

Division 7 Drainage Structures, Storm Sewers, Sanitary Sewers, Water Mains, and Conduits

7-01 Drains

7-01.1 Description

This Work consists of constructing drain pipe and underdrain pipe in accordance with the Plans, these Specifications and *Standard Plans*, at the locations staked.

7-01.2 Materials

Materials shall meet the requirements of the following sections:

Gravel Backfill for Drains	9-03.12(4)
Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Drain Pipe	9-05.1(2)
Corrugated Aluminum Alloy Drain Pipe	9-05.1(3)
Polyvinyl Chloride (PVC) Drain Pipe, Couplings and Fittings	9-05.1(5)
Corrugated Polyethylene (PE) Drain Pipe, Couplings and Fittings (up to 10 inch)	9-05.1(6)
Corrugated Polyethylene (PE) Drain Pipe, Couplings and Fittings (12 through 60 inch)	9-05.1(7)
Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Underdrain Pipe	9-05.2(4)
Perforated Corrugated Aluminum Alloy Underdrain Pipe	9-05.2(5)
Perforated Polyvinyl Chloride (PVC) Underdrain Pipe, 8-inch diameter maximum	9-05.2(6)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe (up to 10 inch)	9-05.2(7)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe (12 through 60 inch)	9-05.2(8)

Drain pipes may be concrete, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

Underdrain pipe, other than AASHTO M36 Type III Class IV, shall be perforated. They may be concrete, bituminized fiber, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

It is not necessary that all drain or underdrain pipes on any one project be of the same kind of material; however, all contiguous pipe shall be of the same kind.

7-01.3 Construction Requirements

A trench of the dimensions shown in the Plans or as specified by the Engineer shall be excavated to the grade and line given by the Engineer.

7-01.3(1) Drain Pipe

Drain pipe shall be laid in conformity with the line and grades as shown in the Plans. The drain pipe shall be laid with soil tight joints unless otherwise specified. PVC drain pipe shall be jointed with a bell and spigot joint using a flexible elastomeric seal as described in Section 9-04.8. The bell shall be laid upstream. PE drain pipe shall be jointed with snap-on, screw-on, bell and spigot, or wraparound coupling bands as recommended by the manufacturer of the tubing.

7-01.3(2) Underdrain Pipe

When underdrain pipe is being installed as a means of intercepting ground or surface water, the trench shall be fine-graded in the existing soil 3 inches below the grade of the pipe as shown in the Plans. Gravel backfill shall be used under the pipe. Gravel backfill shall be placed to the depth shown in the Plans or as designated by the Engineer. All backfill shall be placed in 12-inch maximum layers and be thoroughly compacted with three passes of a vibratory compactor for each layer. The Contractor shall use care in placing the gravel backfill material to prevent its contamination.

Class 2 perforations shall be used unless otherwise specified. When Class 1 perforations are specified the perforated pipe shall be laid with the perforations down. Upon final acceptance of the Work, all drain pipes shall be open, clean, and free draining. Perforated pipe does not require a watertight joint. PVC underdrain pipe shall be jointed using either the flexible elastomeric seal as described in Section 9-04.8 or solvent cement as described in Section 9-04.9, at the option of the Contractor unless otherwise specified in the Plans. The bell shall be laid upstream. PE drainage tubing underdrain pipe shall be jointed with snap-on, screw-on, bell and spigot, or wraparound coupling bands, as recommended by the manufacturer of the tubing.

7-01.4 Measurement

The length of drain or underdrain pipe will be the number of linear feet of completed installation measured along the invert. Pipe placed in excess of the length shown in the Plans will not be measured or paid for.

Excavation of the trench will be measured as Structure excavation Class B or Structure excavation Class B including haul by the cubic yard as specified in Section 2-09.

Gravel backfill for drains will be measured by the volume placed within the neatline limits of Structure excavation Class B.

7-01.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

- “Drain Pipe ____ In. Diam.”, per linear foot.
- “Underdrain Pipe ____ In. Diam.”, per linear foot.
- “Gravel Backfill for Drain”, per cubic yard.
- “Structure Excavation Class B”, per cubic yard.
- “Structure Excavation Class B Incl. Haul”, per cubic yard.

7-02 Culvert Pipe

7-02.1 Description

This Work consists of constructing culvert pipes of the various types and classes in accordance with the Plans, these Specifications, and the [Standard Plans](#), at the locations staked.

Culvert pipes may be used for transverse drains under the Roadway or as conduits for water pipe or other utilities passing under the Roadway.

7-02.2 Materials

Materials shall meet the requirements of the following sections:

Cement	9-01
Aggregates for Concrete	9-03.1
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)
Butyl Rubber Sealant	9-04.11
External Sealing Band	9-04.12
Plain Concrete Culvert Pipe	9-05.3(1)
Reinforced Concrete Culvert Pipe	9-05.3(2)
Mitered Concrete End Sections	9-05.3(3)
Steel Culvert Pipe and Pipe Arch	9-05.4
Steel Nestable Pipe and Pipe Arch	9-05.4(8)
Steel End Sections	9-05.4(9)
Aluminum Culvert Pipe	9-05.5
Aluminum End Sections	9-05.5(6)
Solid Wall PVC Culvert Pipe	9-05.12(1)
Profile Wall PVC Culvert Pipe	9-05.12(2)
Corrugated Polyethylene Culvert Pipe	9-05.19
Steel Rib Reinforced Polyethylene Culvert Pipe	9-05.21
High-Density Polyethylene (HDPE) Pipe	9-05.23
Polypropylene Culvert Pipe	9-05.24
Steel Reinforcing Bar	9-07.2
Epoxy-Coated Steel Reinforcing Bar	9-07.3
Welded Wire Reinforcement	9-07.7
Deformed Wire	9-07.8
Cold Drawn Wire	9-07.9
Grout	9-20.3(2)
Mortar	9-20.4
Concrete Curing Materials and Admixtures	9-23

Where steel or aluminum are referred to in this section in regard to a kind of culvert pipe, pipe arch, or end sections, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel, and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic culvert pipe includes solid wall PVC culvert pipe, profile wall PVC culvert pipe, corrugated polyethylene culvert pipe, steel rib reinforced polyethylene culvert pipe, high-density polyethylene (HDPE) pipe, and polypropylene culvert pipe.

It is not necessary that all culvert pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

Measurement for payment of the Bid items associated with the drainage installation will be based on the diameter of the culvert pipe described by the Bid item in the Proposal.

When schedule A, B, C, or D culvert pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Culvert Pipe Schedules Table.

The use of tongue and groove concrete pipe shall only be allowed under side road connections. All tongue and groove pipe shall be joined with cement mortar or butyl rubber sealant.

Culvert Pipe Schedules					
Schedule (Fill Height)	Diameter in inches	Concrete	Steel 2½" x ½"	Aluminum 2½" x ½"	Thermoplastic PE ¹ , PVC ² , or PP ³
A 2' - 15'	12, 18, 24	Class III	.064" (16 Ga.)	.060" (16 Ga.)	PE, PVC, or PP
	30, 36	Class III	.064" (16 Ga.)	.075" (14 Ga.)	PE, PVC, or PP
	42, 48	Class III	.064" (16 Ga.)	.105" (12 Ga.)	PE, PVC, or PP
B 15' - 25'	12, 18, 24	Class V	.064" (16 Ga.)	.060" (16 Ga.)	PE, PVC, or PP
	30, 36	Class IV	.064" (16 Ga.)	.075" (14 Ga.)	PE, PVC, or PP
	42, 48	Class IV	.064" (16 Ga.)	.105" (12 Ga.)	PE, PVC, or PP
C 25' - 40'	12, 18, 24	Class V	.064" (16 Ga.)	.060" (16 Ga.)	None
	30, 36	Class V	.064" (16 Ga.)	.075" (14 Ga.)	None
	42, 48	Class V	.064" (16 Ga.)	.105" (12 Ga.)	None
D 40' - 60'	12, 18	None	.064" (16 Ga.)	.060" (16 Ga.)	None
	24	None	.064" (16 Ga.)	.075" (14 Ga.)	None
	30, 36	None	.064" (16 Ga.)	.105" (12 Ga.)	None
	42, 48	None	.079" (14 Ga.)	.135" (10 Ga.)	None

¹Corrugated polyethylene pipe.

²Polyvinyl chloride pipe. Solid wall or profile wall for diameters through 27 inches Profile wall for diameters larger than 27 inches.

³Polypropylene pipe, 12 inch to 30 inch diameters approved for Schedule A and Schedule B, and 36 inch to 60 inch diameters approved for Schedule A only.

7-02.3 Construction Requirements

Culvert pipes shall be constructed in accordance with Section 7-08.3.

7-02.3(1) Placing Culvert Pipe - General

A dike or plug of impervious material shall be placed near the intake end of the culvert pipe to prevent piping. The dike shall be 2 feet long and adequately surround the pipe to form an impervious barrier. When suitable impervious materials are not available at the site, suitable backfill shall be obtained as provided in Section 2-09.3(1)E.

The ends of the pipe or pipe arch shall be rigidly supported to prevent movement before and during the construction of end walls or headers.

Culvert pipes shall not be left extending beyond the staked limits unless approved by the Engineer.

For pipes 30-inches and less in diameter, the ends shall be mitered in accordance with the [Standard Plans](#).

7-02.3(2) Installation of Metal End Sections

Metal end sections shall be installed in accordance with the requirements of the *Standard Plans*, the Plans, and applicable portions of these Specifications.

When flared metal end sections are installed on concrete pipe, Design B end sections will be used on the inlet end only. Design C end sections will be used on the outlet ends only according to the following schedule:

Concrete Pipe Nominal Dia. in inches	End Section Nominal Dia. in inches
12	15
18	24
24	30
30	36
36	42
42	48
48	60
54	66
60	72
66	78
72	84

7-02.3(3) Headwalls

If headwalls are specified in the Plans, they shall be constructed as soon as the embankment has been completed to a sufficient height over the Structure to allow the required Work. Headwalls shall be constructed in accordance with applicable portions of Section 6-02.

7-02.3(4) Removing and Relaying Culvert Pipes

Where shown in the Plans or where designated by the Engineer, existing culvert pipes shall be removed and relaid in accordance with these Specifications. All culvert pipe damaged by the Contractor's operations shall be replaced by the Contractor at no expense to the Contracting Agency. In the case of concrete pipe, all joints of the pipe before being relaid shall be cleaned so as to be free from all adhering material, including old mortar placed as a collar or seal in the original construction.

All culvert pipe sections removed and not relaid shall become the property of the Contractor.

7-02.3(5) Safety Bars for Culvert Pipe

When shown in the Plans, safety bars for culvert pipe shall be constructed in accordance with the *Standard Plans* and shall meet the requirements of Section 9-05.18.

7-02.4 Measurement

The length of culvert pipe or pipe arch will be the number of linear feet of completed installation measured along the invert.

Mitered end sections will be considered as part of the culvert pipe and shall be measured as culvert pipes.

Flared end sections will be measured by each completed end section.

The pipe connector section of end section Design A shall be fabricated as a part of the integral unit of the end section but will be measured as linear feet of pipe or pipe arch of the treatment, thickness and dimensions of pipe to which it is attached. If there is no Bid item for pipe of the proper dimensions for the end sections, the pipe connector sections will be considered as part of the integral unit and will not be measured as pipe.

The length of safety bars for culvert pipe will be the number of linear feet of each safety bar installed.

Tapered end section with safety bars will be measured by the unit per each.

7-02.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

“Schedule ____ Culv. Pipe ____ In. Diam.”, per linear foot.

“Plain Conc. Culv. Pipe ____ In. Diam.”, per linear feet.

“Cl. ____ Reinf. Conc. Culv. Pipe ____ In. Diam.”, per linear foot.

“Plain St. Culv. Pipe ____ In. Th. ____ In. Diam.”, per linear foot.

“Tr. ____ St. Culv. Pipe ____ In. Th. ____ In. Diam.”, per linear foot.

“Plain St. Culv. Pipe Arch ____ In. Th. ____ In. Span”, per linear foot.

“Tr. ____ St. Culv. Pipe Arch ____ In. Th. ____ In. Span”, per linear foot.

“Plain Nestable St. Pipe ____ In. Th. ____ In. Diam.”, per linear foot.

“Tr. ____ Nestable St. Pipe ____ In. Th. ____ In. Diam.”, per linear foot.

“Plain Al. Culv. Pipe ____ In. Th. ____ In. Diam.”, per linear foot.

“Plain Al. Culv. Pipe Arch ____ In. Th. ____ In. Span”, per linear foot.

“Relaying (type of Pipe and Size)”, per linear foot.

“Solid Wall PVC Culv. Pipe ____ In. Diam.”, per linear foot.

“Profile Wall PVC Culv. Pipe ____ In. Diam.”, per linear foot.

“Corrugated Polyethylene Culv. Pipe ____ In. Diam.”, per linear foot.

“St. Rib Reinf Polyethylene Culv. Pipe ____ In. Diam.”, per linear foot.

“High-Density Polyethylene (HDPE) Pipe ____ In. Diam.”, per linear foot.

“Polypropylene Culvert Pipe ____ In. Diam.”, per linear foot.

Where culvert pipes are to be removed but are not to be relaid, all costs in connection with the removal shall be included in the unit Contract price per cubic yard for “Structure Excavation Class B” or “Structure Excavation Class B Incl. Haul”.

“Flared End Section ____ In. Diam.”, per each.

“Flared End Section ____ In. Span”, per each.

“Safety Bars for Culvert Pipe Type _____”, per linear foot.

“Tapered End Sect. with Type ____ Safety Bars ____ In. Diam.”, per each.

7-03 Vacant

7-04 Storm Sewers

7-04.1 Description

This Work consists of constructing storm sewer lines in accordance with the Plans, these Specifications, and the [Standard Plans](#), as staked.

7-04.2 Materials

Materials shall meet the requirements of the following sections:

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Steel Spiral Rib Storm Sewer Pipe	9-05.9
Steel Storm Sewer Pipe	9-05.10
Aluminum Storm Sewer Pipe	9-05.11
Solid Wall PVC Storm Sewer Pipe	9-05.12(1)
Profile Wall PVC Storm Sewer Pipe	9-05.12(2)
Aluminum Spiral Rib Storm Sewer Pipe	9-05.17
Corrugated Polyethylene Storm Sewer Pipe	9-05.20
Steel Rib Reinforced Polyethylene Storm Sewer Pipe	9-05.22
High-Density Polyethylene (HDPE) Pipe	9-05.23
Polypropylene Storm Sewer Pipe	9-05.24

Where steel or aluminum are referred to in this section in regard to a kind of storm sewer pipe, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic storm sewer pipe includes solid wall PVC storm sewer pipe, profile wall PVC storm sewer pipe, corrugated polyethylene storm sewer pipe, steel rib reinforced polyethylene storm sewer pipe, high-density polyethylene (HDPE) pipe, and polypropylene storm sewer pipe.

Measurement for payment of the Bid items associated with the storm sewer installation will be based on the diameter of the storm sewer pipe described by the Bid item in the Plans.

It is not necessary that all storm sewer pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

When schedule A or B storm sewer pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Storm Sewer Pipe Schedules Table. Concrete pipe shall be considered rigid. All other stated pipe materials shall be considered flexible.

7-04.3 Construction Requirements

Storm sewers shall be constructed in accordance with Section 7-08.3.

7-04.3(1) Cleaning and Testing

7-04.3(1)A General

The requirements of Section 7-17.3(2)A shall apply to storm sewers.

7-04.3(1)B Exfiltration Test – Storm Sewers

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls.

Leakage shall be no more than 1 gallon per hour per inch of diameter per 100 feet of storm sewer pipe, with a minimum test pressure of 6 feet of water column above the

crown at the upper end of the pipe or above the active ground water table, whichever is higher as determined by the Engineer. The length of pipe tested shall be limited so that the pressure on the invert of the lower end of the Section tested shall not exceed 16 feet of water column. For each increase in pressure of 2 feet above a basic 6 feet measured above the crown at the lower end of the test section, the allowable leakage shall be increased by 10 percent.

Storm Sewer Pipe Schedules							
Schedules (Fill Ht.)	Dia. (In.)	Concrete	PVC ¹	PE ² PP ⁴	Steel ³ 2 2/3" x 1/2" or Spiral Rib	Aluminum	
						2 2/3" x 1/2" Corr. • Tr. 5 • Plain With Gasketed Seams	Spiral Rib • Tr. 5 • Plain With Gasketed Seams
A 2' - 15'	12	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	18	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	24	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	30	Class III	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.060" (16 Ga.)
	36	Class III	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.060" (16 Ga.)
	42	Class III	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.075" (14 Ga.)
	48	Class III	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.075" (14 Ga.)
B 15' - 25'	12	Class V	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	18	Class V	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	24	Class V	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	30	Class V	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.075" (14 Ga.)
	36	Class V	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.105" (12 Ga.)
	42	Class V	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.105" (12 Ga.)
	48	Class V	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.105" (12 Ga.)

¹PVC = Polyvinyl Chloride Pipe, SW = Solid Wall PVC, PW = Profile Wall PVC

²PE = Corrugated Polyethylene Pipe

³Steel pipe options for either 2 2/3" x 1/2" corrugations or spiral rib include: Tr. 5 galvanized, Tr. 2 galvanized with gasketed seams, Tr. 5 aluminized, or plain aluminized with gasketed seams.

⁴PP = Polypropylene Pipe, 12 inch to 30 inch approved for Schedule A and Schedule B and 36 inch to 60 inch diameters approved for Schedule A only.

7-04.3(1)C Infiltration Test – Storm Sewers

Whenever the ground water table is above the crown of the higher end of the pipe section at the time of testing, an infiltration test may be performed in lieu of the exfiltration test upon written permission of the Engineer. The maximum allowable limit for infiltration shall be 0.8 gallon per hour per inch of diameter per 100 feet of length with no allowance for external hydrostatic head.

7-04.3(1)D Other Test Allowances – Storm Sewers

Other allowances for infiltration and exfiltration tests shall be in accordance with Section 7-17.3(2)D.

7-04.3(1)E Low Pressure Air Test for Storm Sewers Constructed of Air Permeable Materials

When air permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than the required time as shown in the table below:

Time in Seconds for Pressure Drop										
Pipe Dia. (in)	Pipe Length (ft)									
	50	100	150	200	250	300	350	400	450	500
4	5	9	14	18	22	27	31	36	40	45
6	10	20	30	40	50	60	70	80	85	85
8	18	36	54	71	89	107	114	114	114	114
10	28	56	84	111	139	142	142	142	143	159
12	40	80	120	160	170	170	170	183	206	228
15	63	125	188	213	213	214	250	286	320	360
18	90	180	255	255	257	310	360	410	460	520
21	123	245	298	298	350	420	490	560	630	700
24	160	320	340	370	460	550	640	730	830	920
27	203	390	390	460	580	700	810	930	1040	1160
30	250	430	430	570	720	860	1000	1140	1290	1430

All time values listed in the table are in seconds. If a section to be tested includes more than one pipe size, the total time required can be found by adding the time values for each size of pipe and its corresponding length. Interpolate between values for pipe lengths not shown.

Pipe over 30 inches in diameter shall be tested one joint at a time in accordance with ASTM C1103.

7-04.3(1)F Low Pressure Air Test for Storm Sewers Constructed of Non Air Permeable Materials

When non air permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than four times the time shown in the table listed in Section 7-04.3(1)E.

Pipe over 30 inches in diameter shall be tested one joint at a time in accordance with ASTM C1103.

Reaches of thermoplastic pipe containing no joints shall be exempt from testing requirements.

7-04.4 Measurement

The length of storm sewer pipe will be the number of linear feet of completed installation measured along the invert and will include the length through elbows, tees, and fittings. The number of linear feet will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type Structures.

The length of testing storm sewer pipe in conformance with Section 7-17.3(2)A will be the number of linear feet of completed installation actually tested inclusive of all tests.

7-04.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

- "Plain Conc. Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "Class ____ Reinf. Conc. Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "Tr. ____ St. Storm Sewer Pipe ____ In. Th. ____ In. Diam.", per linear foot.
- "Tr. ____ Al. Storm Sewer Pipe ____ In. Th. ____ In. Diam.", per linear foot.
- "Solid Wall PVC Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "Profile Wall PVC Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "Corrugated Polyethylene Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "Schedule ____ Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "St. Rib Reinf Polyethylene Storm Sewer Pipe ____ In. Diam.", per linear foot.
- "High-Density Polyethylene (HDPE) Pipe ____ In. Diam.", per linear foot.
- "Polypropylene Storm Sewer Pipe ____ In. Diam.", per linear foot.

The unit Contract price per linear foot for storm sewer pipe of the kind and size specified shall be full pay for all Work to complete the installation, including adjustment of inverts to manholes.

- "Testing Storm Sewer Pipe", per linear foot.

7-05 Manholes, Inlets, Catch Basins, and Drywells

7-05.1 Description

This Work consists of constructing manholes, inlets, drywells, and catch basins and connecting to existing drainage structures of the types and sizes designated in accordance with the Plans, these Specifications, and the [Standard Plans](#), in conformity with the lines and grades staked.

7-05.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Crushed Surfacing Base Course	9-03.9(3)
Gravel Backfill for Drywells	9-03.12(5)
Rubber Gaskets	9-04.4
Flexible Plastic Gaskets	9-04.5
Metal Castings	9-05.15
Grate Inlets and Drop Inlets	9-05.16
Reinforcing Steel	9-07
Concrete Blocks	9-12.1
Concrete Brick	9-12.2
Precast Concrete Manhole	9-05.50(2)
Precast Concrete Catch Basins	9-05.50(3)
Precast Concrete Inlets	9-05.50(4)
Precast Concrete Drywells	9-05.50(5)
Underground Drainage Geotextile, Moderate Survivability	9-33.1
Mortar	9-20.4

7-05.3 Construction Requirements

The excavation for all manholes, inlets, and catch basins shall be sufficient to leave 1 foot in the clear between their outer surfaces and the earth bank.

The excavation for drywells shall be in accordance with the [Standard Plans](#). The drywell and gravel backfill for drywell shall be completely encased in moderate survivability underground drainage geotextile in accordance with the [Standard Plans](#) and in conformance with Section 2-12.3. During construction of the drywell, all necessary precautions shall be taken to prevent debris and eroded material from entering the drywell.

The cover or grating of a manhole, catch basin, or inlet shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the Engineer to grout the cover or grating in place. Covers shall be seated properly to prevent rocking. Leveling and adjustment devices that do not modify the structural integrity of the metal frame, grate or cover, and do not void the originating foundry's compliance to these specifications and warranty are allowed. Leveling and adjusting devices that interfere with the backfilling, backfill density, grouting and asphalt density will not be allowed. The hardware for leveling and adjusting devices shall be completely removed when specified by the Engineer.

The channels in manholes shall conform accurately to the sewer grade.

Ladder rungs shall be grouted in the precast concrete walls. Rungs shall be uniformly spaced at 12 inches and be vertically aligned.

In the event any pipe enters the manhole through the precast concrete units, the Contractor shall make the necessary cut through the manhole wall and steel mesh. The steel shall be cut flush with the face of the concrete and shall be cut in such a manner that it will not loosen the reinforcement in the manhole wall.

The ends of all pipes shall be trimmed flush with the inside walls.

Rubber gaskets or flexible plastic gaskets may be used in tongue and groove joints of precast units. Joints between precast manhole units used for sanitary sewers shall be rubber gasketed. All other joints and all openings cut through the walls shall be grouted and watertight. Mortar shall conform to the requirements of Section 9-20.4(3).

If gaskets are used, handling of the precast units after the gasket has been affixed shall be done carefully to avoid disturbing or damaging the gasket or contaminating it with foreign material. Care shall be exercised to attain proper alignment before the joints are entirely forced home. During insertion of the tongue or spigot, the units shall be partially supported to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned.

Rigid pipes connecting to sanitary sewer manholes shall be provided with a flexible joint at a distance from the face of the manhole of not more than $1\frac{1}{2}$ times the nominal pipe diameter or 18 inches, whichever is greater.

Flexible pipes as listed in Sections 7-04.2 and 7-17.2, connecting to either sanitary sewer manholes or drainage structures shall be provided with an entry coupling or gasket approved by the Engineer. No pipe joint in flexible pipe shall be placed within 10 feet of the sanitary sewer manhole or drainage structure.

Backfilling around the Work will not be allowed until the concrete or mortar has thoroughly set.

Catch basins, manholes, and inlets shall be watertight.

Catch basin, grate inlet, and drop inlet connections to a sewer shall be so placed that the connecting pipe may be easily rodded over its entire length. After the connections are made, the Contractor shall rod all inlet and outlet pipes. All connections that cannot be successfully rodded shall be removed and new connections made.

Backfilling of manholes, inlets, catch basins, and drywells shall be done in accordance with the provisions of Section 2-09.

Manholes, catch basins, inlets, and drywells shall be constructed on a compacted or undisturbed level foundation. If the Contractor elects to use a separate cast-in-place base, the concrete shall be Class 4000. Upon final acceptance of the Work, all manholes, catch basins, inlets, drywells, and other drainage Structures shall conform to the requirements of the [Standard Plans](#) except as approved by the Engineer.

Any shoring or extra excavation required shall meet the requirements of Section 2-09.3.

See Section 7-08 for pipe connection requirements.

7-05.3(1) Adjusting Manholes and Catch Basins to Grade

Where shown in the Plans or where directed by the Engineer, the existing manholes, catch basins, or inlets shall be adjusted to the grade as staked or otherwise designated by the Engineer.

The existing cast iron ring and cover on manholes and the catch basin and inlet frame and grate shall first be removed and thoroughly cleaned for reinstalling at the new elevation. From that point, the existing Structure shall be raised or lowered to the required elevation. The materials and method of construction shall conform to the requirements specified above, and the finished Structure shall conform to the requirements of the [Standard Plans](#) except as approved by the Engineer.

7-05.3(2) Abandon Existing Manholes

Where it is required that an existing manhole be abandoned, the Structure shall be broken down to a depth of at least 4 feet below the revised surface elevation, all connections plugged, and the manhole filled with sand and compacted to 90 percent density as specified in Section 2-03.3(14)C. Debris resulting from breaking the upper part of the manhole may be mixed with the sand subject to the approval of the Engineer. The ring and cover shall be salvaged and all other surplus material disposed of.

7-05.3(3) Connections to Existing Manholes

The Contractor shall verify invert elevations prior to construction. The crown elevation of laterals shall be the same as the crown elevation of the incoming pipe unless specified. The existing base shall be reshaped to provide a channel equivalent to that specified for a new manhole.

The Contractor shall excavate completely around the manhole to prevent unbalanced loading. The manhole shall be kept in operation at all times and the necessary precautions shall be taken to prevent debris or other material from entering the sewer, including a tight pipeline bypass through the existing channel if required. Water used for flushing and testing shall not be allowed to enter the sewer.

All damage to the manhole resulting from the Contractor's operation shall be repaired at no expense to the Contracting Agency.

7-05.3(4) Drop Manhole Connection

Drop manhole connections shall be constructed in accordance with the Plans. One length of ductile iron pipe shall be provided outside the manhole.

7-05.4 Measurement

Manholes will be measured per each. In addition to the measurement per each, manholes in excess of 10 feet in height will be measured per linear foot for each additional foot of height over 10 feet. Measurement of manhole heights for payment purposes will be the distance from the flow line of the outlet pipe to the top of the manhole ring measured to the nearest foot.

Catch basins and inlets, will be measured per each.

Adjustment of manholes, catch basins, and inlets will be per each.

Structure excavation Class B and Structure excavation Class B including haul will be measured by the cubic yard as specified in Section 2-09.

Abandon existing manholes will be measured per each.

Connections to existing drainage structures will be measured per each.

Shoring or extra excavation will be measured as specified in Section 2-09.4.

Drop manhole connections will be measured per each.

Precast concrete drywell will be measured per each.

7-05.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

"Manhole ____ In. Diam. Type ____", per each.

"Manhole Additional Height ____ In. Diam. Type ____", per linear foot.

"Catch Basin Type ____", per each.

"Catch Basin Type 2 ____ In. Diam.", per each.

"Grate Inlet Type ____", per each.

"Drop Inlet Type ____", per each.

"Concrete Inlet", per each

All costs associated with furnishing and installing gravel backfill for bedding manholes, inlets and catch basins shall be included in the unit Contract price for the item installed.

"Precast Concrete Drywell", per each.

The unit Contract price per each for "Precast Concrete Drywell" shall be full pay for furnishing and installing the drywell, including all Structure excavation, gravel backfill for drywell, crushed surfacing base course, and drainage geotextile.

"Combination Inlet", per each.

All costs associated with furnishing and installing gravel backfill for bedding manholes, inlets, and catch basins shall be in the unit Contract price for the item installed.

"Adjust Manhole", per each.

"Adjust Catch Basin", per each.

"Adjust Inlet, per each.

The unit Contract price per each for "Adjust Manhole", "Adjust Catch Basin", or "Adjust Inlet" shall be full pay for all costs necessary to make the adjustment including restoration of adjacent areas in a manner acceptable to the Engineer.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

Structure excavation for concrete inlets is considered incidental to the cost of the inlets and shall be included in the unit Contract price for the concrete inlet.

"Abandon Existing Manhole", per each.

"Connection to Drainage Structure", per each.

All costs associated with connecting to an existing drainage structure shall be in the unit Contract price for each connection.

Payment for connections to existing pipes shall be included in the unit Contract prices for the drain, culvert, or storm sewer pipes.

"Shoring or Extra Excavation Class B", per square foot.

"Drop Manhole Connection", per each.

The price paid per drop connection is in addition to the price paid for manholes and for the specified sewer pipe that is replaced with ductile iron pipe.

7-06 Vacant

7-07 Cleaning Existing Drainage Structures**7-07.1 Description**

This Work consists of cleaning, removing, and disposing of all debris and obstructions from existing culvert pipes, storm sewer pipes, drains, inlet Structures, manholes, box culverts, grates, trash racks, or other drainage features within the limits of the project.

7-07.2 Vacant**7-07.3 Construction Requirements**

All pipes and drainage Structures that require cleaning are identified in the Plans. They shall be cleaned by flushing, rodding, or whatever means are necessary to provide unobstructed drainage. All catch basin sumps, manholes, inlet and outlet Structures, and debris racks shall also be freed of all dirt, rock, and debris. Existing drainage facilities shall be cleaned as a first order of Work to enhance natural drainage off and through the project. They shall be kept clean throughout the life of the project and be clean upon final acceptance of the Work.

Material to be removed shall be disposed of in the following manner:

1. Structures specifically noted in the Contract that are suspected to contain contaminated sediment shall be disposed of at a licensed disposal facility.
2. While performing the Work, if drainage water and/or soil appear oily, exhibit an unusual color or odor, or if staining or corrosion is observed, the Contractor shall stop work and immediately notify the Engineer. Additional work necessary in handling materials shall be in accordance with Section 1-04.4.
3. If sediment and water from structures does not meet the conditions described in 1 or 2 above, material may be placed in an upland area with no possibility of surface runoff to waters of the State, including wetlands.

While performing the Work, the Contractor shall implement all necessary best management practices and measures to meet the conditions of Section 1-07.5.

7-07.4 Vacant**7-07.5 Payment**

Payment will be made for the following Bid item when it is included in the Proposal:

“Cleaning Existing Drainage Structure”, lump sum.

The lump sum Contract price for “Cleaning Existing Drainage Structure” shall be full pay for performing all Work as specified. In the event the Contract does not include a Bid item for cleaning existing drainage Structure, such Work, if required, shall be performed by the Contractor in accordance with Section 1-04.4.

7-08 General Pipe Installation Requirements**7-08.1 Description**

This Work includes installing culverts, storm sewers, and sanitary sewers. The Contractor shall also follow Section 7-02, 7-04, or 7-17 as it applies to the specific kind of Work.

7-08.2 Materials

Gravel Backfill for Foundations	9-03.12(1)
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)

7-08.3 Construction Requirements**7-08.3(1) Excavation and Preparation of Trench****7-08.3(1)A Trenches**

The length of trench excavation in advance of pipe laying shall be kept to a minimum. Excavations shall either be closed up at the end of the day or protected per Section 1-07.23(1).

The trench width shall be as specified in Section 2-09.4 and shall be excavated to the depth and grade as staked by the Engineer.

Trenches must be of sufficient width in the pipe zone to permit proper installation and bedding of the pipe and to provide the required compaction of backfill. Above the top of the pipe zone, the Contractor may excavate to any width.

All ledgerrock, boulders, and stones shall be removed to provide a minimum of 6 inches clearance under all portions of the pipe.

Placement of bedding material shall precede the installation of all pipe. This shall include necessary leveling of the native trench bottom or the top of the foundation material as well as placement and compaction of required bedding material to a uniform grade so that the entire length of pipe will be supported on a uniformly dense unyielding foundation.

When, after excavating to the foundation level, the material remaining in the trench bottom is determined to be unsuitable by the Engineer, excavation shall be continued to such additional depth and width as required by the Engineer. Unsuitable foundation materials shall be disposed of at an approved site. The trench foundation shall be backfilled to the bottom of the pipe zone with gravel backfill for foundations, gravel backfill for pipe zone bedding, or other suitable material, and compacted to form a uniformly dense, unyielding foundation.

All material excavated from trenches and piled adjacent to the trench shall be maintained so that the toe of the slope is at least 2 feet from the edge of the trench. It shall be piled to cause a minimum of inconvenience to public travel, and provision shall be made for merging traffic where necessary. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable free flow of storm water in gutters, conduits, or natural watercourses.

If any part of the excavated material meets the Specifications of Section 9-03.12(3), the Engineer may require that such material, in the quantity required, be selectively removed, stockpiled separately, and used as pipe bedding instead of quantities of gravel backfill for pipe zone bedding. If material so stockpiled becomes contaminated, the Contractor shall furnish suitable material in an amount equal to that lost by contamination at no expense to the Contracting Agency. All costs involved in storing, protecting, re-handling, and placing the material shall be included in other items of Work on the project.

Excavation for manholes and other Structures connected to the pipelines shall be sufficient to provide a minimum of 12 inches between their surfaces and the sides of the excavation.

The Contractor shall furnish, install, and operate all necessary equipment to keep excavations above the foundation level free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property or nuisance to the public. Sufficient pumping equipment in good working condition shall be available at all times for all emergencies, including power outage, and shall have available at all times competent workers for the operation of the pumping equipment.

Where pipe is to be placed in a new embankment, the embankment shall be constructed as shown in the Plans or as designated by the Engineer for a distance each side of the pipe location of not less than five times the diameter and to a minimum height equal to $\frac{1}{2}$ of the outside diameter of the pipe. The embankment material shall be compacted to 95 percent of maximum density and the moisture content at the time of compaction shall be between optimum and 3 percentage points below optimum as determined by the Compaction Control Tests specified in Section 2-03.3(14)D. The trench shall then be excavated to a width as specified in Section 2-09.4, and the pipe installed in accordance with the [Standard Plans](#).

7-08.3(1)B Shoring

The Contractor shall provide all materials, labor, and equipment necessary to shore trenches to protect the Work, existing property, utilities, pavement, etc., and to provide safe working conditions in the trench. The Contractor may elect to use any combination of shoring and overbreak, tunneling, boring, sliding trench shield, or other method of accomplishing the Work consistent with applicable local, State, or Federal safety codes.

If workers enter any trench or other excavation 4 feet or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

Upon completing the Work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

Shoring to be removed, or moveable trench shields or boxes, shall be located at least $2\frac{1}{2}$ pipe diameters away from metal or thermoplastic pipe if the bottom of the shoring, shield, or box extends below the top of the pipe, unless a satisfactory means of reconsolidating the bedding or side support material disturbed by shoring removal can be demonstrated.

Damages resulting from improper shoring or failure to shore shall be the sole responsibility of the Contractor.

7-08.3(1)C Bedding the Pipe

Pipe zone bedding material shall provide uniform support along the entire pipe barrel, without load concentration at joint collars or bells. All adjustment to line and grade shall be made by scraping away or filling in with bedding material under the body of the pipe and not by blocking or wedging. Bedding disturbed by pipe movement, or by removal of shoring movement of a trench shield or box, shall be reconsolidated prior to backfill.

Pipe zone bedding shall be as specified in the [Standard Plans](#) and shall be compacted to 90 percent maximum density. Bedding shall be placed, spread, and compacted before the pipe is installed so that the pipe is uniformly supported along the barrel. Lifts of not more than 6 inches in thickness shall be placed and compacted along the sides of the pipe to the height shown in the [Standard Plans](#). Material shall be worked carefully under the pipe haunches and then compacted.

If the Engineer determines that the material existing in the bottom of the trench is satisfactory for bedding the pipe, the bedding material specified in the [Standard Plans](#) is not required, provided the existing material is loosened, regraded, and compacted to form a dense, unyielding base.

7-08.3(2) Laying Pipe**7-08.3(2)A Survey Line and Grade**

Survey line and grade control hubs will be placed in a manner consistent with accepted practices.

The Contractor shall transfer line and grade into the trench where they shall be carried by means of a laser beam or taut grade line supported on firmly set batter boards at intervals of not more than 30 feet. Not less than three batter boards shall be in use at one time. Grades shall be constantly checked and in the event the batter boards do not line up, the Work shall be immediately stopped, the Engineer notified, and the cause remedied before proceeding with the Work. Any other procedure shall have the written approval of the Engineer.

7-08.3(2)B Pipe Laying – General

After an accurate grade line has been established, the pipe shall be laid in conformity with the established line and grade in the properly dewatered trench. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces.

All pipe laid in the trench to the specified line and grade shall be kept in longitudinal compression until the backfill has been compacted to the crown of the pipe. All pipe shall be laid to conform to the prescribed line and grade shown in the Plans, within the limits that follow.

Pipe shall be laid to a true line and grade at the invert of the pipe and the Contractor shall exercise care in matching pipe joints for concentricity and compatibility. In no case shall two pipes be joined together with ends having the maximum manufacturer's tolerance. The invert line may vary from the true line and grade within the limits stated to develop uniformity, concentricity, and uniform compression of jointing material provided such variance does not result in a reverse sloping invert. The limit of the variance at the invert shall not exceed plus or minus 0.03 feet at the time of backfill. Checking of the invert elevation of the pipe may be made by calculations from measurements on the top of the pipe.

The pipe, unless otherwise approved by the Engineer, shall be laid up grade from point of connection on the existing pipe or from a designated starting point. The pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug.

Where pipe joints must be deflected within the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, it shall first be joined in straight alignment and then deflected as required.

Where pipe joints must be deflected to an amount greater than the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, the curves shall be achieved with a series of tangents and shop fabricated bends, subject to the approval of the Engineer.

Upon final acceptance of the Work, all pipe and appurtenances shall be open, clean, and free draining.

7-08.3(2)C Pipe Laying – Concrete

For concrete pipe with elliptical reinforcement, the markings indicating the minor axis of the reinforcement shall be placed in a vertical plane (top or bottom) when the pipe is laid.

7-08.3(2)D Pipe Laying – Steel or Aluminum

Pipe with riveted or resistance spot welded seams shall be laid in the trench with the outside laps of circumferential joints upgrade and with longitudinal laps positioned other than in the invert, and firmly joined together with approved bands.

Aluminum pipe or pipe arch used in cement concrete shall be painted with two coats of paint. The paint shall cover all the surfaces in contact with the cement concrete and extend one inch beyond the point of contact. The aluminum pipe to be painted shall be cleaned with solvent to remove contaminants. After cleaning, the pipe shall be painted with two coats of paint conforming to Federal Specification TT-P-645 (primer, paint, zinc chromate, alkyd vehicle). Aluminized steel pipe will not require painting when placed in Controlled Density Fill (CDF) or when in contact concrete head walls.

All costs of cleaning and painting the aluminum surfaces as specified shall be included in the unit Contract price per linear foot for the aluminum pipe or pipe arch.

7-08.3(2)E Rubber Gasketed Joints

In laying pipe with rubber gaskets, the pipe shall be handled carefully to avoid knocking the gasket out of position or contaminating it with foreign material. Any gasket so disturbed shall be removed, cleaned, relubricated if required, and replaced before joining the sections.

The pipe shall be properly aligned before joints are forced home. Sufficient pressure shall be applied in making the joint to ensure that the joint is home, as defined in the standard installation instructions provided by the pipe manufacturer. The Contractor may use any method acceptable to the Engineer for pulling the pipe together, except that driving or ramming by hand or machinery will not be permitted. Any pipe damaged during joining and joint tightening shall be removed and replaced at no expense to the Contracting Agency.

Care shall be taken to properly align the pipe before joints are entirely forced home. During insertion of the tongue or spigot, the pipe shall be partially supported by hand, sling or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since most gasketed joints tend to creep apart when the end of the pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.

Sufficient restraint shall be applied to the line to ensure that joints once home are held so by compacting backfill material under and alongside the pipe or by other acceptable means. At the end of the work day, the last pipe shall be blocked in such a manner as may be required to prevent creep.

7-08.3(2)F Plugs and Connections

Plugs for pipe branches, stubs, or other open ends which are not to be immediately connected shall be made of an approved material and shall be secured in a place with a joint comparable to the main line joint, or stoppers may be of an integrally cast breakout design.

7-08.3(2)G Jointing of Dissimilar Pipe

Dissimilar pipe shall be jointed by use of a factory-fabricated adapter coupling or a pipe collar as detailed in the [Standard Plans](#).

7-08.3(2)H Sewer Line Connections

Storm and sanitary sewer line connections to trunks, mains, laterals, or side sewers shall be left uncovered until after the Engineer has inspected and approved the Work. After approval of the connection, the trench shall be backfilled as specified.

7-08.3(2)I Side Sewer Connections

Where a storm or sanitary side sewer is larger than the trunk, main, or lateral to which it is to be connected, the connection shall be made only at a standard manhole unless otherwise provided in the Plans or in the Special Provisions, or unless otherwise authorized by the Engineer.

7-08.3(3) Backfilling

Placement of pipe zone backfill shall be performed in accordance with these requirements and the [Standard Plans](#). Trenches shall be backfilled as soon after the pipe laying as possible.

Pipe zone backfill material shall be clean earth or sand, free from clay, frozen lumps, roots, or moisture in excess of that permitting required compaction. Rocks or lumps larger than 3 inches maximum shall not be used for pipe zone backfill.

Pipe zone backfill shall be placed in loose layers and compacted to 90 percent maximum density. Backfill shall be brought up simultaneously on each side of the pipe to the top of the pipe zone. The pipe shall then be covered to the top of the pipe zone and the materials compacted in a manner to avoid damaging or disturbing the completed pipe.

Backfill above the pipe zone shall be accomplished in such a manner that the pipe will not be shifted out of position nor damaged by impact or overloading. If pipe is being placed in a new embankment, backfill above the pipe zone shall be placed in accordance with Section 2-03.3(14)C. If pipe is being placed under existing paved areas, or Roadways, backfill above the pipe zone shall be placed in horizontal layers no more than 6 inches thick and compacted to 95 percent maximum density. If pipe is being placed in non-traffic areas, backfill above the pipe zone shall be placed in horizontal layers no more than 6 inches thick and shall be compacted to 85 percent maximum density. All compaction shall be in accordance with the Compaction Control Test of Section 2-03.3(14)D, except in the case that 100% Recycled Concrete Aggregate is used. When 100% Recycled Concrete Aggregate is used, the Contractor may submit a written request to use a test point evaluation for compaction acceptance. Test Point evaluation shall be performed in accordance with SOP 738. Material excavated from the trench shall be used for backfill above the pipe zone, except that organic material, frozen lumps, wood, rocks, or pavement chunks larger than 6 inches in maximum dimension shall not be used. Materials determined by the Engineer to be unsuitable for backfill at the time of excavation shall be removed and replaced with imported backfill material.

Backfilling of trenches in the vicinity of catch basins, manholes, or other appurtenances will not be permitted until the cement in the masonry has become thoroughly hardened.

When it is required that a blanket of select material or bank run gravel is to be placed on top of the native backfill, the backfill shall be placed to the elevations shown in the Plans, or to the elevations specified by the Engineer. Compaction of the native material shall be as required by the Contracting Agency and shall be performed prior to placing the select material. Surface material shall be loosened to whatever depth is required to prevent bridging of the top layer, but shall in no case be less than 18 inches.

The Contractor shall not operate tractors or other heavy equipment over the top of the pipe until the backfill has reached a height of 3 feet above the top of the pipe.

7-08.3(4) Plugging Existing Pipe

Where shown in the Plans or where designated by the Engineer, existing pipes shall be plugged on the inlet end for a distance of 2 diameters with commercial concrete. Care shall be used in placing the concrete in the pipe to see that the opening of the pipe is completely filled and thoroughly plugged.

7-08.4 Measurement

Gravel backfill for foundations, or gravel backfill for pipe zone bedding when included in the Proposal, shall be measured by the cubic yard, including haul, as specified in Section 2-09.

Plugging pipes will be measured per each, for each plug installed, for pipe diameters up to and including 36 inches. The concrete for plugging pipes in excess of 36 inches in diameter will be measured by the cubic yard. Computations for corrugated metal pipes will be based on the nominal diameter.

Excavation of the trench will be measured as Structure excavation Class B or Structure excavation Class B including haul, by the cubic yard as specified in Section 2-09. When excavation below grade is necessary, excavation will be measured to the limits ordered by the Engineer.

Embankment construction before pipe placement under the applicable provisions of Section 7-08.3(1)A will be measured in accordance with Section 2-03.

Shoring or extra excavation class B will be measured as specified in Section 2-09.4.

7-08.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

“Gravel Backfill for Foundations Class ____”, per cubic yard.

“Gravel Backfill for Pipe Zone Bedding”, per cubic yard.

All costs associated with furnishing and installing bedding and backfill material within the pipe zone in the installation of culvert, storm sewer, and sanitary sewer pipes shall be included in the unit Contract price for the type and size of pipe installed.

“Plugging Existing Pipe”, per each.

“Commercial Concrete”, per cubic yard.

“Structure Excavation Class B”, per cubic yard.

“Structure Excavation Class B Incl. Haul”, per cubic yard.

“Shoring or Extra Excavation Class B”, per square foot.

All costs in jointing dissimilar pipe with a coupling or concrete collar shall be included in the unit Contract price per foot for the size and type of pipe being jointed.

7-09 Water Mains**7-09.1 Description**

This Work consists of constructing water mains 16 inches in diameter and smaller in accordance with the Plans, these *Standard Specifications*, the Special Provisions and the *Standard Plans*, at the location shown on the Plans.

7-09.1(1) Definitions**7-09.1(1)A Trench Widths**

Trench width is from trench wall to trench wall, outside of shoring.

7-09.1(1)B Unsuitable Material

Material removed because it is unsatisfactory for foundations is defined as unsuitable foundation material.

Material removed in trenching which is unsuitable for replacement in the backfill is defined as unsuitable backfill material.

7-09.1(1)C Gravel Backfill for Pipe Zone Bedding

Gravel backfill for pipe zone bedding is the method or material used to transmit load from the pipe into the foundation or into the sidewall support.

7-09.1(1)D Pipe Zone Backfill

Pipe zone backfill includes material placed above the gravel backfill for pipe zone bedding up to the depths shown on the *Standard Plans*.

7-09.1(1)E Trench Backfill

Trench backfill includes materials placed above the pipe zone backfill. Trench backfill within the Roadway prism shall extend up to the underside of the pavement or surfacing materials. Trench backfill outside the Roadway prism shall extend up to original ground or finished grade.

7-09.2 Materials

Materials shall meet the requirements of the following sections:

Pipe for main line:	9-30.1
Ductile Iron Pipe	9-30.1(1)
Steel Pipe (6 inches and over)	9-30.1(4)A
Polyvinyl Chloride (PVC) Pressure Pipe (4 inches and over)	9-30.1(5)A
Polyvinyl Chloride (PVC) Pressure Pipe (under 4 inches)	9-30.1(5)B
Polyethylene (PE) Pressure Pipe (4 inches and over)	9-30.1(6)
Fittings for Main Lines:	9-30.2
Ductile Iron Pipe	9-30.2(1)
Steel Pipe (6 inches and over)	9-30.2(4)A
Polyvinyl Chloride (PVC) Pipe (4 inches and over)	9-30.2(5)A
Polyvinyl Chloride (PVC) Pipe (under 4 inches)	9-30.2(5)B
Restrained Joints	9-30.2(6)
Bolted, Sleeve-Type Couplings for Plain End Pipe	9-30.2(7)
Restrained Flexible Couplings	9-30.2(8)
Grooved and Shouldered Joints	9-30.2(9)
Polyethylene (PE) Pipe (4 inches and over)	9-30.2(10)
Fabricated Steel Mechanical Slip-Type Expansion Joints	9-30.2(11)

Appurtenances:

Concrete Blocking	6-02.3(2)B
Detectable Marking Tape	9-15.18
Blow Off Assemblies	9-30.1, 9-30.2, 9-30.3, 9-30.6
Polyethylene Encasement	9-30.1(2)
Steel Pipe (4 inches and under)	9-30.1(4)B
Fittings for Steel Pipe (4 inches and under)	9-30.2(4)B

Aggregates:

Foundation Material	9-03.17, 9-03.18
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)
Pipe Zone Backfill	9-03.19
Trench Backfill	9-03.15 or 9-03.19

It is not intended that materials listed herein are to be necessarily considered equal or generally interchangeable for all applications. Those suitable for the project shall be specified in the Special Provisions or shown on the Plans.

The pipe manufacturer shall test all pipe and fittings as required by these *Standard Specifications* and the standards referenced. The Contractor shall submit Type 1 Working Drawings consisting of all test results from the pipe manufacturer including a written certification that material to be delivered is represented by the samples tested and that such delivered materials meet or exceed the specified requirements. No pipe shall be delivered until test results and certifications are in the hands of the Engineer.

The Engineer shall have free access to all testing and records pertaining to material to be delivered to the job site. The Engineer may elect to be present at any or all material testing operations.

The basis of acceptance shall be a certificate of compliance as described in Section 1-06.3, accompanied by two copies of pressure test results of the pipe or fittings involved.

7-09.3 Construction Requirements**7-09.3(1) General**

Trench excavation required for the installation of water mains and appurtenances shall be unclassified. Material excavated from trenches and piled adjacent to the trench or in a Roadway or public thoroughfare shall be piled and maintained so that the toe of the slope of the spoil material is at least 2 feet from the edge of the trench. It shall be piled in a manner to prevent surface water from flowing into the excavation and in a manner that will cause a minimum of inconvenience to public travel. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable the free flow of storm water in gutters, conduits, and natural watercourses.

7-09.3(2) Ungraded Streets

On ungraded streets, when grading is not called for in the Contract, the depth of trench excavation shall be as shown on the Plans and as staked.

Where the Plans show the pipe is to be laid above the existing ground surface, an embankment fill shall be made and compacted to conform with the section shown on the Plans, and the water main trench shall be excavated therein. That portion of the embankment below the bottom of the pipe shall be compacted with rollers or mechanical compactors under controlled moisture conditions as required under Method B of Section 2-03.3(14)C.

7-09.3(3) Clearing and Grubbing in Ungraded Streets

On ungraded streets, where clearing and grubbing is not called for in the Contract, the area to be excavated or filled shall be cleared and grubbed by the Contractor. This Work shall consist of the removal and disposal of logs, stumps, roots, brush, and other refuse within 5 feet of the centerline of the pipe. Such material shall be disposed of in accordance with the Special Provisions.

7-09.3(4) Removal of Existing Street Improvements

Removal of existing street improvements and pavement from driveways and sidewalks shall be performed as specified in Section 2-02. Stockpiling of waste materials along the trench shall not be allowed.

7-09.3(5) Grade and Alignment

The location of blow off assemblies and combination air release/air vacuum valves are shown on the Plans.

The Contractor shall verify the locations and establish the depth of the existing water mains at the points where connections are to be made prior to trenching for the pipelines. The profile shall be adjusted so no new high spots or low spots are created between the connection points to the existing water mains.

The depth of trenching for water mains shall be such as to give a minimum cover of 36 inches over the top of the pipe unless otherwise specified in the Special Provisions. Deeper excavation may be required due to localized breaks in grade, or to install the new main under existing culverts or other utilities where necessary. Where the profile of the pipeline and the ground surface is shown on the Plans, the pipeline shall be laid to the elevation shown regardless of depth. The excavation shall be to such depth that the minimum cover over valve operating nuts shall be 1 foot.

7-09.3(6) Existing Utilities

Existing utilities of record, except services, are shown on the Plans. These are shown for convenience only, and the Engineer assumes no responsibility for improper locations or failure to show utility locations on the Plans.

When utility services occupy the same space as the new water main, the Contractor shall complete necessary excavation to fully expose such services. The Contractor shall protect said services, and work around them during excavating and pipe laying operations. Any damages to services resulting from the Contractor's operation shall be reported to the appropriate utility. Such damage shall be repaired at the Contractor's expense.

7-09.3(7) Trench Excavation

The Contractor shall perform excavation of every description and in whatever materials encountered to the depth indicated on the Plans or specified in the Special Provisions. Excavations shall be made by open cut unless otherwise provided for. Trenches shall be excavated to true and smooth bottom grades and in accordance with the lines given by the Engineer or shown on the Plans. The trench bottom shall provide uniform bearing and support for each length of pipe.

Bell holes shall be excavated to the extent necessary to permit accurate Work in making and inspecting the joints. The banks of the trenches shall be kept as nearly vertical as soil conditions will permit, and where required to control trench width or to protect adjacent Structures, the trench shall be sheeted and braced. Trench widths to 1 foot above the top of the pipe shall not exceed 30 inches maximum or $1\frac{1}{2}$ times the outside diameter of the pipe plus 18 inches whichever is greater. Standard excavating equipment shall be adjusted so as to excavate the narrowest trench possible.

The length of trench excavation in advance of pipe laying shall be kept to a minimum. Excavations shall be either closed up at the end of the day or protected per Section 1-07.23(1).

The Contractor shall exercise sound engineering and construction practices in excavating the trench and maintaining the trench so that no damage will occur to any foundation, Structure, pole line, pipe line, or other facility because of slough or slopes, or from any other cause. If, as a result of the excavation, there is disturbance of the ground, which may endanger other property, the Contractor shall immediately take remedial action at no additional expense to the Contracting Agency. No act, representation, or instruction of the Engineer shall in any way relieve the Contractor from liability for damages or costs that result from trench excavation.

Care shall be taken not to excavate below the depth specified. Excavation below that depth shall be backfilled with foundation material and compacted as specified herein.

If workers have to enter any trench or other excavation 4 feet or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

Upon completing the Work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

7-09.3(7)A Dewatering of Trench

Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Trench water or other deleterious materials shall not be allowed to enter the pipe at any time.

7-09.3(7)B Rock Excavation

Rock excavation shall cover the removal and disposal of rock that requires systematic drilling and blasting for its removal, and also boulders exceeding $\frac{1}{2}$ cubic yard. Ledge rock, boulders, or stones shall be removed to provide a minimum clearance of 4 inches under the pipe.

Hardpan, hard clay, glacial till, sandstone, siltstone, shale, or other sedimentary rocks, which are soft, weathered, or extensively fissured will not be classified as rock excavation. Rock is defined as one that has a modulus of elasticity of more than 200,000 psi or unconfined compressive strength at field moisture content of more than 2,000 psi.

Materials removed shall be replaced with gravel backfill for pipe zone bedding, pipe zone backfill or trench backfill as designated by the Engineer.

7-09.3(7)C Extra Trench Excavation

Changes in grades of the water main from those shown on the Plans, or as provided in the Special Provisions, may be necessary because of unexpected utilities, or for other reasons. If, in the opinion of the Engineer, it is necessary to adjust, correct, relocate, or in any way change the line and grade, such changes shall be made by the Contractor under the terms of these *Standard Specifications*.

When pipeline grade is lowered in excess of 1 foot below the grade indicated on the Plans, the Contractor shall make such extra excavation as necessary.

When the pipeline horizontal alignment is changed by more than 1 foot from the line indicated on the Plans, after the trench has been excavated, the Contractor shall excavate the trench at the changed location and backfill and compact the previous trench.

Additional excavation so required will be classified as extra trench excavation.

7-09.3(8) Removal and Replacement of Unsuitable Materials

Whenever in excavating the trench for water mains, the bottom of the trench exposes peat, soft clay, quicksand, or other unsuitable foundation material, such material shall be removed to the depth directed by the Engineer and backfilled with foundation material. When determined by the Engineer that silty soils or fine sandy soils are encountered, Class C foundation material shall be required. Silty soils or fine sandy soils usually flow in the presence of a stream of water. When determined by the Engineer that clay, peat, or other soft materials are encountered that become saturated with water, but do not break down into fine particles and flow, Class A or Class B foundation material shall be required.

Material removed from the trench that is unsuitable for trench backfill shall be removed and hauled to a waste site. If material is not available within the limits of the project for backfilling the trench, the Contractor shall furnish trench backfill meeting the requirements of Section 9-03.12(3) or 9-03.19 as required.

Unsuitable material shall be loaded directly into trucks and hauled to a waste site obtained by the Contractor. Stockpiling of unsuitable material at the project site shall not be allowed.

7-09.3(9) Bedding the Pipe

Gravel backfill for pipe zone bedding shall be select granular material free from wood waste, organic material, and other extraneous or objectionable materials and shall have a maximum dimension of 1½ inches. Gravel backfill for pipe zone bedding shall be placed to the depths shown in the [Standard Plans](#). Gravel backfill for pipe zone bedding shall be rammed and tamped around the pipe to 95 percent of maximum density by approved hand-held tools, so as to provide firm and uniform support for the full length of the pipe, valves, and fittings. Care shall be taken to prevent any damage to the pipe or its protective coating.

7-09.3(10) Backfilling Trenches

Prior to backfilling, form lumber and debris shall be removed from the trench. Sheeting used by the Contractor shall be removed just ahead of the backfilling.

Backfill up to 12 inches over the top of the pipe shall be evenly and carefully placed. Materials capable of damaging the pipe or its coating shall be removed from the backfill material. The remainder of the material shall be placed by dumping into the trench by any method at the option of the Contractor, and shall be compacted as specified hereinafter.

A minimum 3 inch sand cushion shall be placed between the water main and existing pipelines or other conduits when encountered during construction.

7-09.3(11) Compaction of Backfill

Backfill shall be compacted to at least 95 percent of maximum density as specified in Section 2-03.3(14)D.

At locations where paved streets, Roadway Shoulders, driveways, or sidewalks will be constructed or reconstructed over the trench, the backfill shall be spread in layers and be compacted by mechanical tampers. In such cases, the backfill material shall be placed in successive layers not exceeding 6 inches in loose thickness, and each layer shall be compacted with mechanical tampers to the density specified herein. Mechanical tampers shall be of the impact type as approved by the Engineer.

7-09.3(12) General Pipe Installation

Pipe shall be installed in accordance with the manufacturer's printed Specifications and instructions, and to the standards of the AWWA for installing the type of pipe used. The Contractor shall provide tools and equipment, including any special tools required for installing each particular type of pipe used.

Short lengths of pipe supplied by the manufacturer shall be used whenever possible to provide the proper spacing of valves, tees, or special fittings.

7-09.3(13) Handling of Pipe

Pipe shall be handled in a manner that will prevent damage to the pipe, pipe lining, or coating. Pipe and fittings shall be loaded and unloaded using hoists and slings in a manner to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled against other pipe. If any part of the coating or lining is damaged, repair thereof shall be made by the Contractor at no additional expense to the Contracting Agency and in a manner satisfactory to the Engineer. Damaged pipe shall be rejected, and the Contractor shall immediately place damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.

Threaded pipe ends shall be protected by couplings or other means until laid.

Pipe and fittings shall be inspected for defects.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations, and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned, and re-laid. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the Engineer to ensure cleanliness inside the pipe.

7-09.3(14) Cutting Pipe

Whenever it becomes necessary to cut a length of pipe, the cut shall be made by abrasive saw or by a special pipe cutter. Pipe ends shall be square with the longitudinal axis of the pipe and shall be reamed and otherwise smoothed so that good connections can be made. Threads shall be cleanly cut. Oxyacetylene torch cutting of ductile iron pipe shall not be allowed.

7-09.3(15) Laying of Pipe on Curves**7-09.3(15)A Ductile Iron Pipe**

Long radius curves, either horizontal or vertical, may be laid with standard pipe lengths by deflecting the joints. If the pipe is shown curved on the Plans and no special fittings are shown, the Contractor can assume that the curves can be made by deflecting the joints with standard lengths of pipe. If shorter lengths are required, the Plans will indicate maximum lengths that can be used. The amount of deflection at each pipe joint when pipe is laid on a horizontal or vertical curve shall not exceed the manufacturer's printed recommended deflections.

Where field conditions require deflection or curves not anticipated by the Plans, the Engineer will determine the methods to be used. No additional payment will be made for laying pipe on curves as shown on the Plans, or for field changes involving standard lengths of pipe deflected at the joints. When special fittings not shown on the Plans are required to meet field conditions, additional payment will be made for special fittings as provided in Section 1-09.6.

When rubber gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. Trenches shall be made wider on curves for this purpose.

7-09.3(15)B Polyvinyl Chloride (PVC) Pipe (4 inches and Over)

PVC pipe may be bent to allow for slight changes in direction. The minimum bending radius shall be as follows:

Size	Minimum Bending Radius
4 inch	125 feet
6 inch	175 feet
8 inch	225 feet
10 inch	275 feet
12 inch	325 feet
14 inch	400 feet

Axial deflection at the pipe joints shall not be allowed.

For 16-inch diameter pipe, changes in direction may be accomplished by axial deflection of the pipe joint. The maximum axial deflection allowed at each joint is 1 degree. For changes in direction greater than 1 degree per pipe joint, fittings shall be used.

7-09.3(16) Cleaning and Assembling Joint

The pipe ends, couplings, fittings, and appurtenances shall be cleaned to remove oil, grit, or other foreign matter from the joint. Care shall be taken to keep the joint from contacting the ground.

Pipe not furnished with a depth mark shall be marked before assembly to ensure visual observation of the Work.

7-09.3(17) Laying Ductile Iron Pipe With Polyethylene Encasement

Where shown on the Plans, the Contractor shall lay ductile iron pipe with a polyethylene encasement. Pipe and polyethylene encasement shall be installed in accordance with AWWA C105.

7-09.3(18) Coupled Pipe 4 inches in Diameter and Larger

Joints for steel pipe shall be bell and spigot or welded as specified in the Special Provisions.

Component parts of couplings, rings, and bells shall receive a protective coating in the same manner as specified for the steel pipe. Bolts and nuts, exposed edges, and flanges shall, after installation, be covered with coal-tar protective coating conforming to AWWA C203 or other coating approved by the Engineer.

Steel pipe 4 inches and larger for aboveground service shall be coupled with flanges, compression type or grooved type couplings.

Pipe for outdoor service above ground shall be protected with a coal-tar protective coating conforming to AWWA C203 or other coating approved by the Engineer.

7-09.3(19) Connections**7-09.3(19)A Connections to Existing Mains**

Connections to the existing water main shall not be made without first making the necessary scheduling arrangements with the Engineer in advance. Work shall not be started until all the materials, equipment, and labor necessary to properly complete the Work are assembled on the site.

Existing water mains shall be cut by the Contractor unless otherwise specified in the Special Provisions. The Contractor shall remove the portions of pipe to provide for the installation of the required fittings at the points of connection. Damage caused by the Contractor's operations to existing joints in piping to remain in-service shall be repaired

by the Contractor at no additional expense to the Contracting Agency. The Contractor shall determine the exact length of the existing water main that must be removed. The pipe ends shall be beveled to prevent damage to the transition coupling gasket during installation of the coupling. The exterior of the existing pipe end shall be cleaned to a sound, smooth finish before installation of the coupling.

Transition couplings shall be installed by the Contractor and shall be provided with a plastic film wrap. The plastic film wrap shall be wrapped loosely around the pipe, fittings, and couplings, and secured with 2-inch-wide polyethylene adhesive tape. Pipelines in which the couplings are installed shall be wrapped a minimum of 3 feet on each side of the coupling. Joints or seams in the plastic film wrap shall be made using the 2-inch-wide polyethylene adhesive tape. The plastic film wrap need not be watertight, but no part of the pipe or coupling shall be exposed to the backfill. Care shall be exercised during backfilling to prevent the plastic film wrap from being punctured or otherwise damaged. Plastic film wrap and its installation shall conform to AWWA C105 except as modified herein.

Once Work is started on a connection, it shall proceed continuously without interruption and as rapidly as possible until completed. No shutoff of mains will be permitted overnight, over weekends, or on holidays.

If the connection to the existing system involves turning off the water, the Contractor shall be responsible for notifying the residents affected by the shutoff. The Engineer will advise which property owners are to be notified.

The Contractor may be required to perform the connection during times other than normal working hours. The Contractor shall not operate any valves on the existing system without specific permission of the Engineer.

The types of connections are varied and suggested piping arrangements have been shown on the Plans. For the installation of these connections, the surfaced portion of the Roadway shall not be penetrated unless the connecting point is directly under it. For connection by any other method, the Contractor shall furnish a detailed sketch for approval not less than 2 weeks prior to the expected construction.

7-09.3(19)B Maintaining Service

Where existing services are to be transferred from old to new mains, the Contractor shall plan and coordinate its Work with that of the Utility so that service will be resumed with the least possible inconvenience to customers.

To supply customers with water during the construction of a water main project where any section of the pipe has passed satisfactory hydrostatic and bacteriological tests, the Utility reserves the right to tap corporation stops into the section of new pipe and install service connections at such locations as the Utility may elect. The installation of any such service connections by the Utility shall not be construed by the Contractor as an acceptance by the Contracting Agency of any part of the Work required under the Contract.

7-09.3(20) Detectable Marking Tape

Detectable marking tape shall be installed over nonmetallic water lines including services lines. The tape shall be placed approximately 1 foot above the top of the line and shall extend its full length. Detectable marking tape shall meet the requirements of Section 9-15.18.

7-09.3(21) Concrete Thrust Blocking

Concrete thrust blocking, as detailed on the Plans, shall be placed at bends, tees, dead ends, and crosses. Blocking shall be commercial concrete meeting the requirement of Section 6-02.3(2)B poured in place.

Concrete blocking shall bear against solid undisturbed earth at the sides and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints of the pipe or fittings.

7-09.3(22) Blowoff Assemblies

Blowoff Assemblies shall be constructed at the locations shown on the Plans and in accordance with the [Standard Plans](#).

7-09.3(23) Hydrostatic Pressure Test

Water main appurtenances and service connections to the meter setter shall be tested in sections of convenient length under a hydrostatic pressure equal to 150 psi in excess of that under which they will operate or in no case shall the test pressure be less than 225 psi. Pumps, gauges, plugs, saddles, corporation stops, miscellaneous hose and piping, and measuring equipment necessary for performing the test shall be furnished and operated by the Contractor.

Sections to be tested shall normally be limited to 1,500 feet. The Engineer may require that the first section of pipe, not less than 1,000 feet in length, installed by each of the Contractor's crews, be tested in order to qualify the crew and the materials. Pipe laying shall not be continued more than an additional 1,000 feet until the first section has been tested successfully.

The pipeline shall be backfilled sufficiently to prevent movement of the pipe under pressure. Thrust blocks shall be in place and time allowed for the concrete to cure before testing. Where permanent blocking is not required, the Contractor shall furnish and install temporary blocking and remove it after testing.

The mains shall be filled with water and allowed to stand under pressure a sufficient length of time to allow the escape of air and allow the lining of the pipe to absorb water. The Contracting Agency will furnish the water necessary to fill the pipelines for testing purposes at a time of day when sufficient quantities of water are available for normal system operation.

The test shall be accomplished by pumping the main up to the required pressure, stopping the pump for 15 minutes, and then pumping the main up to the test pressure again. During the test, the section being tested shall be observed to detect any visible leakage.

A clean container shall be used for holding water for pumping up pressure on the main being tested. This makeup water shall be sterilized by the addition of chlorine to a concentration of 50 mg/l.

The quantity of water required to restore the pressure shall be accurately determined by pumping through a positive displacement water meter. The meter shall be approved by the Engineer. Acceptability of the test will be determined as follows:

$$L = \frac{SD\sqrt{P}}{266,400}$$

The quantity of water lost from the main shall not exceed the number of gallons per hour as determined by the formula:

Where:

- L = allowable leakage, gallons/hour
- D = nominal diameter of the pipe in inches
- P = test pressure during the leakage test (psi)
- S = gross length of pipe tested, feet

There shall not be an appreciable or abrupt loss in pressure during the 15-minute test period.

Pressure gauges used in the test shall be accompanied with certifications of accuracy from a testing Laboratory approved by the Engineer.

Any visible leakage detected shall be corrected by the Contractor regardless of the allowable leakage specified above. Should the tested section fail to meet the pressure test successfully as specified, the Contractor shall, at no additional expense to the Contracting Agency, locate and repair the defects and then retest the pipeline.

Tests shall be made with the hydrant auxiliary gate valves open and pressure against the hydrant valve. Each valve shall be tested by closing each in turn and relieving the pressure beyond. This test of the valve will be acceptable if there is no immediate loss of pressure on the gauge when the pressure comes against the valve being checked. The Contractor shall verify that the pressure differential across the valve does not exceed the rated working pressure of the valve.

Prior to calling out the Engineer to witness the pressure test, the Contractor shall have all equipment set up completely ready for operation and shall have successfully performed the test to ensure that the pipe is in satisfactory condition.

Defective materials or Work, discovered as a result of hydrostatic field test, shall be replaced by the Contractor at no additional expense to the Contracting Agency. Whenever it is necessary to replace defective material or correct the Work, the hydrostatic test shall be re-run at the Contractor's expense until a satisfactory test is obtained.

7-09.3(23)A Testing Extensions From Existing Mains

When an existing water main is extended with new pipe to a new valve and the distance from the existing pipe to the new valve is 18 feet or less, the section of new pipe installed between the new valve and the end of the existing main shall be made with pretested, prechlorinated pipe, and no hydrostatic test will be required. When the required hydrostatic tests are conducted in the new main section beyond the installed new valve in the closed position, the normal pressure of the existing main may be present against the other side of the new valve.

Where the distance between the end of an existing water main pipe extension to the new valve is more than 18 feet, the connection of the new pipe to existing pipe shall not be made until after hydrostatic tests have been made to the required pressure in both directions against the new valve. This shall be accomplished by a temporary cap or plug installed on the end of the new pipe, beyond the new valve, as close as possible to the existing pipe for testing purposes.

The short length of pipe between the temporary cap or plug end with the new valve in the closed position, with no hydrostatic pressure active on the opposite side of the valve, shall be subjected to the required test pressure. The same test shall be made against the other side of the new valve when that section of pipe is tested with no hydrostatic pressure active in the short section of pipe toward the existing main. The final connection to the existing main shall be made with pretested prechlorinated pipe.

7-09.3(23)B Testing Section With Hydrants Installed

When hydrants are included with the section of main pipe to be tested, the testing shall be conducted in three separate tests as follows:

Test No. 1 - Water main gate valves and hydrant auxiliary gate valves closed, with the hydrant operating stem valves and hose ports wide open.

Test No. 2 - Water main gate valves and the hydrant operating the stem valves tightly closed but the hydrant auxiliary gate valves and hose ports wide open.

Test No. 3 - Each hydrant shall be tested to the pressure indicated in Section 7-09.3(23) with the hydrant auxiliary gate valve and hose ports closed and the hydrant operating stem valve wide open.

7-09.3(23)C Testing Hydrants Installed on Existing Mains

For hydrants installed and connected to an existing main, the hydrant connection including hydrant tee, connection pipe, and auxiliary gate valves, shall be installed with pretested materials.

Before the hydrant connection is made to the existing main, the hydrant installation shall be subjected to the hydrostatic Test No. 3 as specified in Section 7-09.3(23)B. Hydrants installed and connected to an existing main shall have a satisfactory bacteriological sample obtained following the hydrostatic test.

7-09.3(24) Disinfection of Water Mains

Before being placed into service, new water mains and repaired portions of, or extensions to, existing mains shall be chlorinated and a satisfactory bacteriological report obtained. In the event two unsatisfactory bacteriological reports are obtained on a section of pipe, the Contractor shall revise his method of disinfection and the form of applied chlorine.

7-09.3(24)A Flushing

Sections of pipe to be disinfected shall first be flushed to remove any solids or contaminated material that may have become lodged in the pipe. If a hydrant is not installed at the end of the main, then a tap shall be provided large enough to develop a flow velocity of at least 2.5 fps in the water main.

Taps required by the Contractor for temporary or permanent release of air, chlorination or flushing purposes shall be provided by the Contractor as part of the construction of water mains.

Where dry calcium hypochlorite is used for disinfection of the pipe, flushing shall be done after disinfection.

The Contractor shall be responsible for disposal of treated water flushed from mains and shall neutralize the wastewater for protection of aquatic life in the receiving water before disposal into any natural drainage channel, i.e., receiving water, waters of the State, including wetlands. The Contractor shall be responsible for disposing of disinfecting solution to the satisfaction of the Contracting Agency and local authorities. At a minimum, chlorinated water shall be dechlorinated to a concentration of 0.1 parts per million (ppm) or less, and pH adjustment to within 6.5 – 8.5 standard units before discharging to surface waters of the State or to a storm sewer system that drains to surface waters of the State.

If approved by the Engineer and by the local authority responsible for the sanitary sewer system, disposal of treated water from mains may be made to an available sanitary sewer, provided the rate of disposal will not overload the sewer.

7-09.3(24)B Requirement of Chlorine

Before being placed into service, new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than 25 mg/l remains in the water after standing 24 hours in the pipe. The initial chlorine content of the water shall be not less than 50 mg/l.

7-09.3(24)C Form of Applied Chlorine

Chlorine shall be applied by one of the methods which follow, to give a dosage of not less than 50 mg/l of available chlorine.

7-09.3(24)D Dry Calcium Hypochlorite

As each length of pipe is laid, sufficient high-test calcium hypochlorite (65 to 70 percent chlorine) shall be placed inside the pipe to yield a dosage of not less than 50 mg/l available chlorine, calculated on the volume of the water that the pipe and appurtenances will contain.

The number of grams of 70 percent test calcium hypochlorite required for a 20-foot length of pipe equals $0.238 \times d^2$, in which "d" is the diameter in inches.

7-09.3(24)E Liquid Chlorine

A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device, or the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, must provide means for preventing the backflow of water into the chlorine.

7-09.3(24)F Chlorine-Bearing Compounds in Water

A mixture of water and high-test calcium hypochlorite (65 to 70 percent Cl) may be substituted for the chlorine gas-water mixture. The dry powder shall first be mixed as a paste and then thinned to a 1 percent chlorine solution by adding water to give a total quantity of 7.5 gallons of water per pound of dry powder. This solution shall be injected in one end of the section of main to be disinfected while filling the main with water.

7-09.3(24)G Sodium Hypochlorite

Sodium hypochlorite, commercial grade (12.5 percent Cl) or in the form of liquid household bleach (5 to 6 percent Cl), may be substituted for the chlorine gas-water mixture. This liquid chlorine compound may be used full strength or diluted with water and injected into the main in correct proportion to the fill water so that dosage applied to the water will be at least 50 mg/l.

7-09.3(24)H Point of Application

The point of application of the chlorinating agent shall be at the beginning of the pipeline extension or any valved section of it, and through a corporation stop inserted in the horizontal axis of the pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension. Alternate points of applications may be used when approved by the Engineer.

7-09.3(24)I Rate of Application

Water from the existing distribution system, or other source of supply, shall be controlled to flow very slowly into the newly-laid pipeline during application of the chlorine. The rate of chlorine gas-water mixture or dry gas feed shall be in such proportion to the rate of water entering the newly-laid pipe that the dosage applied to the water will be at least 50 mg/l.

7-09.3(24)J Preventing Reverse Flow

No connections shall be made between the existing distribution system and pipelines not disinfected that are constructed under this Contract without a State Department of Health approved backflow preventer installed in the connecting line.

7-09.3(24)K Retention Period

Treated water shall be retained in the pipe at least 24 hours. After this period, the chlorine residual at pipe extremities and at other representative points shall be at least 25 mg/l.

7-09.3(24)L Chlorinating Valves, Hydrants, and Appurtenances

In the process of chlorinating newly laid pipe, valves, hydrants, and other appurtenances shall be operated while the pipeline is filled with the chlorinating agent and under normal operating pressure.

7-09.3(24)M Chlorinating Connections to Existing Water Mains and Water Service Connections

The chlorinating procedure to be followed shall be as specified in AWWA Standard C651. All closure fittings shall be swabbed with a very strong chlorine solution at least as strong as liquid household bleach (5 to 6 percent Cl).

7-09.3(24)N Final Flushing and Testing

Following chlorination, treated water shall be flushed from the newly-laid pipe until the replacement water throughout its length shows, upon test, the absence of chlorine. In the event chlorine is normally used in the source of supply, then the tests shall show a residual not in excess of that carried in the water supply system.

A sample tap shall be located ahead of the flushing hose for convenience and for sanitary sampling.

Before placing the lines into service, a satisfactory report shall be received from the local or State Health Department on samples collected from representative points in the new system. Samples will be collected and bacteriological tests obtained by the Engineer.

At a minimum, chlorinated water shall be dechlorinated to a concentration of 0.1 parts per million (ppm) or less, and pH adjustment to within 6.5 to 8.5 standard units, if necessary, before discharging to surface waters of the State or to a storm sewer system that drains to surface waters of the State.

7-09.3(24)O Repetition of Flushing and Testing

Should the initial treatment result in an unsatisfactory bacteriological test, the original chlorination procedure shall be repeated by the Contractor until satisfactory results are obtained. Failure to get a satisfactory test shall be considered as failure of the Contractor to keep the pipe clean during construction, or to properly chlorinate the main.

7-09.4 Measurement

Measurement for payment of pipe for water mains will be by the linear foot of pipe laid and tested and shall be measured along the pipe through fittings, valves, and couplings.

Measurement for payment of blowoff assembly will be per each.

When listed as a pay item, rock excavation will be measured in its original position by volume in cubic yards. The quantity measured for payment will include only the material excavated from within the limits hereinafter defined. Any additional excavation outside of these limits will be considered as having been made for the Contractor's benefit, and all costs in connection with such excavation shall be included in the unit Contract prices for the various items of Work.

The horizontal limits for measuring rock excavation will be the sides of the trench, except no payment will be made for material removed outside of vertical planes extended beyond the maximum trench widths, as specified in Section 7-09.3(7). Vertical distances shall be measured from the upper surface of the rock to an elevation 6 inches below the underside of the pipe barrel, or to the lower surface of the rock, whichever is less. Boulders exceeding 1 cubic yard in volume shall be paid for according to their measured volume.

Removal of the extra trench excavation as defined in Section 7-09.3(7)C will be measured by the cubic yard. The depth shall be the actual depth removed for the changed line or grade in accordance with Section 7-09.3(5) or as ordered by the Engineer in accordance with Section 1-04.4. The width shall be the actual width removed for the changed line or grade, but in no case shall the measured width exceed the allowable widths specified in Section 7-09.3(7).

Removal and replacement of unsuitable material will be measured by the cubic yard. The depth shall be the actual depth removed below the depth specified in Section 7-09.3(5). The width shall be the actual width removed, but in no case shall the measured width exceed the allowable widths specified in Section 7-09.3(7).

Measurement of bank run gravel for trench backfill will be by the cubic yard measured in trucks at the point of delivery.

Shoring or extra trench excavation will be measured as specified in Section 2-09.4 for shoring or extra excavation Class B.

7-09.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

“_____Pipe for Water Main_____ In. Diam.”, per linear foot.

The unit Contract price per linear foot for each size and kind of “_____ Pipe for Water Main _____ In. Diam.” shall be full pay for all Work to complete the installation of the water main, including but not limited to, trench excavation, bedding, laying and jointing pipe and fittings, backfilling, concrete thrust blocking, testing, disinfecting the pipeline, flushing, dechlorination of water used for flushing, and cleanup.

Payment for restoration will be made under the applicable items shown in the Proposal. If no pay items for restoration are included in the Proposal, restoration shall be considered incidental to the Work of constructing the water main, and all costs thereof shall be included in the unit Contract price Bid for “_____ Pipe for Water Main _____ In. Diam.”

“Rock Excavation”, per cubic yard.

If no pay item is listed, rock excavation shall be considered incidental to the Work to construct the water main and all costs shall be included in other items of Work specified in Section 7-09.5.

“Extra Trench Excavation”, per cubic yard.

“Removal and Replacement of Unsuitable Material”, per cubic yard.

“Bank Run Gravel for Trench Backfill”, per cubic yard.

No separate payment will be made for clearing and grubbing, removal of existing street improvements, furnishing and installing sand cushion, protection of existing utilities and services, trench excavation and backfill, bedding the pipe, and compacting the backfill. These items shall all be considered as incidental to the Work of constructing the water main, and all costs thereof shall be included in the payment as specified in Section 7-09.5.

“Shoring or Extra Excavation Trench”, per square foot.

“Blowoff Assembly”, per each.

The unit Contract price Bid per each for “Blowoff Assembly” shall be full pay for all Work to install the blowoff assembly, including but not limited to excavating, backfilling, laying and jointing pipe, tapping the main, corporation stop, pipe and fittings, gate valve, meter box, and cover and cleanup.

7-10 Vacant

7-11 Vacant

7-12 Valves for Water Mains

7-12.1 Description

Valves for water mains shall be suitable for ordinary waterworks service, intended to be installed in a normal position on buried pipelines for water distribution systems.

Valves shall open counterclockwise and shall be equipped with a 2-inch-square AWWA standard operating nut. Unless otherwise specified, all valves shall be the nonrising stem type.

7-12.2 Materials

Materials shall meet the requirements of the following sections:

Gate Valves (3 to 16 inches)	9-30.3(1)
Butterfly Valves	9-30.3(3)
Valve Boxes	9-30.3(4)
Valve Marker Posts	9-30.3(5)
Combination Air Release/Air Vacuum Valves	9-30.3(7)
End Connections	9-30.5(1)
Tapping Sleeve and Valve Assembly	9-30.3(8)

The valves shall be standard pattern of a manufacturer whose products are approved by the Engineer and shall have the name or mark of the manufacturer, year valve casting was made, size and working pressure plainly cast in raised letters on the valve body.

The valve bodies shall be cast iron, ductile iron, or other approved material mounted with approved noncorrosive metals. All wearing surfaces shall be bronze or other approved noncorrosive material, and there shall be no moving bearing or contact surfaces of iron in contact with iron. Contact surfaces shall be machined smooth and finished. All wearing surfaces shall be easily renewable.

7-12.3 Construction Requirements

All valves shall be inspected upon delivery in the field to ensure proper working order before installation. They shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connecting ends furnished. The valves shall also be carefully inspected for injury to the outer protective coatings. At all places where the coating has been ruptured or scraped off, the damaged area shall be cleaned to expose the iron base installation, and the cleaned area shall then be recoated with two or more field coats of approved protective coating.

Upon delivery at the work site, all valves shall be opened to prevent the collection of water in the valve. Valves shall have the interiors cleaned of all foreign matter and shall be inspected both in open and closed position prior to installation. Valves and valve boxes shall be set plumb and valve boxes shall be placed over the valve or valve operator in a manner that the valve box does not transmit shock or stress to the valve. The lower casting of the unit is installed first, in a manner as to be supported by a minimum backfill or by a Styrofoam collar not less than 2 inches in thickness. The casting shall not rest directly upon the body of the valve or upon the water main. Backfill shall be carefully tamped around the valve box to a distance of 3 feet on all sides or to the undisturbed face of the trench if it is closer. The cast iron valve box cover shall be set flush with the Roadbed or finished paved surface.

The combination air release/air vacuum valves shall be installed as shown in the Plans. All piping shall be sloped to permit escape of any entrapped air. Backfilling and compaction shall be as specified in Section 7-09.

After installation, all valves shall be subjected to field testing and disinfected as outlined in Section 7-09. Should any defects in materials or Work become evident during testing, the Contractor shall correct such defects with the least possible delay. The testing shall be repeated at the Contractor's expense until a satisfactory test is achieved.

7-12.3(1) Installation of Valve Marker Post

Where required, a valve marker post shall be furnished and installed with each valve. Valve marker posts shall be placed at the edge of the Right of Way opposite the valve and be set with 18 inches of the post exposed above grade. The exposed portion of the valve marker posts shall be painted with two coats of concrete paint in a color selected by the Engineer, and then the size of the valve and the distance in feet and inches to the valve shall be stenciled with black paint on the face of the post, using a stencil which will produce letters 2 inches high.

7-12.4 Measurement

Measurement of valves shall be per each for each type and size actually installed.

7-12.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

"Gate Valve ____ In.," per each.

"Butterfly Valve ____ In.," per each.

"Comb. Air Release/Air Vacuum Valve Assembly ____ In.," per each.

"Tapping Sleeve and Valve Assembly ____ In.," per each.

The unit Contract price per each for the valve specified shall be full pay for all Work to furnish and install the valve complete in place on the water main, including trenching, jointing, blocking of valve, painting, disinfecting, hydrostatic testing, valve box, and marker post.

7-13 Vacant

7-14 Hydrants**7-14.1 Description**

This section covers the installation of dry barrel fire hydrants intended for ordinary water works service.

7-14.2 Materials

Materials shall meet the requirements of the following sections:

Hydrants	9-30.5
End Connections	9-30.5(1)
Hydrant Dimensions	9-30.5(2)
Hydrant Extensions	9-30.5(3)
Hydrant Restraint	9-30.5(4)
Traffic Flange	9-30.5(5)
Guard Posts	9-30.5(6)

7-14.3 Construction Requirements**7-14.3(1) Setting Hydrants**

Where shown in the Plans, hydrants shall be installed in accordance with the [Standard Plans](#). In addition, a minimum 3-foot radius unobstructed working area shall be provided around all hydrants. The sidewalk flange shall be set 2 inches above finished grade.

All hydrants shall be set on concrete blocks as shown in the [Standard Plans](#). The hydrant barrel drain shall waste into a pit of porous gravel material situated at the base of the hydrant as shown in the [Standard Plans](#).

All hydrants shall be inspected upon delivery in the field to ensure proper working order. After installation, fire hydrants, auxiliary gate valves, and other appurtenances thereto shall be subjected to a hydrostatic test and disinfection procedures as specified in Section 7-09.

After all installation and testing is complete, the exposed portion of the hydrant shall be painted with one field coat. The type and color of paint will be designated by the Engineer.

Any hydrant not in service shall be identified by covering with a burlap or plastic bag properly secured.

7-14.3(2) Hydrant Connections

Hydrant laterals shall consist of one continuous section of 6-inch ductile iron pipe from the main to the hydrant and shall include an auxiliary gate valve set vertically and placed in accordance with the [Standard Plans](#).

7-14.3(2)A Hydrant Restraints

The thrust created in the hydrant lateral shall be restrained as shown in the [Standard Plans](#). If applicable, shackle rods, after installation, shall be cleaned and painted with two coats of asphalt varnish, or with such other bituminous coating as may be approved by the Engineer.

7-14.3(2)B Auxiliary Gate Valves and Valve Boxes

Auxiliary gate valves and valve boxes shall be installed in accordance with Section 7-12 except that the end connections shall be provided with lugs for shackling, or the bells shall provide sufficient clearance between the body of the valve and the hub to permit the installation of shackles.

7-14.3(2)C Hydrant Guard Posts

Hydrant guard posts shall be constructed at the locations shown in the Plans. The exposed portion of each guard post shall be painted with one coating of the type and color designated by the Engineer.

7-14.3(3) Resetting Existing Hydrants

Where existing hydrants are shown in the Plans for adjustments to conform to a new street alignment or grade or both, the hydrant shall be relocated without disturbing the location of the hydrant lateral tee at the main.

The method for thrust restraint for the hydrant lateral shall be determined by the conditions found in the field and shall be constructed as ordered by the Engineer at no additional cost to the Contracting Agency.

This Work shall conform to Section 7-14.3(1).

7-14.3(4) Moving Existing Hydrants

Existing hydrants shall be moved where shown in the Plans. When the existing hydrant lateral tee does not accommodate a new hydrant location, a new hydrant lateral tee shall be installed in the main. The existing hydrant lateral tee shall be removed from the main (if said main is to remain active), and a new section of pipe inserted into the water main in place of the existing hydrant lateral tee. Where the existing main to which the existing hydrant lateral tee is connected, and is to be abandoned or temporarily activated after the existing hydrant is moved, the open end of the hydrant lateral pipeline shall be plugged (and temporary thrust restrain provided if temporarily reactivated). All Work shall meet the requirements of Section 7-14.3(1).

7-14.3(5) Reconnecting Existing Hydrants

Existing hydrants shall be reconnected where shown in the Plans. The location and elevation of the existing hydrant shall remain unchanged, but the existing hydrant connection is changed to connect with a new hydrant tee provided in a new main.

Where existing hydrants were not shackled to the old main, the new connection shall be shackled with steel rods as shown in the [Standard Plans](#), or by such other shackling method as approved by the Engineer.

Hydrant reconnections shall meet the requirements of Sections 7-14.3(1) and 7-14.3(2).

7-14.3(6) Hydrant Extensions

The Contractor shall furnish and install hydrant extensions where required. The hydrant extensions, operating stems for the hydrant main valves, and sidewalk flanges shall conform to AWWA C502. After installation, the extended fire hydrant shall be subjected to a hydrostatic pressure test and disinfection procedure as specified in Section 7-09.

7-14.4 Measurement

Measurement of hydrant assembly, resetting existing hydrants, moving existing hydrants, and reconnecting existing hydrants will be made per each. Measurement of hydrant extension will be made per linear foot.

7-14.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

“Hydrant Assembly”, per each.

The unit Contract price per each for “Hydrant Assembly” shall be full pay for all Work to furnish and install fire hydrant assemblies, including all costs for auxiliary gate valve, shackles, tie rods, concrete blocks, gravel, and painting required for the complete installation of the hydrant assembly as specified, except the pipe connecting the hydrant to the main and the hydrant lateral tee will be paid for as specified in Section 7-09.5.

“Resetting Existing Hydrant”, per each.

The unit Contract price per each for “Resetting Existing Hydrant” shall be full pay for all Work to reset the existing hydrant, including shackling, painting, and reconnecting to the main. New pipe required from the main to the hydrant will be paid as specified in Section 7-09.5.

“Moving Existing Hydrant”, per each.

The unit Contract price per each for “Moving Existing Hydrant” shall be full pay for all Work to move the existing hydrant, including new hydrant lateral tee, shackling, painting, and reconnecting to the main. New pipe for hydrant connections will be paid for as specified in Section 7-09.5.

“Reconnecting Existing Hydrant”, per each.

The unit Contract price per each for “Reconnecting Existing Hydrant” shall be full pay for all Work to reconnect the existing hydrant, excepting however, that new pipe used for the connection will be paid as specified in Section 7-09.5.

“Hydrant Extension”, per linear foot.

The unit Contract price per linear foot for “Hydrant Extension” shall be full pay for all Work to extend the hydrant vertically.

7-15 Service Connections**7-15.1 Description**

This Work consists of installing 2 inch and smaller service connections from the main to and including the meter setter for the premises served. Service connections larger than 2 inches shall be installed as detailed on the Plans or as described in the Special Provisions.

7-15.2 Materials

Materials shall meet the requirements of the following sections:

Saddles	9-30.6(1)
Corporation Stops	9-30.6(2)
Service Pipe	9-30.6(3)
Service Fittings	9-30.6(4)
Meter Setters	9-30.6(5)
Bronze Nipples and Fittings	9-30.6(6)
Meter Boxes	9-30.6(7)

7-15.3 Construction Requirements

All service connections to water mains, except to ductile iron pipe Class 52 or stronger, shall be made using saddles as specified and be of the size and type suitable for use with the pipe being installed. Ductile iron pipe Class 52 or stronger may be direct tapped for corporation stops in accordance with the recommendations of DIPRA; unless direct taps are prohibited by the Special Provisions. Service pipelines shall be installed perpendicular to the main, unless shown otherwise in the Plans.

The depth of trenching for service connection piping shall provide a minimum of 3 feet of cover over the top of the pipe. Particular care shall be exercised to ensure that the main is not damaged by the Work undertaken to install the service. Excavating and backfilling for service connections shall be as specified in Section 7-09, except that the service pipeline shall be installed under pavement, curbs, and sidewalks by boring methods approved by the governmental agency having jurisdiction over the Roadway.

Service pipes shall be cut using a tool or tools specifically designed to leave a smooth, even, and square end on the piping material to be cut. Cut ends shall be reamed to the full inside diameter of the pipe. Pipe ends to be connected using couplings which seal to the outside surface of the pipe shall be cleaned to a sound, smooth finish before the couplings are installed. The meter box shall be adjusted to the finished grade after the surface has been acceptably restored.

Where shown in the Plans, existing service connections shall be reconnected to the new mains. The location of existing service connections shall be verified in the field by the Contractor. The Contractor shall notify affected customers of the service interruption at least 24 hours prior to service interruption.

Pipe materials used to extend or replace existing service connections beyond the meter box shall be copper or polyethylene pipe. Insulating couplings shall be used at any connection between galvanized steel or iron pipe and copper pipe. All fittings, appurtenances, and other miscellaneous materials on the sections of existing pipe that have been removed shall become the property of the Contractor.

7-15.3(1) Flushing and Disinfection

All service pipe and appurtenances shall be prechlorinated prior to installation. After installation, the service connection shall be flushed prior to connecting the meter.

7-15.4 Measurement

Service connections will be measured per each for each size of service connection installed.

7-15.5 Payment

Payment will be made for the following Bid item when it is included in the Proposal:

“Service Connection ____ In. Diam.”, per each.

The unit Contract price per each for “Service Connection ____ In. Diam.” shall be full pay for all Work to install the service connection, including but not limited to, excavating, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, testing, flushing, and disinfection of the service connection.

7-16 Vacant

7-17 Sanitary Sewers

7-17.1 Description

This Work consists of constructing sanitary sewer lines in accordance with the Plans, these Specifications, and the [Standard Plans](#), as staked.

7-17.2 Materials

Pipe used for sanitary sewers may be:

1. Concrete
2. Vitrified Clay
3. Ductile Iron
4. ABS Composite
5. PVC (Polyvinyl Chloride)
6. Polypropylene

All sanitary sewer pipe shall have flexible gasketed joints unless otherwise specified.

Materials shall meet the requirements of the following sections.

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Vitrified Clay Sewer Pipe	9-05.8
Solid Wall PVC Sanitary Sewer Pipe	9-05.12(1)
Profile Wall PVC Sanitary Sewer Pipe	9-05.12(2)
Ductile Iron Sewer Pipe	9-05.13
ABS Composite Sewer Pipe	9-05.14
Polypropylene Sewer Pipe	9-05.24

All pipe shall be clearly marked with type, class, and thickness. Lettering shall be legible and permanent under normal conditions of handling and storage. Concrete, vitrified clay, and ductile iron pipes shall be considered rigid. All other stated pipe materials shall be considered flexible.

7-17.3 Construction Requirements

Sanitary sewers shall be constructed in accordance with Section 7-08.3.

7-17.3(1) Protection of Existing Sewerage Facilities

All existing live sewers including septic tanks and drain fields shall be kept in service at all times. Provision shall be made for disposal of sewage flow if any existing sewers are damaged. Damage to existing sewers shall be repaired by the Contractor, at no expense to the Contracting Agency, to a condition equal to or better than their condition prior to the damage.

Water accumulating during construction shall be removed from the new sewers but shall not be permitted to enter the existing system. The Contractor shall be responsible for flushing out and cleaning existing sewers into which gravel, rocks, or other debris has entered as a result of their operations and shall repair lift stations or other facilities damaged by the Contractor's operations.

The physical connection to an existing manhole or sewer shall not be made until authorized by the Engineer. Such authorization will not be given until all upstream lines have been completely cleaned, all debris removed, and where applicable, a pipe temporarily placed in the existing channel and sealed.

7-17.3(2) Cleaning and Testing**7-17.3(2)A General**

Sewers and appurtenances, where required in the Plans, shall be cleaned and tested after backfilling by either the exfiltration or low-pressure air method at the option of the Contractor, except where the ground water table is such that the Engineer will require the infiltration test.

All Work involved in cleaning and testing sewer lines between manholes or rodding inlets as required shall be completed within 15 working days after backfilling of sewer lines and Structures. Any further delay will require the written consent of the Engineer. The Contractor shall furnish all labor, materials, tools, and equipment necessary to make the test, clean the lines, and perform all incidental Work. The Contractor shall perform the tests in the presence of the Engineer. Precautions shall be taken to prevent joints from separating during tests. Damage resulting from these tests shall be repaired by the Contractor at no expense to the Contracting Agency. The manner and time of testing shall be subject to approval by the Engineer.

All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

Testing side sanitary sewers shall be for their entire length from the public sewer in the street to the connection with the building's plumbing. Testing shall be as required by the local sanitary agency. When the local sanitary agency does not have a standard for testing, the pipe will be filled with water before backfilling and visually inspecting the exterior for leakage. The decision of the Engineer as to acceptance of the side sanitary sewer shall be final.

If any sewer installation fails to meet the requirements of the test method used, the Contractor shall determine, at no expense to the Contracting Agency, the source or sources of leakage and shall repair or replace all defective materials or Work at no expense to the Contracting Agency. The complete pipe installation shall meet the requirements of the test method used before being considered acceptable.

7-17.3(2)B Exfiltration Test

Prior to making exfiltration leakage tests, the Contractor shall fill the pipe with clear water to permit normal absorption into the pipe walls provided, however, that after so filling the pipe, the Contractor shall complete the leakage test within 24 hours after filling. During testing, the allowable leakage shall be limited according to the provisions that follow. Specified allowances assume pre-wetted pipe.

Leakage shall be no more than 0.28 gph per inch diameter per 100 feet of sewer, with a hydrostatic head of 6 feet above the crown at the upper end of the test section, or 6 feet above the natural ground water table at the time of test, whichever is higher. The length of pipe tested shall be limited so that the pressure at the lower end of the Section tested does not exceed 16 feet of head above the invert, and shall not exceed 700 feet.

Where the test head is other than 6 feet, the maximum leakage shall not exceed the amount determined from the following equation:

$$\text{Maximum leakage (in gallons per hour)} = 0.28 \times (\sqrt{H}/\sqrt{6}) \times D \times (L/100)$$

Where:

- D = diameter (in.)
- L = length of pipe (ft.)
- H = test head (ft.)

When the test is to be made one joint at a time, the leakage per joint shall not exceed the computed allowable leakage per length of pipe.

7-17.3(2)C Infiltration Test

Where the natural ground water head over the pipe is 2 feet or less above the crown of pipe at the upper end of the test section, the infiltration test leakage shall not exceed 0.16 gallons per hour per inch of diameter per 100 feet of pipe length. The length of pipe tested shall not exceed 700 feet.

Where the natural ground water head is greater than 2 feet, the maximum leakage shall not exceed the amount determined from the following equation:

$$\text{Maximum leakage (in` gallons per hour)} = 0.16 \times (\sqrt{H}/\sqrt{2}) \times D \times (L/100)$$

Where:

D	=	diameter (in.)
L	=	length of pipe (ft.)
H	=	natural ground water head (ft.)

When a suitable head of ground water exists above the crown of the pipe and when the pipe is large enough to work inside, acceptance may be based on the repair of visible leakage by means satisfactory to the Engineer.

7-17.3(2)D Other Test Allowances

For either the infiltration or exfiltration test, all lateral or side sewer branches included in the test section shall be taken into account in computing allowable leakage. An allowance of 0.2 gallons per hour per foot of head above invert shall be made for each manhole included in a test section.

Upon final acceptance of the Work all sewers, side sewers and fittings shall be open, clean, and free draining.

7-17.3(2)E Low Pressure Air Test for Sanitary Sewers Constructed of Air Permeable Materials

Air permeable materials include concrete and vitrified clay. Low pressure air testing may be used for air permeable pipes 30 inches in diameter and smaller.

The test equipment to be used shall be furnished by the Contractor and shall be inspected and approved by the Engineer prior to use. The Engineer may at any time require a calibration test of gauges or other instrumentation that is incorporated into the test equipment. Calibration tests shall be certified by an independent testing Laboratory.

Plugs used to close the pipe for the air test must be securely braced to prevent the unintentional release of a plug. Gauges, air piping manifold, and valves shall be located at the top of the ground. No one shall be permitted to enter a manhole or catch basin where a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure release device, such as a rupture disk or a pressure relief valve, designed to activate when the pressure in the pipe exceeds 2 psig above the required test pressure.

If the pipe to be tested is submerged by groundwater, the backpressure on the pipe created by the groundwater submergence must be determined. All gauge pressures described in the test shall be increased by that amount.

The first section of pipe installed by each crew shall be tested in order to qualify the crew and material. A successful test for the section shall be a prerequisite to further installation by that crew. Following the initial test, pipes shall be tested from manhole to manhole, catch basin to catch basin, or such shorter lengths as determined by the Contractor.

Air shall be slowly supplied to the plugged pipe section until the internal air pressure reaches 4 psig. Wait at least 2 minutes to allow for pressure and temperature stabilization to occur within the pipe.

When the pressure decreases to 3.5 psig, the air pressure test shall begin. The test shall consist of measuring the time in seconds for the pressure in the pipe to drop from 3.5 psig to 2.5 psig. The pipe shall be considered acceptable if the time in seconds for the pressure drop is equal to or greater than the required time as calculated below:

$$K = 0.0111d^2L$$

$$C = 0.0003918dL$$

$$\text{If } C_T < 1, \text{ then time} = K_T$$

$$\text{If } 1 < C_T < 1.75, \text{ then time} = K_T/C_T$$

$$\text{If } C_T > 1.75, \text{ then time} = K_T/1.75$$

Where:

d = Pipe diameter (inches)

L = Pipe length (feet)

K = value for each length of pipe of a specific diameter

C = value for each length of pipe of a specific diameter

K_T = sum of all K values

C_T = sum of all C values

This method was developed based on an allowable air loss rate of 0.003 cubic feet per minute (cfm) per square foot of internal pipe surface, with the total air loss rate not less than 2 cfm nor greater than 3.5 cfm. At the Contractor's option, the pipe may be tested without pre-wetting; however, the allowable air loss rate assumes pre-wetted pipe.

Pipe over 30 inches in diameter shall be tested one joint at a time in accordance with ASTM C1103.

7-17.3(2)F Low Pressure Air Test for Sanitary Sewers Constructed of Non-Air Permeable Materials

Non air permeable materials include ductile iron, ABS composite, polyvinyl chloride (PVC), and polyethylene (PE). When non air permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than four times the required time calculated in Section 7-17.3(2)E.

Pipe over 30 inches in diameter shall be tested one joint at a time in accordance with ASTM C1103.

Reaches of thermoplastic pipe containing no joints shall be exempt from testing requirements.

7-17.3(2)G Deflection Test for Thermoplastic Pipe

Sanitary sewers constructed of thermoplastic pipe shall be tested for deflection not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling a properly sized "go-nogo" mandrel through the completed pipeline. Testing shall be conducted on a manhole-to-manhole basis and shall be done after the line has been completely flushed out with water.

The mandrel shall be a rigid, nonadjustable mandrel having an effective length of not less than its normal diameter and an odd-number of legs (9 legs minimum). Minimum diameter at any point along the full length of the mandrel shall be 95 percent of the base inside diameter of the pipe being tested.

Base inside diameter is derived by subtracting a statistical tolerance package from the average inside diameter. The tolerance package is defined as the square root of the sum of squared manufacturing tolerances. The tolerance package for controlled outside diameter pipe consists of (1) outside diameter tolerance specified in applicable ASTM Standard, (2) 12 percent of one wall thickness specified in applicable ASTM Standard, and (3) out of roundness tolerance listed in appendix of applicable ASTM Standard. The items in

the tolerance package for controlled inside diameter pipe consists of (1) inside diameter tolerance listed in appendix of applicable ASTM Standard and (2) out of roundness tolerance listed in appendix of applicable ASTM Standard. When out of roundness tolerance is not listed, use 3 percent of average inside diameter.

The average inside diameter for pipe with controlled outside diameter shall be equal to the average outside diameter as specified in applicable ASTM Standard minus 2 minimum wall thicknesses as specified in applicable ASTM Standard and minus 2 times excess wall tolerance of 6 percent. The average inside diameter for pipes with controlled inside diameter shall be the average inside diameter as specified in applicable ASTM Standard.

The Contractor shall be required, at no expense to the Contracting Agency, to locate and uncover any sections failing to pass the test and, if not damaged, reinstall the pipe. The use of a vibratory re-rounding device or any process other than removal or reinstallation shall not be acceptable. The Contractor shall retest the section after replacement of the pipe.

Pipe large enough to work inside of may be accepted on the basis of direct measurement.

7-17.3(2)H Television Inspection

The Engineer may require any or all sanitary sewer lines be inspected by the use of a television camera before final acceptance. The costs incurred in making the initial inspection shall be borne by the owner of the sanitary sewer.

The Contractor shall bear all costs incurred in correcting deficiencies found during television inspection including the cost of additional television inspections that may be required by the Engineer to verify the correction of said deficiency.

The Contractor shall be responsible for all costs incurred in television inspections performed solely for the benefit of the Contractor.

7-17.4 Measurement

The length of sewer pipe will be the number of linear feet of completed installation measured along the invert and will include the length through elbows, tees and fittings. The number of linear feet will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type Structures.

The length of testing sewer pipe in conformance with Section 7-17.3(2) will be the number of linear feet of completed installation actually tested.

7-17.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

“Plain Conc. or V.C. Sewer Pipe ____ In. Diam.”, per linear foot.

“Cl. ____ Reinf. Conc. Sewer Pipe ____ In. Diam.”, per linear foot.

“PVC Sanitary Sewer Pipe ____ In. Diam.”, per linear foot.

“Ductile Iron Sewer Pipe ____ In. Diam.”, per linear foot.

“ABS Composite Sewer Pipe ____ In. Diam.”, per linear foot.

“Polypropylene Sewer Pipe ____ In. Diam.”, per linear foot.

The unit Contract price per linear foot for sewer pipe of the kind and size specified shall be full pay for furnishing, hauling, and assembling in place the completed installation including all wyes, tees, special fittings, joint materials, bedding and backfill material, and adjustment of inverts to manholes for the completion of the installation to the required lines and grades.

“Testing Sewer Pipe”, per linear foot.

The unit Contract price per linear foot for “Testing Sewer Pipe” shall be full pay for all labor, material and equipment required to conduct the leakage tests required in Section 7-17.3(2).

“Removal and Replacement of Unsuitable Material”, per cubic yard.

The unit Contract price per cubic yard for “Removal and Replacement of Unsuitable Material” shall be full pay for all Work to remove unsuitable material and replace and compact suitable material as specified in Section 7-08.3(1)A.

7-18 Side Sewers**7-18.1 Description**

This Work shall consist of constructing side sewers in accordance with the Plans, these Specifications, and the *Standard Plans*, at locations staked, on both the right of way and private property between the main sanitary sewer line and the stubout from a residence or other building.

7-18.2 Materials

Materials shall be the same as required for sanitary sewers in Section 7-17.

7-18.3 Construction Requirements**7-18.3(1) General**

The construction requirements for sanitary sewers in Section 7-17 shall apply to the construction of side sewers.

Side sewers shall not be backfilled prior to inspection.

Side sewers shall be constructed with a maximum joint deflection not to exceed the manufacturer's printed recommendations and in no case shall exceed 2 inches per foot in any joint. Larger changes in direction shall be made by use of standard $\frac{1}{8}$ bends.

7-18.3(2) Fittings

Side sewers shall be connected to the tee, wye, or riser provided in the public sewer, where such is available, utilizing approved fittings or adapters. Where no tee, wye, or riser is provided or available, connection shall be made by machine made tap and approved saddle.

7-18.3(3) Testing

All side sewers shall be tested after backfilling.

All side sewers constructed in conjunction with the main sewer shall, for purposes of testing as specified in Section 7-17, have a 6-inch tee fitting pipe placed at the point where the side sewer crosses the street or other public Right of Way margin. The tee opening shall be positioned perpendicular to the side sewer slope, unless otherwise directed by the Engineer.

When side sewers are not tested simultaneously with the testing of the main sewer, the Contractor, at no expense to the Contracting Agency, shall furnish and place an additional tee in the first pipe out of the main sewer tee or wye branch, so that an inflatable rubber ball can be inserted for sealing off the side sewer and thus permit separate tests.

7-18.3(4) Extending Side Sewers Into Private Property

Side sewers shall not be constructed on private property prior to completion and acceptance of the main line and side sewer on public Right of Way or easement unless approved in writing by the Engineer.

7-18.3(5) End Pipe Marker

The location of side sewers at the property line shall be marked by the Contractor with a 2 by 4-inch wooden stake 4 feet long buried in the ground a depth of 3 feet. The low end shall have a 2 by 4-inch cleat nailed to it to prevent withdrawal of the stake. The exposed end shall be painted traffic white and the depth to the side sewer or tee shall be indicated in black paint on the 2 by 4. In addition, a length of 12-gage galvanized wire shall be provided to extend from the plugged end of the side sewer or tee. The upper end shall emerge at the 4-foot stake, but shall not be fastened to it.

7-18.4 Measurement

Measurement shall be as specified in Section 7-17.4.

7-18.5 Payment

Payment shall be made for each of the Bid items shown in Section 7-17.5 that are included in the Proposal.

The unit Contract price per linear foot for sewer pipe of the various kind and size specified shall be full pay for all Work required for the completion of the installation including fittings and end pipe marker.

7-19 Sewer Cleanouts

7-19.1 Description

This Work consists of constructing sanitary sewer cleanouts in accordance with the Plans, these Specifications, and the [Standard Plans](#) as staked.

7-19.2 Materials

All materials incorporated into the total cleanout Structure shall meet the requirements of the various applicable sections of these Specifications.

7-19.3 Construction Requirements

A cleanout shall be provided for each total change of 90 degrees of grade or alignment and in no case shall the spacing of cleanouts exceed 100 feet. No cleanout will be required at the connection of the side sewer to a riser on the public sewer. A suitably located cleanout in the house piping or plumbing may be considered as a cleanout for the side sewer. Cleanouts shall consist of a wye branch in the side sewer.

All cleanouts located in public rights of way shall be extended to grade.

The extension of cleanouts to grade on private property will be optional with the property owner. When extended to grade, cleanouts shall be full side sewer diameter and shall be extended to a point not less than 6 inches nor more than 12 inches below the finished ground surface and shall be plugged with a removable stopper which will prevent passage of dirt or water. When specified, the Contractor shall install an approved casting to provide ready access to the cleanout stopper. A $\frac{1}{8}$ bend shall be used to deflect the side sewer upward as a cleanout where the terminal end of the side sewer lies upstream from the last point of connection.

7-19.4 Measurement

Sewer cleanouts will be measured per each.

7-19.5 Payment

Payment will be made for the following Bid item when listed in the Proposal:

“Sewer Cleanout”, per each.

The unit Contract price per each for cleanouts shall be full pay for furnishing and placing the wye, pipe, pipe bends, pipe plug, castings, and collar as specified herein and as shown on the [Standard Plans](#).

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