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Iowa Department of Transportation

DEVELOPMENTAL SPECIFICATIONS FOR STORM SEWER

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THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

This Developmental Specification is a rewrite. Please read carefully.

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The applicable sections of the SUDAS Standard Specifications have been included and modified in this specification.

DIVISION 3. TRENCH AND TRENCHLESS CONSTRUCTION

SECTION 3010 - TRENCH EXCAVATION AND BACKFILL.

3010.01 DESCRIPTION.

A. Excavate trench for pipe installation.

B. Stabilize trench and install pipe bedding materials.

C. Place backfill material in trench.

3010.02 MATERIALS.

A. Materials Excavated from a Trench.

1. Standard Trench Excavation.
All materials encountered during trench excavation, except rock and over-excavation.

a. Suitable Backfill Material.
Class II, Class III, Class IVA, or Class IVB as defined in Article 3010.02, B.

b. Unsuitable Backfill Material.
Includes, but is not limited to:

1) Soils not classified as suitable backfill material, as defined in Article 3010.02, B.
2) Individual stones or concrete chunks larger than 6 inches (150 mm) and averaging more than one per cubic foot (0.03 cubic meters) of soil.
3) Frozen materials.
4) Stumps, logs, branches, and brush.
5) Trash, metal, or construction waste.
6) Soil in clumps or clods larger than 6 inches (150 mm) and without sufficient fine materials to fill voids during placement.
7) Environmentally contaminated soils.
8) Materials removed as rock excavation or over-excavation.

c. Topsoil.
Class V material. Comply with Article 3010.02, C.

2. Rock Excavation.
Boulders or sedimentary deposits that cannot be removed from the trench without continuous use of pneumatic tools or blasting.

3. Over-Excavation.
Excavation of unsuitable or unstable material in trenches below the pipe zone.

B. Bedding and Backfill Material.

1. Class I Material.

a. Crushed stone complying with the following gradation:

Sieve	Percent Passing
1 1/2 inch (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

b. The Engineer may allow the use of gravel or authorize a change in gradation subject to materials available locally at the time of construction

c. The Engineer may authorize the use of crushed PCC for pipe sizes up to 12 inches (300 mm).

d. Use aggregates having a percentage of wear, Grading A or B, not exceeding 50%, determined according to AASHTO T 96.

2. Class II Material.

Manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse grained natural soils (clean) with little or no fines. Comply with Table 3010.02-1.

Table 3010.02-1: Class II Material

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 µm)	LL	PI	Uni-formity C_u	Curva-ture C_c
II	Coarse Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100%	‹50% of "Coarse Fraction"	‹5%	Non Plastic		›4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						‹4	‹1 or ›3
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"				›6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						‹6	‹1 or ›3
	Coarse Grained Soils, borderline clean to with fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100%	Varies	5% to 12%	Non Plastic		Same as for GW, GP, SW and SP	

3. Class III Material.

a. Natural coarse-grained soils with fines. Comply with Table 3010.02-2.

b. Do not use where water conditions in trench may cause instability.

Table 3010.02-2: Class III Material

Class	Type	Soil Group Symbol	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5	No. 4 (4.75 mm)	No. 200 (75 µm)	LL	PI	Uni-formity	Curva-ture

		ASTM D 2487		mm)					C_u	C_c
III	Coarse Grained Soils, with fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	‹50% of "Coarse Fraction"	12% to 50%	N/A	‹4 or ‹"A" Line	N/A	N/A
		GC	Clayey gravels, gravel-sand-clay mixtures.					‹7 and ›"A" Line		
		SM	Silty sands, sand-silt mixtures.		›50% of "Coarse Fraction"			›4 or ‹"A" Line		
		SC	Clayey sands, sand-clay mixtures.					›7 and ›"A" Line		

4. Class IVA Material.

a. Natural fine grained inorganic soils. Comply with Table 3010.02-3.

b. The Engineer will determine if material is not suitable for use as backfill material under deep fills, surface applied wheel loads, heavy vibratory compactors, tampers, or other conditions.

c. Do not use where water conditions in trench may cause instability.

d. Material is suitable for use in dry trench conditions only.

Table 3010.02-3: Class IVA Material

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 µm)	LL	PI	Uni-formity C_u	Curva-ture C_c
IVA	Fine Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line	N/A	N/A
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clay, lean clays.					›7 and ›"A" Line		

5. Class IVB Material.

a. Natural fine grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%. Comply with Table 3010.02-4.

b. When approved by the Engineer, material may be used as final trench backfill in a dry trench.

c. Do not use in the pipe embedment zone.

Table 3010.02-4: Class IVB Material

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 µm)	LL	PI	Uni-formity C_u	Curva-ture C_c
IVB	Fine Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	›50%	›50	‹"A" Line	N/A	N/A

		CH	Inorganic clays of high plasticity, fat clays.					›"A" Line		

C. Class V Material (Topsoil).

1. Organic soils. Comply with Table 3010.02-5.

2. Use only as topsoil outside of the pavement, unless otherwise specified or allowed by the Engineer.

3. Do not use in the pipe embedment zone.

Table 3010.02-5: Class V Material

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 μm)	LL	PI	Uni-formity C_u	Curva-ture C_c
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line	N/A	N/A
		OH	Organic clays of medium to high plasticity, organic silts.				›50	‹"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.							

D. Stabilization (Foundation) Materials.

1. Clean 2 1/2 inch (63.5 mm) crushed stone with the following gradation:

Sieve	Percent Passing
2 1/2 inch (63 mm)	100
2 inch (50 mm)	90 to 100
1 1/2 inch (37.5 mm)	35 to 70
1 inch (25 mm)	0 to 20
1/2 inch (12.5 mm)	0 to 5

2. The Engineer may authorize a change in gradation subject to materials available locally at time of construction.

3. Subject to the Engineer's approval, crushed concrete may be used if it is within ± 5% of the gradation for each size of material.

E. Special Pipe Embedment and Encasement Material.

1. Concrete Cradle, Arch, or Encasement.
Use Class C concrete.

2. Flowable Mortar.
Apply Section 2506 of the Standard Specifications.

3. Controlled Low Strength Material (CLSM).
a. Approximate quantities per cubic yard (cubic meter):
1) Cement 50 pounds (30 kg)
2) Fly ash 250 pounds (150 kg)

3) Fine aggregate 2910 pounds (1729 kg)
4) Water 60 gallons (296 L)

b. A compressive strength of at least 50 psi (345 kPa) at 28 days can be expected.
c. Apply Article 2506.02 of the Standard Specifications.

3010.03 CONSTRUCTION.

A. Trench Excavation.

1. Notify the Engineer prior to the start of excavation activities.

2. Remove topsoil to a minimum depth of 12 inches (300 mm) and stockpile.

3. Excavate trench to required elevations and dimensions.

a. Protect existing facilities, trees, and shrubs during trench excavation.

b. Place excavated material away from trench.

c. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

4. Unsuitable backfill material:
a. If unsuitable backfill material is encountered, notify the Engineer.
b. Remove rock, rubbish, boulders, debris, and other unsuitable backfill materials at least 6 inches (150 mm) below and on each side of the pipe.
c. Keep unsuitable backfill material separated from suitable backfill material and topsoil.
d. Restore trench to design dimensions using bedding or stabilization material.

B. Rock or Unstable Soils in Trench Bottom.

1. Notify the Engineer prior to over-excavation.

2. The Engineer will determine the need for over-excavation and trench foundation stabilization prior to installation of pipes and structures.

3. Refer to the contract documents for details of over-excavation of rock and wet or soft foundations.

C. Trench Protection.

1. Install adequate trench protection (sheeting, shoring, and bracing) to prevent ground movement or damage to adjacent structures, pipelines, and utilities.

2. Move trench boxes carefully to avoid disturbing pipe, bedding, or trench wall.

D. Dewatering.

Submit a dewatering plan to the Engineer for approval.

1. Maintain water levels below the bottom of trench excavation.

2. Perform the dewatering operation according to the dewatering plan approved by the Engineer. The dewatering plan may be modified to meet actual field conditions, with approval of the Engineer.

3. Ensure operation of the dewatering system does not damage adjoining structures and facilities. Cease dewatering operations and notify the Engineer if damage is observed.

4. Discharged water:
- **a.** Do not discharge water into sanitary sewers.
- **b.** Discharging water into storm sewers requires the Engineer's approval.
- **c.** Obtain permission of adjacent property owner prior to discharging water onto their property.
- **d.** Maintain and control water discharge as necessary to prevent a safety hazard for vehicular and pedestrian traffic.
- **e.** Direct water discharge away from electrical facilities or equipment.
- **f.** Use dewatering equipment that will minimize disturbance from noise and fumes.
- **g.** Protect discharge points from erosion. Provide sediment control for sediment contaminated water discharged directly from trench.

E. Pipe Bedding and Backfill.

1. General.
- **a.** Bedding and backfill used for pipe installation will depend on:
  - **1)** Pipe material.
  - **2)** Depth of bury.
  - **3)** Pipe diameter.
- **b.** After pipe installation, place remaining bedding material and immediately place backfill in trench.
- **c.** Adjust the moisture content of excessively wet, but otherwise suitable, backfill material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
- **d.** Adjust the moisture content of excessively dry, but otherwise suitable, backfill material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
- **e.** Hydraulic compaction (flooding with water) is not allowed unless authorized by the Engineer.

2. Pipe Bedding.
- **a. Granular Material.**
  - **1)** Place bedding material in the bottom of the trench in lifts no greater than 6 inches (150 mm) thick. Consolidate and moderately compact bedding material.
  - **2)** Shape bedding material to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe. Excavate for pipe bells.
  - **3)** Install pipe and system components.
  - **4)** Place, consolidate, and moderately compact additional bedding material adjacent to the pipe to a depth equal to 1/6 the outside diameter of the pipe.
- **b. Suitable Backfill Material.**
  - **1)** Only use with pressure pipe.
  - **2)** Use suitable backfill material to shape trench bottom to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe. Excavate for pipe bells.
- **c. Special Pipe Embedment and Encasement Materials.**
  - **1)** If required in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other bedding materials.
  - **2)** Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

3. Haunch Support.
Place from the top of the pipe bedding to the springline of the pipe.
- **a. Granular Material.**
  - **1)** Place Class I material in lifts no greater than 6 inches (150 mm) thick.

2) Consolidate and moderately compact by slicing with a shovel or using other approved techniques.

b. Suitable Backfill Material.

1) Place in lifts no greater than 6 inches (150 mm) thick.
2) For Class II backfill material, consolidate and moderately compact by slicing with a shovel or using other approved techniques.
3) For Class III and Class IVA backfill materials, compact to at least 90% of Standard Proctor Density. Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

c. Special Pipe Embedment and Encasement Materials.

1) If required in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other haunch materials.
2) Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

4. Primary and Secondary Backfill.

a. General.

1) For primary backfill, place from the springline of the pipe to the top of the pipe.
2) For secondary backfill, place from the top of the pipe to 1 foot (300 mm) above the top of the pipe.

b. Granular Material.

1) Place in lifts no greater than 6 inches (150 mm) thick.
2) Compact to at least 65% relative density.

c. Suitable Backfill Material.

1) Place in lifts no greater than 6 inches (150 mm) thick.
2) For Class II backfill material, compact to at least 65% relative density.
3) For Class III and Class IVA backfill materials, compact to at least 95% of Standard Proctor Density. Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

d. Special Pipe Embedment and Encasement Materials.

1) If required in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other primary or secondary backfill materials.
2) Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

5. Final Trench Backfill.

a. Place suitable backfill material from 1 foot (300 mm) above the top of the pipe to the top of the trench.

1) Use no more than 8 inch (200 mm) thick lifts for backfill areas more than 3 feet (1 m) below the bottom of pavement.
2) Use no more than 6 inch (150 mm) thick lifts for backfill areas less than or equal to 3 feet (1 m) below the bottom of pavement.

b. Place backfill material after recording locations of connections and appurtenances or at the Engineer's direction.

c. Class I and Class II backfill material:

1) Compact to at least 65% relative density within right-of-way.
2) Compact to at least 50% relative density outside right-of-way.

d. Class III and Class IVA backfill material:

1) Compact to at least 95% of Standard Proctor Density within right-of-way.
2) Compact to at least 90% of Standard Proctor Density outside right-of-way.
3) Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

e. In areas to remain unpaved, terminate backfill material 8 inches (200 mm) below finish grade. Use topsoil for the final 8 inches (200 mm) above trench backfill material.

f. Terminate backfill material at subgrade elevation in areas to be paved.

F. Trench Compaction Testing.

1. General.
When trench compaction testing is specified in the contract documents as the Contractor's responsibility, provide testing of trench backfill material using the services of an independent testing laboratory approved by the Engineer.

2. Soil Testing.

a. Cohesive soils.

1) Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.

2) Determine in-place density and moisture content. Use ASTM D 1556 (sand-cone method) and D 2216 (laboratory moisture content), or use ASTM D 6938 (nuclear methods for density and moisture content).

b. Cohesionless soils.

1) Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and ASTM D 4254.

2) For Class I granular bedding material, determine gradation according to ASTM C 136.

3. Field Testing.

a. Testing Frequency and Locations.
Perform testing of the final trench backfill, beginning at a depth of 2 feet (600 mm) above the top of the pipe, as follows:

1) Coordinate the timing of testing with the Engineer.

2) The Engineer will determine the location of testing.

3) For each 2 vertical feet (600 vertical mm) of consolidated fill, provide tests at a maximum horizontal spacing of 200 feet (60 m) and at all street crossings.

4) Additional testing may be required by the Engineer in the event of non-compliance or if conditions change.

5) If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill material and recompact.

b. Test Failure and Retesting.
Rework, recompact, and retest as necessary until specified compaction and moisture content is achieved in all areas of the trench. In the event of failed tests, the Engineer may require retesting as deemed necessary.

3010.04 METHOD OF MEASUREMENT.

A. Rock Excavation.
Measurement will be by cubic yards (cubic meters) of rock removed.

B. Trench Foundation.
Measurement will be in tons (megagrams) for the quantity of stabilization material required to replace material removed by over-excavation. Measurement will be based on the scale tickets for the material delivered and incorporated into the project. Trench foundation required to correct unauthorized over-excavation will not be measured.

C. Replacement of Unsuitable Backfill Material.
Measurement will be in cubic yards (cubic meters) for the quantity of backfill material required to replace unsuitable backfill material removed during standard trench excavation. Measurement will be based on compacted material in place.

D. Special Pipe Embedment or Encasement.
Measurement will be by the linear foot (meter) along the centerline of pipe for each type of special embedment or encasement.

E. Trench Compaction Testing.

1. The Contractor is not responsible for trench compaction testing or payment unless otherwise specified in the contract documents.

2. If the contract documents specify that the Contractor is responsible for trench compaction testing performed by an independent testing laboratory hired by the Contractor, measurement will be a lump sum.

3010.05 BASIS OF PAYMENT.

A. General.
The following items are incidental to the underground utility being installed and will not be paid for separately:

1. Standard trench excavation.

2. Removal and disposal of unsuitable backfill material encountered during standard trench excavation.

3. Removal of abandoned private utilities encountered during trench excavation.

4. Furnishing and placing granular bedding material.

5. Placing and compacting backfill material.

6. Dewatering.

7. Sheeting, shoring, and bracing.

8. Adjusting the moisture content of excavated backfill material to the range specified for placement and compaction.

B. Rock Excavation.
Payment will be at the contract unit price per cubic yard (cubic meter) for the quantity of rock removed.

C. Trench Foundation.

1. Payment will be at the contract unit price per ton (megagram) for the quantity of stabilization material furnished and placed.

2. Payment is full compensation for:
   - Removal and disposal of over-excavated material required to stabilize trench foundation, and
   - Furnishing, hauling, and placing stabilization material.

D. Replacement of Unsuitable Backfill Material.

1. Payment will be at the contract unit price per cubic yard (cubic meter) for the quantity of backfill material furnished.

2. Payment is full compensation for furnishing, hauling, and placing backfill material.

E. Special Pipe Embedment or Encasement.

1. Payment will be at the contract unit price per linear foot (meter) for each type of special pipe embedment or encasement.

2. Payment is full compensation for (but is not limited to) furnishing and placing all required special pipe embedment or encasement materials.

F. Trench Compaction Testing.

1. If the contract documents specify that the Contractor is responsible for trench compaction testing performed by an independent testing laboratory hired by the Contractor, payment will be at the contract unit price for the lump sum.

2. The Contractor will be responsible for payments associated with all retesting resulting from failure of initial tests.

SECTION 3020 - TRENCHLESS CONSTRUCTION.

3020.01 DESCRIPTION.

A. Excavate launching and receiving pits.

B. Install casing or storm sewer pipe by trenchless methods.

C. Install storm sewer pipe inside casing pipe (if required).

D. Place backfill material in excavations.

3020.02 MATERIALS.

A. Storm Sewer.
Apply Article 4020.02.

B. Casing Pipe.

1. Pipe.
Use only new steel pipe meeting the requirements of ASTM A 139/A 139M, Grade B; ASTM A 252, Grade 2; or ASTM A 53/A 53M, Grade B. Pipe may be welded or seamless. Use the wall thickness specified in the contract documents.

2. Joints.
a. Comply with American Welding Society Code D1.1M/D1.1. Weld all joints with full penetrating weld. Welders are required to be qualified according to Materials I.M. 560. Welds are required to comply with Materials I.M. 558.
b. Upon approval of the Engineer, adjacent pieces of steel pipe may be connected during installation using CNC machined integral press fit connections as long as loading and installation design criteria are met. Install press fit connections according to the pipe manufacturer's recommendation.

3. Pipe Diameter.
Casing Pipe Minimum Wall Thickness: Refer to Table 3020.02-1.

Table 3020.02-1: Minimum Wall Thickness

NOMINAL DIAMETER INCHES (mm)	WALL THICKNESS, MINIMUM INCHES (mm)	
	UNDER HIGHWAY	UNDER RAILROAD
6 thru 14 (150 thru 355)	0.188 (4.78)	0.25000 (6.35)
16 (465)	0.188 (4.78)	0.28125 (7.14)
18 (450)	0.25 (6.35)	0.31250 (7.94)
20 (510)	0.25 (6.35)	0.34375 (8.73)
22 (560)	0.25 (6.35)	0.34375 (8.73)
24 (600)	0.281 (7.14)	0.37500 (9.53)
26 (660)	0.281 (7.14)	0.40625 (10.32)
28 (710)	0.312 (7.92)	0.43750 (11.11)
30 (750)	0.312 (7.92)	0.46875 (11.91)
32 (815)	0.312 (7.92)	0.50000 (12.70)
34 (865)	0.312 (7.92)	0.53125 (13.49)
36 (900)	0.344 (8.74)	0.53125 (13.49)
38 (965)	0.344 (8.74)	0.56250 (14.29)
40 (1015)	0.344 (8.74)	0.59375 (15.08)
42 (1050)	0.344 (8.74)	0.62500 (15.88)
44 (1120)	0.344 (8.74)	0.65625 (16.67)
46 (1170)	0.344 (8.74)	0.65625 (16.67)
48 (1200)	0.344 (8.74)	0.68750 (17.46)
50 (1270)	For sizes greater than 48 inch (1200 mm) diameter, consult the Engineer	0.71875 (18.26)
52 (1320)		0.75000 (19.05)
54 (1370)		0.78125 (19.84)
56 (1420)		0.81250 (20.64)
58 (1470)		0.81250 (20.64)
60 (1525)		0.84375 (21.43)
62 (1575)		0.87500 (22.23)
64 (1625)		0.90625 (23.02)
66 (1675)		0.93750 (23.81)
68 (1725)		0.93750 (23.81)
70 (1780)		0.96875 (24.61)
72 (1830)		1.00000 (25.40)

C. Casing Spacers.

1. Use manufactured casing spacers to position storm sewer pipe in casing. Do not use wood skids.

2. Meet the following material requirements:
- **a. HDPE Band/Panel and Riser:** ASTM D 638.
- **b. Stainless Steel or Carbon Steel Band/Panel and Riser:** Type 304 stainless steel according to ASTM A 240/A 240M or carbon steel according to ASTM A 36/A 36M.
  - **1) Liner:** Elastomeric PVC per ASTM D 149.
  - **2) Spacer Skid/Runner:** Abrasion resistant polymer with a low coefficient of friction.
  - **3) Fasteners:** Type 304 (18-8) stainless steel per ASTM A 193/A 193M.

D. Backfill for Abandoned Tunnels.

1. **Option 1:** Use Class C concrete, approximately 4 inch (100 mm) slump.

2. **Option 2:** Flowable mortar or controlled low strength material (CLSM) according to Article 3010.02, E.

E. Backfill Material.

1. **Excavated Materials.**
   Apply Section 3010 for classification of excavated materials. Use only suitable material for backfill material.

2. **Special Fill Materials.**
   For use where specified in the contract documents.
   a. **PCC:** Use Class C concrete, approximately 4 inch (100 mm) slump.
   b. **Flowable Mortar:** Apply Section 2506.02 of the Standard Specifications.
   c. **Controlled Low Strength Material (CLSM):** Apply Article 3010.02, E.

F. Casing End Seal.

1. **Manufactured:** Minimum 1/8 inch (3.0 mm) thick manufactured synthetic rubber casing end seal with stainless steel bands and fasteners.

2. **PCC:** Apply Section 2403 of the Standard Specifications. Do not use PCC casing end seals with flexible storm sewer pipes.

3020.03 CONSTRUCTION.

A. Excavation.

1. Notify the Engineer prior to the start of excavation activities.

2. Remove topsoil to minimum depth of 12 inches (300 mm) and stockpile.

3. Excavate the minimum size pits necessary to safely and properly perform the work.
   a. Protect existing facilities, trees, and shrubs during excavation.
   b. Place excavated material away from trench.
   c. Grade and shape spoil piles to drain and protect adjacent areas from runoff. Do not allow spoil piles to obstruct drainage. Stabilize stockpiles with seeding and provide sediment control around stockpiles.

4. Remove rock, rubbish, debris, and other materials not suitable for use as backfill.

B. Sheeting Shoring, and Bracing.
Apply Article 3010.03, C.

C. Dewatering.
Apply Article 3010.03, D.

D. Trenchless Installation.

1. **General.**
   Select a method of installation that is appropriate for the soil conditions anticipated and will: 1) allow the pipe to be installed to the desired line and grade within the specified tolerances;

2) prevent heaving or settlement of the ground surface or damage to nearby facilities; and 3) prevent damage to the storm sewer pipe and lining materials within the storm sewer pipe.

a. Installation Methods.

1) **Auger Boring:** A method that utilizes a rotating cutting head to form the bore hole and a series of rotating augers inside a casing pipe to remove the spoil.
2) **Directional Drilling:** A method for installing pipe from a surface launched drilling rig. A pilot bore is formed and then enlarged by back reaming and removing the spoil material. The pipe is then pulled in place.
3) **Open-ended Pipe Ramming:** A method that involves driving a steel casing pipe with a percussive hammer. The front end of the casing pipe is open ended. Spoils are removed from the pipe.
4) **Pipe Jacking:** A method in which pipe is pushed into the ground with hydraulic jacks while soil is simultaneously excavated. Excavation is normally completed with a tunnel boring machine.
5) **Microtunneling:** A method of pipe jacking using a remote controlled tunnel boring machine.
6) **Utility Tunneling:** A method of forming large diameter tunnels. As excavation takes place at the front of the tunnel, a liner is constructed to temporarily support the tunnel. Upon completion of the tunnel, the pipe is pushed in place.
7) **Other:** Other methods may be allowed with the Engineer's approval.

b. Line and Grade.

1) Install pipe at line and grade that will allow the storm sewer pipe to be installed at its true starting elevation and grade within a maximum alignment deviation of the pipe centerline as specified in the contract documents.
2) When no deviation tolerances are specified in the contract documents, apply the following maximum deviations to the storm sewer pipe:
   a) Horizontally: ± 1.0 foot per 100 feet (0.3 m per 30 m).
   b) Vertically: ± 0.2 feet up to 100 feet (0.06 m per 30 m). An additional ± 0.1 foot per 100 feet (0.03 m per 30 m) thereafter. Backfall in pipe is not allowed.
   c) Greater deviation or interference with other identified facilities may be cause for rejection.

c. Deviation from Line and Grade.

1) Provided adequate clearance remains for proper installation of the storm sewer pipe, the Contractor will be allowed to correct deviations in grade of a casing pipe in order to achieve design grade of the storm sewer pipe by:
   - Pouring an invert in the casing pipe, or
   - Shimming the storm sewer pipe with casing spacers to a uniform grade.
2) Installations deviating from the specified tolerances that cannot be adjusted to conform to the specified tolerances may be rejected by the Engineer. If a non-conforming installation is not rejected, provide all additional fittings, manholes, or appurtenances needed to accommodate horizontal or vertical misalignment, at no additional cost to the Contracting Authority.
3) Abandon rejected installations and place special fill materials, at no additional cost to the Contracting Authority. Replace abandoned installations, including all additional fittings, manholes, or appurtenances required to replace rejected installations.

2. Casing Pipe or Un-cased Storm Sewer Pipe Installation.

a. Install pipe by approved methods.

b. Use a jacking collar, timbers, and other means as necessary to protect the driven end of the pipe from damage.

c. Do not exceed the compressive or tensile strength capacity of the pipe during pushing or pulling operations.

d. Fully support bore hole at all times to prevent collapse. Insert pipe as soil is removed, or support bore with drilling fluid.

e. Fully weld all casing pipe joints. Use an interlocking connection system when approved by the Engineer.

f. Fill space between the inside of the bore hole and the outside of the pipe with special fill material if the space is greater than 1 inch (25 mm).

3. Storm Sewer Pipe Installation through Casing.

a. Clean dirt and debris from the interior of the casing pipe after installation.

b. Install casing spacers on storm sewer pipe sections as necessary to support the pipe barrel according to the pipe manufacturer's recommendations subject to the following minimum requirements:

1) Install a spacer within 1 foot (0.3 m) of each side of the storm sewer pipe joint and at a maximum spacing of 6 feet (1.8 m).

2) Do not allow the pipe to be supported by joint bells.

3) Lubricate casing spacers with drilling mud or flax soap. Do not use petroleum-based lubricants or oils.

c. Ensure that thrust loads will not damage storm sewer pipe joints. Provide thrust collars between joint shoulders of concrete pipe.

d. Provide timbers for sufficient cushioning between the end of the pipe pushed and the jacking equipment to prevent damage to the pipe. Do not allow the steel jack face to thrust against the unprotected pipe end.

e. Position jacks so the resulting force is applied evenly to the entire end of the pipe.

f. Assemble pipe joints in the jacking pit before pushing the storm sewer pipe into the casing.

g. Close the end of the casing pipe around the storm sewer pipe with a casing end seal.

h. When specified in the contract documents, fill the annular space between the storm sewer and casing pipe with flowable mortar or CLSM.

E. Pit Restoration.

1. Remove installation equipment and unused materials from the launching and receiving pits.

2. When the storm sewer pipe extends beyond the limits of trenchless installation and into the bore pit, place bedding and backfill material according to Section 3010.

3. Place suitable backfill material in the pit. Apply the testing requirements of Section 3010.

4. Restore the site to original condition or better.

3020.04 METHOD OF MEASUREMENT.

Trenchless Construction will not be measured for payment. Excavation for boulders smaller than one-third the diameter of the pipe being installed, or parts of existing structures identified in the contract documents will not be measured for payment, but are to be considered incidental to the price bid for trenchless construction. Excavation and removal of boulders larger than one-third the diameter of the pipe being installed, or parts of existing structures not identified in the contract documents will be paid for in accordance with Article 1109.03, B.

3020.05 BASIS OF PAYMENT.

Trenchless Construction is incidental to the underground utility pipe being installed and will not be paid for separately.

DIVISION 4. SEWERS

SECTION 4020 - STORM SEWERS

4020.01 DESCRIPTION.

A. Construct storm sewers.

B. Abandon storm sewer.

4020.02 MATERIALS.

A. Reinforced Concrete Pipe (RCP).

1. Comply with ASTM C 76/C 76M.

2. Minimum Class 2000D (Class III, Wall B).

3. Use tongue and groove joints with cold applied bituminous or rubber rope gasket jointing material, unless otherwise specified. If specified, use rubber O-ring or profile gasket complying with ASTM C 443/C 443M (AASHTO M 315/M 315M).

4. If specified, wrap exterior of each joint with engineering fabric.

B. Reinforced Concrete Arch Pipe (RCAP).

1. Comply with ASTM C 506/C 506M.

2. Minimum Class 2000D (A-III).

3. Use tongue and groove joints with cold applied bituminous or rubber rope gasket jointing materials, unless specified otherwise.

4. If specified, wrap exterior of each joint with engineering fabric.

C. Reinforced Concrete Elliptical Pipe (RCEP).

1. Comply with ASTM C 507/C 507M.

2. Minimum Class 2000D (Class HE III or Class VE III).

3. Use tongue and groove joints with cold applied bituminous or rubber rope gasket jointing materials, unless specified otherwise.

4. If specified, wrap exterior of each joint with engineering fabric.

D. Reinforced Concrete Low Head Pressure Pipe (RCPP).

1. Comply with ASTM C 361/C 361M, minimum Class C 25.

2. Use tongue and groove joints. Comply with ASTM C 361/C 361M for rubber O-rings or profile gaskets.

E. Polyvinyl Chloride Pipe (PVC).
Use pipe complying with the following:

1. Types of PVC pipes:
- **a.** Corrugated exterior, smooth interior, ASTM F 949.
- **b.** Solid wall, ASTM D 3034 or ASTM F 679.
- **c.** Closed profile, ASTM F 1803.
- **d.** Composite, ASTM D 2680.

2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.

3. Minimum pipe stiffness of 46 psi (320 kPa).

4. Integral bell and spigot joints with elastomeric seals according to ASTM D 3212 and ASTM F 477.

F. High Density Polyethylene Pipe (HDPE).
Use pipe complying with the following:

1. AASHTO M 294, Type S corrugated exterior and smooth interior.

2. ASTM D 3350 minimum resin Cell Classification 335420 C.

3. Minimum pipe stiffness at 5% deflection complying with ASTM D 2412.

4. Integral bell and spigot joints with elastomeric seals complying with ASTM F 477.

5. Maximum 5% deflection of the average inside diameter by testing after installation according to Article 4060.03, C.

G. Corrugated Metal Pipe (CMP).
Use pipe complying with the following:

1. AASHTO M 36, Type I.

2. Zinc coating complying with AASHTO M 218.

3. Corrugated steel circular section with annular or helical corrugations.

4. Gage of pipe according to Standard Road Plan RF-32 or as specified in the contract documents.

5. Coupling bands with annular or helical corrugations to match pipe ends.

H. Spiral Rib Pipe.
Use pipe complying with the following:

1. ASTM A 760/A 760M Type 1R.

2. Corrugation profile of 3/4 inch (19 mm) by 3/4 inch (19 mm) by 7 1/2 inches (190 mm).

3. Type 2 aluminized steel complying with ASTM A 929/A 929M.

4. Minimum thickness of 0.064 inch (1.6 mm). Use gage of pipe according to manufacturer's requirements or as specified in the contract documents.

5. Coupling bands complying with manufacturer's recommendations.

I. Coated Corrugated Metal Pipe.

1. Use in corrosive soil or effluent conditions, or where indicated in the contract documents or required by the Engineer.

2. Comply with AASHTO M 274. Use gage of pipe according to Standard Road Plan RF-32 or as specified in the contract documents.

J. Corrugated Metal Arch Pipe (CMAP).
Use pipe complying with the following:

1. AASHTO M 36, Type II.

2. Zinc coating complying with AASHTO M 218.

3. Corrugated steel Type I pipe reformed into a pipe-arch having an approximately flat bottom.

4. Coupling bands with annular corrugations or helical corrugations to match pipe ends.

5. Gage of pipe according to Standard Road Plan RF-32.

K. Spiral Rib Arch Pipe.
Use pipe complying with the following:

1. ASTM A 760/A 760M Type IIR.

2. Corrugation profile of 3/4 inch (19 mm) by 3/4 inch (19 mm) by 7 1/2 inches (190 mm).

3. Type 2 aluminized steel complying with ASTM A 929/A 929M.

4. Minimum thickness of 0.064 inch (1.6 mm). Use gage of pipe complying with manufacturer's requirements or as specified in the contract documents.

5. Coupling bands complying with manufacturer's recommendations.

L. Jointing Material for Concrete Apron.

1. **Bituminous Jointing Material.**
Use a cold-applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Engineer. Comply with AASHTO M 198.

2. **Rubber Rope Gasket Jointing Material.**
Comply with ASTM C 990/C 990M.

3. **Rubber O-ring or Profile Gasket.**
Comply with ASTM C 443/C 443M (for RCP) or ASTM C 361/C 361M (for RCPP).

M. Bituminous Joint Primer.
Material intended for use in priming concrete joints. Comply with the requirements of ASTM D 41.

N. Engineering Fabric.
Apply Article 4196.01 of the Standard Specifications.

O. Non-Shrink Grout.
Apply Materials I.M. 491.13.

P. Casing Pipe.
Apply Article 3020.02 for casing pipe requirements.

4020.03 CONSTRUCTION.

A. Examination.

1. Verify measurements at site and make necessary field measurements to accurately determine pipe makeup lengths or closures.

2. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

B. Pipe Installation.

1. **General.**
   - **a.** Provide proper facilities for lowering the sections into place without damaging the pipe.
   - **b.** Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.
   - **c.** Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.
   - **d.** Begin at the lowest point in the line. Lay groove or bell end pointing upstream unless specifically noted otherwise.
   - **e.** Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.
   - **f.** Assemble joints as specified by the pipe manufacturer. When specified, wrap exterior of storm sewer pipe joints with engineering fabric.
   - **g.** Cut ends of pipe at manholes, intakes, and structures. Do not hammer cut or break pipe.
   - **h.** Provide manholes and intakes as specified in the contract documents.
   - **i.** Use watertight stopper, plug, or other approved means to protect the exposed upstream ends of the pipe and prevent soil sediment from entering the storm sewer system.

2. **Trenched.**
   - **a.** Excavate trench and provide bedding and backfill material as specified in Section 3010.
   - **b.** Prepare trench bottom to design line and grade so that only minor movement of the pipe is necessary after installation.
   - **c.** Lay pipe to design line and grade:
     - **1)** Install pipe to line and grade specified in the contract documents. Set field grades to invert of pipe.
     - **2)** At no additional cost to the Contracting Authority, correct misalignment, displacement, or otherwise defective pipe by removing, relaying, or replacing pipe.
   - **d.** Provide uniform bearing for full pipe barrel length. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
   - **e.** Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe prior to placing backfill material.
   - **f.** Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.
3. **Trenchless.**
   Apply Section 3020.

C. Storm Sewer Pipe Installed within a Casing Pipe.

Apply Article 3020.03, D, for installation of storm sewer pipe within casing pipe.

D. Pipe Jointing.

1. **General.**
   - **a.** Clean joint surfaces to remove soil or foreign material prior to jointing pipe.
   - **b.** Assemble joints according to the pipe manufacturer's recommendations. Use equipment that does not apply damaging forces to pipe joints.

2. **RCP, RCAP, and RCEP.**
   a. Use cold applied bituminous or rubber rope gasket jointing materials unless specified otherwise.
      1) Apply joint material to entire tongue, or to top half of tongue and bottom half of groove, in sufficient quantity to fill the joint. Close the joint between pipes.
      2) Fill remaining voids in the joint, both inside and outside of pipe, with joint material. Smooth the joint material on the inside of pipes 24 inches (600 mm) and larger.
   b. If a rubber O-ring or profile gasket is specified for RCP, coat the rubber gasket and joint with soap based lubricant immediately prior to closing the joint.
   c. If wrapped pipe joint is specified, secure engineering fabric in place to prevent displacement while placing backfill material.
   d. Place pipe such that joint openings on the outside or inside of the pipe do not exceed 1/8 inch (3 mm) at the bottom and 5/8 inch (15 mm) at the top.

3. **RCPP, PVC and Corrugated PVC, and HDPE.**
   Coat gasket and joint with soap based lubricant immediately prior to closing the joint.

4. **CMP and CMAP.**
   Lap coupling bands to form a tightly closed joint upon installation.

5. **Connections between Dissimilar Pipes.**
   a. Use manufactured adapters or couplings approved by the Engineer.
   b. Where adapters or couplings are not available, the Engineer may authorize use of a concrete collar as shown in the contract documents.

E. Tolerances.

The following tolerances apply to utilities installed by open trench construction. For trenchless construction, apply Section 3020.

1. Ensure horizontal and vertical alignment of gravity sewer lines does not vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch (6 mm), whichever is larger.

2. Tolerance is allowed only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.

3. Reverse slope on pipe is prohibited. Remove and reinstall to proper grade.

F. Conflicts.

1. Provide temporary support for existing water, gas, telephone, power, and other utilities or services that cross the trench.

2. Compact backfill material under existing utility crossing as specified in Section 3010, or construct utility line supports where specified in the contract documents or as directed by the Engineer.

G. Storm Sewer Abandonment.

1. Prior to placing the sewer plug, the Engineer will verify the sewer line is not in use.

2. Construct sewer plug by completely filling the end of the pipe with concrete. Force concrete into the end of the pipe for a distance of 16 inches (400 mm), or one-half the pipe diameter, whichever is greater.

3. If noted in the plans, fill the line to be abandoned with flowable mortar or CLSM (complying with Section 3010) by gravity flow or pumping.

H. Connection to Existing Manhole or Intake.
Comply with Section 6010.03, E.

I. Cleaning, Inspection, and Testing of Storm Sewer.
Clean, inspect, and test storm sewer according to Section 4060.

4020.04 METHOD OF MEASUREMENT.

A. Storm Sewer.

1. **Trenched.**
Measurement for each type and size of pipe installed in a trench will be in linear feet (meters) along the centerline of the pipe from center of intake or manhole to center of intake or manhole. Where the end of the pipe discharges to a ditch or waterway, measurement will be to the end of the pipe, exclusive of aprons. Lengths of elbows and tees will be included in the length of pipe measured.

2. **Trenchless.**
Measurement for each type and size of pipe installed by tenchless methods will be in linear feet (meters) along the centerline of the pipe.

B. Storm Sewer with Casing Pipe.

1. **Trenched.**
Measurement for each type and size of pipe installed with a casing pipe in a trench will be in linear feet (meters) along the centerline of the casing pipe from end of casing to end of casing.

2. **Trenchless.**
Measurement for each type and size of pipe installed by trenchless methods with a casing pipe will be in linear feet (meters) along the centerline of the casing pipe from end of casing to end of casing.

C. Removal of Storm Sewer.
Measurement for each type and size of pipe removed will be in linear feet (meters) from end to end.

4020.05 BASIS OF PAYMENT.

A. Storm Sewer.

1. **Trenched.**
   a. Payment will be made at the contract unit price per linear foot (meter) for each type and size of pipe.
   b. Payment is full compensation for:
      - Trench excavation,
      - Dewatering,
      - Furnishing bedding material,
      - Placing bedding and backfill material,
      - Joint wrapping,
      - Connectors, and
      - Testing and inspection.

2. **Trenchless.**
   a. Payment will be made at the contract unit price per linear foot (meter) for each type and size of pipe.
   b. Payment is full compensation for:
      - Furnishing and installing pipe,
      - Trenchless installation materials and equipment,
      - Pit excavation, dewatering, and placing backfill material,
      - Pipe connections, and
      - Testing and inspection.

B. Storm Sewer with Casing Pipe.

1. **Trenched.**
   a. Payment will be made at the contract unit price per linear foot (meter) for each type and size of pipe.
   b. Payment is full compensation for:
      - Furnishing and installing both storm sewer pipe and casing pipe,
      - Trench excavation,
      - Dewatering,
      - Furnishing bedding material,
      - Placing bedding and backfill material,
      - Furnishing and installing annular space fill material,
      - Casing spacers,
      - Pipe connections, and
      - Testing and inspection.

2. **Trenchless.**
   a. Payment will be made at the contract unit price per linear foot (meter) for each type and size of storm sewer pipe.
   b. Payment is full compensation for:
      - Furnishing and installing both storm sewer pipe and casing pipe,
      - Trenchless installation materials and equipment,
      - Pit excavation, dewatering, and placing backfill material
      - Casing spacers,
      - Furnishing and installing annular space fill material,
      - Pipe connections,
      - Testing and inspection.

C. Removal of Storm Sewer.

1. Payment will be made at the contract unit price per linear foot (meter) for each type and size of pipe removed.

2. Payment is full compensation for removal, disposal, and capping (if specified) of pipe.

SECTION 4060 - CLEANING, INSPECTION, AND TESTING OF STORM SEWERS

4060.01 DESCRIPTION.
Clean, inspect, and test storm sewers.

4060.02 MATERIALS.
None.

4060.03 PROCESS.
Notify the Engineer at least 24 hours prior to performing testing. The Engineer must be present to review testing procedures and record results.

A. Cleaning.

1. Clean all storm sewers by flushing with high pressure water and removing debris by vacuum extraction, and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris.

2. Do not discharge soil sediment or debris to drainage channels, existing storm sewers, or existing sanitary sewers.

B. Visual Inspection.

1. Check each section of storm sewer by lamping.

2. Light should be visible through section of pipe lamped.

3. Visually inspect each run of pipe.

4. Repair or replace defective pipe or joints, or remove and relay pipe not meeting alignment tolerances, as directed by the Engineer.

C. Deflection Testing.

1. Perform deflection tests on all HDPE storm sewer 12 inches (300 mm) in diameter or greater.

2. Perform deflection tests after backfill has been in place at least 30 calendar days and before paving activity takes place, or as per appropriate sections of these specifications.

3. Pull a 9 arm deflection mandrel complying with applicable ASTM Standards through the sewer by hand.

4. Ensure pipe deflection does not exceed 5% of average inside diameter as established by ASTM Standards.

5. Remove and replace pipe exceeding deflection limits.

6. Handle and divert existing flows during deflection testing.

4060.04 METHOD OF MEASUREMENT.
None.

4060.05 BASIS OF PAYMENT.
Cleaning, inspection, and testing of storm sewers is incidental to other project costs and will not be paid for separately.

DIVISION 6. STRUCTURES FOR STORM SEWERS

SECTION 6010 - STRUCTURES FOR STORM SEWERS

6010.01 DESCRIPTION.

A. Construct storm sewer manholes to provide access to sewer systems for maintenance and cleaning purposes.

B. Construct storm sewer intakes for collection of surface water and conveyance to the storm sewer system.

C. Modify existing manholes and intakes as necessitated by other improvements adjacent to the manholes or intakes.

6010.02 MATERIALS.

A. Concrete.

1. Precast: Comply with ASTM C 478/C 478M.

2. Cast-in-place: Use Class C concrete. Comply with Section 2403 of the Standard Specifications.

B. Reinforcement.
Comply with Section 2404 of the Standard Specifications.

C. Non-shrink Grout.
Comply with Materials I.M. 491.13.

D. Precast Riser Joints.

1. Joint Ends.
a. Use tongue and groove ends.
b. If cast-in-place base is used, provide bottom riser with square bottom edge.

2. Joint Sealant.
a. Rubber Rope Gasket Jointing Material: Comply with ASTM C 990/C 990M.
b. Engineering Fabric Wrap: If required by contract documents, supply engineering fabric wrap complying with Article 4196.01, B of the Standard Specifications.

E. Manhole or Intake Top.
Capable of supporting HS-20 loading.

F. Base.

1. Manhole.
Use precast or cast-in-place concrete base.

2. Intake.
Use precast or cast-in-place concrete base.

G. Pipe Connections.
Comply with Article 6010.02, C.

H. Manhole or Intake Adjustment Rings (Grade Rings).

1. Use one of the following methods for grade adjustments of manhole or intake frame and cover assemblies:
a. Reinforced Concrete Adjustment Rings.
Comply with ASTM C 478/C 478M. Provide rings free from cracks, voids, and other defects.

b. High Density Polyethylene Adjustment Rings.
Comply with ASTM D 1248 for recycled plastic.

1) Test and certify material properties by the methods in Table 6010.02-1:

Table 6010.02-1: Test Methods

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g/10 minutes
Density	ASTM D 792	0.94 to 0.98 g/cm^3
Tensile Strength	ASTM D 638	2000 to 5000 lb/in^2 (14 to 35 MPa)

2) Do not use polyethylene grade adjustment rings when they are exposed to HMA pavement.

3) When used in a single configuration, provide tapered adjustment ring with thickness that varies from 1/2 inch to 3 inches (13 mm to 75 mm).

4) Install adjustment rings on clean, flat surfaces according to the manufacturer's recommendations with the proper butyl rubber sealant/adhesive.

2. Ensure the inside diameter of the adjustment ring is not less than the inside diameter of the manhole frame or not less than the inside dimension of the intake grate opening.

3. Construct manholes and intakes with the following adjustment ring stack heights:

a. Minimum: 4 inches (100 mm) for new manholes and intakes.

b. Maximum: 12 inches (300 mm) for new manholes and intakes; 16 inches (400 mm) for existing manholes.

I. Castings (Ring, Cover, Grate, and Extensions).

1. Gray Cast Iron.
Comply with AASHTO M 306.

2. Load Capacity.
Standard duty unless specified otherwise.

a. Standard Duty: Casting certified for 40,000 pound (18,150 kg) proof-load according to AASHTO M 306.

b. Light Duty: Casting certified according to requirements of AASHTO M 306 for a 16,000 pound (7260 kg) proof-load (HS-20). 40,000 pound (18,150 kg) proof-load is not required.

3. Casting Types.

a. Manholes.
Refer to the contract documents.

b. Intakes.

1) Refer to the contract documents.

2) Castings may include environmental symbols and/or messages such as “DUMP NO WASTE, DRAINS TO RIVER.”

c. Manhole Casting Extension Ring.

1) Match the dimensions of the existing ring and cover with an allowable diameter tolerance of -1/4 inch (6 mm) for the frame ridge and +1/4 inch (6 mm) for the cover recess.

2) Provide extension ring with height as required to raise the top of the casting to make it level or no more than 1/4 inch (6 mm) below the finished pavement surface. Maximum ring height is 3 inches (75 mm).

J. Invert.

1. Cast-in-place Base: Provide cast-in-place invert complying with concrete meeting the requirements of Section 2403 of the Standard Specifications.

2. **Precast Base Section:** Provide a precast invert with concrete meeting the requirements of Section 2403 of the Standard Specifications.

K. Steps.

1. Provide steps in all circular, precast manholes unless specified otherwise in the contract documents.

2. Comply with ASTM C 478/C 478M.

3. Manufacture using polypropylene encased steel.

L. Precast Concrete Tee.

1. **Tee and Eccentric Reducers.**
   Comply with ASTM C 478/C 478M.

2. **Composite Tee.**
   Refer to the contract documents. May be substituted for pipe diameters less than 48 inches (1200 mm).

M. Anchor Bolts.

1. Material: Stainless steel or hot-dipped galvanized.

2. Diameter: Minimum 1/2 inch (13 mm) diameter.

3. Length: As required to pass through adjustment rings and into manhole or intake structure to embedment depth recommended by anchor manufacturer.

N. Excavation and Backfill Materials.
Comply with Section 3010 for bedding and backfill materials.

6010.03 CONSTRUCTION.

A. General Requirements for Installation of Manholes and Intakes.

1. **Excavation.**
   Excavate according to Section 3010.

2. **Subgrade Preparation.**
   a. **Cut Sections (Undisturbed Soil):** Prepare subgrade to accurate elevation required to place structure base or subbase.
   b. **Fill Sections:** Compact to 95% of maximum Standard Proctor Density and hand grade to accurate elevation required to place structure base or subbase, or install stabilization material as directed by the Engineer.
   c. **Unstable Soil:** Install stabilization material as directed by the Engineer.

3. **Subbase.**
   a. **Cast-in-place Structures:** No subbase material is required.
   b. **Precast Structures:** If precast structure is provided, install 8 inch (200 mm) thick pad of Class I bedding material a minimum of 12 inches (300 mm) outside the footprint of the structure.

4. **Installation of Manhole or Intake Structure.**
   a. **Cast-in-place:** Apply Article 6010.03, B.
   b. **Precast:** Apply Article 6010.03, C.

5. **Steps.**
   a. Uniformly space steps at 12 to 16 inches (300 to 400 mm).
   b. Align with vertical side of eccentric top section.
   c. Place first step no more than 36 inches (900 mm) from top of casting.

6. **Pipes.**
   Install and bed pipes and connect to manhole or intake. Install pipe flush with inside wall of structure. Place bedding and pipe embedment material according to Section 3010.
   a. **Cast-in-place Structures.**
      Form structure walls around pipe.
   b. **Precast Storm Sewer Manholes or Intakes.**
      Fill space between pipe and structure with non-shrink grout.

7. **Joint Sealant.**
   a. Apply bituminous jointing material or install rubber rope gasket.
   b. If indicated in the contract documents, apply engineering fabric wrap to joints.

8. **Invert.**
   a. Construct manhole or intake invert up to one-half diameter to produce a smooth half-pipe shape between pipe inverts.
   b. Shape invert to provide a smooth transition between pipe inverts.
   c. Slope invert top toward pipe 1/2 inch per foot (40 mm per meter) perpendicular to flow line.
   d. For precast inverts, remove any projections and repair any voids to provide a hydraulically smooth channel between ends of pipes.

9. **Top Sections.**
   Install manhole eccentric cone or flat top section or install intake top.

10. **Adjustment Ring(s).**
    Bed each concrete ring with bituminous jointing material in trowelable or rope form. Bed each polyethylene ring with the manufacturer's approved product. Do not install more than a total ring stack height of 12 inches (300 mm). For greater adjustment, modify lower riser section(s).

11. **Casting.**
    Install the type of casting specified in the contract documents and adjust to proper grade. Where a manhole or intake is to be in a paved area, adjust the casting to match the slope of the finished surface. When specified in the contract documents, attach a casting frame to the structure with four anchor bolts.

12. **Backfill and Compaction.**
    a. Place suitable backfill material after concrete in structure has reached at least 3000 psi (21 MPa) compressive strength or 550 psi (3850 kPa) flexural strength. If concrete strength is not determined, place backfill at least 14 calendar days after initial concrete placement.
    b. Place backfill material simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times.
    c. Compact the 3 feet (1 m) closest to all walls for wing faces using pneumatic or hand tampers only. Ensure proper and uniform compaction of backfill around structure.

B. Additional Requirements for Cast-in-place Concrete Structures.

1. Forms.

a. Apply Article 2403.07, E of the Standard Specifications.

b. Form all cast-in-place manholes and intakes on both the inside and the outside face above the base. Do not form against excavated earthen surface.

2. Reinforcing Steel.

a. Apply Section 2404 of the Standard Specifications.

b. Lap bars a minimum of 36 diameters, unless specified otherwise in the contract documents.

c. Provide a minimum 3 inches (75 mm) of clearance for structure bases and a minimum 2 inches (50 mm) for walls and tops.

3. Concrete Mixing.

a. Apply Article 2403.06 of the Standard Specifications.

b. When using ready-mixed concrete, comply with ASTM C 94/C 94M.

4. Concrete Placing.

a. Apply Article 2403.08 of the Standard Specifications.

b. Do not place concrete when the air temperature is less than 40°F (5ºC) without the approval of the Engineer. When placement below 40ºF (5ºC) is allowed, apply Article 2403.11 of the Standard Specifications.

c. Place concrete continuously in each section until complete. Do not allow more than 30 minutes to elapse between depositing adjacent layers of concrete within each section.

d. Apply Article 2403.09 of the Standard Specifications for concrete vibration.

e. Form 1 1/2 inch by 3 inch (38 mm by 75 mm) keyed construction joints at locations shown in the contract documents.

f. Provide a broom finish on portions of structure that are to become part of exposed pavement.

5. Stripping and Cleaning.

a. Remove forms for manhole and intake walls and tops according to Article 2403.18 of the Standard Specifications. References to culverts include all storm structures. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used in determining concrete strength of structure tops.

b. Finish surfaces according to Article 2403.21 of the Standard Specifications. Give exposed surfaces a Class 2 finish.

6. Curing.

a. Apply Article 2403.10.

b. For surfaces visible to the public, use only curing compounds complying with ASTM C 309, Type 1-D or Type 2.

7. Exterior Loading.

a. Restrict exterior loads on concrete according to Article 2403.19 of the Standard Specifications.

b. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used.

8. Repairs.

After visual inspection of the completed manhole or intake, repair honeycomb areas, visible leaks, tie holes, or other damage areas. Remove concrete webs or protrusions.

C. Additional Requirements for Precast Concrete Structures.

1. **Substitutions.**
   Precast structures may be substituted for designated cast-in-place structures so long as structure is constructed as specified in the contract documents and according to Article 6010.03, B.

2. **Cast-in-place Base.**
   a. Apply Article 6010.03, B, for placement of concrete.
   b. Ensure proper vertical and horizontal alignment of base riser section.

3. **Precast Base or Base with Integral Riser Section.**
   Place base or base with integral riser section and ensure proper vertical and horizontal alignment.

4. **Additional Riser Sections.**
   Install additional riser sections as required.

5. **Lift Holes.**
   Install rubber plug in lift holes and cover plug and hole with non-shrink grout.

D. Adjustment of Existing Manhole or Intake.

1. **Casting Extension Rings.**
   a. Only install casting extension rings when allowed by the contract documents, and only in conjunction with pavement overlays.
   b. Install according to the manufacturer's recommendation and adjust for proper alignment.

2. **Minor Adjustment (Adding or Removing Adjustment Rings).**
   a. Remove casting.
   b. Modify adjustment ring stack height by one of the following methods:
      1) Add adjustment rings as necessary to adjust existing manhole or intake to finished pavement grade or finished topsoil grade, to a maximum ring stack height of 16 inches (400 mm). Bed each concrete ring with bituminous jointing material. Bed each polyethylene ring with manufacturer's approved product.
      2) Remove one or more adjustment rings, as appropriate, to reduce casting elevation.
   c. Install new casting on modified adjustment ring stack. Existing casting may be reinstalled when allowed by the contract documents.

3. **Major Adjustment (Adding, Removing, or Modifying Riser or Cone Section).**
   When adjustment is greater than can be accomplished through adding or removing adjustment rings, a major adjustment will be required.
   a. Remove casting.
   b. Remove top.
   c. Remove and replace or modify existing riser section or top section, or both, as appropriate.
   d. Install new frame and cover or grate. Existing casting may be reinstalled when allowed by the contract documents.

E. Connection to Existing Manhole or Intake.

1. Excavate as required.

2. Cut opening to manhole or intake to 3 to 6 inches (75 to 150 mm) beyond the outside of the pipe. Remove existing invert as necessary to install pipe at required elevation and develop hydraulic channel.

3. Position end of pipe flush with interior wall of manhole.

4. Fill opening between manhole wall and outside of pipe with non-shrink. Construct a concrete collar around the pipe.

5. Reconstruct invert according to Article 6010.02, J.

6. Place backfill material according to Section 3010.

6010.04 METHOD OF MEASURMENT.

A. Manhole.
Each type and size of manhole will be counted.

B. Intake.
Each type and size of intake will be counted.

C. Casting Extension Rings.
Each casting extension ring will be counted.

D. Manhole or Intake Adjustment, Minor.
Each existing manhole or intake adjusted to finished grade by addition or removal of adjustment rings or adjustment of adjustable casting will be counted.

E. Manhole or Intake Adjustment, Major.
Each existing manhole or intake adjusted to grade by addition or removal of riser, cone or flat top sections, or the exchange of existing riser sections with sections having different vertical dimensions will be counted.

F. Connection to Existing Storm Sewer Manhole or Intake.
Each connection made to an existing storm sewer manhole or intake will be counted.

6010.05 BASIS OF PAYMENT.

A. Manhole.

1. Payment will be at the contract unit price for each type and size of manhole.

2. Payment is full compensation for excavation, placing bedding and backfill material, compaction, base, structural concrete, reinforcing steel, precast units (if used), chimney seals, castings, and adjustment rings.

B. Intake.

1. Payment will be at the contract unit price for each type and size of intake.

2. Payment is full compensation for excavation, placing bedding and backfill material, compaction, base, structural concrete, reinforcing steel, precast units (if used), castings, adjustment rings, and all appurtenances necessary for proper installation.

C. Casting Extension Rings.
Payment will be at the unit price for each casting extension ring.

D. Manhole or Intake Adjustment, Minor.

1. Payment will be made at the contract unit price for each minor manhole or intake adjustment.

2. Payment is full compensation for:
- Removing existing casting and existing adjustment rings,
- Furnishing and installing adjustment rings, and
- Furnishing and installing new casting.

E. Manhole or Intake Adjustment, Major.

1. Payment will be at the contract unit price for each major adjustment.

2. Payment is full compensation for:
- Removal of existing casting, adjustment rings, top sections and risers,
- Excavation,
- Concrete and reinforcing steel or precast sections,
- Furnishing and installing new casting,
- Placing backfill material, and
- Compaction.

G. Connection to Existing Storm Sewer Manhole or Intake.

1. Payment will be made at the contract unit price for each sewer connection.

2. Payment is full compensation for cutting into the existing storm sewer manhole or intake, pipe connectors, and grout.

SECTION 6030 - CLEANING AND INSPECTION OF STRUCTURES

6030.01 DESCRIPTION.
Clean and inspect storm sewer manholes, intakes, and other utility structures.

6030.02 MATERIALS.
None.

6030.03 PROCESS.

A. Cleaning.

1. Clean all manholes, intakes, and structures by removing sheeting, bracing, shoring, forms, soil sediment, concrete waste, and other debris.

2. Do not discharge soil sediment or debris to drainage channels, existing storm sewers, or existing sanitary sewers.

B. Visual Inspection.

1. Examine structure for:
- **a.** Damage.
- **b.** Slipped forms.
- **c.** Indication of displacement of reinforcement.
- **d.** Porous areas or voids.
- **e.** Proper placement of seals, gaskets, and embedments.

2. Verify that the structure is set to true line, grade, and plumb.

3. Verify structure dimensions and thicknesses.

C. Repair.
Apply Article 6010.03, B, 8.

6030.04 METHOD OF MEASUREMENT.
None.

6030.05 BASIS OF PAYMENT.
Cleaning and inspection of storm sewer structures is incidental to the construction of the structure and will not be paid for separately.