



**DEVELOPMENTAL SPECIFICATIONS**  
**For**  
**WATER MAIN**  
**(SUDAS)**

Effective Date  
January 19, 2005

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

TABLE OF CONTENTS

<b>DIVISION 3. TRENCH, BACKFILL, AND TUNNELING</b> .....	<b>4</b>
<b>SECTION 3010 - Trench AND Backfill</b> .....	<b>4</b>
PART 1 - GENERAL.....	4
1.01 SECTION INCLUDES .....	4
1.02 DESCRIPTION OF WORK.....	4
1.03 SUBMITTALS .....	4
1.04 SUBSTITUTIONS.....	4
1.05 DELIVERY, STORAGE, AND HANDLING .....	4
1.06 SCHEDULING AND CONFLICTS .....	4
1.07 SPECIAL REQUIREMENTS .....	5
1.08 MEASUREMENT FOR PAYMENT.....	5
PART 2 - PRODUCTS.....	6
2.01 EXCAVATION MATERIALS.....	6
2.02 STABILIZATION (FOUNDATION) MATERIALS .....	9
2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (Storm Sewer and Sanitary Sewers) .....	10
2.04 CLASS II BACKFILL MATERIAL (WATER MAINS).....	10
2.05 CLASS III BACKFILL MATERIAL (WATER MAINS).....	11
2.06 CLASS IVA BACKFILL MATERIAL (WATER MAINS) .....	11
2.07 CLASS IVB BACKFILL MATERIAL (water mains) .....	12
2.08 CLASS V BACKFILL MATERIAL (Unsuitable Backfill) .....	12
2.09 INTENTIONALLY LEFT BLANK.....	12
2.10 INTENTIONALLY LEFT BLANK.....	12
2.11 SPECIAL PIPE EMBEDMENT MATERIAL .....	12
2.12 CASING PIPE.....	13
PART 3 - EXECUTION .....	13
3.01 PREPARATION.....	13
3.02 TRENCH EXCAVATION .....	13
3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM .....	15
3.04 SHEETING, SHORING, AND BRACING .....	15
3.05 DEWATERING .....	16
3.06 PIPE PLACEMENT FOR WATER MAINS .....	17
3.07 INTENTIONALLY LEFT BLANK.....	18
3.08 STRUCTURE BEDDING .....	18

3.09	STRUCTURE BACKFILL .....	19
3.10	FIELD QUALITY CONTROL .....	21
<b>SECTION 3020 - Trenchless Construction (Boring, Jacking, and Tunneling).....</b>		<b>22</b>
PART 1 - GENERAL.....		22
1.01	SECTION INCLUDES .....	22
1.02	DESCRIPTION OF WORK.....	23
1.03	SUBMITTALS.....	23
1.04	SUBSTITUTIONS.....	24
1.05	DELIVERY, STORAGE, AND HANDLING .....	24
1.06	SCHEDULING AND CONFLICTS .....	24
1.07	SPECIAL REQUIREMENTS .....	24
1.08	MEASUREMENT FOR PAYMENT.....	25
PART 2 - PRODUCTS.....		25
2.01	CARRIER PIPE .....	25
2.02	CASING PIPE.....	25
2.03	CASING PIPE FILLER .....	26
2.04	CARRIER PIPE GUIDE.....	26
2.05	BACKFILL FOR ABANDONED TUNNELS .....	27
PART 3 - EXECUTION.....		27
3.01	PREPARATION.....	27
3.02	EXCAVATION .....	27
3.03	SHEETING, SHORING, AND BRACING .....	28
3.04	DEWATERING .....	28
3.05	TRENCHLESS INSTALLATION.....	28
3.06	FIELD QUALITY CONTROL .....	30
<b>DIVISION 4 – SEWERS AND DRAINS .....</b>		<b>30</b>
<b>SECTION 4010 - Sanitary Sewers .....</b>		<b>30</b>
PART 2 - PRODUCTS.....		30
2.01	SANITARY SEWERS (Gravity) .....	30
<b>DIVISION 5 - WATER MAIN AND APPURTENANCES.....</b>		<b>31</b>
<b>SECTION 5010 - PIPE AND FITTINGS.....</b>		<b>31</b>
PART 1 - GENERAL.....		31
1.01	SECTION INCLUDES .....	31
1.02	DESCRIPTION OF WORK.....	31
1.03	SUBMITTALS.....	31
1.04	SUBSTITUTIONS.....	31
1.05	DELIVERY, STORAGE, AND HANDLING .....	31
1.06	SCHEDULING AND CONFLICTS .....	31
1.07	SPECIAL REQUIREMENTS .....	32
1.08	MEASUREMENT FOR PAYMENT.....	32
PART 2 - PRODUCTS.....		35
2.01	WATER MAIN PIPE .....	35
2.02	WATER SERVICE PIPES .....	36
2.03	BOLTS FOR WATER MAIN PIPE AND FITTINGS.....	36
2.04	FITTINGS .....	37
2.05	SPECIAL FITTINGS .....	39
2.06	PIPELINE ACCESSORIES .....	40
2.07	GASKETS, SPECIAL .....	41
PART 3 - EXECUTION.....		41
3.01	GENERAL PIPE INSTALLATION.....	41
3.02	ADDITIONAL REQUIREMENTS FOR DUCTILE IRON PIPE INSTALLATION .....	42
3.03	ADDITIONAL REQUIREMENTS FOR PVC PIPE INSTALLATION .....	42
3.04	ADDITIONAL REQUIREMENTS FOR PRESTRESSED CONCRETE CYLINDER PIPE INSTALLATION.....	42
3.05	POLYETHYLENE ENCASEMENT INSTALLATION .....	43
3.06	TRACER SYSTEM INSTALLATION .....	43

3.07	CONFLICTS .....	43
3.08	TRANSITIONS IN PIPING SYSTEMS .....	44
3.09	STRUCTURE PENETRATIONS .....	44
3.10	SERVICE TAPS AND CONNECTIONS .....	45
3.11	WATER SERVICE RELOCATIONS .....	45
3.12	TESTING .....	46
3.13	FLUSHING .....	46
3.14	PROTECTION .....	46
<b>SECTION 5020. VALVES, HYDRANTS, AND APPURTENANCES.....</b>		<b>46</b>
PART 1 - GENERAL.....		46
1.01	SECTION INCLUDES .....	46
1.02	DESCRIPTION OF WORK.....	47
1.03	SUBMITTALS.....	47
1.04	SUBSTITUTIONS.....	47
1.05	DELIVERY, STORAGE AND HANDLING .....	47
1.06	SCHEDULING AND CONFLICTS .....	47
1.07	SPECIAL REQUIREMENTS .....	48
1.08	MEASUREMENT FOR PAYMENT.....	48
PART 2 - PRODUCTS.....		49
2.01	VALVES.....	49
2.02	FIRE HYDRANT .....	52
2.03	APPURTENANCES.....	55
PART 3 - EXECUTION.....		56
3.01	GENERAL .....	56
3.02	FLUSHING DEVICE (BLOWOFF).....	56
3.03	FIRE HYDRANT .....	56
<b>SECTION 5030. TESTING AND DISINFECTION.....</b>		<b>57</b>
PART 1 - GENERAL.....		57
1.01	SECTION INCLUDES .....	57
1.02	DESCRIPTION OF WORK.....	57
1.03	SCHEDULING .....	57
1.04	REGULATORY REQUIREMENTS.....	57
1.05	MEASUREMENT FOR PAYMENT.....	57
PART 2 - PRODUCTS.....		57
2.01	DISINFECTION AGENT - CHLORINE .....	57
PART 3 - EXECUTION.....		58
3.01	SEQUENCE OF OPERATION .....	58
3.02	PRESSURE AND LEAK TESTING .....	58
3.03	INITIAL FLUSHING .....	59
3.04	DISINFECTION .....	60
3.05	FLUSHING AFTER DISINFECTION IS COMPLETE .....	60
3.06	PUTTING WATER MAIN IN SERVICE .....	61

The applicable sections of the Urban Standard Specifications for Public Improvements have been included and modified in these Developmental Specifications.

The applicable figures referenced in this Developmental Specification are included in the plans.

### **DIVISION 3. TRENCH, BACKFILL, AND TUNNELING**

#### **SECTION 3010 - TRENCH AND BACKFILL**

##### **PART 1 - GENERAL**

###### **1.01 SECTION INCLUDES**

- A. Trench excavation for pipe systems, utility accesses, and other structures.
- B. Trench bedding and foundation stabilization.
- C. Pipe and structure placement and backfill.

###### **1.02 DESCRIPTION OF WORK**

- A. Perform all excavations required to complete the work shown in the plans.
- B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.
- C. Complete specified backfill operation.

###### **1.03 SUBMITTALS**

- A. Samples, granular bedding material: submit 10 pounds (5 kg) samples of each type, if required.
- B. Samples, granular backfill material: submit 10 pounds (5 kg) samples, if required.
- C. Gradation reports for fill materials and bedding materials, if required.
- D. Results of Standard Proctor and In-Place Density Tests on backfill, if required.
- E. Upon requests the Contractor shall provide material certifications to the Engineer.

###### **1.04 SUBSTITUTIONS**

- A. Obtain approval of the Engineer for all substitutions prior to use.

###### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.
- B. Remove unsuitable and excess materials from the site.

###### **1.06 SCHEDULING AND CONFLICTS**

- A. Construction Sequence:
  - 1. Attend a preconstruction meeting if required by the Engineer.
  - 2. Submit plan for construction sequence and schedule prior to commencing construction.

**B. Conflict Avoidance:**

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Contractor shall verify elevations and locations of each and verify clearance for proposed construction.
2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.
3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

**1.07 SPECIAL REQUIREMENTS**

**A. Stop Work:** Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

**B. Use of Explosives:** Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.
2. Use experienced demolition personnel.

**C. Abandoned Utilities:** Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

**1.08 MEASUREMENT FOR PAYMENT**

All measurements for payment will be made by the Engineer.

**A. General:** Trenching, Bedding, Backfilling, Compaction, and Dewatering shall be included in the costs in the contract unit price for all pipe and structures, except as follows:

1. **Rock Excavation (Class 22 Excavation):** Rock, if encountered and verified by the Engineer, will be measured by the Engineer and paid for by the cubic yard (cubic meter) removed from the excavation, or shall be paid for in accordance with Article 1109.03, B of the Standard Specifications.
2. **Over-excavation and trench bottom stabilization.** (Measured by the Engineer):
  - a. Measure authorized over-excavation and trench stabilization by cubic yards (cubic meters) removed.
  - b. Measure quantity in tons (kilograms) of stabilization material placed in the over-excavation.
  - c. Payment will be made for over-excavation, stabilization material, and placement on the basis of the contract unit price or in accordance with Article 1109.03, B, of the Standard Specifications.

**3. Unsuitable Backfill:**

- a. Where excavated material is found to be unsuitable for backfill and cannot be made suitable in the opinion of the Engineer, the Engineer will measure replacement material furnished by Contractor from outside the project limits by cubic yards (cubic meters), furnished, transported, and properly installed. Payment will be made at the contract unit price per cubic yard (cubic meter) or in accordance with Article 1109.03, B, of the Standard Specifications.
- b. Except for over-excavation removal of unsuitable soil shall be considered as incidental to unclassified excavation.
- c. If suitable backfill replacement material is within the project limits it will not be measured and paid separately.

**B. Open Cut Casing Pipe Installation:** Measurement will be for the length of properly installed casing, measured along the centerline of the casing.

**C. Unintentional Over-Excavation and Repair of Same:** No payment shall be made.

**D. Structure Removal:** The Engineer shall count the quantity of structures to be removed including each utility access and inlet removed in accordance with the plans and will be paid for by the number removed.

**E. Surfacing Removal and Replacement:** All temporary or permanent surface removals and replacements for both granular and hard surfaces for streets, drives, and sidewalks will be included in the contract unit prices for all pipe and structures.

**F. Utilities Abandonment:** The Contractor, in cooperation with utility companies, shall verify abandoned utility lines including gas, water mains, telephone conduits, services, etc. and upon verification shall remove and dispose of the utilities within the work zone which shall be considered included in the contract unit price for pipes and structures.

**G. Compaction Testing:** Shall be in accordance with the following:

1. Contract documents shall indicate whether the Contracting Authority or Contractor shall be responsible for testing.
2. If the Contractor is responsible for testing, it shall be performed by an authorized independent testing lab hired by the Contractor.
3. If the Contracting Authority is responsible for testing, the Contracting Authority will assume costs of all tests required, except retesting resulting from failure of the initial tests. Pay request for testing shall indicate whether the test is an initial test or a retest.
4. In all cases, the Contractor shall pay for retesting resulting from failure of initial tests.

**PART 2 - PRODUCTS**

**2.01 EXCAVATION MATERIALS**

**A. Unclassified Excavation:** Excavation of all materials encountered, except for culverts, rock, over-excavation, trench bottom stabilization, unsuitable soil replacement, or as specified in the contract documents. No separate payment will be made for unclassified excavation.

**B. Culvert Excavation (Class 20 Excavation):** All excavation required for culverts except Class 22 excavation.

**C. Rock Excavation (Class 22 Excavation):** Boulders or sedimentary deposits so firmly cemented together that they cannot be removed without continuous use of pneumatic tools or blasting.

**D. Structures Removed:** Concrete structures: utility accesses and storm drain inlets.

**E. Surfacing Materials:** In accordance with Section 2301 or 2303 of the Standard Specifications.

**F. Suitable Excavated Materials for Backfill:**

1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D 2321, Class II through IVA.
2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) may be used in the final backfill upon approval of the Engineer.
3. Adjust moisture content of excessively wet, but otherwise acceptable material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
5. Lime or fly ash may be added to earth material to produce a suitable backfill material. Uniformly mix soil and additive. Prepare new Standard Proctor Tests of the modified material. Amount of additive applied is subject to the Engineer's approval.

**G. Non-Manufactured (Excavated) Backfill Materials:** (See Sections 3010, 2.03 and 2.04 of this Developmental Specification for manufactured backfill)

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 µm)	LL	PI	Uni- formity C <sub>u</sub>	Curva- ture C <sub>c</sub>
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100%	≥50% of "Coarse Fraction"	≤5%	Non Plastic	≥4	1 to 3	
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.					≤4	≤1 or ≥3	
		SW	Well-graded sands and gravelly sands; little or no fines.					≥6	1 to 3	
		SP	Poorly-graded sands and gravelly sands; little or no fines.					≤6	≤1 or ≥3	
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM	Sands and gravels that are borderline between clean and with fines.	100%	Varies	5% to 12%	Non Plastic	Same as for GW, GP, SW and SP		
III	Coarse-Grained Soils, with Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	≥50% of "Coarse Fraction"	12% to 50%		≤4 or ≤"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					≤7 and ≥"A" Line		
		SM	Silty sands, sand-silt mixtures.		≥50% of "Coarse Fraction"			≤4 or ≤"A" Line		
		SC	Clayey sands, sand-clay mixtures.		≤7 and ≥"A" Line					
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100%	100%	≥50%	≤50	≤4 or ≤"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clay, lean clays.					≥7 and ≥"A" Line		
IVB (1)	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	≥50%	≥50	≤"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					≥"A" Line		
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	≥50%	≤50	≤4 or ≤"A" Line		
		OH	Organic Clays of Medium to high plasticity, organic silts.					≤"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.				≥50			

(1) See Section 3010, 2.01 F.2 of this Developmental Specification for restrictive use.

**H. Unsuitable Material:** Unsuitable materials such as trees, stumps, waste construction materials, scrap metals, and other materials not suitable for backfilling or for topsoil.

1. Rock with gradation not meeting the stated gradation for stabilization material.
2. Individual stones or concrete chunks larger than 6 inches (150 mm), and averaging more than one per each cubic foot (0.03 m<sup>3</sup>) of earth.
3. Frozen materials.
4. Stumps, logs, branches, and brush.
5. Trash or construction waste.
6. Earth in clumps or clods larger than 6 inches (150 mm), and without sufficient fine materials to fill voids during placement.
7. Earth, outside of the suitable soil range as stated in Article 2102.06, A, 2 of the Standard Specifications.
8. Class V Material (ASTM D 2321).

**I. Replacement of Unsuitable Earth Materials:**

1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary earth backfill material.
2. Remove and dispose of unsuitable material from the site.

**2.02 STABILIZATION (FOUNDATION) MATERIALS**

**A.** Clean 2 1/2 inch (63.5 mm) crushed stone or crushed P.C. concrete material, with the following gradation:

Sieve	Percent Passing
2 1/2 inch (63 mm)	100
2 inch (50 mm)	90 to 100
1 1/2 inch (37.5 mm)	35 to 70
1 inch (25 mm)	0 to 15
1/2 inch (12.5 mm)	0 to 5

**B.** The Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within  $\pm 5\%$  of the gradation for each size of material.

**2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (Storm Sewer and Sanitary Sewers)**

A. Granular bedding shall be gravel, crushed stone, or crushed PCC, complying with the following gradation:

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

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

B. Compaction: minimum density of 90% Standard Proctor or 45% Relative Density.

**2.04 CLASS II BACKFILL MATERIAL (WATER MAINS)**

A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse grained natural soils (clean) with little or no fines.

B. Class II material is non-plastic soil less than 1.5 inches (37.5 mm) in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 µm) sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 µm) sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 µm) sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 µm) sieve. Clean.	

C. Compaction: Minimum Density of 90% Standard Proctor in 6 inch (150 mm) layers or 45% Relative Density.

D. Class II material may be specified in the contract documents, between the pipe embedment zone and the top 2 feet (0.6 m) of final backfill when the trench is under the pavement.

**2.05 CLASS III BACKFILL MATERIAL (WATER MAINS)**

- A. Class III material is natural coarse grained soils with fines.
- B. Class III material follows Section 3010, 2.01 G of this Developmental Specification and consist of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 $\mu$ m) sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 $\mu$ m) sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 $\mu$ m) sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 $\mu$ m) sieve.	

- C. Compaction: Minimum Density of 95% Standard Proctor with - 2% deviation. Compact in 6 inch (150 mm) layers.

**2.06 CLASS IVA BACKFILL MATERIAL (WATER MAINS)**

- A. Class IVA material is natural fine grained inorganic soils.
- B. Class IVA material follows Section 3010, 2.01 G of this Developmental Specification and consist of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty, or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 (75 $\mu$ m) sieve.	Obtain geotechnical evaluation of proposed material, may not be Suitable under high earth Fills, surface applied where Loads and under heavy Vibratory compactors and Tampers. Do not use where water conditions in Trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 (75 $\mu$ m) sieve.	

- C. Compaction: Minimum Density of 95% Standard Proctor in 6 inch (150 mm) layers.
- D. Suitable only in dry trench conditions.

**2.07 CLASS IVB BACKFILL MATERIAL (WATER MAINS)**

- A. Class IVB material is natural fine grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.
- B. Class IVB material follows Section 3010, 2.01 G of this Developmental Specification and consist of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 (75 µm) sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 (75 µm) sieve.	

- C. Compaction: Minimum Density of 95% Standard Proctor in 6 inch (150 mm) layers.
- D. Upon the approval of the Engineer suitable only as final backfill in a dry trench and shall not be used in pipe embedment zone.

**2.08 CLASS V BACKFILL MATERIAL (UNSUITABLE BACKFILL)**

- A. Class V Material is natural highly organic soils with a liquid limit of greater than 50%. See Section 3010, 2.01 G of this Developmental Specification.
- B. Use Class V Material only as topsoil in the final top 6 inches (150 mm) of backfill outside of the pavement.
- C. Class V Material shall not be used in the pipe embedment zone.

**2.09 INTENTIONALLY LEFT BLANK**

**2.10 INTENTIONALLY LEFT BLANK**

**2.11 SPECIAL PIPE EMBEDMENT MATERIAL**

- A. **Concrete Supports:** Where specified in the contract documents the Contractor shall construct concrete support systems in accordance with Figures 3010.2, 3010.3, 3010.4, 3010.5, 3010.6, and 3010.7.
- B. **Concrete Bedding, Arch, or Encasement:**
  1. Concrete; commercial, 4,000 psi (27.6 MPa) compressive strength.
  2. Unreinforced.
  3. Minimum concrete thickness; 6 inches (150 mm).

**C. Flowable Mortar:**

1. Approximate quantities per cubic yard (cubic meter);
  - a. Cement 100 pounds (60 kg)
  - b. Fly ash 300 pounds (180 kg)
  - c. Fine aggregate 2,600 pounds (1,545 kg)
  - d. Water, approximate 70 gallons (345 L)
2. Compressive strength at 28 days; 100 psi to 200 psi (690 kPa to 1,380 kPa).

**D. Controlled Low Strength Material (CLSM):**

1. Approximate quantities per cubic yard (cubic meter);
  - a. Cement 50 pounds (30 kg)
  - b. Fly ash 250 pounds (150 kg)
  - c. Fine aggregate 2910 pounds (1,729 kg)
  - d. Water, approximate 60 gallons (296 L)
2. Compressive strength at 28 days 50 psi (345 kPa).

**2.12 CASING PIPE**

See Section 3020, 2.02 of this Developmental Specification.

**PART 3 - EXECUTION****3.01 PREPARATION**

- A. When natural soils for Class II, III and IV backfill material are required as specified in Figure 3010.1 the Contractor shall provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.
- B. Locate, mark, and protect existing utilities and facilities in the work area.
- C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.
- D. Identify owners of utilities on or near the site, and notify them of operations to occur.
- E. Protect existing facilities and landscaping features, or replace as shown on the plans.
- F. Protect bench marks, control points, and land survey monuments, or replace at Contractor's expense.

**3.02 TRENCH EXCAVATION**

- A. Notify the Engineer prior to start of excavation activities.
- B. Remove and stockpile top 8 inches (200 mm) of topsoil for subsequent reuse.
- C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

**D.** Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches (150 mm) below and on each side of the pipe. Restore grade using soil suitable for backfill.

**E.** Correct unauthorized excavation at no cost to Contracting Authority, using bedding or stabilization materials.

**F.** Provide protective fences and barricades around open excavations, appropriate to the surrounding area.

**G.** Provide scale tickets for stabilization material to the Engineer at the time of delivery.

**H.** Provide safety fence around open excavations.

**I.** Trench Excavation for Water Mains:

**1.** Maximum pipe trench width: Limit width at top of pipe to diameter of the pipe, plus 24 inches (600 mm), plus minimum clearance for shoring, sheeting, or trench box (if any).

**2.** Minimum pipe trench width: Pipe nominal diameter plus 18 inches (450 mm), but not less than 24 inches (600 mm) total.

**3.** Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping.

- a.** Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
- b.** Provide bell holes.

**4.** Trench bottom, conduit supported by bedding material.

- a.** Excavate trench as shown in the plans.
- b.** Install bedding material to support the full length of the pipe barrel.

**5.** Trench depth:

- a.** See Figures 3010.1.
- b.** For those material types not shown in Figure 3010.1 and maximum height of bury shall be 20 feet (6 m) without a designed trench with the Engineer's certification.

**J.** Intentionally Left Blank.

**K.** Structure Excavation:

**1.** For concrete structures and parts of structures without footings, 18 inches (450 mm) outside the horizontal projection of the structure.

**2.** For concrete structures with footings, 18 inches (450 mm) outside the footings.

**3.** For anchor rods, 12 inches (300 mm) on each side of the rod.

**4.** For buried anchors, the face of the buried anchor on one side and 24 inches (600 mm) outside the buried anchor on the other face.

### **3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM**

- A. Notify the Engineer prior to over-excavation.
- B. The Engineer shall determine the need for trench bottom stabilization prior to installation of pipes and structures.
- C. Remove rock or very hard clay or soft areas of the trench bottom to a depth of 1 foot (0.3 m) below the base of the pipe or structure, and backfill with earth or stabilization materials as required.
- D. Provide scale tickets for the stabilization material to the Engineer at the time of delivery.

### **3.04 SHEETING, SHORING, AND BRACING**

- A. Sheeting and bracing of all excavations shall conform to the latest state and federal regulations governing safety of workers in the construction industry.
- B. Leave in place all temporary sheeting below 2 feet (600 mm) over top of pipe unless sheeting removal plan is approved by the Engineer.
- C. Move trench boxes carefully to avoid excavated wall displacement or damage.
- D. When necessary or required, adequate sheeting and bracing shall be installed to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.
- E. Any damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.
- F. Sides of trenches in unsuitable, loose or soft material, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect employees working within them.
- G. Where excavations are made with vertical sides that require supporting, the sheeting and bracing shall be of sufficient strength to sustain the sides of the excavations and to prevent movement that could in any way injure the work, or adjacent structures, or diminish the working space sufficiently to delay the work.
- H. It shall be the Contractor's responsibility to select sheeting and bracing material of sufficient dimensions and strength to adequately support the sides of trenches and excavations, shall not split when driven and shall be free of imperfections that may impair its strength or durability.
- I. Sheeting shall be driven to true alignment and to insure contact of adjacent pieces.
- J. In wet excavation grooved sheeting shall be used to prevent passage of soil. Any voids between sheeting and face of excavation shall be filled with suitable material.
- K. Sheeting and bracing shall not be removed before the completion of the work, unless otherwise directed in writing by the Engineer.
- L. Sheeting that is left in place shall be cut off 18 inches (0.5 m) for clearance below the bottom of the pavement in streets/highways and 18 inches (0.5 m) below the original ground surface,

unless otherwise required by the contract documents. Leave in place all temporary sheeting below 2 feet (0.6 m) over top of pipe unless sheeting removal plan is reviewed by the Engineer.

### **3.05 DEWATERING**

- A.** Do all work in dry conditions; do not install pipes on excessively wet soil.
- B.** The dewatering operation shall be performed in accordance with the dewatering plan submitted to the Engineer by the Contractor. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.
- C.** Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.
- D.** Install dewatering system appropriate for the soil conditions.
- E.** Maintain water levels sufficiently below the bottom of trench excavation, (typically 2 feet (0.6 m)) to prevent upward seepage.
- F.** Provide for handling water encountered during construction:
  - 1.** Prevent surface water from flowing into excavation. Remove water as it accumulates.
  - 2.** Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires the Engineer's approval.
  - 3.** Do not discharge water onto adjacent property without property owner's written approval.
  - 4.** Water discharge shall be maintained and controlled as necessary so not to create a safety hazard for vehicular and pedestrian traffic.
  - 5.** Water discharge shall be directed away from electrical facilities or equipment, and intersections.
  - 6.** Dewatering equipment shall include noise and fume reduction devices to minimize disturbance.
  - 7.** Contractor shall provide at least two operating pumps for each trench opened in wet ground and at the same time shall have one pump in reserve.
- G.** Backfill pipes prior to stopping dewatering operations.
- H.** Trench water discharge points shall be protected from erosion.
- I.** Contractor shall operate dewatering systems so as not to damage adjoining structures and facilities.
- J.** Contractor shall monitor adjoining structures and facilities during dewatering operations. Dewatering operations shall cease and the Engineer shall be notified if damage is observed.

### **3.06 PIPE PLACEMENT FOR WATER MAINS**

Refer to Figure 3010.1, included in the plans, as appropriate for the installation being made. Use only the types of materials shown for each position within the trench, for the given groundwater conditions, for the compaction to be provided and for the type of pipe being installed.

#### **A. Pipe Bedding:**

1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.
2. Install pipe and system components.
3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.
4. Place bedding in lifts not greater than 6 inches (150 mm) thickness and compact to 90% Standard Proctor Density or 45% Relative Density using vibratory compactor.
5. Concrete encasement: Install where shown in the plans.
6. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.
7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

#### **B. Haunch Support:**

1. Refer to Figures 3010.1 and 3010.2, as appropriate for the installation being made.
2. Place haunch material in lifts not greater than 6 inches (150 mm) thickness and compact to minimum 90% Standard Proctor Density using vibratory compactor for granular soils.
3. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other haunch material types.
4. Secure pipe against displacement or flotation prior to placing flowable mortar, Controlled Low Strength Material, or concrete encasement.

#### **C. Primary and Secondary Backfill (Pipe Cover):**

1. Refer to Figures 3010.1, 3010.2, and 3010.3 as appropriate for the installation being made.
2. Place pipe cover material in 6 inches (150 mm) lifts and compact to densities required according to class of material. See Section 3010, 2.04, 2.05, and 2.06 of this Developmental Specification.
3. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types.
4. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

5. Special Pipe Support: If required, provide special pipe support as shown on the plans (See Figures 3010.2-7).

**D. Final Trench Backfill:**

1. Backfill trench immediately after recording locations of connections and appurtenances, or at the Engineer's direction.
2. Backfill structures immediately after concrete has reached design strength and connecting work has been completed.
3. Allow no more than 100 feet (30 m) of trench to be open overnight or when work is not in progress.
4. Backfill with suitable excavated earth materials:
  - a. Carefully place backfill over top of pipe and around structures.
  - b. Compact as required.
5. Compaction:
  - a. Place backfill more than 3 feet (900 mm) below pavement structure in uncompacted lifts not thicker than 8 inches (200 mm). Compact each lift to at least 95% of maximum Standard Proctor Density.
  - b. Place backfill in remainder of excavation in 6 inch (150 mm) lifts. Compact each lift to at least 95% of maximum Standard Proctor Density. Terminate backfill at 6 inches (150 mm) below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved.
  - c. For VCP, all heavy compaction equipment shall be kept 5 vertical feet (1.5 vertical meters) above the top of the pipe. In the area less than 5 vertical feet (1.5 vertical meters), hand held compactors shall be used. Care should be taken to not allow the compactor to come in contact with the pipe.
6. Dispose of surplus and unsuitable materials.
7. Hydraulic compaction is not allowed unless authorized by the Engineer.

- E. Casing Pipe:** Bed and backfill casing pipes as for a rigid gravity flow pipe.

**3.07 INTENTIONALLY LEFT BLANK**

**3.08 STRUCTURE BEDDING**

**A. Bedding for Structures Bearing on Undisturbed Soils:**

1. Shape the bottom to accurate grade and size.
2. Remove loose material, large clods, stones, and foreign materials.
3. In unstable soils condition see Section 3010, 3.03 of this Developmental Specification for stabilization requirements.
4. If rock, clay, or unstable soils are encountered the material below the structure shall be excavated to a depth at least 1 foot (300 mm) and backfilled with material specified in Section

3010, 2.02 of this Developmental Specification. Bedding will be required as shown in Figure 3010.1.

**B. Bedding for Structures Bearing on Bedding Material:**

1. Over excavate to minimum of 8 inches (200 mm) or as specified in the contract documents.
2. Place bedding material for structures in accordance with the contract documents and with the material and control specified in Figure 3010.1.

**3.09 STRUCTURE BACKFILL**

**A. Removal of Forms and Falsework:** Unless otherwise indicated in the contract documents, forms and falsework shall be removed and may normally be removed in accordance with the following provisions. In cool or unfavorable weather, the Engineer may require forms to remain in place for longer periods.

**1. Forms that may be removed in less than 5 calendar days:**

- a. Forms for ornamental work, railings, parapets, curbs, and any other vertical surfaces may be removed whenever the concrete will not be damaged by so doing, but not less than 12 hours after the concrete is placed.
- b. Forms for roofs of culverts may be removed when the concrete has attained an age of 3 calendar days and a flexural strength of 350 psi (2.4 MPa) for spans of 4 feet (1.2 m) or less, 400 psi (2.7 MPa) for spans 4 to 6 feet (1.2 m to 1.8 m), and 450 psi (3.1 MPa) for spans exceeding 6 feet (1.8 m).

**2. Forms that must remain in place 5 calendar days or longer:**

- a. Except when form removal is permitted in less than 5 calendar days, forms may be removed as soon after 5 calendar days as the concrete has attained the required strength.
- b. When strength is not determined, forms for box culverts 4 feet (1.2 m) or less in width may be removed after the concrete has attained an age of 7 calendar days, and forms for other concrete may be removed after the concrete has attained an age of 14 calendar days.

**3. Use of Fly Ash:** Class F fly ash is used and strength is not determined, the ages for form removal, described above, shall be increased to 8 calendar days and 15 calendar days, respectively.

**B. Backfill Placement:** Backfill immediately after structure concrete has reached design strength and connecting work has been completed.

**C. Backfill Against Two Walls:**

1. Where backfill is required on both sides of a concrete wall, or other monolithic structure, filling operations shall proceed simultaneously on both sides of the structure so that the two fills are kept at approximately the same elevation at all times. For the purposes of this paragraph, concrete box, arch, and circular culverts shall be considered to be monolithic structures.
2. Compaction of the 3 feet (900 mm) closest to these walls or wing faces shall be done by pneumatic or hand tampers only.

**D. Backfill Against One Wall:**

1. Where backfill is to be placed on one side only of retaining walls, or wingwalls of culverts 8 feet (2.45 m) or more in height, rolling shall not be done within 3 feet (900 mm) of the wall face.
2. Compaction of the 3 feet (900 mm) closest to these walls or wing faces shall be done by pneumatic or hand tampers only.

**E. Moisture Control and Density:**

1. When moisture control is required, backfill material shall be placed in layers not more than 8 inches (200 mm) in loose thickness.
2. Each layer shall be reasonably leveled and thoroughly compacted before the next layer is placed.
3. A tamping type roller shall be used, and compaction shall be not less than one roller passage per inch (25 mm) of loose thickness. Excavation shall be to a width to accommodate the roller to be used and to provide a reasonably level area for the roller operation for the first and all subsequent layers.
4. A mechanical tamper shall be used for each layer in areas inaccessible to the roller.

**F. Backfilling with Excavated Material:**

1. When flowable mortar, controlled low strength material, or granular backfill is not specified in the contract documents, excavated material shall be used.
2. Backfilling shall continue to natural ground line unless there is an inadequate quantity of suitable excavated material.
3. If there is an inadequate quantity of suitable excavated material, backfilling shall be continued until the suitable material is depleted.
4. Material used for backfilling shall be free from organic material, boulders or broken concrete over 6 inches (150 mm) in the greatest dimension, or frozen material.
5. At the time soil is placed for backfill, its moisture content shall be suitable for compaction. When compaction with moisture control is required by the contract documents, the moisture content in the backfill material shall be increased or reduced, as necessary, to bring the moisture within the designated moisture limits prior to and during placement and compaction.

**G. Backfilling with Granular Backfill:**

1. When granular backfill material is specified, backfill material shall meet the following requirements. When the volume of material excavated exceeds that of backfill required by the contract documents, the quantity of granular backfill material furnished shall be increased to provide backfill for the excess volume of excavation.

Sieve	Percent Passing
3 inch (75 mm)	100
No. 8 (2.36 mm)	20 to 100
No. 200 (75 µm)	0 to 10

Article 4102.09, Gradation 32, of the Standard Specifications.

Note: Crushed stone shall have 100% passing the 1 inch (25 mm) sieve.

2. Granular backfill shall be constructed in layers of not more than 8 inches (200 mm). Each layer shall be thoroughly tamped or vibrated to insure compaction. The Engineer may require granular material to be moistened with water during backfilling operations.

**3. Backfill in Water:**

- a. Backfill material may be placed in water only when removal of water from the area to be backfilled is impractical, within the waterway or in other deep excavations where removal of cofferdams is required before backfilling and such removal prevents dewatering.
- b. Backfill material placed in water need not be consolidated. When specified, all backfill material placed under water, over which a subsequent embankment is to be placed, shall be granular backfill material.

**4. Backfill above Water:**

- a. Backfill material placed above the water line shall be placed in layers not more than 8 inches (200 mm) in loose thickness.
- b. Each layer shall be thoroughly compacted before material for the next layer is placed.
- c. All compaction shall be accomplished by rolling with an approved roller or by tamping with a mechanical tamper. Pneumatic tampers shall be operated according to the manufacturer's recommendations.

**H. Compaction Outside Road Right-of-Way in Unpaved Areas:**

- 1. Place backfill in lifts not thicker than 8 inches (200 mm), to 6 inches (150 mm) below finish grade.
- 2. Obtain at least 90% of maximum Standard Proctor Density using compaction equipment.

**I. Compaction within Road Right-of-Way, in Paved Areas, and in Areas to be Paved:**

- 1. Place backfill more than 3 feet (900 mm) below pavement structure in lifts not thicker than 8 inches (200 mm). Compact each lift to at least 95% of maximum Standard Proctor Density.
- 2. Place backfill in the remainder of the excavation in lifts not thicker than 6 inches (150 mm). Compact each lift to at least 95% of Standard Proctor Density.

**3.10 FIELD QUALITY CONTROL**

**A. References:**

- 1. ASTM C 136; Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- 2. ASTM D 698; Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5 lb. (4.54 kg) Rammer and 12 inch (305 mm) Drop. (Standard Proctor Method)
- 3. ASTM D 2922 and D 3017; Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).

4. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.

**B. Compaction Testing:** Provide compaction testing of backfill, using the services of an independent testing laboratory approved by the Engineer, unless testing is provided by the Engineer.

**C. Moisture Range:** Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

**D. Schedule Testing:** Notify the Engineer when work is prepared for testing.

**E. Soil Testing:**

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

2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).

3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).

4. Gradation: Test in accordance with ASTM C 136.

**F. Testing Frequency:** Unless otherwise provided by the Contracting Authority, the Contractor shall complete the following tests:

1. Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill at each street crossing.

2. Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill for each 200 linear feet (60 linear m) of trench.

3. Additional testing may be required by the Engineer if non-compliance or a change in conditions occurs.

**G. Test Failure:** Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the trench.

**H. Retesting:** In event of failed tests, the Engineer may retest as deemed necessary. Costs of such retesting shall be paid by the Contractor. Refer to Section 3010, 1.08 G of this Developmental Specification.

## **SECTION 3020 - TRENCHLESS CONSTRUCTION (BORING, JACKING, AND TUNNELING)**

### **PART 1 - GENERAL**

#### **1.01 SECTION INCLUDES**

A. Trenchless installation of carrier pipe with casing pipe.

B. Trenchless installation of carrier pipe without casing pipe.

## 1.02 DESCRIPTION OF WORK

- A. Excavate launch and receiving pits.
- B. Install casing pipe.
- C. Install carrier pipe.
- D. Backfill excavations.
- E. Possible methods of trenchless installation (refer to Section 3020, 3.05 B of this Developmental Specification for restrictions):
  - 1. **Auger Boring:** A boring method that utilizes a rotating cutting head to form the bore and a series of rotating augers inside a casing pipe to remove the spoil.
  - 2. **Compaction Method:** Boring methods that displace soil radially rather than removing spoil. Bore hole may be formed with a push rod or impact mole.
  - 3. **Directional Drilling:** A boring method for installing pipe from a surface launched drilling rig. A pilot bore is formed and then enlarged by back reaming. The product pipe is then pulled in.
  - 4. **Pipe Ramming:** A boring method that involves driving a steel casing pipe with a percussive hammer. The front end of the casing pipe may be open ended or closed. If open, spoil must be removed from the pipe.
  - 5. **Slurry Boring:** A boring method that first forms a pilot bore by forcing a drill tube through the ground. The pilot hole is then enlarged by reaming. As the hole is enlarged with the reamer, drilling fluid (slurry) is pumped into the hole to hold the soil cuttings in suspension. After reaming, the product pipe is pulled into place.
  - 6. **Microtunneling:** A boring method that consists of a remotely controlled pipe jacking operation utilizing a tunnel boring machine. Personnel entry is not required.
  - 7. **Pipe Jacking:** A jacking method in which pipe is pushed into the ground with hydraulic rams while soil is simultaneously excavated. Excavation is normally completed with a tunnel boring machine. This method requires personnel to enter the tunnel during the excavation process.
  - 8. **Utility Tunneling:** A method of forming large diameter tunnels. As excavation takes place at the front of the tunnel, a liner is constructed to temporarily support the tunnel. Upon completion of the tunnel, the product pipe is pushed in place.
  - 9. Other proven methods not described here may be allowed upon approval of the Engineer.

## 1.03 SUBMITTALS

- A. Proposed installation methods and equipment.
- B. Samples, granular bedding material: submit 10 pound (5 kg) samples if required.
- C. Samples, granular backfill material: submit 10 pound (5 kg) samples if required.

- D. Gradation reports for fill materials and bedding materials unless the material used has been submitted and approved for related work on the project.
- E. Results of Standard Proctor and In-Place Density Tests on pit backfill if required.
- F. Construction sequence.
- G. Catalog cuts, samples, manufacturer's data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.
- H. Certification that materials being provided meets the requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer.
- I. Project Record Documents.
- J. Upon requests the Contractor shall provide material certifications to the Engineer.

#### **1.04 SUBSTITUTIONS**

- A. Obtain approval of the Engineer for all substitutions prior to use.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.
- B. Remove unsuitable and excess materials from the site.

#### **1.06 SCHEDULING AND CONFLICTS**

##### **A. Construction Sequence:**

1. Attend a preconstruction meeting if required by the Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

##### **B. Conflict Avoidance:**

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.
3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

#### **1.07 SPECIAL REQUIREMENTS**

- A. **Stop Work:** Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

**B. Use of Explosives:** Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.
2. Use experienced demolition personnel.

## 1.08 MEASUREMENT FOR PAYMENT

All measurements for payments will be made by the Engineer.

**A. Boring, Jacking, or Tunneling with Casing Pipe:** Measure the length of casing pipe and carrier pipe properly installed along the centerline of the casing. Payment will be made for both the carrier pipe and casing pipe as a combined single contract unit for the appropriate method of installation.

**B. Jacking or Boring without a Casing Pipe:** Measure the length of the carrier pipe properly installed along the centerline of the carrier pipe.

**C. Incidental Items:** Unless otherwise specified in the contract documents the following items shall be included in the contract unit price for boring, jacking, or tunneling either with or without a casing.

1. Launch or reception pits, or other construction excavations.
2. Backfilling of construction excavations or pits, compaction, and compaction testing of backfill material.
3. Guides, fillers, levels, backfill, and other appurtenances necessary to perform specified function.

## PART 2 - PRODUCTS

### 2.01 CARRIER PIPE

The carrier pipe within the casing pipe is used for conveyance of water, sewage, or other material. See Division 4 or Division 5 of this Developmental Specification.

### 2.02 CASING PIPE

**A. Casing Pipe:** The pipe used for structural strength of the installation and for protection of the carrier pipe. Use only new, welded or seamless steel pipe per ASTM A 139, Grade B; ASTM A 252, Grade 2; or ASTM A 53, Grade B.

**B. Joints:**

1. Comply with American Welding Society Code of Arc and Gas Welding in Building Construction. Fully weld all joints with full penetrating weld.
2. Upon approval of the Engineer, an interlocking casing pipe connection system may be used instead of field welding the sections of casing pipe.

**C. Casing Pipe Diameter:** Minimum inside diameter as shown on the plans. If not shown, casing diameter shall not be less than 4 inches (100 mm) greater than the greatest outside diameter of the carrier pipe, including pipe bells.

**D. Casing Pipe Minimum Wall Thickness:**

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

**2.03 CASING PIPE FILLER**

**A. Fill only if required on plans:** The space between the carrier and casing pipe should not be filled completely to avoid transfer of earth and live loads from the casing to the carrier pipe (AWWA 6600).

**B. Fill material:** Fill sand, Controlled Low Strength Material (CLSM), or flowable mortar.

**2.04 CARRIER PIPE GUIDE**

See Figure 3020.1.

- A. Manufactured guide to position carried pipe in casing. Wood skids will not be allowed.
- B. Material requirements for carrier pipe guide shall be in accordance with the following:
  - 1. **Band/Panel:** Type 304 Stainless Steel per ASTM A 240 or Carbon Steel per ASTM A 36.
  - 2. **Riser:** Type 304 Stainless Steel per ASTM A 340 or Carbon Steel per ASTM A 36.
  - 3. **Liner:** Elastomeric PVC per ASTM D 149.
  - 4. **Chock Skid/Runner:** Abrasion resistant polymer with a low coefficient of friction.
  - 5. **Fasteners:** Type 304 (18-8) Stainless Steel per ASTM A 193.

#### **2.05 BACKFILL FOR ABANDONED TUNNELS**

- A. Option 1 - PCC, 3,000 psi (20.7 MPa) minimum, approximately 4 inch (100 mm) slump.
- B. Option 2 - Flowable mortar or CLSM per Section 3010, 2.11 C of this Developmental Specification.

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

- A. Verify suitability of excavated materials for reuse as backfill.
- B. Locate, mark, and protect existing utilities and facilities in the work area.
- C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.
- D. Identify owners of utilities on or near the site, and notify them of operations to occur.
- E. Protect existing facilities and landscaping features or replace as shown on the plans.
- F. Protect bench marks, control points, and land survey monuments or replace at Contractor's expense.
- G. Select a method of installation that is appropriate for the soil conditions anticipated; shall allow the pipe to be installed to the desired line and grade within the specified tolerances; shall prevent heaving or settlement of the ground surface or damage to nearby facilities.

#### **3.02 EXCAVATION**

- A. Notify the Engineer prior to start of tunneling activities.
- B. Remove and stockpile top 8 inches (200 mm) of topsoil for subsequent reuse. Do not mix topsoil with other excavated materials.
- C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.
- D. Remove rock, rubbish, debris, and unsuitable materials.

- E. Excavate the minimum size pits necessary to safely and properly perform the work.

### **3.03 SHEETING, SHORING, AND BRACING**

Provide and install sheeting, shoring, and bracing or trench boxes as required to safely perform work, protect nearby structures, and work under construction.

### **3.04 DEWATERING**

See Section 3010 of this Developmental Specification.

### **3.05 TRENCHLESS INSTALLATION**

#### **A. General:**

1. Install pipes by boring, jacking, or tunneling only where required by the plans.
2. Bedding and backfilling of the carrier pipe beyond the end of the casing pipe, tunneling pits, and casing pipes installed by open-cut trenching shall be in conformance with Section 3010 of this Developmental Specification.
3. Install pipe at line and grade that:
  - a. Shall permit the carrier pipe to be installed at its true starting elevation and grade within a maximum alignment deviation of the pipe centerline as specified in the contract documents.
  - b. When no deviation tolerances are specified in the contract documents, the following shall apply:
    - 1) **Gravity Pipe:**  
Horizontally:  $\pm 1.0$  foot per 100 feet ( $\pm 300$  mm per 30 m) of tunneling  
Vertically:  $\pm 0.2$  foot up to 200 feet ( $\pm 60$  mm per 60 m) of tunneling; an additional  $\pm 0.1$  foot ( $\pm 30$  mm) between 200 feet and 300 feet (60 m and 90 m) or a total of  $\pm 0.3$  foot ( $\pm 90$  mm) deviation between 200 feet and 300 feet (60 m and 90 m). No backfill in the pipe shall be allowed.
    - 2) **Pressure Pipe:**  
Horizontally:  $\pm 2.0$  foot ( $\pm 600$  mm)  
Vertically:  $\pm 1.0$  foot ( $\pm 300$  mm). Minimum depth of 5 feet (1.5 m) or as specified in the contract documents shall be maintained.
  - c. Greater deviation may be cause for rejection of the tunnel.
  - d. Shall not cause unintentional interference with other facilities.
4. Provide any additional fittings, utility accesses, or appurtenances needed to accommodate any horizontal or vertical misalignment, if allowed by the Engineer, at no added cost.
5. Contractor shall be allowed to correct errors in grade of the casing pipe in order to achieve design grade of the carrier pipe by pouring an invert in the casing pipe, or by shimming the carrier pipe to a uniform grade, provided adequate clearance remains for proper installation of the carrier pipe, if allowed by the Engineer.

6. If a solution to correct misaligned casing or carrier pipes(s) is not acceptable to the Engineer, and the Engineer determines it is possible to redo the tunneling, the Contractor shall re-tunnel at the Contractor's expense. This shall include any additional fittings, utility access, or appurtenances needed to accommodate a horizontal or vertical misalignment.

**B. Casing Pipe or Un-cased Carrier Pipe Installation:**

1. Install pipe by auger boring, pipe jacking, microtunneling, open-ended pipe ramming, directional drilling (back-reaming required), or utility tunneling.
2. Methods that displace excess soil, rather than removing it, such as impact moling, push rod, or closed end pipe ramming shall not be permitted unless specified in the contract documents, or permitted by the Engineer.
3. Water jetting will not be allowed.
4. Use a jacking collar, timbers, and other means as necessary to protect the driven end of the pipe from damage.
5. Fully support borehole at all times to prevent collapse. Insert pipe as earth is removed, or support bore with drilling fluid.
6. Fully weld all casing pipe joints or use interlocking connection system according to Section 3020, 2.02 B of this Developmental Specification.
7. Fill annular space between the inside of the bore hole and the outside of the pipe if the space is greater than 1 inch (25 mm). Use flowable mortar, CLSM (See Section 3010 of this Developmental Specification), or 3,000 psi (20.7 MPa) concrete.

**C. Carrier Pipe Installation Through Casing:**

1. Clean dirt and debris from the casing pipe after installation.
2. Attach pipe guides or casing chocks to pipe sections as necessary to support pipe barrel in accordance with pipe manufacturer's recommendation. Do not allow pipe to be supported by joint bells. See Figure 3020.1.
  - a. Pipe guides: At least one per pipe section.
  - b. Lubricant for pipe guides: Drilling mud or flax soap. Do not use petroleum-based lubricants or oils.
3. Assure that thrust loads will not damage carrier pipe joints. Provide thrust collars between joint shoulders of concrete pipe.
4. Provide timbers for sufficient cushioning between the end of the pipe pushed and the jacking equipment to prevent damage to the pipe. Do not allow steel jack face to thrust against unprotected pipe end.
5. Position jacks so that resultant force is applied along the centerline of the pipe, and that force is applied evenly to the entire end of the pipe.
6. Assemble pipe joints in the jacking pit, before pushing the carrier pipe into the casing.

7. Close end of casing pipe around the carrier pipe with open joint masonry plug. See Figure 3020.2.

### **3.06 FIELD QUALITY CONTROL**

Provide compaction testing of backfills and embankment, if required, as part of the field quality control for the carrier pipe line being constructed. Assure that at least one compaction test site occurs at each pit.

## **DIVISION 4 – SEWERS AND DRAINS**

### **SECTION 4010 - SANITARY SEWERS**

#### **PART 2 - PRODUCTS**

##### **2.01 SANITARY SEWERS (GRAVITY)**

**A thru F Intentionally Left Blank**

##### **G. Ductile Iron Pipe (DI) 8 inch to 54 inch (200 mm – 1350 mm):**

1. Conform to AWWA C 151/ANSI A 21.51.
2. Minimum pressure class: Class 52.
3. Interior linings.
  - a. Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.
  - b. Linings shall be specifically designed for sanitary sewer applications and may include: calcium aluminate, polyethylene, ceramic epoxy, and coal tar epoxy. Other lining types may be allowed upon approval of the Engineer.
  - c. Apply lining to interior of unlined ductile iron pipe and fittings in accordance with published specifications from manufacturer.
  - d. Seal all cut ends and repair field damaged areas in accordance with manufacturers recommendations.
4. Exterior coating: asphalt.
5. Push on joint: AWWA C111/ANSI A 21.11.
6. Fittings: mechanical joint AWWA C 110/ANSI A 21.10.
7. Polyethylene encasement: conform to AWWA C 105/ANSI A 21.5.
  - a. Minimum thickness: 8 mils (200  $\mu$ m).
  - b. Use for all ductile iron pipe and fittings in buried service.

## **DIVISION 5 - WATER MAIN AND APPURTENANCES**

### **SECTION 5010 - PIPE AND FITTINGS**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Pipe.
- B. Fittings.
- C. Special Fittings.
- D. Pipeline Accessories.

##### **1.02 DESCRIPTION OF WORK**

- A. Construct water mains and building service pipes.

##### **1.03 SUBMITTALS**

- A. Manufacturer's instructions for installation for all pipe and fittings utilized.
- B. Construction sequencing.
- C. Catalog cuts, samples, manufacturer's data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by Engineer.
- D. Joint restraint system.
- E. Project record documents.
- F. Upon requests the Contractor shall provide material certifications to the Engineer.

##### **1.04 SUBSTITUTIONS**

- A. Obtain written approval of Engineer for all substitutions prior to use.

##### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials in a protected environment, on pallets, or lagging.
- B. Pipe and fittings contaminated with mud and surface water shall be removed from the site and not used in construction unless thoroughly cleaned, inspected, and approved by Engineer.
- D. Handle all materials so as to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

##### **1.06 SCHEDULING AND CONFLICTS**

###### **A. Construction Sequence:**

1. Attend a preconstruction meeting if required by Engineer.

2. Submit plan for construction sequence prior to commencing construction unless specifically not required by Engineer.

**B. Conflict Avoidance:**

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations of each and verify clearances for proposed construction.
2. Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.
3. Notify Engineer of any conflicts discovered or any changes needed to accommodate unknown or changed conditions.

**1.07 SPECIAL REQUIREMENTS**

- A. Stop Work:** Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

**1.08 MEASUREMENT FOR PAYMENT**

All measurements for payments will be made by the Engineer.

**A. Water Main Pipe:**

1. Measure pipe in feet (meters) along the centerline of the pipe installed.
2. For water main installed within casing pipe (Section 3020, 1.08 of this Developmental Specification) measure the length in feet (meters) of casing/carrier pipe, along the centerline of the casing. Payment will be made for both carrier and casing pipe as a contract unit price for the appropriate method of installation.
3. No payment shall be made for pipe not properly installed.
4. Where a fitting is inserted in a straight section of pipe, include the laying length of the fitting in the direction of a straight section of pipe with the total length of pipe laid to obtain the total length of pipe for payment.
5. Payment will be made at the contract unit price for the quantity of each type of pipe installed in the project in accordance with the contract documents.

**B. Water Service Stubs and Stop Box:** That portion of the water service that is within the public right-of-way from the water main to the stop box. Count each water service stub installed.

**C. Fittings:**

1. Count fittings by type and size, for those shown on the contract.
2. Payment will be made for each type and size of fitting listed in the contract and installed in accordance with the contract documents at the contract unit price.
3. No separate payment will be made for fittings not shown as individual items in the contract.

**D. Pipeline Accessories:**

1. Count each pipeline accessory item of each type and size for those accessory items shown on the contract.
2. Payment will be made for each type and size of pipeline accessory at the contract unit price.
3. No separate payment will be made for pipeline accessories not shown as individual items in the contract.

**E. Water Service Relocation:**

1. Water Service Stop Box Relocation.
  - a. Count each separate stop box relocated.
  - b. Payment will be made at the contract unit price for each Stop Box relocated and shall include all work and materials required to move the stop box from its existing location to its new location.
  - c. Contract unit price shall assume:
    - 1) Existing ground key stop shall remain in place.
    - 2) New ground key stop with connections shall be installed.
    - 3) Where required, a new service box stem and rod shall be installed.
  - d. The cost of excavation and backfill shall be incidental to this item.
  - e. Stop boxes relocated in conjunction with "New Water Service", "Lower Existing Service," or "Lower Existing Service with New Copper" shall be considered incidental to those items.
2. Water Service Depth Check.
  - a. Payment will be made at the contract unit price for each Water Service that is checked in an individual trench.
  - b. Multiple services in one trench:
    - 1) Payment will be made for first service checked.
    - 2) No additional payment will be made for subsequent services in the same trench.
  - c. Excavation and backfill required to check the depth of the existing water service shall be incidental to the item.
  - d. For services that do not require lowering, relocation, replacement with a new service, or stop box relocation, payment will be made at the contract unit price for check depth of water service.
  - e. For services that require lowering, relocation, replacement with a new service, or stop box relocation, no separate payment will be made for checking depth.
3. Water Service Lowering.
  - a. The contract unit price shall include all work and materials required to lower designated service as required in Section 5010, 3.11 C of this Developmental Specification.
  - b. Payment will be made at the contract unit price for lower water service for each water service lowered in an individual trench.



e. Excavation and backfill shall be considered incidental to this item.

**7. Water Service Disconnection.**

- a. The contract unit price shall include all work and materials required to disconnect abandoned water services from the water main.
- b. Payment will be made at the contract unit price for the actual number of services disconnected.
- c. Excavation and backfill shall be considered incidental to this item.

**F. Incidental Items:**

- 1. Include the cost for testing and disinfection in the contract unit price for pipe and fittings.

**PART 2 - PRODUCTS**

**2.01 WATER MAIN PIPE**

**A. Polyvinyl Chloride (PVC) Pipe:**

- 1. Conform to ANSI/AWWA C900 or C905 with cast iron pipe equivalent outside diameters.
- 2. Wall Thicknesses:
  - a. 4 inch (100 mm) through 24 inch (600 mm) sizes: DR 18.
  - b. Sizes over 24 inch (600 mm): Refer to contract documents.
- 3. **Markings on Pipe:**
  - a. Name of manufacturer.
  - b. Size and class.
  - c. Spigot insertion depth gauge.
  - d. National Sanitation Foundation (NSF) seal.

**B. Ductile Iron Pipe:**

- 1. **Minimum Thickness Class:**
  - a. 4 inch (100 mm) through 24 inch (600 mm) sizes; Class 52 per ANSI/AWWA C151/A21.51.
  - b. Sizes over 24 inches (600 mm); as shown in the contract documents.
- 2. Cement-mortar lined, per ANSI/AWWA C104/A21.4 with asphalt seal coat.
- 3. External coating: asphalt.
- 4. Joint Type: Use push-on type, except as otherwise required in the contract documents.
  - a. Push-on: per ANSI/AWWA C111/A21.11.
  - b. Mechanical: per ANSI/AWWA C111/A21.11.
  - c. Restrained, buried: Pipe manufacturer's standard field removable system.
  - d. Restrained, in structures: Restraining gland, flanged or grooved.
  - e. Flanged: ANSI/AWWA C111/A21.11.

- f. Grooved: ANSI/AWWA C606.
- g. Gaskets: Per ANSI/AWWA C111/A21.11.

**5. Markings on Pipe:**

- a. Name of manufacturer.
- b. Size and class.
- c. Spigot insertion depth gauge.

**C. Prestressed Concrete Cylinder Pipe:**

**1. Design and manufacture in accordance with AWWA C301 and C304 to meet the following minimum conditions.**

- a. Internal pressure: 150 psi (1035 kPa).
- b. Earth loads: actual trench depth, but not less than 6 feet (1.8 m).
- c. Live loads: HS 20 vehicle over trench.
- d. Surge pressure: allowance 60 psi (415 kPa).
- e. Bedding: Type R2, AWWA C304, Figure 9.
- f. Safety factor: 2.5.

**2. Joints:**

- a. Steel joint rings with rubber gaskets per AWWA C301.
- b. External joint filler; cement mortar with diapers.
- c. Outlets: flanged, per ANSI B16.1, Class 125, with 1/8 inch (3 mm) minimum thickness rubber gaskets.

**3. Manufacture in accordance with AWWA C304.**

**2.02 WATER SERVICE PIPES**

- A.** Refer also to water service pipe matrix.
- B.** Controlling standards: Local plumbing and fire codes.

**C. Materials:**

**1. Copper Pipe:**

- a. Conform to ASTM B 88.
- b. Wall thickness: Type K.

**2. Ductile Iron Pipe:** As specified in Section 5010 2.01 polyethylene wrap is required.

**3. PVC Pipe:** ASTM 1785, SDR 21, Schedule 80, Type S joints.

**4. Brass Pipe:** Red, seamless, per ASTM B 43.

**5. Polyethylene Pipe:** Class 200, per ANSI/AWWA C901.

**2.03 BOLTS FOR WATER MAIN PIPE AND FITTINGS**

**A.** Corrosion Resistant:

- 1. Low alloy steel.

2. Ductile iron.
  3. Zinc or cadmium plated.
  4. Cor-Blue or approved equal
- B.** Uncoated Cor-Ten steel bolts are not allowed.

## **2.04 FITTINGS**

**A. For Polyvinyl Chloride (PVC) Pipe:** Use only ductile iron mechanical joint fittings as specified elsewhere in this section.

**B. For Ductile Iron Pipe:**

1. ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53.
  2. Joint Type: Mechanical or restrained, as required by Engineer.
  3. Cement-mortar lined per ANSI/AWWA C104/A21.4 with asphalt coating.
  4. Restrained Joints:
    - a. Restrained Mechanical Joints: Pipe manufacturer's standard field removable system.
    - b. Flanged: ANSI/AWWA C110/A21.10:
      - 1) Nuts: ASTM A 563, Grade A, heavy hex head.
      - 2) Gaskets: Rubber or approved composition; 0.125 inch (3 mm) thick; full face.
    - c. Grooved:
      - 1) ANSI/AWWA C606.
      - 2) Face to face dimensions: Equivalent to flanged, ANSI/AWWA C110/A21.10.
  5. Wall thickness: ANSI/AWWA C153/A21.53.
  6. Gaskets: Per ANSI/AWWA C111/A21.11.
- C. Fittings for Prestressed Concrete Cylinder Pipe:**
1. Design: Same as for Prestressed Concrete Cylinder Pipe.
  2. Conform to project requirements for locations, sizes, types, and orientations.

**SERVICE PIPE MATRIX**

Jurisdiction	Materials Allowed						Materials Allowed	
	Minimum Size Allowed, inches (mm)	Size 2 inches (50 mm) or Smaller Copper, Type K	Sizes greater than 2 inches (50 mm) to less than 4 inches (100 mm)				Sizes 4 inches (100 mm) and greater	
			PVC, SDR 21	PVC, Schedule 80	Polyethylene, Class 200	Brass	PVC, AWWA C900	Ductile Iron Pipe (1)
Algona	3/4 (19)	Yes				Yes		Yes
Altoona	1 (25)	Yes		Above 2" (50 mm)	Above 2" (50 mm)	Yes	Yes	Yes
Ames	1 (25)	Yes			SDR 7		Yes	Yes
Ankeny	3/4 (19)	Yes			1" to 3" (25 mm-75 mm)		Yes	Yes
Bondurant	1 (25)	Yes		Yes			Yes	
Boone	3/4 (19)	Yes						Yes
Carlisle	1 (25)	Yes					Yes	Yes
Clive	1 (25)	Yes						Yes
Colfax	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Creston								
Cumming	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Dallas County	1 (25)	Yes	Yes	Yes			Yes	Yes
Des Moines Water Works (2)	1 (25)	Yes				Yes		Yes
Fort Dodge	3/4 (19)	Yes						Yes
Grimes								
Jefferson	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Johnston	1 (25)	Yes						Yes
Knoxville	3/4 (19)	Yes	Yes	Yes		Yes	Yes	Yes
Madrid	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Mitchellville	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Nevada	1 (25)	Yes					Yes	Yes
Newton	3/4 (19)	Yes						Yes

Jurisdiction	Materials Allowed						Materials Allowed	
	Minimum Size Allowed, inches (mm)	Size 2 inches (50 mm) or Smaller Copper, Type K	Sizes greater than 2 inches (50 mm) to less than 4 inches (100 mm)				Sizes 4 inches (100 mm) and greater	
			PVC, SDR 21	PVC, Schedule 80	Polyethylene, Class 200	Brass	PVC, AWWA C900	Ductile Iron Pipe (1)
Norwalk	1 (25)	Yes		Yes			Yes	Yes
Pella	1 (25)	≤ 1" (25 mm)		1" - 4" (25 mm-100 mm)			DR14	Yes
Perry								
Pleasant Hill	1 (25)	Yes	Yes	Yes			Yes	Yes
Polk County	1 (25)	Yes						Yes
Sioux City	1 (25) Plastic 3/4 (19) Cu	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Urbandale Water Department	1 (25)	Yes					Yes	Yes
Webster City								
West Des Moines Water Works (3)	1 (25)	Yes				Yes	Yes	Yes
Windsor Heights	Refer to Des Moines Water Works							

**NOTES:**

1. Polyethylene wrap is required on all ductile iron pipe and iron fittings.
2. Service taps on mains owned by Des Moines Water Works will be made by Des Moines Water Works.
3. Service taps on mains owned by West Des Moines Water Works will be made by West Des Moines Water Works.
4. Contact Jurisdiction for Water Service Pipe requirements

**2.05 SPECIAL FITTINGS**

**A. Flange Adapter:**

1. Utilize where noted in the contract documents to allow for ease of dismantling piping in the future.
2. Body: Ductile iron conforming to the requirements of ASTM A 536.
3. End Rings (Follower Rings): Ductile iron conforming to the requirements of ASTM A 536
4. Gaskets: New rubber compounded for water service and resistant to permanent set.
5. Bolts and Nuts: High strength, low alloy corrosion resistant steel or carbon steel bolts conforming to the requirements of ASTM A 307

**B. Pipe Coupling:**

1. Utilize where noted on drawings to allow for ease of dismantling piping in the future, unless grooved fittings are furnished.

2. Center Sleeve (Center Ring): Steel pipe or tubing conforming to the requirements of ASTM A 53, A 512; or formed carbon steel with a minimum yield of 30,000 psi (207 MPa).
3. End Ring (Follower Ring): Ductile iron conforming to the requirements of ASTM A 536, or steel meeting or exceeding the requirements of ASTM A 576, Grade 1010-1020.
4. Gaskets: New rubber compounded for water service and resistant to permanent set.
5. Bolts and Nuts: High strength, low alloy corrosion resistant steel.

**C. Restrained Joints (Ductile iron pipe and PVC pipe only):**

1. Utilize to restrain mechanical joints at tees, bends, and dead ends.
2. Required for pipe sizes greater than 16 inches (400 mm) in diameter.
3. On pipe size 16 inch (400 mm) diameter or smaller, restrained joints are to be used in lieu of or in addition to thrust blocks when specified in the contract documents.
4. Manufacturer's standard field removable restraint system.
  - a. Suitable for buried service.
  - b. Corrosion resistant components.
  - c. Joint restraint system to be field installable, field removable, and re-installable.
5. Restraint systems involving pipe clamps and connecting rods are not acceptable unless specifically required in the contract documents.
6. Joint restraint system approval; in writing from the Engineer.
7. Install restrained joints for lengths shown on the plans.

**D. Concrete Thrust Blocks:**

1. For use with all pipe sizes 16 inch (400 mm) diameter or smaller.
2. On pipe sizes greater than 16 inches (400 mm), use in lieu of or in addition to restrained joints when specified in the contract documents.
3. Refer to the plans for dimensions and installation of thrust blocks.
4. Concrete thrust blocks shall be poured in place with a C-4 mix.

**2.06 PIPELINE ACCESSORIES**

**A. Polyethylene Wrap:**

1. Utilize: On all ductile iron pipe and fittings in buried service.
2. Conform to ANSI/AWWA C105/A21.5.
3. Minimum thickness: 8 mil (200  $\mu$ m).

**B. Tracer System:** Some of the following equipment may be supplied by some Jurisdictions. Check with appropriate Jurisdiction for a list of components that will be supplied.

1. Tracer Wire: #12 AWG solid single copper conductor.
  - a. Insulation material: Linear low-density polyethylene (LLDPE) installation suitable for direct burial applications.
  - b. Insulation thickness: 0.045 inches (1 mm), minimum.
2. Ground Rod: 3/8 inch (10 mm) diameter, 60 inch (1.5 m) long steel rod uniformly coated with metallicly bonded electrolytic copper.
3. Ground-rod Clamp: High-strength, corrosion-resistant copper alloy.
4. Splice Kit: Inline resin splice kit with split bolt for 1 kV and 5 kV. Insulates and seals single conductor and unshielded cable splices for direct bury and submersible applications.
5. Tracer Wire Test Station:
  - a. Two internal terminals with shunt.
  - b. 5 foot (1.5 m) white plastic triangular post.
  - c. Removable top cap with lock.
  - d. Three 2 7/8 inch by 14 inch (70 mm by 350 mm) custom-vinyl decals.
  - e. Tri-grip anchor.

## 2.07 GASKETS, SPECIAL

- A. Use special pipe gaskets in contaminated soils when specified in the contract documents.
- B. Soils contaminated with gasoline; Neoprene or Buna N material.
- C. Use special pipe gaskets to handle volatile organic compounds, Nitrile (NBR) or fluoro carbon gaskets.

## PART 3 - EXECUTION

### 3.01 GENERAL PIPE INSTALLATION

- A. Install only approved materials.
- B. Protect pipe joints and valves from damage while handling and storing.
- C. Use no deformed, defective, gouged, or otherwise damaged pipe or fittings.
- D. Excavate and prepare trench as outlined in Division 3 of this Developmental Specification.
- E. Prepare the trench bottom with sufficient exactness so that only minor movement of the pipe will be necessary after installation.
- F. Clean pipe interior prior to placement in the trench.
- G. Install pipe with fittings and valves to the lines and grades shown in the plans, with a maximum allowable variation of 3 inches (75 mm).

- H. Provide uniform bearing along the full length of the pipe barrel. Provide bell holes.
- I. Clean joint surfaces thoroughly and apply lubricant approved for use with potable water.
- J. Make joints according to pipe manufacturer's recommendations and these specifications.
- K. Limit joint deflections to one degree less than pipe manufacturer's recommended maximum limit.
- L. Tighten bolts in a joint evenly around the pipe.
- M. Install concrete thrust blocks or joint restraints where shown or required. Refer to Figures 5010.1A, 1B, 1C.
- N. Install remaining pipe bedding in accordance with the plans.
- O. Do not install pipe in water. Keep trench free of water. Refer to ANSI/AWWA C651 for wet trench installation procedures, if such installation is approved by Engineer.
- P. Keep exposed pipe ends closed with rodent-proof end gates at all times when pipe installation is not occurring.
- Q. Close ends of installed pipe with water-tight plugs during nights and non-working days.
- R. Do not allow any water from the new pipeline to enter existing distribution system piping.
- S. Do not locate water service lines under proposed driveway locations.

### **3.02 ADDITIONAL REQUIREMENTS FOR DUCTILE IRON PIPE INSTALLATION**

- A. Install in accordance with AWWA C600.
- B. Cut pipe perpendicular to pipe barrel. Do not damage cement lining. Bevel cut ends for push-on joints according to AWWA C600.
- C. Encase all pipe, valves, and fittings with polyethylene wrap. Refer to the plans.
- D. Refer also to AWWA C600.

### **3.03 ADDITIONAL REQUIREMENTS FOR PVC PIPE INSTALLATION**

- A. Cut pipe perpendicular to pipe barrel.
- B. Bevel cut end of pipe barrel per pipe manufacturer's recommendation.
- C. Refer also to AWWA C605.

### **3.04 ADDITIONAL REQUIREMENTS FOR PRESTRESSED CONCRETE CYLINDER PIPE INSTALLATION**

- A. Install in accordance with AWWA Manual M9.
- B. Relieve gasket tension by inserting a small rod between the gasket and the gasket groove, and running the tool around the pipe twice.

- C. Push pipe joint fully home before making any joint deflections.
- D. Check gasket position using a metal feeler gauge after the joint has been assembled.
- E. Complete joint exterior grouting after pipe has been properly positioned using non-shrink grout.

### **3.05 POLYETHYLENE ENCASUREMENT INSTALLATION**

- A. Application: All buried ductile iron pipe, fittings, fire hydrants, and appurtenances.
- B. Install in accordance with AWWA C105.
- C. The polyethylene encasement is to prevent contact between the pipe and the bedding material, but need not be airtight or watertight.
- D. Secure and repair encasement material using polyethylene tape, or replace as necessary.

### **3.06 TRACER SYSTEM INSTALLATION**

- A. Applicability: All buried water main piping.
- B. Begin and terminate system at all connections to existing mains.
- C. Install wire continuously along lower quadrant of pipe. Do not install wire along bottom of pipe. Attach wire to pipe at midpoint of each pipe length; use 2 inch (50 mm) wide 10 mil (250 µm) thickness polyethylene pressure sensitive tape.
- D. Install splices only as authorized by Engineer. Allow Engineer to inspect all below grade splices of tracer wire prior to backfill.
- E. Install ground rods adjacent to connections to existing piping and at locations shown on plans.
- F. Bring double run of wire to surface at each hydrant location and into tracer wire test station; connect to internal terminals.
- G. Location of tracer wire test station: At each hydrant location, unless directed otherwise in the plans.
- H. Final inspection of the tracer system will be conducted at the completion of the project and prior to acceptance by the Contracting Authority. Verify the electrical continuity of the system. Repair any discontinuities.
- I. Refer to the plans for tracer wire installation.

### **3.07 CONFLICTS**

- A. Provide temporary support for existing gas, telephone, power, or other utilities or services that cross trench.
- B. Compact backfill under existing utility crossing as specified in Section 3010 of this Developmental Specification or construct utility line supports where indicated on plans.

**C.** Separate water mains from gravity sewers by horizontal distance of at least 10 feet (3 m) unless:

1. Bottom of water main is at least 18 inches (0.5 m) above top of sewer.
2. Sewer is placed in separate trench or in same trench on bench of undisturbed earth with at least 3 feet (1 m) separation from water main.

**D.** Use ductile iron pipe as specified in Section 4010, 2.01 G of this Developmental Specification for gravity sewers with less than 10 feet (3 m) horizontal distance and bottom of water main less than 18 inches (0.5 m) above top of sewer; maintain at least 2 feet (0.6 m) linear separation.

**E.** Where water main or service crosses under gravity sewer or where bottom of water main or service is less than 18 inches (0.5m) above top of sewer:

1. If physical conditions prohibit the separation, the water main may not be placed closer than 6 inches (150 mm) above a sewer or 18 inches (0.5 m) below a sewer. The separation distance shall be the maximum feasible in all cases.
2. Use 20 feet (6 m) length of ductile iron pipe as specified in Section 4010, 2.01 G of this Developmental Specification for gravity sewer centered on water main.
3. The water main and sewer must be adequately supported and have watertight joints.
4. Backfill trench with low permeability soil for 20 feet (6 m) length centered on crossing.

**F.** Separate water mains from sanitary sewer force mains by horizontal distance of at least 10 feet (3 m) unless the force main is constructed of water main materials meeting minimum pressure rating of 200 psi (1380 kPa) and is installed at least 4 feet (1.2 m) horizontally from the water main.

### **3.08 TRANSITIONS IN PIPING SYSTEMS**

**A.** Where the specified material of piping system entering or exiting a structure changes, the change shall occur at the outside of the structure wall, beyond any wall pipe or wall fitting required, unless otherwise shown or specified.

### **3.09 STRUCTURE PENETRATIONS**

**A.** Wall Pipes:

1. Install where pipes penetrate and terminate at a wall or floor surface of a concrete structure, or where the pipe protrudes through the concrete wall or floor and the protrusion is otherwise unsupported.
2. Provide a waterstop flange near the center of the embedment length. Waterstop is to be cast integrally with the wall pipe, or fully welded to it around the pipe circumference.

**B.** Wall Sleeves:

1. Install where a pipe passes through a structure wall.
2. Sleeves in concrete walls are to be supplied with a waterstop collar, fully welded, and shall be cast in place in the concrete.

**3.10 SERVICE TAPS AND CONNECTIONS**

- A.** Provide service tap and connection for each lot or property, or as otherwise shown on the plans.
- B.** Construct service in conformance with the plans and local Jurisdiction guidelines.
  - 1. Prepare the site and make preparatory excavation at the location for the tap in accordance with Jurisdiction guidelines.
  - 2. Notify Jurisdiction when tap site is ready.
  - 3. Jurisdiction may make tap. Unless stated in the contract documents, Contractor shall be responsible for the tap.
  - 4. Jurisdiction may provide fittings and curb valve box. Unless stated in the contract documents, Contractor shall install fittings, stop box and pipe.
  - 5. Close the tap site in accordance with the contract documents and the Jurisdiction guidelines.

**3.11 WATER SERVICE RELOCATIONS**

- A.** Water Service Stop Box Relocation
  - 1. Relocate Stop Box from its existing location to its new location as shown on the plans.
  - 2. When Stop Boxes are not as indicated, the relocation shall be verified by the Engineer before relocating.
- B.** Water Service Depth Check
  - 1. Measure and assure that existing water service is a minimum of 60 inches (1.5 m) below the finished grade and not in conflict with proposed sewers, walls, and other structures.
  - 2. If the depth of the service is not adequate, the service shall be lowered in accordance with Section 5010, 3.11 C of this Developmental Specification.
- C.** Water Service Lowering
  - 1. The existing water service shall be lowered to provide a minimum of 60 inches (1.5 m) of earth cover and to minimum clearances as shown in Figure 5010.9 for proposed sewers, walls, and structures.
  - 2. Replace stop box and pipe and fittings if required.
- D.** Lower Water Service with New Copper
  - 1. Replace services that do not meet plumbing code standards with new 1 inch (25 mm) copper tubing.
  - 2. Lower to provide a minimum of 60 inches (1.5 m) earth cover and to minimum clearances at proposed sewers, walls, and structures as shown in plans.
  - 3. Replace stop box, if required.

**E. New Water Service**

1. At locations where plumbing code enforcement dictates that the existing water service must be reconstructed in conjunction with relocating water services or relocating stop boxes, the existing water service must be reconstructed from the water main to and including the stop box.
2. The new service shall be constructed to provide a minimum of 60 inches (1.5 m) of earth cover to minimum clearances at proposed sewers, walls, and structures as shown plans.
3. Utilize the existing corporation tap on the water main and provide all new materials required

**F. Water Service Relocation**

1. Relocate the existing water service when there is conflict with sewer construction.
2. Relocate Stop Box if required.

**G. Water Service Disconnection**

1. Disconnect abandoned water service
2. Abandon in accordance with local water works requirements.
3. Utilize the existing corporation tap on the water main and provide all new materials required.

**3.12 TESTING**

- A.** Test in accordance with Section 5030 of this Developmental Specification.

**3.13 FLUSHING**

- A.** Method of flushing is subject to approval of Engineer. Flush in accordance with approved method under the supervision of the Engineer. Refer to Section 5030 of this Developmental Specification.
- B.** Disinfection: According to Section 5030 of this Developmental Specification.

**3.14 PROTECTION**

- C.** Close pipe ends in trench securely when work is stopped. Install watertight plug in pipe end when work is stopped overnight or for longer periods.

**SECTION 5020. VALVES, HYDRANTS, AND APPURTENANCES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A.** Butterfly valves.
- B.** Gate valves.
- C.** Tapping valve assemblies.
- D.** Fire hydrant assemblies.

- E. Flushing Devices (blowoffs).
- F. Valve boxes.
- G. Incidental items.

**1.02 DESCRIPTION OF WORK**

- A. Install valves, hydrants, and appurtenances for water mains.

**1.03 SUBMITTALS**

- A. Manufacturer's instructions for installation for all valves, hydrants, and assemblies.
- B. Construction sequencing.
- C. Catalog cuts, samples, manufacturer's data, and listing of applicable standards for special, unique or proposed substitute materials if requested by Engineer.
- E. Upon request the Contractor shall provide material certifications to the Engineer.

**1.04 SUBSTITUTIONS**

- A. Obtain written approval of Engineer for all substitutions prior to use.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Store materials in a protected environment, on pallets, or lagging.
- B. Valves, hydrants, and appurtenances contaminated with mud and surface water shall be removed from the site and not used in construction unless thoroughly cleaned, inspected, and approved by Engineer.
- C. Handle all materials so as to avoid damage. Remove from the site and replace any damaged materials.

**1.06 SCHEDULING AND CONFLICTS**

- A. Construction Sequence:
  - 1. Attend a preconstruction meeting if required by Engineer.
  - 2. Submit plan for construction sequence prior to commencing construction unless specifically not required by Engineer.
- B. Conflict Avoidance:
  - 1. Expose possible conflicts In advance of construction, such as utility lines and drainage structures. Verify elevations of each and verify clearances for proposed construction.
  - 2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.
  - 3. Notify Engineer of any conflicts discovered or any changes needed to accommodate unknown or changed conditions.

### **1.07 SPECIAL REQUIREMENTS**

- A. Stop Work:** Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

### **1.08 MEASUREMENT FOR PAYMENT**

All measurements for payment will be made by the Engineer.

**A. Butterfly Valve:**

1. Butterfly valve item includes all components attached to the valve or required for its complete installation, including but not limited to underground or above ground operator, square valve operating nut, valve box, valve box extension, extension shaft sufficient to position the valve operating nut within 2 feet (0.6 m) and below the ground surface, hand wheels, and incidental items.
2. Count each butterfly valve of each size installed.
3. Payment will be at the contract unit price for each size and type of valve installed.

**B. Gate Valve:**

1. Gate valve includes all components attached to the valve or required for its complete installation, including but not limited to underground or above ground operator, square valve operating nut, valve box, valve box extension, extension shaft sufficient to position the valve operating nut within 2 feet (0.6 m) and below the ground surface, hand wheels, and incidental items.
2. Count each gate valve of each size installed.
3. Payment will be at the contract unit price for each size and type of valve installed.
4. See Section 5020 1.08 D of this Developmental Specification for payment for valves on fire hydrant leads.

**C. Tapping Valve Assembly:**

1. Unit includes tapping sleeve and all other components needed to complete the installation, and for successfully completing of the tap.
2. Count each tapping valve assembly of each size installed.

**D. Fire Hydrant Assembly:**

1. Fire hydrant includes the fire hydrant, with barrel extensions sufficient to achieve proper hydrant bury length of the unit.
2. Count each fire hydrant installed.
3. Components to connect the fire hydrant to the water main, including pipe, fittings, and auxiliary valve, except tapping valve assembly if used, shall be considered incidental to the contract unit price bid for fire hydrant assembly.

**E. Flushing Device (Blowoff):**

1. Each blowoff assembly includes the valve, fittings, and all pipe segments. Pipe used in the blowoff assembly will not be paid for separately.
2. Measure each blowoff assembly of each size installed by count.

**F. Valve Box:**

1. Each valve box shall include the lid and any extensions required extend from the valve to the ground surface.
2. Valve box or extensions will not be measured separately for payment unless identified separately in the contract. If so identified, measure each valve box, with extensions as a unit.

**PART 2 - PRODUCTS****2.01 VALVES****A. General:**

1. Same size as pipeline in which it is installed, unless noted otherwise in the plans.
2. Manufacturer's name or initial and working pressure cast on valve body.
3. Open when turned counterclockwise for most situations. If the Contractor is not sure of the direction of opening of the valve, the Contractor shall contact the Engineer.
4. Factory tested to twice the rated working pressure.
5. Buried service: Mechanical joints.
6. Service within structure:
  - a. Flanged, per ANSI/AWWA C110/A21.10.
  - b. Flanges, drilled to conform to ASME/ANSI B16.1 Class 125, unless noted otherwise on plans.
7. All valve operators to be supplied by valve supplier.
8. Bolts for joints: Refer to Section 5010 of this Developmental Specification.

**B. Butterfly Valves, Buried Service:**

1. Type: Rubber seat.
2. Pressure rating: 150 psi (1035 kPa) working pressure.
3. Bubble-tight at rated pressures with flow in either direction.
4. Comply with: ANSI/AWWA C504 class 150B.
5. Body:

- a. Cast iron per ASTM A 126 Class B.
- b. Two trunnions for shaft bearings.

**6. Ends:**

- a. Flanged, with flange adapters, except as otherwise shown in the plans.
- b. Flange adapter: Refer to Section 5010 of this Developmental Specification.

**7. Disc:**

- a. Material: Ductile iron ASTM A 536 or Cast iron ASTM A 126 Class B, with plasma applied nickel-chromium edge or ASTM A 240, Type 316 stainless steel edge.
- b. Connection to shaft: Mechanically fixed stainless steel pins.

**8. Shaft:**

- a. Material: Stainless steel ASTM A 240, Type 304.
- b. Turned, ground, and polished.

**9. Seat:**

- a. Material: Synthetic rubber compound.
- b. Simultaneously molded in, vulcanized and bonded to body or mechanically retained.

**10. Bearings:**

- a. Corrosion resistant non-metallic and self-lubricating, sleeve type.
- b. Bearing load: No greater than 1/5 the compressive strength of the bearing or shaft material.

**11. Packing:** Self adjusting chevron type.

**12. Operator:**

- a. Type: Buried service.
- b. Three bolt, minimum, mounting to valve.
- c. Hold valve in any intermediate position between fully open and fully closed without creeping or fluttering.
- d. Equipped with mechanical stop-limiting devices to prevent over-travel of the disc in the open and closed positions.
- e. Fully enclosed, gasketed, and grease packed.
- f. Designed to operate the valve under full rated working pressure with a maximum of 80 foot-pounds (108 N•m) applied force.
- g. Withstand an input of 450 foot-pounds (610 N•m) at extreme operator position without damage.

**13. Finish:** In accordance with ANSI/AWWA C504.

**14. Exposed bolts and hex nuts:** Stainless steel.

**C. Gate Valves, Buried Service:**

- 1. Type: Non-rising stem, resilient seat.

2. Pressure rating: 200 psi (1380 kPa) working pressure, minimum.
3. Comply with: ANSI/AWWA C509.
4. Body, Bonnet, and Discs: Cast iron per ASTM A 126 class B.
5. Ends: Mechanical connection.
6. Seat: Field replaceable with stainless steel fasteners.
7. Shaft seals: Double O-rings permanently lubricated between seals. Lubricant certified for use in potable water.
8. Exposed bolts and hex nuts: ASTM A 240, Type 304 stainless steel.
9. Operator: 2 inch (50 mm) square nut.
10. Interior and exterior valve coating shall be minimum 10 mil (250  $\mu$ m) thick fusion bonded epoxy per AWWA C550.
11. Valve design shall not allow metal-to-metal contact between gate and body.

**D. Tapping Valve Assemblies:**

1. Valve: Tapping valve conforming to ANSI/AWWA C509.
  2. Sleeve:
    - a. Minimum 14 gauge.
    - b. Stainless steel, ASTM A 240, Type 304.
    - c. Working pressure 200 psi (1380 kPa).
    - d. Must fully surround pipe.
    - e. Refer to table for minimum sleeve length
  3. Gasket:
    - a. To completely surround pipe.
    - b. Minimum thickness 0.125 inch (3 mm).
    - c. Material: nitrile rubber.
  4. Outlet Flange:
    - a. Stainless steel, ASTM A 240, Type 304.
    - b. ANSI B16.1, 125 pound pattern.
  5. Bolts: Stainless steel, ASTM A 240, Type 304.
- NOTE: For Des Moines only: Tapping sleeve and valve will be provided by Des Moines Water Works for use when tapping mains under Des Moines Water Works jurisdiction.

6. Minimum sleeve length:

Outlet Flange Size, Inches (mm)	Minimum Sleeve Length, Inches (mm)
4 (100)	15 (375)
6 (150)	15 (375)
8 (200)	21 (525)
10 (250)	27 (675)
12 (300)	30 (750)
Sizes over 12 (300)	Consult Engineer

7. Consult Engineer for applicability. Use tapping valve assemblies only where approved and authorized or shown on plans.

**2.02 FIRE HYDRANT**

**A. Material:** Conform to ANSI/AWWA C502, as modified herein.

**B. Manufacturers:** See Fire Hydrant Matrix.

**C. Features:**

1. Refer to Fire Hydrant Matrix.
2. Break-away stem coupling.
3. Operating nut: Pentagonal. See Fire Hydrant Matrix for size.
4. Inlet nominal size: 6 inch (150 mm).
5. Inlet connection type: Mechanical Joint.
6. Hose nozzles: two 2 1/2 inch (63 mm).
7. Pumper nozzle: See Fire Hydrant Matrix.



Nevada																See Note 8
Newton																See Note 8
Norwalk				X		X		5.25" (133 mm)	4.5" (114 mm)	1.5" (38 mm)	Yes	6' (1.8 m)	CCW			See Note 8
Pella																See Note 8
Perry																See Note 8
Pleasant Hill				X		X	X	5.25" (133 mm)	4" (101 mm)	1.5" (38 mm)	Yes	5' (1.5 m)	CCW			See Note 8
Polk County	X	X		X		X	X	4.5" (114 mm)	Note 8	1-3/16" (30 mm)	Note 1	Note 8	CW			See Notes 1, 2, and 8
Urbandale Water Department						X	X	X	5.25" (133 mm)	4.5" (114 mm)	1.5" (38 mm)	Yes	6' (1.8 m)	CCW		See Note 9
Webster City																See Note 8
West Des Moines Water Works		X				X	X	5.25" (133 mm)	4.5" (114 mm)	1.5" (38 mm)	Yes	5' (1.5 m)	CCW			See Note 6
Windsor Heights	Refer to Des Moines Water Works														See Note 8	

**Notes:**

- |    |                                 |                   |                     |
|----|---------------------------------|-------------------|---------------------|
| 1. | Nozzle threads                  | <u>Hose</u>       | <u>Pumper</u>       |
|    | Nominal inside diameter         | 2 1/2" (63.5 mm)  | 4" (101 mm)         |
|    | Outside diameter of male thread | 3 1/16" (77.8 mm) | 4 31/32" (126.2 mm) |
|    | Diameter at root of male thread | 2 7/8" (73 mm)    | 4 19/32" (116.7 mm) |
|    | Threads per inch (25 mm)        | 7 1/2             | 4                   |
|    | Length of nozzle threads        | 1" (25.4 mm)      | 1 1/2" (38.1 mm)    |
|    | Cut off at top of threads       | 1/4" (6.4 mm)     | 1 1/4" (31.8 mm)    |
2. Do not furnish chains with nozzle caps.
  3. All threaded internal parts exposed to water shall consist of bronze.
  4. All exterior bolts, nuts, set screws, and other fasteners to be stainless steel (ASTM A 193, Grade B-8) or silicon bronze (ASTM B 98, Alloy 651).
  5. All cotter pins, drive pins, bolts, and screws exposed to water shall consist of stainless steel or brass.
  6. Fire hydrant bury length; match water main depth, but not less than 5 feet (1.5 m).
  7. Setting depth; nozzle 18 inches (450 mm) above finish grade, minimum.
  8. Check with Local Agency.
  9. Barrel flange to be 4 inches (100 mm) above finish grade.

**8.** Nozzle Threads: See Fire Hydrant Matrix.

**9.** Nominal bury length: See Fire Hydrant Matrix.

**10.** Main valve size: See Fire Hydrant Matrix.

**11.** Direction of opening: See Fire Hydrant Matrix.

**D.** Substitutions: None, unless approved in writing by Engineer.

- E. Size (Main valve nominal opening): See Fire Hydrant Matrix.
- F. Bury length: Refer to plans.
- G. Painting:
  - 1. Shop coating; per ANSI/AWWA C502.
  - 2. Field coating above grade; Exterior coating, type, and color selection by Engineer.
- H. Provide auxiliary gate valve with valve box conforming to Paragraph 2.01.C above. Refer to the plans.
- I. Exposed Bolts And Hex Nuts: Stainless steel.

### **2.03 APPURTENANCES**

#### **A. Flushing Device (Blowoff):**

- 1. Construct according to the plans for temporary or permanent unit. Refer to plans for applicable type at each location.
- 2. Nominal size: two pipe diameters less than the water main to which it is attached.
- 3. Locations: Where shown on the plans.
- 4. Components: pipe, gate or butterfly valve, valve box, tee, reducer, thrust block, elbow, pipe cap, and miscellaneous fittings, all as specified elsewhere in these Developmental Specifications.

#### **B. Valve Box:**

- 1. Applicability: For all buried gate or butterfly valves.
- 2. Type:
  - a. In paved areas; slide type.
  - b. In all other areas; screw extension.
- 3. Material: Cast iron.
- 4. Cover: Cast iron, labeled "WATER"
- 5. Wall thickness: 3/16 inch (4.8 mm), minimum.
- 6. Inside diameter: 5 inches (127 mm), minimum.
- 7. Length: Adequate to bring top to ground surface.
- 8. Factory finish: Asphalt coating.
- 9. Installation to include valve box ring.

**C. Incidental Items:**

1. Valve Stem Extension: Provide for all buried valves. Raise 2 inch (50 mm) operating nut to within 2 feet (0.6 m) of, but not closer than 6 inches (150 mm) of the surface. Stem diameter per valve manufacturer's recommendations, but not less than 1 inch (25 mm).

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Install only approved materials.
- B. Install in accordance with the contract documents.
- C. Test and disinfect all valves, hydrants, and appurtenances as components of the completed water main in accordance with Section 5030 of this Developmental Specification.
- D. Apply polyethylene wrap to all iron pipe, valves, valve boxes, hydrants, and fittings.
- E. Set tops of valve boxes to finish grade.
- F. Check the working order of all valves by opening and closing through entire range. Before exercising the valve, check with Engineer on operating requirements.

**3.02 FLUSHING DEVICE (BLOWOFF)**

- A. Install where shown on the plans.
  1. Install gravel backfill.
  2. Install thrust block, bearing on perpendicular excavation face of undisturbed earth.
- B. Temporary locations to be used only where approved by Engineer. Temporary blowoff must be removed prior to project completion and acceptance.

**3.03 FIRE HYDRANT**

- A. If auxiliary valve is positioned adjacent to water main, attach it to anchoring tee.
- B. If auxiliary valve is positioned away from water main, restrain all joints between valve and water main.
- C. Position auxiliary valve at least 15 inches (0.4 m) (clearance) away from fire hydrant.
- D. **Fire Hydrant Depth Setting:**
  1. Use adjacent finish grade to determine setting depth.
  2. Nozzle not less than 18 inches (0.45 m) nor more than 23 inches (0.55 m) above grade, measured from centerline of nozzle to grade. Adjust barrel length, or add or remove extensions as required.
  3. If finish grade is not to be obtained during the current project, consult with Engineer for proper setting dimension.
  4. Refer also to Fire Hydrant Matrix.

- E. Coordinate installation with tracer wire installation.
- F. Orient fire hydrant nozzles as directed by Engineer.

## **SECTION 5030. TESTING AND DISINFECTION**

### **PART 1 - GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Pressure and leak testing of water system.
- B. Disinfection of potable water systems.

#### **1.02 DESCRIPTION OF WORK**

- A. Test and disinfect water mains, valves, hydrants, and appurtenances.

#### **1.03 SCHEDULING**

- A. Notify Engineer 1 working day in advance of testing or disinfection operations to coordinate the operations.
- B. Engineer must be in attendance during testing or disinfection.

#### **1.04 REGULATORY REQUIREMENTS**

- A. Conform to Iowa DNR "Iowa Water Supply Facilities Design Standards".

#### **1.05 MEASUREMENT FOR PAYMENT**

All measurements for payments will be made by the Engineer.

- A. Testing and inspection of water systems is incidental to construction. Include the costs in the contract unit price for pipe and fittings.

### **PART 2 - PRODUCTS**

#### **2.01 DISINFECTION AGENT - CHLORINE**

- A. **Meet Requirements:**
  - 1. Calcium Hypochlorite, per ANSI/AWWA B300.
  - 2. Sodium Hypochlorite, per ANSI/AWWA B300.
- B. Chlorine containers shall have AWWA stamp.

## **PART 3 - EXECUTION**

### **3.01 SEQUENCE OF OPERATION**

**A. New Water System Construction:** Perform operations in the following sequence:

1. Perform initial flush.
2. Make all service taps.
3. Perform pressure and leak testing.
4. Perform disinfection.
5. Flush after disinfection.

**B. Water System Rehabilitation:** Perform operations in the following sequence:

1. Perform initial flush.
2. Perform pressure and leak testing.
3. Perform disinfection.
4. Flush after disinfection.
5. Make all service taps.

**C.** Successfully complete each operation before commencing to the next operation.

**D.** Local agency will provide reasonable quantities of water for flushing and testing.

### **3.02 PRESSURE AND LEAK TESTING**

**A.** Remove any debris from within pipe. Clean and swab out pipe if required.

**B.** Secure any unrestrained pipe ends against uncontrolled movement.

**C.** Isolate new piping from the existing water system.

**D.** Fill and flush all new piping with potable water. Ensure that all trapped air is removed.

**E.** Pressurize the new pipe to the test pressure at the highest point in the isolated system. Do not pressurize to more than 5 psi (34 kPa) over the test pressure at the highest point in the isolated system.

**F.** Test the completed piping system at 1 1/2 times the system working pressure or 150 psi (1035 kPa), whichever is greater, for 2 hours.

**G.** Monitor the pressure in the line for a period of not less than 2 hours.

**H.** If at any time during the test the pressure drops to 5 psi (34 kPa) below the test pressure, repressurize the pipe by pumping in potable water in sufficient quantity to bring the pressure back to the original test pressure.

I. Accurately measure the amount of water required to repressurize the system to the test pressure.

J. Maximum Allowable Leakage Rate

**English Units**

$$L = \frac{(S)(D)(P)^{1/2}}{133,200}$$

Where:

- L = leakage allowable, in gallons per hour.
- S = length of pipe test section, in feet.
- D = pipe diameter, in inches.
- P = average test pressure, psig.

**Metric Units**

$$L_m = \frac{(SD)(P)^{1/2}}{715,317}$$

Where:

- L<sub>m</sub> = leakage allowable, in liters per hour.
- S = length of pipe test section, in meters.
- D = pipe diameter, in millimeters.
- P = average test pressure, kPa.

K. If the average measured leakage per hour exceeds the maximum allowable leakage rate, repair and retest the water line.

L. If the measured pressure loss does not exceed 5 psi (34 kPa) the test will be considered acceptable.

M. Repair all visible leaks regardless of the amount of leakage.

**3.03 INITIAL FLUSHING**

**A. Flushing:**

1. Flush pipe prior to disinfection using potable water.
2. Use pitot tube to measure flushing velocity.
3. Obtain a minimum flushing velocity of 2.5 feet (0.76 m) per second in the pipe to be disinfected.

**B. Minimum Flushing Rate:**

Pipe Diameter, inches (mm)	Flow Rate for Flushing, gallons/minute (L/minute)	Pipe Diameter, inches (mm)	Flow Rate for Flushing, gallons/minute (L/minute)
4 (100)	100 (379)	16 (400)	1,600 (6057)
6 (150)	220 (833)	18 (450)	2,000 (7571)
8 (200)	390 (1476)	20 (500)	2,500 (9464)
10 (250)	600 (2271)	24 (600)	3,500 (13,249)
12 (300)	870 (3293)	30 (750)	5,500 (20,820)
14 (350)	1,200 (4542)	36 (900)	8,000 (30,283)

**C. Property Protection:** Protect public and private property from damage during flushing operations.

### **3.04 DISINFECTION**

#### **A. General:**

1. Applicable standard: ANSI/AWWA C651.
2. Disinfect only after satisfactory pressure testing has been completed.
3. Keep piping to be chlorinated isolated from lines in service and from points of use.
4. Coordinate disinfection with Engineer.
5. Engineer will obtain and test water samples.

#### **B. Disinfection:**

1. Induce flow of potable water through the pipe.
2. Introduce highly chlorinated water to the pipe at a point within 5 pipe diameters of the pipe's connection to an existing potable system, or within 5 pipe diameters of a closed end, if there is no connection to an existing system.
3. Introduce water containing 25 mg/L free chlorine minimum until the entire new pipe contains 25 mg/L free chlorine minimum.
4. Retain chlorinated water in pipe for at least 24 hours and not more than 48 hours.
5. If test is not successful, repeat disinfection procedure.

### **3.05 FLUSHING AFTER DISINFECTION IS COMPLETE**

**A.** Maintain isolation of the new pipe from the existing potable water system until test results have been approved, but not less than 24 hours after flushing has been completed.

**B.** Flush pipe using potable water until chlorine residual equals that of the existing potable water system.

**C.** Discharge chlorinated water in a safe manner.

**D.** Disposal of heavily chlorinated water

1. Check with the local sewer department for the conditions of disposal to the sanitary sewer.
2. Chlorine residual of water being disposed will be neutralized by treating with one of the chemicals listed in Table C.1.

Table C.1 Amounts of chemicals required to neutralize various residual chlorine concentrations in 100,000 gal (378.5 m<sup>3</sup>) of water\*

Residual Chlorine Concentration	Sulfur Dioxide (SO <sub>2</sub> )		Sodium Bisulfite (NaHSO <sub>3</sub> )		Sodium Sulfite (Na <sub>2</sub> SO <sub>3</sub> )		Sodium Thiosulfate (Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> + 5H <sub>2</sub> O)	
	mg / L	lb	(kg)	lb	(kg)	lb	(kg)	lb
1	0.8	(.36)	1.2	(.54)	1.4	(.64)	1.2	(.54)
2	1.7	(.77)	2.5	(1.13)	2.9	(1.32)	2.4	(1.09)
10	8.3	(3.76)	12.5	(5.67)	14.6	(6.62)	12.0	(5.44)
50	41.7	(18.91)	62.6	(28.39)	73.0	(33.11)	60.0	(27.22)

\* Except for residual chlorine concentration, all amounts are in pounds (kilograms).

### 3.06 PUTTING WATER MAIN IN SERVICE

- A. Obtain Engineer's approval to put the completed water system in service.