inlet shut-off valve, blow-off valve, clear water inlet valve and rubber supply hose with quick disconnect couplings.

2.11 Structures

Material for force main structures shall conform to the requirements as indicated on the Plans and as specified below. Precast concrete structures are required except when constructing a structure over an existing sewer may require limited use of concrete block or brick as approved by the ENGINEER.

A. Concrete Brick:
Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.

B. Concrete Block:
Block shall conform to ASTM C139, Portland cement conforming to ASTM C150, Type II. Blocks shall be solid curved blocks with the inside and outside surfaces parallel and curved to the required radii. The blocks shall have a groove or other approved type of joint at the ends.

C. Precast Concrete:
Precast concrete manhole, riser and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement. Base slab shall be eight (8) inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).

Precast bottom sections shall be cast with the bottom end flat to provide bearing of the full wall thickness. The openings for sewer pipe shall be cast in the manhole and the bottom section by the manufacturer.

Riser sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets or a tongue and groove joint with a Butyl Rubber based gasket type sealant meeting the requirements of AASHTO M-198 and having a nominal size of 1-inch (25 mm).

Eccentric cone sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets and be provided with 4-stud inserts cast in the top. The top shall have a smooth finished surface.

Concrete grade rings shall have smooth finished top and bottom surfaces. Grade rings shall be provided with "O" ring gaskets.

D. Manhole Steps:
Cast iron manhole steps shall conform to ASTM A48, Class 30, gray iron with a minimum cross section dimension of 1-inch (25 mm) in any direction.

Steel reinforced plastic manhole steps shall be of suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60 and shall be in accordance with ASTM C478.

Manhole steps shall be of the types and sizes indicated on the Plans and shall comply with applicable Michigan Occupational Safety and Health Standards (MIOSHA).

E. Manhole Frames and Covers:
Manhole frames and covers shall conform to ASTM A48, Class 30, gray iron and shall be of the types and sizes as indicated on the Plans. The castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of casting shall be ground to assure proper fit and to prevent rocking.

2.12 Valve Boxes

Three piece, 5-1/4 inch (135 mm) diameter, screw type, gray iron castings conforming to ASTM A48, Class 20 with adjustable length. Lids shall have "Sanitary Force Main" plainly cast in tops.

2.13 Concrete

In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m^3); 6A coarse aggregate; 2NS fine aggregate; 5%±1% air content; 3-inch (75 mm) maximum slump; no admixtures without the ENGINEER's approval.

2.14 Concrete Reinforcement

In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.15 Restraints, Clamps, Rods, and Ties

Cast iron or stainless steel as recommended by pipe manufacturer. Bolts, nuts, clamps, rods, ties and fittings shall be bronze alloy or corrosion protected steel.

2.16 Tracer Wire

Copper clad steel wire with 30 mil High Density Polyethylene insulation. Concentric copper cladding metallurgically bonded to a steel core through a continuous solid cladding process. Copper cladding to measure 3% minimum of the overall wire diameter. Wire to be 12 AWG, .0808 in. diameter, .00242 inch nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength. Wire to be Copperweld ® or equal.

Part 3 Execution

3.01 CONTRACTOR's Verification

Prior to the installation of any force main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that all excavation bottoms, compacted subgrades and pipe bedding are adequate to receive force main materials to be installed. Correct all defects and deficiencies before proceeding with the Work.

3.02 Preparation of Pipe Ends

Remove all lumps, blisters and excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of all plain ends and the inside surfaces of all socket ends before installation. Any pipe or fitting which has acquired a coating of mud or other adhesive foreign material shall be scrubbed clean.

3.03 Examination of Materials

All pipe fittings, accessories, and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be rejected and removed from the Project by the CONTRACTOR.

3.04 Installation - General

Foreign matter shall be prevented from entering the pipe while it is being placed in the trench. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe. Plug pipe ends when construction stops overnight or for extended periods.

Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes.

Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles, shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer of the pipe materials being cut and according to the best trade practices.

When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.

Where pipe using a resilient gasket to effect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burrs which might damage the gasket.

Provide restrained joints meeting this specification and as recommended by the manufacturer. Connection shall be made in accordance with manufacturer's recommendations.

After the bottom of trench has been excavated, the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. The pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.

A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.

Unless otherwise specified, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell end of the adjacent pipe section, the pipe shoved into position and brought to true alignment and secured. Adequate support shall be provided for all force main pipe.

Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.

All fittings, plugs, adapters, and horizontal and vertical blocking shall be installed by the CONTRACTOR as shown on the Plans.

3.05 Installation of Ductile Iron Pipe

Push on joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be pre-lubricated before installation using a lubricant recommended by the pipe manufacturer. The seated joint shall be identified by the visible mark on the spigot of the installed pipe section.

When the temperature is above 60 degrees F (15° C), the spigot end of each pipe lead shall be forced tightly on the bell of the proceeding pipe. When the temperature is below 60 degrees F (15° C), the pipe shall be laid with the spigot end 1/16-inch (1 mm) from the face of the bell for expansion.

Mechanical joints shall be made with bolts, molded resilient gasket and cast iron follower gland. All nuts shall be screwed up finger tight before using a wrench. The gland and rubber gasket shall be brought up evenly at all points around the bell flange and then torqued per the manufacturers recommendations.

Exposed portions of bolts shall be covered with mastic.

Flexible joint pipe shall be assembled, handled and installed in accordance with the printed recommendations which accompanies the pipe and is provided by the manufacturer of the piping materials being installed. Methods of handling and installation shall be acceptable to the ENGINEER.

3.06 Installation of Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be laid with gasketed joints in complete accordance with the pipe manufacturers published instructions. The joints shall be sufficiently lubricated using the pipe manufacturers recommended lubricant.

Gaskets for pipe joints shall be inserted with the painted edge facing the end of the bell. Each length of pipe shall be pushed home individually. The pipe shall be positioned so that the reference mark on the spigot end is in line with the bell end.

When called for on the plans or in the specifications, tracer wire is to be installed along with the force main. Tracer wire is to be continuous from end to end and terminate at each structure in such a way and with a sufficient length of wire to allow for easy connection to utility tracing equipment. Wire shall be continuity tested after installation. Any wire which fails the continuity test shall be replaced.

3.07 Subaqueous Pipe

Provide sections of pipe with joints for subaqueous trench installation as indicated on the Plans. Sections of pipe shall be assembled, bedded and backfilled before connecting to land lines. Sections shall be assembled on shore, then dragged or floated into position for installation. Joints of pipe lengths and connections to land lines shall be in accordance with manufacturer's recommendations.

3.08 Installation of Restrained Joints

Restrained joints shall be provided where indicated on the plans. Joints shall be assembled in strict accordance with manufacturer’s directions. All joints shall be fully extended after assembly.

3.09 Polyethylene Encasement

Where called for on the plans, ductile iron water main, fittings and hydrants shall be encased in a polyethylene film tube. The polyethylene film tube shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Method A consists of cutting the polyethylene tube two feet (600 mm) longer than the pipe to provide an overlap at the joints. The cost of the polyethylene encasement shall be incidental to the water main.

3.10 Anchors and Thrust Blocks

Anchors, encasements and restraints shall be provided at the locations and dimensions as indicated on the Plans. Anchoring, encasement and restraint methods shall be as detailed. All bearings shall be as shown. Anchors, encasements and restraints shall rest on firm, stable, compacted bedding and shall be provided for all standard and special fittings.

3.11 Valves

All valves shall be installed to the grade, lines, levels and locations indicated on the Plans.

Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.

Where required, valves shall be supported with special supports as indicated on the Plans and as approved by the ENGINEER. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.

Provide all materials and install air release and vacuum release valve assemblies at locations indicated on the Plans. Include all valves, reducers, connections and other fittings necessary for installation. Fittings and joint materials shall be compatible to the force main piping material.

3.12 Valve Boxes

Install valve boxes to the grade, lines, levels and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.13 Structures

Construct structures to the dimensions, grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment rings, etc., as shown and as required for a complete installation. Construction of structures shall conform to the dimensions indicated on the Plans and as described below.

Provide two to four courses of 3-inch (75 mm) brick or precast concrete grade rings at top of structure for future adjustment. Cement mortar plaster coat shall be applied to the exterior surfaces of all brick or precast concrete grade rings. Plaster coat shall be 1/2 inch (10 mm) thick and shall be applied to the outer surfaces of the structures. Provide mortar joints struck smooth.

Provide and install to the elevations shown all cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 1/2-inch (10 mm) thick minimum. Mortar joints shall be struck smooth.

Install steps for structures of types and in locations indicated on the Plans. Steps shall be installed on 16-inch (400 mm) centers minimum.

Pipe placed in structures for inlet or outlet connections shall extend through the walls and beyond the outside wall surfaces a sufficient distance to allow for complete connections. Openings between pipes and walls shall be sealed with a full bed of cement mortar. Pipe shall be supported by concrete supports.

3.14 Hydrostatic Testing

After the pipe has been laid and backfilled, the pipe shall be hydrostatically tested for leakage. The CONTRACTOR shall furnish the pump, pipe connection, blow-off valves and all other necessary apparatus including gages and meters and all personnel necessary for conducting the test. Before applying the test pressure, all air shall be expelled from the pipe. If necessary, threaded taps shall be made at the points of higher elevation and then closed with brass plugs.

Any faulty pipe fittings, valves or other accessories which permit leaks during testing shall be replaced by the CONTRACTOR with sound material and the test shall be repeated until specified requirements are met.

When practicable, tests shall be made on sections between valves, or sections not exceeding 2,000 feet (610 m) in length. Dead ends, bends and other fittings shall have a firm foundation and be securely blocked against the trench walls before testing or completing the backfill as specified.

The full test pressure shall be held for no less than one (1) hour or longer as necessary to permit thorough examination of all exposed joints in the section of main being tested. Test pressure shall be maintained at 150 psi (1000 kPa) for force mains.

Leakage shall be measured by the quantity of water pumped into the pipe to maintain test pressure during test period. All leaks shall be located and repaired until the test meets the following requirements.

Maximum permissible leakage of force main shall not exceed the following:

Force Main Diameter inches (mm)	Allowable Leakage gallons/1,000 feet/hour (liters/0.5 km/hour)
4 (100) or less	0.5 (3.0)
6 (150)	0.75 (4.5)
8 (200)	1.00 (6.0)
10 (250)	1.25 (8.0)
12 (300)	1.50 (9.0)
14 (350)	1.75 (11.0)
16 (400)	2.00 (12.5)
18 (450)	2.25 (14.0)
20 (500)	2.50 (15.5)
22 (550)	2.75 (17.0)
24 (600)	3.00 (18.5)

3.15 Water for Testing

Water for testing shall be obtained from the OWNER's existing facilities. The CONTRACTOR shall make all necessary arrangements with the authority which controls the source of water system and shall be governed in his use of water by all rules and regulations imposed thereon by said authority. The CONTRACTOR shall provide and remove temporary connections between the source water system and the mains constructed under this Contract. All temporary connections shall meet the approval of the ENGINEER, the authority controlling the source water system and authorities havingjurisdiction.

Water for testing shall be removed from the force main by pumping to waste. Water discharge shall be controlled adequately to protect any surface water resource or adjacent property from potential environmental damage or from creation of hazard to traffic.

3.16 Flushing Force Main

At pump station start-up, should the force main flows not meet design requirements, the CONTRACTOR shall flush the force main at no additional cost to the OWNER. Flushing shall be done using the "poly-pig" method of flushing. The CONTRACTOR shall furnish foam "poly-pig" swabs to be used. Prior to pigging and flushing, the force main must be charged with water. The CONTRACTOR shall insert "poly-pig" swab in the end of the new main nearest the pump station (or where shown on the Plans). The swab shall be passed through the new main using water pressure. The swab shall be recovered at the end of the main or cleanout.

End of Section