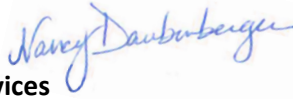


Technical Memorandum

To: Electronic Distribution Recipients

From: Nancy T. Daubenberger, P.E.
Division Director, Engineering Services



Subject: Use of Plastic Pipe for Storm Sewer and Culverts on Trunk Highways

Expiration

This Technical Memorandum supersedes 12-01-B-01: Use of Plastic Pipe for Storm Sewer and Culverts on Trunk Highways, and will remain in effect until April 11, 2022 unless superseded or included in the MnDOT Drainage Manual or Standard Specifications for Construction prior to that date.

Implementation

The provisions contained in this Technical Memorandum are for immediate implementation on trunk highway projects.

Introduction

This Technical Memorandum is an update to Technical Memorandum No. 12-01-B-01. The Technical Memorandum is being revised in recognition of changes to MnDOT bedding and backfill standards, MAP-21, updates to MnDOT LRFD load computations, availability of a new plastic pipe material, and removal of information that has already been incorporated in the current MnDOT Standard Specifications for Construction. MAP-21 includes guidance that state transportation departments have the autonomy to determine culvert and storm sewer material types to be included in the construction of a project on a Federal-aid highway. This means MnDOT has the sole authority and discretion to make a decision regarding culvert and storm sewer material types. Where use of alternative pipe materials increases competition, MnDOT continues to recommend consideration of alternative pipe materials including plastic pipe where appropriate.

Purpose

The purpose of this Technical Memorandum is to provide updated design criteria on the use of plastic pipe for storm sewer and culverts. Detailed information is given for the use of corrugated polyethylene (CP) pipe, polypropylene (PP) pipe, and polyvinyl chloride (PVC) pipe.

Guidelines

When approved by the District Hydraulic Engineer, plastic pipe located within MnDOT right of way may be used in accordance with the following guidelines. For pipe placed off of MnDOT right of way, such as a storm sewer outfall along a city street, or pipe located on property to be turned back to a local entity such as a frontage road, contact the local unit of government to determine the type(s) of pipe to include in the plan.

Within the guidelines of this Technical Memorandum, plastic pipe, which includes AASHTO Type S dual wall corrugated polyethylene (CP), AASHTO Type S dual wall polypropylene (PP) and polyvinyl chloride (PVC), may be used on all trunk highway projects as an alternative to reinforced concrete (RC) or corrugated steel (CS) pipe. If polypropylene (PP) pipe is allowed, include Attachment A or Attachment B in the Special Provisions. Use the approved products list when it is available. Qualified plastic pipe products and vendors are listed on the approved products list under drainage products.

Provide connections with bell and spigot joints using an elastomeric rubber seal (gasket) to provide a water-tight joint that does not allow soil, silt or water to migrate through the joint.

Minimum plastic pipe installation requirements including maximum cover and minimum cover are provided in the attachment C titled "Plastic Pipe Minimum and Maximum Cover Requirements". Include the Attachment C detail in the plan. Bedding, backfill and trench width requirements for flexible pipe are provided in Attachments D and E, or the Pavement Design Manual Chapter 3. When culvert case treatments are specified for reinforced concrete pipe, plastic pipe shall also be installed with the same culvert case treatment.

Do not use plastic pipe unless minimum cover requirements are met. Minimum cover is measured from the outside top of the pipe to the top of the road or ground surface. Minimum cover requirements are as follows:

Nominal Diameter (inches)	Minimum Cover (feet) ¹			
	Paved Roads	Unpaved Roads ³	Private Entrances	Non-Roadway ²
12	3	2	1	1
15	3	2	1	1
18	3	2	1	1
24	3	2	1	1
30	3	2	2	1.5
36	3	2	2	1.5
42	3	2	2	1.5
48	3	2	2	1.5

¹ Include a minimum of 12" compacted embedment material over the top of the pipe.

² Topsoil and erosion control products are not included in minimum cover depth.

³ Potential for rutting, frost heave and grading tolerances have been considered.

Plastic pipe is dependent on soil interaction for support. Adequate compaction must be attainable for the pipe to perform satisfactorily. Plastic pipe should not be used where groundwater may be encountered within the trench zone or where poor soils are encountered. Deflection testing is required for plastic pipe installation acceptance and payment. Provide mandrel testing or other deflection testing results to the State Hydraulic Engineer.

Plastic pipe should not be used in locations with standing water without requirements for dewatering and in some cases buoyancy prevention. Plastic pipe is buoyant and may float. Plastic pipe requires deflection

testing and post-construction inspections that cannot be completed if the pipe is submerged without dewatering. Pipes can be stabilized with anchors such as a concrete headwall or in-ground anchors; installations in these cases require a design detail in the plan and a special provision indicating additional cost of buoyancy mitigation is included in the contract unit price of the pipe pay item. Where buoyancy potential exists and buoyancy prevention is not used, the required minimum cover will be the greater of the depths from the Minimum Cover Table and the Buoyancy Minimum Cover Requirement Table.

Buoyancy Minimum Cover Requirement		
Nominal Diameter (inches)	Cover for PVC (feet)	Cover for CP and PP (feet)
12	1	1
15	1	1
18	1	1.5
24	1	1.5
30	1.5	2
36	2	2.5
42	2	2.5
48	2.5	3

Plastic pipe should not be used where there is a likelihood of exposure to fire without fire mitigation. Fire mitigation alternatives include concrete slope paving, concrete headwall, and concrete aprons. Use of fire mitigation alternatives requires a design detail in the plan and a special provision indicating additional cost of fire mitigation is included in the contract unit price of the pipe pay item.

Polyvinyl Chloride (PVC) pipe is sensitive to ultra violet (UV) radiation and exposure to sunlight may accelerate deterioration. It is recommended PVC be limited to applications and locations where pipe is not exposed to UV radiation.

Safety grates may interfere with required deflection testing and post-construction inspections. Plastic pipe is not recommended in locations within the clear zone where safety grates are required or where errant vehicles leaving the roadway may damage the pipe. Use metal aprons for end treatments unless an alternative is specified in the plan.

Plastic pipe is considered to be resistant to deterioration in corrosive soils and resistant to salts, alkalides, and chlorides. Chemical contamination such as petroleum or solvents may degrade gaskets but will typically not affect the plastic pipe material. Ensure that pipe and gasket materials are compatible with contaminants present in soil or surface waters in the area of placement.

The plastic pipes included in this Technical Memorandum have watertight joints to prevent loss of soil and silt embedment material through the joint. Pipe materials have been analyzed using LRFD methodology, and if installed correctly are expected to meet the loads in the fill height tables provided in Attachment C "Plastic Pipe Minimum and Maximum Cover Requirements".

Pipes conveying public waters must meet DNR requirements. Smooth plastic pipe should be evaluated to verify velocity requirements are met and that there are no negative impacts to fish passage or increase in erosion potential.

As with all other drainage products, engineering judgment should be used in determining the suitability of specific materials on individual projects. To ensure adequate hydraulic capacity, applicable pipe options must be approved by the District Hydraulics/Water Resource Engineer. When conditions warrant, additional locations beyond those identified in these guidelines may be considered; contact the State Hydraulics Engineer to discuss the options.

Locations of plastic pipe installations should be reported by construction staff to the State Hydraulic Engineer so inventory data, date built, and deflection testing results can be entered into the Department's asset management system for pipes, HydInfra. Future updates to design recommendations and pipe material selection criteria will be dependent on the ability to monitor and track pipe performance over time.

Storm Sewer

The maximum allowable diameter is 48".

Plastic pipe can be used as storm sewer under pavement with no ADT restrictions.

Corrugated polyethylene (CP), polypropylene (PP) and polyvinyl chloride (PVC) are allowable plastic pipe options for storm sewer installations. Watertight joints are required. In order to make it clear which pipes have options, the allowable options shall be noted in the drainage tabulation for each reach of pipe. On the Statement of Estimated Quantities, the listed pay item will be reinforced concrete pipe. A note shall be provided on each appropriate pay item noting that plastic pipe may be used as an option.

In the situation where some of the storm sewer pipe qualifies for the plastic pipe option and the remainder is reinforced concrete pipe, the pay item shall have a note on the estimate sheet showing how much pipe may be plastic.

Bed the storm drain pipe according to Specification 2503 and the detail shown in Attachment D "Flexible Pipe Storm Drain Bedding and Backfill Requirement". Include the design detail in the plan.

Centerline Culvert

The maximum allowable diameter is 48".

Allowed at locations where ADT is less than 5000 or under unpaved roads.

Corrugated polyethylene (CP) and polypropylene (PP) are allowable plastic pipe options for centerline culvert installations. In order to make it clear which pipes shall have options, the allowable options shall be noted in the drainage tabulation for each reach of pipe. On the Statement of Estimated Quantities, the listed pay item will be reinforced concrete pipe. A note shall be provided on each appropriate pay item noting which plastic pipe types may be used as an option.

Bed the culvert pipe according to Specification 2501 and the detail shown in Attachment E "Flexible Pipe Culvert Bedding, Backfill and Treatment Type". Where treatments are required use design details as modified by the District Materials Engineer. Include relevant design details in the plan.

Side Culvert

The maximum allowable diameter is 48”.

Allowed at locations where ADT is less than 5000 or under unpaved roads.

Corrugated polyethylene (CP) and polypropylene (PP) are allowable plastic pipe options for side culvert installations. In order to make it clear which pipes have options, the options should be noted in the drainage tabulation for each culvert. On the Statement of Estimated Quantities, the listed pay item will be a generic pipe culvert and generic apron with a note indicating the applicable pipe options.

Bed side culverts according to Specification 2501 and as recommended by the District Materials Engineer.

All costs associated with using an alternative, such as differences in installation requirements including but not limited to deflection testing, dewatering, trench width, buoyancy prevention, fire mitigation, or embedment material specifications and quantities are included in the contract unit prices of the relevant pipe pay items.

Questions

Any questions regarding the technical provisions of this Technical Memorandum can be address to the following:

Andrea Hendrickson
(651) 366-4466.

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at <http://techmemos.dot.state.mn.us/techmemo.aspx>.

To add, remove or change your name on the Technical Memoranda mailing list, please visit the web page <http://techmemos.dot.state.mn.us/subscribe.aspx>

Attachments:

- A. Specifications for Polypropylene Pipe Culverts
- B. Specifications for Polypropylene Pipe Sewer
- C. Plastic Pipe Minimum and Maximum Cover Requirements
- D. Flexible Pipe Storm Drain Bedding and Backfill Requirements
- E. Flexible Pipe Culvert Bedding, Backfill and Treatment Type

(2501) POLYPROPYLENE PIPE CULVERTS

Use S-X if Polypropylene pipe option is allowed as pipe material for culverts.

S-X (2501) PIPE CULVERTS

S-x.1 This work consists of furnishing and installing polypropylene (PP) dual-wall pipe culverts and fittings in accordance with the Plans, the MnDOT Standard Specifications, Section 12 of the AASHTO LRFD Bridge Design Specifications, the attached detail "Plastic Pipe Minimum and Maximum Cover Requirements", and the following:

S-x.2 Provide corrugated polypropylene (PP) dual-wall pipe with couplings and fittings meeting the requirements of the following:

- (1) AASHTO M330 dual wall Type "S" pipe, and
- (2) Section 12 of the AASHTO LRFD Bridge Design Specifications, and
- (3) Gasketed integral bell and spigot joint meeting the requirements of ASTM F2881, for respective diameters, and
- (4) Water tight joints that meet a 10.8 psi laboratory test per ASTM D 3212 with a gasket that meets the requirements of ASTM F 477 and
- (5) Protect polypropylene compounds from ultraviolet (UV) degradation with Titanium Dioxide and UV stabilizers.

S-x.3 Provide laboratory certification that the pipe connection for each size of pipe meets or exceeds these requirements. Submit shop drawings of each pipe coupler and any additional mechanical connections required by the plans. Mitered end sections are not to be constructed of polypropylene.

S-x.4 Provide polypropylene (PP) pipe and fittings manufactured from high-density polypropylene (PP) virgin compounds. May use clean, reworked PP materials from the manufacturer's own production, if the pipe and fittings produced meet the requirements of this section.

S-x.5 Store and handle polypropylene (PP) pipe as recommended by the manufacturer. Provide pipe manufactured no more than six months prior to installation. Do not use damaged pipe.

S-x.6 Polypropylene (PP) pipe is considered to be plastic pipe and must be installed according to 2501.3.C.4 and must pass deflection testing for acceptance.

S-x.7 Submit a manufacturer's Certificate of Compliance, including date manufactured, with each pipe shipment to the Engineer.

S-x.8 Approved manufactures of polypropylene (PP) pipe are listed on the Approved Products List.

S-x.9 Polypropylene (PP) manufacturing facilities are required to participate and be in compliance with AASHTO's National Transportation Product Evaluation Program (NTPEP) for producers of AASHTO M330 polypropylene (PP) pipe. The engineer confirms the plant where the pipe is manufactured is in compliant status by checking the NTPEP website, a link is provided through the Approved Products List.

S-x.10 Payment for pipe culverts will be made in accordance with the schedule set forth below at the appropriate Contract unit bid price for each separate item of work, which shall, in each instance, be compensation in full for the costs of all materials, equipment, and labor required to complete the work as specified, to the satisfaction of the Engineer. Payment will not be made until proof of an adequate deflection test is provided.

S-x.11 The Department will identify alternatives in the plans. The Department will include the costs associated with using an alternative, such as differences in installation requirements including deflection testing, trench width or embedment material specifications and quantities in the contract unit prices of the relevant pipe pay items.

Item No.	Description	Unit
2501.603	___ in Pipe Culvert	linear foot

(2503) POLYPROPYLENE PIPE SEWER

Use S-X if Polypropylene pipe option is allowed as pipe material for pipe sewers.

S-X (2503) PIPE SEWERS

S-x.1 This work consists of furnishing and installing polypropylene (PP) dual-wall pipe sewers and fittings in accordance with the Plans, the MnDOT Standard Specifications, Section 12 of the AASHTO LRFD Bridge Design Specifications, the attached detail "Plastic Pipe Minimum and Maximum Cover Requirements", and the following:

S-x.2 Provide corrugated polypropylene (PP) dual-wall pipe with couplings and fittings meeting the requirements of the following:

- (1) AASHTO M330 dual wall Type "S" pipe, and
- (2) Section 12 of the AASHTO LRFD Bridge Design Specifications, and
- (3) Gasketed integral bell and spigot joint meeting the requirements of ASTM F2881, for respective diameters, and
- (4) Water tight joints that meet a 10.8 psi laboratory test per ASTM D 3212 with a gasket that meets the requirements of ASTM F 477 and
- (5) Protect polypropylene compounds from ultraviolet (UV) degradation with Titanium Dioxide and UV stabilizers.

S-x.3 Provide laboratory certification that the pipe connection for each size of pipe meets or exceeds these requirements. Submit shop drawings of each pipe coupler and any additional mechanical connections required by the plans. Mitered end sections are not to be constructed of polypropylene.

S-x.4 Provide polypropylene (PP) pipe and fittings manufactured from high-density polypropylene (PP) virgin compounds. May use clean, reworked PP materials from the manufacturer's own production, if the pipe fittings produced meet the requirements of this section.

S-x.5 Store and handle polypropylene (PP) pipe as recommended by the manufacturer. Provide pipe manufactured no more than six months prior to installation. Do not use damaged pipe.

S-x.6 Polypropylene (PP) pipe is considered to be plastic pipe and must be installed according to 2501.3.C.4 and must pass deflection testing for acceptance.

S-x.7 Submit a manufacturer's Certificate of Compliance, including date manufactured, with each pipe shipment to the Engineer.

S-x.8 Approved manufactures of polypropylene (PP) pipe are listed on the Approved Products List.

S-x.9 Polypropylene (PP) manufacturing facilities are required to participate and be in compliance with AASHTO's National Transportation Product Evaluation Program (NTPEP) for producers of AASHTO M330 polypropylene (PP) pipe. The engineer confirms the plant where the pipe is manufactured is in compliant status by checking the NTPEP website, a link is provided through the Approved Products List.

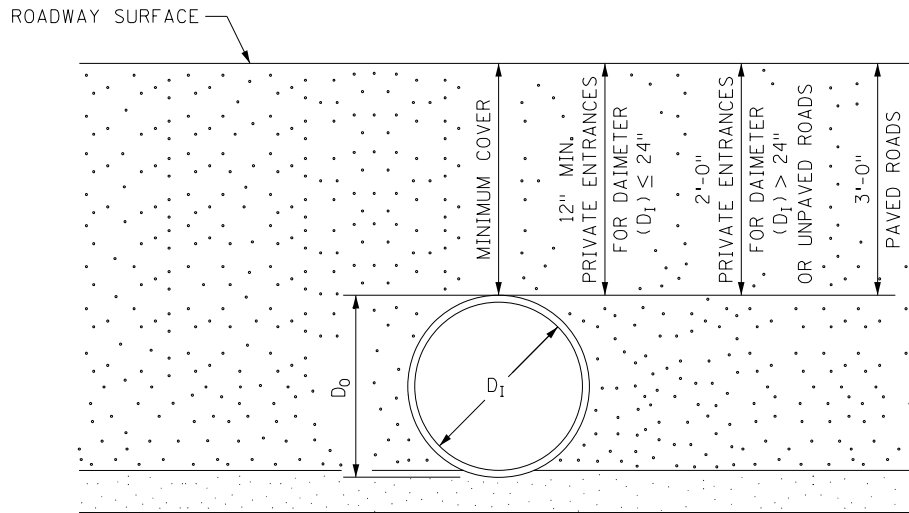
S-x.10 Payment for pipe sewers will be made in accordance with the schedule set forth below at the appropriate Contract unit bid price for each separate item of work, which shall, in each instance, be compensation in full for the costs of all materials, equipment, and labor required to complete the work as specified, to the satisfaction of the Engineer. Payment will not be made until proof of an adequate deflection test is provided.

S-x.11 The Department will identify alternatives in the plans. The Department will include the costs associated with using an alternative, such as differences in installation requirements including deflection testing, trench width or embedment material specifications and quantities in the contract unit prices of the relevant pipe pay items.

Item No.	Description	Unit
2503.603	___ in Pipe Sewer	linear foot

PLASTIC PIPE MINIMUM AND MAXIMUM COVER REQUIREMENTS

PLASTIC PIPE MINIMUM AND MAXIMUM COVER REQUIREMENTS
FOR STORM DRAIN AND CULVERTS



D₁ = INSIDE DIAMETER
D₀ = OUTSIDE DIAMETER

NOTES

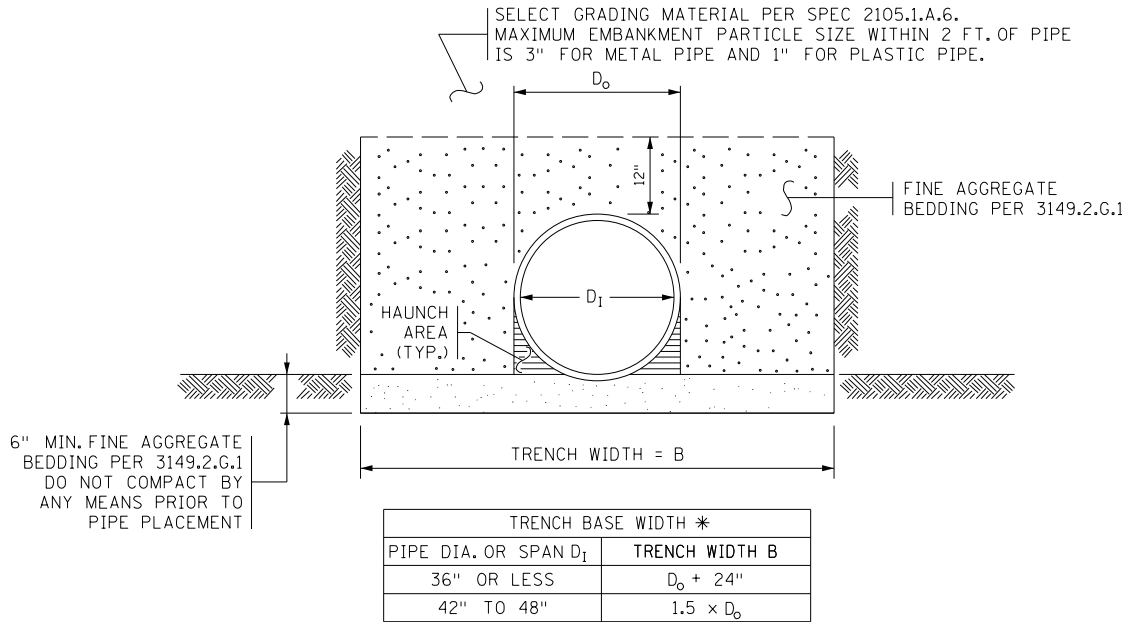
- PIPE SIZE IS BASED ON THE NOMINAL INSIDE DIAMETER OF THE PIPE.
- MAXIMUM NOMINAL PIPE DIAMETER IS 48" FOR STORM SEWER AND CULVERTS.
- MAXIMUM EMBANKMENT PARTICLE SIZE WITHIN 2 FT. OF PLASTIC PIPE IS 1".
- A PASSING DEFLECTION TEST IS REQUIRED FOR ACCEPTANCE OF PIPE.
- DO NOT PERFORM PIPE INSTALLATION, EMBEDMENT COMPACTION OR DEFLECTION TESTING IN STANDING WATER.
- PROTECT PIPE UNDER SHALLOW COVER FROM DAMAGE DURING CONSTRUCTION DUE TO LOADING FROM HEAVY EQUIPMENT.
- WHEN CULVERT TREATMENTS ARE REQUIRED USE THE LARGEST OF THE TRENCH WIDTHS REQUIRED BY THE CASE TREATMENT DETAIL OR TRENCH WIDTH TABLE FOR FILL HEIGHT ≥ 10 FT.
- MINIMUM COVER FOR NON-ROADWAY LOCATIONS IS 1 FT. FOR 12-24 INCH PIPE AND 1.5 FT. FOR 30-48 INCH PIPE. TOP SOIL AND EROSION CONTROL PRODUCTS ARE NOT INCLUDED IN MINIMUM COVER DEPTHS.

PIPE DIA (in)	MAXIMUM COVER (ft)		
	CP	PP	PVC
12	12	18	27
15	12	18	27
18	12	18	27
24	12	16	27
30	12	16	27
36	12	14	22
42	12	14	22
48	12	14	22

CP = CORRUGATED POLYETHYLENE (AASHTO M294)
PP = POLYPROPYLENE (AASHTO M330)
PVC = POLYVINYL CHLORIDE (ASTM F794)

FLEXIBLE PIPE STORM DRAIN BEDDING AND BACKFILL REQUIREMENTS

FLEXIBLE STORM DRAIN PIPE BEDDING



* MODIFY TRENCH WIDTH & SLOPE AS NECESSARY TO COMPLY WITH OSHA REQUIREMENTS.

CONSTRUCTION SEQUENCE

1. LOOSELY PLACE 6" OF FINE AGGREGATE BEDDING MATERIAL TO GRADE. DO NOT COMPACT PRIOR TO PIPE PLACEMENT.
2. FOR PIPES WITH BELL, REMOVE MATERIAL IN BELL AREA PRIOR TO PLACEMENT.
3. FURNISH AND INSTALL PIPE TO GRADE.
4. AFTER INSTALLATION OF PIPE, PLACE ADDITIONAL FINE AGGREGATE BEDDING AND COMPACT THE FULL LENGTH ON BOTH SIDES OF THE CULVERT/PIPE UNDERNEATH THE HAUNCH AREA BY FIRST SHOVEL SLICING (MANUALLY SHOVE THE BLADE END OF SHOVEL AT AN ANGLE DOWN THE ENTIRE LENGTH OF HAUNCH UNDER CULVERT/PIPE) THEN COMPACT THE HAUNCH AT AN ANGLE USING A POWERED MECHANICAL OR PNEUMATIC DEVICE (I.E. POLE TAMPER, JUMPING JACK, OR SIMILAR). COMPACT THE REMAINING MATERIAL OUTSIDE THE HAUNCH AREA TO THE REQUIREMENTS OF SPEC. 2105, ENSURING THAT THE ENTIRE LENGTH OF PIPE IS SUPPORTED UNIFORMLY BY BEDDING.
5. PLACE AND COMPACT BACKFILL EVENLY AND SIMULTANEOUSLY IN 6" LIFTS ON EACH SIDE OF THE PIPE UP TO 12" ABOVE THE PIPE WHEN COMPACTED.
6. COMPLETE REMAINING BACKFILL.

NOTES

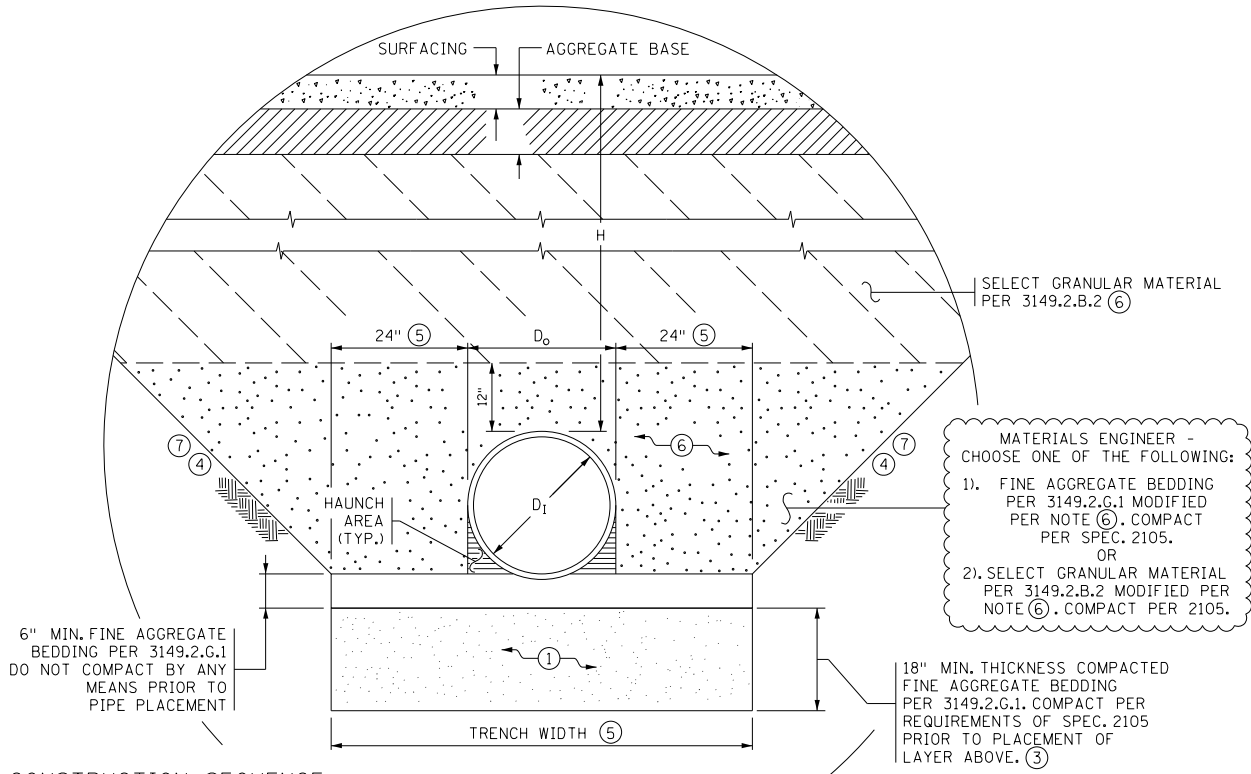
EXCAVATE & CONSTRUCT ALL TRENCHES AND SLOPES PER OSHA REQUIREMENTS.

D_1 = INSIDE DIAMETER

D_o = OUTSIDE DIAMETER OF ROUND PIPE OR OUTSIDE SPAN OF PIPE-ARCH.

FLEXIBLE PIPE CULVERT BEDDING, BACKFILL AND TREATMENT TYPE

STANDARD FLEXIBLE CULVERT PIPE BEDDING
(REFER TO CULVERT TABULATION TABLE FOR TREATMENT TYPE)



CONSTRUCTION SEQUENCE

1. PLACE AND COMPACT 18" OF FINE AGGREGATE BEDDING TO THE REQUIREMENTS OF SPEC 2105.
2. LOOSELY PLACE 6" OF FINE AGGREGATE BEDDING MATERIAL TO GRADE. DO NOT COMPACT PRIOR TO PIPE PLACEMENT.
3. FOR PIPES WITH BELL, REMOVE MATERIAL IN BELL AREA PRIOR TO PLACEMENT.
4. FURNISH AND INSTALL PIPE TO GRADE.
5. AFTER PLACEMENT OF THE PIPE, PLACE ADDITIONAL BEDDING AND COMPACT THE FULL LENGTH ON BOTH SIDES OF THE CULVERT/PIPE UNDERNEATH THE HAUNCH AREA BY FIRST SHOVEL SLICING (MANUALLY SHOVEL THE BLADE END OF A SHOVEL AT AN ANGLE DOWN THE ENTIRE LENGTH OF THE HAUNCH UNDER THE CULVERT/PIPE) THEN COMPACT THE HAUNCH AT AN ANGLE USING A POWERED MECHANICAL OR PNEUMATIC DEVICE (I.E. POLE TAMPER, JUMPING JACK, OR SIMILAR). COMPACT THE REMAINING MATERIAL OUTSIDE THE HAUNCH AREA TO THE REQUIREMENTS OF APPLICABLE MATERIAL TYPE ENSURING THAT THE ENTIRE LENGTH OF PIPE IS SUPPORTED UNIFORMLY BY BEDDING.
6. PLACE AND COMPACT BACKFILL EVENLY AND SIMULTANEOUSLY IN 6" LIFTS ON EACH SIDE OF THE PIPE TO 12" ABOVE TOP OF PIPE WHEN COMPACTED.
7. COMPLETE REMAINING BACKFILL PER THE APPROPRIATE TREATMENT REQUIREMENTS.
8. PIPE INSTALLATION MAY REQUIRE THE USE OF RESTRAINTS, WEIGHTING OR OTHER APPROVED METHODS IN ORDER TO HELP MAINTAIN GRADE AND ALIGNMENT.

NOTES

EXCAVATE & CONSTRUCT ALL TRENCHES AND SLOPES PER OSHA REQUIREMENTS.
ALL SLOPES SHOWN AS (V) : (H)

PIPE SIZE IS BASED ON THE NOMINAL INSIDE DIAMETER.

- (1) IF APPROVED BY THE ENGINEER IN WET CONDITIONS THE CONTRACTOR MAY SUBSTITUTE 18" OF COARSE FILTER AGGREGATE PER 3149.2.H COMPACTED TO THE QUALITY COMPACTION REQUIREMENTS OF SPEC. 2105. WRAP WITH GEOTEXTILE FABRIC TYPE IV PER SPEC 3733. SEAM ALL FABRIC SIDES AND ENDS PER SPEC TABLE 3733-1 INCLUDING FOOTNOTE (e) OR OVERLAP A MINIMUM OF 3 FT. ALL AT NO ADDITIONAL COST.
- (2) FOR FILL HEIGHTS (H) LESS THAN 3 FT., OMIT 1:1 1/2 TAPER
- (3) FOR INSTALLATIONS ON INTACT BEDROCK, OMIT THIS LAYER.
- (4) OVER EXCAVATION BENEATH TAPERS IS NOT PERMITTED UNLESS REQUIRED BY OSHA. (TYP.)
- (5) SEE TABLE BELOW FOR TRENCH WIDTHS FOR THERMOPLASTIC PIPES WITH MORE THAN 10 FT. OF FILL OVER THE PIPE.
- (6) MAXIMUM EMBANKMENT PARTICLE SIZE WITHIN 2 FT. OF PIPE IS 3" FOR METAL PIPES AND 1" FOR PLASTIC PIPES.
- (7) REFER TO TREATMENT TYPE DETAILS FOR TRENCH SLOPE.

PROTECT ALL PIPE DURING CONSTRUCTION PER SPEC. 2501 OR 2503.

PLACE MULTIPLE PIPE CULVERTS WITH A MIN. CLEARANCE OF 24 INCHES OR GREATER BETWEEN STRINGS OF PIPE.

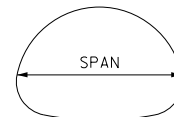
DESIGNER NOTE: SLOPING AND BENCHING FOR EXCAVATIONS GREATER THAN 20 FT. DEEP SHALL BE DESIGNED BY A REGISTERED ENGINEER.

THERMOPLASTIC PIPE WITH FILL > 10 FT.

PIPE DIA.	TRENCH WIDTH (FEET)
12"	5'-2"
15"	5'-6"
18"	5'-9"
24"	6'-6"
30"	8'-0"
36"	9'-6"
42"	11'-0"
48"	12'-6"

-LEGEND-

- D₁ = NOMINAL INSIDE DIAMETER OR SPAN OF PIPE
- D_o = OUTSIDE DIAMETER OF ROUND PIPE, OR OUTSIDE SPAN OF PIPE-ARCH.
- H = FILL COVER HEIGHT OVER PIPE (FEET)
- = UNDISTURBED SOIL



NOTES INSIDE BUBBLE ARE DESIGNER NOTES. MODIFY OR REMOVE BEFORE PRINTING FINAL PLAN.

