

PART IV

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PART IV

SANITARY SEWER SYSTEM DESIGN & SPECIFICATIONS

SECTION 1. DESIGN CRITERIA FOR SANITARY SEWER SYSTEM

1.1 General

The purpose of this section is to provide information for the design and layout of a sanitary sewer collection system acceptable to the Johnstown Waste Water Department (JWWD). All sanitary sewer system design shall be in accordance with the requirements of this section and the Town of Johnstown Standard Construction Specifications for Sanitary Sewer Construction.

1.2 Definitions and Abbreviations

A. Collection Mains

1. A sanitary sewer collection main is defined as a system that gathers flows directly from individual building services and transports the material to an interceptor or main sewer.

B. Interceptor Sewer

1. An interceptor, or main, sanitary sewer carries flows from the collections sewers to a point of treatment or disposal of the wastewater.

C. Sanitary Sewer Services

1. All pipe and fittings used to convey sanitary sewage from the plumbing system in a building to a collection main.

D. Abbreviations

- | | | |
|----|------|----------------------------|
| 1. | cfs | cubic feet per second |
| 2. | fps | feet per second |
| 3. | gpcd | gallons per capita per day |
| 4. | gpd | gallons per day |

1.3 System Requirements

A. Design Flow

1. The sanitary sewer collection system design shall include consideration for providing service for the entire area tributary to the outfall point. Sanitary sewer flow information for the existing collection system may only be obtained from the Town. Estimates for sanitary sewer flows shall use the following guidelines:
 - a. Residential sewage contribution shall be based on 100-gpcd average flows.

- b. Minimum residential population density shall be figured on a basis of 2.5 persons per house, six (6) houses per acre and, 70% of total land area developed as residential, unless detailed analysis of the proposed service area indicates differently.
- c. Estimates shall include allowances for a maximum infiltration of 100 gallons per day per inch diameter per mile of pipe.
- d. Commercial and industrial sewage contribution estimates shall be submitted to the Sewer Department for review prior to design acceptance

1.4 Hydraulic Design

A. Sanitary sewer grades shall be designed to produce flow characteristics as close to optimum as is physically and economically feasible.

- 1. The size of pipe required shall be computed by Manning's Equation.

$$Q = \frac{1.486AR^{2/3} \sqrt{S}}{n}$$

Where: Q=Flow
n=Manning's Coefficient of Coefficient, 0.013
A=Area of Flow (ft²)
R=Hydraulic Radius (A/P)
Where P =Wetted Perimeter
S=Slope of pipe (ft/ft)

- 2. All sanitary sewer collection pipes shall be designed to flow maximum half full (d/D=0.5) at design flows.

Where: d=Depth of Flow
D=Diameter of Pipe

The design depth of flow should be greater than two-inches (2") where practical.

- 3. Optimum velocities are four (4) to five (5) feet per second (fps) at design flow. The minimum and maximum velocity at the design flow rate shall be two (2) fps and fifteen (15) fps respectively unless prior written acceptance is to received from the Water and Sewer District.

1.5 Phasing

A. Sanitary sewer phasing, if proposed, must meet the following conditions for acceptance:

- 1. Shown on the master utility plan.
- 2. Terminal manhole shall be located at either the phase line or subsequent next manhole in the adjoining phase.
- 3. A stub out for future phasing may be made by providing a block out in the terminal manhole for future lines. The inverts in the terminal manhole shall be called out for all pipes entering and exiting the manhole.

1.6 Collection Main Slope and Size

- A. In addition to the criteria stated in Section 1.4, Hydraulic Design, the following shall apply to sanitary sewers:
1. Sanitary Sewer mains shall be eight-inch (8") diameter or larger. Service connections are four-inch (4") diameter or larger.
 2. Table 1.6-1 displays the applicable minimum grades per pipe diameter. These minimum grades may be used provided Section 1.4 criteria are met.

**TABLE 1.6-1
APPLICABLE MINIMUM GRADES**

<u>Sewer Diameter</u>	<u>Minimum Grade (%)</u>
4 inch	2.00
6 inch	0.60
8 inch	0.40
10 inch	0.28
12 inch	0.22
15 inch	0.15
18 inch	0.12
21-inch	JWWD acceptance

*Subject to Section 1.4, Hydraulic Design

3. The maximum grade for any sanitary sewer line shall be 5.00% unless prior acceptance is obtained from the JWWD.
4. If the JWWD requires the Developer to install a collection main larger than needed to adequately serve the development, the Town may reimburse the Developer for the extra materials cost and depth of excavation above what is required for the development. Extra material costs shall include on the difference between the size of pipe and manholes. Extra depth costs shall include only the extra depth of excavation required to install the pipe in excess of what would have been required for the development. Material prices must be verified from supplier's invoices and the extra depth costs must be shown on the Contractor's bid sheet. All prices must be accepted by the Town prior to start of construction.

1.7 Location of Collection Mains

- A. Sanitary sewer mains shall be extended to the greater distance of either the far or upstream edge of the end service lot or property, regardless of where the tap is made, or to the edge of the platted subdivision. The Town may grant exception to this requirement if development of adjacent property is infeasible and/or unforeseeable.
- B. The centerline of sanitary sewer mains shall not be placed closer than eight feet (8') to the face of an existing or future curb, gutter, or walk without written acceptance by the Town.

- C. All sewer mains shall terminate at a manhole.
- D. A stub out of future extensions shall consist of a block out for future pipes in the terminal manhole. The stub out shall consist of a block out for future pipes in the terminal manhole. The invert elevations shall be shown for pipes entering and exiting the manhole.
- E. Sewer lines shall be straight – not curved – between manholes, both in line and grade.
- F. Clean outs on sewer main lines shall be prohibited.

1.8 Easements

- A. When the Sewer Department determines it is not feasible for an installation in a dedicated street right-of-way, the installation shall be made in an easement. The conditions for allowance of such an exception shall be determined for each individual case. The minimum easement width acceptable by the Sewer Department is as follows:
 - 1. For a dedicated sanitary sewer easement, the width shall be twenty feet (20') or twice the depth to the invert of the water pipe, whichever is greater, and shall be for the exclusive use of Town of Johnstown water mains. These easements shall be labeled on the construction and plat documents as "EXCLUSIVE SEWER LINE EASEMENT."
 - 2. For a combined sanitary sewer and water easement, the total width shall be twice the maximum depth to the invert of the sanitary sewer line plus twice the maximum depth to the invert to the water pipe or thirty feet (30'), whichever is greater.
 - 3. The easement width will be required to be wider than the minimum widths previously stated if the line depth would require additional width to be able to safely excavate around the pipe without the use of a trench box.
 - 4. The sanitary sewer line shall be located a minimum ten feet (10') from the edge of the easement, or equal to the depth to the pipe invert, which ever is greater.
- B. The Sewer Department shall have the exclusive utility use of the exclusive sanitary sewer and sanitary sewer easements except for angled utility crossings. The Sewer Department shall review for acceptance all utility crossing methods prior to construction.
- C. All easement documents shall be recorded prior to construction drawing acceptance.
- D. The easement shall be COMPLETELY CLEAR OF landscaping greater than three feet (3') tall (mature growth), permanent structures, and storm water detention ponds.

1.9 Manhole Size and Location

- A. Table 1.9-1 displays the applicable diameter of standard manholes per pipe diameter.

**TABLE 1.9-1
APPLICABLE STANDARD MANHOLE DIAMETER**

<u>Sewer Pipe Diameter</u>	<u>Manhole Diameter</u>
8 inch to 15 inch	48 inch
15 inch to 36 inch	60 inch
48 inch and larger	Sewer Dept Acceptance

- B. Manholes shall be provided at every change in direction, grade, or connection with other sewer mains.
- C. Maximum manhole spacing shall be 450 feet (450') for lines ten-inches (10") or smaller, or 550 feet (550') for lines twelve-inches (12") or larger.
- D. The center of any manhole shall not be placed closer than eight feet (8') to the face of an existing or future curb, gutter, or sidewalk.
- E. A minimum ten feet (10') horizontal separation shall be maintained from the center of the sanitary sewer manhole and any other utility.
- F. Manholes outside of road right-of-ways should be located in areas that are not subject to flooding from surface runoff. No manholes shall be located in areas where ponding or storm detention basins are to be used.
1. If the possibility of surface runoff cannot be avoided a solid manhole cover, with an integral O-ring type gasket that can be bolted closed must be used.
 2. All manholes that are to be designed and constructed with a watertight, bolted type cover, the manhole ring shall be bolted to the manhole cone, and all manhole joints and grade rings shall be sealed from the outside with an approved seal wrap.
- G. There shall be no more than three (3) lines designed to discharge into any one manhole. This includes service lines.
- H. Rim and invert elevations of all lines (including services) entering and exiting a manhole shall be shown on the project plans in the profile view.
- I. Manholes shall be located in areas that allow direct access by Town maintenance vehicles (up to 35 tons) via all weather roads. An all-weather road design shall be submitted by a qualified Geotechnical Engineer to the Town for acceptance prior to construction drawing approval.
- J. The Design Engineer shall determine if conditions require a protective coating to protect the manhole from corrosion.

1.10 Manhole Inverts

- A. Inverts of a straight channel sanitary sewer manhole, without laterals, may be set by using the same grade as the main provided that the upstream and downstream grades are the same and the manhole is constructed by laying pipe through the manhole and removing the upper half of the pipe. Refer to Standard Details for this type of manhole construction.
- B. If the conditions in 1.10.A cannot be maintained, the minimum elevation drop across a straight channel manhole shall be one-tenth-of-a-foot (0.1').
- C. Where a sanitary sewer of the same size changes direction by 30° or more, the inlet and outlet flowline elevations shall have at least two tenths-of-a-foot (0.2') difference across the manhole.
- D. When a tree invert is constructed with the inlet(s) and outlet being the same size, the inverts coming into the manhole must be at least two tenths-of-a-foot (0.2') higher than the outlet invert.
- E. Where a smaller sewer joins a larger on a straight channel, the smaller sewer crown elevation shall match the crown elevation of the larger line. This includes service lines.
- F. Where a sanitary sewer lateral main connects to a sanitary trunk sewer with a diameter of ten inches (10") or more, the crown elevation of the lateral main shall match the crown elevation of the trunk sanitary sewer line.
- G. Inside drop manholes shall be provided for a sewer entering a manhole with an elevation twenty four-inches (24") or more above the manhole invert.
 - 1. Drop inlet pipes equal to or greater than 10 inches shall require a 60-inch diameter manhole.
- H. Where the invert elevation difference is less than two feet (2') but greater than six-inches (6"), the invert shall be filleted, as shown on Standard Details, to prevent solids deposition.

1.11 Pipe Material

- A. Standard residential development shall use polyvinyl chloride (PVC) SDR 35 pipe suitable for sanitary sewer flows. The Design Engineer shall specify acceptable pipe material for commercial or industrial applications for corrosive or solvent-entrained wastewater and any other conditions that require a non-SDR35 PVC pipe. The Town shall approve use and length of the specified pipe.

1.12 Depth of Bury

- A. Sewer mains shall have a minimum cover of four feet (4') to the finished ground surface.
- B. Where minimum cover provides less than nine feet (9') of elevation difference between the finished lot grade at building line and the top of the sewer main, the plans and the plat shall indicate that the lot is served by a "shallow sewer" and appropriate elevation information shall be given.

1.13 Sanitary Sewer Services

- A. Each structure and each subdivided lot shall be served by separate service lines. No compound services are allowed.
- B. All lots shall have separate sewer services without crossing any adjacent properties.
- C. Service lines shall be designed with a minimum fall as shown in Table 1.6-1.
- D. Service lines shall have a maximum velocity of ten feet per second (10 fps).
- E. The service line shall flow maximum half full at peak design flow.
- F. The minimum allowable service line size is four-inches (4").
- G. Sanitary sewer services shall be located ten feet (10') down grade, or down stream, of the water service wherever feasible. Certain cul-de-sacs may have the sewer service line located further than ten feet (10') off the water service to allow the sewer service not to be located under a driveway.
- H. Service lines may not be installed in trenches with other conduits. A service line shall be separated from other conduits a minimum of ten feet (10') horizontally.
- I. Clean-outs shall be located at all points of deflection (i.e. bends) and every 100 feet (100') in a service line with the following exception:
 - 1. No clean out shall be located within a public right-of-way.
- J. Each lot or separate building site shall have tees or tapping saddles for service connections.
 - 1. Service tees or tapping saddles on the main shall have a minimum five feet (5') separation.
- K. Riser connections shall be prohibited.
- L. All service lines greater than six-inch (6") diameter shall be connected at a manhole. This service connection shall channel the flow through the manhole bench to the invert unless the difference in invert elevations is greater than twenty-four inches (24"). See Section 4.10.07.

1.14 Relation to Water Mains and Sewer Pipes

- A. Sanitary sewer services and collection mains shall be located horizontally a minimum of ten feet (10') centerline to centerline of existing or proposed water or storm lines.

- B. Where sanitary sewer lines cross water mains, the sanitary sewer pipe shall have a minimum eighteen-inches (18") clear distance vertically below the water main. If this clear distance is not feasible or the sanitary sewer line is above the water line, the crossing must be designed and constructed, using pipe encasement on the sanitary sewer main, to protect the water main. Refer to Standard Details for construction.
- C. Storm sewers shall have the same restrictions as water mains.

1.15 Other Utility Crossings

- A. The minimum horizontal separation shall be ten feet (10') when parallel in the public right-of-way. The same restrictions as sanitary sewer shall apply.
- B. Right angle crossings are permitted under the sanitary sewer pipe with a two-foot (2') vertical clearance.
 - 1. Tunneling or boring is preferable but if open cut is the only solution, the trench shall be as narrow as possible and backfill shall be flowfill from the top of the lower pipe up to the spring line of the sanitary sewer pipe.
- C. For crossings above the sanitary sewer pipe, the utility crossing shall have a minimum eighteen-inches of vertical clearance and be installed in High Density Polyethylene pipe (HDPE), Standard Dimension Ratio (SDR) 11 from edge to edge of the easement or right-of way or ten feet (10') either side of the sanitary sewer line, which ever is greater.
- D. Sanitary sewer crossings of open irrigation ditches shall be detailed, have four feet (5') minimum cover, and be approved by the ditch company. See Standard Details for typical pipe crossing requirements.

SECTION 2: TESTING SANITARY SEWER COLLECTION SYSTEM

2.1 Scope

- A. This section addresses the testing of sanitary sewer collection mains, manholes, and appurtenances.
 - 1. All sanitary sewer pipelines shall be air tested per these specifications.
 - 2. All sanitary sewer manholes shall be vacuum tested per these specifications.
 - 3. All sanitary sewer collection systems shall be video inspected per these specifications.

2.2 Quality Assurance

- A. Standards (as applicable).
 - 1. ASTM C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum), latest revision.
 - 2. ASTM F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision.

2.3 General

- A. Testing shall be conducted when:
 - 1. Backfill and compaction has been completed but before street improvements are installed.
 - 2. Main and manholes have been thoroughly cleaned of all foreign material.
- B. The Contractor shall furnish all equipment, labor, and incidentals necessary to perform tests.
 - 1. The maximum allowable pressure gauge shall be 0.1 psi.
- C. The Town shall witness tests and record times, leakage readings, and pressure over the test period.
 - 1. Contractor shall provide the Town a minimum 48 hours advance notice of any tests.
- D. All tests shall occur after completion of backfilling and compaction but prior to paving unless otherwise stated in these specifications.

2.4 Alignment Test

- A. Video each section of sanitary sewer between manholes to determine whether any displacement of pipe has occurred.
 - 1. Videoing shall be done after pipe trench is compacted and brought to grade or pavement subgrade and submitted to the Town.
 - 2. "Full moon" shall be visible for grand alignment.
 - 3. No less than "half moon" shall be visible for horizontal alignment.
 - 4. Repair poor alignment, displaced pipe, or other defects discovered.

2.5 Pipe Deflection Test

- A. Each section of sanitary sewer shall be tested for deflection by an independent testing firm as hired by the Contractor prior to Town acceptance and as deemed necessary within the warranty/construction period by the Town.
 - 1. The maximum allowable deflection for Town acceptance is 5% of the base internal diameter.
 - 2. The maximum allowable deflection at the end of the warranty period shall be 7.5% of the base internal diameter.

3. Mandrel outside diameters in inches is as follows:

<u>Pipe Size</u>	<u>Base I.D.</u>	<u>5% Deflection Mandrel</u>	<u>7.5% Deflection Mandrel</u>
6	5.742	5.455	5.311
8	7.665	7.282	7.090
10	9.563	9.085	8.846
12	11.361	10.793	10.509
15	13.898	13.203	12.856
18	16.976	16.127	15.703
21	20.004	19.004	18.504
24	22.480	21.356	20.794
27	25.327	24.061	23.427

4. Sections of the pipe that fail the deflection test shall have the defects repaired and the test repeated.

2.6 Air Testing Sanitary Sewer Mains

A. Conduct tests in conformance with ASTM F1417, Time Pressure Drop Method, and these specifications.

B. Preparation for tests:

1. Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results.
2. Provide a relief valve on the pressuring equipment to avoid over-pressurizing and damaging an otherwise acceptable line.
 - a. Set relief valve at 5 psi.
3. Plug and brace all openings in the main sanitary sewer line and the upper connections.
 - a. Check all pipe plugs with a soap solution to detect any air leakage.
 - b. If leaks are found, release the air pressure, eliminate the leaks and start the test procedures over again.

C. Test Procedure

1. Add air until the internal pressure of the sewer line is raised to approximately 40-psi gage.
 - a. Maintain the air pressure between 3.5 psig and 4.5 psig until the air temperature in the pipe is stabilized with the pipe/ground temperature.
2. Disconnect the air supply and reduce the air pressure to 3.5 psig before starting the test.
 - a. If the groundwater is higher than the top of the pipe, the test pressure shall be adjusted to account for the high groundwater. The test pressure shall be increased by 0.43 psi per foot of ground water up to five feet (5') of ground water. For ground water over five feet (5') in depth, an infiltration test shall be conducted in place of the air test. Contact the JWWDD for infiltration testing procedure and criteria.

3. Determine the time required for the air pressure to drop from 3.5 psig to 2.5 psig.
 a. The time elapsed shall not be less than:

$$T = 0.085 \frac{(DK)}{(Q)}$$

Where:

T = Shortest time (s) allowed for the air pressure to drop 1.0 psig

K = 0.000419 DL but not less than 1.0

Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF

D = measured average inside diameter of pipe (in)

L = length of test section (ft)

- b. Example calculation for an 8-inch diameter sanitary sewer pipe with a test section 400 feet long:

$$T = 0.085 \left[\frac{8\text{in}(0.00419)(8\text{in})(400\text{ft})}{0.0015\text{CFM/SF}} \right]$$

$$T = 608 \text{ seconds or } 10 \text{ minutes } 08 \text{ seconds (10:08)}$$

- c. The following table contains the test durations for pipe diameters between four (4") and fifteen (15") inches, for pipe lengths up to 500 feet. The test durations for pipe larger than fifteen-inches (15") shall be calculated using the formula given above.

*Specified Test Duration for Length of Pipe Indicated
(duration indicated in min:sec)*

Pipe Diameter	Pipe Length (feet)						
	0-150	200	250	300	350	400	500
4"	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6"	5:40	5:40	5:40	5:40	5:40	5:42	7:07
8"	7:34	7:34	7:34	7:36	8:52	10:08	12:38
10"	9:26	9:26	9:53	11:52	13:51	15:49	19:45
12"	11:20	11:24	14:15	17:05	19:56	22:47	28:26
15"	14:10	17:48	22:15	26:42	31:09	35:36	44:26

4. If lateral or service lines are included in the test, their length may be ignored for computing required test time if the test time requirements are met. If the test section fails, time shall be recomputed to include all the lateral lengths using the following formula:

$$T = 0.085 \left[\frac{D_1^2 L_1 + D_2^2 L_2 + \dots + D_n^2 L_n}{D_1 L_1 + D_2 L_2 + \dots + D_n L_n} \right] \frac{K}{Q}$$

where:

T = shortest time (s) allowed for the air pressure to drop 1.0 psig.

K = 0.000419 ($D_1 L_1 + D_2 L_2 + \dots + D_n L_n$) but not less than 1.0

Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF

$D_1, D_2, \text{ etc.}$ = measured average inside diameter of pipe (in)

$L_1, L_2, \text{ etc.}$ = length of test section (ft)

- a. If the recomputed test time is short enough to allow the section tested to pass, then the test section meets the requirements of this specification.
5. Sections of the pipe that fail the air test shall have the defects repaired and the test repeated.

2.7 Vacuum Testing Manholes

- A. Manholes shall be tested before the ring and cover and grade adjustment rings are installed, and after backfill and compaction is complete.
- B. Conduct tests in conformance with ASTM C1244 and these specifications.
- C. Preparation for tests:
 - 1. All lift holes, joints, and other imperfections shall be filled with an approved non-shrink grout, to provide a smooth finish appearance.
 - 2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manholes.
- D. Test Procedure:
 - 1. The test shall be placed at the top of the manhole in accordance with the manufacturer's recommendation.
 - 2. A vacuum of 10-inches mercury shall be drawn in the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off.
 - a. The time shall be measured for the vacuum to drop to 9-inches mercury.
 - 3. The manhole shall pass if the time for the vacuum reading to drop from 10-inches mercury to 9-inches mercury meets or exceeds the values indicated in the following table.

Minimum Test Times for Various Manhole Diameters

Depth ¹ (ft)	Diameter (in)		
	48	60	72
Time (s)			
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

¹Round actual depth of manhole to next depth up (ex. 11 foot deep manhole, use depth of 10 feet).

- 4. If the manhole fails any test, necessary repairs shall be made by an approved method and the manhole shall be retested until a satisfactory test is obtained.

2.8 Televising Sanitary Sewer Main

- A. All sanitary sewer lines shall be televised three (3) months prior to the end of the warranty period or as deemed necessary within the warranty/construction period by the Town. The televising shall be made by the Contractor or a Sub-consultant to the contractor and the recording shall be submitted to the Town for acceptance.
1. The recording shall be made using a color camera, self-propelled or other having sufficient light to show detail of problem areas and joints.
 2. Camera shall have a swivel head capable of looking up each service connection.
 3. Camera speed shall not exceed three feet (3') per second.
 4. If problem areas or concerns are seen by operator, then the camera shall be backed up and an extended look at the area will be recorded.
 5. All recordings will have location (i.e. manhole # to manhole #), time, date, and footage displayed.
- B. The warranty period for the sanitary sewer collection system WILL continue to be in effect for the time specified in Town of Johnstown Water and Sewer Construction Specifications, latest edition, or until the JWWD has received and approved the video recordings, which ever is longer.

END OF SECTION

SECTION 3: AS-BUILT AND RECORD DOCUMENTS

3.1 Scope

- A. This section addresses the As-Built Drawings and Record Documents for the construction of sanitary sewer collection mains, sanitary sewer facilities, and miscellaneous appurtenances.

3.2 Maintenance of Documents and Samples

- A. Store documents in Contractor's field office apart from documents used for construction.
 - 1. Provide files and racks for storage of documents.
 - 2. Provide storage space for samples.
- B. File documents and samples in accordance with the specification's section numbers.
- C. Maintain documents and samples in a clean, dry legible condition and in good order. Do not use as-built and record documents for construction purposes.
- D. Documents shall be made available for inspection by the Town upon request.

3.3 Recording

- A. Label each drawing "AS-BUILT RECORD DRAWING" in neat large printed letters.
- B. Record information concurrently with construction progress.
 - 1. Do not backfill Work until required information is recorded.
- C. Marking of Project Records.
 - 1. Legible and with a dark pen or pencil.
 - 2. Ink shall not be water based or subject to easy smearing.
- D. Mark Drawings to record actual construction.
 - 1. Field dimensions, elevations, and details.
 - 2. Changes made by a Town approved modification.
 - 3. Details not on original Drawings.
 - 4. Horizontal and vertical locations of underground utilities and appurtenances, referenced to a minimum of two permanent surface improvements.
 - 5. Depths of various elements in relation to project datum.

3.4 Submission

- A. Submit as-built information to the Project Engineer to review and prepare final As-Built Record Drawings.

- B. Accompany the submittal to Project Engineer with a transmittal letter in duplicate containing:
 - 1. Date
 - 2. Project title and number
 - 3. Contractor's name, address, and telephone number
 - 4. Index containing title and number of each Record Document
 - 5. Signature of Contractor or his authorized representative
- C. All As-Built Record Drawings submitted to the Town for approval shall be on 24" x 36" blue-line or blackline form.
- D. Final acceptance of the utility lines will not be given until the As-Built Record Drawings have been submitted to and accepted by the Town.
 - 1. Warranty period will not begin until the Town gives initial acceptance.
 - 2. No certificate of occupancy will be issued for structures connecting to water and sanitary sewer until the Town gives final acceptance of the As-Built Record Drawings.
 - 3. The site Developer will be responsible for utility locate until the Town gives final acceptance of As-Built Record Drawings.

SECTION 4: MANHOLES

4.1 Scope

- A. This section addresses sanitary sewer manholes, and includes the acceptable products, materials, and construction practices which may be used in the construction and installation of manholes.
- B. Manholes shall be furnished with all accessories, including steps, base, cone section, and ring and cover.
- C. Manholes shall be installed wherever there is a change in size, direction, slope, at junctions, and intervals of not more than four hundred feet (400') for 10-inch and smaller diameter pipe and five hundred feet (500') for pipe diameters greater than 10-inches.

4.2 Quality Assurance

- A. Standards (as applicable)
 - 1. ASTM A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement, latest revision.
 - 2. ASTM A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, latest revision.
 - 3. ASTM A996, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement, latest revision.

4. ASTM B108, Standard specification for Aluminum-Alloy Permanent Mold Castings, latest revision.
5. ASTM C33, Standard Specification for Concrete Aggregates, latest revision.
6. ASTM C144, Standard Specification for Aggregate for Masonry Mortar, latest revision.
7. ASTM C150, Standard Specification for Portland Cement, latest revision.
8. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes, latest revision.
9. ASTM C478, Standard Specification for Precast Reinforcement Concrete Manhole Sections, latest revision.
10. ASTM C497, Standard Test Method for Concrete Pipe, Manhole Sections, or Tile, latest revision.

4.3 Product Delivery, Storage, and Handling

- A. Manholes shall be handled, stored, and protected in such a manner as to prevent damage to materials.
- B. All joint surfaces shall be free from dirt, oil, and grease at the time of installation.

4.4 Precast Concrete Manholes

- A. Precast manhole bases, risers, and cone sections shall be manufactured in accordance with ASTM C478, and shall be made with Type I/II cement.
 1. All cone sections shall be the eccentric type.
- B. Concrete and Reinforcing Materials
 1. All reinforcing materials shall conform to ASTM A615, ASTM A617, or ASTM A185.
 2. Reference Section 03400, Precast Concrete.

4.5 Cast-In-Place Manholes

- A. Cement used in cast-in-place manholes shall conform to ASTM C150, Type I/II.
- B. All fine and coarse aggregate shall conform to ASTM C33.
- C. All deformed reinforcing bars shall conform to ASTM A615, or ASTM A996.
 1. All bars shall be either Grade 40 or 60.
- D. All welded steel wire fabric shall conform to ASTM A185.
- E. Concrete used in cast-in-place manholes shall have a minimum of six (6) sacks per cubic yard, and develop a minimum compressive strength of 4000 psi after 28 days.
 1. Concrete shall have a max allowable water/cement ration of 0.50, by weight.

F. Reference Section 03300, Cast-in-Place Concrete.

4.6 Mortar

A. Mortar shall be Sand-Cement grout, using the following ratio of ingredients:

1. One part Portland Cement; conforming to ASTM C150, Type I/II.
2. Two parts sand; conforming to ASTM C144.
3. One-half part hydrated lime; conforming to ASTM C207, Type S.

4.7 Grout

A. Grout shall be one of the following:

1. Pre-mixed, nonmetallic grout; the acceptable types and manufacturers of which are listed below:
 - a. Master Builders; "Embeco Mortar".
 - b. Sonneborn; "Ferrolith G-D.S. Redi-Mixed".
 - c. Or approved equivalent.
2. Job-mixed grout, using the following ratio of ingredients:
 - a. One part Portland Cement; conforming to ASTM C207, Type I/II.
 - b. One part sand; conforming to ASTM C144.
 - c. One part shrinkage correcting aggregate; the acceptable types and manufacturers are:
 - (1) Master Builders; "Embeco Aggregate".
 - (2) Sonneborn; "Ferrolith G-D.S".
 - (3) Or approved equivalent.

4.8 Ring and Cover

A. All rings shall be maximum eight-inches (8") in height.

B. Iron ring and covers shall be gray iron conforming to ASTM A48, with a coal-tar epoxy finish.

1. The word "SEWER" shall be cast in the cover.
2. Covers shall be non-perforated.
3. Cover shall be a Denver heavy-duty traffic lid and not rock under traffic.
4. Pick-hole shall be 1 1/2 inch wide by 1/2 inch deep.
5. Acceptable rings and covers are:
 - a. Neenah, R-1706.
 - b. Or approved equivalent.

4.9 Steps

- A. Steps in manholes shall not be installed unless prior written approval is received from the Town of Johnstown JWWD.
 - 1. If the JWWD accepts manhole steps to be installed, the steps shall be made a minimum 3/8-inch diameter grade 60 steel-reinforcing rod completely encapsulated in a copolymer polypropylene plastic, conforming to ASTM C478 and ASTM C497.
 - 2. Acceptable steps and their manufacturers are:
 - a. M.A. Industries; PS-2-PFS.
 - b. M.A. Industries; PS-2PF.
 - c. Or approved equivalent.

4.10 Preformed Plastic Gaskets

- A. All preformed plastic gaskets shall conform to Federal specification SS-S-00210 (GSA-FSS). Type I, rope form.
- B. The diameter of the preformed plastic gasket shall be 1.5-inches (1.5”).
- C. Acceptable gaskets and their manufacturers are:
 - 1. Hamilton-Kent Manufacturing Co.; Kent Seal.
 - 2. Con Seal; CS-202.
 - 3. Or approved equivalent.

4.11 Inspection

- A. Manholes shall be inspected for cracks, abrasions, or other flaws prior to installation.
 - 1. Damaged or flawed manholes shall be rejected and not used.
 - a. Mark defective manholes and store them on site at a separate location away from the work until after acceptance of the piping system at which time it shall be removed from the site.

4.12 Preparation

- A. Reference Part V, Section 02221, Trenching, Backfilling, and Compaction.

4.13 Manhole Construction

- A. Standard manholes shall be installed in accordance with Standard Drawings.
- B. Flat-top manholes shall be installed in accordance with Standard Drawings.
 - 1. Flat-top manholes are required whenever the distance between the finished ground surface and the manhole barrel section does not allow room for a cone section.
 - 2. Access holes for flat-top manholes shall be offset from center.

C. Cast-In-Place Concrete Base

1. Invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sanitary sewer pipe section.
2. Form inverts directly in the concrete of the base, or for a straight through manhole with no other inlets the channel may be constructed by laying a full section pipe through the manhole and by cutting out the top half of the pipe after the surrounding concrete has hardened.
3. Changes in direction of flow shall be made with a smooth curve having as large a radius as the manhole will permit.
4. The floor of the manhole outside of the channels shall have a smooth trowel finish and shall slope toward the channels at one-inch (1") per foot.
5. Pipe size changes shall be accomplished by matching the pipe crowns and forming the channel to accommodate the pipe size differential.
6. Where shown on the approved Construction Drawings, a piece of pipe of the proper size shall be built into the manhole where future laterals may be connected.
 - a. The stub-out shall be sealed with a plug at its outer end and an invert shall be built into each manhole for such lateral connections.
7. Manhole bases shall be thoroughly bonded to the barrel of the pipe.
 - a. Provide a rubber gasket on the pipe barrel for PVC pipe.
 - b. All connections with the pipe shall be made without projections or voids.
8. Inverts must meet the requirements of the Town.

D. Drop Manholes

1. Where difference in elevation between the incoming sanitary sewer pipe invert and the outgoing manhole invert is less than twenty-four inches (24"), the channel invert through the manhole shall be formed to make a smooth transition between the incoming and outgoing inverts.
2. Where the difference in elevation is twenty-four inches (24") or more, provide an inside drop pipe for the sanitary sewer entering the manhole.
 - a. The inside drop shall be the same diameter as the incoming pipe diameter.
 - b. Manhole diameter per diameter of inside drop shall be:

<u>Drop Diameter</u>	<u>Manhole Diameter</u>
8-inch and below	5 feet
10-inch to 15-inch	6 feet
18-inch and above	Contact JWWD

3. The inside drop shall be manufactured by Reliner or approved equivalent.
4. Reference Town of Johnstown Sewer Standard Details.

E. Manholes shall be constructed at the location and to the elevation indicated on the accepted Construction Drawings, or as stated by Sewer Department to accommodate field conditions.

1. Reference Section 8, Gravity Sanitary Sewer Collection System.

2. All buried manhole covers shall be referenced to a minimum of two permanent surface references and recorded on the As-Built Record Drawings.
- F. The manhole shall be set plumb.
1. Precast concrete adjustment rings shall be used to bring the ring and cover to grade.
 - a. The total height from the top of the cone section to the finished grade shall not exceed 16-inches.
 - b. The adjustment rings shall be flush with the inside of the manhole and grouted.
- G. Step Spacing (If Required)
1. Manhole steps shall be placed 12-inches on center.
 2. The maximum distance from the cover of the manhole to the top most step shall be 18-inches.
 3. The maximum distance from the bench of the manhole to the lowest step shall be 18-inches.
- H. Manhole sections shall be joined to each other using preformed flexible plastic gaskets on both interior and exterior shiplaps. The manhole section shall be joined to the base using a double row of preformed flexible plastic gaskets.
1. All joint surfaces shall be kept clean and dry during installation.
 2. Gaskets shall be pliable at the time of installation.
 3. Primer shall be used on both section/base surfaces unless directed by the Town.
- I. Adjustment shims, and ring and covers shall be joined to the manhole section and to each other using flexible plastic gaskets.
1. All joint surfaces shall be kept clean, dry, and warm during installation.
 2. Manhole sections shall be grouted to ring and covers on the inside.
- J. All lifting holes, joints, and other imperfections shall be filled with an approved non-shrink grout, to provide a smooth finished appearance.

SECTION 5: GRAVITY SANITARY SEWER COLLECTION SYSTEM

5.1 Scope

- A. This section addresses the installation of sanitary sewer collection mains and includes the acceptable products, materials, and construction practices which may be used in the installation of sanitary sewer collection systems.

5.2 Quality Assurance

- A. Standards (as applicable).
 - 1. ASTM C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum), latest revision.
 - 2. ASTM F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision.
- B. Materials
 - 1. All materials used in the construction of gravity sanitary sewer collection systems shall be new.
- C. Horizontal alignment shall remain uniform between consecutive manholes and shall not deviate from the Town accepted construction documents by more than 6-inches (0.5 feet).
- D. Vertical alignment shall remain uniform between consecutive manholes and shall not deviate from the Town accepted construction documents by more than 0.05 feet.
 - 1. The only acceptable methods for the laying of sanitary sewer lines shall be with a laser.

5.3 Job Conditions

- A. Foreign material, including trench water, debris, etc., shall not be permitted to enter the pipe under construction.
- B. Debris or other material shall not be permitted in the pipe.
- C. Water shall be prevented from entering the sanitary sewer pipe that is already in services and has been previously accepted by the Town.
- D. Pipe delivered for construction shall be strung to minimize entrance of foreign material.
- E. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of a day's work or for other reasons, such as rest breaks or meal periods.
- F. Do not place debris, tools, clothing, or other material in the pipe.
- G. Use effective measures to prevent uplifting or floating of the pipeline prior to completion of backfilling operations.
- H. Do not install pipe under the following conditions:
 - 1. When the trench contains water.
 - 2. When weather conditions are unsuitable.

- a. Temperature is less than 10° Fahrenheit.
 - b. Snowing
 - c. Raining
 - d. High winds that in the opinion of the Town impact construction and/or project safety.
 - 3. When the trench bottom is unstable.
- I. Protect pipe and appurtenances against dropping and damage.
- 1. Do not use pipe and appurtenances if they are damaged.
- J. Drainage and groundwater.
- 1. Contractor shall obtain all necessary permits prior to starting dewatering operations.
 - a. If groundwater will be discharged into an irrigation ditch, pond, stream or waterway, or will drain to an irrigation ditch, pond, stream or waterway, a Colorado Department of Health Dewatering Permit will be required.
 - (1) Permit applications may take up to 30 days to be reviewed by the Colorado Department of Health.
 - (2) Contractor is required to complete and process the Discharge Monitoring Report (DMR) that is typically a part of the Dewatering Permit.
 - b. Upon completion of the work, the Contractor shall be responsible for completing a Colorado Department of Health Discharge Termination Notice.
 - 2. Water that is encountered in the trench shall be removed to the extent necessary to:
 - a. Provide a firm subgrade.
 - b. Permit connections to be made in dry conditions.
 - c. Prevent entrance of water into the pipeline.
 - 3. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.
 - 4. The excavation or trench shall be kept free from water until the structure, or pipe, to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
 - 5. The pipe shall not be used to dewater the trench.

5.4 Manholes

- A. Reference Town of Johnstown Sanitary Sewer Construction Specifications, latest edition, Section 4, Manholes.

5.5 Pipe

- A. Reference Town of Johnstown Sanitary Sewer Construction Specifications, latest edition, Section 6, Sanitary Sewer Service Lines.

5.6 Sanitary Sewer Service Lines

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 6, Sanitary Sewer Service Lines.

5.7 Inspection

- A. Pipe barrel and manholes shall be free of dirt or other foreign objects prior to installation.
- B. Pipe and manholes shall be inspected for cracks, dents, abrasions, or other flaws prior to installation.
 - 1. Damaged or flawed pipe or manholes shall be rejected and not used.
 - a. Mark defective pipe and/or manholes and store them on site at a separate location away from the work until after acceptance of the piping system at which time it shall be removed from the site.
- C. Operational Inspection:
 - 1. At the completion of the project and in the presence of the Town, the Contractor shall video all lines to ensure that no debris is left in the lines/manholes and the lines are not plugged.

5.8 Preparation

- A. Trenching, Backfilling, and Compaction
 - 1. Reference Construction Specifications, latest edition, Section 02221, Trenching, Backfilling, and Compaction.
- B. Pipe
 - 1. Reference Sanitary Sewer Construction Specifications, latest edition, Section 6, Polyvinyl Chloride (PVC) Non-Pressure Pipe.
- C. Manholes
 - 1. Reference Sanitary Sewer Construction Specifications, latest edition, Section 4, Manholes.
- D. Existing Utilities
 - 1. The horizontal and vertical location of existing utilities shall be field verified prior to start of construction.
 - a. Any deviation from what is shown on the approved construction drawings shall be reported to the Engineer immediately and documented on the As-Built drawings.

5.9 Connections to Existing System

- A. Connections to existing sanitary sewer collection system shall be made at an existing manhole or by setting a new manhole on the existing line.
 - 1. A watertight plug shall be installed in the new line to prevent any material from entering the existing system until the Town accepts the new system.
- B. At locations where connections to existing sanitary sewer collection mains are to be installed, the Contractor shall locate the existing mains both vertically and horizontally and verify their exact size and material prior to start of construction.
 - 1. The JWWD personnel will examine the existing pipe or manhole. Any necessary adjustments in line, grade, or connection requirements to accomplish the connection shall be reviewed and accepted by the Town prior to making the connection.

5.10 Pipe Installation

- A. Pipe Laying
 - 1. Pipe installation shall begin at the lowest elevation and proceed upstream to the highest, unless prior written approval is obtained from the JWWD.
 - a. Pipe shall be installed so that the bells are pointing uphill.
 - b. Lay pipe true to line and grade.
 - 2. Take effective measures to prevent opening of joints during bedding and backfilling operations.
 - 3. Complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade as each length of pipe is placed in the trench.
 - a. Make adjustments in line and grade by scraping away or filling pipe bedding under the entire length of the pipe, except at bells, and not by wedging, blocking, or mounding up the pipe or bells.
 - 4. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints.
 - a. Do not disturb the pipe after the jointing has been completed.
 - b. Do not use mechanical compacting equipment in the zone above the horizontal centerline of the pipe and below a plane one foot (1') above the top of the pipe.
 - 5. Do not walk on small diameter pipe or otherwise disturb pipe after the jointing has been completed.
- B. For water and sanitary sewer pipe crossings see the requirements set forth in Sanitary Sewer Construction Specifications, latest edition, Section 4, Relation to Water Mains and Sewer Pipes.

5.11 Manhole Installation

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 4, Manholes.
- B. Manholes shall be installed at the location and to the elevation shown on the approved Construction Drawings, or as approved by Sewer Department to accommodate field conditions.
- C. Measurements of the actual location and elevation of sanitary sewer inverts and rim shall be made for the As-Built Drawings.

5.12 Sanitary Sewer Service Connections

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 6, Sanitary Sewer Service Lines.

5.13 Field Quality Control

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 2, Testing Sanitary Sewer Collection System.

SECTION 6: SANITARY SEWER SERVICE LINES

6.1 Scope

- A. This section addresses the installation of sanitary sewer service lines plus furnishing and installation of clean-outs and other appurtenances.

6.2 Quality Assurance

- A. Construction Staking
 - 1. Reference Construction Specifications, latest edition, Section 02221, Trenching, Backfilling, and Compaction
- B. Materials
 - 1. All materials used in the construction of gravity sanitary sewer services shall be new.

6.3 Job Conditions

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 7, Gravity Sanitary Sewer Systems.

6.4 Pipe

- A. Reference Sanitary Sewer Construction Specifications, latest edition, Section 4, Pipe Material

6.5 Flexible Couplings

- A. When joining pipes where conditions will not allow joining by use of a bell section, use one of the following adaptors:
 - 1. Can-Tex, C-T Adaptors
 - 2. Fernco, Flexible couplings or reducing couplings
 - 3. Jointers Inc., Calder Coupling
 - 4. Mission, Bushing Adaptors
 - 5. Nashua Pre-cast corp., Flex-O-Joint
 - 6. Or approved equivalent

6.6 General

- A. Only those Contractors licensed and bonded with the Town of Johnstown will be permitted to install sanitary sewer service connections.
- B. Sanitary sewer service connections shall be installed at locations designated on the Town accepted construction drawings.
- C. The Contractor shall mark the location of the sanitary sewer service with a stamped "S", four-inches (4") high, three-inches (3") wide into the face of the curb and gutter.

6.7 Trenching, Backfilling, and Compaction

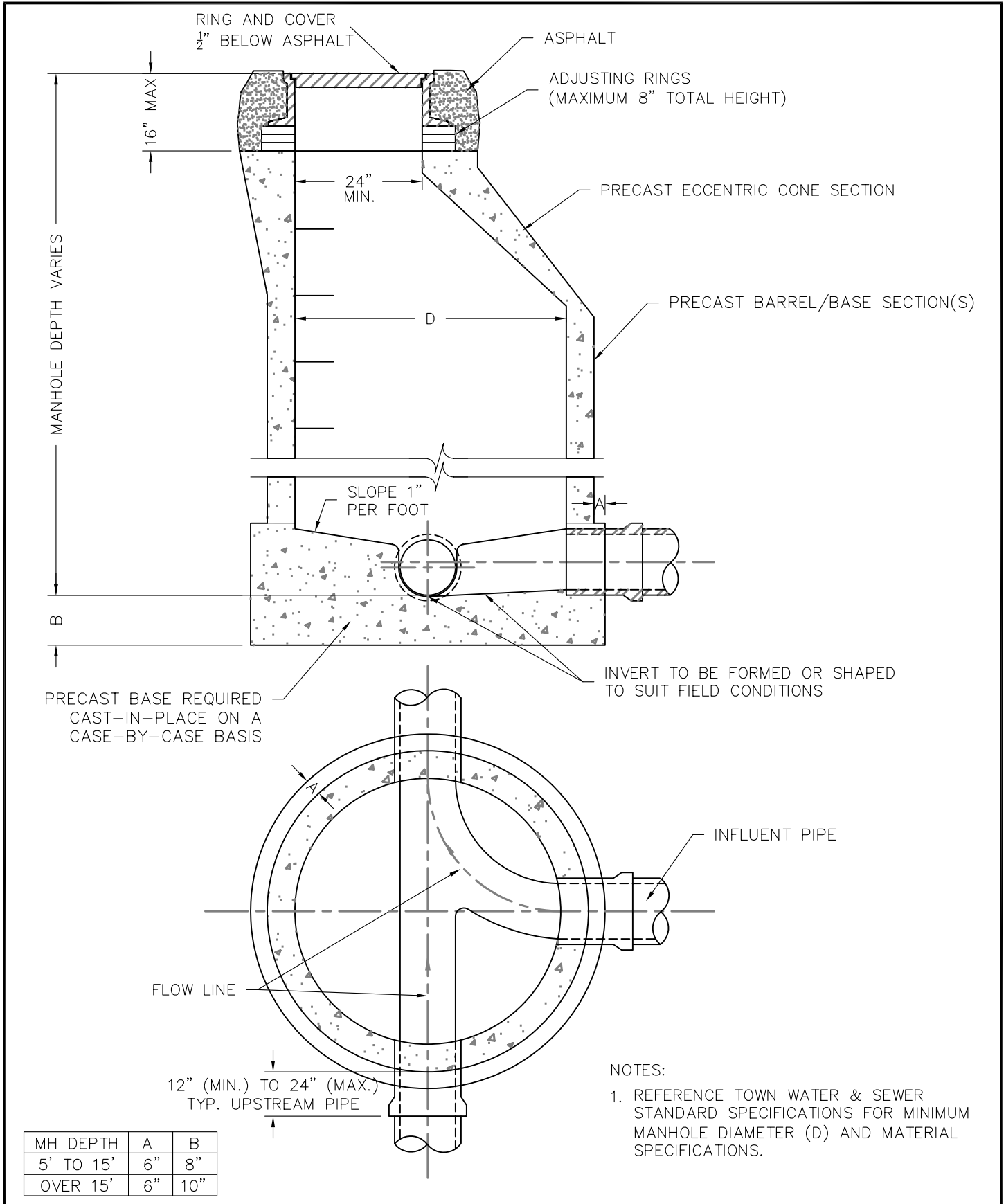
- A. Reference, Construction Specifications, latest edition, Part V, Section 02221, Trenching, Backfilling, and Compaction.

6.8 Taps

- A. Unless prior approval is given by the Town, only Town personnel shall make service taps on mains that have passed final acceptance by the City.
- B. The Contractor shall not make any taps without permission from the Town.
- C. Wyes and bends shall not be permitted for service connections unless previously approved in writing by the Town.
- D. Taps shall not be made within five feet (5') of a manhole.
- E. The flow line of the service connection shall be at or above the spring line of the sanitary sewer collection main and no closer than three feet (3') to the bell or spigot of the pipe.
- F. Reference Standard Drawings.

6.9 Service Lines

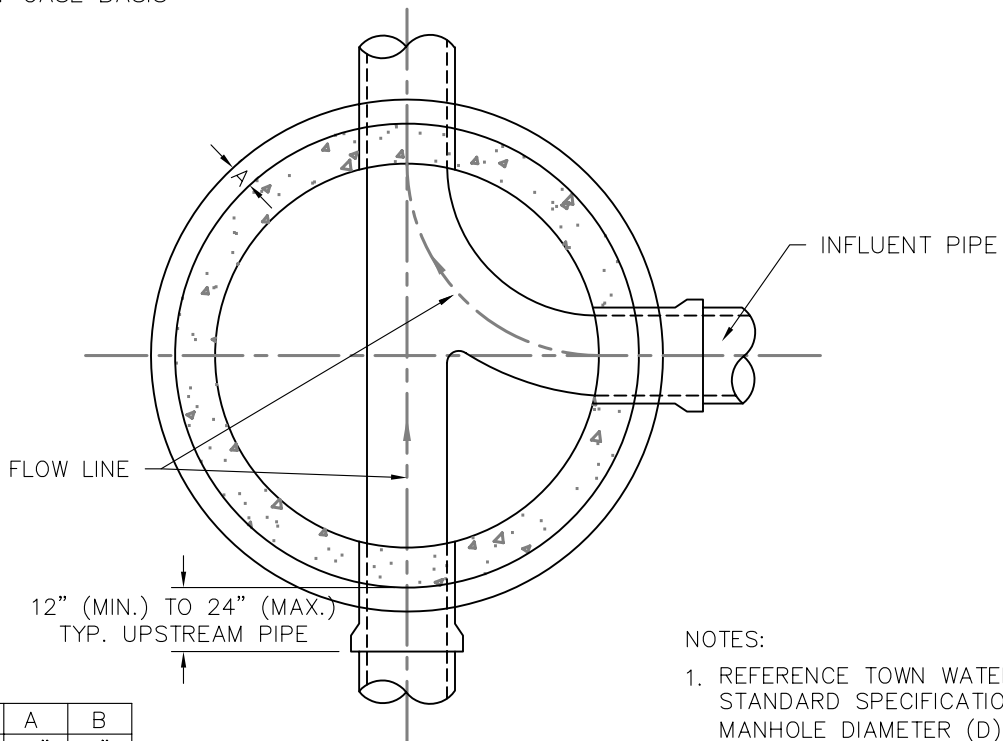
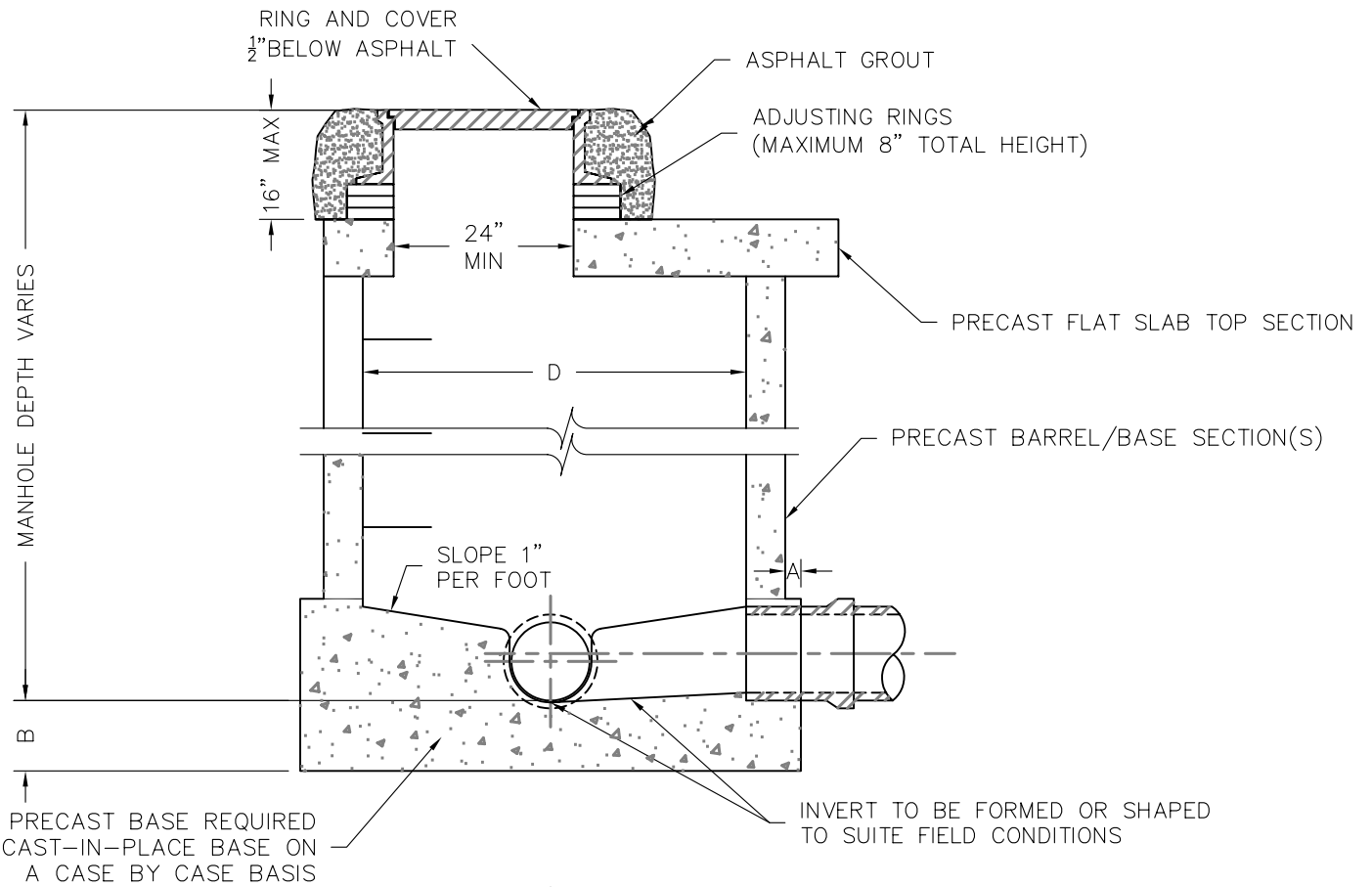
- A. All sanitary sewer services shall be extended at a constant grade from the tap on the collection main to the building.
 - 1. Maximum slope of all services shall be 8%.
 - 2. Minimum slope of 4-inch services shall be $\frac{1}{4}$ -inch per foot (2%).
 - 3. Minimum slope of 6-inch services shall be $\frac{1}{8}$ -inch per foot (1%).
- B. Sanitary sewer service lines shall be uniform in size from the tap to the building.
- C. Sanitary sewer service trenches shall be subject to compaction specifications. Reference Construction Specifications, latest edition, Part V, Section 02221, Trenching, Backfilling, and Compaction.
- D. The end of all sanitary sewer services shall be plugged with an airtight cap or plug.
- E. The end of all sanitary sewer services shall be marked with a 2-inch by 4-inch (2" x 4") wood post.
 - 1. All wooden posts shall extend from the end of the service to a point two feet, minimum, above the ground surface and shall be painted green.
 - 2. Locator balls/rings or adequate steel to be located by a ferrous metal detector shall be placed at the end of the service at an adequate depth to not be disturbed by grading and construction operations.
 - 3. Maintenance of the marker posts shall be responsibility of the Contractor.



**TOWN OF
JOHNSTOWN**

**STANDARD
MANHOLE DETAIL**





NOTES:

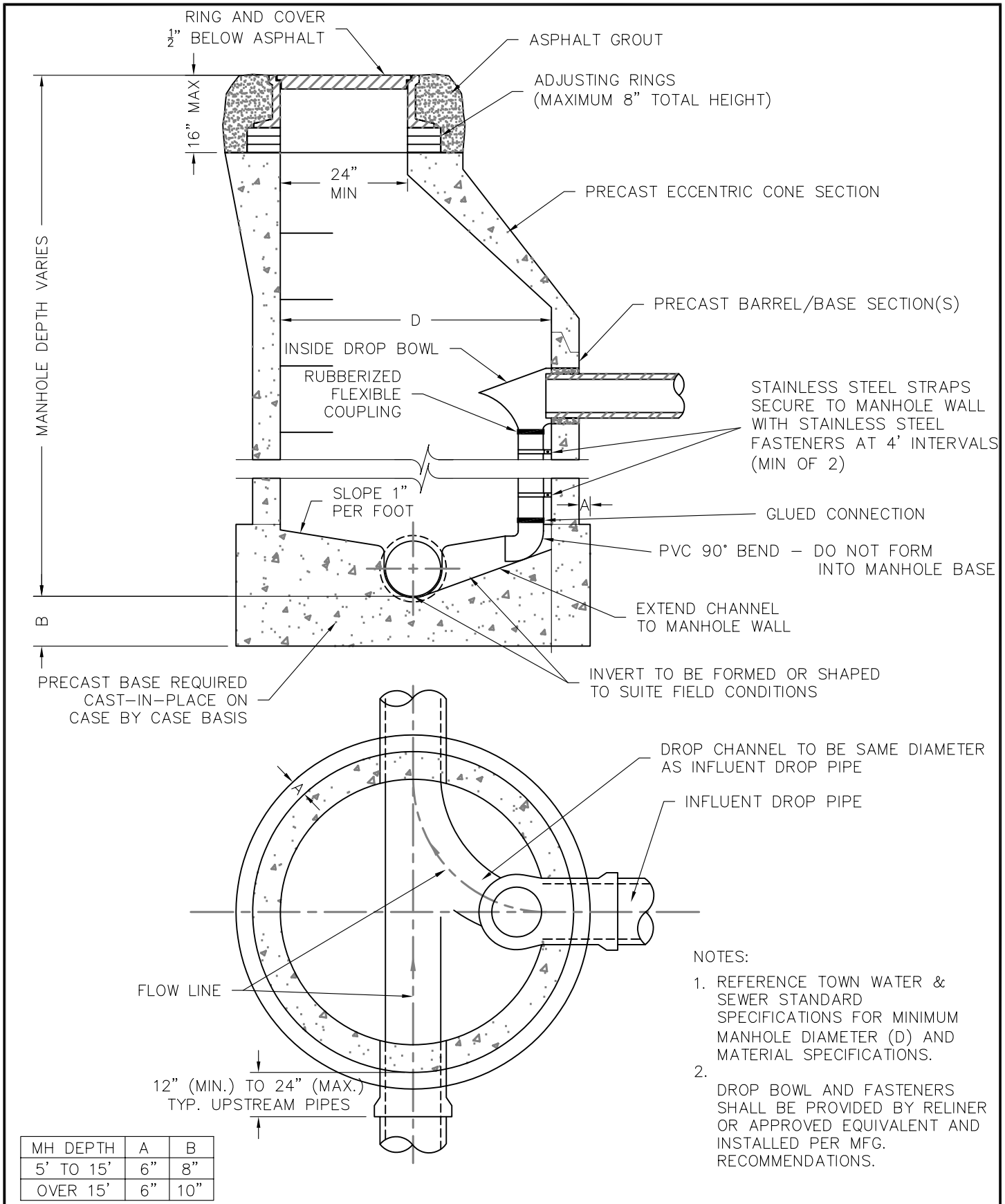
1. REFERENCE TOWN WATER & SEWER STANDARD SPECIFICATIONS FOR MINIMUM MANHOLE DIAMETER (D) AND MATERIAL SPECIFICATIONS.

MH DEPTH	A	B
5' TO 15'	6"	8"
OVER 15'	6"	10"

**TOWN OF
JOHNSTOWN**

**SHALLOW
MANHOLE DETAIL**

TST

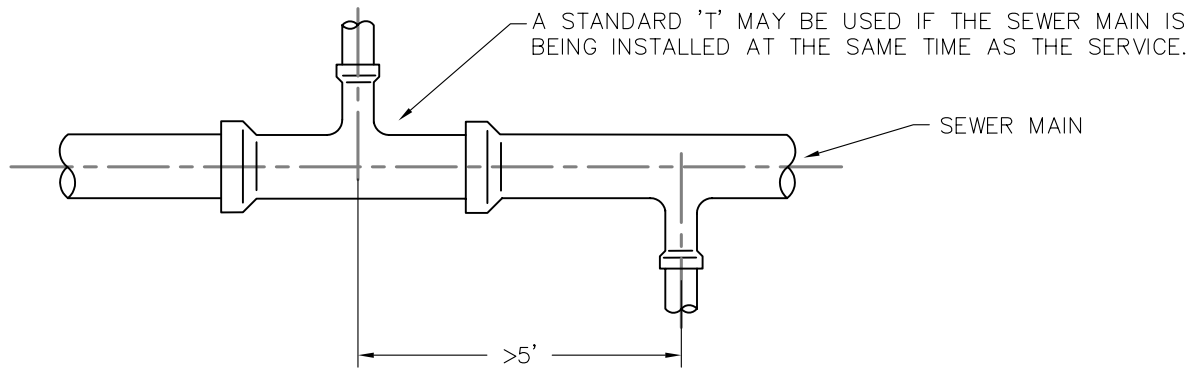
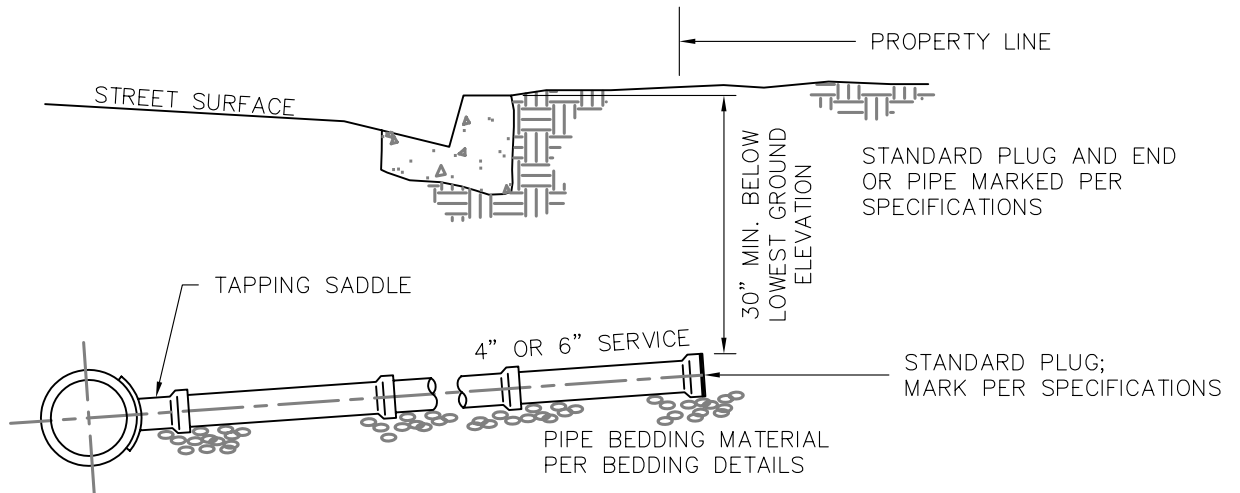


MH DEPTH	A	B
5' TO 15'	6"	8"
OVER 15'	6"	10"

**TOWN OF
JOHNSTOWN**

**INSIDE/DROP
MANHOLE DETAIL**





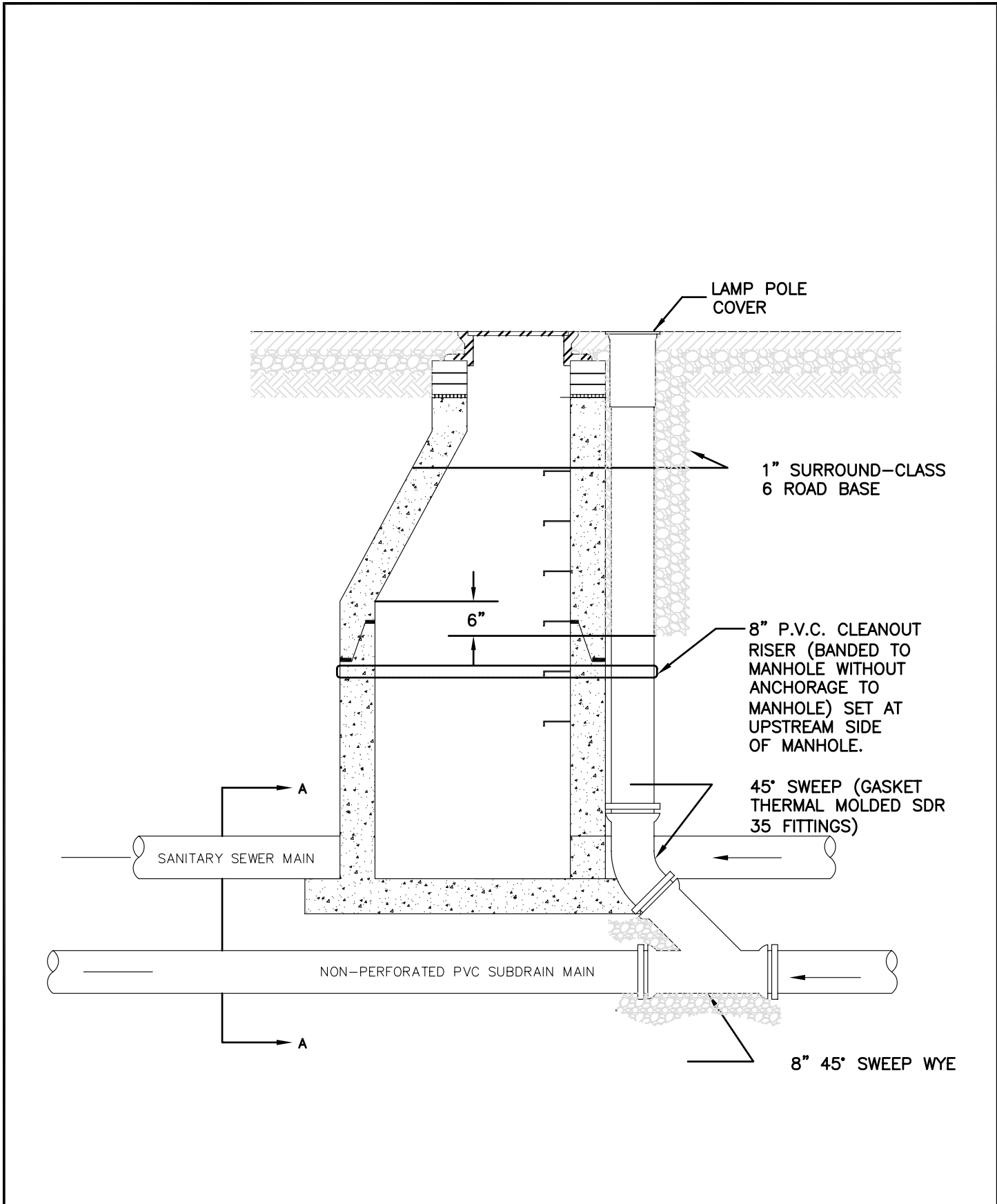
NOTES:

1. IN NO CASE SHALL THE SEWER SERVICE PROTRUDE INTO THE SEWER MAIN.
2. 4" SEWER SERVICES SHALL HAVE A MINIMUM SLOPE OF 2.0% AND A MAXIMUM SLOPE OF 8%.
3. 6" SEWER SERVICES SHALL HAVE A MINIMUM SLOPE OF 1.0% AND A MAXIMUM SLOPE OF 8%.
4. SERVICES SHALL NOT BE MADE CLOSER THAN 5 FT. FROM EACH OTHER ON THE MAIN.
5. SERVICES LARGER THAN 6" SHALL BE MADE AT A MANHOLE.
6. SERVICES SHALL EXTEND TO PROPERTY LINE UNLESS OTHERWISE SHOWN ON CITY ACCEPTED PLANS.

**TOWN OF
JOHNSTOWN**

**SEWER SERVICE
ALT. CONNECTION**

TST



**TOWN OF
JOHNSTOWN**

**UNDERDRAIN MH
CONNECT DETAIL**

