

CITY OF TANEYTOWN

Carroll County, Maryland

SPECIFICATIONS FOR SANITARY SEWER SYSTEM CONSTRUCTION

March 2026



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Recipients of this document must keep themselves informed of any revisions which may be made to the Specifications.

FIRST EDITION – NOVEMBER 2010

SECOND EDITION – JULY 2022

THIRD EDITION – JANUARY 2023

FOURTH EDITION – MARCH 2026

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Carroll County, Maryland**

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FOR
SANITARY SEWER SYSTEM CONSTRUCTION**

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SECTION 1 - GENERAL REQUIREMENTS

A. GENERAL

1. Definitions

- a. Applicant/Owner: All references to the "Applicant or Owner" in these specifications pertain to the individual, organization, company or developer requesting sanitary sewer capacity allocation from the City.
- b. City: City of Taneytown
- c. Customer: Any person or company who receives sanitary sewer service from the City.
- d. Extendor: The builder of the sanitary sewer extension or sewage pumping facilities. Where the Extendor is acting as an agent of the Applicant, the requirements of the Extendor under these specifications shall also apply to the Applicant, and the City shall have recourse to either party. These Specifications shall not, however, be construed to dictate the legal relationship between the Applicant and his Extendor.

2. Scope

Where an Applicant for sanitary sewer service desires to design and construct an extension to the sanitary sewer system, the Applicant shall consult with the City prior to design, to obtain approval and to establish design criteria.

All sanitary sewer service projects shall be done in accordance with the latest edition of the *Code of the City of Taneytown* and these *Specifications for Sanitary Sewer System Construction*.

An Applicant for an extension of the sanitary sewer system shall submit plans providing the following information:

a. Sanitary Sewer Requirements:

Number and type of housing units, with anticipated construction schedule

Estimated total population served

Average daily sewage flows

Maximum daily sewage flows

Construction elevations (U.S.G.S. datum)

b. Existing and proposed streets, property and lot lines, and building locations.

c. Existing and proposed utilities including location and sizes of sewer lines, manholes, pumping stations, and other facilities.

d. Legend of symbols, scale and date.

e. A note which states: "All sanitary sewer construction shall conform to the City of Taneytown's *Specifications for Sanitary Sewer System Construction*, which shall take precedence over other notes on the Drawings".

3. Design Criteria

The following design criteria shall be used unless exceptions are approved in writing by the City. Where special design criteria are required, the Applicants should consult with the City prior to preparation and submission of plans.

a. Domestic Sanitary Sewer Requirements:

Average Daily Requirement: 250 gallons per day per EDU (the City, at its own discretion, may apply a reserve factor in excess of the 250 gpd)
Maximum Daily Requirement: 4.0 times average daily demand

b. Commercial, Industrial or Special Sanitary Sewer Requirements:

Established for each installation

4. Liability

The Extendor shall be responsible for any and all damage, loss, or injury to persons or property that may arise, or be incurred, in or during the conduct or progress of the work.

5. City's Right of Inspection

The City shall have the right to inspect any sewer system construction carried out by the Applicant. Should the inspected work prove to be unsatisfactory, the cost of removing and replacing, renewing and making good the unsatisfactory work shall be borne by the Applicant. No sanitary sewer facility shall be placed in service until it has been successfully tested in the presence of an authorized City representative.

6. Working Conditions

No night, Saturday, Sunday or National Holiday work subject to City inspection will be permitted except in cases of emergency with written City consent. No work shall be done when, in the opinion of the City, the weather is unsuitable.

7. Standard Specifications

Standard specifications of societies, associations, institutes, etc., referred to in these Specifications, shall be the latest edition of such specifications unless otherwise noted.

8. Work Area Traffic Control and Maintenance

- a. Traffic in work areas shall be controlled to protect the public and workmen, while minimizing the inconvenience to the public. Traffic control devices shall conform to the Maryland State Highway Administration (MDSHA) requirements. Traffic control measures shall be coordinated with the City of Taneytown.
- b. Unless authorized by the City to completely close the road, the contractor must take the necessary measures to keep the road open for traffic, at his own expense. When vehicles must be stopped for short periods, work shall be performed during other than peak traffic periods. During progress of work, sidewalks and crossings must be kept open for pedestrians, unless otherwise authorized. Access to residential and business establishments shall be maintained, except when work is actually being performed in the area. During non-working hours the Extendor shall insure that all streets affected by construction are open and can be safely traveled by vehicles.
- c. The Extendor shall construct and maintain, without extra compensation, adequate and proper bridges over excavations for safe accommodation of pedestrians or vehicles. The Extendor shall furnish and erect approved barricades at crossings of trenches, or along the trench, to protect the public.
- d. All sidewalks, roadways and private property shall be kept clear of excessive dust, dirt, mud or other excavated material. The City shall be empowered to require the cleaning and/or dampening of any area if, in the judgment of the City's inspector, such action is necessary for the safety and accommodation of traffic and the public. Trenches across driveways, side streets, alleys and entrances shall be maintained after backfilling.
- e. All stored materials and equipment which may obstruct traffic shall be protected by approved lights, lanterns, torches, or guards.

9. MISS UTILITY

The location and type of utility lines at the work site must be identified and detailed information from each user (utility owner or operator) must be requested at least 48 hours before beginning work, excluding weekends and legal holidays. In Maryland, the organization to contact is MISS UTILITY. The telephone number is 1-800-257-7777. The Extendor must provide his operators with the information and must inform any user of any damage made or discovered during construction.

10. Permits

- a. The Applicant shall secure, in the name of the City, all permits that are required from the Maryland Department of the Environment (MDE), Maryland State Highway Administration, and the Maryland Midland Railroad. The Applicant shall secure, in his own name, all required construction permits such as local street opening permits and Carroll Soil Conservation District permits from Carroll County. Any existing street, highway or other improvements disturbed during construction shall be restored to the satisfaction of the City before the facilities will be approved for final acceptance by the City. All costs of such permits, including any and all bonds required, shall be the sole expense of the Applicant. Prior to opening any excavation within the right-of-way of any railroad or state highway, the Extendor shall make certain that the

necessary agreements have been executed and that all required permits have been obtained.

- b. The Applicant shall acquire all necessary permits for blasting and for special equipment. Any provisions in these permits shall supersede the above provisions. If blasting is to be performed, the Applicant shall provide written notices to the City and all residences and businesses in the surrounding area a minimum of 48 hours in advance of the blasting.
- c. Approval by the City inspector of all or part of any work performed under a permit issued by an independent agency shall not constitute acknowledgement that the work was performed in accordance with such permit; nor shall such approval by the inspector be construed as a release of the applicant from his obligations to meet the requirements of the permit, or that such approval serves as a waiver of the City's right to seek enforcement from the permitting agency.

11. General Excavation

- a. Clearing and Grubbing

Clearing includes the cutting and disposal of all trees, vegetation, and other objectionable material occurring within a width of the work area established prior to construction. Grubbing includes the removal and disposal of all stumps and root mats located within the established area. The method of disposal of waste material shall conform to all state and local laws, ordinances and regulations, including the Air Pollution Control Act of 1990, or as amended.

Trees cut down shall have their stumps removed, and all resulting debris shall be removed and disposed of by the Extensor at his expense.

- b. Exploratory Test Pits

Test pits shall be dug in advance of trench excavation when necessary to determine the location and depth of existing utilities, rock, groundwater levels, or other conditions that might affect construction.

- c. Protection of Property and Structures

The Extensor shall, at his own expense, sustain in their places, and protect from direct or indirect injury, all poles, pipes, conduits, tracks, roadways, curbs, walks, walls, buildings, and other structures or property in the vicinity of his work. The Extensor shall be responsible for any damages, and assume all expense for direct or indirect injury, caused by his work, to any person, property, or structure. Pipes and underground conduits exposed as a result of the Extensor's operations shall be adequately supported by timber or planking, such that the anchorage of the supports will not be disturbed or weakened during backfilling. Approved backfill material shall be carefully tamped under and around the supports, and all supports shall be left in place.

Any removal, realignment, or change in the position of any pipe, conduit, pole, or other structure due to the construction shall be done at the Extendor's expense and with the approval of the owner of the obstruction. If fencing removed served as an enclosure for animals, the Extendor shall prevent the escape of the animals. When the sanitary sewer is completed, the Extendor shall restore the temporary and permanent rights of way to their original condition at his own expense.

d. Removal of Pavement and Storage of Materials

The Extendor shall grub and clear the surface and remove all surface materials over the line of the trench; properly separate and classify the material removed; and store, guard, and preserve any materials required for backfilling or other purposes. All materials taken from the trenches shall be stored away from the street or highway, unless otherwise authorized by the City. The materials shall be placed or stored in a manner that will not obstruct any pipe, culvert, gutter, drain, ditch, or water way. The width of existing pavement removed shall be no greater than the trench widths as specified in the detail drawings, unless otherwise directed by the City. Pavement shall be cut to neat lines with a concrete saw or air spade in accordance with local government regulations.

Backfill material shall not be removed from the lines of work before the excavation is refilled, except with City approval. This provision shall not relieve the Extendor of his obligation to remove and dispose of the excavated material at his expense.

In business districts, state highways, streets with heavy traffic, narrow streets, or any other locations where working space is limited, the excavated material shall, when required by the City, be removed at the Extendor's own cost and expense, as soon as excavated. The Extendor shall not cast excavated material beyond the curb or right-of-way lines, or on sidewalks or lawns. Excess excavated material shall be removed to a location provided by the Extendor. The Extendor may, at his own cost and expense bring back this material for backfill, if it is suitable, or shall provide other suitable material. When soft or wet material must be hauled over streets, the Extendor shall prevent spillage. All topsoil within the trench limits shall be removed prior to excavation and replaced after backfilling.

12. Drainage and Dewatering

The Extendor shall keep gutters, storm sewers, drains, and ditches open at all times for surface drainage. The Extendor shall direct water across or over pavements only through approved pipes or properly constructed troughs, and he shall do so at his own cost and expense. The ground surface shall be properly ditched to prevent water from running into the pipe trenches.

The Extendor shall keep all excavations free from water at his own expense.

13. Special Requirements

- a. All sewer lines shall be extended to the furthest property lines or corners of the development under consideration. The exception shall be where lines cannot be further extended at the sole discretion of the City. The size and location of the sewer mains, pumping stations, treatment facilities, valves and other appurtenances shall be determined or approved by the City's Engineer so as to comply with the City's long-range facilities planning.
- b. The Extendor shall maintain existing sanitary sewer lines in service. If an existing sewer line is damaged or broken, the Extendor shall expeditiously restore service at his expense.
- c. All sewer mains to be dedicated to the City shall have a 30' right-of-way.
- d. Gas utility mains shall be shown on water and sewer plan and profile sheets during the design phase of the project for City approval prior to construction.
- e. Construction of sewers and appurtenances shall conform to the requirements of the Occupational Safety and Health Act (OSHA).
- f. All equipment used on roadways shall be equipped with rubber tires or treads. If other than rubber tires or treads are used, the pavement shall be protected by heavy rubber belting. If pavement, curb and/or sidewalk is damaged or marked by construction equipment, the areas shall be restored at no cost to the City.
- g. The Extendor shall not obstruct fire hydrants.
- h. The work shall be protected from damage during storms.
- i. A competent person shall be identified and made available within 2 hours in case emergency situations arise during non-working hours.
- j. The local Police and Fire Departments shall be informed of the work schedule and of possible street obstructions.
- k. Any damage to existing utilities shall be repaired at the Extendor's expense and to the satisfaction of the owner of the utility.

END OF SECTION

SECTION 2 - SANITARY SEWER LATERALS

A. GENERAL

1. A sanitary sewer lateral is that section of a sanitary sewer that extends from the sewer main to a point 12 inches beyond the right of way, curb or sidewalk in front of the property which it serves (refer to Details 5, 6, 7, 9 for lateral connections).
2. Each improved property shall have its own sanitary sewer lateral. Each side of a duplex, or each townhouse unit shall have its own sewer lateral.

3. Permits

The Applicant shall secure, in the name of the City, all permits that are required from the Maryland Department of the Environment (MDE) and the Maryland State Highway Administration (MDSHA). The Applicant shall secure, in his own name, all required construction permits such as highway or local street opening permits. Any existing street, highway or other improvements disturbed during construction shall be restored to the satisfaction of the appropriate municipality or Owner before the facilities will be approved for final acceptance by the City. All costs of such permits, including any and all bonds required, shall be the sole expense of the Applicant.

4. Disconnection of Sewer Laterals

Disconnection of a sewer lateral shall be done at the sewer main. The 45° bend and the lateral pipe shall be removed and a cap installed on the sanitary tee on the main line. After the cap has been installed, concrete shall be poured over the sanitary tee and cap to prevent future connections at that point. If it is not possible to remove the lateral pipe, and at the discretion of the Engineer, the pipe may be filled with AASHTO No. 8 stone, sand or flowable fill to prevent future use.

B. DESIGN CRITERIA

Fittings (sanitary tees, risers and bends) and sewer lateral pipe shall be furnished and installed in strict accordance with these specifications and any and all practices and precautions required for the main gravity sewers are equally applicable to the sewer laterals.

1. Diameter and Slope

Sewer laterals shall be designed so that all units shall be served by a minimum 6-inch sewer lateral. Laterals shall be installed with a minimum 1% slope and shall include a watertight cap or stopper. All sanitary tees shall be set in accordance with the detail drawings using 6-inch bends. The invert elevation of the 6-inch service lateral at the 45° bend shall be the same as the elevation of the crown of the main.

2. Depth and Alignment

All laterals shall be provided with a minimum cover of 3'-6". A maximum cover of 7 feet shall be allowed at the curb. Laterals shall be constructed, generally, perpendicular to the sanitary sewer main. Laterals shall only be constructed at an angle other than perpendicular to the main when no other reasonable alternative exists, and/or at the discretion and approval of the City's Engineer.

3. Separation of Utilities

a. Parallel Installation

A minimum 10-foot horizontal separation (measured from edge of pipe to edge of pipe) between sanitary sewer lines and water lines shall be required when the lines are constructed parallel (relatively) to one another. When this condition cannot be met, concrete encasement of the sanitary sewer line shall be required for the length of line that fails to meet the 10-foot separation distance requirement, at the discretion of the City's Engineer. However, under no conditions shall the horizontal separation distance between sewer and water lines be less than 5 feet.

b. Line Crossings

A minimum 18-inch vertical separation between the top of the sanitary sewer line and the bottom of the water line shall be required when the lines cross one another. When this separation cannot be met, concrete encasement of the sanitary sewer line shall be required for a minimum distance of 10-feet on either side of the point of crossing, and/or until the minimum 10-foot separation distance requirement is met (depending on the angle of crossing).

Where a water main crosses below a sewer main, structural support must be provided for the sewer main to prevent any damage to the water main.

These requirements shall apply to laterals (both water and sewer) as well as main line construction.

4. Sewer laterals shall not be connected to manholes unless approved by Engineer.

C. MATERIALS AND EQUIPMENT

1. Gravity Sewer Laterals

a. Ductile Iron Pipe and Fittings

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

b. Polyvinyl Chloride Sewer Pipe and Fittings

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

c. Alternative Gravity Sewer Pipe Materials

Alternative gravity sewer pipe materials may be considered and will be subject to approval by the City on a case-by-case basis. Full details of alternatives must be submitted.

2. Sanitary Tees for Connection to Main Line

Sanitary tees shall conform to the pipe materials specifications above.

3. Lateral Connections to Existing Sanitary Sewer Lines

- a. Lateral connections to existing PVC gravity sewer main shall be made by cutting out a small section of the main and installing a PVC tee. The tee shall be secured to the main by attaching the bell ends of the tee on one side and a short section of pipe on the other side. The short section of pipe shall be secured to the main using a gasketed PVC coupling.
- b. Lateral connections to existing non-rehabilitated terra cotta or asbestos cement (transite) pipe shall be made by cutting out a small section of the main and installing a PVC tee. Connection of the tee to the main shall be made with Fernco style transition couplings or approved equal.
- c. Lateral connections to existing, rehabilitated terra cotta or asbestos cement (transite) pipe shall be made by core-drilling through the existing host pipe and the liner and installing a 6-inch saddle tee (CB Sewer Saddle by Romac Industries or approved equal). The saddle tee shall be secured to the pipe using stainless steel bands. The hole for this saddle must be carefully cut into the existing line, making sure that the cut-out pieces are not dropped into the pipe. The annular space between the CIPP liner and the host pipe that was exposed as a result of cutting the sewer shall be sealed with a two-part, 100% solids, epoxy-based patching compound (Splash Zone A-788 by Carboline Company, or an approved equal). Under no circumstances should any inserted pipe protrude into the sewer main.
- d. Lateral connections to existing ductile iron gravity sewer main shall be made by cutting out a small section of the main and installing a ductile iron tee. The tee shall be secured to the main by attaching the bell ends of the tee to the main line on one side and a short section of pipe on the other side. The short section of pipe shall be secured to the main using a Dresser style repair coupling or approved equal.

4. Detectable Warning Tape

Detectable warning tape shall be polyethylene film encasing a metallic core, minimum 6" wide and 4 mils thick, color-coded green for sewer, bearing in black letter – CAUTION: SEWER LINE BELOW.

5. Drops

Where necessary, laterals shall be constructed using a riser as shown in detail 6 of these specifications. Risers shall be constructed at an angle no greater than 45 degrees from horizontal. Cleanouts shall not be used as drops.

D. INSTALLATION

1. General

Where no sanitary tee is present in an existing sewer line, lateral connections shall be made with a saddle type connection. The hole for this saddle must be carefully cut into the existing line, making sure that the cut-out piece is not dropped into the pipe. All saddles shall be securely fastened to the existing line with two stainless steel straps, one on each side of the opening in the pipe. In addition, saddles installed on PVC pipe shall be glued per the manufacturer's recommendations. A bead of silicone caulk shall be used to seal the saddle at the interface with the existing sewer main. Under no circumstances should any inserted pipe protrude into the sewer main.

2. Excavation

Trench excavation, in any material, shall extend four (4) feet beyond the end of the lateral for the full depth of the lateral. If the lateral is intended to be used at a later date, then prior to backfilling, a minimum 2-inch x 4-inch treated lumber locator marker shall be placed against the end of the lateral and shall extend a minimum of 12 inches above finished grade.

Refer to SECTION 3 – GRAVITY SEWERS for other requirements.

3. Bedding

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

4. Laying Pipe

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

5. Backfilling

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

6. Surface Restoration

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

7. Drops

Where necessary, drops shall be installed in laterals to facilitate shallower depths at the curb. Drops are to be installed at an angle no greater 45° from horizontal. The use of vertical drops with or without a cleanout stack above the drop shall not be permitted. If this configuration is not possible, the owner is to consult the City on alternative installation methods.

E. TESTING AND INSPECTION

1. Lateral connections which are constructed as part of new sanitary sewer installations shall be tested and inspected as described in SECTION 3 – GRAVITY SEWERS.
2. Lateral connections to existing sanitary sewer lines shall be visually inspected prior to backfilling. Laterals shall be inspected for alignment, depth, slope, and for fittings and pipe material used.

F. DETAIL DRAWINGS

Relevant detail drawings are:

- 1 Right of way Restoration
- 2 Pavement Restoration
- 3 Concrete Encasement
- 5 Lateral Connection
- 6 Lateral Connection Riser
- 7 Lateral Connection Riser with Concrete Encasement
- 8 Standard Lateral or Service Line Cleanout

END OF SECTION

SECTION 3 - GRAVITY SEWERS

A. GENERAL

1. All designs shall conform to good engineering practice and shall meet the requirements of the Maryland Department of the Environment (MDE), Occupational Health and Safety Administration (OSHA), Maryland Department of Labor, Licensing & Regulation and the Maryland State Highway Administration (MDSHA) and shall conform to the requirements contained herein.

2. Permits

The Applicant shall secure, in the name of the City, all permits that are required from MDE, Maryland Midland Railroad and MDSHA. The Applicant shall secure, in his own name, all required construction permits such as highway or local street opening permits. Any existing street, highway or other improvements disturbed during construction shall be restored to the satisfaction of the appropriate municipality or Owner before the facilities will be accepted for dedication by the City. All costs of such permits, including any and all bonds required, shall be the sole expense of the Applicant.

B. DESIGN CRITERIA

1. Diameter and Slope

The minimum sewer diameter shall be 8 inches and the minimum slope for all gravity sewer shall be as listed in the *Design Guidelines for Sewerage Facilities* from the Environmental Health Administration Department of Health and Mental Hygiene (1978 Edition). The minimum slope for all terminal sections of sewers shall be 1.0%. The maximum distance between manholes shall be 400 feet.

2. Depth of Sewers

- a. All sewers shall be designed to provide a minimum depth of cover of 4'-0" above the top of the pipe.
- b. Under normal conditions, sewer lines with depths greater than 15 feet will not be approved. If greater depths of sewers are deemed necessary, the design should be thoroughly evaluated and discussed with the City prior to formal submission of the plans for approval. In all cases where subsequent approval is given by the City, the pipe shall be ductile iron.

3. Separation of Utilities

- a. Parallel Installation

A minimum 10-foot horizontal separation (measured from edge of pipe to edge of pipe) between sanitary sewer lines and water lines shall be required when the lines

are constructed parallel (relatively) to one another. When this condition cannot be met, concrete encasement of the sanitary sewer line shall be required for the entire length of the line that fails to meet the 10-foot separation distance requirement, at the discretion of the City's Engineer. However, under no conditions shall the horizontal separation distance between sewer and water lines be less than 5 feet.

b. Line Crossings

A minimum 18-inch vertical separation between the top of the sanitary sewer line and the bottom of the water line shall be required when the lines cross one another. When this separation cannot be met, concrete encasement of the sanitary sewer line shall be required for a minimum distance of 10 feet on either side of the point of crossing, and/or until the minimum 10-foot separation distance requirement is met (depending on the angle of crossing).

Where a water main crosses below a sewer main, structural support must be provided for the sewer main to prevent any damage to the water main.

These requirements shall apply to laterals (both water and sewer) as well as main line construction.

4. Borings

Bored crossings shall be done in accordance with MDSHA requirements.

C. MATERIALS AND EQUIPMENT

1. Ductile Iron Pipe and Fittings

(References to ASTM, AWWA and ANSI Specifications imply latest edition.)

a. Ductile Iron Pipe

Ductile iron pipe shall conform to AWWA C151 and ASTM A746. Pipe shall be supplied in standard lengths as much as possible and shall be by U.S. Pipe and Foundry Company or American Ductile Iron Pipe Company.

b. Joints

Joints shall be rubber-gasket push-on type or rubber-gasket mechanical joint type conforming to AWWA C111. Gasket shall be of SBR.

c. Linings

Ductile iron pipe and fittings shall be lined with Protecto 401 ceramic-filled amine cured epoxy by Indurall, SewperCoat calcium aluminate mortar by Lafarge Calcium Aluminates or approved equal.

d. Minimum Thickness

Thickness design shall be per AWWA C150, except provide minimum Class 350.

2. Polyvinyl Chloride Sewer Pipe and Fittings

a. Materials

Polyvinyl chloride (PVC) sewer pipe and fittings shall be PVC SDR 35 with full diameter dimensions and shall conform to ASTM D3034 for sizes 6 (for sanitary sewer laterals) through 15 inches and shall conform to ASTM F679 for sizes 18 through 36 inches.

PVC Schedule 40 pipe shall be used for 4-inch pipe (for service lines). PVC Schedule 40 pipe shall conform to ASTM D1785.

b. Joints

PVC pipe and fittings shall have bell and spigot push-on joints. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket (as manufactured by J.M. Eagle Co. or approved equal) securely locked in place to prevent displacement during assembly. Installation of elastomeric gasketed joints and performance of the joint shall conform to ASTM F477, ASTM D3139 or ASTM D3212.

3. Alternative Gravity Sewer Pipe Materials

Alternative gravity sewer pipe materials may be considered and will be subject to approval by the City on a case-by-case basis. Full details of alternatives must be submitted.

4. Steel Casing Pipe

- a. The steel casing pipe shall have a minimum yield strength of 35,000 psi, have a thickness as required but not less than 0.375 inches, be equipped with grout holes and conform to AWWA C200 and ASTM A53.
- b. Casing interior and exterior shall be painted with two coats bitumastic enamel coating in accordance with AWWA C203.
- c. Pipe cradles or isolators shall be as shown on the detail drawing, APS casing spacers, Model SSI or approved equal.
- d. Minimum casing diameter shall be in accordance with Amtrak requirements as applicable.

5. Detectable Warning Tape

Detectable warning tape shall be polyethylene film encasing a metallic core, minimum 6" wide and 4 mils thick, color-coded green for sewer, bearing in black letter – CAUTION: SEWER LINE BELOW.

D. INSTALLATION

1. Excavation

- a. The trench shall be excavated to a depth of six inches below the outside diameter of the pipe barrel, or deeper if so specified. The width of the trench shall be as shown on the detail drawings. The resultant subgrade shall be undisturbed, or compacted as approved by the Engineer if disturbed.
- b. When the pipe is to be laid in fill, bring the fill to two feet above the elevation of the top of pipe to be laid before excavation commences. Compact fill to 95% of the maximum density as determined by ASTM D1557-70 or AASHTO T-180, Method D (Modified Proctor). The bottom of the trench shall be compacted to 95% of maximum density prior to installation of the pipe bedding.

2. Bedding

- a. The pipe shall be bedded on 6" of AASHTO No. 8 stone, the full width of the trench (a minimum of 6" on either side of the pipe), and shall be covered with AASHTO No. 8 stone to a height of 12" over the top of the pipe. The bedding shall be thoroughly compacted. The bedding shall provide uniform and continuous bearing and support for the pipe at every point between the bells.
- b. Flowable fill shall also be an acceptable material for trench bedding and backfill and shall conform to MDSHA *Standard Specifications for Construction and Materials Section 314 - Flowable Backfill for Utility Cuts*.
- c. If potentially corrosive materials are encountered, polyethylene encasement shall be installed to protect ductile iron pipe in accordance with ANSI/AWWA C105/A21.5.
- d. Unstable Subgrade

Where the bottom of the trench at subgrade is found to be unstable or to include ashes, cinders, any type of refuse, vegetable, or other organic material, or large pieces or fragments of inorganic material, which, in the opinion of the City, should be removed, the Applicant shall excavate and remove such unsuitable material to the width and depth recommended by the City. Before pipe is laid, the subgrade shall be formed by backfilling with AASHTO No. 57 stone in 3-inch (uncompacted thickness) layers thoroughly compacted to 95% of standard Proctor density and the bedding prepared as specified above in D.2.a.

e. Special Foundations

Where the bottom of the trench at the subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the City, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, the Applicant shall construct a foundation for the pipe consisting of piling, timbers or other materials, in accordance with plans approved by the City.

f. Concrete Encasement

Pipes to be encased in concrete shall have a minimum six inches of concrete above and below the pipe and the concrete shall be extended for the full width of the trench. No formwork to limit the concrete width shall be used. Flexible pipe joints shall be provided in the pipe at a distance of three times the pipe diameter from the ends of the concrete encasement, to provide pipe articulation. Pipes shall be protected against flotation during placement of concrete encasement. This may require two-stage concrete placement combined with anchor straps.

3. Laying Pipe

a. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600. PVC pipe and fittings shall be installed in accordance with the requirements of the manufacturer and ASTM D2321. All pipes shall be laid to a uniform line and grade, bell ends upgrade, with a firm and even bearing along the barrel of the pipe. The spigot end of the pipe is to be centered in, shoved tight and secured against the bell of the previously laid pipe. The interior of each pipe shall be cleaned of all foreign material before the next pipe is laid. Pipe laying shall commence at the lowest point and proceed upgrade. At the close of each day's work, and at such other times when pipe is not being laid, the open end of the pipe shall be closed by a watertight plug or other approved means.

b. Grade and Alignment Control

At the request of the City, a grade sheet for each manhole run shall be furnished. Grade and alignment control shall be established by laser (direct reading).

c. Pipe Clearance in Rocks

(1) Ledge rock, boulders and large stones shall be removed to provide a clearance of at least 6 inches below and on each side of all pipe and fittings for pipes 24 inches in diameter or smaller, and 9 inches for pipes larger than 24 inches in diameter.

(2) The specified minimum clearances are the minimum clear distances which will be permitted between any part of the pipe and/or fitting being laid and any part, projection or point of such rock, boulder or stone.

d. Pipes at Manholes or Other Rigid Structures

Pipes directly connected to or supported by rigid structures shall not have a length beyond the rigid support in excess of that shown in the manhole detail drawings.

e. Water in Trenches

Trenches shall be dewatered prior to laying pipes. Ground and surface water in trenches shall not be permitted to enter the sewerage system.

4. Backfilling

- a. The trench may be filled with excavated material above the AASHTO No. 8 stone as specified above except that stones larger than eight (8) inches may not go in the trench and the fill shall not contain more than 20% stone in total volume.
- b. Where a new sewer main is installed in an existing roadway, that portion of the trench shall be backfilled with compacted CR-6 stone. Native fill may not be placed back in the trench due to the potential for settlement.
- c. The trench shall be properly tamped in lifts not to exceed the maximum thickness for the type of tamping equipment used.
- d. All bedding and backfilling shall be compacted to 95% of maximum density as determined by ASTM D1557-70 or AASHTO T-180, Method D (Modified Proctor).
- e. Backfilling shall not be done with frozen material. No backfilling shall be done if the material already in the trench is frozen.
- f. In state highways, all backfill shall be in accordance with the requirements of MDSHA. The requirement for backfilling in other streets shall be as required by the municipality in which the street is located.

5. Surface Restoration

- a. In state highways surface restoration shall be in accordance with MDSHA requirements, or as specified in the MDSHA permit issued for the subject project.
- b. In non-state roads, paved areas or other traffic areas, surface restoration shall be in accordance with the requirements of the local municipality in which the street is located.
- c. All street, road or highway surfaces which are disturbed or damaged during installation of the sewers shall be properly repaired at the Owner's cost.

- d. Subsequent settlement of the street, road or highway surface resulting from improper compaction of the sewer line trench or failure to protect the sewer line trench shall be promptly repaired at the Owner's cost.
- e. The City may require televising and air testing of lines in settled areas to confirm the absence of sags or damage to the sewer pipe.

6. Bored Crossings

- a. The carrier pipe shall be installed to the exact line and grade required within the casing pipe using a leveling grout course, adjustable pipe supports, or other methods as approved by the City.
- b. The carrier pipes shall be supported within the casing pipes so that the pipe bells do not rest directly on the casing. The load of the carrier pipes shall be distributed along the casing by the method of support shown on the detail drawings.
- c. All work shall be performed in conformance with the requirements of MDSHA, Maryland Midland Railroad or other regulatory agencies involved.

E. TESTING AND INSPECTION

1. Notification

It is incumbent upon the Applicant to notify the City a minimum of 24 hours in advance of when the work will be ready for inspection.

2. Alignment Test

After the mains have been laid and backfilled, the City's inspector will flash a light between manholes or manhole locations to determine whether the alignment of the sewer is true and whether any pipe has been displaced, broken or otherwise damaged subsequent to laying. This test will again be conducted before final acceptance of the sewer. Each section (manhole to manhole) of sewer shall show a good light circle throughout its length and any and all defects shall be corrected to the satisfaction of the City before acceptance.

3. Televising Test

The Contractor shall coordinate with City personnel so that the City may perform televising on the new sewer mains.

4. Leakage Tests

- a. Sewers shall be tested for leakage only after all sewers and sewer laterals, including stoppers, are installed. Each sewer section between manholes including all laterals will be tested with low pressure air. Testing will be done only after all backfilling has

been completed and trench settlement has been minimized. The Applicant shall furnish all labor, materials, tools, equipment and accessories necessary to perform the required tests. All tests shall be made in the presence of, and to the complete satisfaction of the City.

- b. The equipment shall be specifically designed and manufactured for testing pipelines with low-pressure air and shall be provided with an air regulator valve or air safety valve set to prevent the air pressure in the pipeline from exceeding 9 psig. All plugs shall be braced to prevent blowout. Care must be taken so that the pressures generated by the air testing equipment do not exceed the pipe manufacturer's recommendations.
- c. The above ground air control equipment shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge and a continuous monitoring pressure gauge having a range from 0 to 10 or 15 psi.
- d. Low pressure air shall be slowly introduced into the sealed line until the internal pressure reaches approximately 5 psig. The pipe shall remain under pressure for not less than 2 minutes before the test begins, to allow equilibrium of the air temperature with the pipe wall.
- e. When the pressure has stabilized at 5 psig, the air hose from the control panel to the air supply shall be disconnected.
- f. The pipe shall be considered acceptable if the pipe holds a pressure of 5 psig for a minimum of 5 minutes.
- g. The Applicant shall repair or replace all defective material and/or workmanship and shall conduct such additional tests as required to demonstrate that the sewer meets the requirements, at no additional cost to the City. All materials and methods used to repair the sewer shall meet with the approval of the City's Engineer.

5. Cleaning

At the conclusion of the work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipe. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Engineer or the City will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired or replaced as directed by the Engineer or the City.

F. DETAIL DRAWINGS

Relevant detail drawings are:

- 1 Right of way Restoration
- 2 Pavement Restoration
- 3 Concrete Encasement
- 4 Pipe Cradle in Casings

END OF SECTION

SECTION 4 - TV INSPECTION OF SEWER PIPELINES

A. GENERAL

1. Summary

a. Section includes:

- (1) Assess the condition of the indicated sanitary gravity sewer pipes.
- (2) Closed-circuit television (CCTV) of selected gravity sewer pipes using the National Association of Sewer Service Companies (NASSCO) industry standard Pipeline Assessment and Certification Program (PACP) forms and coding.
- (3) Creation of a digital submission of sewer inspection data, videos, photos, and reports on portable external hard drives.
- (4) Provide a visual and written record of internal pipeline features including, general information, overall condition, wastewater depth, structural integrity, and significant defects.

2. Quality Assurance

- a. Perform Work according to NASSCO PACP standards, latest version.

B. PRODUCTS

1. External Hard Drives

- a. Description: A portable storage device that can be attached to a computer through a USB connection.
- b. Solid state data storage devices are preferred.

2. CCTV Software

- a. Capable of providing complete survey reports in compliance with NASSCO PACP Version 7.0 or newer.
- b. The PACP defect and construction codes shall be pre-programmed in the CCTV software and shall be grouped by PACP Groups.
- c. Software and Databases
 - (1) Fully compliant with PACP.
 - (2) Capable of customization with the ability to modify or add to the pipeline condition and group them for ease of use.

- (3) Assessment and reporting software program shall be menu-driven and shall have a complete on-screen help file.
 - (4) NASSCO PACP mandatory fields and any additional available field requested by the City shall be setup in the software prior to the assessment, and all these fields shall be populated with information collected during the assessment. Any general and pipe segment information that is already known prior to the assessment shall be entered into the appropriate fields in advance of performing the physical assessment.
 - (5) Maintain a database of underground pipe and manhole assets. Structure the asset database similar to the one referencing pipe usage (i.e., sanitary, storm, drainage, etc.) sections (i.e., projects, areas, quadrants).
 - (6) Surveys include a method of pipe segment numbering and a chronological survey set-up numbering system.
 - (7) Capacity to import and export survey results in the most recent NASSCO PACP exchange format.
- d. The footage reading from the camera equipment shall be automatically entered into the survey log and shall directly correspond to the noted observation location throughout the pipe graphical and tabular reports generated.

3. Sewer Assessment Reports

- a. File Naming Conventions: Name all files in accordance with the requirements of the City to allow direct linking of files to pipe assets using a common unique identifier.
 - (1) Each manhole has been given a unique manhole identification (Asset ID) the file name for each pipeline assessed shall be that unique upstream manhole Asset ID followed by an underscore followed by the unique downstream manhole such as MH-52_MH-51.pdf.
 - (2) If an unnamed manhole is found, the letter "A" shall be added to the end of the upstream manhole's Asset ID to form a new Asset ID. The data/video files shall then be renamed to include the new Asset ID and a new CCTV assessment shall be started from the new Asset ID.
 - (3) If more than one unnamed manhole is found between two named manholes, subsequent new manhole Asset IDs shall be formed using the letters "B", "C", etc.
 - (4) If an unnamed manhole is found, provide documentation showing the location of the unnamed manhole to the City depicting the change in connectivity found in the field.
 - (5) If the contractor performs a reverse setup and televises an individual pipe segment from more than one direction (i.e., the camera is only able to televise a portion of the entire segment heading downstream, and the remaining portion of the pipe segment was televised heading upstream) then two or more separate video files are allowable.

The name of the additional database files etc. (i.e., unique manhole Asset ID followed by an underscore followed by the unique downstream Asset ID) followed by “_1”, “_2” etc. at the end of the filename so that it is clear there are multiple files and videos for the same pipe segment. If unnamed manhole(s) is (are) found the procedure previously described shall also apply. Examples:

- (a) Initial filename: MH-52_MH-51
- (b) Additional filenames: MH-52_MH-51_1
- (c) Base the name of each digital still photo on the video/data filename of the specific sewer in which the photo was taken. Record the name as the video/data filename followed by the PACP code for the item pictured followed by the footage at which the observation was encountered. Examples:
 - (d) (Filename)_(PACP Coded)@(footage).jpg
 - (e) MH-52_MH-51_HSV@37_2.jpg
 - (f) MH-52_MH-51_1_MCU@113_6.jpg
- b. Format all data files to facilitate upload into a NASSCO PACP exchange database.
- c. Digital Video: CCTV assessments shall be captured at a minimum video bit rate of 4,500 kbps.
- d. Indicate individual survey results in tabular form and provide a sortable list of surveys based on a user-defined description field. Include the starting and ending manhole Asset IDs depths, pipe material, total survey length, and pipe diameter. All reports and and/or submittals shall comply with the most recent version of NASSCO PACP standards.
- e. Submit assessment data to the City on a weekly basis, including digital videos, digital photos, and evaluation reports, all in electronic format on portable external hard drive. All hard drives and the information contained within them are the property of the City after submittal.
 - (1) Fill data on each portable external hard drive to minimize the number of hard drives submitted. The hard drives shall contain separate digital files for each manhole-to-manhole section of pipe assessed.
 - (2) Sections of a single segment of sewer shall not be recorded to more than one hard drive.
 - (3) Video footage of recorded segments shall be grouped by area and shall be submitted in sequential order relating to the area mapping designation.
 - (4) The footage counter reading from the camera shall appear on all videos.

- f. Create separate folders for each inspection. Within each inspection folder include the video file, digital photos, evaluation reports, supporting documentation etc.
 - (1) Label each portable external hard drive clearly to indicate the date range of the assessments included on the hard drive, the name of the project, the City's project number, Contactor's name, and the index number of the hard drive. The index number for each hard drive shall be the sequential number followed by the area number.
 - (2) Each portable external hard drive submitted shall contain all sewer assessment data obtained to date. The database shall be comprehensive for the entire project and additional data shall be added to the database each week.
 - (3) On each hard drive, new data collected since the previous hard drive submittal shall be indicated as such to facilitate separation of the new data from the previously submitted data.
 - (4) A typewritten summary in pdf format shall be provided for each portable external hard drive that lists the files contained on that hard drive.

C. EXECUTION

1. PREPARATION

a. Sewer Flow Control

- (1) Evaluate each segment of sewer to be assessed with respect to diameter, flowrate, velocity, upstream/downstream manhole diameter, debris levels, extent of pipe wall corrosion, and accessibility. Select and provide the most appropriate equipment and methods based on the condition of the specific sewer line segment and its access manhole(s) at the time the work commences.
- (2) All assessment work shall be attempted during periods of low flow in the sewer segments being assessed.
- (3) At all times during the assessment, the flow in the sewer line segment(s) being assessed shall be suitably controlled as needed to perform the assessment.
- (4) If the depth of flow in the sewer segments to be assessed is above the maximum allowable for the use of floating inspection equipment, off peak hours should be pursued to perform the assessment. If flow levels are not sufficient during off peak hours, the flow level shall be lowered by either:
 - (a) using flow through plugs
 - (b) performing bypass pumping as approved by the City.
- (5) When flow in a sewer line is plugged, blocked, or bypassed, take precautions:

- (a) to protect the sewer lines from damage that might result from sewer surcharging.
 - (b) to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewer involved.
- (6) The use of floating inspection equipment is subject to approval by the City only after all other methods included in this section have been ineffective or deemed not practical.
- b. The equipment and methods used for each sewer pipe and the setup location shall conform to the submitted and reviewed plan.
 - (1) Standard CCTV equipment is appropriate for sewer segments that:
 - (a) Have a depth of flow less than 25 percent of the pipe diameter.
 - (b) Do not have signs of corrosion.
 - (c) Do not appear to have significant debris accumulation below the water surface.
 - (2) Floating HD Image equipment is appropriate for sewer segments that:
 - (a) Do not meet the previously listed conditions for using standard and CCTV equipment.
 - (b) Require longer continuous lengths of assessment due to the difficulty of the manhole access or connection to a buried manhole or manholes.

2. APPLICATION

a. CCTV Equipment

- (1) Provide a mobile vehicle large enough to accommodate at least three people with video monitoring equipment specifically compatible with the camera equipment being used. City shall have unrestricted access to observe the television screen and all other operations.
- (2) CCTV Camera:
 - (a) Designed and constructed for such assessment and shall be capable of producing digital still photos of all sewer observations and service connections.
 - (b) Adjustable light source that generates an even distribution of lighting for the camera that results in a clear color picture of the entire periphery of the pipe.
 - (c) Operable in 100 percent humidity conditions and in a hazardous and corrosive environment.

- (a) Capable of panning 360 degrees and tilting 270 degrees and with minimum optical zoom ratio of 10:1 plus a minimum digital zoom ration of 4:1 to facilitate the assessment of all laterals and defects with optimum picture quality provided by focus and iris adjustment.
- (3) Provide a backup (spare) camera either on the project site or at a nearby location so performance of the Work is not delayed.
- (4) When usage of standard CCTV equipment is not feasible due to access issues, pipe condition, and/or depth of water flow, floating camera equipment may be used.
- (5) Floating HD Camera: the camera shall be capable of recording 360-degree view using a fisheye lens without tilting or panning.
- (6) CCTV Equipment:
 - (a) Camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the City. Picture resolution shall be a minimum of 460 television lines (TVL).
 - (b) Provide a lighting system adequate for quality pictures. A reflector in front of the camera may be required to enhance the lighting in black pipe.
 - (c) Accurate footage counter to display on the monitor the exact distance of the camera from the centerline of the starting manhole.
 - (d) Compatible with the version of NASSCO PACP used by the CCTV software and the reports and submittals generated from the software.

D. FIELD QUALITY CONTROL

- 1. The following measurements shall be collected for each accessible manhole and included in the PACP exchange database:
 - a. Utilize GPS equipment to obtain X and Y state plane coordinates with a submeter accuracy.
 - b. Field-measure the vertical distance from the top of the manhole frame to the invert in accordance to NASSCO PACP standards.
- 2. Pipeline Assessment:
 - a. Each sewer section shall be assessed from the upstream manhole to the downstream manhole if possible.
 - b. For the upstream and downstream manholes on each segment of pipe that is assessed, pan and tilt from the invert and take digital still photos that clearly depict the entirety of the manhole interior, including cone section.

- c. Assess the full length of each sewer between access points. When the camera is unable to pass an obstruction even though flow is continuing, perform a reverse setup of the CCTV equipment from the opposite access point.
 - d. Perform all CCTV assessments using personnel who are trained and certified (current standing) in the use of NASSCO's PACP.
 - e. Multiple upstream and/or downstream sewer segments can be televised from a single manhole setup location as long as each manhole-to-manhole video section restarts its footage counter at zero and a separate video file for each assessment is submitted.
 - f. The CCTV camera shall travel through the lines using its own power unless a tethered floating unit is used. The pictures taken of the entire inside periphery of the pipe shall be clear and visible. Picture quality and definition shall be to the satisfaction of the City.
 - g. Stop the camera at all service laterals and pan at such an angle that an internal view of the service lateral is available to determine if the lateral is active, inactive, or plugged. Take photos:
 - (1) include a brief description of the subject of the photo directly on the photo.
 - (2) catalogue and link in the CCTV database so the photos correspond with the length along the sewer line where the photo of the recorded observation was taken.
 - h. JPEG format and at least 50 kilobytes in size.
 - i. Adjust the camera height such that the camera lens is always centered in the pipe being televised.
 - j. Retrieve camera equipment that becomes stuck within a sewer.
 - k. Submit CCTV inspection videos, where reversal setups are not required, in one continuous video section from manhole to the immediately adjacent manhole and not in multiple files. If a reverse setup is required, two complete inspections and video are acceptable.
3. Project Notifications: Notify the City immediately if:
- a. A collapsed pipe or other significant pipe failure is discovered.
 - b. The conditions for CCTV assessment are found to be unsafe or impractical.
 - c. A manhole is buried, cannot be found, or cannot be accessed. Include a diagram in PDF file format that clearly indicates the location of the manhole, identifies its Asset ID, and lists the procedures that were used to attempt to locate the manhole.
 - d. Any defects that pose immediate danger to the public are observed (i.e., missing, or broken manhole covers, sinkholes, etc.).

- e. Any major pipe blockages, manhole surcharging, or potential overflow conditions are observed.
 - f. The pipe configuration in the field is different than shown on the Drawings. Include a diagram in PDF file format that clearly indicates the location of structures in relation to immediately adjacent structures.
 - g. Any significant obstructions are found within permanent sewer easement, even if these obstructions do not impact the Work.
4. Public Notifications: Provide 48-hour notice prior to the assessment of any pipe segment, distribute door-to-door a door hanger, approved by the City, describing the work to be performed to notify the owner of every property, including residences and businesses, that may be affected. Door hangers shall be double-sided with the notification information in the English language on one side and in the Spanish language on the reverse side. Affected properties shall include, but not be limited to, properties on which:
- a. A manhole for accessing a sewer to be accessed is located.
 - b. An existing sewer easement that could be used to access the sewer is located.
 - c. A temporary right-of-entry agreement with the property owner and the contractor for accessing a sewer or manhole on the property.
 - d. An existing sewer lateral serving the property directly connects to a sewer to be assessed or manhole to be accessed for the sewer assessment.

E. DATA QUALITY CONTROL

- 1. Review quality and accuracy of each submittal of CCTV assessment data and revise as needed to correct any inaccuracies prior to providing submittal to the City.
- 2. Quality Review:
 - a. City requires a 30-day period to review sewer assessment data/videos after each submittal has been received.
 - b. Payment applications will not be processed until the sewer assessment data/videos have successfully passed the quality review and have been accepted by the City.
 - c. Additional 30-day review periods apply to each resubmittal of data/videos determined to be unacceptable by the City.
 - d. Re-inspection is required when digital videos are inaccurate or of such poor quality that the City is unable to evaluate the condition of the sewer or locate sewer service connections.
 - e. Provide CCTV assessment data contained on each portable external hard drive in the

most recent version of PACP exchange format. Include video indexing for all observations. CCTV assessment data to be submitted:

- (1) Database file
- (2) Still photos in JPEG file format for each observation
- (3) Video for each inspection in MP4 file format
- (4) Summary report for each pipe segment in PDF format

END OF SECTION

SECTION 5 - CLEANING OF SEWERS

A. GENERAL

1. Section includes cleaning of sewer pipe and fittings installed and/or rehabilitated, complete as shown on the approved drawings and as specified herein.
2. Cleaning includes proper high-pressure water jetting, rodding, bucketing, brushing, and flushing of sewers and manholes prior to inspection by closed circuit television, pipeline rehabilitation or replacement, point repairs, manhole preparation, and testing operations.
3. Clean all sewers to remove debris, roots, intruding services, deposits, and other blockages to a minimum of 95 percent open. Perform sewer cleaning work to an acceptable level as necessary to perform a thorough television inspection of sewer. If pipe condition is such that cleaning may cause a potential collapse, then pipe shall be televised without attempting to clean it to 95 percent condition, pending approval by City.
4. Submit one complete set of documentation regarding inspections and work performed. Based on work scope, submit written reports, photographs and External Hard Drives that incorporate color video and data per SECTION 4 – TV INSPECTION OF SEWER PIPELINES.
5. Submit a safety plan prior to performing any on-site work that includes the following as a minimum:
 - a. Confined Space Entry
 - b. Personal Protective Equipment

B. QUALIFICATIONS STATEMENTS

1. Contractor shall have a minimum of five years' experience in sewer line and underground structure cleaning. Submit a list of at least three customers who have had similar work complete. Furnish trained and qualified technicians with proper experience operating equipment that is being used for the work.

C. DEFINITIONS

1. Light Cleaning: Small amounts of debris existing within sewer line and where sewer reaches do not require heavy cleaning, as defined below, and that produce little or no debris. Minimum of 2 jetting passes.
2. Heavy Cleaning: Large deposits of debris or heavy root growth existing within sewer line and where sewer reaches require debris removal of depths up to 25 percent of pipe height.
3. Excessive Heavy Cleaning: Large deposits of debris or heavy root growth existing within sewer line and where sewer reaches require debris removal exceeding the definition of Heavy Cleaning, and time required to clean and inspect the line must be at least twice the average time required to clean and inspect other sewers of comparable length and diameter.

D. MEASUREMENT

1. Light Cleaning: Clean sewer using standard industry procedures of high-pressure water jetting equipment or other approved equipment. Costs related to cleaning of such sewers shall be included in Contractor's unit prices for CCTV and Light Cleaning.
 - a. Basis of Measurement: By linear foot, measured to the nearest foot.
 - b. Basis of Payment: TV inspection, data compiling according to NASSCO PACP standards, and audio-video recording of pipeline.
2. Heavy cleaning: Heavy cleaning must be designated as such by the City and approved by City prior to work taking place. Include costs related to cleaning of such sewers in Unit Prices for Heavy Cleaning. Costs related to televising of such sewers following heavy cleaning shall be included in Unit Prices for CCTV and Light Cleaning. Compensation for heavy cleaning of a particular line will only be paid if:
 - a. Heavy cleaning was authorized by City prior to performance of the work.
 - b. Debris is causing a blockage of 25% or more of the area of the pipe.
 - c. Adequate video proof of 'before' blockage, debris, grit or grease build-up, or other condition is provided.
 - d. A submerged camera does not justify a need for heavy cleaning; proof that submergence was due to a blockage or heavy debris and not a sag in the line will be required.
 - e. Heavy Cleaning will be paid for on a lineal foot basis only for length required to be cleaned, i.e., from downstream manhole to approximate location of heavy cleaning. This may or may not include entire pipe section, unless otherwise approved by City.
 - f. Basis of Measurement: By linear foot measured to the nearest foot.
 - g. Basis of Payment: TV inspection, data compiling according to NASSCO PACP standards, and audio-video recording of pipeline.
3. Excessive Heavy Cleaning: Pipes that contain excessive blockages will be paid on a time and material basis, upon approval by City. A full-time inspector is required to oversee time and material work. Provide direct water source as required. City may determine any individual pipe be cleaned on a time and material basis.
 - a. The contractor shall prove that both significant time and effort is necessary to clean the line (i.e. time required to clean and inspect the line must be at least twice the average time required to clean and inspect other sewers of comparable length and diameter).

E. EXECUTION

1. Remove debris, roots, intruding services, deposits, and other blockages to a minimum of 95 percent open as necessary to perform a thorough television inspection of sewer. If pipe condition is such that cleaning may cause a potential collapse, televise pipe without attempting to clean it to 95 percent condition, pending approval by City.
2. Preparation
 - a. Select, based on pre-construction CCTV inspection, cleaning equipment to address conditions of manhole and sewer lines at the time the work commences to adequately remove dirt, grease, rocks, sand, and other materials and obstructions from sewer lines and manholes to allow performance of other work.
 - b. Take satisfactory precautions to protect sewer lines from damage that might be caused by improper use of cleaning equipment. Whenever using hydraulically propelled cleaning tools that depend upon water pressure to provide their cleaning force, or any tools that retard flow of water in sewer line, take precautions to ensure that water does not cause damage or flooding to public or private property.
 - c. No fire hydrant shall be obstructed in case of a fire in area served by hydrant. Remove water meters, piping, and related equipment from fire hydrants at end of each workday.
3. Equipment
 - a. Hydraulic Sewer Cleaning Equipment:
 - (1) Equipment: movable dam type constructed so that a portion of the dam may be collapsed at any time during cleaning operation to protect against flooding of sewer.
 - (a) Movable dam shall be same diameter as pipe being cleaned and shall provide flexible scraper around outer periphery to ensure total removal of grease. If sewer cleaning balls or other such equipment which cannot be collapsed instantly are used, take special precautions against flooding of sewers and public or private property.
 - b. High Velocity Jet (Hydrocleaning) Equipment:
 - (1) Have a minimum of 500 feet of high-pressure hose.
 - (2) Have a selection of two or more velocity nozzles that can produce a scouring action from 15 to 45 degrees in all size lines to be cleaned. Also include a high velocity gun for washing and scouring manhole walls and floor.
 - (3) Be capable of producing a minimum of 80 gallons per minute flows from a fine spray to a long-distance solid stream and delivering up to 1000 psi. Be able to carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. Locate controls so equipment can be operated above ground. Select flowrates and pressures

as required for each size of sewer, type of debris, and amount of debris, and as recommended by nozzle manufacturers.

(4) Have a water tank, auxiliary engines and pumps, and a hydraulically driven hose reel.

(5) Have root cutting blades that are hydraulically spun.

c. Mechanical Cleaning Equipment:

(1) Bucket machines shall be in pairs and with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe shall not be acceptable.

(2) Power rodding machines shall be either sectional or continuous type capable of holding a minimum of 750 feet of rod. Rod shall be specifically treated steel. To ensure safe operation, machine shall have a fully enclosed body and an automatic safety release clutch or relief valve.

4. Application

- a. Provide appropriate screening to stop passing of materials into downstream sewers. Sludge, dirt, sand, rocks, grease, and other solid or semisolid residue, debris, and material resulting from cleaning operations shall be removed at downstream manhole of section of sewer being cleaned. Passing material from manhole section to manhole section which could cause line stoppages, accumulations of sand in wet wells, or damage to pumping equipment shall not be permitted.
- b. Remove debris, residue, and other materials resulting from cleaning operations from site at end of each workday and dispose of in an approved and lawful manner. Under no circumstances will accumulation of debris, residue, and other matter be permitted on site beyond stated time, unless prior written authorization is given for storage in totally enclosed containers. Contractor shall be fully responsible for the disposal of debris at the end of each working day.
- c. Specifics regarding the scheduling, monitoring, disposal fees (if any) and approved methods and procedures for disposal must be arranged with
- d. Flushing of sanitary sewers to facilitate cleaning activities without the capture of solids and debris is expressly prohibited.
- e. Retrieval of equipment lodged in pipes or a wet well is Contractor's responsibility and shall be performed at Contractor's expense.
- f. Cleaning Precautions: During sewer cleaning operations, satisfactory precautions shall be taken in use of cleaning equipment. When hydraulically propelled cleaning tools

(which depend upon water pressure to provide their cleaning force) or tools which retard flow in sewer line are used, precautions shall be taken to ensure that water pressure created does not damage or cause flooding of public or private property being served by sewer. When possible, flow of sewage in sewer shall be utilized to provide necessary pressure for hydraulic cleaning devices. When additional water from fire hydrants is necessary to avoid delay in normal work procedures, water shall be conserved and not used unnecessarily.

- g. No sewer cleaning shall take place in a particular sewer segment until upstream pipe segments have been cleaned. If cleaning is done in a downstream pipe segment to facilitate overall cleaning operations, segment shall be re-cleaned at no additional cost to City, after pipes upstream of that segment have been cleaned.
- h. Sewer line walls shall be cleaned adequately to provide for proper operation of joint testing and sealing equipment or internal inspection to discern structural defects, misalignment, and infiltration/inflow sources. Cleaning shall be performed immediately prior to joint testing and sealing and internal inspection to preclude build-up of debris from infiltration/inflow sources and discharges from upstream pipeline sections.
- i. Designated sewer manhole sections shall be cleaned using hydraulically propelled, high velocity jet, or mechanically powered equipment. If cleaning of an entire section cannot be successfully performed from one manhole, equipment shall be set up on other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or equipment fails to traverse entire manhole section, it will be assumed that a major blockage exists, and cleaning effort shall be repeated with other types of equipment. Immediately report any blockages to City.
- j. Water for sewer cleaning shall be purchased and obtained at locations in accordance with utility owner. If water is obtained from a potable supply, provide appropriate backflow prevention devices as required by authority having jurisdiction to protect potable system from cross connections and contamination. Prevent cross contamination of any public or private water systems used for this purpose.

5. Field Quality Control

- a. Acceptance of sewer line cleaning is contingent on satisfactory completion of television inspection. If television inspection shows cleaning to be unsatisfactory, re-clean sewer line and re-inspect until cleaning is shown to be satisfactory.
- b. If internal joint testing and sealing is to follow cleaning, give particular attention to adequacy of cleaning to ensure that proper seating of sealing packer can be achieved.
- c. Inspection of cleaning operations will be made daily by the City.

6. Final Cleaning

- a. Upon cleaning of underground sewer lines or structures, removal debris from finish grade and clean work areas so conditions at conclusion of the work are equal to or better than areas prior to work of this Section.

END OF SECTION

SECTION 6 - CURED-IN-PLACE PIPE LINING

A. GENERAL

1. Furnish all labor, materials, equipment, and incidentals required to install and test the cured-in- place pipe (CIPP) lining and appurtenances complete as shown on the approved drawings and as specified herein, including, but not limited to services necessary for traffic control, bypass pumping and/or diversion of sewage flows, cleaning and television inspection of sewers to be lined, liner installation, reinstatement of service connections, quality control, providing samples for performance of required material tests, final television inspection, testing of lined pipe system and warranty work, all as specified herein.
2. Sewer cleaning, pre-rehabilitation, and post-rehabilitation CCTV inspection of all pipes to be rehabilitated by CIPP lining methods are required per SECTION 4 – TV INSPECTION OF SEWER PIPELINES.
3. Remove obstructions and protruding service connections as required to complete the CIPP rehabilitation. Removal of all pipeline obstructions and protruding service connections required for sewer rehabilitation using cured-in-place pipe lining shall be completed prior to the pre-rehabilitation CCTV inspection.
4. Neither the CIPP system, nor its installation, shall cause adverse effects to any of the City's processes or facilities. The use of the product shall not result in the formation or production of any detrimental compounds or by-products in the system or at the wastewater treatment plant. Notify the City and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements. Cleanup and restore existing surface conditions and structures, and repair any of the CIPP system determined to be defective. Conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property Owners or tenants.
5. The installer performing the work shall not change any material, design values or procedural matters stated or approved herein, without informing the City and receiving written approval of the change. Such changes constitute a breach of contract and shall result in rejection and removal of work performed with the unapproved materials or processes at no expense to the City.
6. Maintenance and Protection of Traffic, confined space entry, and work site protection shall be the responsibility of the installer and costs of these items are included in the cost of the work. Notify Police, Fire, Ambulance agencies, and residents/businesses in advance of any and all road closures. Comply with applicable OSHA trench safety rules, confined space, and sewer system entry.
7. Submit to the City shop drawings, product data, materials of construction, design calculations, and details of installation including all information described in items 8 to 25

below. Provide this information without delay or claim to any confidentiality and include all information described in items 8 to 25 below.

8. Detailed information on the CIPP installation procedures (wet-out, heating, curing, and cool down, if applicable) and all tools and equipment required for a complete installation identifying which tools and equipment will be redundant on job site in the event of equipment breakdown. Equipment to be furnished for the work, including proposed back-up equipment, shall be clearly described. Outline the mitigation procedure to be implemented in the event of key equipment failure during the installation process.
9. CIPP lining schedules including field-verified lengths and diameters of all CIPP lining and appurtenances required shall be provided. Plans should include map(s) that show insertion point manholes for all CIPP installations. Insertion points that are not manholes shall be brought to the specific attention of the City for review prior to plan approval.
10. Shop drawings and product data to demonstrate compliance with these specifications and identify materials of construction (including resins, catalysts, felt, etc.), felt manufacturer, location of the felt manufacturing facility, location of the wet-out facility, etc., flexible membrane (coating) material (including recommended repair/patching procedure, if applicable) shall be provided.
11. Manufacturers' shipping, storage, and handling recommendations for all components of the CIPP System.
12. MSDS sheets for all proposed products and materials to be furnished for the work.
13. Detailed sample collection, laboratory testing and quality control procedures, including schedule and shipping and storage requirements.
14. A written description and/or plan for odor control that will ensure that project specific odors such as styrene will be minimized at the work site and surrounding area.
15. Provide the end seal material(s) and description of their installation such that a hydraulic seal is present between the CIPP liner and host pipe at the manholes.
16. Detailed written plan of the method of flow maintenance (Bypass Pumping Plan) and noise prevention measures shall be provided.
17. A detailed description of the installer's proposed procedures for removal of any existing blockages in the pipeline that may be encountered during the cleaning process.
18. A detailed written traffic-control plan that details every street that will be impacted and how impacts will be mitigated.
19. Data on the maximum allowable stresses and elongation of the tube during installation and the means in which monitoring stress and elongation shall be provided (i.e., ideal inversion head and maximum cold head, minimum inversion head, maximum hot head).

20. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation.
21. A complete description of the proposed wet-out procedure for the proposed technology.
22. A Safety Plan identifying all competent persons, a description of a daily safety program for the job site and all emergency procedures to be implemented in the event of a safety incident. All work shall be conducted in accordance with the submitted Safety Plan.
23. A detailed quality control plan (QCP) that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include the following:
 - a. A detailed discussion of the proposed quality controls to be performed by the installer.
 - b. Defined responsibilities of the installer's personnel for assuring that all quality requirements for this work are met. These shall be assigned by the installer, to specific personnel.
 - c. Proposed procedures for quality control including those pertaining to fit and finish, and product sampling and testing shall be defined and submitted as part of the plan.
 - d. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.
 - e. A schedule for performance and product test result reviews with the City at regularly scheduled job meetings.
 - f. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in these specifications and submitted with the QCP.
24. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F 1216 for fully deteriorated "deteriorated gravity pipe conditions." Thickness of liners for oval and egg-shaped pipe shall be calculated in accordance with the "Sewerage Rehabilitation Manual" published by the Water Research Center (WRC). All calculations shall be prepared under the supervision of and stamped by a professional engineer registered in the State of Maryland.
25. Before, during, and after CIPP installation, work shall include the following:
 - a. Prior to each shipment of CIPP lining, submit certified test reports that the CIPP lining was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.
 - b. CIPP lining schedules including field-verified lengths and diameters of all CIPP lining and appurtenances required to show that every pipe to be rehabilitated has been

physically measured. Plans should include map(s) that show insertion points for all CIPP installations.

- c. Detailed installation procedures and manufacturer's recommended cure method for each diameter and thickness of CIPP liner to be installed, including CIPP lining production schedule, acceptable inversion heads and pressures, inversion or winching procedures, curing and cool-down procedures detailing the curing rate of temperature increases and cool down and the method of application, and times for each stage of the process.
- d. Wet-out forms/reports for each CIPP segment with detailed information including but not limited to: date and time of wet-out, wet-out facility address, volumes and/or weights of resin, length and diameter of CIPP liner (both wet-tube and dry-tube), roller gap settings, start times, finish times, resin used (product name and batch/shipment number) and quantity, gel times, resin injection locations, thickness of CIPP liner (dry and wet), catalyst(s) name and quantity used, and any other pertinent data documenting the wet-out for each section of CIPP liner manufactured. The wet-out forms shall be submitted prior to CIPP liner installation and shall be provided without delay or claim to any confidentiality. Wet out forms shall be submitted to the City field representative on the day of delivery.
- e. CIPP liner field curing reports documenting the liner installation for all sewer segments. The CIPP liner reports shall document all details of liner installation, including manhole numbers, street names/sewer location, project number, date, time, ambient temperature, heads used during the inversion process, pressures and/or heads (minimum inversion pressure, ideal head, maximum hot head, and maximum cold head) used during curing (including cool down if applicable), curing temperature, curing time, rate of cool down, CIPP liner thickness, etc. A sample report shall be submitted to the City for approval prior to the installation of any CIPP lining. The reports shall be submitted without delay or claim to any confidentiality.
- f. For UV cured liners, record the curing and light train speed (feet per minute), light source (number of lamps, intensity, and wattage), inner air pressure (psi), exothermic (curing) temperatures per unit time over the length of the liner, and temperature of the internal liner surface. Include liner manufacturer recommended citations in the submittal.
- g. Complete certified copies of the report(s) output(s) of the continuous temperature monitoring systems used in the control of the curing, printed and in electronic format. The reports shall be submitted without delay or claim to any confidentiality. Also provide the City with access to the website where the secure reports can be obtained.
- h. Pre-rehabilitation and post-rehabilitation closed-circuit television (CCTV) inspection data as further defined herein. Post-rehabilitation CCTV inspection data shall be submitted within one week after the CIPP segment is installed and conform to requirements set forth in SECTION 4 – TV INSPECTION OF SEWER PIPELINES.

- i. Samples of installed liner(s) for testing to be performed by an ASTM-certified independent testing laboratory, as described further herein.
- j. Information on any grouts, epoxy, or cements proposed for sealing annular space between CIPP liner and host pipe at manholes, or for other uses.
- k. Submit daily production reports to the City's Superintendent and/or field representative at the end of each workday.
- l. A list of all service laterals (with distances and clock position) that were abandoned or reconnected as part of the work as further defined herein.
- m. Some installations may result in the need to repair or replace a defective CIPP. Submit in writing, for review by the City, specific repair or replacement procedures for potential defects that may occur in the installed CIPP. Repair/replacement procedures shall be as recommended by the CIPP system manufacturer and shall be submitted to also include the following:
 - (1) Defects in the installed CIPP that will not affect the operation and long-term life of the product shall be identified and defined.
 - (2) Repairable defects that may occur in the installed CIPP shall be specifically defined by the installer based on manufacturer's recommendations, including a detailed step-by-step repair procedure, resulting in a finished product meeting the requirements of these specifications. Repairable defects may include but are not limited to blisters, wrinkles, fins, pinholes, over- or under-cut lateral connections, and any voids found between liner and the host pipe.
 - (3) Un-repairable defects that may occur to the CIPP shall be clearly defined by the installer based on the manufacturer's recommendations, including a recommended procedure for the removal and replacement of the CIPP. Un-repairable defects may include but are not limited to thickness below required minimum thickness, structural strength below required limits, lifts, shrinkage, folds, bulges, and delamination.
- n. A list of all repair or replacement of CIPP defects that were executed during the work including identification of segment, location of the repair, and type of repair.

B. MATERIALS AND EQUIPMENT

1. CIPP Liner

- a. CIPP liner shall be Inliner by Inliner Solutions, Insituform by Azuria Water Solutions Co., National Liner by National Liner LLC, SAK Liner by SAK Construction LLC, Vortex Companies, or City approved equal.
- b. CIPP liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or

other fibers and meet the requirements of ASTM F 1216, ASTM F 1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP), and ASTM D 5813 "Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems". Determine the felt content of CIPP liner; however, it shall not exceed 15 percent of the total impregnated liner volume. Fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures, and curing temperatures and stretch to fit irregular pipe sections. Submit certified information from felt manufacturer on normal void volume in the felt fabric that will be filled with resin.

- c. CIPP liner tube may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick, unless the tube is made of fiberglass material. Wet-out fabric tube shall have a uniform thickness and void space for resin distribution that when compressed at installation pressures will produce a predictable finished thickness that meets or exceeds the design thickness after cure.
- d. No material shall be included in fabric tube that may cause de-lamination in cured CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between felt fabric and activated resin containing a colorant.
- e. Wall color of interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made. Hue of the color shall be dark enough to distinguish a contrast between fully resin saturated felt fabric and dry or resin lean areas.
- f. Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813.
- g. The outside layer of the tube shall be coated with an impermeable material compatible with the resin and fabric.
- h. Prior to inversion, if applicable, outside and/or inside layer of tube (before inversion/pull-in as applicable) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate, if applicable, vacuum impregnation and monitoring of resin saturation during the resin impregnation (wet out) procedure.
- i. Exterior of manufactured tube shall have distance markings along its length at regular intervals not to exceed 5 feet. Use these marks as a gauge to measure elongation during insertion. Should overall elongation of a reach exceed 5 percent, liner tube shall be rejected and replaced.
- j. Identify the wet-out facility where all CIPP liner under this specification will be manufactured. All CIPP liner shall be manufactured from this designated wet-out facility throughout the entire project unless specifically approved otherwise by City in writing. Multiple wet-out facilities shall not be allowed.
- k. City and/or an agent of City may inspect CIPP liner during manufacturing and wet-

out. City shall be given an opportunity to witness manufacturing of all CIPP liner for this project. City is responsible for costs associated with witnessing the manufacturing of CIPP liner.

- l. If City decides to inspect the manufacturing of CIPP liner, provide full access to witness wet-out process and shall provide any and all information related to the manufacturing as requested by City or City's agent without delay and without claims of confidentiality or product privacy.
- m. Application of resin to felt tubing (wet-out) shall be conducted under factory conditions using vacuum impregnation and materials shall be fully protected against UV light, excessive heat, and contamination at all times. If on-site wet out is required, maintain ambient conditions similar to those encountered during factory wet outs.
- n. Liners that are impregnated at the factory and transported to the project site in refrigerated trucks shall be installed as soon as possible and no more than two (2) weeks after the date of impregnation at the factory.
- o. CIPP liner shall form a continuous, tight-fitting, hard, impermeable liner that is chemically resistant to any chemicals normally found in domestic sewage per Table 2.1 in ASTM F 1216. CIPP liner shall be chemically resistant to trace amounts of gasoline and other oil products commonly found in municipal sewerage and soils adjacent to sewer pipe to be lined.
- p. CIPP liner tube shall be manufactured or fabricated to a size that will tightly fit internal circumference of sewer being rehabilitated after being installed and cured. CIPP liner shall be capable of fitting into irregularly shaped pipe sections and through bends and dips within the pipeline. Allowance for longitudinal and circumferential expansion shall be considered when sizing and installing CIPP liner. Tube shall be properly sized to diameter of existing pipe and length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. Determine minimum tube length necessary to effectively span designated run between manholes. Verify lengths in field prior to ordering and prior to impregnation of tube with resin, to ensure that tube will have sufficient length to extend entire length of the run, which is defined as the length of the existing host pipe measured from the interior walls of the manholes, and/or from the ends of the pipe when/if the pipe extends into the manholes. Measure inside diameter and circumference of existing pipelines at face of each manhole in field prior to ordering liner so that liner can be installed in a tight-fitted condition with little or no wrinkling.
- q. Length of CIPP liner shall be as deemed necessary to effectively carry out insertion of CIPP liner and sealing of CIPP liner at outlet and inlet manholes. Required diameter and length of each pipe segment shall be measured in advance of wet-out and a list of these measurements shall be submitted to City at least one week prior to installation of each CIPP liner.
- r. Installer shall be responsible for ensuring that correct liner is installed in each sewer

reach being rehabilitated.

- s. All pipes of diameter 8-in and greater shall have a minimum finished thickness of 6mm or as designed, whichever is greater.
- t. Verify proposed CIPP liner thicknesses and submit associated calculations. Actual cured liner thickness shall be $-5/+10$ percent of approved design thickness and shall not include thickness of any non-structural membrane (inner/pre- liner). CIPP liner shall be designed in accordance with applicable provisions of ASTM F 1216 for “fully deteriorated gravity pipe conditions”, unless City agrees in writing, prior to installation that “partially deteriorated gravity pipe conditions” shall apply based upon review of CCTV video. CIPP liner shall meet following design conditions, unless City agrees in writing of their change:
 - (1) AASHTO H 20 Live Load.
 - (2) Constrained soil modulus of native soil in the pipe zone of 1,000 psi.
 - (3) Soil weight of 120 pounds per cubic foot and a coefficient of friction of $Ku'=0.130r$ shall be used for the installed depths.
 - (4) Long-term flexural modulus used in design calculations shall be estimated by multiplying lowest short-term flexural modulus used in design calculations by a retention factor of 0.50 (i.e., long-term retention of mechanical properties equal to 50 percent.)
 - (5) Design safety factor of 2.0.
 - (6) Typical groundwater levels shall be estimated at one half (1/2) the distance between crown of pipe and ground surface. If actual groundwater depth information is available from USGS or other sources, it shall be utilized in calculations. Groundwater depth used in calculations shall be from estimated maximum groundwater level from surface to invert of interior pipe or at elevation specified for in these Standard Specifications.
 - (7) Service temperature range shall be 40 to 100 degrees F.
 - (8) Minimum ovality of host pipe of 2 percent.
 - (9) Long-term retention of mechanical properties equal to 50 percent.
 - (10) Thickness to be used for CIPP liner shall be largest thickness as determined by calculations for deflection, bending, buckling and minimum stiffness.
 - (11) CIPP liner thickness for non-round pipes or circular pipes with greater than 10 percent ovality shall be designed on accordance with WRC Sewerage Rehabilitation Manual, Type II Design, Section 5.3.2.iii.

- (12) Minimum liner thickness after installation and curing for all pipes 8 inches in diameter and larger shall be 6 mm or as designed, whichever is greater. Thicknesses following installation and curing shall be based on design calculations provided by the installer.
- (13) CIPP liner shall provide a minimum service life of 50 years and, for design purposes, shall have the following minimum initial and long-term properties:

Property	Test Method	Initial (psi)	Long Term (psi)
Flexural Strength	ASTM D 790	4,500	2,250
Flexural Modulus of Elasticity	ASTM D 790	350,000	175,000

- (14) The CIPP shall be designed to withstand all imposed loads, including dead and live loads and, if applicable, hydrostatic pressure. The liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.

2. Resin

- a. Resin shall be a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system manufactured specifically for sewer rehabilitation, that, and when properly cured within the tube composite, meets the requirements of ASTM F 1216, ASTM F 1743 or ASTM F 2019 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)), the physical properties herein, and those, which are to be utilized in the design of CIPP for this project. Resin shall produce CIPP that will comply with or exceed structural and chemical resistance requirements of this specification. Liner material and resin shall be completely compatible. Generally, resin shall not contain fillers, except those required for viscosity control or fire retardance or increase strength, and with applications for which inert fillers would facilitate better heat transfer and retention during installation. Liner installer may add up to 5 percent by mass, a thixotropic agent for viscosity control, which will not interfere with visual inspection.
- b. Resins may contain pigments, dyes, or colorants, which shall not interfere with visual inspection of cured liner. Quantity of resin used for tube impregnation shall be sufficient to fill volume of air voids in tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in original pipe wall. Use serial vacuum impregnation or pressure impregnation process (or approved equal) to provide maximum resin impregnation throughout the tube.

3. Styrene Reducing Agent

- a. The styrene reducing agent shall be a gelatin, water soluble, biodegradable, non-

toxic, FDA approved powder and/or capsule. The styrene reducing agent shall be added in a calculated amount according to manufacturer's recommendations into the down-tube for water curing or directly into the water holding tank for steam curing.

- b. The styrene reducing agent shall be StyRedux by Integrated Chemical & Equipment Corporation or approved equal.

4. End Seals

- a. End seals shall be composed of hydrophilic rubber and molded as a one-piece, three-inch wide cylinder which when installed will form a 360-degree seal between the host pipe and the newly installed liner. Use of caulking, rope or band type of an end seal shall not be allowed. Acceptable end seals are Insignia™ End Seals by LMK Technologies or approved equal.
- b. Where manhole rehabilitation is necessary and required, install epoxy at the end of each lined pipe to cover any piece of existing pipe that are exposed at the manhole wall. Acceptable epoxy resins are Sikadur 31 or approved equal. Where rehabilitation of the manholes is not necessary or feasible, the hydrophilic seals shall provide adequate protection against infiltration.

5. Service Lateral Seals

- a. Service lateral connections shall be sealed. Seal the service lateral connection by installing a hydrophilic rubber connection seal.
- b. Rubber connection seals shall be composed of a hat made of hydrophilic polymeric neoprene rubber designed with a specified wall thickness to provide a compression seal at connection of a lateral and a mainline pipe. Use of caulking, rope or band type of an end seal shall not be allowed.
- c. Acceptable hydrophilic rubber seals are Insignia™ Hydrophilic Connection Hat by LMK Enterprises or approved equal.

6. CIPP Spot Repairs

- a. Install a sectional CIPP spot repair for areas where longitudinal shrinkage of the installed CIPP liner near the manholes is three (3) inches or more, at no cost to the City.
- b. For any other longitudinal shrinkage observed within a pipe segment, install a sectional CIPP spot repair.
- c. CIPP spot repair shall be accomplished using a liner tube of a particular length and a thermo-set resin with physical and chemical properties appropriate for the application. The tube positioned within a translucent inversion bladder is vacuum impregnated with the resin, then placed inside a protective launching device and winched through the sewer pipe. The tube shall consist of one or more layers of flexible non-woven

needed felt or a reinforced non-woven felt. The tube shall be continuous in length exhibiting a uniform minimum wall thickness based upon design calculations found in ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube, appendix XI. No overlapping sections shall be allowed in the circumference or the length of the liner. The tube shall include compressible material at each end forming a smooth transition to the host pipe. The liner shall be capable of conforming to offset joints, bells, and disfigured pipe sections. The resin shall be polyester, vinyl-ester or epoxy with proper catalysts as designed for the specific application. The cured-in-place pipe shall provide a smooth bore interior. Each installation shall have a design report documenting the design criteria for a fully deteriorated pipe section, or a partially deteriorated pipe in cases where the pipe has previously been lined. The installation procedure shall conform to ASTM F2599-11 "Standard Practice for Sectional Repair of Damaged Pipe by Means of an Inverted Cured-In-Place Liner". The cured-in-place pipe shall meet or exceed the minimum test standards specified by the American Society for Testing Methods as described in the most current ASTM F1216 standard, most current edition. Acceptable CIPP spot repairs are LMK Performance Liner or approved equal.

- d. CIPP spot repairs shall be ambient cure and shall have a fiberglass mat consisting of two or more layers of 0/90 degrees bias woven fiberglass with a Trevara felt coating on one side and capable of carrying a two component, 100 percent solid epoxy or silicate base resin. Acceptable fiberglass CIPP spot repairs are Prime Line sectional lining spot repair or approved equal.

C. INSTALLATION

1. Delivery, Storage, and Handling

- a. Care shall be taken in shipping, handling, and laying to avoid damaging the CIPP liner. CIPP liner damaged beyond repair in shipment shall be replaced as directed by City.
- b. Any CIPP liner showing a visible split, tear, or defect, shall be repaired per manufacturer's recommendations and to the satisfaction of the City or, if not possible, shall be removed at once from the project site.
- c. While stored, CIPP shall be adequately supported and protected in a manner as recommended by manufacturer.
- d. CIPP liner shall be maintained at a proper temperature in refrigerated facilities to prevent premature curing at all times prior to installation. CIPP liner shall be protected from UV light. CIPP liner showing evidence of premature curing will be rejected for use and shall be immediately removed from the site.

2. If available, examine City's CCTV video of each pipe segment before starting work.

3. Notify all property owners or businesses that discharge sewage directly to sewer being

lined and whose service lateral will be affected by lining work, that their service will be temporarily discontinued during installation of CIPP liner. Deliver written notification to each such resident or business at least 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted, and any restrictions on use of sewage system facilities including exact days and hours when sewer system cannot be used. Method of notification, and the text included in the notification, shall be approved by City.

4. Clean each length of pipe to be lined and shall dispose of all resulting material offsite as specified in SECTION 5 – CLEANING OF SEWERS.
5. Conduct a pre-rehabilitation CCTV inspection of all sewers to be rehabilitated by CIPP lining methods. Inspection shall be for purpose of identifying defects in pipe, to document location of all service lateral connections, and to confirm point repair locations. The project manager and/or superintendent shall review the pre-rehabilitation inspection videos to confirm the quality of the videos, locations of lateral connections, and locations of point repairs to be performed; only after the video quality is adequate for a clear review of pipeline, shall they be submitted to the City. City will review pre-rehabilitation inspection videos to confirm locations of point repairs to be performed. If the City is on site or immediately available, allow the City to view the pre-installation video to verify the pipe is ready for CIPP installation which includes proper cleaning, trimming protruding taps and mitigating and significant infiltration.
6. If the data is available, City will provide information on location of known active laterals and cleanouts; however, this list may not be interpreted as all-inclusive. Installer shall be responsible for verifying active customer service connection prior to rehabilitation. Compare service connections from CCTV video with the above ground measurements at approximate location of center of each house or building. Any discrepancies between CCTV data and above ground measurements of laterals shall be brought to attention of City for a determination of lateral reinstatements. If an error is discovered or an addition to the list provided, immediately notify City for additional investigation. Upon completion of rehabilitation work, a list of all service laterals abandoned or reconnected as part of the work shall be submitted to City. Compiled list can be in the form of post-inspection installation inspection logs and shall include the following information:
 - a. Location of each service lateral based on CCTV inspection logs. Location shall include both accurate distance measured from centerline of starting manhole as well as a notation (by clock-reference) of where on circumference of pipe, the service lateral connects.
 - b. Status (Active or Inactive).
 - c. Address of each customer and associated active lateral location.
7. During pre-rehabilitation CCTV inspection and prior to installation of CIPP lining, all service lateral connections protruding into main line by 1/2-inch or more shall be internally cut or ground down flush with pipe wall with a robotic cutter specifically

designed for this purpose. Internal cutter shall be capable of cutting unreinforced concrete pipe (CP), cast iron pipe, PVC, vitrified clay pipe (VCP), ductile iron pipe, and Orangeburg pipe. All materials / cuttings shall be removed from sewer and properly disposed of.

8. Infiltration runners or gushers as defined by NASSCO PACP that are observed during the pre- rehabilitation CCTV shall be stopped by injecting a chemical hydrophilic grout as required using a remote packer, unless otherwise approved by the City. If the pipe is larger than 36 inches, man-entry with hand-applied fast-setting epoxy can be performed to stop the infiltration.
9. Maximum amount of time any home or business shall be without sanitary sewer service is 10 hours and not between 6:00 PM and 8:00 AM. Any service out longer than 10 hours shall be bypassed to a sanitary sewer at no cost to City.
10. Provide bypass pumping of sewage flows to accommodate the work. Service connection effluent may be plugged only after proper notification to affected residence and may not remain plugged overnight. Installation of liner shall not begin until the required plugs or a sewage by-pass system have been installed and all pumping facilities have been tested under full operating conditions, including bypass of mainline and side sewer flows. Once lining process has begun, existing sewage flows shall be maintained, until resin/felt tube composite is fully cured, cooled down, fully televised and CIPP ends finished.
11. Wastewater flows from existing sewers shall not be allowed to enter the new or rehabilitated facilities until the new or rehabilitated facilities have been cleaned and tested as required in these Standard Specifications.
12. Provide CIPP liner in full length of sewer as shown on work orders. Installation of CIPP liner shall be in complete accordance with applicable provisions of ASTM F 1216 or ASTM F 1743 and manufacturer's recommendations.
13. Install a hydrophilic end seal at face of each manhole at all manhole penetrations prior to inverting or pulling in uncured CIPP liner.
14. If in the opinion of CIPP liner manufacturer and/or the City, rate of infiltration in sewer segment is high enough to risk washout of resin, perform measures, as required, to minimize infiltration prior to installation, including pre-liners, grouting, etc. If during pre-lining CCTV inspection, any infiltration runners, or gushers (per NASSCO PACP®) are observed, submit in writing for approval by City the methods and materials for mitigating any adverse impacts from the infiltration.
15. Pressure gauges for the ends shall be digital pressure/vacuum gauges with a pressure range of 0 to 50 psi and $\pm 0.25\%$ test gauge accuracy.
16. For pipes 18-in diameter and larger, install and use continuous temperature sensor strips. Provide the Owner's representative with access to the longitudinal temperature monitoring system data during the installation via digital data, web-based or other

approved methodology and printed reports.

17. CIPP liner shall be installed via inversion using hydrostatic head or air pressure in accordance with ASTM F 1216 or ASTM F 1743 and manufacturer's recommendations or inserted through a manhole by means and methods required by the manufacturer. Hydrostatic head and/or steam pressure used during installation process shall be sufficient to hold liner tight to pipe wall, producing dimples at all service connections, and flared ends at two access manholes. Closely follow the requirements in the submitted liner field curing reports, including the minimum inversion pressure, ideal head, maximum hot head, and maximum cold head for each installation.
18. If CIPP does not fit tightly against original pipe at its termination points, at no additional cost to City, the full circumference of CIPP exiting host pipe shall be filled with a resin mixture compatible with CIPP, approved by CIPP manufacturer and City. There shall be no significant leakage of groundwater between existing pipe and CIPP at manhole connection or service lateral connections. Any leakage shall be removed and/or eliminated at no additional expense to City. Any infiltration found at manhole and/or service connections shall be eliminated by no additional expense to City. Any infiltration runners or gushers as defined by NASSCO PACP shall be stopped with chemical hydrophilic grouting.
19. Fit heat source with monitors to accurately gauge temperature of incoming and outgoing water or steam supply. Place another such gauge between CIPP liner and pipe invert at downstream end to determine temperature during curing process. Temperature in CIPP during curing process shall be as recommended by resin manufacturer. Length of time for allowing curing process to be completed shall be of duration recommended by manufacturer, during which time the installer shall maintain required temperature throughout CIPP. Provide a written temperature data chart/curing log to City's Representative for review to ensure that curing temperatures for resin meet manufacturer's recommendations.
20. The full length from manhole to manhole of the installed resin-impregnated flexible felt tube CIPP liner shall be cured using circulating heated water or steam in accordance with ASTM F 1216 and manufacturer's recommendations or with UV light sources to affect desired cure throughout length of the tube, extending full length from manhole to manhole(s). Resin shall be cured into a rigid, impermeable pipe with minimum specified thickness, providing a structurally sound, uniformly smooth interior and tight-fitting liner within existing pipe. Cool-down procedures shall be in accordance with ASTM F 1216 and manufacturer's recommendations. The cool-down shall follow manufacturer's guidelines, be measured digitally to allow inspector to inspect or record, be linear, and be gradual; no super cooled air shall be allowed to be injected. UV cured CIPP shall not be permitted without written approval from City and after documentation has been reviewed that liner is compatible with all specifications and other related work including any lateral lining systems.
21. For pull-in-place liners cured by UV light (ASTM F2019)

- a. Fiberglass liner shall be cured with UV light sources at a constant inner pressure sufficient to maintain the liner tight against the existing wall of the pipe.
 - b. The time, the rate of travel of the ultraviolet light assembly, light sources and the internal pressures shall all be recorded and as specified by the liner manufacturer. This segment curing data shall be submitted to the City, along with the manufacturer's curing standards.
22. CIPP lining may be installed in multiple sewer segments at one time where possible. When installing CIPP lining in multiple sewer segments at one time, the top one-half of CIPP liner in intermediate manhole shall be neatly removed, leaving the invert in place, and void between CIPP liner and existing channel shall be filled with non-shrink grout. Manhole bench shall be reconstructed as required to provide a smooth transition to new CIPP liner.
23. All cutting and sealing of CIPP liner at manhole connections shall provide watertight pipe and manhole seals. All cut edges of cured liner shall be thoroughly sealed with same resin as was used in liner. Catalyst or hardener used shall be compatible with resin/catalyst used in liner previously but shall not require an external heat source to begin exothermic reaction (curing). There shall be no leakage of groundwater into manhole between CIPP liner and existing sewer pipe and between existing sewer pipe and manhole wall.
24. Continuous temperature monitoring systems are required for all 18 inches or larger sewer or any sized sewer in locations with significant known groundwater infiltration or if pipe is within 50 feet of stream, river or lake for liners being cured by heated water or steam. This system shall be installed at the invert of pipe and be installed per manufacturers recommended procedures. Temperature sensors shall be placed at upstream and downstream ends of reach being lined to monitor pressurized fluid's (air or water) temperature during curing process. To monitor temperatures inside tube, wall and to verify proper curing, temperature sensors shall be placed between host pipe and liner in bottom of host pipe (invert) throughout the reach to record the heating and cooling that takes place on the outside of liner during processing. As a minimum, sensors shall be spaced apart at intervals no greater than 20 feet for pipe sizes up to 15 inches in diameter; and no greater than 10 feet for pipe sizes 18 inches and larger. Additionally, sensors shall be strategically placed at points where a significant heat sink is likely to be anticipated. Monitoring of these sensors shall be by a computer that can record temperatures at this interface throughout processing of CIPP utilizing a tamper-proof database. Temperature monitoring systems shall be Zia Systems or Pipeline Renewal Technologies by Vortex Technology Group.
25. Pipes smaller than 18 inches may be monitored with thermocouples at the upstream and downstream manholes.
26. Prior to installing liner in host pipe, temperature monitoring system's proper functioning shall be confirmed by hooking it up to computer and seeing that sensors are reporting their ambient temperatures. No more than two sensors in sequence can be found faulty

during this test. If three or more sensors in sequence are discovered faulty, a new sensor array shall be provided and installed at no extra cost to the City; and the new array shall be again tested for its proper functioning.

27. Curing of resin system shall be as per recommendations of CIPP system manufacturer of CIPP product. Temperatures achieved and duration of holding the liner at those temperatures shall be per System Manufacturer's established procedures. If any sensor or sensors along reach indicates that there is a localized issue with respect to achieving proper curing per written installation procedure, the installer shall address the issue prior to acceptance of the liner. Sensor array's database required in above paragraphs shall have an output report that identifies each sensor by its station in reach and shows maximum temperature achieved during processing of CIPP and time sustained at or above Manufacturer's required curing temperature at each sensor. The temperature of the liner shall be recorded until the liner has completed the cool-down process.
28. If cool-down is to be accomplished by introduction of cool water into an inversion standpipe to replace water being drained from a small hole made in downstream end, the hardened liner shall be cooled down to a temperature below 100 degrees F (38 degrees C), or ambient temperature, whichever is smaller, before relieving static head in inversion standpipe. Take measures to ensure that, in release of static head, a vacuum will not be produced that could damage the newly installed CIPP liner.
29. Incorporate mitigation measures to control styrene odors during installation and curing of the liner. If any styrene odor complaints occur on the jobsite, means and methods shall be provided to immediately mitigate the issue at no additional expense to the City.
30. Vent and/or exhaust noxious fumes or odors generated during and remaining after curing process is completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for materials used and there is no more air pollution or potential health hazard left to general public or construction workers.
31. Identify points to which curing water can be discharged. At no point shall curing water be discharged to a storm sewer system.
32. Provide piping, pumps, valves, and other equipment to discharge curing water.
33. After the installation of the first 1,000 linear feet of CIPP lining, no additional CIPP lining shall be installed until acceptance testing demonstrates that the product meets all thickness and strength properties specified herein. Once the City has reviewed and approved the test results, the remainder of the lining installation may resume.
34. REINSTATEMENT OF SERVICES
 - a. After new CIPP has been cured and completely cooled down, if applicable, reconnect existing service laterals as designated by pre-installation television inspection report. This shall be done without excavation but from interior of pipeline by means of a

television camera and a remote cutting device that reestablishes service connection to not less than 95 percent or better of original diameter and to a maximum of 100 percent of original diameter; overcut connections are not acceptable. All openings shall be clean and neatly cut and the cut shall be buffed with a wire brush to remove rough edges and provide a smooth finish. Bottom of openings shall be flush with bottom of lateral pipe and shall have smooth edges with no protruding material capable of hindering flow or catching debris. All service lateral connections shall be sealed per the requirements of this specification.

- b. Coupons shall be removed from laterals by any means possible including flushing water into yard cleanouts and, with approval of the homeowner, entering homes to flush the material via access from cleanout or other sewer drainage points.
- c. Excess resin that builds up and hardens in and around the lateral connections(s) must be removed and/or ground down prior to acceptance of the re-instatement. Supply an extended lateral cutter bit to reach resin buildup beyond standard length bits.
- d. If necessary, because of uncertainty of matching each tap in the sewer with each property, perform a dye test to verify if a service connection is active at the direction of the City.
- e. Service laterals that were determined to be inactive during CCTV inspection will be abandoned by not reopening service connection after installation of cured-in-place pipe liner. All lateral connections shall be identified as repaired or abandoned in post rehabilitation CCTV. Provide an image file for all lateral locations along a given pipe segment, even if lateral connection has been abandoned.
- f. Do not open abandoned/capped service connections except at City's direction. If an abandoned service connection is opened without City's approval, an internal spot repair shall be performed to close connection, at no additional expense to the City.
- g. Provide a fully operational backup device for reinstating service laterals. If for any reason remote cutting device fails during reinstatement of a service lateral, immediately deploy the standby device to complete reinstatement. Backup equipment shall be onsite throughout reinstatement process.
- h. For service lateral reconnections and/or renewals to be made by excavation methods, InsertaTees may be used for solid wall pipes having a 0.36-inch or greater wall thickness. InsertaTees shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360-degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test or approved equal. Romac type saddles shall be used for pipes having a wall thickness thinner than 0.36-inches. Saddle connections shall be seated and sealed to new CIPP using grout or resin compatible with the CIPP.
- i. All existing break-in and/or hammer-tap (break-in) laterals shall be cut and sealed to

provide a watertight connection between the lateral and the lined pipe. The method for cutting and sealing of each lateral shall be submitted to the City for approval.

D. TESTING AND INSPECTION

1. CIPP lining placed shall be guaranteed by the installer and manufacturer for a period of two years from Substantial Completion. During this period, serious defects discovered in CIPP lining, as determined by City and which may materially affect the integrity, strength, function and/or operation of pipe, shall be removed and replaced as recommended by the manufacturer in a satisfactory manner at no expense to City. City may conduct an independent CCTV inspection, at its own expense, of CIPP lining work prior to completion of warranty period. Defects replaced at that time shall be fully warranted by the installer and manufacturer for a period of two years from date the defect was repaired. Wrinkles in flow stream, blisters that may affect the longevity of CIPP liner, dry spots where liner tube has no resin saturation, or other defects that may affect the integrity or strength of the CIPP or the flow capacity of the pipe, are unacceptable. Installer shall be responsible to remove and repair, at no expense to the City, all such defects in a manner that is satisfactory to City. Defects also include but not limited to the following:
 - a. Leakage through the liner or between liner and host pipe.
 - b. Reduction of liner thickness of more than 10 percent of the thickness designed and/or required. Final liner thickness shall be delivered based on installed product physical properties and as specified in these Standard Specifications.
 - c. Separation of liner from host pipe where an annular space is clearly noticed, shrinkages (longitudinal and/or circumferential), dry spots, delamination of liner, cured lifts, dry spots, bulges due to external loading, reverse curvatures, splits, cracks, lifts, breaks, folds, major wrinkles (as defined further herein), flats, pinholes, crazing and any other defects that in the CIPP lining will compromise the longevity of the installed product.
 - d. Circumferential defects (wrinkle, fin, bulge, etc.) in the invert of pipe between 4:00 and 8:00 o'clock shall not exceed three percent of the host pipe diameter or 1/2-inch by visual measurement, whichever is smaller, at the discretion of the City.
 - e. Longitudinal wrinkles or fins shall not exceed maximum allowable height of five percent of equivalent host pipe diameter or 1-inch, whichever is smaller.
 - f. Structural strength below the required limits
2. CIPP linings shall follow the quality control plan submitted to the City.
3. CIPP linings shall be from a single manufacturer. Suppliers shall be responsible for provisions of all test requirements specified herein as applicable. In addition, CIPP lining to be installed under this specification may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by City. The installer

shall require manufacturer's cooperation with these inspections. Cost of plant inspection of all CIPP lining approved will be the responsibility of City.

4. Inspections of CIPP lining may also be made by the City or other representatives after delivery. CIPP lining shall be subject to rejection at any time on account of failure to meet any of the requirements specified, even though sample CIPP lining may have been accepted as satisfactory at the place of manufacture. CIPP lining rejected after delivery shall be marked for identification and shall be removed from the job site.
5. Field acceptance of CIPP lining shall be based on City's evaluation of installation, including a review of the CIPP liner curing data, review of post-rehabilitation CCTV inspection data, and review of certified test data for installed CIPP liner, including air testing. All CIPP sample testing, and repairs to installed CIPP as applicable, shall be completed before final acceptance, meeting requirements of these specifications and documented in written form.
6. In the event that an installation is rejected based on review of the post-rehabilitation CCTV inspection, the sewer segment shall be repaired to the satisfaction of the City at no additional expense to the City.
7. For every 1,000 linear feet of CIPP liner installed for the first 5,000 linear feet, sampling and testing shall be performed to determine the installed CIPP liner flexural properties and CIPP liner thickness. After the first five test results have been collected and all have passed the minimum standards per the specification, the City may require collecting random samples up to one sample per 5,000 linear feet for testing. Frequency of testing may be reduced as approved by City after sufficient tests are performed to verify CIPP liner design, production, and installation procedures. Likewise, frequency of testing may be increased by City and performed at no additional expense to City when required tests show that installed CIPP liner does not meet specifications. If a test is not passed, the installer shall re-evaluate liner thickness design to determine if installed physical properties meet minimum design requirements; if it does not, liner shall be replaced or relined with approval from City at no additional expense to City.
8. Testing shall be performed by an independent testing laboratory certified by the American Association for Laboratory Accreditation (A2LA). Submit to the City the name and location of independent testing laboratory, a certified statement from laboratory indicating that they are independent from and not associated with the installer in any way, and A2LA certification for independent testing laboratory.
9. All expenses for sampling and testing of installed liner shall be paid for the installation contractor. Cost of all manufacturer's testing to qualify products furnished to project site shall also be the responsibility of the installer.
10. Sampling and testing of the installed CIPP liner shall conform to ASTM F 1216 and the following requirements:
 - a. Remove one restrained sample of installed CIPP liner at least 18-inches in length.

Sample shall be captured by installing CIPP liner through a section of PVC pipe (same diameter as existing sewer diameter) within the most downstream manhole of installation and at all intermediate manholes if multiple sewer segments are lined at same time. The installer may elect to cut the sample longitudinally and provide 1/2 the sample to City's representative or inspector for direct shipping to laboratory and keep other half of sample for additional testing if necessary.

- b. CIPP liner thickness shall be measured in accordance with ASTM D 5813. Flexural properties shall be determined in accordance with ASTM D 790. Label and date all samples and provide to inspector or City's representative same day of installation for shipping to independent testing laboratory. City shall be copied on all transmittals to independent testing laboratory. Testing results shall be submitted to the City within 30 days after installation of CIPP liner.
 - c. Any CIPP lining that does not meet new calculated thickness requirements shall be corrected in a manner approved by the City at no additional expense to City. City's decision on how to correct deficient CIPP liner installations shall be final. Options for correcting deficient CIPP liner installations that will be considered by City include the following: removal of existing CIPP liner and re-lining the sewer, open-cut replacement of sewer from manhole to manhole, re-lining sewer with existing CIPP liner in place, or accept a deduct from the total work value.
11. Along with the physical properties testing and post installation CCTV survey, deliver a certified copy of the curing report output from the temperature monitoring system used in the control of the curing process for pipes; or provide the City with access to the website where the secure report can be obtained.
12. Perform a post-rehabilitation CCTV inspection of all sewers rehabilitated using CIPP lining methods. Post-rehabilitation CCTV inspection shall be performed following installation of CIPP liner and reinstatement of all active service laterals. The installer's project manager and/or superintendent shall review the post-rehabilitation inspection videos to confirm the quality of the videos and of the installed CIPP; only after the video is confirmed to be of good quality, the videos shall be submitted to the City. If it is determined that any repairs are needed at any segment, a new CCTV inspection shall be performed of the entire segment(s) after the repairs have been completed.
13. Liner Installation Inspection - A visual inspection of the liner will be considered acceptable if liner shows no significant, wrinkles, lifts, ridges, splits, cracks, delamination, flats, dry spots, pinholes, shrinkage, foreign inclusions, crazing, reverse curvatures, or other type of defects in the CIPP lining. Significant defects as defined in this section; and/or any defect that may create a maintenance issue in future such as inhibiting CCTV cameras or allowing solids to get caught on defect, and/or any defect that appears to reduce long-term structural strength or stability of pipeline. Longitudinal wrinkles/fins in height up to a maximum of five percent of inside diameter of host pipe or 1-inch, whichever is smaller, may be acceptable and shall be evaluated by the City for acceptance on a case-by-case basis. Defective lining shall be repaired or replaced at no additional expense to City. If during removal process, the pipe is damaged, perform a point repair at no additional

expense to the City.

14. Post CCTV Video Inspection: Submit a digital CCTV of post-lined sewer within seven business days for each pipe segment. City shall review these post-lining videos and approve the installation based upon satisfactory completion of a liner that is free of significant defects.
 - a. Removal of wrinkles or fins deemed significant at the discretion of the City, shall be removed using a milling head, relined, or replaced as directed by the City at no additional expense to the City. There shall be no evidence of other major defects in the CIPP lining.
 - b. Longitudinal shrinkage of the CIPP liner's length, of more than three (3) inches from the face of the manhole shall be repaired with a fiberglass reinforced CIPP spot repair at no cost to the City.
 - c. Circular shrinkage shall be measured via man entry to try to insert a 1/16" thick ruler or similar into any gap more than 8 inches past the MH wall. Document these measurements with digital photos that shall be submitted to the City for approval. Circular shrinkage shall be repaired per manufacturer recommendations at no expense to the City.
15. The CIPP liner shall be watertight. Groundwater infiltration through the wall of the liner shall be zero.
16. All service connections shall be opened to a minimum of 95 percent and a maximum of 100 percent of opening so that a new lateral or lateral lining can be installed properly. Any overcuts more than 105 percent shall be repaired with hydrophilic seal hat connection, CIPP liner or other approved method by the City.
17. All coupons and excess resin shall be removed from reinstated service laterals prior to acceptance of CIPP lining.
18. All pipe-to-manhole connections shall be watertight and free of infiltration.
19. When CIPP is installed using pressurized air, perform an air-test per SECTION 3 – SANITARY SEWERS in presence of City's representative immediately following cool down and prior to lateral reinstatement. Otherwise, hydrostatic testing (exfiltration test) of completed liner shall be performed after liner curing and cool down in accordance with ASTM F 1216. Hydrostatic testing shall be performed prior to reinstatement of active services.
20. CIPP liners installed with water inversion methods shall be tested for water tightness using an exfiltration test. Maximum allowable leakage shall be 50 gallons per day per diameter inch of pipe per mile in accordance with ASTM F 1216.
21. After all installations are complete, inspected, post-construction CCTV has been

reviewed and approved by the City, and all work is satisfactory to City, cut and trim the new liner at each manhole wall flush. Seal liner to manhole wall with a sealant material.

END OF SECTION

SECTION 7 - MANHOLES

A. DESIGN CRITERIA

1. Manholes between gravity sewers shall be placed at all pipe intersections and at intervals not greater than 400 feet. Manholes shall be placed at all changes in grade, pipe size and alignment. External drop manholes are required if the invert of the incoming pipe is greater than 2'-0" above the invert of the outgoing pipe. However, use of drop manholes shall be avoided wherever possible.
2. Unless otherwise noted, manholes shall be constructed of precast concrete with cast iron frames and covers, as shown on the detail drawings contained herein. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be with a smooth curve of as large a radius as the size of the manhole will permit.
3. All manholes shall be adjusted to ¼" below finished grade in paved areas and 12-inches to 18-inches above grade in rights of way or unpaved areas or as approved by the Engineer. If a manhole is to be in unpaved areas on residential properties, or at the discretion of the City, the cover shall be 2 to 3 inches above grade and the manhole shall be located in areas not subject to ponding or flooding. If the proposed construction includes an existing street or right of way in which the existing grade will be changed, the Applicant shall be responsible for adjusting all existing manholes to finished grade. All adjustments required shall be in accordance with methods approved by the City. Such approval must be obtained in writing prior to construction. When installing manholes in paved areas, temporary paving material shall be gently ramped up to lid and frame and maintained that way until final paving is completed.
4. Liftholes in manholes shall not extend through the entire width of the wall.
5. Exterior and interior surfaces of the manholes must be coated or lined, as described in Paragraph B – Materials and Equipment.
6. Manholes shall be constructed in accordance with the standard details noted on the detail drawings contained herein. Shop drawings shall be submitted for approval.
7. Manholes that are installed in field or wooded areas may, at the discretion of the City, be required to have a post installed adjacent to the manhole to serve as a marker.

B. MATERIALS AND EQUIPMENT

1. Precast Reinforced Concrete Manhole Riser and Tops
 - a. Precast reinforced concrete manhole risers and tops shall conform to ASTM Specification C-478 Latest Edition and shall be of watertight construction. Joints between manhole sections shall be provided with preformed plastic joint sealing material conforming to ASTM C990 and shall be ConSeal as manufactured by

- Concrete Sealants Inc., Ram-Nek as manufactured by Henry Company or approved equal. The preformed joint sealer shall be protected by a removable two-piece wrapper and shall be applied in strict accordance with the manufacturer's recommendations. The chemical composition of the sealer shall meet the following requirements: the latest revision of: Bitumen-ASTM D-477, Inert Ash Mineral AASHTO T-11-42, Volatile Matter ASTM D-667. Shop drawings and specifications must be submitted for approval prior to installation.
- b. All joints shall be wrapped on the exterior with 6" ConWrap CS-212 polyolefin backed adhesive joint wrap as manufactured by ConSeal Concrete Sealants, Inc., or equal.
 - c. Manhole bases may be cast-in-place concrete, and shall have a compressive strength of not less than 4,000 psi after 28 days (tests to be in accordance with ASTM Specification C-39, Latest Revision).
 - d. Precast manhole bases shall have flexible watertight joints at the point of entry of any sewer pipe into the manhole. The rubber materials shall conform to ASTM C443. The gaskets shall be cast into the manhole base to become an integral part of the concrete. The gaskets shall be Dual Seal II Series Tylox Cast-in Connector as manufactured by Hamilton Kent, PSX Wedge Drive as manufactured by Press-Seal Gasket Corporation, Dura-Seal III as manufactured by Blackthorn, LLC., or equivalent.
 - e. Manhole bases with precast outside drop shall conform to ASTM C478, Latest Revision and shall provide a 90-degree elbow cast in monolithically with the base. The riser pipe shall be supported by concrete U-shaped collars. The collars shall be a minimum vertical height of 12 inches and shall be connected by tongue-and-groove joints.
 - f. Precast concrete grade rings with a minimum thickness of 2 inches used for leveling and adjusting to grade shall be of compressive strength as specified above. Precast rings shall be a single piece (no semi-circular pieces). Rubber grade rings are acceptable with a minimum thickness of 0.5 inches and for tapered arrangements, and shall be Infra-Riser as manufactured by EJ Group, Inc.. The use of poured concrete grade rings shall be allowed only with prior approval from the City. Design of the grade rings must provide for full bearing of manhole frame. Joints between grade rings must be sealed using an approved preformed plastic joint sealing material specified in this section. Cement mortar will not be permitted in any joints.
2. Frame and Cover
- a. Manhole frame and cover shall be of cast iron, 24-inch diameter and equal in design to Model R-1554, as manufactured by the Neenah Foundry, model 1545A by EJ Group, Inc., or approved equal machined and having the letters "SANITARY SEWER" cast approximately in the center of the cover.

- b. All manhole cover frames shall be securely attached to the manhole by use of anchor bolts. The joint between the frame and the precast manhole section shall be provided with preformed plastic joint sealing material equal to ConSeal as manufactured by Concrete Sealants Inc. and shall be of self-sealing design with a continuous rubber gasket supplied in a machined groove in the surface upon which the cover rests.

3. Watertight Manhole Frame and Cover

- a. Watertight manhole covers shall be 24-inch diameter of cast iron similar in design to Model R-1916 as manufactured by the Neenah Foundry, model 1040APT by EJ Group, Inc., or equal, and having the letters "SANITARY SEWER" cast approximately in the center of the cover.
- b. Watertight frames shall be securely attached to the manhole by use of anchor bolts. The joint between the frame and the precast manhole section shall be provided with preformed plastic joint sealing material equal to ConSeal as manufactured by Concrete Sealants Inc. All joints shall be watertight. Manhole covers shall be bolted to the frames using four 4 ½-inch stainless steel bolts. A ¼" diameter neoprene gasket shall be installed between the frame and cover to promote a watertight seal.

4. Manhole Inserts

- a. Inserts shall be of the appropriate size to match the manhole frame and cover and shall be manufactured of high density polyethylene, meeting the requirements of ASTM D1248, Class A, Category 5, with a finish thickness of 1/8 inch. The inserts shall be of the no-valve, shallow bowl design unless otherwise required by the City, and shall be as manufactured by Parsons Environmental Products, Inc., Reading, PA, or approved equal. Except where a watertight manhole lid is installed, manhole inserts with the appropriate gasket shall be installed in all manholes by the Extendor at his expense.

5. Manhole Steps

- a. Manhole steps shall be composed of a ½-inch Grade 60, ASTM A615 steel reinforcing bar completely encapsulated in Grade 49108, ASTM D2146 polypropylene copolymer compound, as manufactured by M.A. Industries Inc., Peachtree City, GA or equal. The City reserves the right to have steps tested according to the latest revision of ASTM Specification C-478 at the Extendor's cost.
- b. Manhole steps shall be positioned to form a continuous ladder with 12-inch intermediate spacing in the manhole in such a manner to permit easy access to the manhole and not conflict with either influent or effluent lines. The first step shall be no further than 24-inches from the top of the manhole, and the bottom step shall be no higher than 16-inches from the bench.

6. Protective Coatings and Linings

a. Exterior Coating

All exterior surfaces shall be coated with dampproofing. Dampproofing shall be coal tar waterproofing pitch; Bitumastic No 300-M by Koppers, Cooper Black No. 760 By Coopers Creek Chemical Corporation, or approved equal.

b. Interior Coating (hydrogen sulfide corrosion protection)

(1) New manholes with an internal drop of less than 2 feet shall have a white epoxy coating (Carboguard epoxy waterproofing by Carboline Company or approved equal) applied to all interior surfaces at the manhole manufacturer's facility before delivery to the site. Surface preparation and application shall be as recommended by coating manufacturer.

(2) New manholes with a drop of 2 feet or greater or force main terminal manholes shall have one of the following liners:

(a) A High-Density Polyethylene (HDPE) liner to provide an impermeable lining on the interior concrete surfaces shall be AGRU Sure Grip HDPE of polypropylene random copolymer as furnished and installed by Terre Hill Concrete Products, Terre Hill, PA. The Sure Grip liner shall have a minimum thickness of 2 mm. The minimum anchor stud density shall be 39 studs per square foot. The anchoring studs shall not be welded or mechanically attached to the liner. All joints shall be sealed by thermal welding performed by AGRU certified welders. The interior surfaces to be protected shall include the wall, ceiling, pipe entries and structure chimney.

(b) A Polyvinyl Chloride (PVC) resin liner to provide an impermeable lining on the interior concrete surfaces shall be Dura Plate 100 as manufactured by Atlantic Concrete Products, Inc. The Dura Plate liner shall have a minimum thickness of 1.65 mm. The PVC liner, channel joints, H-joints and corner joints shall be manufactured from PVC and shall be white in color. A combination of standing ribs and dovetails shall be used to secure the liner panels to the wall of the structure and shall be spaced a maximum of 6 inches apart. Liner panels for 48" through 60" diameter manholes shall be a minimum of 0.50 inches high and shall be 0.75 inches high for 72" and larger diameter manholes. Liner panels shall be formed to the correct radius and have a PVC return into the joint of 0.50 inch. The fabricated liner panels shall be joined together by a slotted strip of EPDM rubber meeting the manufacturer's specifications. Sections of lined concrete structure shall be joined together by an approved butyl rubber strip as manufactured by Atlantic Concrete Products, Inc., designed to produce sufficient squeeze-out between PVC returns. Manhole steps, if required, shall be polypropylene drive-in step. Pipe penetrations through the wall shall be afforded protection by applying

0.125-inch cementitious corrosion resistant material, Forsroc Epoxy Liner, to the unlined exposed areas within the openings and shall overlap the liner wall a minimum of 1.50 inches. The manhole chimney shall be protected by installing a telescoping PVC connector, Water-Lok, as manufactured by Atlantic Concrete Products, Inc. The interior surfaces to be protected shall include the wall, ceiling, pipe entries and structure chimney.

- (c) Manholes to receive a PVC or HDPE liner shall also have a fiberglass reinforced plastic (FRP)-lined base. The FRP base liner shall be by GU International. The liner shall be of one-piece construction of unlayered, homogenous composite. Minimum thickness shall be 0.12" – 0.20" (3 mm – 5 mm) and shall be in lengths and nominal inside diameters corresponding to the precast concrete base section. The prefabricated FRP base liner shall include full flow channels with side walls to the crown of the pipe; inner surface of the bench shall have an anti-skid pattern; watertight gasketed pipe bell connections of FRP/PVC boot hole sleeves to suit specific pipe types, grade and alignment, shall be monolithically attached to prefabricated FRP base liners to extend to the outside profile of the precast concrete structure. The outer surface of the liner shall be aggregate-coated and shall have steel spirals/lattice bonded to the FRP to ensure adequate anchoring to concrete base sections to pass vacuum test with 10" of negative pressure.
- (3) Existing manholes receiving a new drop connection of 2 feet or greater or a new force main connection shall have a spray-applied polyurethane coating such as SprayWall by Sprayroq or a spray-applied polyurea coating by Obic, provided that the condition of the manhole is suitable. The interior coating shall be installed by a certified technician. All liners shall be applied so that they result in a monolithic liner covering the invert, walls and corbelled top up to the cast iron manhole frame.

If the City determines that an existing manhole requiring an interior coating is in poor condition, a new manhole will be required and the interior shall be as described in paragraph B.6.b.(2) above.

C. INSTALLATION

1. General

The relevant parts of SECTION 3 – GRAVITY SEWERS shall apply regarding earthwork.

2. Precast Concrete Bases

a. Bedding

Install bases on a 6-inch deep compacted layer of aggregate meeting requirements of pipe bedding as specified previously in SECTION 3 – GRAVITY SEWERS.

- b. When using prefabricated pipe opening seals (i.e., Press Wedge II, Dura-Seal, etc.) for connecting pipes into manholes, and such seals create an annular space on interior and exterior of manhole wall pipe openings after pipe connection is made, fill such annular spaces with non-shrink grout. Following sealing compound installation, trowel compound surface smooth and flush with interior face of manhole.

3. Concrete Channel Fill

- a. The following criteria shall apply to both field and factory formed bases:
 - (1) Form inverts directly in concrete channel fill. Concrete fill shall be a minimum depth of 3 inches.
 - (2) Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
 - (3) Make changes in size and grade gradually.
 - (4) Make changes in direction of entering sewer and branches to a true curve of as large a radius as manhole size will permit.
 - (5) Make slopes gradual outside the invert channels. Provide a minimum slope of 1"/foot and a maximum slope of 2"/foot.
- b. Use 3000 psi concrete unless indicated otherwise on the detail drawings.
- c. Channels shall be full pipe height; PVC channels may be used for invert section.

4. Manhole Wall Erection

a. Precast Components

Provide precast reinforced concrete straight riser, tapered riser and top sections necessary to construct complete manholes. Fit the different manhole components together to permit watertight jointing and true vertical alignment of manhole steps.

- b. Install two rings of preformed plastic sealing compound between sections in accordance with manufacturer's recommendations and as shown on the detail drawings, and join sections in accordance with written instructions of manhole component manufacturer.
 - (1) Prime joint surfaces if required by preformed sealing compound manufacturer.

- (2) If sealing compound is installed in advance of section joining, leave exposed half of two-piece protective wrapper in place until just prior to section joining.
- (3) Use preformed sealing compound as the sole element used in sealing section joints from internal and external hydrostatic pressure.
- (4) Following manhole section installation, trim any excess sealing compound to provide a smooth surface that is flush with interior face of manhole.
- (5) Make pipe connections into manhole walls as specified previously for pipes connecting into manhole bases.

5. Frame and Cover Installation

- a. Adjust frames using grade rings. Set grade rings in preformed plastic joint sealing material specified in this section.
- b. Bolt manhole frames in place on manhole top section, or on grade rings, if required, after installing ½-inch thick preformed plastic sealing compound on bearing surface of manhole frame and between grade rings. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.
- c. Use bolts of sufficient length to properly pass through concrete grade rings, if any; engage full depth of manhole top section inserts and allowing enough threaded end to pass through manhole frame to properly tighten nut and washer.

6. Drop Manholes

Construct as depicted on the detail drawings.

D. TESTING AND INSPECTION

1. Notification

It is incumbent upon the applicant to notify the City a minimum of 24 hours in advance of when the work will be ready for inspection.

2. All manholes shall be tested for water infiltration. The Extendor shall furnish all labor, materials, water, tools, equipment and accessories necessary to perform the required tests. All tests shall be made in the presence of and to the complete satisfaction of the City.
3. The manhole shall be thoroughly cleaned and all openings sealed to the satisfaction of the City. All pipe openings in the base and the walls shall be plugged with plugs properly designed to provide a watertight and airtight seal. All excess joint sealing material protruding into the manhole shall be removed.

4. There shall be no groundwater around the outside of the manhole during the vacuum test. If there is groundwater around the manhole during the vacuum test and any water is found in the manhole at the conclusion of the test, it shall be deemed to have failed the test.
5. The manhole shall be tested using the vacuum testing method (ASTM C1244)
 - a. An inflatable circular rubberized seal shall be placed in the manhole cover frame, and a vacuum of 10 inches (mercury) shall be applied to the manhole. The time lapse shall be measured for the vacuum to drop from 10 inches to 9 inches. The vacuum drop shall be measured by a vacuum gauge graduated between 0 and 20 inches (mercury).
 - b. If the time lapse is greater than 60 seconds, the manhole is considered to have passed the test.
 - c. If any manhole fails to meet the testing requirements, the Extendor shall determine at his expense the source or sources of leakage. The Extendor shall repair or replace all defective material and/or workmanship and shall conduct such additional tests as required to demonstrate that the manhole meets the requirements, at his expense. All materials and methods used to repair the manholes shall meet with the approval of the City.

E. DETAIL DRAWINGS

Relevant detail drawings are:

- 11 Precast Concrete Manhole
- 12 Cast-in-Place Drop Connection to Manhole
- 13 Precast Drop Connection to Manhole
- 14 Cast-in-Place Base – New Manhole Over Existing Sewer
- 15 New Sewer to Existing Manhole Connection
- 16 Force Main Connection to Manhole
- 17 Manhole Location Post

END OF SECTION

SECTION 8 - FORCE MAINS

A. GENERAL

1. Force mains described and specified in this section are sewers which convey sewage under high pressure from pumping stations to locations in the gravity sewer system.
2. Force mains shall be installed in strict accordance with these specifications, and any applicable practices and precautions required for gravity sewer are equally applicable to the installation of pressure sewers. These include, but are not limited to, excavation, pipe bedding, concrete encasement and backfilling.
3. The use of polyvinyl chloride (PVC) pipe and fittings will not be permitted.

B. DESIGN CRITERIA

1. Diameter and Slope

The diameter shall be determined by the flow required to be conveyed and shall not be less than 4 inches. During the installation of a force main, the pipe shall be laid at a continuously increasing grade to each air release manhole or point of discharge. The Applicant shall provide sufficient construction control to assure that there are no sags or decrease in slope in the force main which could tend to accumulate and trap air.

2. Depth of Sewers

A minimum cover of 3'-6" over the top of the pipe shall be maintained.

3. Separation of Utilities

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

4. Thrust Restraint and Blocking

Thrust restraints shall be provided at all tees, bends, wyes, pipe ends or other locations that could become disconnected in the event of a pressure surge.

5. Air Release Valves

The use of air release valves will only be considered if it is demonstrated that they are absolutely necessary and that no alternatives are possible.

C. MATERIALS AND EQUIPMENT

1. Ductile Iron Pipe and Fittings.

(References to ASTM, AWWA and ANSI Specifications imply latest edition.)

a. Ductile Iron Pipe

- (1) Pipe shall conform to ANSI Specification A21.51, AWWA C151 and ASTM A746 for the material class or pressure designated and ANSI A21.50 and AWWA C150, for wall thickness. Pipe shall be supplied in standard lengths as much as possible.
- (2) Ductile iron pipe shall be by U.S. Pipe and Foundry Company or American Ductile Iron Pipe Company.

b. Joints

- (1) Joints shall be rubber-gasket push-on type or rubber-gasket mechanical joint type conforming to AWWA C111. Gasket shall be of SBR.
- (2) Restrained joints shall be push-on restrained joints (U.S. Pipe and Foundry Co.'s. Field Lok 350 Gaskets or equal) as manufactured by the pipe supplier or manufacturer subject to the City's approval. The restraint provided shall be standard restrained joint or bolt-less, integral restraining system. Restrained joints shall be suitable for the specified test pressure. Mechanical joint retainer glands ("Megalug") as manufactured by EBAA Iron Inc. of Texas can be selected for restraining the mechanical joint of ductile iron pipe for field closures as approved by the City. The minimum number of restrained joints required for resisting forces at fittings and changes in direction of pipe shall be determined from the length of restrained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil.
- (3) Sleeve type couplings shall be ductile iron mechanical joint solid sleeves.

c. Minimum Thickness

Thickness design shall be per AWWA C150, except provide minimum Class 52.

d. Ductile Iron Fittings

- (1) Pipe fittings shall be ductile iron with pressure rating of 350 psi for 24-inch and smaller piping and 250 psi for 30-inch and larger piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, at a minimum, of the connecting pipe.
- (2) Closures shall be made with mechanical joint ductile iron solid sleeves and shall be located in straight runs of pipe at minimum cover outside the limits of restrained joint sections. Location of closures shall be subject to approval of the Engineer.

e. Interior Lining

- (1) Cement mortar lining shall only be used in pipe and fittings that are continuously filled or full flow not exposed to the atmosphere. The cement mortar lining with an asphalt seal coat shall conform to ANSI Specification A21.4 or AWWA C104, latest edition, except the thickness of linings should not be less than 1/8-inch.
- (2) Hydrogen sulfide resistant linings shall be used in all pipe and fittings with partial flow depth or exposed to the atmosphere (in the vicinity of air release valves, terminal manholes, etc.). These linings shall be one of the following:
 - (a) Protecto 401 ceramic-filled amine cured epoxy lining shall be as manufactured by Indurall. The lining thickness shall be 40 mils minimum. Application shall be performed by an applicator approved by the coating manufacturer, in accordance with manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.
 - (b) Calcium aluminate mortar shall be made of fused calcium aluminate cement and fused calcium aluminate aggregates as manufactured by Holcim UK or approved equal. The minimum lining thickness shall be 0.125 inch for 6 through 12 inch pipe, 0.1875 inch for 14 through 24 inch pipe and 0.250 inch for 30 through 54 inch pipe. The interior and exterior of the spigot end and the interior of the socket end, including a portion of the pipe barrel, shall be coated with a minimum of 8 mils of epoxy prior to lining.
 - (c) Polyethylene lining shall consist of a blend of polyethylene powders applied to the interior of a preheated pipe. The nominal lining film thickness shall be 40 mils minimum. Polyethylene lining of ductile iron pipe shall be done at pipe manufacturer's plant; fittings shall be done at pipe manufacturer's plant, or at experienced shop approved by the pipe manufacturer. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.

f. Exterior Coating

- (1) Buried pipe shall be installed with a bituminous coating in accordance with AWWA C151 and C110 respectively.
- (2) Buried pipe in corrosive soils shall be installed with polyethylene encasement conforming to AWWA C105, where indicated on the drawings or as directed by the City. The polyethylene sheet shall be 8 mils thick minimum.

2. Plug Valves

- a. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at the rated pressure. The disc shall be completely out of the flow path when open. Plug valves specified herein shall be Millcentric by Milliken or equal.
- b. All buried valves shall open counter-clockwise and be especially constructed for buried service. Exterior ferrous metal surfaces of all buried valves shall be blast cleaned in accordance with SSPC SP 6 and given two shop coats of an approved two-component coal tar epoxy paint.
- c. All size plug valves shall have a minimum port area of 80 percent.
- d. Valves shall be rated at minimum 175 psi WOG (water, oil and gas) working pressure for sizes 4 inch to 12 inch inclusive and at minimum 150 psi WOG working pressure for sizes 14 inch and larger.
- e. All plug valves under this paragraph shall be performance, leakage and hydrostatically tested in accordance with AWWA C504, except as modified herein. At the above rated minimum working pressures, the valves shall be certified by the manufacturer as permitting zero leakage for a period of at least 30 minutes with pressure applied to the seating face.
- f. Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A126, Grade B, or of ductile iron, ASTM A536 and of the top entry, bolted bonnet design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts and washers shall have Type 316 stainless steel hardware.
- g. The valve disc shall be cast iron ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65 45-12, be removable without removing the valve from the line and have an integral upper and lower shaft which shall have seals on the upper and lower journals to prevent entrance of solids into the journals.
- h. Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve or shall have self adjusting packing.
- i. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded in high nickel content overlay seating surface in the body.
- j. Discs shall have a full resilient facing of neoprene or Buna N.

3. Valve Boxes

All buried valves shall be provided with extension-type, roadway-type valve boxes. Valve boxes shall be cast iron and shall be two-piece telescoping screw-type construction. Valve boxes shall have 5 1/4-inch shafts, shall have covers marked "SEWER", and shall be coated inside and out with a tar or asphalt compound. Valve boxes shall be manufactured by Capital Foundry of VA, Inc., Bingham & Taylor or Tyler Union.

4. Air Release Valves

- a. The valves shall be designed for sewage service and shall be non-clogging with cast iron or 316 stainless steel body, bronze or 316 stainless steel trim and 316 stainless steel floats. Valves shall be provided with shutoff valve, blow-off valve and quick disconnect hose connection and backflushing hose and valve.
- b. Valves shall have a venting capacity as appropriate for the application and shall be similar to those manufactured by A.R.I., DeZurik, GA Industries, Val-Matic or approved equivalent. Submit calculations to the City's engineer for review showing that air release valves are appropriately sized.
- c. Valve chamber shall be standard precast concrete manhole construction in accordance with ASTM C478, and shall be of adequate size to permit entry around valve for servicing and maintenance. Manhole base shall be provided with drain. Manhole cover shall be adequately vented to ensure discharge or intake of free air.

5. Detectable Warning Tape

Detectable warning tape shall be polyethylene film encasing a metallic core, minimum 6" wide and 4 mils thick, color-coded green for sewer, bearing in black letter – CAUTION: SEWER LINE BELOW.

D. INSTALLATION

1. General

Ductile iron pipe shall be installed in accordance with AWWA C600.

2. Excavation

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

3. Bedding

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

4. Laying Pipe

a. Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

b. Construction Control

During the installation of a force main, the pipe shall be laid at a constantly increasing grade to each high point, air release manhole, or point of discharge, as indicated on the Drawings. The Contractor shall provide sufficient construction control to assure that there are no sags or loss in grade in the force main which could tend to accumulate air.

c. Permissible Deflection of Joints

If deflection is required, the amount of deflection shall not exceed the maximum limits as specified in the AWWA Standard C600, or those specified by the pipe manufacturer.

d. Fittings and Valves

(1) General

Valves and fittings shall be set and jointed to pipe in the manner specified previously for cleaning, laying and jointing pipe.

(2) Valve Chamber

Provide a precast concrete manhole for every air release and vacuum valve as specified in SECTION 7 - MANHOLES. The manholes shall be constructed of sufficient size to permit entry for valve repairs and protect the valve and pipe from impact where they pass through the manhole walls. All valves and fittings shall be supported as indicated on the detail drawings.

5. Thrust Restraint and Blocking

Restraint of pipe and fittings shall be provided at all tees, crosses, bends, wyes, pipe ends, or at other locations that have unbalanced pressure forces. Restraint shall be provided by one of the following:

a. Pipe manufacturer's restrained joint system as approved by the City.

(1) Provide computations for the embedment lengths required for the following minimum conditions:

Design pressure = 150 psi

Depth of cover = 3.5 feet

Safety factor	=	1.5
Soil type	=	cohesive granular
Soil internal friction angle	=	20 degrees
Soil cohesion	=	200 psf
Soil density	=	90 pcf

Ref. - "Thrust Restraint for Ductile Iron Pipe", DIPRA

- (2) Minimum restrained lengths required for pipe anchorage with restrained joints as shown on the detail drawings.

b. Metal harness or tie rods

- (1) Metal harness or tie rods of adequate strength to prevent movement shall be used.
- (2) Restrained pipe length shall be the same as those for restrained joints.
- (3) Steel rods or clamps shall be suitable to be buried. The minimum number shall be as follows:
 - (a) Use a minimum of two $\frac{3}{4}$ -inch diameter rods for pipes 6 inches and smaller.
 - (b) Use a minimum of four 1-inch diameter rods for pipes 8 inches through 14 inches.
 - (c) Minimum restrained length required for pipe anchorage with metal harness and tie rods shall be the same as those indicated for restrained joint pipe.

c. Concrete anchor blocks

- (1) Concrete anchor blocks shall be designed for the same parameters as those for restrained joints with the additional condition of a minimum allowable soil bearing pressure of 2000 psf.
- (2) Minimum anchor blocks shall be as shown on the detail drawings.

6. Backfilling

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

7. Surface Restoration

Refer to SECTION 3 – GRAVITY SEWERS for these requirements.

E. TESTING AND INSPECTION

1. Notification

It is incumbent upon the applicant to notify the City a minimum of 24 hours in advance of when the work will be ready for inspection.

2. Pressure Test

- a. After the pipe has been laid and backfilled as specified, all newly laid pipe shall be subjected to a hydrostatic pressure of 150 pounds per square inch or 150% of the normal working pressure, whichever is greater, in accordance with AWWA C600.
- b. Where any section of a force main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two days have elapsed.

- c. Air release valves shall be installed but isolated during testing of the pipeline.

d. Duration of Pressure Tests

The duration of each pressure test shall be two hours.

e. Procedure

Each section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pipe connections, and all necessary apparatus, including gauges, shall be furnished by the Contractor and are subject to approval by the Engineer. The Contractor will make all taps into the pipe, and furnish all necessary assistance for conducting the tests. The Contractor shall supply either a container calibrated in 0.1 gallon increments or a laboratory certified calibrated water meter calibrated to an accuracy of 0.1 gallons.

f. Expelling Air Before Test

Before applying the specified test pressure, all air shall be expelled from the pipe. If permanent air release valves are not located at all high points, the Contractor shall make the necessary taps at such points before the test is made. After the test has been completed, the Contractor shall remove and plug the taps or leave them in place at the direction of the Engineer.

g. Examination Under Pressure

Any cracks or defective pipes, fittings or valves discovered in consequence of this pressure test, shall be removed and replaced by the Contractor, and the test shall be repeated.

- h. If the pressure does not drop within the 2-hour test period, the test shall be deemed to be successful.

F. DETAIL DRAWINGS

The relevant detail drawings are:

- 1 Right of way Restoration
- 2 Pavement Restoration
- 3 Concrete Encasement
- 4 Pipe Cradle in Casings
- 16 Force Main Connection to Manhole
- 18 Air Release Valve and Chamber
- 19 Thrust Blocks for Horizontal Bends and Lower Vertical Bends
- 20 Restrained DI Pipe Length

END OF SECTION

SECTION 9 – PUMPING STATIONS

A. GENERAL

1. The information contained in this section is meant to serve as a general guide for pumping station design. All pumping station designs must be submitted to the City for review and approval prior to construction.

2. State Requirements

Sanitary sewage pumping stations shall be properly designed to conform to all applicable regulations of the Maryland Department of the Environment (MDE), National Fire Protection Association (NFPA), Occupational Safety and Health Administration (OSHA), and the Maryland Department of Labor, Licensing & Regulation.

3. Pumping Station Types

Both wetwell/drywell and submersible type pumping stations will be considered. The type of pumping station is subject to the approval of the City. If the proposed pumps will require a motor of 100 horsepower (HP) or greater, the pumping station shall be of a wetwell/drywell design.

These requirements pertain to pumping stations which will serve multiple and/or industrial or other developments which discharge sewage by gravity to the pumping station site.

4. Permits

The Applicant shall secure, in the name of the City, all permits that are required in the name of the City such as those from MDE, Maryland Midland Railroad, and the Maryland State Highway Administration (MDSHA). The Applicant shall secure, in their own name, all required construction permits such as building permits and local street opening permits. Costs of all permits, including any and all bonds required, shall be the sole expense of the Applicant. Any existing street, highway, or other improvements disturbed during construction shall be restored to the satisfaction of the appropriate municipality or Owner before the facilities will be approved for final acceptance by the City.

5. Hazardous Areas

Special consideration must be given to the fact that wetwells, other than those in residential properties, are considered a hazardous (Class 1, Division 1 or 2, Group D) environment. Other spaces outside the wetwell may also be considered hazardous areas.

All pumping stations must comply with NFPA 820 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities) and the applicable provisions in NFPA 70 (National Electrical Code) Articles 500 and 501.

The pump station design package must include a drawing diagrammatically identifying the hazardous areas as well as a table indicating for each area within and around the pump station the following information:

- Area/Room Name
- Environmental Designation (Dry, Damp, Wet, Wet/Corrosive, etc.)
- NEC Classification (Unclassified, Class I/Division 2, Class I/Division 1)
- Referenced NFPA 820 Table Line or Figure (i.e. Table 4.2.2, Row 14[a] or Figure A.4.2[b])
- Ventilation Measures per NFPA 820 (NNV, A, B [12 ACH], C [6 ACH], D)
- Fire Protection Measures per NFPA 820 (i.e. H, FE, or FAS)
- Electrical Enclosure NEMA Rating (i.e. NEMA 1, NEMA 4X, or NEMA 7/4X)
- Electric Motor Enclosure Rating (i.e. TEFC, TENV, or TEXP)

6. Safety Requirements

All gears, chains, couplings, projecting set screws, keys, and similar rotating or reciprocating parts shall be protected in accordance with the American National Standards Institute (ANSI).

7. Drawings and Details

Prior to approval by the City, detailed construction drawings, specifications, design calculations, and pump curves must be submitted for review by the Engineer. The drawings will be reviewed for general design, general dimensions and apparent suitability and will be approved or returned for revisions. Such approval will not relieve the Applicant of the responsibility for furnishing equipment which will satisfactorily perform under the conditions specified.

B. DESIGN CRITERIA

1. Municipal Requirements

All aspects of the site design shall be in accordance with county and local municipal zoning and land development requirements.

2. Site

- a. The pumping station site shall be properly graded to eliminate any storm water problems and/or ponding conditions. After grading, the site shall be seeded and landscaped. Provisions shall be made to include shrubbery or trees in the

landscaping to enhance the appearance of the station. The Applicant is responsible for obtaining a good stand of grass until the time of first cutting.

- b. The site shall be of sufficient size to accommodate the pumping facilities and to permit the turn-around of service vehicles.

3. Access Road and Turn-Around

- a. The access road and turn-around at the pumping station shall have a paved surface. The minimum width of the paved surface of the access road shall be 12 feet and the access road and turn-around shall be constructed to the following minimum requirements:

Formed, shaped and compacted subgrade

DGSA base course - 6" thick

Bituminous concrete binder course - 3" thick

Bituminous concrete wearing course - 1 1/2 " thick

- b. The paved area within the fenced area must be large enough and be designed so as to allow the turn-around of a single unit utility vehicle with a wheelbase of 20' and width of 8'-6".

4. Fencing and Lighting

- a. The site shall be fenced with vinyl-coated chain link fence with barbed wire 6'-0" high with sliding/rolling link fence gate and personnel gate. The personnel gate must be separate from the sliding/rolling gate. Locking devices must be provided on both gates.
- b. Barbed wire, conforming to ASTM A121, shall consist of two 12 ½-gauge twisted line wires with 14-gauge round aluminum wire barbs, having 4 points and spaced 5 inches on center. Line wire shall have a vinyl coating to match the fence chain link. Barbed wire support arms shall be single arm, for 3 strands of barbed wire and be at an angle of 45 degrees, with the top strand of barbed wire being 12 inches above and 12 inches out from the fence line.
- c. The site shall be provided with overhead exterior lighting.

5. Flow Metering

- a. A magnetic flow meter capable of continuously recording pumped flows shall be provided.

6. Water Supply

- a. Where public water supply is available, furnish and install a 1" diameter metered water service terminating at a frost-proof yard hydrant in the case of a submersible type pumping station, and terminating inside the drywell in the case of a wetwell/drywell pumping station. A back flow preventer shall be provided inside the building as required by the County. Outdoor installations of the backflow preventer shall not be permitted. Service shall include all fees and charges for the provision thereof.
- b. Where public water supply is not available, furnish and install a well and well pump with all controls, power supply, frost-proof hydrant, and necessary appurtenances. The well and well pump must be capable of producing a minimum of 5 gpm at a pressure of 50 – 70 psig at the hydropneumatic tank.

7. Power Supply

The power supply for each new pump station shall be a three-phase service from the electrical utility company. Services shall be 208/120 Volts or 480/277 Volts, wye-grounded. Delta-type services including open-delta are prohibited unless required by the electric utility and reviewed/approved by the Engineer on a case-by-case basis.

Additionally, all new pump motors shall operate on three-phase power. Phase converters shall not be allowed. Any exceptions to this requirement must be reviewed and approved by the Engineer on a case-by-case basis.

8. Bypass Pumping Connection

A tee with a blind flange shall be provided on the pump discharge piping to allow for future bypass pumping operations. The blind flange shall be tapped for a 6" MPT connection.

C. MATERIALS AND EQUIPMENT

1. Description of Equipment

The Applicant shall furnish a complete description of all equipment to be supplied including manufacturer's information and relevant pump characteristic curves based on laboratory tests of existing similar pumps. The curves shall show the capacity, head, efficiency, and brake horsepower throughout the head and capacity range.

2. Spare Parts and Tools

- a. The Applicant shall furnish one complete set of all tools that are necessary for the maintenance and repair of the pumps. One pressure grease gun for each type of grease required for pumps and motors shall be furnished.
- b. Spare parts shall consist of one extra set of ball and/or roller bearings, two sets of mechanical seals for each pump, and one extra shaft sleeve for each pump size.

3. Pipes and Fittings

Suction and discharge piping shall be Class 52 (min) ductile iron: ANSI A21.50 and ANSI A21.51. Fittings shall be gray iron or ductile iron: ANSI A21.10, up to 12" inclusive, 250 psi rated. Flanged joints shall be used inside structures. Mechanical joints shall be used for buried pipe.

4. Valves

All valves of the same type shall be provided by the same manufacturer.

a. Plug Valves

- (1) Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at the rated pressure. The disc shall be completely out of the flow path when open. Plug valves specified herein shall be Millcentric by Milliken or equal.
- (2) All size plug valves shall have a minimum port area of 80 percent.
- (3) Valves shall be rated at minimum 175 psi WOG (water, oil and gas) working pressure for sizes 4 inch to 12 inch inclusive and at minimum 150 psi WOG working pressure for sizes 14 inch and larger.
- (4) All plug valves under this paragraph shall be performance, leakage, and hydrostatically tested in accordance with AWWA C504, except as modified herein. At the above rated minimum working pressures, the valves shall be certified by the manufacturer as permitting zero leakage for a period of at least 30 minutes with pressure applied to the seating face.
- (5) Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A126, Grade B, or of ductile iron, ASTM A536 and of the top entry, bolted bonnet design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts, and washers shall have Type 316 stainless steel hardware.
- (6) The valve disc shall be cast iron ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65 45-12, be removable without removing the valve from the line and have an integral upper and lower shaft which shall have seals on the upper and lower journals to prevent entrance of solids into the journals.
- (7) Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve or shall have self adjusting packing.

(8) The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded in high nickel content overlay seating surface in the body.

(9) Discs shall have a full resilient facing of neoprene or Buna N.

b. Check Valves

(1) The valve shall be designed for a minimum working water pressure of 150 psi.

(2) The valve shall be iron body, bronze mounted, full opening swing check type with bolted cover, stainless steel hinge and malleable iron clapper arm. Disc shall be of cast iron with bronze seat ring.

(3) Valves less than 10" diameter shall be furnished with outside lever and weight.

(4) Valves 10" diameter and larger shall be furnished with outside lever and spring.

5. Control Building

All electrical controls (including automatic transfer controls) shall be mounted permanently in a building. The building shall also house the pump control panel and the backflow preventer, meter, and hose bibb for installations using public water. The building shall be a masonry type building with split face block exterior blending aesthetically with the surrounding environment. Interior walls shall be of block construction; dry wall material shall not be allowed. Construction details of the building shall be subject to approval by the City. Neither temporary structures nor fiberglass housings will be accepted.

D. STATION CONSTRUCTION

1. Wetwell/Drywell Type Pumping Stations

a. General

The station shall be designed and constructed in accordance with the requirements of MDE, NFPA, OSHA, and the Maryland Department of Labor, Licensing & Regulation.

b. Pumping Facilities

(1) A minimum of 2 pumps (one duty, one standby) shall be provided and installed. Pumps shall be of the non-clog type capable of passing a sphere with a minimum diameter of 3 inches. Pump casing shall have built-in suction elbow. Each pump shall be close coupled and shall have two sets of ball bearings designed for both radial and vertical thrust.

- (2) The pump shaft shall be sealed by self-aligning, double tandem mounted mechanical seals immersed in an oil bath chamber. Seals shall be stainless steel construction with a carbon rotating seal face and stationary ceramic seal face on the upper seal, and silicon carbide rotating seal face and silicon carbide or tungsten carbide stationary seal face on the lower seal.
- (3) A manually-operated brass valve shall be provided to vent the pump volute.
- (4) Pumps shall be as manufactured by Flowserve.

c. Motors

- (1) The pump motors shall be specifically built NEMA P base, TEFC enclosure, induction type, suitable for 3-phase, 60 Hz, 208 or 460 Volt AC electrical service. The motors shall have a service factor of 1.15 when operated on sinusoidal power and 1.0 when operated on a variable-frequency source. They shall have normal starting torque and low starting current, as specified for NEMA Design B characteristics. The motors shall not be overloaded at the design condition, nor at any head in the specified operating range.
- (2) Motors shall have Class F insulation, Class B temperature rise, 40° ambient. Insulation shall be of non-hygroscopic materials which resist moisture and are fungus-resistant.
- (3) Each motor shall have oversized, grease-lubricated ball bearings with the thrust bearing at the bottom locked in position to eliminate shaft end-play. The motor shaft shall be solid stainless steel.
- (4) The motor-pump shaft shall be centered, in relation to the motor base, within 0.005. The shaft run-out shall be limited to 0.003.
- (5) A special varnish treatment shall be applied to the stator windings and rust preventative compounds shall be used to coat the rotor and stator air gap surfaces and protect the motor against corrosion.
- (6) Motors installed in dry-wells or outdoors shall be equipped with integral 120 Volt AC space heaters to prevent condensation in the motor windings when the motor is offline.

d. Dehumidifier

The Applicant shall install an automatic refrigeration type dehumidifier to maintain the relative humidity of the air in the pump chamber as low as possible. The dehumidifier shall be capable of removing three gallons of moisture per twenty-four hours, and shall be automatically controlled by an adjustable thermostat and a panel-mounted humidistat. The condensation shall drain to a sump.

e. Sump Pump

The Applicant shall install in each pumping station a submersible sewage or grinder sump pump with motor mounted directly above the impeller. The volute casting shall have feet to support the impeller entrance the proper distance above the bottom of the sump. The pump shall have a minimum capacity of 100 gpm. The pump shall be controlled by a level control switch, capable of operation on a 2" differential water level. It shall discharge to the wetwell through a 1-1/4" - 2" pipe with two check valves and a gate valve within the pump chamber.

f. Mechanical Ventilation

Mechanical ventilation shall be provided for the pump chamber and wetwell. The equipment must be capable of providing the number of air changes per hour as dictated by the requirements of NFPA, MDE, and OSHA.

g. Wiring

The pumping station control panel shall be completely wired at the factory, except for the power feed lines, and shall be in accordance with NFPA 70 (National Electric Code). All wiring in the pumping station shall be color-coded as indicated on the wiring diagram. All wiring outside the panel shall be in conduit, 3/4" minimum, except for 115 volt accessory items which are provided with a connecting insulated service cord by the manufacturer. Accessory items such as the sump pump, dehumidifier and air compressors shall be plugged into polarized, grounded convenience outlets, located close to their installed position so that such items can be readily removed and serviced if necessary.

Conduit shall be rigid galvanized steel only in indoor dry (non-process) areas and PVC where buried (Schedule 40 if concrete encased, Schedule 80 if direct buried). Conduit in other areas including conduit outside and in process areas shall be PVC-coated rigid galvanized steel.

Conduit seal-off fittings shall be installed per NEC Article 501 requirements to minimize the passage of gases/vapors and prevent the passage of flames thru the conduits.

Outlets in wet, damp, process, or outdoor areas shall be weather-protected and GFCI-type. Daisy-chaining GFCI outlets is prohibited.

h. Heater

Electrical unit heaters shall be installed in the station and sized to maintain a minimum ambient temperature of 60° F in the drywell. Heaters shall be thermostatically controlled. The heater shall not be placed within two (2) feet of the control panel and electrical equipment.

i. Station Painting

In wetwell/drywell pumping stations the following shall apply:

- (1) Metal Surfaces: All motors, pumps, bases, brackets, ladders, piping and steel supports shall be properly primed and painted with two coats of rust inhibitor paint in strict accordance with the manufacturer's recommendations.
- (2) Plastic Surfaces: One coat of epoxy primer followed by one coat of acrylic urethane.
- (3) Concrete and Masonry Walls and Ceilings: One coat of epoxy primer followed by one coat of washable enamel paint.
- (4) Wetwells: Paint all surfaces with sulfide resistant system such as Sauereisen Sewergard - Trowelable No. 210 or approved equivalent.

All paint, painting procedures and application methods shall be as recommended by a reputable paint manufacturer and approved by the City.

2. Submersible Type Pumping Stations

a. General

A minimum of two pumps (one duty, one standby) must be provided and installed. The station, including pump and valve chambers, manholes, meter pits, and other structures constructed below grade shall be watertight and must meet current ASTM Specifications. A separate valve chamber must be provided.

b. Wetwell and Cover

The wetwell shall be of reinforced concrete and shall be provided with a hinged aluminum cover of non-skid pattern. The cover shall be large enough to comfortably accommodate the pumps. The cover shall have angle frame with rectangular opening of sufficient size to permit easy removal of the pumps. Cover shall have a hold-open bar that can be locked in open position, and shall have a lock that uses a key or special insert to open. All hardware shall be 316 stainless steel. All interior concrete surfaces shall be lined with either a PVC or HDPE liner as specified in SECTION 7 - MANHOLES.

c. Valve Chamber

- (1) A separate valve chamber shall be provided on the discharge side of the wetwell. The valve chamber shall accommodate a check valve and a plug valve for each pump, and shall be large enough to comfortably accommodate the valves and fittings.

- (2) A NEMA 4X limit switch shall be provided on each check valve to signal open/close operation. The switches shall have N.O. (normally open) and N.C. (normally closed) contacts rated 120 Volts AC, 10 amps and 24 Volts DC, 1 amp minimum. These switches shall be connected to the pump fail circuitry.
- (3) The valve chamber shall be provided with an aluminum hatch cover with a non-skid pattern.
- (4) Chamber shall be minimum 6'-6" deep with aluminum access ladder with rungs at 12" on center or steps of ½ " reinforcing bar encased with copolymer propylene. A 3" diameter drain shall be provided from the floor of the chamber to the wetwell. The floor shall be sloped towards the drain. The drain shall have a check valve to prevent backflow from the wetwell in case of high water level in the wetwell.
- (5) A 120 Volt AC single-phase GFCI receptacle shall be provided in the valve chamber for operation of a dehumidifier.

d. Meter Chamber

- (1) A separate meter chamber shall be provided on the discharge side of the valve chamber. The valve chamber shall accommodate a magnetic flow meter and restrained dismantling joint on the downstream side of the meter. A buried plug valve and box shall be installed on the downstream side of the meter chamber.
- (2) The meter chamber shall be provided with an aluminum hatch as manufactured by USF Fabrication, Inc., Bilco, Halliday Products, or approved equal. Chamber shall be a minimum 6'-6" deep precast or reinforced concrete structure with aluminum access ladder with rungs at 12" on center or steps of ½ " reinforcing bar encased with copolymer propylene. A 3" diameter drain shall be provided from the floor of the chamber to the wet well. The floor shall be sloped towards the drain. The drain shall have a trap and check valve to prevent backflow from the wet well in case of high water level in the wet well.
- (3) A 120 Volt AC single-phase GFCI receptacle shall be provided in the valve chamber for operation of a dehumidifier.

e. Lift-out Rail System

Station shall be provided with a rail system to facilitate easy removal of the pumps. Rails shall be made of stainless steel and are to be firmly fixed with stainless steel rail supports and hardware to the wall of the wetwell or the frame of the cover. However, the rails shall not interfere with the opening and closing of the cover.

f. Submersible Pumps

- (1) Casings: Pump casing and motor casing of ASTM-A48 cast iron. Pump casing of the single volute type, ribbed to prevent excessive deflection and hydrostatically tested to twice the design head, or 150% of the shutoff head, whichever is greater. Volute sized at all points to pass solids which can pass through the impeller and internally finished to provide smooth, unobstructed flow.
- (2) Impeller: Non-clogging type of ASTM-A48 cast iron, statically, dynamically, and hydraulically balanced, capable of passing 3" solids. Key seat the impeller and secure it to the shaft by a hex head impeller nut.
- (3) Pump Shaft: Stainless steel of sufficient strength and size to safely transmit the maximum torque developed by the drive unit. Shaft sized to provide rigid support of the impeller and prevent excessive vibration.
- (4) Pump Shaft Bearings: Ball or roller type, oil lubricated. Upper bearings to support full dead load and hydraulic thrust. Design bearings with a 20,000-hour B10 minimum bearing life per AFBMA test procedure.
- (5) Shaft Seals: Provide each pumping unit with a double mechanical seal, running in an oil-filled reservoir, composed of two separate lapped faced seals, each consisting of one stationary and one rotating tungsten carbide ring each held in contact by a separate spring, so that the outside pressure assists spring compression in preventing the seal faces from opening.
 - (a) Protect the compression spring against exposure to the pumped liquid. Seal the pumped liquid from the oil reservoir by one face seal and the oil reservoir from the motor chamber by the other.
 - (b) Equip each pumping unit with an electronic liquid sensing device to prevent damage to the motor in the event of a shaft seal failure.
- (6) Pump Motor: Provide a motor having Class F insulated windings (which are moisture resistant) designed for Class B temperature rise housed in watertight casing. The motor shall have cooling characteristics suitable to permit continuous operation in a totally, partially, or non-submerged condition. Motors shall be rated Class I, Division 1, Group D hazardous environments.
- (7) Pump Accessories: Provide the following accessories with each pumping unit.
 - (a) Stainless steel chain of adequate strength and length to permit raising of the pump to the outside of the wetwell for inspection and removal. Chain must have large secondary links attached at minimum 10' intervals.
 - (b) Stainless steel guide rails.
 - (c) Stainless steel upper guide rail brackets.

(d) Pump mooring plate with discharge elbow and lower guide rail support brackets.

(e) Power and control cable of adequate length.

(8) Pumps are to be manufactured by Flygt or KSB.

E. FLOW METER

1. A flow metering device which is capable of continuously recording pumped flows and displaying instantaneous flow rate and totalized flow shall be provided. Meter shall be a WaterMaster magnetic flowmeter by ABB, Proline Promag W 400 by Endress + Hauser, or approved equal. It shall have a polyurethane liner; ANSI 150, 304 stainless steel flanges and metering tube; 316 SST bullet nose type electrodes; Class I, Division 2, Group D Hazardous Location, safety rating; operating on 120 Volts AC, 60 Hz power; 120 Volts AC, 60 Hz remote mounted electronics; occasional submergence enclosure; process temperature to 190° F; 4-20 mA dc output signal. Meter shall be factory calibrated with a copy of the report in the O & M manual. Meter grounding shall be in accordance with the manufacturer's recommendations. Meter shall be capable of running empty indefinitely without damage to any component. Meter shall also have communication capabilities to allow for output of flow signal via future telemetry by others.
2. A flow converter / transmitter shall be furnished with the meter. It shall operate on 120 Volts AC, 60 Hz power, have an isolated 4-20 mA output into a 0 to 1,000 ohms; with a NEMA 4X wall mount; connecting signal cable between flow meter and signal converter; and a seven digit, non-reset totalizer on the face of the enclosure and a scalable pulse output to drive the totalizer with a multiplier power of 10. Mount transmitter outside the classified area, adjacent to the pump control panel.

F. ALARM SYSTEM

1. The pump station shall be equipped with an Allen Bradley Compact Logix controller and Phoenix Plate radios for transmitting alarms. Alarms shall be handled by a 4-20MA analog output module. Alarms will be transmitted to the City's central controller located at Well 8. The following alarms should be monitored and transmitted.
 - a. Wetwell/Drywell Type Pumping Stations
 - Power failure
 - High wetwell
 - Low wetwell
 - Water in drywell

Generator failure

Louver failure

Pump failure

b. Submersible Type Pumping Stations

Power failure

High wetwell

Low wetwell

Seal Leak

Generator failure

Louver failure

Pump failure

2. The control system shall also be capable of receiving input from the central controller for remote control of the pump station. Inputs from the central controller shall override the local controller at the pump station. Inputs shall be handled by a 4-20 MA input module.
3. The Applicant is responsible for furnishing and installing all necessary equipment and contracting with the City's system integrator for connection to the City's existing telemetry system.

G. Controls

1. Level Controls: One of the following level sensors shall be provided as the primary input to the control system.
 - a. Ultrasonic Level Sensors: Ultrasonic level sensors shall be non-contact type with the transducer encapsulated in Kynar or some other chemical- and corrosion-resistant housing. Transducers shall be capable of being completely submerged without damage.
 - b. Pressure Transducers: Pressure transducers shall have a transmitter assembly of 316 stainless steel or titanium with a bottom diaphragm. Sensors shall be suspended by cable. Cable shall include a vent tube for the transducer. Sensor shall be suspended with a tension-relieving mounting clamp from a four-inch (100 mm) flange. Clamp and flange shall be 316 stainless steel.

3. Mercury Float Switch Controller: Provide a backup control system consisting of mercury float switches and other necessary appurtenances. The floats shall be sealed float-type mercury switches and shall be sealed in a solid polypropylene shell. The support wire shall have a heavy neoprene jacket. A weight shall be attached to the cord above the float. Two float switches shall be used for backup low level and backup high level control. The float switches shall hang in the sump and be supported by a stainless steel bracket and cord snubber to allow flexibility in setting the levels. All mounting structures and hardware shall be 316 stainless steel.
4. Pump Controls: One circuit breaker disconnect unit per pump with magnetic trip sized for individual motor protection. This unit shall provide the maximum electrical motor protection available, serving as a circuit breaker and manual disconnect switch.
 - a. One across-the-line starter per pump, sized in accordance with NEMA horsepower standards.
 - b. One N.O. auxiliary contact for run status and one N.C. auxiliary contact for stop status, overload relay, and all other controls and accessories necessary for proper operation and protection.
 - c. Level sensing circuitry utilizing intrinsically safe relays and barriers for safe operation of the instruments located in hazardous areas.
 - d. Solid state alternator for duplex controls.
 - e. Individual toggle type selector switches to provide "Hand-Off-Auto" control of each pump.
 - f. AC control power transformer, protected by circuit breakers or fuses on both the primary and secondary.
 - g. Terminals shall be provided for connection of the level sensors.
 - h. A removable dead-front panel shall be provided to protect the operator.
 - i. All operator controls, toggle switches, circuit breakers, etc. shall be accessible without removing the dead-front panel.
 - j. NEMA 12 enclosure with latch mechanism. Panel shall receive a single incoming 208 or 480 Volt three-phase power supply from the station electrical system. The enclosure shall have a main disconnect and individual pump disconnects, all operable without opening the enclosure.
 - k. A relay that automatically reconnects the control circuit to the lag/alternate pump if the lead pump fails.

- l. High level and low level alarm relays with dry contacts and terminals shall be included for remote monitoring.
- m. Pump running (red) and stopped (green) LED pilot lights mounted on operator's control panel.
- n. Non-resettable running time meters mounted on operator's control panel.
- o. Seal leak detector for each pump with dry contacts for alarming.
- p. 3-phase power monitor with adjustable settings, with interlocks to stop pumps for low voltage, single phasing, and phase reversal.
- q. A "Hand-Off-Auto" selector switch provided for each of the two pumps controlled with the following operation:
 - (1) Hand Position: In this position, the pump controlled by the switch will run regardless of the wetwell level. The pump will continue to run until the switch is turned to "Off" or "Auto".
 - (2) Auto Position: In this position, the operation of the pumps is controlled automatically by the level sensors in the wetwell based on pre-determined set points as follows:
 - (a) Low-low level – The control circuit is placed in standby mode when the liquid level rises to the lowest level that is a redundant cutoff.
 - (b) Low level – As the level continues to rise, the control circuit is energized when the low level is reached.
 - (c) High level – As the level continues to rise, the first (lead) pump will start. In this step, the pumps will alternate on successive cycles. If Pump No. 1 starts first on one cycle, Pump No. 2 will start first on the next cycle. This insures equal operating time and wear on each pump.
 - (d) As the level in the well is pumped down, the pump(s) will continue to operate until the level drops just below the low level.
 - (e) Lag level – If the level in the well continues to rise with one pump in operation, the second pump will be turned on at the lag level.
 - (f) High-High level – If the water continues to rise above this level, a high level alarm will be activated in the control system.
 - (3) Remote Control: The control system shall be configured to receive input from the City's main controller for operation. Commands received by this controller shall override the Hand-Off-Auto selection and allow City personnel to remotely turn

pumps on and off regardless of current switch selection. Due to the potential that a communication failure could prevent the operator from disabling the pumps remotely, pumps shall be prevented from operating in this way below the low level as defined above.

H. TESTS

1. Field tests shall be carried out at the expense of the Applicant to insure that pumps and all equipment meet the design criteria. The City's personnel will witness the field tests.

I. EMERGENCY POWER

1. The Applicant shall install a diesel emergency generator set and automatic transfer switch to run the pump and all equipment within the station upon loss of normal power.
2. The system components shall be new equipment of current design, not one-of-a-kind, and consist of a state-approved engine-driven, electric generator with mounted start-stop controls, an automatic load transfer control, fuel, oil and antifreeze, and necessary accessories. All components shall be completely built, tested and shipped by a manufacturer who has been regularly engaged in the production of such equipment for the past ten years and who has a local parts and service facility. The generator shall be as manufactured by Kohler, Caterpillar, Cummins, or approved equal.
3. The generator shall be provided with a weatherproof, NEMA 3R outdoor housing and shall be mounted on a welded steel skid base, which in turn shall mount on 6" high I-beams securely mounted to the frame and a concrete pad. The pad shall be sloped to prevent standing water from accumulating under the generator set. The starting batteries shall be placed on a cast iron rack inside the housing.
4. All required anchor bolts shall be furnished and installed.
5. The muffler shall be a hospital-grade silencer attached to the exhaust line by 125-lb. standard pipe flanges. The exhaust line shall contain a condensate trap with drain cock at the first point of rise in the line from the engine. Only long radius elbows shall be used in the exhaust line. A stainless steel flexible pipe shall connect the engine to the exhaust system.
6. Provide thermostatically controlled heaters for both engine jacket water and lubricating oil systems set to maintain 90 degree F temperature in both systems with an ambient temperature of zero degrees. In addition, a battery heater shall also be provided to maintain the battery temperature at a minimum of 50 degrees F and to automatically shut off at 90 degrees F. Provide manual switches to disconnect the heaters when not required.
7. Provide a circuit breaker with the generator. Breaker shall be rated to handle the generated fault currents and shall be one of those listed by the transfer switch

manufacturer. Breaker shall have the required number of poles and current rating capable of handling required load. Breaker shall be mounted within the generator enclosure

8. Provide generator control panel with the following: voltmeter, ammeter, selector switch, start controls, voltage level adjustment rheostat or digital control, oil pressure gauge, fault indicators for safety shutdown, "Auto/Manual" switch, water temperature gauge, running time meter, panel face illumination from the battery, generator failure output contacts.
9. Provide base-mounted diesel fuel tank of sufficient capacity to sustain a minimum of 24 hours running at full load, fuel gauge, fuel lines, threaded vent opening and a full tank of diesel fuel.
10. A current-limiting battery charger shall be furnished to automatically recharge the starting batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, and fused AC input. AC input voltages shall be 120 volts. Amperage output shall be no less than 5 amperes. Charger shall be LaMarche Manufacturing Company, Magnevolt, or approved equal.

J. TRANSFER SWITCH

1. The automatic transfer switch shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power. The switch shall afford complete protection. The switch shall be rated as suitable for all classes of loads without de-rating, either open or enclosed.
2. The transfer switch shall automatically transfer its load circuit to the generator after failure of its normal supply. Upon restoration of the normal supply, the transfer switch shall automatically retransfer its load circuits to the normal supply.
3. All pilot devices/relays shall be of the industrial type rated 10 amperes with self-cleaning contacts.
4. Components of the operating mechanism shall be insulated or electrically dead.
5. All electrical equipment or apparatus of any one system must be the product of one manufacturer, or equivalent products of a number of manufacturers which are suitable for use in a unified system. No circuit breaker types are acceptable, nor parts thereof.
6. For complete protection, voltage sensing relays shall be provided to monitor each phase of the normal supply. A drop in voltage in any phase below the predetermined dropout value of the relay shall initiate load transfer. The relay shall initiate retransfer of the load to normal supply as soon as the voltage is restored in all phases beyond the predetermined pickup value of the relay.

7. The transfer switch shall obtain its operating current from the sources to which the load is being transferred.
8. The automatic transfer switch shall also be furnished with the following options:
adjustable 2 to 120 second time delay on normal to emergency; adjustable 0 to 15 second time delay on engine starting; adjustable 12 second to 30 minute time delay on emergency to normal; adjustable 0 to 30 minutes, set at 5 minute time delay for engine cooloff; frequency/voltage relay for emergency source; test switch in cover of switch; normal supply pilot lights, emergency supply pilot light; engine start-stop contacts; relay auxiliary contacts on normal and emergency source, 1 N.O. and 1 N.C.; solid neutral bar assembly; plant exerciser for automatic test operation of plant with transfer of load for pre-selected intervals (adjustable 0-168 hours in multiples of 15 minutes) at least once a week.
9. All accessories and equipment shall be front accessible for ease of maintenance or removal.
10. Transfer switches and options shall be as manufactured by ASCO, Kohler, Cummins or approved equal.

K. LIGHTING

1. The Applicant shall install lamps and accessories as required. Prior to acceptance of building by the City, all fixtures shall be cleaned, free of dust, insects and all foreign matter.
2. The light fixture schedule is as follows:
 - a. Industrial, ceiling mounted LED, 2-lamp, 4-foot linear fixtures. NEMA 4X rated, 120/277 Volts AC Input.
 - b. Outdoor wall-mounted LED, 120/277 Volts, with integral photocell control. 3000K color temperature max.

L. ELECTRICAL UNIT HEATERS

1. Horizontal forced air unit heaters shall be rated for the building size. Mounting brackets designed for either ceiling or wall swivel mounting shall be furnished for each heater. The cabinet shall be of 18 gauge die-formed furniture grade steel. Individual adjustable louvers shall be furnished to provide desired control of discharge air. All metal surfaces of the casing shall be phosphate coated to resist corrosion, with a baked enamel finish.
2. Automatic reset thermal over-heat protection shall be provided.
3. Motors shall be of the totally enclosed fan-cooled continuous duty (TEFC), sleeve bearing type, equipped with built-in thermal overload protection.

4. Fans shall be aluminum, directly connected to fan motor, dynamically balanced and designed specifically for unit heater application.
5. Heaters shall be equipped with built-in comfort control thermostats and necessary control transformers and contactors. Heaters shall be equipped with cord and twist lock plug for connection to receptacle and shall be Chromalox, Berko or approved equal.

M. METAL LOUVERS AND DAMPERS

1. The Applicant shall furnish and install all metal louvers and dampers required for installation in the control building. Separate louver and damper assemblies shall be supplied for each opening, with the louver assembly on the exterior side and the damper assembly on the interior side.
2. The metal louvers shall be of stationary, weatherproof design complete with screens, trim and closure pieces for a complete installation. It shall be the responsibility of the Applicant to check all opening sizes and completely coordinate the installation.
3. The louver frame and blades shall be extruded aluminum section, 6063-T5 alloy. The heads, sills and jambs shall be one-piece structural members with integral caulking strips and retaining beads. All fasteners shall be stainless steel or aluminum. All louvers shall be provided with a ½-inch mesh aluminum bird screen secured by an extruded aluminum frame.
4. Motor-operated dampers shall be furnished for installation on the air intake. This shall be a fully automatic damper with the operating blades in a spring open position and held closed by a motorized operator. In the event of a power failure, the blades shall open. All necessary controls, relays and wiring necessary for a complete working installation shall be furnished and installed. Dampers shall have parallel blades (opposed blades shall not be allowed).
5. Damper frames shall be 6063-T5 extruded aluminum wall thickness with mitered corners. Blades shall be formed aluminum with extruded vinyl edge seal or 6063T5 extruded aluminum with extruded vinyl edge seals.
6. The operating blades for the motorized dampers shall be operated by an electrically-controlled motor operator and shall be designed to fail in the open position. The motor shall be totally enclosed and suitable for operation on 120 Volt, 60 Hz, single-phase power. The unit shall be furnished with all controls and accessories for a complete working installation. The actuator motor shall be sized so that it can open the damper in sufficient time to prevent the formation of a vacuum within the room.
7. The motor-operated intake damper shall be wired for both manual and automatic operation. A selector switch shall be provided for manual open-close operation.

8. A thermostat shall also be provided to automatically open the intake damper on excessive heat build-up within the control building. The thermostat shall have a control range of 70° to 140° F, and shall be by Honeywell, Chromalox or approved equal.
9. A limit switch shall be installed at the intake damper location, and shall be positioned so that the switch is operated by the opening of the damper blades. If the damper and switch do not open after a preset time, a relay shall signal a "damper failure" condition to the alarm system. Limit switch shall be as manufactured by Square D or approved equal.
10. Both louver and damper assemblies shall be free of scratches and blemishes and provided in a baked enamel finish in a color to be selected by the City.
11. The louvers and dampers shall be manufactured by Ruskin, American Warming & Ventilating or approved equal.

N. ELECTRICAL CONSTRUCTION

1. The Applicant shall meet with the electric utility company to determine all requirements at the site for service and metering. Any excess charges by the utilities for furnishing the required service shall be the responsibility of the Applicant.
2. The Applicant shall furnish and install a service pole at each pumping station if the service is overhead. Service conductors and raceways shall be installed from the building underground to the service pole and up the pole terminating in an approved entrance fitting. The power company will furnish and install an overhead service drop to the pole and connect to service conductors. Poles shall be guyed if required to offset pull of power company's service drop.
3. If the service is underground, the Applicant shall furnish and install underground conduit, current transformer cabinet, and meter base. Current transformer cabinet or self-contained meter base, as necessary, shall be mounted on the building. The utility companies will furnish and install the service lateral.
4. A grounding grid shall be provided at the service location (service pole and/or building). Metal raceways, metal enclosures of electrical devices, transformer frames, neutral conductor and other equipment shall be completely grounded in accordance with the NEC. All necessary conduit, conductors, clamps, connectors, etc. for the grounding system shall be furnished and installed by the Applicant.
5. Provide a main service entrance approved disconnect switch with current limiting fuses as required. Heavy-duty type, NEMA 1 enclosure indoors, NEMA 4X enclosure outdoors with padlock attachment; Square D, Eaton, or approved equal.
6. The panelboard shall be rated for the voltage present, dead-front type, lockable with thermal-magnetic bolt-on circuit breakers, neutral and ground bus, typed circuit directory.

7. Surge protection shall be provided on the incoming feeders immediately on the load side of the main disconnect switch, and the grounding lead connected to the grounding system shall be as short as possible. SPDs shall be Square D, Eaton, or approved equal. Surge protection shall also be supplied for incoming telecom lines; Phoenix Contact, Rockwell, or Approved Equal.
8. Light switches to be 20 Amp, 120/277 Volt rated, Industrial type, Legrand Series 20AC or approved equal. If weatherproof, use Legrand WP-1 lever handle weather-sealing cover with FS-type box .
9. Receptacles shall be 20 Amp rated, 120 Volt, two-pole, hard-use rated, grounding duplex, Legrand 5362 or approved equal; ground fault type to be Legrand, specification-grade; if weatherproof use FS box with wet location cover; power outlet receptacle rated as required, heavy-duty, Legrand or approved equal.
10. Underground ducts shall be encased in four inches of concrete. Where conduits pass under roadways, parking lots, or on filled ground, a mat shall be provided in concrete, consisting of two longitudinal #4 bars with #3 ties, 12" on center. Trenches shall be backfilled with clean dirt, thoroughly compacted.
11. PVC Schedule 40 conduit shall be UL listed and as manufactured by Carlon, Sedco or approved equal. All bends in duct lines of 40° and greater shall be manufactured steel elbows of the same size as the PVC ducts. Rigid galvanized conduit shall conform to Federal Specifications WW-C-581E and be UL listed and manufactured by National, Allied Tube & Conduit, or approved equal. PVC-coated conduit shall be UL listed, 40-mil min exterior PVC coating with 2-mil min interior urethane coating, by Robroy (Plastibond), ABB (Ocal), or approved equal.
12. No EMT or IMC shall be permitted.
13. Install sealing fittings, Crouse-Hinds type EYS or EZS, Appleton type EYS or ESU, or approved equal, wherever a conduit passes into a hazardous area or extends between areas having widely different temperatures. Locations and installation shall be per NEC including Article 501.
14. Wires and cables minimum size shall be #12, medium hard drawn copper. Wire shall have Type THWN-2 or XHHW-2 insulation. Wire size of #12 or larger and shall be stranded (except #12 and #10 lighting and receptacle circuits, which shall be solid). All wiring shall be color coded in accordance with current NEC requirements.
15. For wire size #10 and smaller, a solderless type press connector similar to "Buchanan" shall be used with snap-on type nylon insulator; splices of larger sizes of wire shall be made using an indenter type coupling applied with a hydraulic pressure tool.
16. All materials and workmanship shall meet the minimum requirements of the following standards where applicable:

- a. National Fire Protection Association (NFPA)
- b. National Electrical Manufacturers Association (NEMA)
- c. Institute of Electrical and Electronic Engineers (IEEE)
- d. The U.S.A. Standards Institute - Standards & Definitions of Electrical Terms (U.S.A.S.)
- e. National Electrical Safety Code (NESC)
- f. Underwriter's Laboratories Inc. - Standards
- g. OSHA Standards, where applicable, shall also be met, including those for temporary wiring on construction sites.

17. All necessary permits and fees for this work shall be secured and paid for by the Applicant. Inspection shall be by an approved inspection agency licensed by the State of Maryland and final certificate of approval shall be delivered to the City prior to acceptance.

O. START-UP

- 1. The Applicant shall provide the services of fully qualified manufacturer's representatives for services during installation, at start-up, and for instructing the City's personnel in the operation, routine maintenance, and trouble-shooting for all equipment, mechanical and electrical, furnished with the pumping station. Applicant shall full load test the generator for four (4) continuous hours using Applicant-furnished load bank. Notify Engineer 48-hours prior to the test. If testing stops for any reason, correct the problem and start new four (4) hour test. Submit test results.
- 2. The Applicant shall provide five (5) bound copies of a manual fully explaining the operation, routine maintenance and trouble-shooting for equipment. The manuals shall include copies of all shop drawings with all required revisions. These manuals must be submitted to the City for approval prior to acceptance.
- 3. The manuals must include information relative to suppliers of spare and replacement parts.

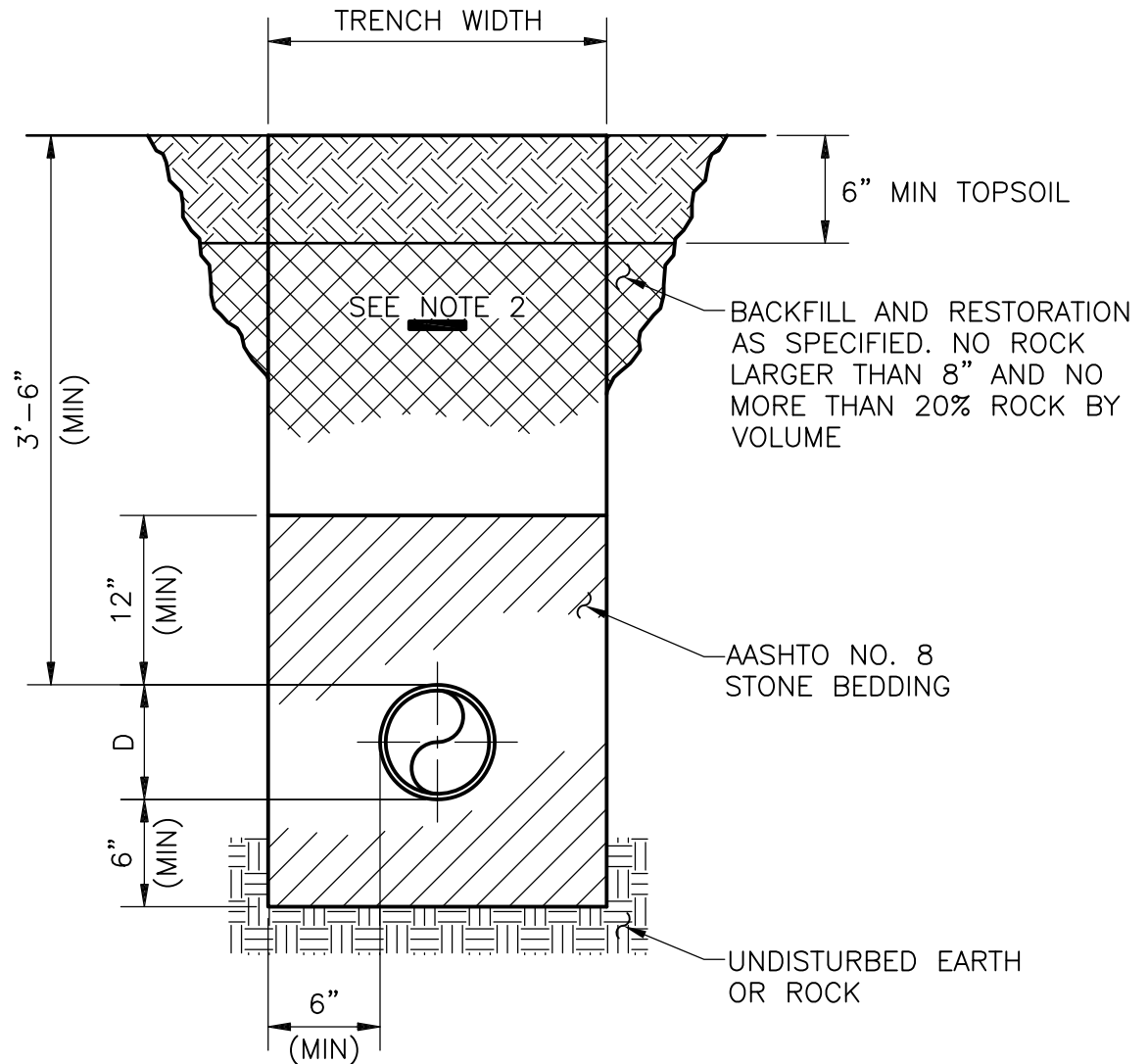
P. DETAIL DRAWINGS

Relevant detail drawings are:

21 Typical Pumping Station Security Fence and Access Gate

END OF SECTION

APPENDIX A
DETAIL DRAWINGS



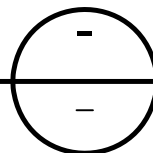
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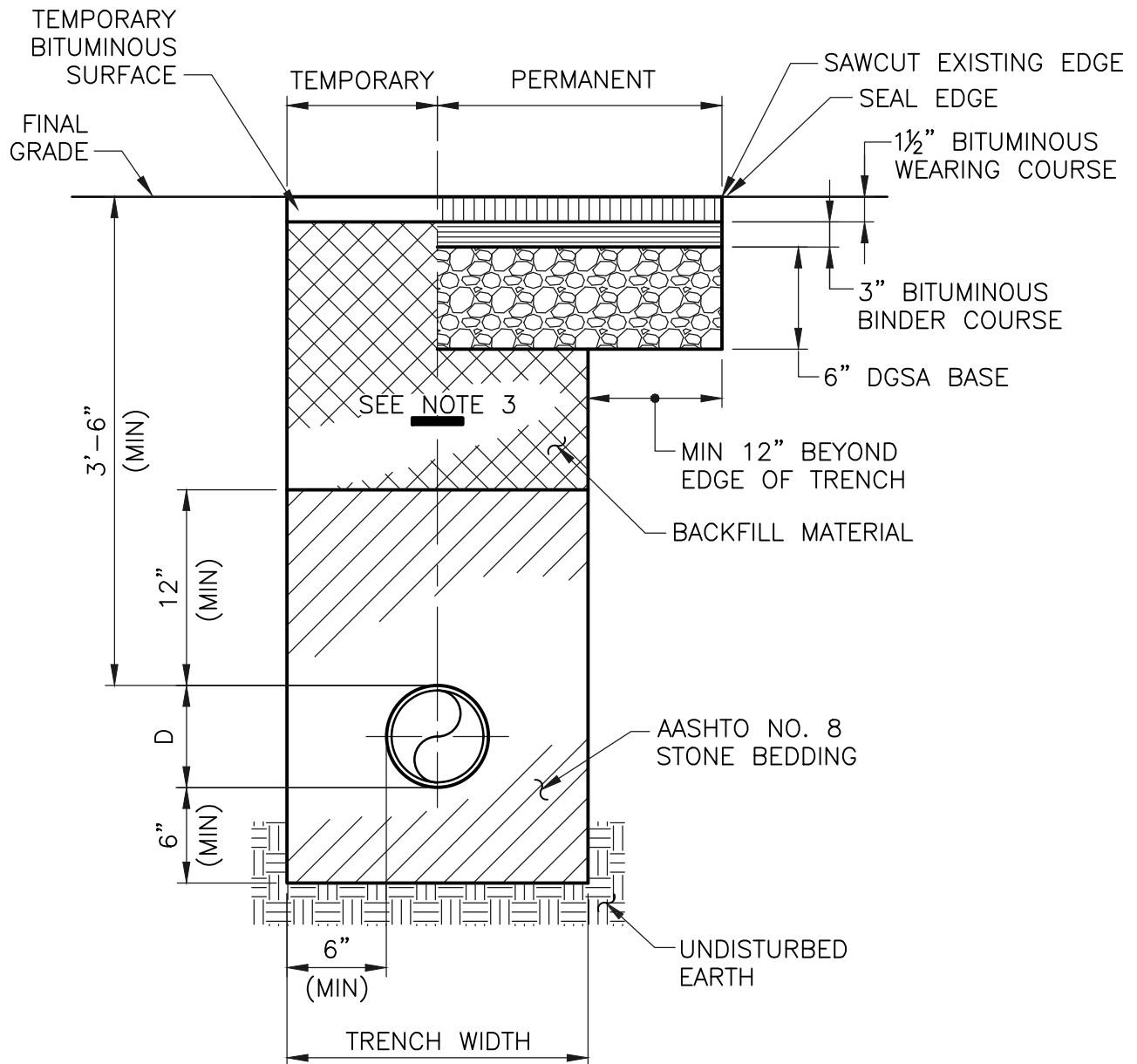
1. TRENCH SIDE SLOPES SHALL BE IN ACCORDANCE WITH OSHA REQUIREMENTS. BEGIN SIDE SLOPES, IF USED, APPROXIMATELY 18" ABOVE TOP OF PIPE (TYPICAL ALL BACKFILL TYPES).
2. ADD MAGNETIC WARNING SAFETY TAPE ABOVE ALL GRAVITY SEWER MAINS, FORCE MAINS AND LATERALS. TAPE SHALL BE PLACED DIRECTLY ABOVE PIPE CENTERLINE, 12-18 INCHES BELOW FINISHED GRADE.

RIGHT-OF-WAY RESTORATION

DETAIL

NO SCALE





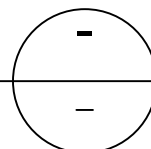
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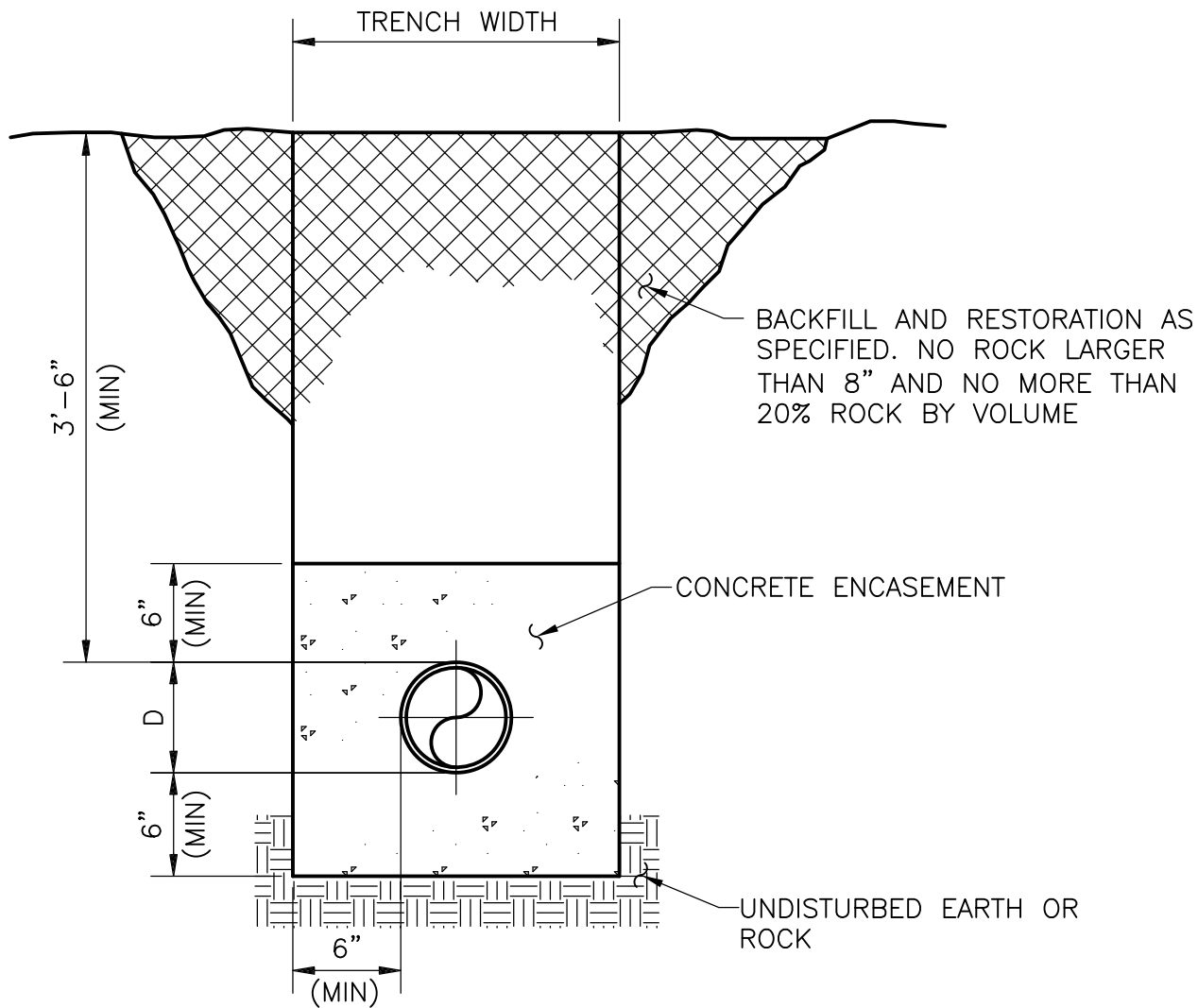
1. BACKFILL & PAVEMENT RESTORATION IN STATE OR COUNTY ROADS SHALL BE AS SPECIFIED BY MDSHA OR CARROLL COUNTY, RESPECTIVELY.
2. BACKFILL & PAVEMENT RESTORATION IN CITY ROADS, ACCESS DRIVES, PARKING AREAS AND LOADING AREAS SHALL BE AS SPECIFIED BY THE ENGINEER. BACKFILL MATERIAL IN EXISTING PAVED AREAS SHALL BE CR-6.
3. ADD MAGNETIC WARNING SAFETY TAPE ABOVE ALL GRAVITY SEWER MAINS, FORCE MAINS AND LATERALS. TAPE SHALL BE PLACED DIRECTLY ABOVE PIPE CENTERLINE, 12-18 INCHES BELOW FINISHED GRADE.

PAVEMENT RESTORATION

DETAIL

NO SCALE





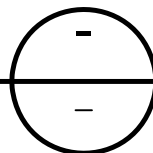
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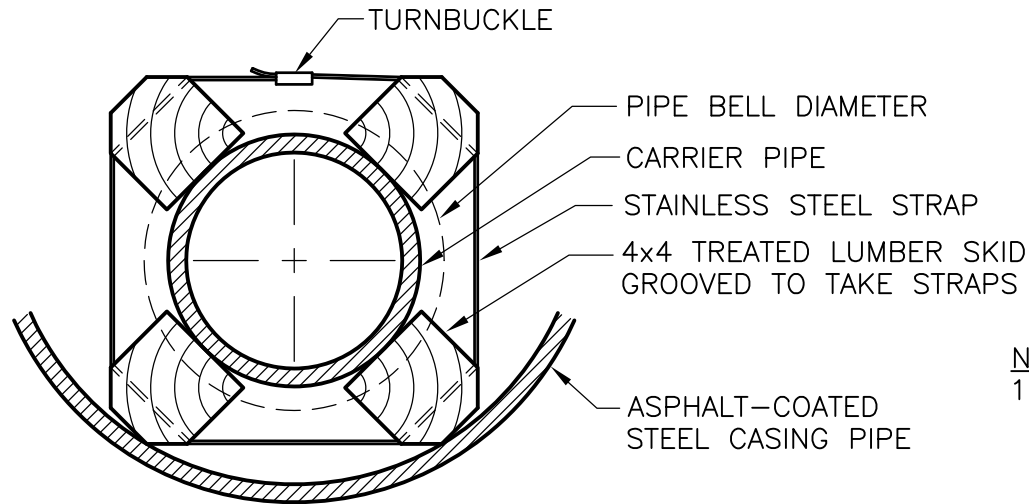
1. TRENCH SIDE SLOPES SHALL BE IN ACCORDANCE WITH OSHA REQUIREMENTS. BEGIN SIDE SLOPES, IF USED, APPROXIMATELY 18" ABOVE TOP OF PIPE (TYPICAL ALL BACKFILL TYPES).
2. CONTRACTOR MUST PROVIDE SOME MEANS OF BRACING TO PREVENT FLOTATION OF THE SEWER LINE PRIOR TO THE POURING OF CONCRETE.

CONCRETE ENCASEMENT

DETAIL

NO SCALE

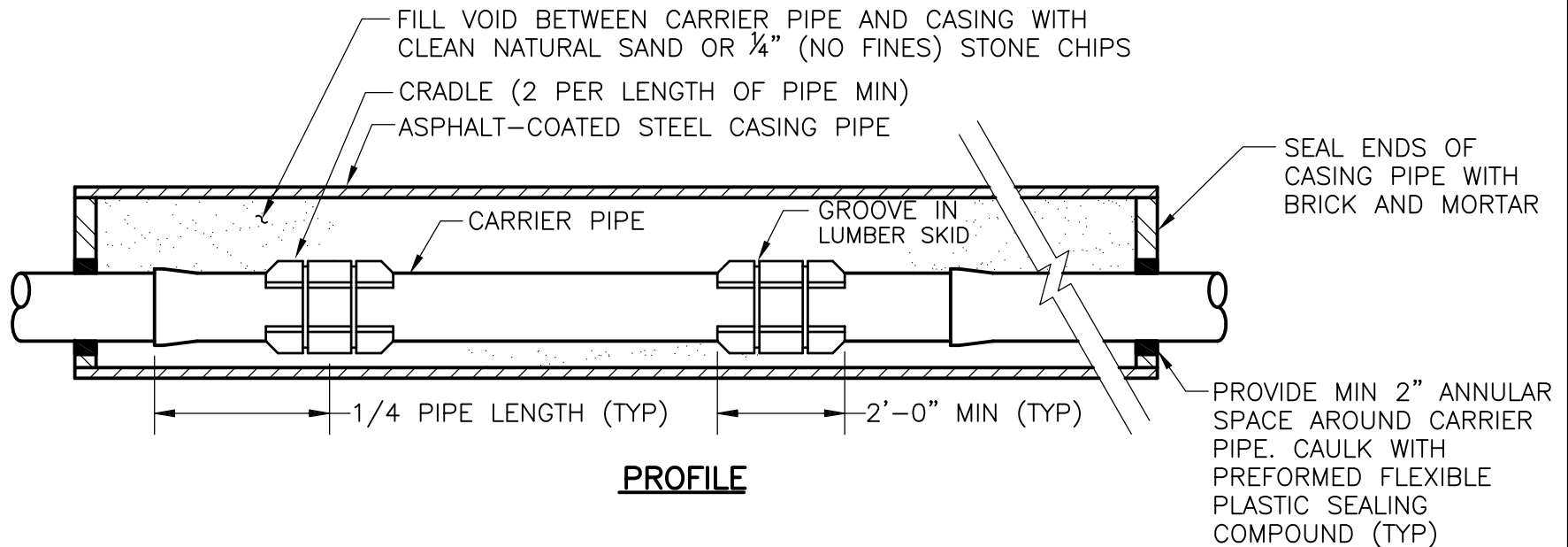




CROSS SECTION

NOTES:

1. FOR PIPES CROSSING STATE ROADS OR RAILROADS ADDITIONAL REQUIREMENTS (IF ANY) IMPOSED BY HIGHWAY OR RAILROAD OWNER MUST BE MET.
2. DIAMETER OF CASING SHALL BE IN ACCORDANCE WITH HIGHWAY OR RAILROAD OWNER'S STANDARDS.

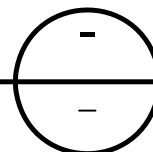


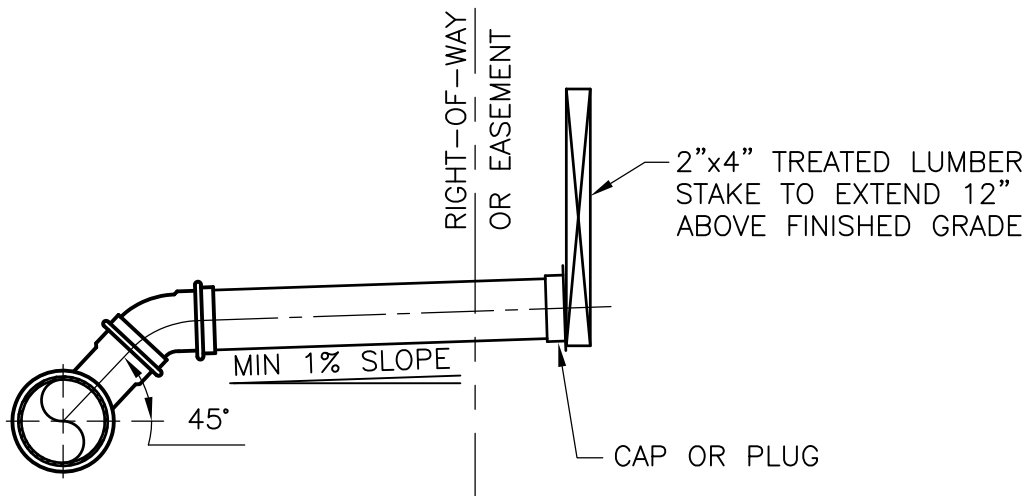
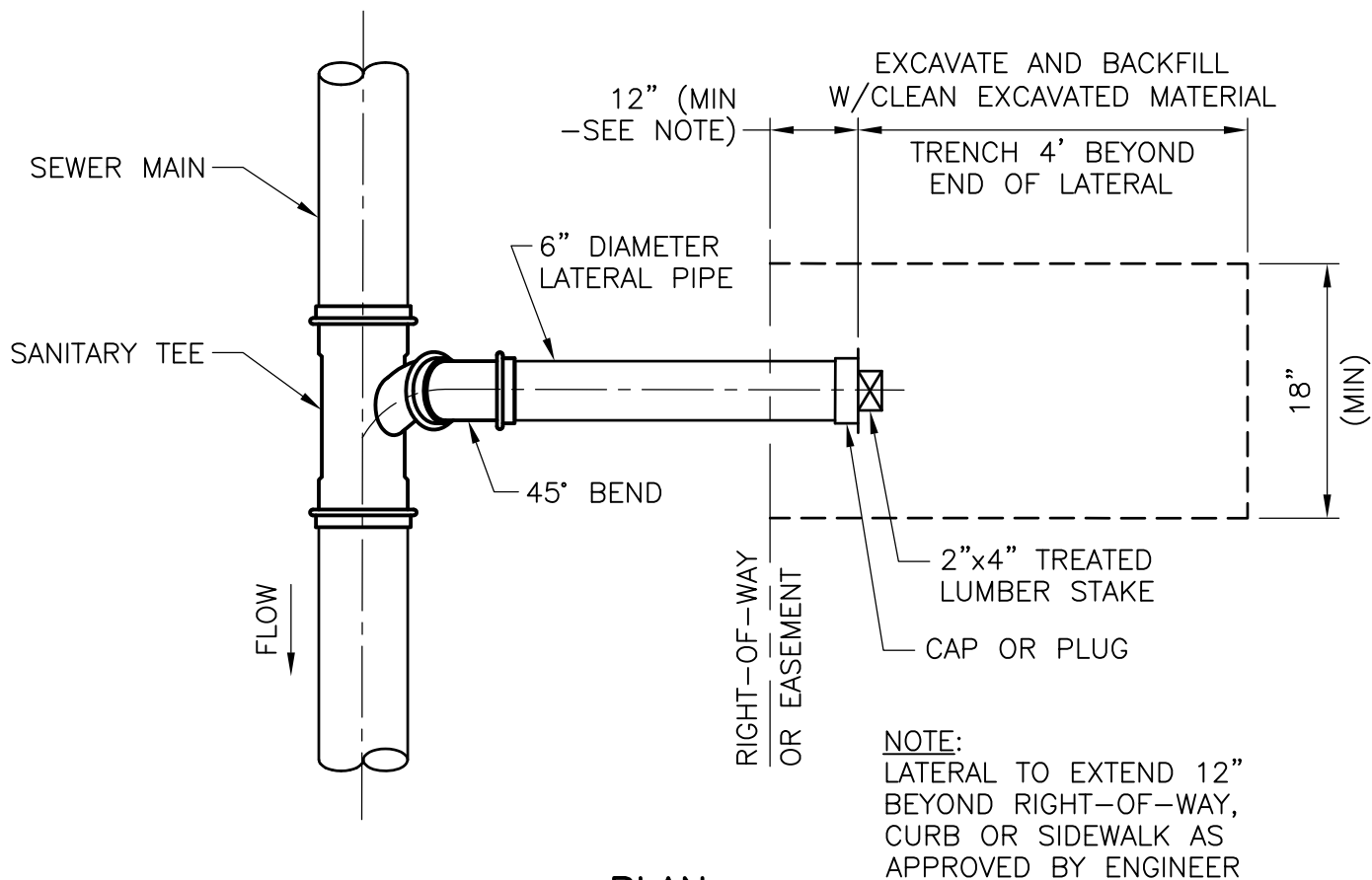
PROFILE

PIPE CRADLE IN CASINGS

DETAIL

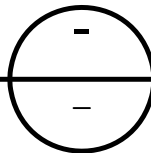
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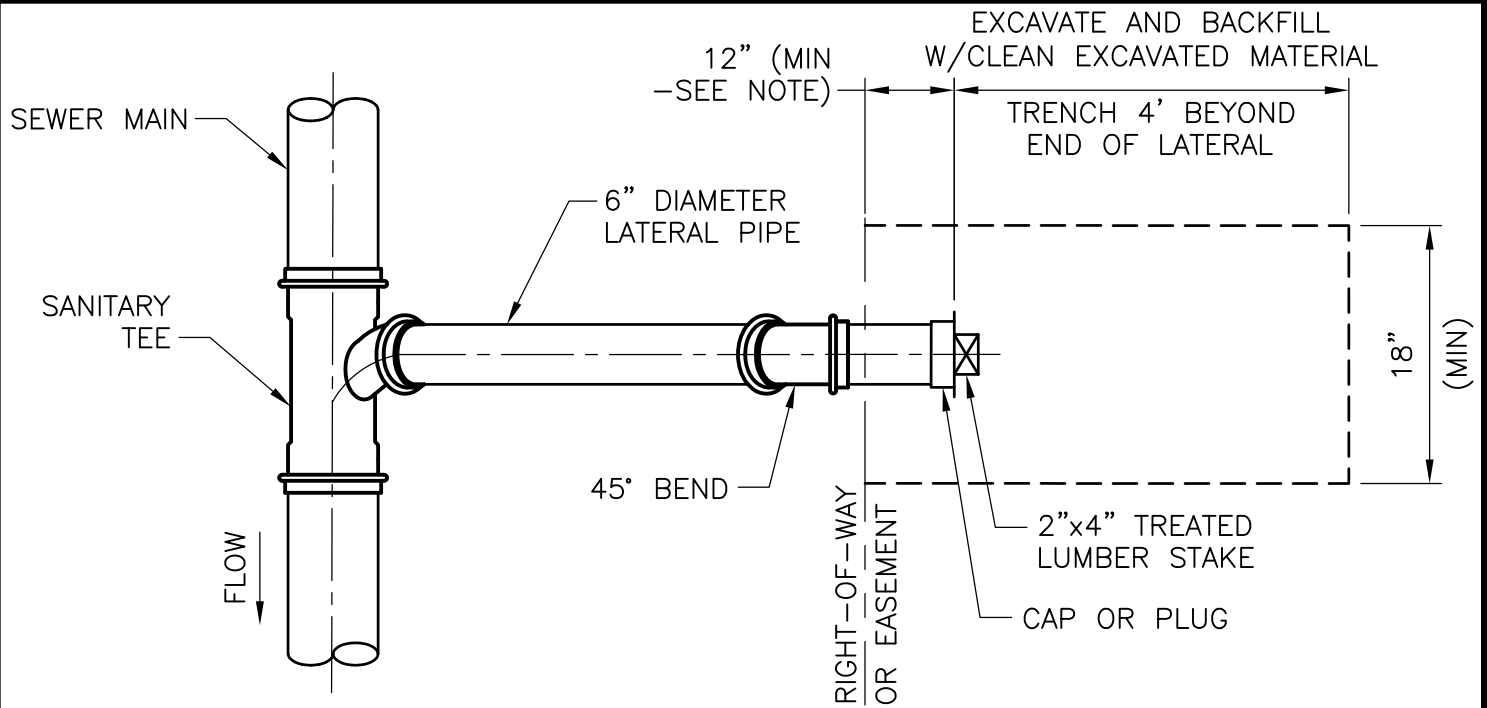




LATERAL CONNECTION
DETAIL

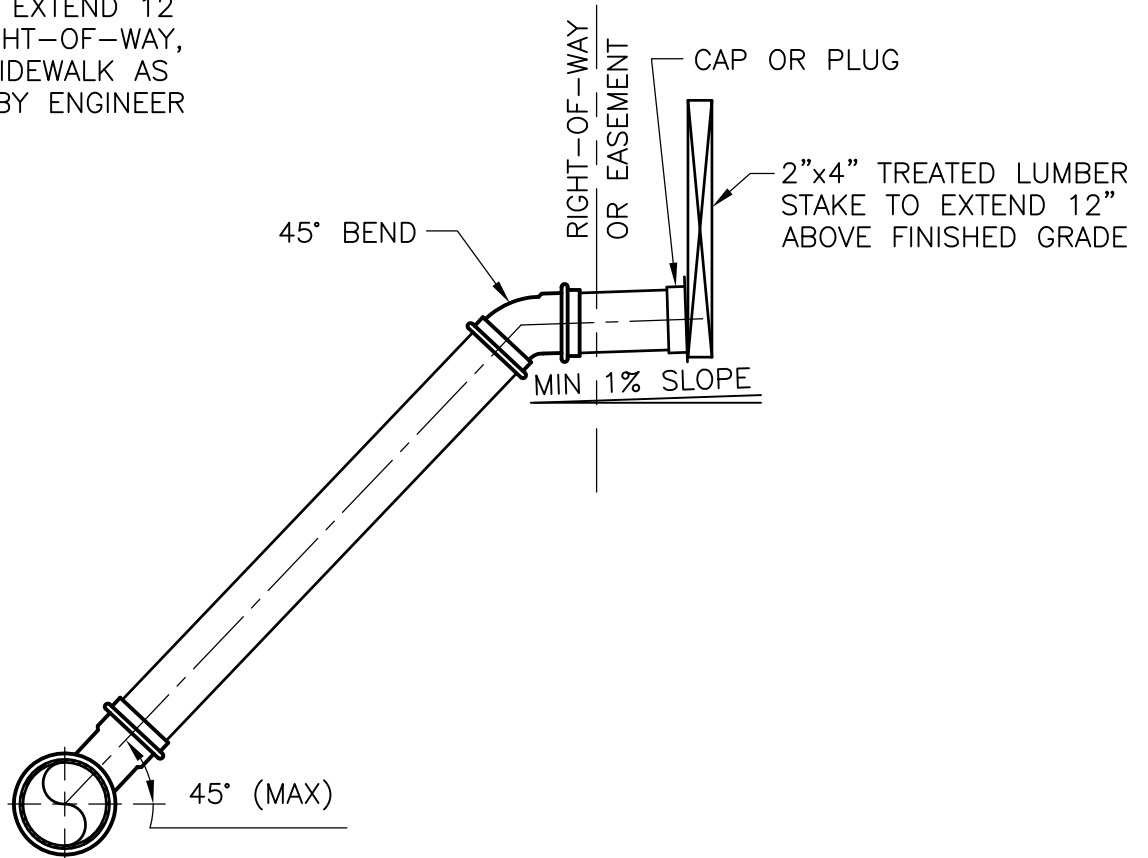
NO SCALE





NOTE:
LATERAL TO EXTEND 12"
BEYOND RIGHT-OF-WAY,
CURB OR SIDEWALK AS
APPROVED BY ENGINEER

PLAN

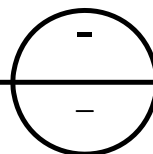


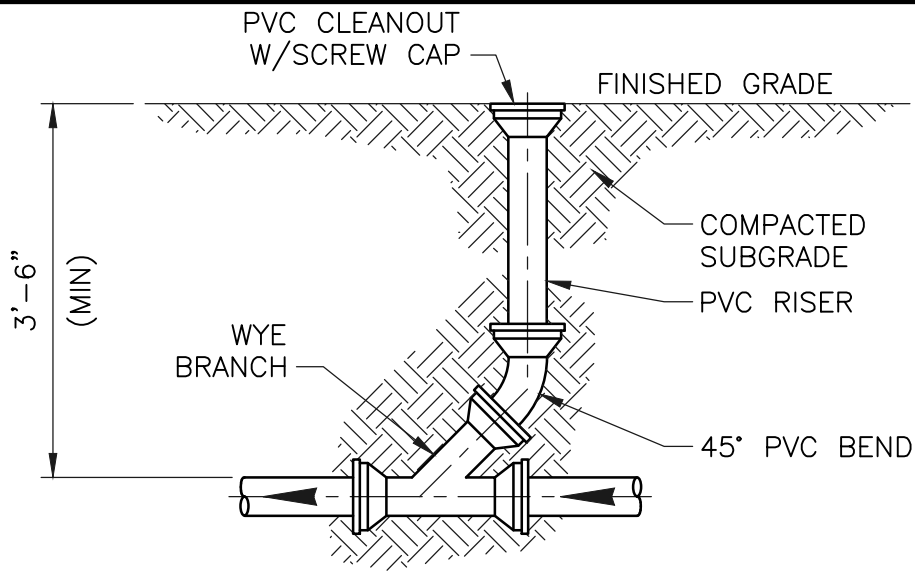
SECTION

LATERAL CONNECTION RISER

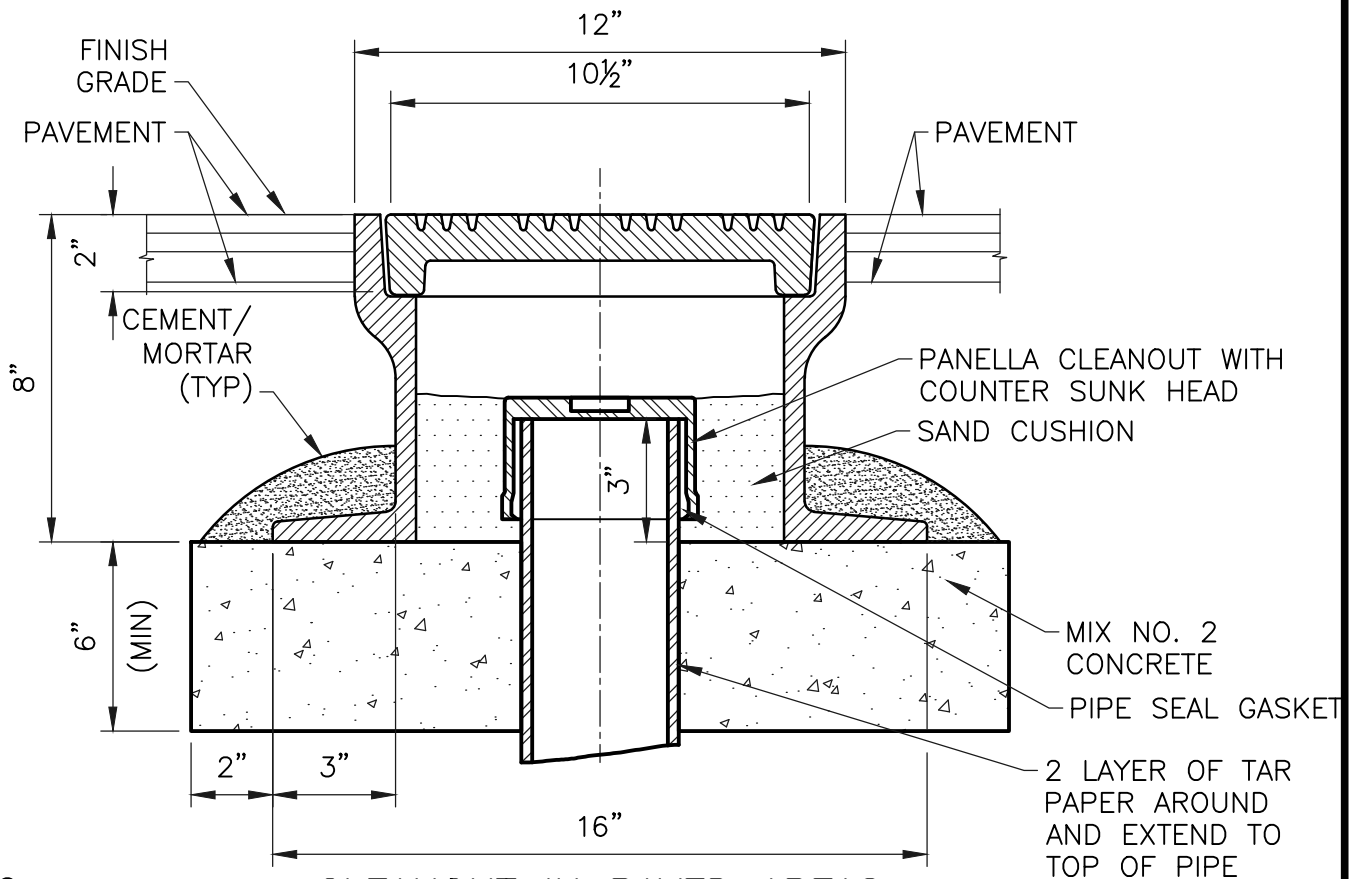
DETAIL

NO SCALE





CLEANOUT IN NON-PAVED AREAS



NOTES:

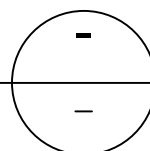
CLEANOUT IN PAVED AREAS

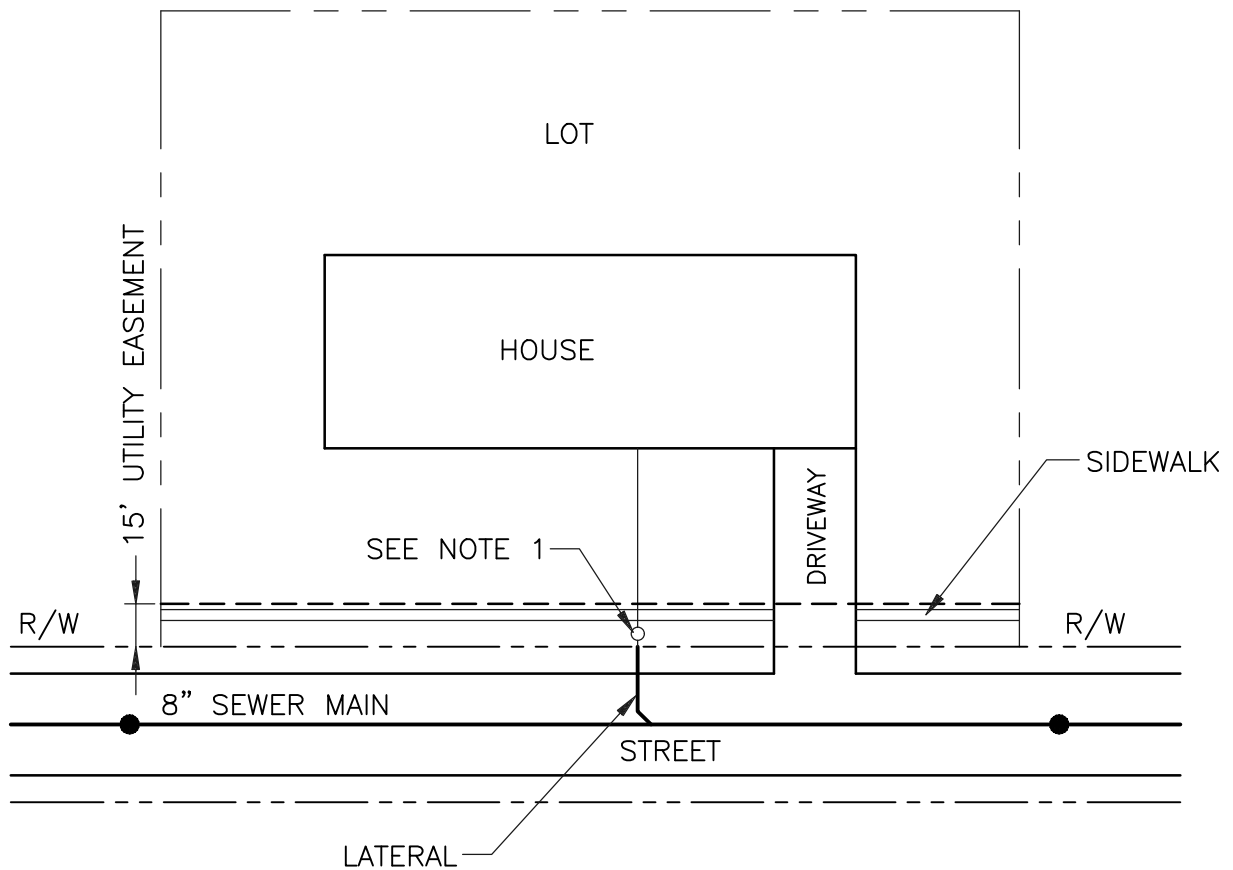
1. THIS DETAIL APPLIES TO RESIDENTIAL APPLICATIONS ONLY; FOR NON-RESIDENTIAL APPLICATIONS, CLEANOUT CONSTRUCTION SHALL BE AS APPROVED BY ENGINEER.
2. SERVICE LINE SHALL BE CONNECTED TO THE CLEANOUT AT THE WYE; CONNECTION OF A SERVICE LINE INTO THE RISER PORTION OF A CLEANOUT SHALL NOT BE PERMITTED.
3. IF LOCATED IN CONCRETE PAVING, THE CLEAN-OUT SHALL BE ENCASED IN A 24"x24" AREA BOXED OUT WITH EXPANSION JOINT MATERIAL.

STANDARD LATERAL OR SERVICE LINE CLEANOUT

DETAIL

NO SCALE





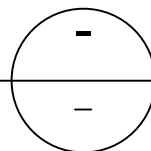
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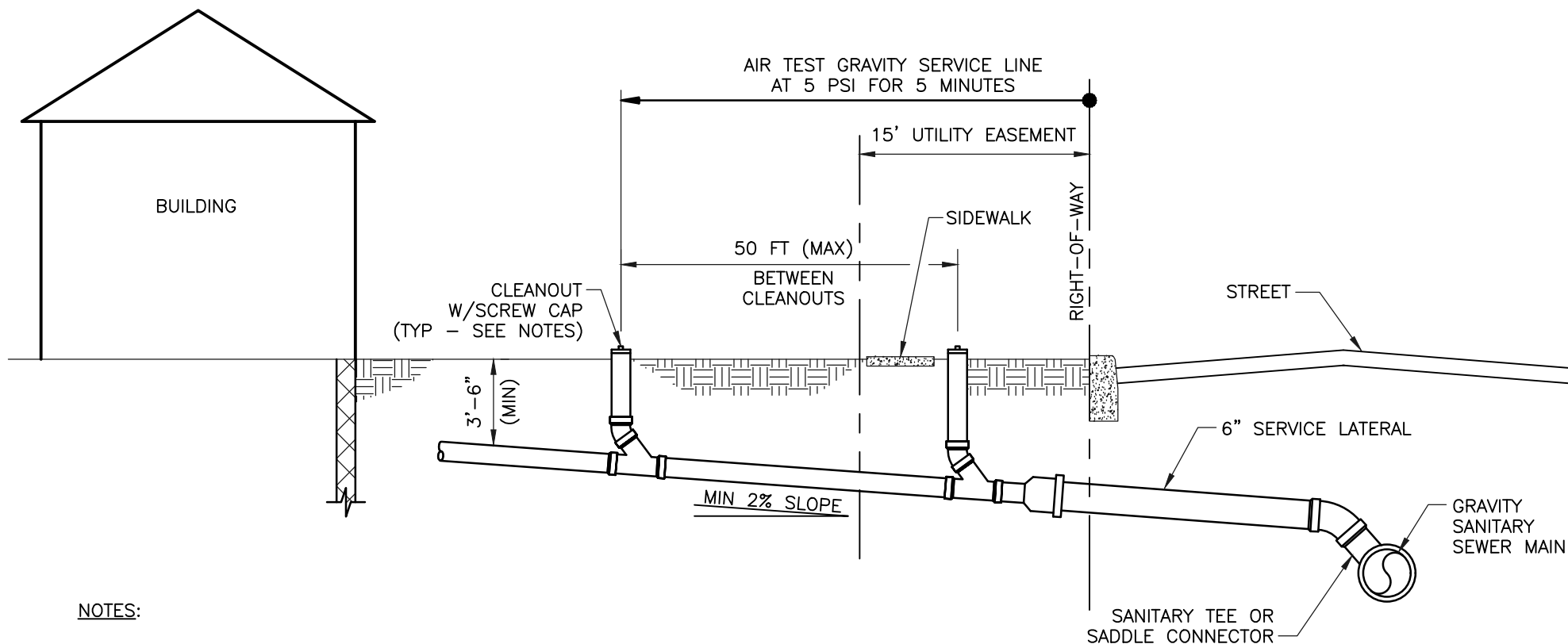
1. ALL CLEANOUTS SHALL BE LOCATED IN THE YARD AREA AND NOT IN DRIVEWAY.
2. IF SEWER LATERAL IS LOCATED UNDER DRIVEWAY, ADD FITTINGS AND PIPE AS REQUIRED TO LOCATE CLEANOUT IN YARD AREA.
3. CLEANOUTS SHALL BE A MINIMUM OF 6" ABOVE FINISHED GRADE.

TYPICAL GRAVITY SERVICE LINE — PLAN

DETAIL

NO SCALE





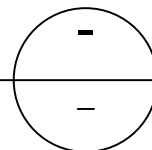
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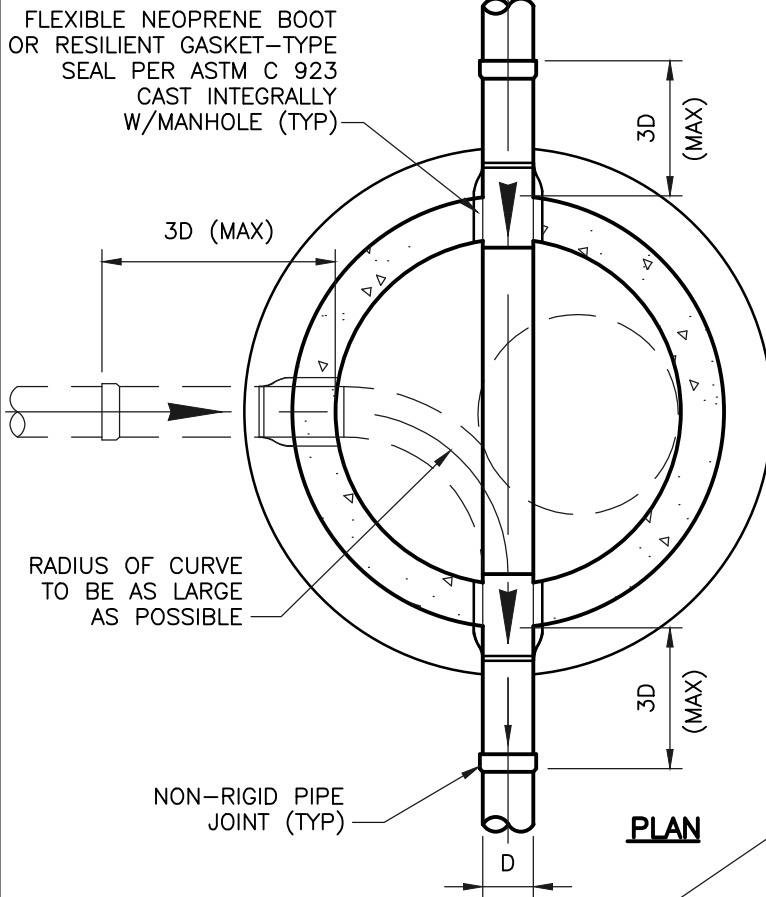
1. CLEANOUT COVER SHALL BE PVC IN UNPAVED AREAS AND CAST IRON IN PAVED AREAS.
2. SERVICE LINE SHALL BE CONNECTED TO THE CLEANOUT AT THE WYE; CONNECTION OF A SERVICE LINE INTO THE RISER PORTION OF A CLEANOUT SHALL NOT BE PERMITTED.
3. SERVICE LINE AND CLEANOUT SIZING SHALL BE PER CAROLL COUNTY REQUIREMENTS.

TYPICAL GRAVITY SERVICE LINE – PROFILE

DETAIL

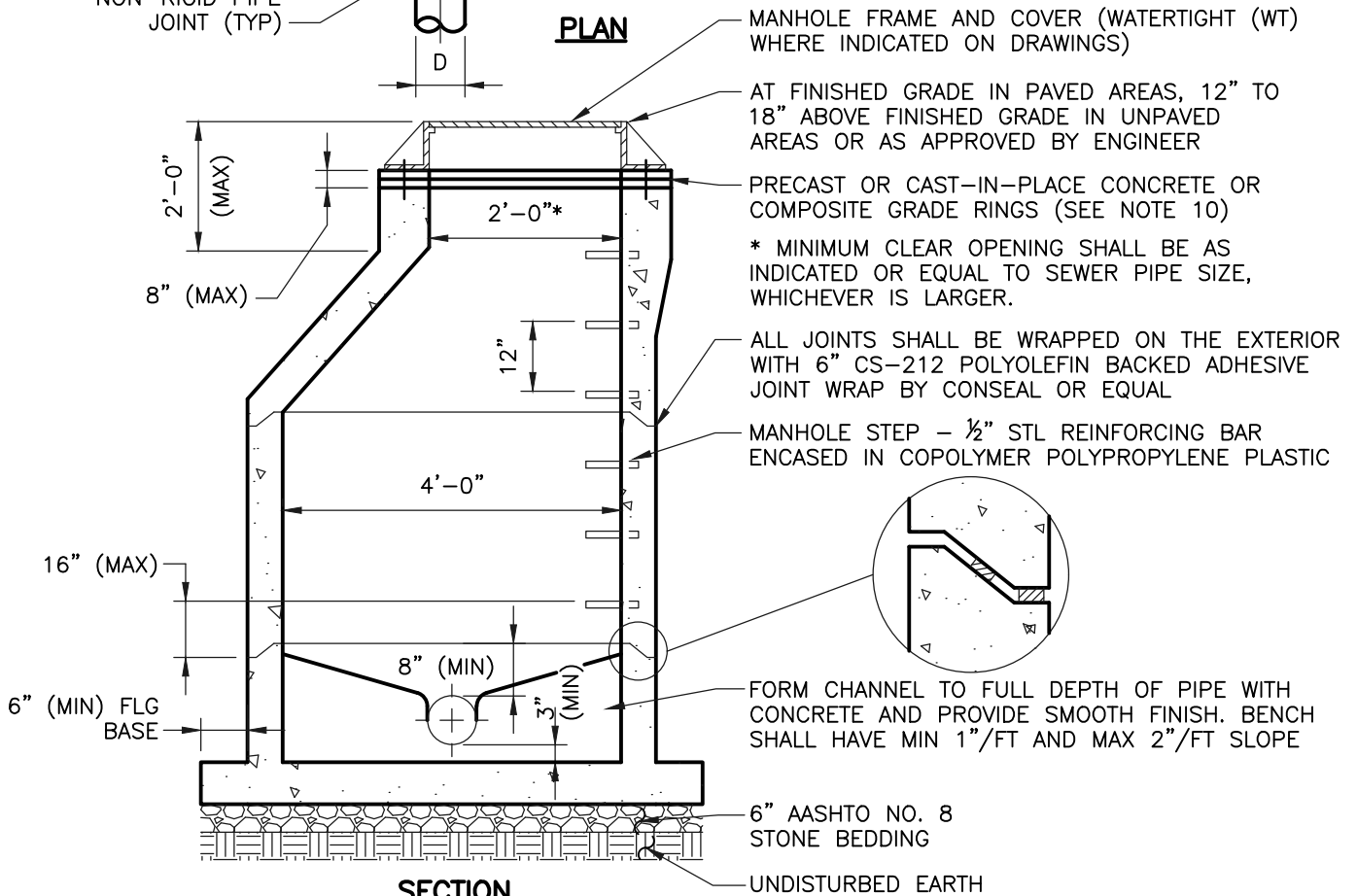
NO SCALE





NOTES:

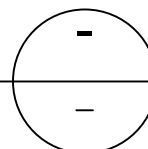
1. ALL PRECAST REINFORCED CONCRETE MANHOLE SECTIONS SHALL COMPLY WITH ASTM C-478.
2. CEMENT SHALL BE TYPE II OR III, AIR ENTRAINED, WITH 4,000 psi AT 28 DAYS.
3. REINFORCEMENT SHALL BE GRADE 60 PER ASTM A-615.
4. 24" DIA CAST IRON FRAME AND COVER PER ASTM A-48, CLASS 30, FOR H-20 LOADING.
5. CAST IRON FRAME TO BE BOLTED TO MANHOLE WITH $\frac{5}{8}$ " ANCHOR BOLTS.
6. CASTING AND GRADE RINGS TO BE SEALED TO MANHOLE WITH PREFORMED PLASTIC SEALING COMPOUND.
7. ALL JOINTS SHALL BE SEALED WITH EITHER TWO RINGS OF PREFORMED PLASTIC SEALING COMPOUND OR ONE O-RING GASKET AND ONE RING OF PLASTIC SEALING COMPOUND.
8. COAT MANHOLE EXTERIOR WITH DAMP PROOFING (PROMASTIC 900 COAL TAR).
9. COAT MANHOLE INTERIOR WITH H₂S CORROSION PROTECTION (PRO GUARD PROCOAT 2228 WHITE EPOXY).
10. PRECAST CONCRETE GRADE ADJUSTMENT RINGS SHALL BE ONE PIECE (NO SEMI-CIRCULAR SECTIONS) AND SHALL HAVE A MINIMUM THICKNESS OF 2 INCHES.



SECTION
PRECAST CONCRETE MANHOLE

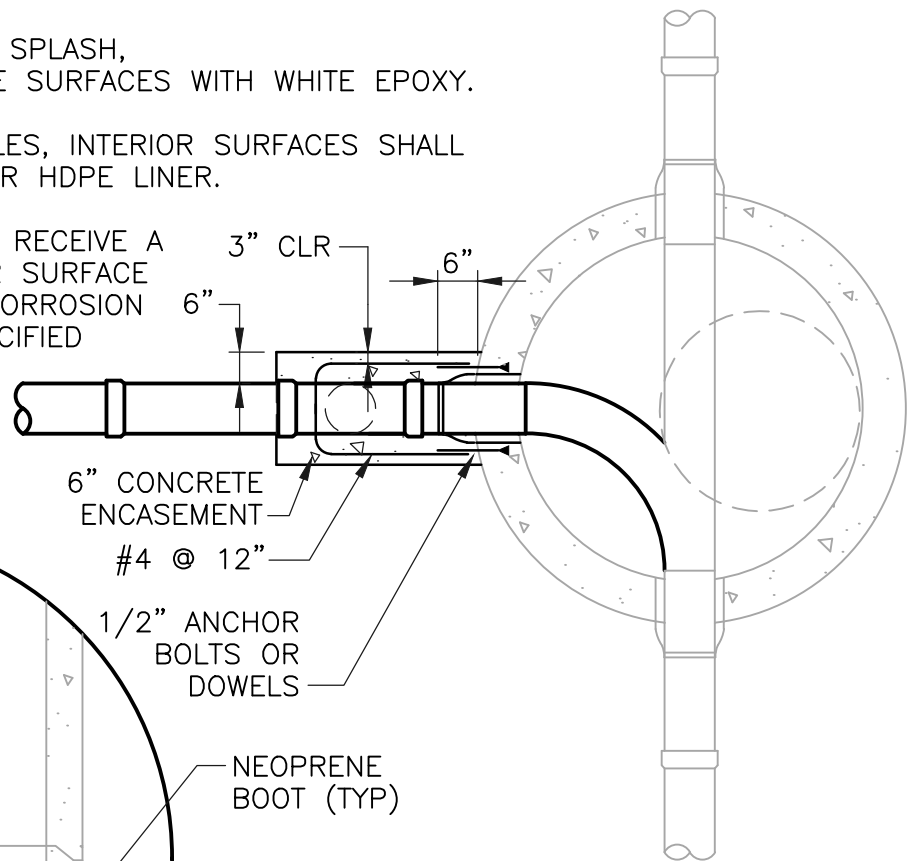
DETAIL

NO SCALE

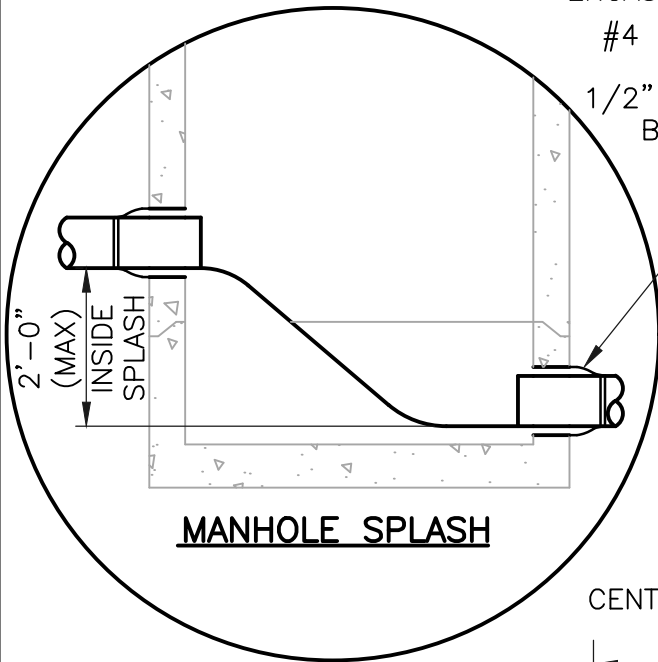


NOTES:

1. FOR MANHOLES WITH INSIDE SPLASH,
COAT ALL INTERIOR MANHOLE SURFACES WITH WHITE EPOXY.
2. FOR ALL NEW DROP MANHOLES, INTERIOR SURFACES SHALL
BE PROVIDED WITH A PVC OR HDPE LINER.
3. FOR EXISTING MANHOLES TO RECEIVE A
DROP CONNECTION, INTERIOR SURFACE
SHALL BE COATED WITH A CORROSION
RESISTANT MATERIAL AS SPECIFIED
IN SECTION 5.
4. NO INTERNAL DROP
CONNECTIONS SHALL
BE PERMITTED.

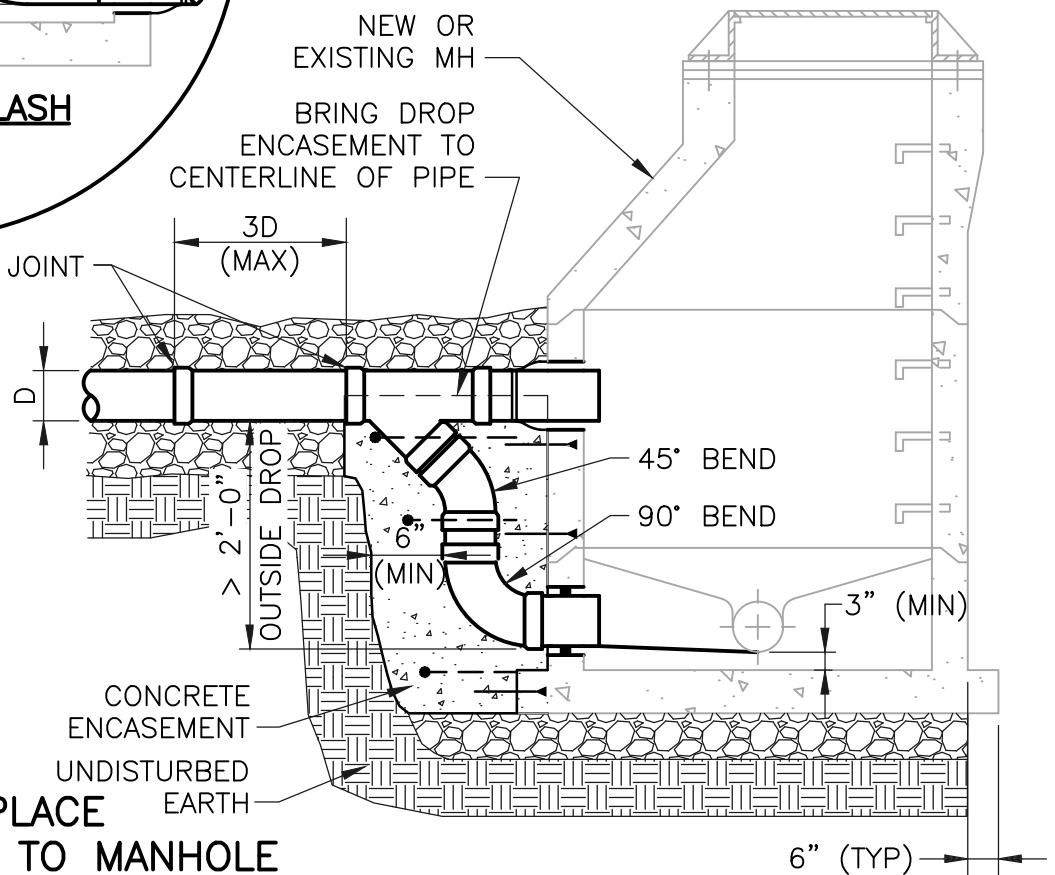


PLAN



MANHOLE SPLASH

NON-RIGID PIPE JOINT

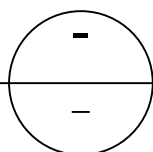


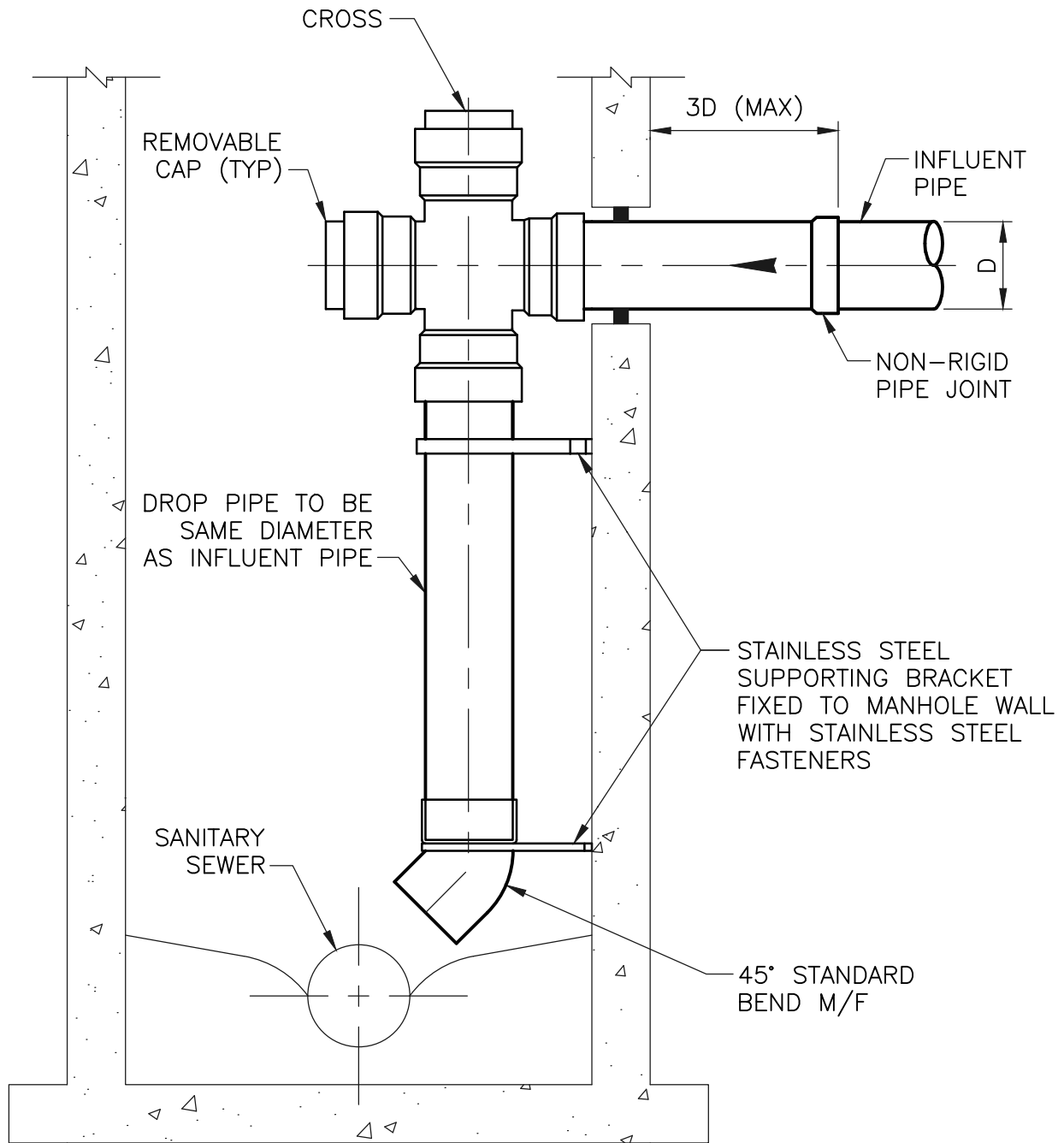
SECTION

**CAST-IN-PLACE
DROP CONNECTION TO MANHOLE**

DETAIL

NO SCALE





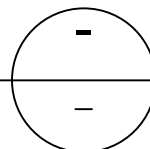
NOTES:

1. MANHOLE INTERIOR WITH H₂S CORROSION PROTECTION SHALL BE PROVIDED AS REQUIRED.
2. MINIMUM INTERNAL DIAMETER OF MANHOLE SHALL BE 5 FEET.
3. INTERNAL DROP CONNECTIONS MAY ONLY BE MADE ON 8" SEWER MAINS.

INTERNAL DROP CONNECTION TO MANHOLE

DETAIL

NO SCALE



CUT EXIST PIPE AND INSTALL
FLEXIBLE COUPLINGS WITH
STAINLESS STEEL BANDS

- INSTALL RESILIENT GASKET
TYPE SEAL PER ASTM C-923
PRIOR TO CASTING BASE

CUT OUT TOP OF PIPE
AFTER FORMING SHELF

- SHAPED INVERT –
RADIUS OF CURVE TO BE
AS LARGE AS POSSIBLE

1. ALL PRECAST REINFORCED CONCRETE
MANHOLE SECTIONS SHALL COMPLY WITH
ASTM C-478.

2. CEMENT SHALL BE TYPE II OR III, AIR
ENTRAINED, WITH 4,000 psi AT 28 DAYS.

3. REINFORCEMENT SHALL BE GRADE 60 PER ASTM A-615.

4. ALL JOINTS SHALL BE SEALED WITH EITHER TWO RINGS PREFORMED PLASTIC SEALING COMPOUND OR ONE O-RING GASKET AND ONE RING OF PLASTIC SEALING COMPOUND.

5. COAT MANHOLE EXTERIOR WITH DAMP PROOFING (PROMASTIC 900 COAL TAR).

6. COAT MANHOLE INTERIOR WITH H₂S CORROSION PROTECTION (PRO GUARD PROCOAT 2228 WHITE EPOXY).

7. REFER TO DETAIL 11 FOR ADDITIONAL
MANHOLE CONSTRUCTION REQUIREMENTS.

PLAN

—PRECAST CONCRETE BARREL
SECTION

—MANHOLE STEP - ½" STL
REINFORCING BAR ENCASED IN
COPOLYMER PROPYLENE PLASTIC

—FORM GROOVE IN MANHOLE BASE
TO RECEIVE TONGUE OF
MANHOLE BARREL AND GASKET

EXIST PIPE

8"
(MIN)

3" C

6" (MIN)

UNDISTURBED EARTH

ON

– WATERSTOP – NOT
REQUIRED IF POURED
MONOLITHICALLY

— CAST-IN-PLACE
CONCRETE BASE

6" AASHTO No. 8
STONE BEDDING

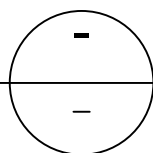
- #4@8" EW

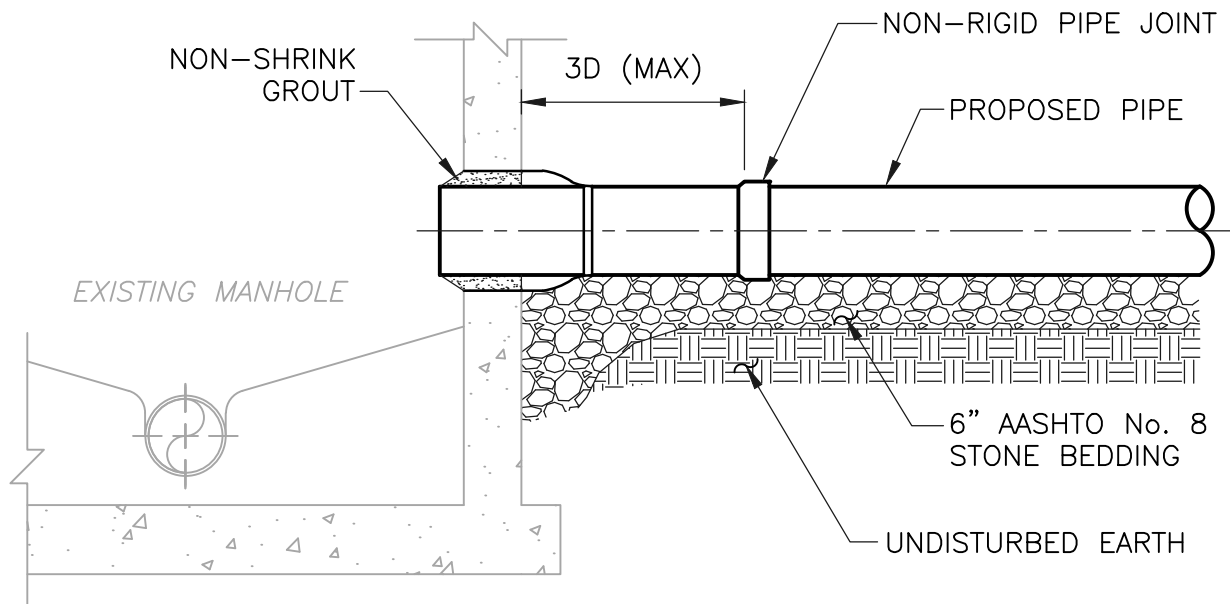
- CONCRETE FILL

CAST-IN-PLACE BASE
NEW MANHOLE OVER EXISTING SEWER

DETAIL

NO SCALE





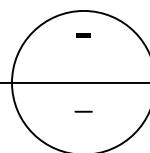
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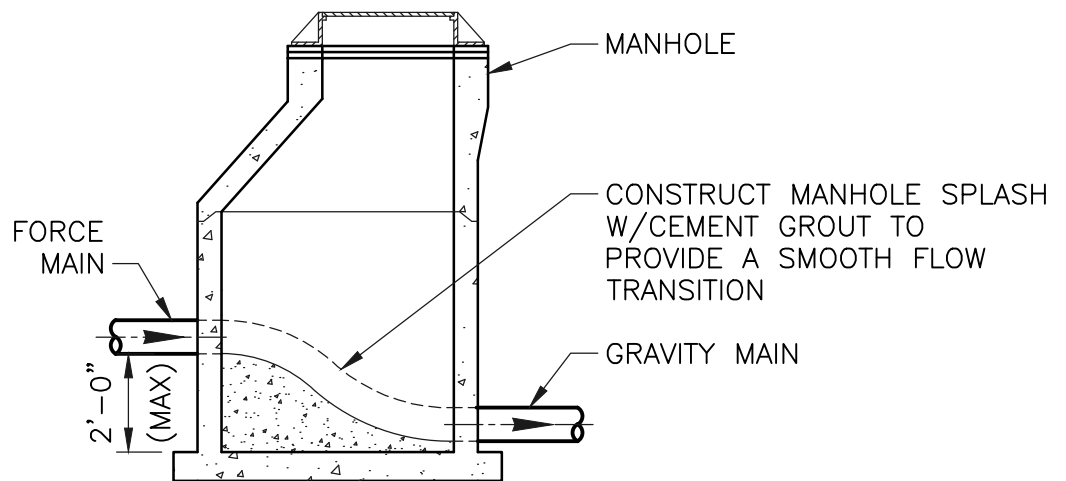
1. CUT HOLE IN EXISTING MANHOLE WITH CORING MACHINE.
2. INSTALL FLEXIBLE NEOPRENE BOOT.
3. FILL ANNULAR SPACE WITH NON-SHRINK GROUT.

NEW SEWER TO EXISTING MANHOLE CONNECTION

DETAIL

NO SCALE

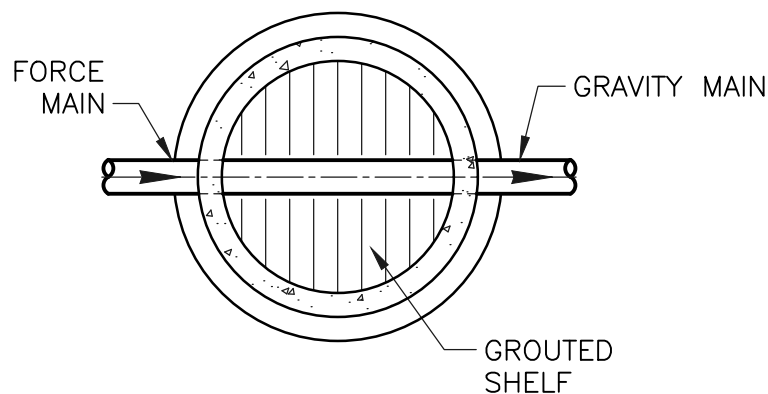




SECTION

NOTE:

AT A MINIMUM, SET FORCE MAIN INVERT EQUAL TO GRAVITY MAIN CROWN ELEVATION; FORCE MAIN INVERT SHALL NOT BE SET HIGHER THAN 2'-0" ABOVE GRAVITY LINE INVERT.



PLAN

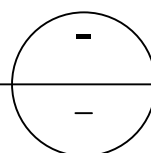
NOTES:

1. A PVC OR HDPE INTERIOR LINING SHALL BE PROVIDED ON ALL PROPOSED MANHOLES THAT WILL HAVE A FORCE MAIN CONNECTION.
2. EXISTING MANHOLES TO RECEIVE A FORCE MAIN CONNECTION SHALL BE COATED WITH A CORROSION RESISTANT MATERIAL AS APPROVED BY THE ENGINEER.
3. DEPENDING UPON THE CONDITION OF AN EXISTING MANHOLE TO RECEIVE A FORCE MAIN CONNECTION, THE MANHOLE MAY NEED TO BE REPLACED AT THE DISCRETION OF THE ENGINEER.

FORCE MAIN CONNECTION TO MANHOLE

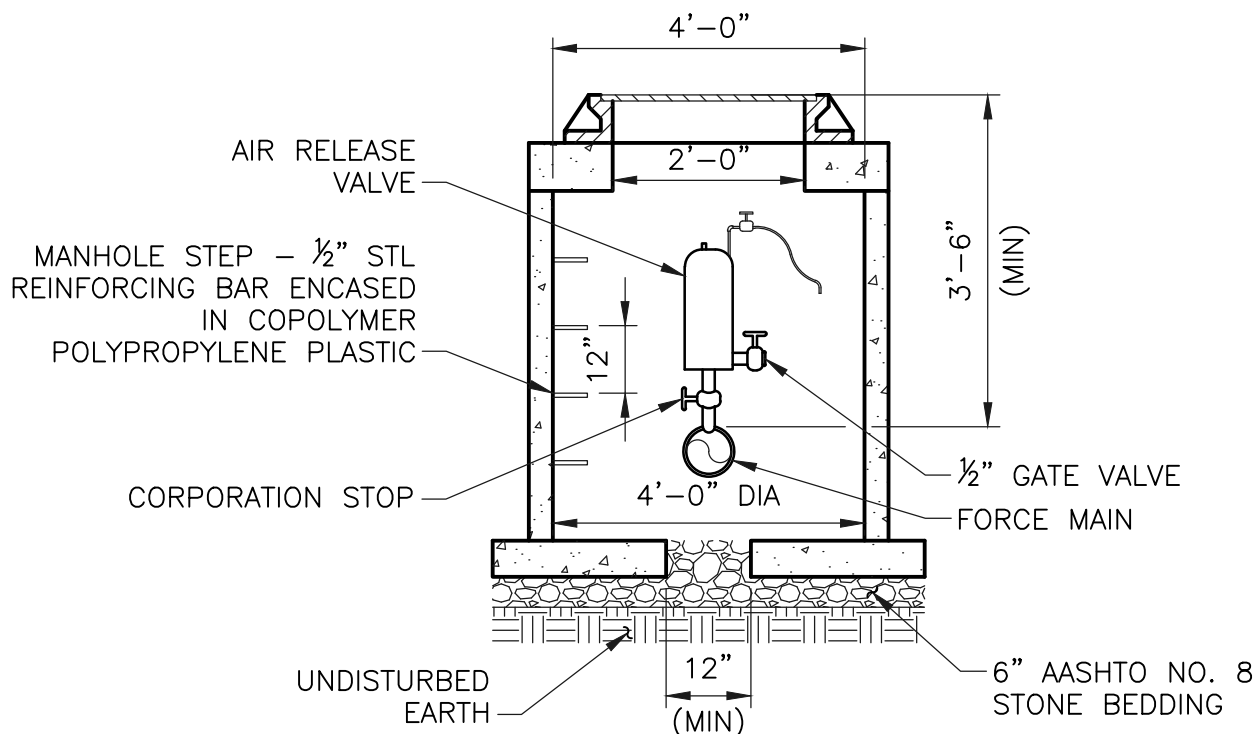
DETAIL

NO SCALE



NOTES:

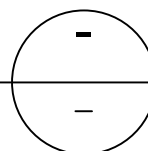
1. ALL PRECAST REINFORCED CONCRETE MANHOLE SECTIONS SHALL COMPLY WITH ASTM C-478.
2. CEMENT SHALL BE TYPE II OR III, AIR ENTRAINED, WITH $f'_c=4,000$ psi AT 28 DAYS.
3. REINFORCEMENT SHALL BE GRADE 60 PER ASTM A-615.
4. 24" DIA. CAST IRON FRAME AND COVER PER ASTM A-48, CLASS 30, FOR H-20 LOADING.
5. CAST IRON FRAME TO BE BOLTED TO MANHOLE WITH 5/8" ANCHOR BOLTS.
6. CASTING AND GRADE RINGS TO BE SEALED TO MANHOLE WITH WATERPROOF MORTAR OR PREFORMED PLASTIC SEALING COMPOUND.
7. ALL JOINTS SHALL BE SEALED WITH PREFORMED PLASTIC SEALING COMPOUND.
8. PROVIDE ADDITIONAL WALL SUPPORTS FOR AIR RELEASE VALVE AS NECESSARY.
9. COAT MANHOLE EXTERIOR W/DAMP PROOFING (PROMASTIC 900 COAL TAR).
10. PRECAST CONCRETE GRADE ADJUSTMENT RINGS SHALL BE ONE PIECE (NO SEMI-CIRCULAR SECTIONS) AND SHALL HAVE A MINIMUM THICKNESS OF 2 INCHES.

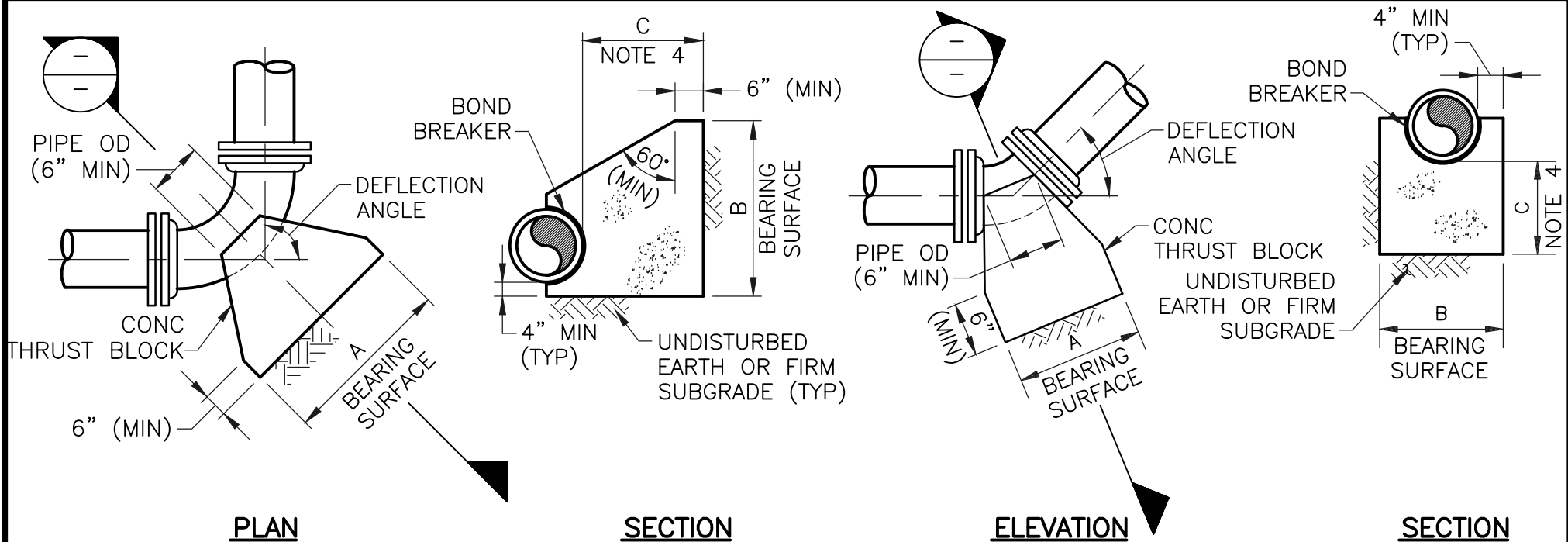


AIR RELEASE VALVE AND CHAMBER

DETAIL

NO SCALE





DETAIL FOR HORIZONTAL BENDS

DETAIL FOR LOWER VERTICAL BENDS

NOMINAL PIPE SIZE (INCHES)	MAXIMUM PIPE OD (INCHES)	REQUIRED BEARING AREA (SQ FT)					
		90 DEG	60 DEG	45 DEG	30 DEG	22.50 DEG	11.25 DEG
4	4.80	2.9	2.0	1.6	1.1	0.8	0.4
8	9.05	10	7	6	4	3	1.4
12	13.20	22	15	12	8	6	3
18	19.50	48	34	26	17	13	7
20	21.60	58	41	32	21	16	8
24	25.80	83	59	45	30	23	12

THRUST BLOCKS FOR HORIZONTAL BENDS AND LOWER VERTICAL BENDS

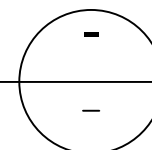
NOTES:

1. MAXIMUM TEST PRESSURE = 1.5×150 PSI
2. MINIMUM ALLOWABLE SOIL BEARING PRESSURE = 2000 PSF
3. BEARING AREA = $A \times B$
4. C SHALL BE GREATER THAN $A/2$ AND $B/2$.

THRUST BLOCKS
FOR HORIZONTAL BENDS
AND LOWER VERTICAL BENDS

DETAIL

NO SCALE



MINIMUM RESTRAINED PIPE LENGTH (FT) FOR VERTICAL BENDS

(WITHOUT POLYETHYLENE ENCASEMENT)

DIAMETER (IN)	VERTICAL BEND ANGLE (DEGREES)		
	45	22½	11¼
6	20	1	5
8	26	12	6
10	32	15	8
12	37	18	9
14	43	21	10
16	48	23	12
18	54	26	13
20	59	28	14
24	70	34	17

MINIMUM RESTRAINED PIPE LENGTH (FT) FOR HORIZONTAL BENDS

(WITHOUT POLYETHYLENE ENCASEMENT)

DIAMETER (IN)	HORIZONTAL BEND ANGLE (DEGREES)			
	90	45	22½	11¼
6	15	6	3	1
8	19	8	4	2
10	23	10	5	2
12	28	11	5	3
14	32	13	6	3
16	36	15	7	4
18	40	16	8	4
20	43	18	9	4
24	51	21	10	5

MINIMUM RESTRAINED PIPE LENGTH (FT) FOR VERTICAL BENDS

(WITH POLYETHYLENE ENCASEMENT)

DIAMETER (IN)	VERTICAL BEND ANGLE (DEGREES)		
	45	22½	11¼
6	29	14	7
8	37	18	9
10	45	22	11
12	53	26	13
14	61	29	15
16	69	33	16
18	77	37	18
20	85	41	20
24	100	48	24

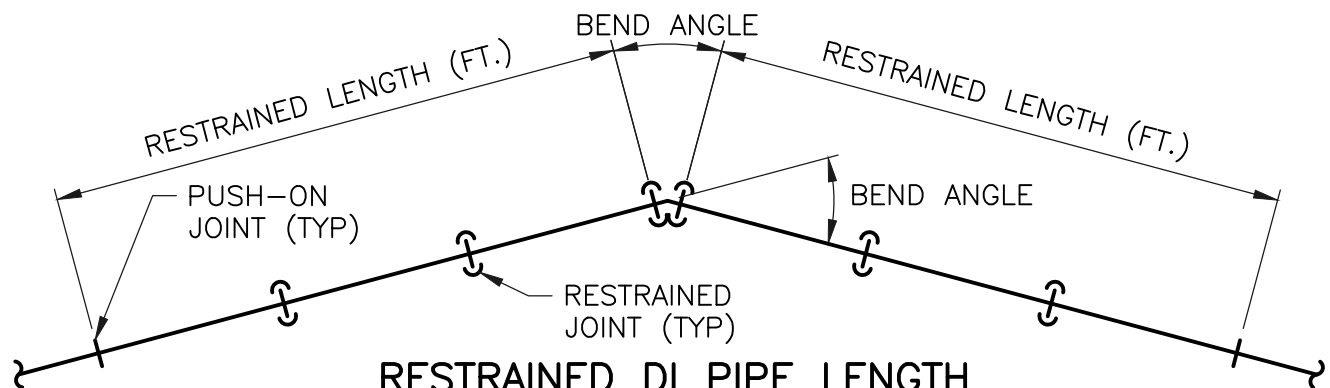
MINIMUM RESTRAINED PIPE LENGTH (FT) FOR HORIZONTAL BENDS

(WITH POLYETHYLENE ENCASEMENT)

DIAMETER (IN)	HORIZONTAL BEND ANGLE (DEGREES)			
	90	45	22½	11¼
6	16	7	3	2
8	21	9	4	2
10	26	11	5	3
12	30	13	6	3
14	35	14	7	3
16	39	16	8	4
18	44	18	9	4
20	48	20	9	5
24	56	23	11	6

NOTES:

- | | | |
|---|------------------------------|--------------------|
| 1 | DESIGN PRESSURE | = 150 PSI |
| 2 | DEPTH OF COVER | = 4 FEET |
| 3 | SAFETY FACTOR | = 1.5 |
| 4 | SOIL TYPE | = COHESIVE ANGULAR |
| 5 | SOIL INTERNAL FRICTION ANGLE | = 20 DEGREES |
| 6 | SOIL COHESION | = 200 PSF |
| 7 | SOIL DENSITY | = 90 PCF |

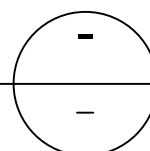


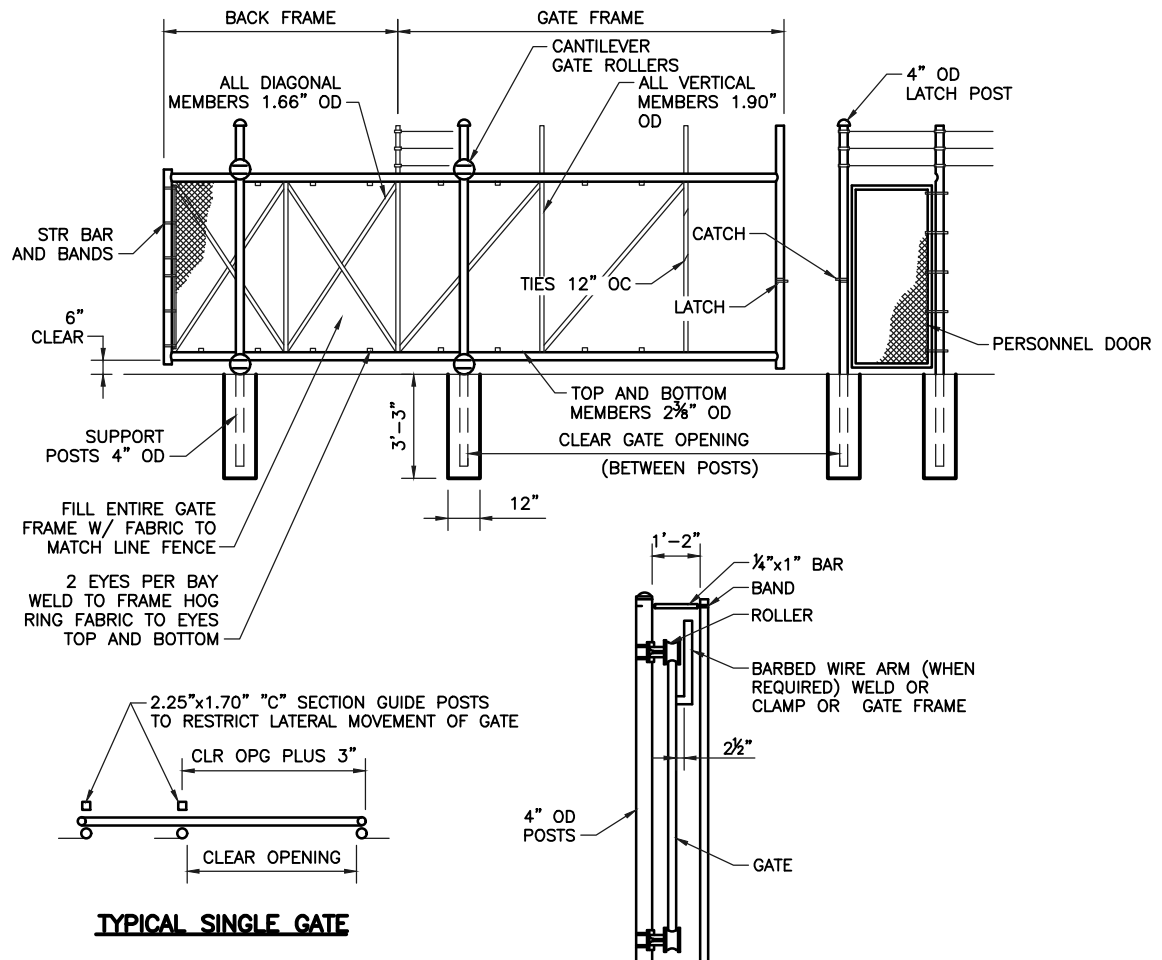
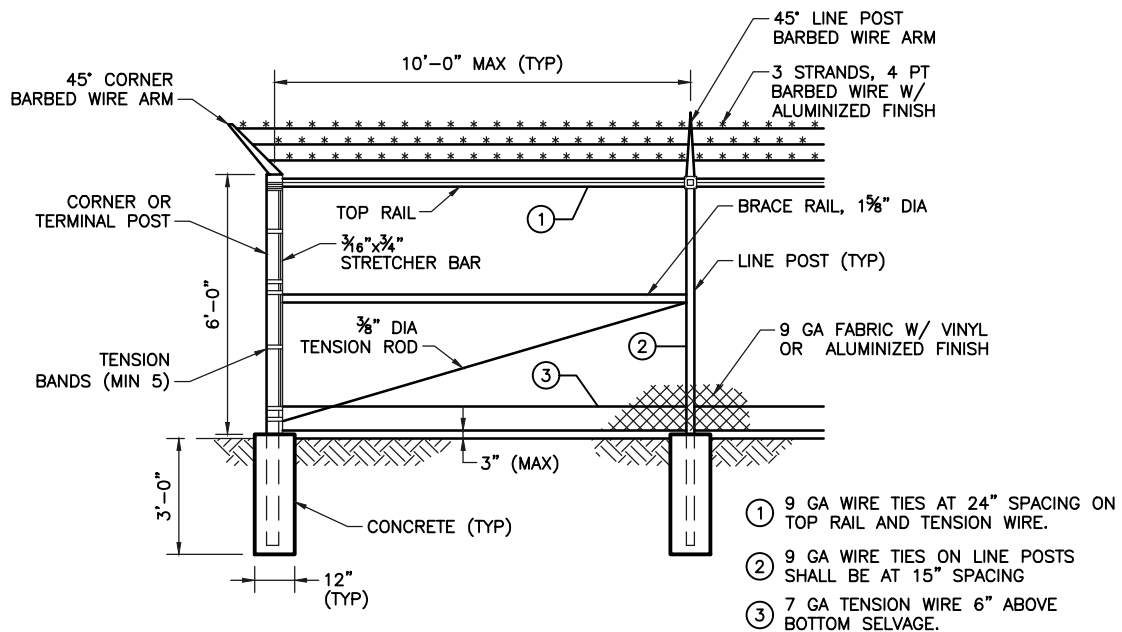
RESTRAINED DI PIPE LENGTH

*PROVIDE ¾" THREADED
RODS (2 PER ASSEMBLY)
AT LEAST 3 PIPE LENGTHS
UPSTREAM AND
DOWNSTREAM OF BEND.

DETAIL

NO SCALE





TYPICAL PUMPING STATION SECURITY FENCE AND ACCESS GATE

DETAIL

NO SCALE

