CITY OF RICHMOND, VIRGINIA
DEPARTMENT OF PUBLIC UTILITIES

SANITARY SEWER SYSTEM
DESIGN GUIDELINES
AND
STANDARD SPECIFICATIONS AND DETAILS

MARCH 2022

The attached "City of Richmond, Virginia Department of Public Utilities Sanitary Sewer System Design Guidelines and Standard Specifications and Details", dated December 2021, are hereby adopted as a City of Richmond Department of Public Utilities (DPU) regulation for the purpose of setting minimum standards and guidelines for sanitary sewer design and construction within DPU's service area, pursuant to Section 28-26 of the Code of Ordinance of the City of Richmond. These regulations shall be effective _____ and that time shall supersede all previous versions.

Approved: _____

April Bingham, Director of Public Utilities

Date: _____

CITY OF RICHMOND
SANITARY SEWER SYSTEM

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I. GENERAL PROVISIONS

PART I

GENERAL PROVISIONS

SECTION 1 ABBREVIATIONS AND DEFINITION OF TERMS

1.1. ABBREVIATIONS

AAN - American Association of Nuserymen
AASHTO - American Association of State Highway & Transportation Officials
ACI - American Concrete Institute
AED - Associated Equipment Distributors
ANSI – American National Standards Institutes
AREMA – American Railway Engineering and Maintenance of Way Association
ASTM - American Society of Testing Materials
AWWA - American Water Works Association
AWS - American Welding Society
BM - Bench Mark
BMP – Best Management Practice
CAD – Computer Aided Design
CB - Catch Basin
CCTV – Closed Circuit Television
CL or C/L - Center Line
CI - Cast Iron
CIP – Capital Improvement Program
CM - Corrugated Metal
C/O – Clean Out
CONC - Concrete
C & P - Chesapeake & Potomac Telephone Company
CSA - City Sewer Atlas
CSO – Combined Sewer Overflow
CSS – Combined Sewer System
CSX – C.S.X Corporation
DEC – Department of Emergency Communication
DI – Drop Inlet
DIP – Ductile Iron Pipe
DMH - Drop Manhole
Dom. – Dominion Energy
DPS - Department of Procurement Services
DPU - Department of Public Utilities

DPW - Department of Public Works
Elev. - Elevation
Ex. Str. - Extra Strength
FL - Flow Line
FL - Flanged
Gr. - Grade
GIS – Geographic Information System(s)
HDPE – High Density Polyethylene
HC - House Connection
IC - Intercepting Chambers
ID - Inside Diameter
IPS – Internal Pipe Size
JC - Junction Chamber
LH - Lamp Hole
MH - Manhole
MJ – Mechanical Joint
NAVD – North American Vertical Datum
NS – Norfolk Southern Corporation
NSF – National Sanitation Foundation
No. - Number
OD - Outside Diameter
O&M – Operations and Maintenance
OSHA – Occupational Safety and Health Administration
PC - Point of Curve
PCC - Point of Compound Curve
PCP - Precast Concrete Pipe
PI - Point of Intersection
PL or P/L - Property Line
PP - Power Pole
PRC - Precast Reinforced Concrete Pipe
PSI - Pounds per Square Inch
PT - Point of Tangency
PVC – Polyvinyl Chloride
Q - Quantity of Flow
R - Radius
RCP – Reinforced Concrete Pipe
RLD – Responsible Land Disturber
R/W - Right-of-Way
San. - Sanitary
SCAT – Sewage Collection and Treatment
SDR – Standard Dimension Ratio
SIC - Standard Industrial Classification
Spec. - Specifications
TC – Terra Cotta
TMH - Trap Manhole
V - Velocity of Flow

VC - Vertical Curve
VDEQ – Virginia Department of Environmental Quality
VDOT - Virginia Department of Transportation
VDH – Virginia Department of Health
Ver. – Verizon Virginia, Inc.
VESCH – Virginia Erosion and Sediment Control Handbook
WI - Wrought Iron
WU - Western Union

1.2. DEFINITIONS - TERMS USED OR REFERRED TO HEREIN ARE DEFINED AS FOLLOWS:

Abandoned (Pipe/Manholes) – A facility that has been purposefully disconnected from an active system such that it no longer serves its original intended function.

Acceptance of the Work - Action by which authorized representatives of the City acknowledge that all or part of the work has been completed substantially in accordance with the plans and specifications.

"Addendum" or "Addenda" - The additional contract provisions issued in writing by the Director of General Services, prior to the receipt of bids.

Approved – When used in these standards without further definition the words "by the Director of Public Utilities" shall be implied.

Bedding - A layer of granular material, gravel, crushed rock, or concrete immediately below and supporting a conduit or fully or partially encasing a conduit. Material existing in a trench, ditch, or tunnel, upon which conduit is placed directly, is considered to be bedding.

Capital Improvement Program (CIP) – A project funded under the City of Richmond Capital Improvement Program

Chief Administrative Officer (CAO) – Appointed by the mayor.

City - The City of Richmond, Virginia, a municipal corporation organized and existing under the constitution of the laws of the Commonwealth of Virginia.

City Code – shall mean the code of the City of Richmond, VA and the General Ordinances including all supplements, latest edition.

Combined Sewer Overflow (CSO) – Discharge of untreated storm and wastewater from a combined sewer system into the environment. This typically occurs when combined sewer systems fill up with too much water for the system to handle, most often during heavy rain events, and the excess water is released into a stream or river.

Combined Sewer System (CSS) – A collection system that conveys both wastewater and stormwater.

Concrete – A composite construction material composed of cement (commonly Portland cement) and other cementitious materials such as fly ash and slag cement, aggregate (generally a course aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures.

Contract - The written agreement executed by the Owner and Contractor setting forth the obligations of the parties, including but not limited to performance of the work, furnishing of labor, equipment and materials, and the basis of payment. It shall include but not necessarily be limited to the Invitation for Bid, the Bid, the General Conditions of the Contract, Special Provisions, Performance Bond, Payment Bond, Certificate of Insurance, Drawings, Specifications, Addenda, written Change Orders, extra Work Orders and Agreements required to complete the construction of the project, including authorized extensions thereof, in an acceptable manner, all of which constitute one instrument. Oral representations or promises not confirmed in writing shall not be considered a part of the contract documents. The contract may be amended or modified only in writing and the amendment and modification will be effective only when approved by all parties to the original document.

Contractor - Any person, firm, association or corporation that for a fixed price, commission, fee or percentage undertakes to bid upon, or accepts or offers to accept orders for performing or superintending in whole or in part the construction, removal, repair or improvement of any building or structure.

Council - The Richmond City Council.

Culvert - Any structure not classified as a bridge which provides an opening under any roadway, driveway or embankment.

Department of Public Utilities (DPU) – The City's DPU operates five utilities: natural gas, water, wastewater, stormwater, and electric street lighting.

Deputy Chief Administrative Officer (DCAO) – Deputy Chief Administrative Office, Operations. Supervises DPU and DPW and reports to CAO.

Developer – Any property owner, or any person or group with written authorization from the property owner, who intends to improve or construct improvements upon a given property.

Director of General Services - The Director of General Services, Richmond, Virginia, acting directly or through his duly authorized representative.

Director of Public Utilities - The Director of Public Utilities, Richmond, Virginia, acting directly or through his duly authorized representative.

Director of Public Works - The Director of Public Works, Richmond, Virginia, acting directly or through his duly authorized representative.

Drainage Ditch - A natural or artificially constructed open depression for the purpose of carrying off surface water.

Easement - A grant of a right of use of the property of an owner for a certain purpose at the will of the grantee, evidenced by a deed recorded with the Clerk of the Circuit Court.

Engineer - Shall mean an individual, firm, association, properly qualified person or the legally authorized representative(s), designated by the Owner, experienced in and legally qualified to practice the profession involved. The term shall apply to the Owner when the Owner is acting as its own Architect or Engineer.

Extra Work - The Contractor shall perform, at the request of the Engineer, any related work not covered by plans and specifications or unit prices which may arise during construction, on the basis of a lump sum negotiated between the Contractor and Architect or Engineer and approved by the Owner for said extra work, which sum shall be broken down into its component parts; or compensation for actual labor, materials and equipment rental involved in said work plus an agreed to percentage of the percentage stipulated in the Bid; or in accordance with the Contingent items schedule included in the Bid for Sewer and Underground Utility Projects.

The cost for labor and equipment for Building and Structures Projects shall cover all actual costs, which shall include all insurance costs, all taxes (including Payroll Taxes), Social Security, Workmen's Compensation, Old Age Benefits, and Bonuses. The percentage on materials for both Building and Structure Projects, and for Sewer Projects shall be sufficient to cover the administrative costs associated with the procurement of the materials and guarantee of the additional work performed by the General Contractor and his Subcontractors. The percentage to be added shall be stipulated in the Bid Package.

All changes in the work or extra work made pursuant to a written order shall be performed under the terms of the Contract Document. The provisions of the following paragraph of the General Conditions shall not be applicable. Should the percentage be divided between the General and a Subcontractor, the Subcontractor should add his portion of the percentage to the actual cost of the work and not to be Subcontractor's total.

Whenever changes, alterations, additions, omissions or revisions are called for by the Owner through the Engineer for which the necessary drawings and details have been completed and submitted to the Contractor, or when changes, alterations, additions or omissions are clearly given in writing to the Contractor, he is to submit the proper extra or credit as the case may be, and in addition, an itemized statement of quantities and prices incidental to such revisions, changes, additions and omissions to facilitate the checking of the quantities involved.

Final Completion – The time at which the Work has progressed to the point where, in the opinion of Engineer, the Work is complete, and the Contractor has delivered, in accordance with the Contract, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents and all other documents required by the Contract.

Guarantee Period - One (1) year following the date of final acceptance of the work by the City unless otherwise specified.

Infiltration and Inflow – Unwanted groundwater or stormwater entering a sanitary or combined sewer collection system through a defect in the sewer system.

Inspector - The person appointed by the Director of Public Works or Utilities, or his duly authorized representative, whose duty it is to inspect the materials used, and see that the work is performed in accordance with the Contract documents; and carry out such instructions as given him by the Engineer.

Invert - The lowest point in the internal cross-section of a pipe.

"May" or "Should" – means highly desirable, but not required.

Notice to Proceed - A written notice to the Contractor of the date on which he shall begin the persecution of the work.

Performance Bond - The approved form of security furnished by the Contractor and his Surety as a guaranty of good faith on the part of the Contractor to execute the work in accordance with the terms of the Contract

Plans - Those drawings specifically referred to as such in the Invitation for Bid or in any Addendum. Drawings issued after the execution of the Contract to further explain, or to illustrate, or to show changes in the work will be known as "Supplementary Drawings" and shall be binding upon the Contractor with the same force as the Plans.

Private Sewer – Refers to any sewer facility or line that is not owned and maintained by DPU.

Proposal - The offer of the Bidder when submitted on proposal form, properly signed and guaranteed.

Public Sewer – Any sewer facility or line that is owned and maintained by DPU.

Right-of-Way (ROW) – Land reserved, used or to be used for a highway, street, alley, walkway, bikeway, sidewalk, utility, drainage facility, or other public purpose.

Roadway - That portion of the street intended for use of vehicular traffic.

Sewage Collection and Treatment (SCAT) Regulations – shall mean the regulations adopted by the Commonwealth of Virginia/State Water Control Board/Virginia Department of Environmental Quality (VDEQ) and authorized by Title 32.1 – 164 and 62.1-44.19 of the Code of Virginia.

Sewer Laterals – The pipe or conduit (generally 6-inches and larger) conveying wastewater in a gravity sewer from a property to the public gravity sewer system and has no other common sewer tributary connected to it

Sewer Gravity Main – The pipe or conduit (generally 8-inches and larger) that conveys wastewater or combined sewage from one point to another by gravity

Sewer Force Main –Pipe that conveys wastewater from one point to another by pressure

Sewer Service Connection – Generally refers to the combination of piping, fittings, and structures that include the cleanout, sewer lateral piping, and point of connection to the sewer gravity main.

Sewer System – the combination of pipes, structures, and pump stations that convey sanitary and combined sewer.

"Shall" or "Must" – means a mandatory requirement.

Special Provisions - Special directions, provisions or requirements peculiar to the project under consideration and not otherwise detailed or set forth in the specifications. Special provisions shall prevail over specifications or supplemental specifications and plans whenever in conflict therewith.

Specifications - Are the documents which describe the work which cannot be readily indicated on the Drawings and which set forth the types and qualities of materials and equipment, the methods of installation of such materials and equipment, and the results to be achieved.

Street - The whole right-of-way included between property lines, reserved for the accommodation of the traveling public, and its appertaining structures and slopes, and all ditches, channels, waterways, etc., necessary to its correct drainage.

Subcontractor - A person, partnership or corporation to whom the Contractor, with written consent of the Owner, sublets part of the work. A Subcontractor has no contractual relationship with the Owner.

Substantial Completion - The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

Superintendent - The executive representative of the Contractor authorized to receive and fulfill instructions from the Engineer and supervise and direct the construction.

Surety - Any person, firm or corporation that has executed as Surety the Contractor's Performance Bond securing the performance of this contract.

Virginia Erosion and Sediment Control Handbook (VESCH) – The publication authorized by Section 34-32, Code of Virginia, latest edition, to control land disturbing activities.

Warranty – A written guarantee of the quality of a product or equipment including a guarantee of repair or replacement in the case of failure of the product or equipment within the specified timeframe.

Work - That which is proposed to be constructed or done under the contract documents.

SECTION 2 GENERAL CONDITIONS

2.1. GENERAL CONDITIONS

The latest issue of the City of Richmond "General Conditions of the Contract" and all amendments thereto are incorporated in and made apart of these Sewer Specifications by reference. If conflicts occur between the Contract and Standards, the more stringent requirement applies.

II. SANITARY SEWER DESIGN STANDARDS & PROCEDURES

SECTION 1
GENERAL DESIGN STANDARDS

1.1 GENERAL REQUIREMENTS

1.1.1 General

A. The purpose of this manual of standards and guidelines is to provide conformity to the design and review of wastewater utility improvements that are to be owned, operated, and maintained by DPU.

The sections of this manual identify routine or standard design assumptions and practices accepted by the Department. Special or unique design situations must be addressed on a case by case basis. This manual is intended for use by design professionals, contractors, and the City in the design, construction, and maintenance of wastewater facilities.

B. The design standards set forth in this manual are adopted pursuant to the authority granted in the Richmond City Code – Chapter 28, Article II, Section 28-26 – Adoption of rules and regulations.

C. The design of all sanitary sewer systems shall be performed under the direction of a registered professional engineer with a current registration in the Commonwealth of Virginia in accordance with Title 54.1, Chapter 3 of the Code of Virginia, 1950, as amended Where applicable, design may be performed under the direction of a certified land surveyor in accordance with Sec. 54.1-408 of the above cited code.

D. All designs shall conform to the Virginia Sewage Collection and Treatment Regulations and to the requirements of other State and Federal Agencies having jurisdiction.

E. All designs shall conform to the requirements of DPU. Where the requirements of the State and City are in conflict, the more restrictive requirements shall govern.

F. The design engineer shall be responsible for obtaining the review and necessary approvals of all drawings and specifications by applicable agencies having jurisdiction. Copies of such approvals shall be submitted to DPU at the time of final review by the Department.

G. Sanitary sewer lines for developments or subdivisions are to be designed to serve the entire sewershed of which the subdivision or development is a part. This necessitates consideration of property beyond the development or subdivision in question. The design engineer is required to design and construct the system, properly sized and at an appropriate location, to permit

future extensions to be made at the limits of the subdivision or development in question. Elevation of the proposed sewer system lines and structures must be designed such that future extensions can serve the entire area which naturally drains towards the existing system.

1.1.2 DPU Review

A. An Engineering Report (Appendix A) shall be submitted to and approved by the Department before approval of drawings and specifications, except for lateral connections. The Engineering Report shall include sewer flow generated in the service area and used for design or other purposes. This report shall contain an Overall (System Layout) Plan, which shall indicate the entire proposed construction area together with a sufficient amount of surrounding area in order to clearly outline the interrelationship of the two. The report shall demonstrate that the sewer lines are designed to serve the entire subdivision or development. Existing and proposed development shall be shown as well as existing and proposed utilities. Where phase development is contemplated, the extent of each phase shall be clearly delineated. Additional requirements for the Engineering Reports are as described in other divisions of these standards (including Paragraphs 1.1.3, and 2.2.2) and as required by the City.

1. Flows determined in accordance with Paragraphs 1.1.3 and 2.2.2 shall be provided to the City, so that a hydraulic analysis can be evaluated with the City's hydraulic water model. The City will evaluate the existing sewer infrastructure with the projected wastewater flows from the proposed construction in conjunction with a 10-year storm event. Modeling results will be provided by the City. Should the City's hydraulic model simulation(s) determine that the projected wastewater flows from the proposed construction exceed 90% capacity of the existing sewer infrastructure during a 10-year storm event, then the entity (Owner/Developer) proposing construction shall be required to address the capacity issues.

B. Prior to construction of sanitary sewer facilities, construction drawings for the proposed facilities must be submitted for review to DPU. The construction drawings must be in a format acceptable to the Department. Prior to submittal of any development/subdivision construction plans, the developer, or its agent, shall submit an overall plan of the proposed wastewater systems for the entire development to DPU for review and approval.

C. The System Layout Plan which delineates sewer shed area boundaries shall be prepared. The plan shall clearly define the areas pertinent to interim and ultimate development of the service area. The System Layout Plan shall show present and future development and proposed interim and future utilities," as well as those existing utilities that will be affected by or have an effect on the proposed utilities. Existing and proposed ground elevations shall be shown at

contour intervals not exceeding 5 feet unless otherwise approved by the City. Proposed utilities necessary to serve adjacent properties and associated easements shall be shown.

D. Easement Requirements:

1. Off-site easements shall be recorded and the Deed Book and Page Numbers of the recordation included on the utilities plans before approval of the plans for construction.

2. Permanent easements shall be a minimum of 20 feet in width with consideration for wider easements where more than one utility may occupy an easement, or where, because of line size or access requirements, wider easements are desirable.

   The following table identifies minimum permanent easement widths based on pipe size and depth.

Table 1-1. Minimum Easement Width Requirements

Trench Depth (ft)	8” - 24” Dia.	27” - 36” Dia.	42” - 64” Dia.
0 - 8	20’	25’	30’
8 - 12	30’	30’	35’
12 - 16	35’	40’	45’
16 - 20	45’	45’	50’

   Where multiple pipes will occupy the easement, the depth of sanitary sewer exceeds 20 feet, or where slopes exceed 30%, easement widths will be determined by DPU on a case-by-case basis.

3. Sanitary sewer easements terminating at a manhole shall extend ten (10) feet beyond the manhole to allow access for maintenance and repair.

4. Temporary construction easements may be required for public sewer facilities where work will be performed on private property.

5. Installation of trees, landscaping, shrubs, light posts, structures, buildings, stormwater facilities, BMPS, wetlands, berms, or other obstructions, which prevent the proper installation, maintenance, rehabilitation, operation, inspection, or removal of water and sewer facilities shall not be permitted within any permanent public utility easement, unless approved in writing by DPU Director or his designee.

1.1.3 System Design

A. An analysis shall be prepared that tabulates the number of people being served or proposed to be served as determined from existing zoning. The tabulation shall be by incremental areas for evaluation purposes.

B. Average and maximum flows shall be developed for areas and sub-areas and tabulated in the report as deemed necessary or appropriate.

C. The design documentation shall address total current and projected future flows and system capacities of existing and proposed utilities and shall provide the proposed sewer line sizes.

D. Facility sizing shall be based on ultimate development (complete build-out of the area) and shall present all information necessary for a sound evaluation of the factors used in development of the report.

E. If proposed, an alternate design incorporating interim or staged construction shall be included in the design report.

1.1.4 Design Information

A. A commercial or industrial establishment that is using an individual private water supply well requesting connection to the City's sanitary sewer system shall install a water meter (per DPU standards) on the well discharge, at their expense, for the purpose of billing sewer charges. Such meter shall be calibrated upon request of DPU at customer’s expense and documentation shall be provided to DPU of such.

B. Request for temporary sewer service for construction trailers shall be directed to DPU, 804-646-8544.

C. All existing sewer services to the property shall be shown on the utility plan. If the existing sewer services will not be utilized, they shall be abandoned in accordance with specification Section 02050 and 02110.

1.1.5 Separation of Water and Sewer Lines

A. Sewers shall be laid at least 10 feet horizontally from a water main. The distance shall be measured edge-to-edge. When local conditions prohibit this horizontal separation, the sewer may be laid closer provided that the water main is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water main is at least 18 inches above the top of the sewer. Where this vertical separation cannot be obtained, the sewer shall be constructed of water pipe material in accordance with AWWA specifications and pressure tested in place without leakage prior to backfilling. The hydrostatic test shall be conducted in accordance with the

most recent edition of the AWWA standard (ANSI/AWWA C600-82) for the pipe material, with a minimum test pressure of 30 psi.

B. Sewers shall cross under water mains such that the top of the sewer is at least 18 inches below the bottom of the water main. When local conditions prohibit this vertical separation, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter. Sewers crossing over water mains shall:

1. Be laid to provide a separation of at least 18 inches between the bottom of the sewer and the top of the water main.
2. Be constructed of AWWA approved water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter.
3. Have adequate structural support to prevent damage to the water main.
4. Have the sewer joints placed equidistant and as far as possible from the water main joints. No water pipe shall pass through or come into contact with any part of a sewer manhole. Manholes shall be placed at least 10 feet horizontally from a water main whenever possible. The distance shall be measured edge-to-edge of the pipes or structures. When local conditions prohibit this horizontal separation, the manhole shall be of watertight construction and tested in place.

1.1.6 Separation of Sanitary and Storm Sewers:

Where the sanitary sewer is installed parallel to a storm sewer, there shall normally be a minimum of 5 feet of horizontal separation measured edge to edge between them. Under unusual conditions, this requirement may be reduced by the City. If a sanitary sewer is located more than 5 feet below the bottom of a parallel storm sewer, DPU may require the horizontal distance between the pipes to be increased.

1.1.7 Sewer In Relation To Streams, Estuaries, Lakes, Reservoirs, Railroads, Roadways, or Piers

A. Location of Sewer in Relation to Streams, Estuaries, Lakes, or Reservoirs:

1. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, 1 foot of suitable cover shall be provided where the stream is located in rock, and 3 feet of suitable cover shall be provided in other material. Less cover may be considered, if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to the stream channel and adequate reason for such reduced cover is provided. Such locations shall be approved by DPU on a case-by-case basis.

2. When proposed under paved channels, the top of the sewer lines should be placed a minimum of 18-inches below the bottom of channel pavement.

3. Clay dams shall be utilized in the trench where the possibility exists for damage or undermining of pipe bedding due to ground or surface water following the sanitary sewer trench.

4. Sewers shall remain fully operational during 25-year flood/wave action. Sewers and their appurtenances located along streams shall be protected against the normal range of high and low water conditions, including the 100-year flood/wave action. Sewers located along streams shall be located outside the stream bed wherever possible and sufficiently removed therefrom to provide for future possible channel widening. Reasons for requesting sewer lines to be located within stream beds shall be thoroughly documented and such locations shall be approved by DPU on a case-by-case basis.

B. Sewer Crossing Streams, Estuaries, Lakes, or Reservoirs:

1. Sewer lines entering or crossing streams shall be constructed of watertight ductile iron pipe for pipes up to 64-inches in diameter. Material for larger pipe shall be evaluated on a case-by-case basis. The pipe and joints shall be tested in place, shall exhibit no infiltration or exfiltration, and shall be designed, constructed, and protected against anticipated external loads, and erosion impact.

2. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade due to erosion or external loads. If an aerial crossing is required, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 50-year flood unless approved otherwise in writing by the DPU Director or his designee. Ductile iron pipe with flanged or restrained mechanical joints shall be used as appropriate to the situation and shall be approved by DPU. Detailed design shall be submitted to include location of piers, structural design of piers, and foundation requirements. Maximum distance between piers shall be based on pipe manufacturer's recommendations.

C. Sewer Crossing Railroads and Roadways:

All sanitary sewer line crossings of railroads, roadways, and other major structures shall be encased in a casing pipe. Design of railroad crossings shall comply with the requirements of American Railway Engineering and Maintenance-of-Easement Association (AREMA) Specifications, Part 5 -

Pipelines (latest revisions) and / or the requirements of the railroad owner / operator.

D. Sewer in Longitudinal Railroad Installations:

Sewers shall not be installed longitudinally in railroad rights-of-way unless it is demonstrated that no other feasible alternative exists for such installation. DPU reserves the right to reject such proposed locations irrespective of railroad approval.

1.1.8 Protection of Water Supplies

A. Water Supply Interconnections:

There shall be no physical connection between a potable water supply and a sewer, sewage pumping station, or appurtenances thereto.

B. Relation to Water Works Structures:

No general statement can be made to cover all conditions; however, for all potable water supply wells and other water supply sources and structures, sewers shall meet the requirements of the Virginia Department of Environmental Quality and the Virginia Department of Health Waterworks Regulations with respect to minimum distances from water supply wells or other water supply sources and structures. No sewer line shall pass within 50 feet of a potable water supply well or other potable water supply source or structure unless special construction and/or pipe materials are used to obtain adequate protection. The designer is referred to the current edition of the Virginia Sewage Collection and Treatment Regulations. The proposed sewer design shall identify and adequately address the protection of all potable water supply structures within 100 feet of the proposed project.

1.1.9 Installation of Tracer wire

A. Buried tracer wire shall be installed on sewer laterals (new installations or replacements) and force mains. Tracer wire shall comply with specifications listed in Section 15051.

1.1.10 Installation of Electronic Markers

A. Buried electronic markers shall be installed at key points along lines as specified in DPU Standard Details. Markers shall comply with specifications listed in Section 15051.

1.1.11 Backfill and Compaction

A. The Design Engineer shall include compaction requirements on the plans:

1. Minimum compaction shall be specified.

2. Compaction requirements for roads and paved areas shall be specified.

3. Compaction requirements adjacent to structures shall be specified.

B. Additional backfill and compaction requirements are provided in specification Section 02220.

1.1.12 Contacting Property Owners

Prior to performing any survey and design work on private property, the engineer/surveyor shall notify all landowners that may be affected by the design or installation of the proposed utility line. Notification shall be made in the form of a letter to be sent to the property owner seven to ten days before commencing work Copies of such letters shall be provided to DPU along with the initial plan submittal.

1.2. DRAWING ORGANIZATION AND FORMAT

1.2.1 Drawing Organization

A. Drawings shall consist of the following types of sheets arranged in the order listed:

1. Cover Sheet.
2. Index Sheet (if necessary).
3. Plan Sheets.
4. Profile Sheets.
5. Standard Sheets and Special Details.
6. Erosion and Sediment Control Details

B. Projects consisting of only structures may not require plan and profile sheets.

1.2.2 Sheet Format

A. All construction drawings shall be on sheets 24 inch x 36 inch.

B. The cover sheet shall contain the Owner's name and project description in large, distinctive letters, a vicinity map drawn on a scale of 1 inch = 2,000 feet to indicate-the general vicinity of the contemplated construction, an index to the plan sheets and a signed stamp of the design engineer or person responsible for the design. The vicinity map shall include a North arrow and a scale.

C. A plan shall be prepared for sewer line and sewage force main projects. The index map shall be to a scale not less than 1 inch = 600 feet and shall show all proposed utilities with tie to existing utilities. The lines of the proposed construction, together with proposed utility structures, shall be indexed to the drawings to indicate the extent of coverage on each drawing, or, in the case of structures, to the group of drawings involved.

D. Where proposed sewer improvements will connect to existing sewer infrastructure, the design plans shall utilize surveyed elevations over City Geographic Information System (GIS) data. Any City GIS elevations shown on the plans shall be designated as "GIS" and shall be for information only. Surveyed data shall be utilized for proposed improvements and modifications to existing infrastructure when elevations are required for specifying the needs of construction.

E. Plan sheets, as well as Plan and Profile Sheets, shall show horizontal, vertical, and topographical data as outlined in Section 1.2 of these Guidelines.

F. All plans shall bear a suitable title showing the name of the municipality, sewer district, and institution or other Owner(s). The plans shall also show the scale in feet, the North arrow, the date, and the name of licensed professional responsible for preparation of the plans. Also, each plan sheet shall bear the same general title identifying the overall project, and shall be numbered.

G. Drafting Conventions:

1. A Symbol Key or Legend of drawing symbols utilized shall be included on the Cover Sheet. Existing facilities shall be half tone.
2. Standard Symbols - Proposed Facilities: Symbols shall be as shown above except that solid lines shall be used for pipes, line weight shall be no lighter than 0.024 inches and no heavier than 0.031 inches.
3. Text, Dimensions, and Notes: Lettering shall be consistent and clear with a minimum height of 0.10 inches.

H. Drawing Standards:

1. All plans submitted for review shall comply with the format and quality control requirements of the DPU Standards. Plans which do not meet these criteria will not be acceptable for review.
2. Plans submitted for review shall be in electronic format (i.e. – PDF format).
3. Drawings shall be clear and legible. Text shall be opened so that it is readable when drawings are reduced to half size. All drawings must be

capable of producing legible second generation prints after being reduced to half size.

4. The contrast of the printed material shall be high, with blank areas being as white as possible, and all information being as dark as practicable, while remaining clear and distinct.

5. Shading, such as on plan views for paving, shall not be used on the drawings where it will hide any information when the drawing is photocopied or scanned. Shading with a pencil or using dark film will not be accepted. For areas that need to be identified or highlighted, stippling or cross hatching may be used, provided no other information is hidden.

6. It is the intent of these Guidelines that all submitted plans are scanned for archiving. If there is any question regarding legibility, the plans shall be scanned and acceptability determined by the City upon printing of the scanned image at half size.

I. Additional Information:

1. Drawings shall include estimated materials quantities.

2. Horizontal scale in Plan and Profile Sheets shall be no smaller than 1 inch = 50 feet.

3. A bar scale shall be included on each sheet.

4. Vertical profile scale shall be no smaller than 1 inch = 5 feet.

5. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, sewer mains, gas mains, storm drains, storm mains, utility service lines, etc. shall be shown in plan and profile.

6. Benchmarks shall be set no more than 500 feet apart along the lines of construction but outside the limits of construction.

7. Drawings shall show off-site easements required and identify Deed Book and Page Number.

J. Record Drawing Requirements:

1. Record drawings for DPU or developer projects shall be prepared by the Engineer based on marked up plans provided by the Contractor upon completion of the work. These drawings must show changes from construction plans, conditions found during the work, and conditions that changed during the work.

2. A complete set of record drawings shall be furnished to DPU in CAD (AutoCAD 2015 or earlier) and .pdf formats at a resolution required to retain all information at a readable level (600 dpi minimum) showing

the asbuilt locations and dimensions. Record drawings shall be combined into one drawing set file and furnished to DPU on a data storage device (CD, DVD, or flash drive).

3. All as-built dimensions shall be expressed in feet.

4. Each sheet shall be marked "Record Drawing" and dated. Where data needs to be revised based on as-built information, the original data shall be removed. Do not use "strike-through/out" on text or items that don't correctly show as-built conditions. Plan view of proposed facilities shall be redrawn to depict as-built conditions if the difference between the approved construction plans and the as-built condition deviates by more than five (5) feet. Utility profiles shall be redrawn if the difference between the approved plans and the as-built condition deviated by more than one (1) foot.

5. In addition to record drawings submitted as detailed above, digital information shall be recorded in the field during and after construction using GPS equipment or conventional survey methods (suitable for the accuracy required herein). This information shall be provided to DPU for the purposes of updating the City's GIS.

6. Survey grade accuracy for as-builts shall be as follows:

   a. Horizontal – approximately 0.5 inch

   b. Vertical – approximately 1 inch

7. For sanitary sewer projects, the following minimum information shall be collected and shown on the asbuilt plans:

   a. Manhole and Cleanout Rim Elevations (at center point of lid)

   b. Manhole inverts of all entering/exiting pipes

   c. Cleanout inverts at property line

   d. Pipe Length (Measurement of pipe between center of upstream and downstream manholes)

   e. Pipe slope between manholes

   f. Pipe material

   g. Utilities encountered during construction but not shown on the original construction plans

   h. Station and offset for lateral connections and cleanouts

   i. Utilities abandoned in place.

1.3. COORDINATION WITH OTHER DEPARTMENTS

1.3.1 Department of Public Works

A. Refer to the latest edition of the City's Municipal Tree Policy.

B. Refer to the latest edition of the City's standard requirements for repaving utility repairs.

SECTION 2
DESIGN STANDARDS FOR GRAVITY SANITARY SEWERS

2.1 GENERAL REQUIREMENTS

2.1.1 New sanitary sewers are to be provided solely for the collection and transport of sanitary wastewater. Storm drain(s) (roof drains, foundation drains, surface or subsurface drains, etc.) shall not be connected to the sanitary sewer system. Exceptions may be made for buildings connecting within the existing combined sewer area that are not extending new mains and not materially increasing flow. Exceptions shall be granted on a case-by-case basis and shall be at DPU's sole discretion. The following design parameters include an adequate allowance for normal infiltration but will not accommodate the above forbidden connections.

2.2. TECHNICAL DESIGN

2.2.1 System Layout

A. The overall layout and general design shall conform to the parameters set forth in the approved engineering report as defined in Section 1.1.2 of these Design Guidelines.

B. All sanitary sewers shall be located in:

1. Legally established road right-of-way; or
2. Legally established permanent easements for such purpose, either existing or as proposed by the designer in accord with Section 1.1.2.D, "Easement Requirements," of these Guidelines.

C. Construction shall be along the center line of travel lane or easements except when this location has been previously used by another utility, or when the width of a road right-of-way justifies the use of two sewer lines. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.

D. All sanitary sewers shall be laid on a straight line between manholes unless approved by the City, except that consideration will be given to laying sewers larger than 24 inches in diameter on a curve.

E. All sewers shall be on continuous grade between manholes.

F. Sewers should intersect in manholes at deflection angles no greater than 90 degrees. In the event that this is impractical, the designer must prove to DPU that adequate losses have been provided in the hydraulic analysis.

G. Where sewer depth is 10 feet or less, sewer mains and manholes shall be located a minimum of 10 feet horizontally from any part of a building,

structure, or its foundation. Where the depth of sewer is greater than 10 feet, the sewer mains and manholes shall be located a minimum of 15 feet from any part of a building, structure or its foundation.

H. Sewers shall be located outside of wetland areas wherever possible.

I. Sewers shall be located outside of the limits of stormwater ponds and basins.

2.2.2 System Design

A. The overall design shall be in accordance with the provisions of the approved engineering report in accordance with Paragraph 1.1.2 of these Guidelines.

1. The design of carrying capacities of sewers shall be based upon the total sewer service area served by the line or lines in question. The design flow shall be based on acreage density, using the Land Use Map or approved zoning, whichever indicates and allows higher densities.

2. Wastewater flows from motels, schools, hospitals, etc. shall be estimated based upon sewer flow rates as found in the Virginia Sewage Collection and Treatment Regulations, latest edition (see Table 2-2).

3. In the absence of information on population densities or unit flows, the designer shall supply sufficient information, substantiated by sound engineering judgment to verify the design flow rates. The information shall be subject to approval by DPU.

2.2.3 Capacity Design

A. Trunks and interceptors shall be designed on the same basis as direct service mains, except in cases where capacities of system or parts thereof can be readily increased by future relief, allowing for shorter capacity design life of initial or subsequent lines.

B. Sewer mains shall be designed to carry ultimate sewer service areas population with a 50-year protection as an upper limit. Proper allowance for peak flow shall be included.

C. Computations for sizing of all lines shall be shown on a form similar to the Sewer Design Form (Appendix B), including anticipated future relief lines that may be required.

Computations shall be accompanied by an Overall (System Layout) Plan (Paragraph 1.1.2.B.), and should conform to index map requirements (Paragraph 1.2.2.C.). Maps shall show entire drainage area involved, location(s) or line(s) in system, and points of entry of flows, including any flows being received from other areas. Drainage area map shall be keyed to the hydraulic analysis computation sheet. Computations and maps shall be submitted to DPU for approval.

The quantity of wastewater for design purpose shall be determined by the future requirements of the total sewer service area.

Average quantities of sewage, including infiltration shall be computed as follows:

The following table should be used when specific information regarding proposed development is not known (i.e. for master planning purposes). The flow factors should be applied to gross acreage minus wetlands or environmental areas that preclude development.

Table 2-1. Average Sewage Quantities

	GALLONS PER DAY PER ACRE	EQUIVALENT PERSONS/ACRE
Single Family Residential		
R-1	500	5
R-2	800	8
R-3	1,200	12
R-4	1,500	15
R-5	2,000	20
R-6, R-7	3,500	35
Multi Family Residential		
R-43, R-48	6,000	60
R-53, R-63, R-73	10,000	100
Commercial		
Retail	2,000	20
Office	1500	15
Industrial		
M-1 Light	2,000	20
M-2, M-3 Medium, Heavy	3,500	35
Other		
Other (Agriculture/Undeveloped Land)	1,000	10

Where site specific determinations can be made, wastewater flows may be determined by using the following design information:

Table 2-2. Predicted Wastewater Flows For Residential Facilities

DISCHARGE FACILITY	DESIGN UNITS	FLOW (GPD)
Residential		
Single family units (includes Townhouses, Individual house trailers, etc.)	3.5 people/dwelling	350
Apartments and Condominiums	4 people/3 bedroom apt. 3 people/2 bedroom apt. 2 people/1 bedroom apt.	350 300 200
Schools with showers and cafeteria	per person - Elementary per person - High School	16 25
Motels and hotels at 65 gals/person (rooms only)	per room	130
Trailer courts at 4 persons/trailer	per trailer	400
Restaurants	per seat	50
Service stations	per vehicle services	10
Factories	per person per 8 hr. shift	25
Shopping centers	per 1000 sq. ft.	250
Hospitals	per bed	300
Nursing homes	per bed	200
Homes for the aged	per bed	100
Doctors office in medical center	per 1000 sq. ft.	500
Laundromats, 9 to 12 machines	per machine	500
Theaters (auditorium type)	per seat	5
Bowling alleys	per lane	75
Office buildings	per 1000 sq. ft. of ultimate floor space	200

Note: Other classifications may be found in the Virginia Sewage Collection and Treatment Regulations, latest edition.

2.2.4 Hydraulic Design - Sewers

A. Minimum grades shall not be less than those required to produce a velocity of approximately two and one-quarter (2.25) feet per second when the sewer size selected is flowing full. Pipe sizes shall not be arbitrarily increased in order to take advantage of a flatter grade.

B. The minimum size pipe to be used in systems shall be 8 inches.

C. Peak flows shall be utilized for the design of gravity sewers and shall be determined as follows:

For average daily flows (Q_A) up to and including 6.0 MGD, peak flows (Q_P) shall be based on the following:

$$Q_P = 3.51153 \times Q_A^{0.8121}$$

For average daily flows (Q_A) greater than 6.0 MGD, peak flows (Q_P) shall be based on the following:

$$Q_P = 2.5 \times Q_A$$

The use of other peaking factors will be allowed on a case by case basis where approved by DPU Deputy Director or designee provided sufficient supporting documentation is provided to justify their use.

D. Allowable minimum sewer line slope grades shall be as follows:

Sewer Size (Inches)	Minimum Slope in Feet/100 Feet
8	0.40
10	0.30
12	0.23
14	0.19
15	0.17
16	0.16
18	0.14
21	0.11
24	0.08
27	0.07
30	0.06
33	0.06
36	0.05
42	0.04
48	0.03
54	0.03
60	0.03
64	0.02

E. Computations for velocity of flows shall be based upon the following values of "n" as used in the Manning formula for velocity of flow.

1. Sizes 8-inch through 21-inch: "n" equals 0.013
2. Sizes 24-inch and above: "n" equals 0.012

Manning Formula

$$v = (1.49/n)R^{2/3} - S^{1/2}$$

Where:

R = Hydraulic Radius
S = Slope
n = Manning's Roughness Coefficient

F. In cases where the calculated depth of flow is less than pipe flowing full, the velocity at actual depth of flow shall be computed.

G. For sewage flow depth less than 1/4 full, an allowance shall be made for increased value of "n" and in no case shall velocities of less than 1.3 feet per second be permitted. Higher than minimum velocities shall be accomplished by steeper grades and not by decreasing pipe diameter.

H. Generally, the size of pipes shall be continually increasing in direction of flow with addition of tributary areas. However, when steep grades are available and length is such that significant cost savings will result without jeopardizing the system, the size of pipe may be reduced to no more than two nominal diameters, but not below 12 inches. Proper hydraulic allowances must be made for resulting head losses.

I. Miscellaneous head losses at manholes and curves shall be computed as follows. Junctions of more than two pipes will require special consideration.

1. Manholes where radius of turn is less than 2 pipe diameters: H

$$= 0.50 \, (\text{angle}/90)^{0.5} \, (V^2/2g)$$

2. Manholes where radius of turn is greater than 2 pipe diameters:

$$H = 0.25 \, (\text{angle}/90)^{0.5} \, (V^2/2g)$$

Where:

"angle" is horizontal deflection angle
$V^2/2g$ is velocity head of effluent pipe

V is velocity in ft/sec
g is earth gravity acceleration

3. Headloss for straight run manhole shall be 0.05 feet. In no case shall loss less than 0.05 feet be allowed.

J. Where pipe diameters increase at manholes, in direction of flow, effluent invert shall be lowered below influent elevation as follows:

Change equals $0.8 \, (D_1 - D_2)$ Ft.

Where:

D_1 equals downstream pipe diameter

D_2 equals upstream pipe diameter

This adjustment shall be in addition to computed miscellaneous headloss.

K. Special consideration shall be given to cases where pipe diameters decrease in direction of flow.

L. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to appropriate ASTM or AWWA specifications which provide protection against internal erosion.

M. Hydraulic computations shall be submitted to DPU for approval. The Design Engineer shall submit the information and calculations on sewer flow demands for the project with the sewer plans. The Design Engineer shall then furnish all calculations used for sizing of the proposed sewer lines.

2.2.5 Structural Design and Location

A. Structural requirements must be considered in the design of all sewers and appurtenances.

B. The proper material strengths shall be determined and indicated for sewer pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width, trench bedding conditions, existing ground conditions, etc. This is a matter of detail design not subject to simple generalizations. Minimum bedding requirements are defined in specification Section 15051.

C. In deep cuts (deeper than 8 feet), it is generally preferable to change pipe strengths to obtain proper design rather than vary bedding conditions. Pipe strength or class shall be shown on plans with stations to indicate the location.

D. No change in pipe strength or material shall be made between manholes unless it can be substantiated that considerable cost savings would result and that the integrity for the system would not be jeopardized. Proper precautions shall be taken regarding correct locations of varying strength of pipe.

E. The minimum manhole diameter shall be determined in the design and is based on pipe diameters and intersecting angles per the Manhole Sanitary Sewer standard details. Depth shall also be considered when sizing manhole diameters as depths over 20 feet require a minimum manhole diameter of 60-inches.

F. Gravity systems receiving pumped flows shall be protected against hydrogen sulfide corrosion for a distance of 1,200 feet downstream from point of pumped flow entry. This shall be accomplished by the use of acid-resistant pipe and manholes. DPU shall approve the materials and design for the conditions at each individual location.

G. Ductile iron pipe shall be used for all stream or estuary crossings. Ductile iron pipe shall be used as the carrier pipe within any casing pipe.

H. Anchor sewers on slopes of 20 percent or greater. Suggested minimum anchorage is as follows but should be:

1. Not over 36 feet center to center on grades 20 percent to 35 percent.
2. Not over 24 feet center to center on grades 35 percent to 50 percent.
3. Not over 16 feet center to center on grades 50 percent and over.

I. Ductile iron pipe shall be used in subdivisions for sanitary sewer lines installed in an easement along the property line between buildable areas.

J. Ductile iron pipe shall be used in easements where, in the opinion of DPU, the sanitary sewer is not accessible from a street parking lot, or driveway.

K. In cases where sanitary sewers are to be constructed on steep grades and velocities may exceed 15 feet per second, solid wall PVC pipe or other abrasion resistant material shall be used.

2.2.6 Sewer Appurtenances

A. Standard and drop manholes, service connections and other appurtenances shall be constructed in accordance with Division 2 specifications and Manhole details Ml – M18.

B. Manholes shall be installed at the end of each line, at all grade, size, or alignment changes, and at all sewer line intersections.

C. Laterals

1. New sewer laterals for both residential and non-residential connections shall have a minimum diameter of 6 inches. Cleanouts shall be installed for each connection in accordance with Sewer Lateral Connection Details P5A and P5B. Connections shall be made at an angle of 90 degrees to the sewer line. Connections shall be installed at a minimum grade of 1/4 inch per 1 foot. Plugged service connections are to be provided when required by DPU for all lots and parcels within a new development. Sewer lateral material shall match the material of the sewer main except as follows:

   a. Unless specified otherwise on the plans, PVC piping shall be used for laterals that connect to sewer mains constructed of brick, HDPE, concrete, clay, segmented block, or other non-standard material.

   b. For deep lateral connections, ductile iron piping shall be used for the laterals. Deep lateral connections are 15’ deep or greater.

2. At an upstream manhole in a cul-de-sac, the maximum number of laterals allowed into the manhole is 3.

3. For single family structures, each house shall be served by one lateral connected to a City sewer main. If sewer main is being extended to serve new single family homes, then the sewer main shall be built to City standards and turned over to the City upon completion.

4. Multi-family, commercial, and industrial businesses shall not have multiple buildings on an individual sewer lateral. Sewer service shall be one of the following:

    a. Each building shall be served by its own separate lateral connection that is connected to a City sewer main.

    b. Extend sewer main onto the property/development to allow each building to have its own separate lateral connection. If main is extended via easement or right-of-way, then the sewer main extension shall be built to City standards and turned over to the City upon completion.

    c. Extension of mains as opposed to use of a lateral may be required for larger single buildings. The engineer shall provide calculations to justify lateral capacity to verify use of a lateral is sufficient.

5. Where new commercial and industrial buildings are proposed to be connected to City sewer where the property has an existing lateral proposed to be re-used, the following conditions and actions shall apply:

    a. Condition of the lateral shall be investigated by the development's owner or their designee via CCTV. The CCTV investigation shall be provided to DPU for review.

    b. Any lateral with large belly sags, deterioration/corrosion, collapses, or any other significant defects shall not be re-used and shall be replaced at DPU cost. The discretion to re-use existing laterals shall be solely DPU's.

6. Service Availability:

    a. Private laterals of any kind are prohibited from being place in City streets per DPW directive. If sewer does not front the property being served, one of the following conditions will apply:

        i. extension of the mains will be required:

        ii. a lateral extension off the main to a neighboring property with a permanent, non-revocable easement from the neighboring property allowing a private lateral extension across their property

        iii. an exception to allow the property to not be served by City sewer

D. When manholes are located in paved areas accessible to vehicular traffic they shall be spaced at distances no greater than 400 feet for sewer sizes up to 15 inches and 500 feet for sewer sizes 16-inch through 30-inch. When located in inaccessible areas, spacing of manholes on sewer lines 30-inch or less shall not exceed 350 feet.

E. Spacing of up to 500 feet may be permitted in sewers larger than 30 inches.

F. Sewer lines shall be protected from a 100 year flood by either raising manhole tops above flood plain or by the use of watertight frames and covers. Where watertight frames and covers are used, unventilated length of sewer should not exceed 1,000 feet. Manhole covers shall be no more than 48 inches above ground level.

G. All manhole rims shall be 6 inches above the 100-year flood elevation, except when the rim would be more than 4 feet above the existing grade in which case watertight covers shall be used and manhole be set at a height 4 feet above final grade.

H. Vandal proof manhole frames and covers shall be used on all manholes located in unpaved streets unless watertight covers are required.

I. Sampling manholes shall be provided for all facilities discharging non domestic wastewater to the sewer system. These facilities include but are not limited to industrial facilities, food preparation establishments, grocery stores, bakeries, automobile service stations, gasoline stations, hospitals, animal hospitals, cleaners, machine shops, photographic finishers, printing shops, laboratories, funeral homes, etc.

J. Physical design of the sampling point must be appropriate for the type of wastewater to be sampled.

K. Grease Traps:

6. The grease trap shall comply with the requirements of the Plumbing Code adopted by the City of Richmond. The grease trap shall be designed for grease-laden waste. Domestic wastewater shall not be discharged to the system through the grease trap. The Design Engineer shall include on the plans a schematic of the grease trap, the total flow-through rating in gallons per minute (gpm), the grease retention capacity and the unit to be used. The Design Engineer shall indicate that the grease trap conforms to the standards outlined in the latest Plumbing Code adopted by the City of Richmond.

7. All new food preparation facilities and, such as restaurants and bakeries, shall be required to construct an outside grease trap for the retention of grease, fats, and oils generated by that business. The grease trap shall be operated and maintained properly by the discharger.

L. Oil/Water separators, where required, shall be shown on the plans. Separators

shall comply with requirements of the Plumbing Code. A schematic of the oil/water separator shall be shown on the plans.

M. A monitoring manhole shall be required on all new construction or renovations or modifications to existing facilities, where the discharge originating in the new, renovated, or modified facility is, or will have the potential to be non-domestic in nature. All wastewater from the facility shall flow through the monitoring manhole.

6. For multi-use buildings such as shopping centers, the sewer lateral should run an adequate distance from the building to allow installation of a monitoring manhole and a grease trap on each sewer lateral when the tenant spaces are upgraded.

7. For individually metered facilities, a sewer lateral is required for each meter. Adequate space to accommodate installation of monitoring manhole and/or grease trap should be provided.

8. If the facility is master metered, a monitoring plan is required for the entire facility. A grease trap and monitoring manhole is required for each individual unit meeting the above definition.

N. Where possible, in unpaved areas, manhole castings shall be approximately 12 inches above final grade.

2.2.7 Depth of Sewers

C. Generally, all sewers shall be of sufficient depth to provide service to the lowest sewered elevation of structure in question, allowing proper service connection grade. Minimum depth of cover over sewers shall be 5.0 feet; however, a greater depth may be required due to future extension or possible future lowering of existing road grade or utilities.

D. The Design Engineer shall certify that all proposed sites will be served by gravity with sewer service connections installed at a slope of 1/4 inch per 1 foot except where shown otherwise on the plans.

E. Exceptions to the above requirements will be considered only if it is impractical to provide required depths, in which case, special approval must be secured, in writing, from DPU. In the special case of less than minimal cover, ductile iron pipe of adequate thickness shall be provided.

F. Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, ductile iron pipe shall be used from manhole to manhole or the entire lateral length and special bedding material is required. Concrete supports may be required for the storm sewer. Where large storm drains (36-inches and larger) are placed over existing PVC gravity sewer mains with less than 12-inches of vertical clearance, concrete supports (storm drain bridge) shall be installed to prevent

future settlement.

2.3. DRAWINGS

2.3.1 In addition to requirements in Section 1.2 of these Guidelines, drawings shall have:

A. Stationing, pipe size, pipe material, bearings, direction of flow, deflection angles, grade, and distance between center lines of manholes.

B. All manholes shall be numbered as instructed by the City. Top, influent and effluent elevations shall be clearly shown. Drop manholes shall be clearly shown and labeled in both plan and profile view.

C. The plans shall indicate the following information to provide for service to the elevation of the connection as follows:

1. Lowest elevation of the sewered structure.
2. Low ground corner of structure with first floor service only.
3. Ground level at building line on unoccupied parcel.
4. The elevation and location of any existing structure to be sewered shall be clearly shown. The street address of existing house(s) shall be shown.
5. Location and size of house connections.

D. All utility crossings shall be shown clearly in profile indicating vertical clearances.

E. All water mains shall be shown in profile and shall indicate points where crossings occur, clearly indicating vertical and horizontal clearances between water and sewer mains.

F. Design Engineer shall show the location of erosion control devices on the plans. These devices shall be in conformance with the Virginia Erosion and Sedimentation Control Handbook, latest edition. Design Engineer shall include erosion control details approved by DPU.

G. Design Engineer designing facilities for developers shall show the appropriate water and sewer notes on the drawings.

H. Sewer lines not to be owned by the City shall be identified as `Private".

SECTION 3
DESIGN STANDARDS FOR WASTEWATER PUMPING STATIONS AND FORCE MAINS

3.1 GENERAL REQUIREMENTS

3.1.1 Wastewater pumping stations and force mains are to be provided solely for the conveyance of sanitary wastewater. Under no circumstances shall any roof foundation, surface or sub-surface drainage, or any other form of storm water be allowed to pass through the proposed facilities.

3.1.2 A detailed Engineering Report, described in Section 1.1.2, shall be submitted to and approved by the City prior to design. The report shall fully evaluate the proposed sanitary sewer service area and the overall effect upon present and future City facilities.

3.1.3 The design must conform to the minimum standards set forth in the Virginia Sewage Collection and Treatment Regulations. City requirements for specific equipment and submittals will be detailed during engineering review.

3.1.4 At a minimum the following data shall be provided when designing a wastewater pumping facility:

A. Structural design drawings and calculations of the facility.

B. Hydraulic design for the equipment selected, including scaled drawings.

C. Electrical and mechanical drawings and specifications for the equipment selected.

D. Specifications.

3.1.5 An operations and maintenance (O&M) manual shall be prepared in accordance with the Virginia Sewage Collection and Treatment Regulations and approved by the State and City. The manual shall contain complete operating information for all equipment installed. In addition, a complete set of approved shop drawings shall be provided with the O&M Manual.

3.1.6 Wastewater pump stations will be used when it has been determined to be the only practical way to provide sanitary service based upon a finding that:

A. It is economically impractical to extend the gravity sewer and the use of a pumping station will not adversely affect the City's ability to serve the area with a gravity sewer in the future; and

B. The proposed design and plan for the pump station and connecting lines do not adversely affect the current financial status of the City utility system or the future ability of the City to install a gravity sewer, and

C. The proposed design of the pump station permits replacement of the pump station with a gravity sewer without significant capital outlay at a future time; and

D. The pump station will not overload the existing wastewater collection and treatment facilities and will not otherwise negatively affect the City's ability to efficiently manage the sewer system.

3.2. TECHNICAL DESIGN

3.2.1 System Layout

A. The sizing and configuration of the pumping station and the sizing of the attendant force main shall be within the parameters set forth in the Engineering Report, described in Section 1.1.2. The facilities to be provided shall be based on ultimate flows unless an interim flow design shall have been incorporated in the approved Engineering Report.

B. The type of equipment to be installed in the pumping station will be influenced by the interim and ultimate capacity of the station and an evaluation of the period of time that the service of the station will be required.

C. Pumping equipment shall consist of dry pit pumps. Wet pit or submerged pumps shall not be used for permanent installations unless otherwise approved by the City.

D. An ample, all-weather road, including surface treatment, storm drainage and parking, shall be provided for easy access to the pumping station.

E. The architecture of the pumping station shall be considered. Site grading, seeding or sodding, and trees or shrubs shall be provided to present a finished appearance, as approved by DPU, consistent with zoning and general appearance of the surrounding area. Approved fencing with gates shall be provided as deemed necessary to properly protect the facility.

F. The Design Engineer shall determine the availability of electric service and coordinate the available electrical service with that required for the facility. The Design Engineer shall also determine the need for primary service extension and advise DPU if an extension is necessary.

G. The Design Engineer shall determine the "Reliability Class" in accordance with the Virginia Sewage Collection and Treatment Regulations and shall

comply with the requirements thereof. Each pumping station shall have a permanently installed emergency generator or alternate power source.

H. The Design Engineer shall consider the need for protection of the pumping station and force main against hydrogen sulfide corrosion and shall provide the proper equipment if such protection is found necessary.

I. All motors, motor control, and other electrical equipment shall be housed in a weather-proof, above-ground structure. Adequate provisions shall be incorporated for the proper ventilation, drainage and flood protection in order to insure maximum reliability, and electrical and personnel safety.

J. All pumping station wet wells shall be considered explosion hazardous. All electrical equipment installed therein shall be approved for Class I, Division 1 in accordance with Article 500 of the National Electric Code. The use of intrinsically safe controls in accordance with NFPA No. 493 is satisfactory, and its use is encouraged.

K. Where structurally separate wet and dry wells are provided, adequate provision for differential settlement shall be incorporated by means of flexible pipe joints consisting of at least two standardized mechanical joint bell connections or their approved equivalent.

L. All pumping stations shall be of sufficient size and shall contain adequate clearances to provide ample room for maintenance and equipment replacement.

M. Consideration shall be given to the need for a water supply well in locations where a public water supply is not available.

N. Force main locations shall generally conform to Section 2.2.1 - "System Layout" of these Standards. Force mains shall have a positive slope for the pumping station to the point of discharge unless unusual conditions make it impractical. Extra depth of bury shall be provided in lieu of air or air/vacuum relief valves wherever feasible. A constant grade shall be used where feasible.

O. Every effort shall be made to maintain the force main below the hydraulic gradient. Where a relief valve is required, an automatic valve shall be provided and installed inside a standard manhole with adequate means of drainage.

P. Every effort shall be made to maintain a full force main under all operating conditions.

Q. Sizing of main shall be such that velocity shall be a minimum of 2 feet per second (fps) for self-scouring velocity. A velocity of 8 fps should not be exceeded.

R. Valves and air releases shall be provided at appropriate locations.

S. All force mains shall be ductile iron unless otherwise specified and approved by the City.

T. The Design Engineer shall consider ground conditions in the case of metallic conduits and provide suitable cathodic protection where necessary.

U. Steel casing pipe shall have a minimum yield strength of 35,000 psi and a minimum internal diameter of 4 inches greater than the largest external diameter of the carrier pipe. The wall thickness of casing pipe shall be sufficient to resist loads to which it will be subjected, but in no case less than 0.25 inches. Standard installation detail shall be as shown in Standard Details P-3A and P-3B.

3.2.2 Capacity Design

A. Capacity design for the pumping station and force main shall be based on Section 2.2.2 - "System Design" of these Standards and shall take into consideration such parameters as minimum, average, and peak station inflows as well as minimum, average, and maximum pumping rates.

B. Pump selection and force main sizing shall be based on a hydraulic analysis of the required flows, pipeline velocities, and receiving gravity sewer capacities.

C. Calculations shall be prepared and a system friction chart prepared that shows static head and total dynamic head for both single and multiple pump operation. The chart shall also show the pump performance curve for both single and multiple pump operation. Where variable speed pumping is contemplated, pump performance curves shall show performance at maximum speed, minimum speed just above static head, and several intermediate speeds that will clearly indicate pump system operation. The system Total Dynamic Head (TDH) curves shall illustrate the effect of wetwell level on system head. Particular attention shall be given to the available versus required net positive suction head (NPSH).

D. Consideration must be given to design which results in minimum power requirements to accomplish the functions required. If requested, supporting data shall be furnished to the City.

3.2.3 Structural Design

A. In addition to conventional design procedures, there are several specific areas that must be considered.

1. Structural requirements for force mains include the proper selection of materials and strengths of pipe and pipe accessories. This will involve a study of anticipated trench conditions and bedding methods. The minimum depth of cover shall be governed by depths of other utilities

and hydraulic gradient; however, not less than 3.5 feet of cover shall be provided.

2. The effect of hydraulic thrust must be countered by the use of thrust blocking, pipe anchorage, or other suitable means to prevent movement of pumping equipment and pipelines.

3.3. DRAWINGS

A. Drawings for pumping stations and plan and profiles for force mains shall be prepared in accordance with Section 1.2 - "Drawing Organization and Format."

B. Drawings and specifications shall be of such quality and contain sufficient details so that no misunderstanding may reasonably arise as to the extent of the work to be performed, the materials to be used, the equipment to be installed, or the quality of the workmanship. Manufacturers of major equipment units shall be specifically approved. No deviation from the approved manufacturers will be permitted.

C. Drawing for pumping stations shall include a site plan drawn to a scale of not less than 1 inch = 20 feet and shall contain existing and proposed contours on a 2-foot contour interval. The boundaries of the site shall be clearly shown on the site plan and shall be permanently monumented in the field prior to completion of construction.

D. Drawings for pumping stations shall be drawn on a scale of not less than 1/4 inch = 1 foot, Drawings required to clarify construction details shall be drawn on an appropriately larger scale.

E. Drawings for force mains shall show stationing, pipe size, bearings, direction of flow, deflection of angles, and curve data.

F. Profiles for force mains shall show the ground line, force main profile, underground utility lines, and structures that might affect force main depth. It shall also show areas where additional depth will be required, required vertical curve data, and locations of all relief valves and appurtenances. All crossings of existing and proposed water mains shall be shown to clearly indicate vertical clearance between utilities.

G. Details shall be shown for all blocking, pipe restraints, and relief valves.

H. Design Engineer shall show the location of erosion control devices on the plans. These devices shall be in conformance with the Virginia Erosion and Sedimentation Control Handbook.

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SECTION 4
DESIGN STANDARDS FOR GRAVITY SANITARY SEWER REHABILITATION

4.1 GENERAL REQUIREMENTS

4.1.1 Introduction: The City has used trenchless techniques for new construction and rehabilitation of existing assets for a number of years. In this section, performance-based guidelines are provided to define the City's approach to trenchless techniques. The guidelines are provided in summary fashion, as trenchless materials and techniques are evolving at a rapid pace. Project-specific specifications that apply to unique scopes of work and site conditions will be provided for each project. These project-specific specifications may be performance specifications, prescriptive specifications or a combination thereof.

4.1.2 General Guidelines:

A. The designer shall consider trenchless technologies and conventional techniques applicable to site-specific conditions to provide best value to the City. Best value considerations shall include cost, design life, project duration and disruption to the public.

B. Minimizing conflicts with or disruption of traffic, other utilities, pavement, residents and businesses shall be considered in the overall value equation.

C. Maximizing collection system storage and flow capacity shall be considered.

D. Consideration of materials and processes that result in watertight and structurally sound systems shall be made.

E. Techniques shall be selected with consideration of the feasibility of executing projects relative to wet weather effects in the combined sewers and operation of the WWTP.

F. Each pipe or project site shall be evaluated with consideration of unique features that will influence selection of the best products and materials (e.g., noncircular pipes, access to the site, previous repairs, etc.).

G. The overall footprint (or space required) to execute the project shall be considered, particularly with regard to inconvenience to residents, businesses and the traveling public.

H. The level of risk and safety factors shall be considered in evaluating alternatives.

I. A robust inspection and quality assurance program shall apply to each project. Emphasis shall be placed on meeting requirements such as level of watertightness; achievement of shape and dimensional requirements; proper alignment, line and grade; materials testing and other scope-specific requirements.

J. All proposed project specifications, designs and products shall be submitted to the City for review.

4.2. TECHNICAL DESIGN

4.2.1 Pipe Cleaning: All pipes and related structures must be cleaned prior to rehabilitation. Although discussed in a separate section, CCTV is part of this process because the videos will be used to verify the required level of cleaning is achieved.

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. In general, existing pipe conditions may include any one or combination of roots; grease; hard deposits; debris; protruding connections; inflow/infiltration; varying pipe sizes and geometries (including circular, egg, box); materials such as clay, concrete, brick, segmented clay tile, and granite block or slabs. Pipes may be in poor condition. The small to medium diameter concrete pipe tends to be significantly deteriorated.

B. Technology/Process: High pressure water jetting is typically used for debris removal. A variety of water jet powered/propelled tools are used for root cutting, deposit removal and grease removal. Protruding connections should be trimmed using these tools or a robot, depending on site conditions. Manned entry, high volume jetting/vacuuming and mechanical cleaning equipment or other technologies may be used where applicable to site conditions.

C. Qualifications: Contractor personnel shall be trained to operate equipment according to manufacturer recommendations. They shall have the training and experience necessary to select and operate the applicable jet nozzles,

cutting tools and related equipment. Minimum experience levels may be defined in project-specific documents.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the cleaning contractor for review. These submittals shall include a performance work statement; training certifications; proposed equipment, tools and procedures; safety plan and quality control plan (QCP).

E. Performance Requirements: Equipment and tools shall be selected and operated so as not to damage the pipe during the cleaning operation. Roots, grease and hard deposits shall be cut. All debris shall be captured and removed from the system. Debris shall be properly disposed as governed by project documents.

F. Quality Assurance/Quality Control: It is the cleaning contractor's responsibility to assure and control quality by operating according to the QCP. The inspector will verify quality performance measures are met by observing the operation of equipment and tools; observing removal of debris from the pipe and manhole benches and reviewing a high quality CCTV video and log (see CCTV for more detail).

4.2.2 Closed Circuit Television (CCTV) Inspection and Video: CCTV inspection and videotaping is required for all cleaning, investigation and rehab projects. Acquired information is used for one or more reasons, such as verifying pipes are clean, condition assessment, design and post rehab quality assurance.

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. The general conditions noted in the cleaning section apply to CCTV. Additional conditions that may affect CCTV equipment selection and operation may include high flow levels (especially in combination pipes during wet weather), debris, large size pipes and actual pipe sizes (or changes in size) that may be different than shown in maps.

B. Technology/Process: CCTV inspections are typically conducted with high resolution (minimum 500 line resolution), color, pan and tilt cameras with integrated lighting systems. Cameras are skid, float or tractor mounted. Cameras shall be equipped with locator devices that facilitate aboveground marking of the location of buried MHs and other features. The CCTV system records data on electronic media. A software system compliant with NASSCO PACP is required.

C. Qualifications: Contractor personnel shall be trained to operate equipment according to manufacturer recommendations. They shall have the training and experience necessary to select and operate the camera, tractor and related equipment to maneuver the camera through pipes to obtain required data. All operators shall be NASSCO PACP certified. Minimum experience levels may be defined in project-specific documents.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the CCTV contractor for review. These submittals shall include a performance work statement; PACP training certifications; proposed equipment, tools and procedures; safety plan and quality control plan (QCP).

E. Performance Requirements: The camera and transport mechanisms shall be selected and operated to position the camera close to pipe centerline and to maneuver the camera through the pipe from one MH to the next MH as conditions allow. The operator shall enter observations according to PACP guidelines. Special care shall be taken to provide high resolution, accurate color, and adequate lighting. The operator shall direct the locator such that aboveground marks of buried MHs, potential point repairs and other features are made.

F. Quality Assurance/Quality Control: CCTV shall be done immediately following cleaning, immediately prior to rehab and immediately following completion of rehab. It is the contractor's responsibility to assure and control quality by operating according to the QCP. The inspector will verify quality performance measures are met by observing the operation of CCTV, monitoring the quality of the video recording and accuracy of PACP information provided in the video log/report. As determined solely by the City's representative, videos shall be high quality. Specified lighting, color and contrast and resolution shall be provided. Flow in the pipe shall not exceed the specified level. The video shall be free of electronic or other distortion.

4.2.3 By-Pass Pumping:

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. The City will provide flow information where data is available. The contractor shall not rely on information provided and

shall make all investigations necessary to properly size bypass systems. Note that flow conditions may vary significantly, especially in combination sewers during wet weather.

B. Technology/Process: Bypass pumps shall be centrifugal self-priming or submersible type and allow for dry running as sewer flows fluctuate. Pumps must be in good working order with a pressure gauge and flowmeter on the discharge. Pumps shall be sound attenuated to meet City noise ordinance requirements.

C. Qualifications: Contractor personnel shall be trained to operate equipment according to manufacturer recommendations. They shall have the training and experience necessary to select and operate pumps and appurtenances commensurate with the size and complexity of the bypass operation.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the contractor. These submittals shall include a performance work statement; training certifications (applicable to large bypass systems); proposed plugs, pumps, pipe or hose, and fittings; leak repair plan and safety plan.

E. Performance Requirements: The bypass system shall be designed by the contractor (and PE stamped, if required by project specifications) and operated to convey flows without backing up the sewers or surcharging manholes in excess of the approved plan. The design shall include excess capacity to accommodate fluctuations in flows. Adequate safety factors and redundancy shall be provided. Positioning of the pumps and routing of piping (or hose) shall be considered to minimize disruption to residents, businesses and traffic. Leakage of sewage from the system is not allowed. The contractor shall monitor the system and immediately deploy leak repairs as needed. The contractor is responsible for cleanup of any leaks that occur.

F. Quality Assurance/Quality Control: The inspector will verify quality performance measures are met by observing the operation of pumps and appurtenances for compliance with the approved submittal. Notes and photos shall be taken concerning surcharging or backing up of the sewer system, bypass system leaks, flow discharge rates, site layout and safety, noise levels, pump run times and overall maintenance.

4.2.4 Gravity Sewer System Rehabilitation: The methods described in the paragraphs below have been used by the City. Other methods may be considered as trenchless rehab technologies continue to evolve. The designer shall evaluate rehabilitation methods for applicability to site-specific conditions.

4.2.5 Cured-In-Place Pipe (CIPP): The City has used the CIPP method of pipe rehabilitation for a number of years. Because this technology continues to evolve at a rapid pace, scope-specific specifications shall be provided for each project. These specifications will specifically reference applicable ASTM, City and other standards. The general guidelines for CIPP are provided below. These guidelines should be used by the designer as a basis for drafting project and site-specific CIPP specifications. Note that detailed references from similar scopes may be provided by the City upon request.

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. In general, existing pipe conditions or access to the pipes may include significantly deteriorated pipe; in-line diameter changes; varying materials of construction or repair; noncircular shapes; a significant percentage of break-in and protruding connections; infiltration; combination sewer and storm piping; and narrow brick chimney access MHs.

B. Technology/Process: CIPP materials and installation processes vary widely. The selection of the appropriate combination of materials and installation processes will be governed by specifications that consider specific site conditions and scopes of work. CIPP tubes may be plain felt or fiber reinforced; coated on one or both sides; impregnated with resin; inverted or pulled in place; and cured by hot water, steam or ultraviolet light. Live service connections shall be opened. Ends at manholes shall be sealed.

C. Qualifications: Contractor personnel shall be certified and trained by the CIPP technology provider. This training shall include materials applications and all aspects of proper tube handling, installation, cure and service connection reinstatement. The Owner may require that the technology provider be present, should the installation crew appear to require guidance in following prescribed procedures. Minimum contractor and crew experience levels may be defined in project-specific documents.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the contractor. These submittals shall include a performance work statement (PWS). The PWS shall be specifically written to address the scope and site conditions of the project. The PWS shall include a

certification of compliance with project specifications; proposed materials (including felt, reinforcement, coatings and resin); installation processes and equipment; manufacturer's recommended cure; 3rd party test information; contractor, project manager, and installation crew qualifications; wet-out procedures; technology and safety training certifications; PE-stamped designs; quality control plan (including detailed tube handling procedures and equipment); odor control plan and safety plan.

The method of determining the design thickness shall be according to ASTM F-1216, Appendix X1, or as otherwise specified. Design assumptions shall include host pipe fully deteriorated (unless otherwise specified), actual ovality, actual depth to pipe invert and groundwater level as specified or as governed by site conditions. A Professional Engineer licensed in the Commonwealth of Virginia shall seal CIPP designs under contract with the CIPP installation contractor. Actual installed thickness shall meet or exceed the design thickness.

Submittals during rehab/construction shall include pre-installation videos; pipe measurement forms; wet-out logs; cure records; post-installation videos; samples for testing; and record drawings.

E. Performance Requirements: The CIPP shall be resistant to the chemical and temperature environment in sewers; maximize storage and flow capacity; be structurally sound; and be leak resistant. The installer will be responsible for repair or replacement of any facilities damaged during installation and any damage to the CIPP during installation.

F. Quality Assurance/Quality Control: The CIPP shall be continuous from MH to MH; tight fitting; free of major wrinkles, fins or folds; free of delamination of the coating or delamination between structural layers; free of dry or resin-lean spots; free of tears, pinholes or blisters; free of leaks through the CIPP pipe wall; sealed ends at MHs; and meet design thickness and materials properties requirements.

The inspector will verify quality performance measures are met by observing and recording various aspects of the installation for conformance with submittals, including review of pre-installation videos; verifying delivery of approved materials; observing cure milestones; reviewing quality of live service connection reinstatements; reviewing post-installation videos; and maintaining chain of custody of samples. The City will

maintain chain of custody of samples and will contract with the lab to conduct applicable testing. Samples shall be tested according to project specifications and applicable ASTM standards.

Cure monitoring over the full length of the liner may be specified.

Defects shall be repaired or the CIPP shall be replaced at the discretion of the City.

A warranty shall be provided as detailed in the project specifications. Rehabilitation projects typically require a 5-year warranty.

4.2.6 CIPP Laterals Rehabilitation

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. In general, existing lateral pipe conditions may include significantly deteriorated pipe; varying materials of construction or repair; varying lateral diameters, although predominantly in the 4" to 6" range; a wide variety of angles of entry into the main; bends in the laterals; a significant percentage of break-in and protruding connections; and infiltration. Access to the laterals may be through narrow brick chimney access MHs; varying circular main diameters; noncircular mains such as egg shapes; and combination sewer and storm piping. Relatively few cleanouts exist.

B. Technology/Process: Laterals CIPP materials and installation processes vary widely. The selection of the appropriate combination of materials and installation processes will be governed by specifications that consider specific site conditions and scopes of work. CIPP tubes may be plain felt or fiber reinforced; coated on the flow carrying surface; impregnated with resin; and inverted or pulled in place. Cures may be ambient or accelerated by hot water, steam or ultraviolet light. Full-wrap or T-connections at the main are preferred. Although some cleanouts may exist or may be included in the project scopes, installation from the main is preferred in order to reduce the need for cleanouts. If a cleanout is not provided, the extent to which the lateral pipe is lined may be limited to the area of the lateral connection or the first few feet of the lateral pipe.

C. Qualifications: Contractor personnel shall be certified and trained by the laterals CIPP technology provider. This training shall include materials

applications and all aspects of tube handling, installation and cure. The Owner may require that the technology provider be present, should the installation crew appear to require guidance in following prescribed procedures. Minimum contractor and crew experience levels may be defined in project-specific documents.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the contractor. These submittals shall include a performance work statement (PWS). The PWS shall be specifically written to address the scope and site conditions of the project. The PWS shall include a certification of compliance with project specifications; proposed materials (including felt, reinforcement, coatings and resin); installation processes and equipment; manufacturer's recommended cure; 3rd party test information; contractor, project manager, and installation crew qualifications; wet-out procedures; technology and safety training certifications; PE-stamped designs; quality control plan (including detailed tube handling procedures); odor control plan and safety plan.

The method of determining the design thickness shall be according to ASTM F-1216, Appendix X1. Design assumptions for the lateral pipe shall include host pipe fully deteriorated (unless otherwise specified), actual ovality, actual depth to pipe invert and groundwater level as specified or governed by site conditions. A partially deteriorated design assumption for the portion of the lateral within the main (i.e., wrap or T) is allowed when the lateral is placed in mains that have been rehabilitated. A Professional Engineer licensed in the Commonwealth of Virginia shall seal CIPP lateral designs under contract with the CIPP laterals installation contractor. Actual installed thickness shall meet or exceed the design thickness.

Submittals during rehab/construction shall include pre-installation videos; wet-out logs; cure records; post-installation videos; samples for testing; and record drawings

E. Performance Requirements: The CIPP lateral shall be resistant to the chemical and temperature environment in sewers; structurally sound; and leak resistant. The installer will be responsible for repair or replacement of any facilities damaged during installation and any damage to the CIPP main or MHs during laterals installation.

F. Quality Assurance/Quality Control: The CIPP laterals shall be tight fitting; free of major wrinkles or folds; free of delamination of the coating or delamination between structural layers; free of dry or resin-lean spots; free of tears, pinholes or blisters; free of leaks through the CIPP pipe wall and nonleaking at the ends of the wrap/T or tail of the lateral liner. The ends of the wrap/T shall provide a tight fitting, tapered transition free of excess resin or installation material; and meet design thickness and materials properties requirements.

The inspector will verify quality performance measures are met by observing and recording various aspects of the installation for conformance with submittals, including review of pre-installation videos; verifying delivery of approved materials; observing cure milestones; reviewing post-installation videos; and maintaining chain of custody of samples. The City will maintain chain of custody of samples and will contract with the lab to conduct applicable testing. Samples shall be tested according to project specifications and applicable ASTM standards.

Defects shall be repaired or the CIPP lateral shall be replaced at the discretion of the City.

A warranty shall be provided as detailed in the project specifications. Rehabilitation projects typically require a 5-year warranty.

4.2.7 CIPP Point Repairs: All items noted for CIPP of sewer mains are applicable to mainline CIPP point repairs. A few exceptions or notable additions are detailed below.

A. Existing Conditions: CIPP point repairs may be installed within existing CIPP, in addition to being installed in unrehabilitated pipes. Installations within CIPP mains are typically done as a repair of a mainline CIPP (e.g., at a localized lift; to cover reinstated dead laterals).

B. Technology/Process: No exceptions or additional notes apply.

C. Qualifications: No exceptions or additional notes apply.

D. Submittals: A partially deteriorated design may be accepted when installing a CIPP PR within a mainline CIPP.

E. Performance Requirements: No exceptions or additional notes apply.

F. Quality Assurance/Quality Control: The CIPP shall be nonleaking at the ends of the point repair. The ends of the CIPP point repair shall provide a tight fitting, tapered transition free of excess resin or installation material.

4.2.8 Manhole Rehabilitation:

A. Existing Conditions: The designer shall define and consider existing conditions at each project site as project-specific specifications and related documents are developed. MHs may be constructed of brick, precast concrete or other materials, with condition varying from MH to MH. Deterioration due to hydrogen sulfide is not prevalent in the system; however, this condition may exist at some locations. Groundwater infiltration is present at many manholes, with the level of water tending to increase after CIPP rehabilitation of the pipes. The majority of MHs are brick, have narrow chimneys, and have missing mortar. The bench and invert of many MHs are in disrepair.

B. Technology/Process: MH rehab materials and installation processes vary widely. The selection of the appropriate combination of materials and installation processes will be governed by specifications that consider specific site conditions and scopes of work. Materials applicable to preparation work such as invert and bench repair, stopping infiltration and filling voids is required. Once water is stopped and preparation is completed, cementitious, plastic (i.e., epoxy, polyurethane) or composite rehab may follow. Materials and processes applicable to damp installation conditions, resistant to hydrogen sulfide deterioration, and applicable to brick manholes is required.

C. Qualifications: Contractor personnel shall be certified and trained by the MH rehab technology provider. This training shall include materials applications and all aspects of MH preparation, application of materials and testing. The Owner may require that the manufacturer or technology provider be present, should the installation crew appear to require guidance in following prescribed procedures. Minimum contractor and crew experience levels may be defined in project-specific documents.

D. Submittals: Prior to beginning field operations, submittals shall be provided by the contractor. These submittals shall include a performance work statement (PWS). The PWS shall be specifically written to address the scope and site conditions of the project. The PWS shall include a certification of compliance with project specifications; proposed materials;

installation processes and equipment; 3rd party test information; contractor, project manager, and installation crew qualifications; technology and safety training certifications; PE-stamped designs; quality control plan (including materials thickness measurement and vacuum testing); and safety plan.

The MH rehab material thickness must be designed to withstand external groundwater load to ground surface (or higher as defined by site conditions). The design thickness must be supported by the manufacturer-certified and 3rd party-verified physical properties. The design method shall be according to applicable standards, or other proven methods acceptable to the City. Design assumptions shall include factors associated with the shape, size and condition of the MH; actual depth to invert and groundwater level as specified or governed by site conditions. A Professional Engineer licensed in the Commonwealth of Virginia shall seal MH rehab thickness designs under contract with the MH rehab contractor. Actual installed thickness shall meet or exceed the design thickness.

Submittals during rehab/construction shall include materials mix logs; thickness measurements; vacuum or spark tests; and samples for testing.

E. Performance Requirements: Unless otherwise specified all MHs will be rehabilitated from the invert of the flow channel to the frame. Materials shall be resistant to the chemical and temperature environment in sewers; structurally sound; and leak resistant. The installer will be responsible for repair or replacement of any facilities damaged during installation, including removal of overspray extending into pipes.

F. Quality Assurance/Quality Control: The MH rehab material shall be continuous from invert to frame; tight fitting and bonded to the substrate; free of pinholes, delamination between applied material layers, and bubbles or blisters; free of leaks; and meet design thickness and materials properties requirements.

The City will assign a staff or third-party field inspector to each project. The inspector will verify quality performance measures are met by observing and recording various aspects of the installation for conformance with submittals, including verification of delivery of approved materials; observing thickness measurements; observing vacuum test or spark tests; and maintaining chain of custody of samples. The City will maintain chain of custody of samples and will contract with the lab to conduct applicable

testing. Samples shall be tested according to project specifications and applicable standards.

Defects shall be repaired or the MH rehabilitation replaced at the discretion of the City.

A warranty shall be provided as detailed in the project specifications. Rehabilitation projects typically require a 5-year warranty.

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SECTION 02010

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: The CONTRACTOR shall furnish, construct, maintain and replace all erosion and sediment control features specified, shown and required by the City, the local sediment control inspectors, any other regulatory agency which has control or jurisdiction over erosion and sedimentation control in the area in which the project is located and Virginia Soil and Water Conservation Commission in the Virginia Erosion and Sediment Control Handbook. CONTRACTOR shall be responsible for obtaining all erosion and sediment control permits required prior to any land disturbing operations.

B. Related Sections:
1. Section 02050 - Site Demolitions.
2. Section 02110 - Clearing, Grubbing and Site Restoration.
3. Section 02220 - Excavation and Backfill.

1.2 QUALITY ASSURANCE

A. Reference Codes and Standards: CONTRACTOR shall reference the latest edition of the code or standard at the time of project advertisement or assignment. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. Virginia Erosion and Sediment Control Handbook, Latest Edition.
2. Virginia Erosion and Sediment Control Regulations.
3. Virginia Erosion and Sediment Control Law.
4. Virginia Storm Water Management Regulations.
5. City of Richmond, Virginia Code Revised Chapter 14 – Floodplain Management, Erosion and Sediment Control, and Drainage.

1.3 SUBMITTALS

A. Shop Drawings:
1. Submit Erosion and Sediment Control plan showing details of erosion and sediment control devices and locations. Submittal information shall comply with requirements of regulatory agency which has jurisdiction over erosion and sediment control in the area in which the project is located. Submit technical data, manufacturer's literature and catalog information for the products specified on the approved plans.
2. Submit copies of approved Erosion and Sediment Control permits from appropriate governing jurisdictions.

3. Submit copy of Responsible Land Disturber certification

PART 2 PRODUCTS

2.1 GENERAL

A. All erosion and sediment control measures shall be furnished as specified in Chapter 3 of the "Virginia Erosion and Sediment Control Handbook" Standards and Specifications and as detailed on the plans. See website http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx

PART 3 INSTALLATION AND MAINTENANCE

3.1 TEMPORARY PRACTICES

A. All erosion and sediment control measures shall be installed as shown and specified in the latest edition of the "Virginia Erosion and Sediment Control Handbook" and as detailed on the plans.

3.2 INSTALLATION AND MAINTENANCE SEQUENCING

A. Erosion and sediment control practices and measures shall be constructed prior to any land disturbing activity. They shall be maintained in accordance with the latest edition of the "Virginia Erosion and Sediment Control Handbook" and local ordinances. They shall be removed only upon completion of all land disturbing activities.

B. All disturbed areas including but not restricted to stock piles, dams, banks of sediment basins and temporary road banks left unprotected for more than 30 days shall be temporarily seeded at the CONTRACTOR'S expense. All disturbed areas shall be protected to control erosion and prevent sedimentation of adjacent properties, storm sewers and/or streams.

C. Sediment control devices such as diversion berms, sediment traps, filter berms, vegetation stabilization, etc., shall be used to prevent off-site sedimentation at all times.

D. All borrow and/or spoil materials shall only be stockpiled within the limits of the permitted site.

E. The proposed grading shall not impair existing surface drainage, constitute a potential erosion hazard, or source of sedimentation to any adjacent property, drainage system or right-of-way.

F. All points of construction ingress and egress shall be protected to prevent tracking of mud on the public streets.

G. Storm drainage pipe discharges shall be diverted to temporary sediment traps. Rip rap aprons shall be constructed during sediment trap removal.

H. Upon completion of all construction activities, and upon stabilizing all areas disturbed by construction activities, remaining temporary sediment control devices shall be removed. Silt fencing shall be installed downhill of sediment traps prior to their removal. Sediment trap areas shall be restored to pre-existing grades and stabilized prior to removing silt fencing.

I. Upon removal of temporary erosion and sediment control features, the construction site shall be inspected for remaining disturbed areas. Stabilize any remaining disturbed areas.

END OF SECTION

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SECTION 02050

SITE DEMOLITIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required for demolitions, removal and disposal Work.
2. Included, but not limited to, are demolition and removal of existing materials, equipment, or work necessary to install the new Work as shown, specified and required. Demolition may include structural concrete, foundations, attachments, appurtenances, piping, paving, curbs, walks, fencing, and similar existing facilities.

B. Related Work Specified in Other Sections Includes:
1. Section 02010 - Erosion and Sediment Control
2. Section 02110 - Clearing, Grubbing and Site Restoration
3. Section 02220 - Excavation and Backfill
4. Section 03300 - Concrete

1.2 SUBMITTALS

A. Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of the City's or others operations.

1.3 JOB CONDITIONS

A. Protection:
1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices in accordance with the approval of authorities having jurisdiction. Road, sidewalk or other access way closure will only be allowed with approval of authorities having jurisdiction.

4. Repair damage to facilities to remain, or to any property belonging to the City or occupants of the facilities.

B. Scheduling: Carry out operations so as to avoid interferences with the City's operations.

C. Notification: At least 48 hours prior to commencement of a demolition or removal, notify the City in writing of proposed schedule. The City will inspect the existing Materials and equipment and mark for identification those items which are to remain the property of the City. Do not start removals without the permission of the City.

D. Explosives:
1. Do not bring explosives on-site nor use explosives without written consent of the City and authorities having jurisdiction. Such written consent will not relieve CONTRACTOR of total responsibility for injury or damage caused by blasting operations.
2. Perform all blasting, if permitted, in compliance with applicable governing regulations.

PART 2 PRODUCTS

2.1 FLOWABLE FILL

A. Comply with requirements specified in Section 03300 Concrete.

PART 3 EXECUTION

3.1 GENERAL

A. All materials and equipment removed from existing work, shall become the property of CONTRACTOR, except for those which the City has identified and marked for their use. All cobblestones and other materials and equipment marked by the City to remain theirs shall be carefully removed by the CONTRACTOR, so as not to be damaged, and shall be cleaned and stored on or adjacent to the site in a protected place specified by the City or loaded onto trucks provided by the City for storage at a City facility.

B. CONTRACTOR shall dispose of all demolition materials, equipment, debris, and all other items not marked by the City to remain as property of the City, off the site and in conformance with all existing applicable laws and regulations.

C. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

D. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new Work or is shown or specified to be removed. Gas and fuel lines shall be purged and made safe prior to removal or capping. Sanitary sewer and manhole abandonment is described in Paragraph 3.2.

E. Any changes to potable water piping shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with local codes.

F. Electrical conduits and wires shall be abandoned or removed as specified by the City. All wires in abandoned conduits shall be removed, salvaged, and stored as specified by the City.

G. Where required, wiring in the underground electrical duct system shall be removed. All such wiring shall be salvaged and stored as specified by the City. CONTRACTOR shall verify the function of all wiring before disconnecting and removing it.

3.2 WASTEWATER COLLECTION SYSTEM ABANDONMENT

A. When shown, requested or required by the City, existing sewer mains, service connections, force mains and/or manholes shall be abandoned.

B. Sanitary Sewer Mains and Laterals:
1. Sanitary sewer mains and laterals designated to be abandoned shall be cleaned and purged.
2. Sanitary sewer mains and laterals designated to be abandoned, but not removed, shall be thoroughly sealed at all open ends and at the structures in which they terminate as applicable. Open ends shall be sealed with grout plugs or brick and mortar.
3. Grout plugs shall use flowable fill.
4. When required by the City or designated on the plans, the CONTRACTOR shall fill the abandoned sanitary sewer with flowable fill. Lines to be filled shall be sealed at the downstream end, filled with the approved mixture and sealed at the upstream end.
5. Update record drawings to ensure mains and laterals are charted as abandoned.

C. Manholes and/or Cleanouts:
   1. CONTRACTOR shall remove the top 2 feet of the structure including manhole frame and cover. Manhole frame and cover shall be returned to the City.
   2. The bottom of abandoned structures shall be perforated or broken to prevent entrapment of water.
   3. CONTRACTOR shall fill the manhole or cleanout with No 57 stone or other suitable material approved by the City.
   4. Sewer lines entering or existing the manhole or cleanout shall be capped or plugged in accordance with Paragraph 3.2.B.
   5. CONTRACTOR shall restore the area above the manhole or cleanout to match the surrounding area. Where manholes or cleanouts are located in roadway, roadway shall be restored in accordance with all VDOT requirements.

D. Sanitary Sewer force mains shall be abandoned as follows:
   1. Sanitary sewer force mains designated to be abandoned shall be cleaned and purged.
   2. A minimum three (3) foot section of pipe shall be removed between the proposed abandoned force main and any piping that will remain active.
   3. Any tees or valves that will remain in service that served as a point of connection for the proposed abandoned force main shall be properly restrained.
   4. The cut ends of the abandoned force main piping shall be capped or plugged.
   5. When required by the City or designated on the plans, the CONTRACTOR shall fill the abandoned sanitary sewer force main with a cement-sand grout slurry (flowable backfill). Air vents shall be installed as directed by DPU to facilitate the grouting operation. Lines to be filled shall be capped or plugged at the downstream end, filled with the approved mixture and capped or plugged at the upstream end.
   6. Update record drawings to ensure sewer force mains are charted as abandoned.

3.3 CLEAN-UP

A. CONTRACTOR shall remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment, waste, and debris of every sort shall be removed and premises shall be left, clean, neat and orderly.

END OF SECTION

SECTION 02110

CLEARING, GRUBBING AND SITE RESTORATION

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to perform all clearing, grubbing, site restoration, fencing, guardrail installation, curbs, and gutters within the limits of work shown, as specified and required by the City in the area of the project.

B. All unpaved areas disturbed by the CONTRACTOR'S operations shall be restored with topsoil, fertilizer, seed, lime and mulch in accordance with the latest edition of Virginia Erosion and Sediment Control Handbook.

C. Related Work Specified in Other Sections Includes:
1. Section 02010 - Erosion and Sediment Control
2. Section 02050 - Site Demolitions
3. Section 02220 - Excavation and Backfill

1.2 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter and the final restoration of the site. CONTRACTOR shall obtain all permits required.

B. Copies of all required permits shall be posted on site by the Contractor in a weatherproof enclosure that is visible at the entrance to the site.

C. CONTRACTOR must comply with all City Ordinances on removal of trees and must coordinate with the City's Urban Forestry Department prior to tree removal.

1.3 SUBMITTALS

Prior to use or placement, the Contractor shall submit certifications in the form of affidavits from the material suppliers, together with supporting data, attesting that the composition of lime, fertilizer, seed, and mulch meet specification requirements.

1.4 JOB CONDITIONS

A. Protection:
1. Streets, roads, adjacent property and other works and structures shall be protected throughout the entire project. CONTRACTOR shall return to

original condition, satisfactory to the City, damaged facilities resulting from the CONTRACTOR'S operations.

2. Trees, shrubs and grassed areas which are to remain shall be protected by fences, barricades, wrapping or other methods as shown, specified, required, or approved by the City. Equipment, stockpiles, etc. shall not be permitted within tree branch spread. Trees shall not be removed without approval of the City unless shown on approved plans.

1.5 GUARANTEE

A. CONTRACTOR shall guarantee that work performed under this Section will not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from CONTRACTOR'S operations appears during the period of up to 12 months after final completion of the project, the CONTRACTOR shall replace damaged items at no expense to the City.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fertilizer:

1. Fertilizer shall be of standard commercial quality containing nitrogen, phosphoric acid and potash in a 1:2:1 ratio, shall be packed in the properly labeled manufacturer's standards bags and each bag shall not weigh in excess of 100 pounds. Labeling shall consist of manufacturer's name, net weight of contents, type of material, and a guaranteed analysis on each container. The fertilizer shall be stored in a weather proof storage area. Material that has become caked or otherwise damaged will be rejected.

B. Seed:

1. All seed shall meet requirements of the Virginia Erosion and Sediment Control Handbook Standard and Specification 3.32, and be delivered in original unopened packages. Seed shall be certified by the Virginia Crop Improvement Association or the certifying agency in other states. Each package shall be guaranteed 95 percent pure and having an analysis showing the following: Kind, Variety, Lot No., Lab Test No., Lab Test Date, Pounds, Purity Percent, Germination Percent and Weed Seed Percent. Packages which do not contain analysis certificates will not be accepted.
2. Seed shall have a minimum germination rate of 85 percent within one year of test.
3. Permanent Seeding Mix shall be in accordance with Table 3.32-D of the Virginia Erosion and Sediment Control Handbook, for General Slope Conditions.
4. Permanent seeding after October 16 will only be allowed if weather conditions permit and with approval of the OWNER. Seeding shall not be performed when the ground is frozen, or when soil and weather conditions would prevent proper soil preparation.

5. Temporary vegetation shall be used to stabilize temporary diversion dikes and disturbed areas that will not be brought to final grade within 30 days, in accordance with Virginia Erosion and Sediment Control Handbook Standard and Specification 3.31.

C. Mulch:
   1. Hay for mulching shall be of mowings of acceptable herbaceous growth, which is free from noxious weeds; normally materials that are low grade and unfit for farm use are acceptable. The weight shall be calculated on the basis of the material not having more than 15 percent moisture content.
   2. Straw for mulching shall be stalks of oats or wheat crops that are free from noxious weeds. Normally materials that is unfit for farm use is acceptable for mulch. The weight shall be calculated on the basis of the material not having more than 15 percent moisture content.

D. Lime:
   1. Lime shall be agriculture grade pelletized or pulverized limestone. Lime shall be applied as directed by the City, generally apply pelletized lime where potential run-off is possible to adjacent water. Pulverized lime shall be used on level areas.
   2. Lime source shall be registered with and approved by the Virginia Department of Agriculture and Commerce in accordance with the Virginia Agricultural Lime Law and shall conform to VDOT Road and Bridge Specifications.

E. Fencing:

   1. Chain link fence material shall conform to Section 507 of the VDOT Road and Bridge Specifications. All other fence material shall match existing type, size, and materials as nearly as possible to existing.

   2. CONTRACTOR to match and replace existing fencing disturbed by construction Fencing damaged by CONTRACTOR'S operations shall be corrected at CONTRACTOR'S expense.

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

A. Limits of clearing shall be limited to areas required by the Work as shown on the Drawings. No clearing shall begin until the CONTRACTOR has marked areas to be cleared, areas to be grubbed, and items to be salvaged with stakes, flags, paint, or plastic colored ribbon and received approval by the City. Damage outside these limits resulting from the CONTRACTOR'S operations shall be corrected at the CONTRACTOR's expense.

B. Except as noted below, CONTRACTOR shall remove from the site and satisfactorily dispose of all trees, shrubs, stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures not covered under other Sections as specified or otherwise required to permit construction of the Work.

C. Grubbing shall include the removal of all stumps and root mat. Roots shall be removed to a depth of not less than 18-inches below subgrade. Any depressions resulting from the removal and grubbing operations shall be backfilled to the original ground elevation.

D. Trees, stumps and other cleared and grubbed material shall be disposed of off the site of the Work at no additional cost to the City. No cleared or grubbed material may be used in backfills or structural embankments.

E. No on-site burning will be allowed unless approved by authorities having jurisdiction.

F. Trees and shrubs shall be trimmed when doing so will avoid removal or damage. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty who are approved by City. Trees and shrubs intended to remain which are damaged beyond repair or removed, shall be replaced by the CONTRACTOR at Contractor's expense.

G. Control air pollution caused by dust and dirt, and comply with governing regulations.

H. CONTRACTOR must comply with all City Ordinances on removal of trees and must coordinate with the City's Urban Forestry Department prior to tree removal.

3.2 TOPSOIL REMOVAL AND INSTALLATION

A. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Topsoil shall be substantially free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.

B. Strip topsoil which is satisfactory to whatever depths are encountered, and in such manner as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

1. Where trees are shown or directed to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system in accordance with the Virginia Erosion and Sediment Control Handbook, Specification 3.38.

C. Stockpile topsoil in storage piles in areas shown, or where otherwise approved by the City. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust. Topsoil in excess of quantity required shall be removed from the site at the CONTRACTOR'S expense. Silt fence shall be installed at the base of the stockpile.

D. Topsoil stockpiles remaining undisturbed for 30 days or more shall be temporarily seeded in accordance with the Virginia Erosion and Sediment Control Handbook, Specification 3.31.

E. Preparation for installation of topsoil:
   1. Loosen subgrade of areas to receive topsoil to a minimum depth of 4 inches by discing, harrowing or other approved method to permit bonding of the topsoil to the subgrade. Operate the equipment used to scarify the subsoil so the ridges and depressions are parallel to the contours.
   2. Remove stones over 1-1/2 inches in any dimension and sticks, roots, rubbish and other extraneous matter.

F. Installation of topsoil:
   1. Topsoil shall be installed in accordance with Virginia Erosion and Sediment Control Handbook, Standard and Specification 3.30, and as specified herein.
   2. Place and spread topsoil, over all unpaved areas disturbed during construction and as directed by the City, to a minimum depth of 4 inches after natural settlement and light rolling, in a manner that the completed work conforms to the lines and grades of the pre-construction ground surface.
   3. Do not compact topsoil, except for light rolling.
   4. After the topsoil is spread, remove all large, stiff clods, rocks, roots or other foreign matter over 2 inches.
   5. Apply soil amendments, as required by machine over all areas receiving topsoil, to bring the soil to a neutral pH. Work lightly into the top 3 inches of topsoil.
   6. Manipulate topsoil to attain a properly drained surface.
   7. Grade topsoil areas to smooth, even surface with loose, uniform, fine texture.
   8. Roll and rake and remove ridges and fill all depressions, ruts, low spots or unsuitable areas which result after settlement so that the area is suitable for subsequent work.

3.3 LIMING, FERTILIZING, SEEDING, MULCHING, HYDROSEEDING

A. Liming: Lime shall be uniformly spread at the rate of 2 tons per acre on areas to be seeded prior to the areas being loosened or roughened

B. Fertilizing: Fertilizer shall be evenly spread at the rate of 1,500 pounds per acre of area and lightly worked in by an approved method.

C. Seeding:
   1. Seeding shall be performed in accordance with the Virginia Erosion and Sediment Control Handbook Standards 3.31 and 3.32, or as specified herein.

All areas where topsoil has been placed, all areas where topsoil already exists but requires reworking, and other regraded or disturbed areas within the Work limit shall be seeded. Seeded areas shall be maintained until a satisfactory growth is obtained. All grassed areas on which the grass is destroyed by operation of the CONTRACTOR shall be restored as specified above at his own expense.

2. Seed shall be evenly spread at the rate of at least 7 pounds of pure live seed per 1,000 square feet of area and shall be lightly raked into the ground to a depth not to exceed 1/4-inch by any approved method. After seed placement, the area shall be rolled.
3. The CONTRACTOR will, at his own expense, be responsible for all maintenance, watering, weeding and repair of failures, to the seeded areas. It shall be the CONTRACTOR's responsibility to protect the seeded areas by whatever method he deems necessary until acceptance of the seeded areas by the City. The CONTRACTOR shall be responsible for producing a satisfactory healthy stand of grass consisting of all the types of grass seeds sown.

D. Mulching:
1. Straw or hay mulch shall be applied at the rate of 2 tons per acre in such a manner so that not more than 10 percent of the soil surface is left exposed. No seeded areas may be left unmulched for a period of more than 48 hours. After the end of 48 hours, the areas which were not mulched shall be reseeded.
2. Straw or hay mulch shall be anchored in accordance with the Virginia Erosion and Sediment Control Handbook Standard Specification 3.35. Asphalt shall not be used to anchor mulch.

E. Hydroseeding:
1. CONTRACTOR may at his option spread fertilizer, seed and mulch with hydroseeding equipment.
2. CONTRACTOR shall submit to the City for approval seed, fertilizer and mulch substitutes required for hydroseeding.
3. Liquid fertilizer shall be applied on a poundage basis, mixed with the same volume of water that would be used with dry fertilizer.
4. Wood cellulose fiber mulch shall be applied at a rate of approximately 1,500 pounds net dry weight per acre and in such a manner to obtain a uniform distribution of mulch.

3.4 MAINTENANCE

A. Maintain topsoiled areas by filling in erosion rills and correcting drainage as required.

B. Maintain the topsoil in a loose, friable condition until the area is reseeded in accordance with the requirements herein.

C. Maintain seeded areas until final acceptance but in no case less than 60 days after planting.

3.5 CLEAN UP AND PROTECTION

A. During site restoration work, store materials and equipment where directed. Keep pavements clean and work areas in an orderly condition.

B. Remove excess excavation, displaced trees, and trimmings and dispose of off the City's property.

C. Do not remove protection barriers until directed by the City, or until final acceptance of the Work by the City.

D. Protect topsoiled and seeded areas and materials from damage due to CONTRACTOR'S operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Repair or replace damaged work as directed.

E. The CONTRACTOR shall protect all roadside features such as signs and supports, delineators, guardrail and post, buildings and tanks, fences or other such property of others from spray applications or fertilizer, mulch or asphalt. All objects defaced during spray applications shall be cleaned or replaced by the CONTRACTOR at Contractor's expense to the satisfaction of the City.

3.6 TEMPORARY EROSION CONTROL

A. Conform to requirements specified in Section 02010 – Erosion and Sediment Control.

3.7 FENCING

A. Chain link fencing installation shall conform to Section 507 of the VDOT Road and Bridge Specifications and VDOT Standard FE-CL. All other fence material shall match existing type, size, and materials as nearly as possible to existing.

3.8 INSPECTION AND ACCEPTANCE

A. When site restoration work is completed, including any required interim maintenance, the City will perform an inspection to determine acceptability.

B. Where inspected work does not comply with the requirements, Contractor shall address identified deficiencies from City's inspector, replace rejected work within five (5) work days, and continue specified interim maintenance until the work is reinspected by the City is found to be acceptable. Remove rejected plants and materials promptly from the Project site.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 02151

SHORING, SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Work required for protection of an excavation or structure through shoring, sheeting, and bracing.

B. Related Work Specified in Other Sections Includes:

1. Section 02220 – Excavation and Backfill
2. Section 15051 – Buried Piping Installations

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Submittals: Submit a CERTIFICATE (ONLY), signed and sealed by a Licensed Professional Engineer experienced in Structural Engineering and registered in the State where the construction will be performed, that certifies that the Licensed Professional Engineer has evaluated and approved the CONTRACTOR's excavation plan and has prepared complete design calculations and working drawings for the shoring, sheeting and bracing, not specifically shown on the Contract Drawings, which will be used for excavation support. Provide a separate CERTIFICATE for each excavation before starting the excavation. Where commercially manufactured trench boxes are to be used, provide a CERTIFICATE from the CONTRACTOR's Licensed Professional Engineer stating the conditions under which the trench boxes will be used.

1.3 REFERENCES

A. Codes and standards referred to in this Section are:
1. All Federal, State and local laws and regulations applying to the design and construction of shoring, sheeting and bracing.
2. National Bureau of Standards Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping Trenches and Excavations."

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

A. Use manufacturers and materials for shoring, sheeting and bracing as recommended by the CONTRACTOR's Licensed Professional Engineer who designed the shoring, sheeting, and bracing. Where wood lagging is to be left in place use oak or treated fir or treated pine. Use only environmentally safe treatment for wood lagging.

B. General
   1. Used material shall be in good condition, not damaged or excessively pitted. All steel sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work. No wood sheeting shall be designated to remain in place.
   2. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction grade or Southern Pine No. 2 Dense, conforming to the applicable requirements of current VDOT Road and Bridge Specifications.
   3. All steel work for sheeting, shoring, bracing, cofferdams, etc. shall be designed in accordance with the provisions of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," of the AISC except that field welding will be permitted.
   4. Steel sheet piling shall be manufactured from steel conforming to ASTM A 328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A 36.

PART 3 EXECUTION

3.1 SHORING, SHEETING AND BRACING INSTALLATION

A. General: Provide safe working conditions, prevent shifting of material, prevent damage to structures or other work, and avoid delay to the work, all in accordance with applicable laws and regulations. Properly shore, sheet, and brace all excavations that are not cut back to the proper slope, as determined by the CONTRACTOR's Licensed Professional Engineer.
   1. Take sole responsibility for the design and adequacy of shoring, sheeting and bracing not shown on the Contract Drawings.
   2. Take sole responsibility for the methods of installation of the shoring, sheeting and bracing.

B. Arrange shoring, sheeting and bracing so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength.

C. If the CONTRACTOR or its Licensed Professional Engineer is of the opinion that at any time the CONTRACTOR's excavation plan, shoring, sheeting or bracing is inadequate or unsuited for the purpose, take immediate and appropriate action.

Provide a new CERTIFICATE if the CONTRACTOR's excavation plans, shoring, sheeting or bracing require modifications.

D. Monitoring: Periodically monitor horizontal and vertical deflections of sheeting, shoring and bracing.

E. Accurately locate all underground utilities and take the required measures necessary to protect them from damage. All underground utilities shall be kept in service at all times as specified in Division 1.

F. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

G. Unless otherwise specified, or ordered, all materials used for temporary construction shall be removed when work is completed. Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent Work.

H. Remove shoring, sheeting and bracing as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures or pipe bedding.
   1. Removal shall be equal on both sides of excavation to ensure no unequal loads on pipe or structure.
   2. Carefully fill voids left by the withdrawal of the shore, sheeting and bracing. No separate payment will be made for the filling of such voids.
   3. If pipe bedding is disturbed, re-compact it to meet specified density requirements.

I. Permission for Removal: Obtain permission from the CONTRACTOR's Licensed Professional Engineer before the removal of any shoring, sheeting or bracing. Retain the responsibility for injury to structures or to other property or persons for failure to leave such shoring, sheeting and bracing in place even though permission for removal has been obtained.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 02220

EXCAVATION AND BACKFILL

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to perform all excavating, sewer abandonment, backfilling, filling and grading, and disposing of earth materials as specified and required for construction and repair of manholes, pipelines, roads, and other facilities required to complete the Work in every respect.
2. Work shall conform to the City of Richmond requirements and where construction is within the State right-of-way, the applicable requirements of the Virginia Department of Transportation.
3. No classification of excavated materials will be made. Excavation includes all material regardless of type, character, composition, moisture, or condition thereof.

B. Related Work Specified in Other Sections Includes:
1. Section 02010 - Erosion and Sediment Control
2. Section 02050 - Site Demolitions
3. Section 02110 - Clearing, Grubbing and Site Restoration
4. Section 02300 - Crossing by Jacking, Boring and Tunneling
5. Section 02606 - Manholes
6. Section 03300 - Concrete
7. Section 15051 - Buried Piping Installation

1.2 QUALITY ASSURANCE

A. Tests:
1. Engage the services of a certified, independent testing laboratory to make tests and determine acceptability of the fill or material as listed below and required by the City. Laboratory shall be acceptable to the City.
2. Required Tests:
a. Select Fill, Subbase Material, General Backfill Samples: Gradation, ASTM D 422.
b. Compaction, ASTM D 1556 and ASTM D 698, and ASTM D 2922.

B. Permits and Regulations:
1. CONTRACTOR shall obtain all necessary City of Richmond and Commonwealth of Virginia permits for work in roads, rights of ways, railroads, etc. Also obtain permits as required by local, state and federal agencies for discharging water from excavations.

2. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
3. All VOSHA safety measures, including but not limited to trenching, confined space, traffic control and other applicable safety measures shall be strictly adhered to and enforced by the CONTRACTOR. CONTRACTOR shall develop a written plan that demonstrates compliance with VOSHA requirements. A copy of the plan shall be maintained at the construction site for the duration of the project.

C. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise specified.

1. ASTM A 36, Specification for Structural Steel.
2. ASTM A 328, Specification for Steel Sheet Piling.
3. ASTM D 422, Method for Particle-Size Analysis of Soils.
4. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,419 ft-lb/ft3)
5. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
6. ASTM D 2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
8. VOSHA Standard.

1.3 SUBMITTALS

A. CONTRACTOR shall prepare drawings for the following items, if used in completion of the Work:
1. Sheeting and bracing, or other protective system(s).
2. Dewatering system.
3. Cofferdams.
4. Underpinning.

Drawings shall be prepared by a licensed professional engineer recognized as expert in the specialty involved. Drawings shall be submitted to the City for record purposes only. Calculations shall not be submitted. Drawings submittals will not be checked and will not imply approval by the City of the Work involved. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering required to complete the Work.

B. Test Reports: The testing laboratory shall submit copies of all test reports directly to the City, with copy to CONTRACTOR.

1.4 JOB CONDITIONS

A. Subsurface Information: If subsurface data is available, it is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. The City will not be responsible for interpretations or conclusions drawn by CONTRACTOR. Data are solely made available for the convenience of CONTRACTOR. Additional test borings and other exploratory operations may be made by CONTRACTOR at no cost to the City.

B. Existing Structures: The Drawings, if any, may show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of CONTRACTOR. CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, they shall be restored immediately by CONTRACTOR at his expense.

C. Existing Utilities:
   1. It shall be the responsibility of the CONTRACTOR to conduct the Work in such a manner as to avoid damage to, or interference with, any utility services. The CONTRACTOR is responsible for providing temporary supports for any utility that may be affected by its work. If any damage, interference, or interruption of service occurs as a result of his Work, it shall be the CONTRACTOR'S responsibility to promptly notify the City and utility owner of the occurrence and to repair or caused to be repaired the damage immediately, at his own expense, and to the satisfaction of the City and the owner of the utility.
   2. It shall be the CONTRACTOR'S responsibility to uncover and expose the location of all service connections to avoid damage or interruption of service. If damage occurs, the CONTRACTOR shall make the necessary repairs in accordance with the above requirements.
   3. It is the responsibility of the CONTRACTOR to determine in advance of beginning the construction effort the exact location of all utilities, and the effect they will have on the work by contacting "Miss Utility" for assistance at 1-800-552-7001, 72 hours prior to starting work. All costs related to identification of utility location shall be the responsibility of the CONTRACTOR.
   4. Do not interrupt existing utilities serving facilities occupied and used by the City or others, except when permitted in writing by the City and then only after acceptable temporary utility services have been provided.
   5. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Protection of Persons and Property:
   1. Barricade open excavations occurring as part of the Work and post with warning lights and other protective measures as recommended by authorities having jurisdiction.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by Work or other operations in the area.

E. Dust Control: Conduct all operations and maintain areas of activity, including sweeping and sprinkling of roadways, to minimize creation and dispersion of dust.

F. Protection of Trees: Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits, and in accordance with requirements of Section 02110 - Clearing, Grubbing and Site Restoration. Work should be performed in accordance with the requirements of the Department of Public Works Urban Forestry Tree Ordinance.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Standard specifications for soil materials are provided herein. Any variance from these specifications shall be at the sole discretion of DPU.

B. Select Fill:
   1. Materials for Select Fill:
      a. Use gravel, crushed stone, limestone screenings or other granular or similar material as approved which can be readily and thoroughly compacted to the required percent of the maximum dry density at optimum moisture content as determined by ASTM D 698.
      b. Place select fill where specified below and around structures, pipelines, roads, walks, and other work.
   2. Grade select fill between the following limits:

U.S. Standard Sieve	Percent Passing by Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95
1/2 inch	45-70
#4	25-50
#10	15-40
#200	5-15

   3. Advise in writing of source and, if required, submit a sample and gradation report of the material for approval.

C. Common Fill:

1. Materials for Common Fill:
   a. Material from on-site excavation in unpaved areas may be used as common fill provided that it can be readily compacted to the required percent of the maximum dry density at optimum moisture content as determined by ASTM D 698.
   b. VDOT No. 21A stone shall be used for work in paved areas.
   c. Fill must not contain unsuitable material.
   d. Select fill may be used at Contractor's option as common fill at no change in the Contract Price.
2. Granular Materials On-Site: Granular on-site material, which is fairly well graded between the following limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing by Weight
3 inch	100
#10	50-100
#60	20-90
#200	0-20

D. Subbase Material: VDOT No. 21A stone.

E. Pipe Bedding

1. Pipe bedding shall be VDOT Size No. 21A. The stone shall conform to Section 203 of the VDOT specifications.
2. For all new pipe installation, pipe bedding and initial pipe backfill to 1 foot over the top of pipe shall be 21A as noted above.

F. General Backfill and Fill Materials:

1. Provide approved soil materials for backfill and fill, free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetable and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for general backfill upon prior approval of the City.
2. Approved materials must be at moisture condition suitable for compaction at required density.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which excavating, filling, and grading are to be performed. Also, remedy any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in manner acceptable to the City.

3.2 PREPARATION

A. Immediately notify the agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from the City and agency for any repairs or relocations, either temporary or permanent.

B. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed through the use of a Licensed Surveyor in the Commonwealth of Virginia.

3.3 EXCAVATION

A. All excavation will be conducted in accordance with "Virginia Occupational Safety and Health Standard for the Construction Industry."

B. Perform all excavation required to complete the Work specified and required. Excavations shall include earth, sand, clay, gravel, rock, hardpan, pavements, rubbish and all other materials within the excavation limits. If excavations are made between the required grades, without the written order of the City, they shall be backfilled with compacted Subbase Material, at the expense of the CONTRACTOR.

C. Practice care during excavation operations to protect adjacent surfaces and subgrade trench walls. Install a trench shoring system and lower the trench shoring system as the excavation progresses based on the soil conditions encountered at the site to prevent trench cave-ins and undermining of adjacent roadway surfaces or structures. Undermining of trench walls and damage to adjacent asphalt, sidewalks, or structures due to negligence will have to be repaired at the CONTRACTOR's cost.

D. Excavations for structures and pipelines shall be open excavations. Provide all excavation protection systems required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. See Section 15051 – Buried Piping Installation for additional requirements.

E. Where a structure or pipeline is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of the structure or pipeline under dry conditions. Dry conditions shall prevail until the pipelines are properly jointed, tested and backfilled. In addition, protect excavation from flooding until all structures are in place and backfilling has begun. Water level shall be maintained below top of backfill at all times. See Section 15051 – Buried Piping Installation for additional requirements.

F. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade. Dispose of water in accordance with Paragraph 3.6.

G. Excavations shall be extended sufficiently on each side of structures, footings, etc., to permit setting of forms, installation of shoring or bracing or the safe sloping of banks.

H. Subgrades for roadways, structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades which are otherwise solid, but which become soft or mucky on top due to construction operations, shall be removed and replaced with No. 57 stone.

I. Pipe Trench Preparation: See Section 15051 – Buried Piping Installation, for additional requirements.
   1. No more than 100 feet of trench may be opened in advance of pipe laying.
   2. Trench width shall be minimized to greatest extent practical but shall conform to the following:
      a. Sufficient to provide room for installing, jointing and inspecting piping.
      b. Enlargements at pipe joints may be made if required and approved by the City.
      c. Sufficient for shoring and bracing, or shielding and dewatering.
      d. Sufficient to allow thorough compaction of backfill adjacent to bottom half of pipe.
      e. Do not use excavating equipment which requires the trench to be excavated to excessive width.
   3. Depth of trench shall be sufficient to install the pipe at the specified grade with suitable pipe support. No additional depth of cut beyond that required is to be made without specific approval of DPU representatives.

J. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations. Dispose of excess soil material and waste materials as specified.

K. Where the City considers the existing material beneath the bedding material unsuitable, CONTRACTOR shall remove same and replace it with No. 57 stone.

L. Undercut Excavation For Trenching:
   1. In the event unsuitable material is encountered at or below the level of the pipe bed, areas of doubtful quality shall be jointly examined by the City and the CONTRACTOR. If approved by the City and after agreement as to the extent of the area, such material shall be removed and replaced. Materials used for replacement shall be crushed stone or gravel aggregate conforming to VDOT No. 57 stone, as directed by the City.
   2. Undercut excavation shall be unclassified and shall consist of removing and disposing of unsuitable material located below plan grade, or finished subgrade, within the construction limits.

3. Undercut excavation shall be disposed of in a legal manner or as indicated in the Contract Documents.
4. CONTRACTOR responsible for keeping undercut excavation dry.

M. Excavation Material Disposal: CONTRACTOR shall assume responsibility for disposal of all excavated materials and for payment of any dumping or tipping fees associated with the disposed excavated materials. Any materials having been in contact with sewer, as well as contents of cleaning trucks are to be disposed of by federal, state and locally approved methods.

3.4 UNAUTHORIZED EXCAVATION

A. All excavation outside the lines and grades specified, and which is not approved by the City, together with the removal and disposal of the associated material shall be at CONTRACTOR'S expense. Unauthorized excavations shall be filled and compacted with No. 21A stone by CONTRACTOR at his expense.

3.5 SEWER ABANDONMENT

A. Comply with requirements specified in Section 02050 Site Demolitions.

3.6 DRAINAGE AND DEWATERING

A. General:
1. Prevent surface and subsurface water from flowing into excavations and from flooding adjacent areas.
2. Remove water from excavation as fast as it collects.
3. Maintain the ground water level below the bottom of the excavation to provide a stable surface for construction operations, a stable subgrade for the permanent work, and to prevent damage to the Work during all stages of construction.
4. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations.
5. Obtain the City’s approval before shutting down dewatering system for any reason.

B. Disposal of Water Removed by Dewatering System:
1. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
2. Dispose of water in such a manner as to cause no inconvenience to the City or others involved in work about the site.
3. Convey water from the construction site in a closed conduit. Do not use trench excavations as temporary drainage ditches. Provide erosion and sediment control devices as required by the Virginia Erosion and Sediment Control handbook prior to discharge to any receiving stream.

3.7 SHEETING, SHORING AND BRACING

A. Comply with requirements specified in Section 02151 Shoring, Sheeting, and Bracing

3.8 TRENCH SHIELDS

A. Excavation of earth material below the bottom of a shield shall not exceed the limits established by ordinances, codes, laws and regulations.

B. When using a shield for pipe installation:
   1. Any portion of the shield that extends below the center line of an installed rigid pipe shall be raised above this point prior to moving the shield ahead for the installation of the next length of pipe.
   2. The bottom of the shield shall not extend below the center line of installed flexible pipe at any time.

C. When a shield is removed or moved ahead, extreme care shall be taken to prevent the movement of pipe or structures or the disturbance of the bedding for pipe or structures. Pipe or structures that are disturbed shall be removed and reinstalled as specified.

3.9 GENERAL REQUIREMENTS FOR BACKFILL, FILL AND COMPACTION

A. Furnish, place and compact all backfill required for structures and trenches. Unless otherwise specified, fill that meets the requirements of general backfill may be obtained from on-site sources. Additional materials, if required, shall be furnished from off-site sources at no additional cost to the City.

B. VDOT No 21A shall be used to backfill excavations in unpaved areas for the first 4-ft. of the trench. The material from on-site excavation shall be used as backfill for the remainder of the excavation. VDOT No. 21A stone shall be used as a backfill material for the entire trench depth for work in paved areas (streets, roadways etc.).

C. Backfill excavations as promptly as Work permits, but not until removal of shoring and bracing.

D. Keep excavations dry during backfilling operations. Bring backfill around structures and piping up evenly on all sides.

E. Practice care when removing trench shoring system and place backfill in lifts as the shoring system is partially removed to prevent trench cave-ins and undermining of adjacent roadway surfaces or structures. Undermining of trench walls and damage to adjacent asphalt, sidewalks, or structures due to negligence will have to be repaired at the Contractor's cost. Place all backfill in pipe trenches which are below structures, other pipes, or paved areas, in horizontal layers not exceeding 6 inches in depth and thoroughly compact each before the next layer is placed. In other pipe

trenches, compacted layers shall be 6 inches up to the pipe center line and 12 inches thereafter.

F. Where pipe is laid in rock excavation, pipe bedding shall be carefully placed and tamped over the rock before the pipe is laid. Depth of bedding shall be at least 9 inches. After laying pipe, the balance of the backfill shall be placed as described herein. In no circumstance shall pipe be allowed to bear directly on rock.

G. Prior to the installation of pipes which are to be installed in fill sections, place the fill as described herein, until a minimum height of 2 feet above the pipe is reached. The fill for the trench width shall then be excavated and the pipe installed and backfilled. The remainder of the fill shall then be placed.

H. Unless otherwise specified or directed by the City, fill shall be placed in horizontal loose lifts not exceeding 12 inches in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing.

I. Control the water content of fill material during placement within the range necessary to obtain the compaction specified. In general, the moisture content of the fill shall be within 3 percent of the optimum moisture content for compaction as determined by laboratory tests. Perform all necessary work to adjust the water content of the material to within the range necessary to permit the compaction specified. Do not place fill material when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted.

J. Do not place or compact fill in a frozen condition or on top of frozen material. Remove fill containing organic materials or other unacceptable material and replace with approved fill material.

K. Perform compaction of fill with equipment suitable for the type of material placed and which is capable of providing the densities required. Flooding with water to achieve compaction shall not be permitted.

L. Fill shall be compacted by at least two passes of all portions of the surface of each lift by compaction equipment. One pass is defined as the condition obtained when all portions of the surface of the fill material have been subjected to the direct contact of the compactor.

M. Test the effectiveness of the equipment selected by CONTRACTOR at the commencement of compaction by construction of a small section of fill within the area where fill is to be placed. If tests on this section of fill show that the specified compaction is not obtained, CONTRACTOR shall increase the number of coverages, decrease the lift thicknesses or obtain a different type of compactor.

N. Perform backfill around structures using the specified procedures, except that within 10 feet of foundations and underground structures, light compaction equipment shall be used, with the gross weight of the equipment not exceeding 7,000 pounds.

Provide equipment that is capable of the required compaction within restricted areas next to structures and around piping.

O. Percentage of maximum density requirements.

1. Compact each layer of fill or backfill to not less than the following percentages of the maximum density at optimum moisture content as determined by ASTM D698.
   a. Under structures – 95 percent
   b. Under paved areas, walks, and fill supporting piping – 95 percent
   c. Under roadways and road shoulders - 95 percent or in accordance with Department of Public Works Standards, whichever is greater.
   d. Other unpaved areas - 90 percent.
2. Compaction testing performed by the City's independent testing firm shall be done in randomly selected locations and in sufficient numbers to verify that the specified density is being obtained.
3. The following number of field density tests shall be the minimum acceptable for each type of operation:
   a. Fills: One test per lift per 10,000 square feet or fraction thereof
   b. Backfill against structures: One or more tests per 100 linear feet.
   c. Trench bedding and backfill: One or more tests per 400 linear feet

P. If the specified densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment, the CONTRACTOR shall perform whatever work is required to provide the required densities. This work shall include complete removal of unacceptable fill areas, and replacement and re-compaction until acceptable fill is provided. Compaction testing of the remedial work shall be done at the CONTRACTOR's expense.

Q. CONTRACTOR shall repair, at his own expense, any after settlement that occurs. He shall make all repairs and replacements necessary within 30 days after notice from the City. In the case where the City deems the depression or damage warrants immediate attention due to public health or safety and an emergency response is required, CONTRACTOR shall have a maximum of four (4) hours to mobilize on site. If CONTRACTOR is unable to meet this timeframe, the City may take necessary measures to have applicable corrective actions taken at the expense of the CONTRACTOR. Contractor shall warranty all repairs and replacements for a period of one year from acceptance of the work by the City.

3.10 WORK WITHIN PUBLIC STREETS AND ROADS

A. Any Work performed in public streets, roads or alleys shall conform to the City of Richmond and Virginia Department of Transportation requirements and recommendations.

B. Repair of any pavement shall be in accordance with the City of Richmond and Virginia Department of Transportation requirements and recommendations.

C. CONTRACTOR shall take all required actions to insure highway safety when working within public streets and roads. Highway safety measures shall conform to the requirements of the Virginia Work Area Protection Manual and ANSI D6.1, Manual on Uniform Traffic Control Devices for Streets and Highways.

3.11 GRADING

A. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are specified, or between such points and existing grades. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 DISPOSAL OF EXCAVATED MATERIALS

A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site by the CONTRACTOR and disposed of in compliance with ordinances, codes, laws and regulations at no additional cost to the City.

END OF SECTION

SECTION 02300

CROSSINGS BY JACKING, BORING AND TUNNELING

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, supervision and incidentals required to furnish and install casing pipe and carrier pipe as specified herein and as required to complete the Work.
   2. The CONTRACTOR may elect to use a larger diameter casing than shown. If the CONTRACTOR elects to utilize the casing diameter called for on the Details, and the installation must be abandoned due to the inability of the CONTRACTOR to hand mine in the casing, the installation will be abandoned at the CONTRACTOR'S expense.

B. Related Work Specified in Other Sections Includes:
   1. Section 02110 – Clearing, Grubbing and Site Restoration
   2. Section 02151 – Shoring, Sheeting, and Bracing
   3. Section 02220 – Excavation and Backfill
   4. Section 03300 – Concrete
   5. Division 15 – Mechanical

1.2 QUALITY ASSURANCE

A. Installer's Qualifications and Experience:
   1. Installer shall be a specialist in the construction of casing pipes by jacking, boring or by installation of tunnel liner plates and shall have at least five years' experience in this specialty. Installer shall have satisfactorily constructed completely in his own name, during the past five years not less than ten similar installations which are comparable in diameter and length to that shown and specified herein.
   2. Use only personnel thoroughly trained and experienced in the skills required. The field supervisor of boring operations and the boring machine operator shall have not less than 12 months experience in the operations of the equipment being used.
   3. Welds shall be made only by welders, tackers and welding operators who have been previously qualified by tests as prescribed in American Welding Society, AWS D.1.1 to perform the type of work required. Show proof of certification when requested by the City's Representative.
   4. The CONTRACTOR shall be responsible for obtaining a survey prior to the beginning of the crossing and upon completion of the crossing work. The survey shall extend along the centerline of the crossing at ground surface a minimum of 50 feet past the end of the crossing in each direction and then at

a right angle to the crossing, in each direction for minimum of 50 feet, on top of each rail or center of lane.

B. Permits: The CONTRACTOR shall be responsible to obtain and pay for all permits, insurance and bonds required to complete the work.

C. Requirements of Regulatory Agencies:
   1. The CONTRACTOR shall comply with all provisions of all permits.
   2. The CONTRACTOR shall obtain all permits, provide insurance, bonds, and guarantees, and all else required by the governing authorities at his own expense. The CONTRACTOR'S responsibility under this paragraph shall include, unless otherwise directed by City, but is not limited to the following:
      a. Constructing and removing temporary facilities or structures.
      b. Providing details of construction methods.
      c. Providing detailed construction schedules.
      d. Reimbursing the applicable authority for all expenses incurred by them in connection with the work.
      e. Traffic maintenance.
      f. Coordination of scheduling with the authority.
      g. Necessary clean-up and restoration.
   3. Materials and methods of construction used on railroad company property shall be subject to the approval of the railroad company and the CONTRACTOR shall at all times conduct his work and operations fully within the railroad company's rules, regulations and requirements. The CONTRACTOR must ascertain from the railroad company its rules, regulations and requirements, and what, if any, delays may be encountered. If required by the railroad company, the CONTRACTOR must submit for approval specific details of the methods of construction he intends to utilize together with any sketches or drawings.

D. Tolerances: The casing pipes shall be installed on the lines and grades shown on the Details and within tolerances required to allow the sewer to be installed in accordance with the lines and grades shown on the Plans.

E. Reference Standards:
   1. ASTM A 139 – Electric-Fusion (ARC Welded) Steel Pipe
   2. ASTM A 153 – Zinc-Coating (Hot Dip) on Iron and Steel Hardware
   3. ASTM A 307 – Low-Carbon Steel Externally and Internally Threaded Standard Fasteners
   4. ASTM A 569 – Hot-Rolled Carbon Steel Sheets and Strip, Commercial Quality
   5. ASTM A 252 – Welded and Seamless Steel Pipe Piles
   6. AASHTO – Interim Specification for Steel Tunnel Liner Plates
   7. AREMA Chapter 1, Part 4 – "Jacking Culvert Pipe through Fills"
   8. AREMA Chapter 1, Part 5 – "Specification for Pipelines Conveying Non-Flammable Substances"
   9. AWS D1.1 – Structural Welding Code
   10. Virginia Work Area Protection Manual

11. OSHA

1.3 SUBMITTALS

A. Installation Methods: The CONTRACTOR shall submit drawings and descriptions showing methods and equipment for the installation of the casing and carrier pipes and methods that will be employed to maintain vertical and horizontal alignment for approval by the City. The CONTRACTOR shall prepare a report of subsurface information, dewatering methods, jacking pit elevations and profile of proposed bore. The report shall be submitted to the City.

B. Technical data, test reports, work schedules and any other information required by the authority having jurisdiction.

C. Manufacturer's catalog cuts, technical data, operation and maintenance data, and/or shop drawings are required for the following components:

1. Pipe
2. Casing Spacers
3. Coatings
4. Pipe Closure System
5. Grout
6. Certified Welders Certificate

D. Casing Pipe Certificates from Manufacturer:
1. Certificate of Conformance in accordance with paragraph 20.2 of ASTM A 139-90.
2. Hydrostatic Test report in accordance with paragraph 12 of ASTM A 139-90.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Exercise special care during delivery not to damage the casing pipe and carrier pipe.
2. Damaged materials will be rejected by the City and replaced by the CONTRACTOR at his expense.
3. Deliver materials to such locations so as to avoid excessive handling.
4. The City is not responsible for accepting shipments of any kind.

B. Storage:
1. Store casing pipe and carrier pipe on approved blocking for protection from corrosion until incorporation into the Work in accordance with manufacturer's recommendation.
2. Store in areas approved by the City.
3. The City shall be permitted access to inspect the materials in storage areas.

C. Handling:
1. Handle materials in a manner so as to avoid damage.

2. Materials damaged during handling shall be repaired or replaced as directed by the City at no additional cost to the City.

1.5 JOB CONDITIONS

A. Protection: Guardrail, fences, signs, lights, barricades, barrels, and all other protective items necessary shall be provided in accordance with the requirements of all applicable permits, laws, regulations, and ordinances, including the Virginia Work Area Protection Manual, and as necessary to prevent damage or injury to private or public property or to workmen or the general public.

B. Adequately support and protect utilities and facilities that are encountered in, or may be affected by the work.

C. If the railroad company requires the installation of track supports, the CONTRACTOR shall install such supports. If the supports are not furnished by the railroad company, the CONTRACTOR shall be responsible for fabricating the track supports in accordance with the requirements of the Railroad Company's Chief Engineer. It should be noted, however, that railroad companies usually require that any work involving rails, ties, or other track material be performed by their own forces. The cost of such work, even though carried out by the railroad company, is at the expense of the CONTRACTOR.

D. The CONTRACTOR must observe all necessary and appropriate safety precautions when working on railroad right-of-way or property. At the discretion of the railroad, the CONTRACTOR shall provide a qualified watchman or pay for a watchman supplied by the railroad to warn workmen of the approach of any train or other moving equipment upon the tracks of the railroad, and to keep all workmen or other persons, equipment and materials from the tracks including any power, communication, and signal wires, so that there will be no contacts with trains, rolling equipment, or wires. CONTRACTOR shall comply with all railroad requirements.

E. All excavations shall be sheeted, shored and braced as required to prevent subsurface subsidence.

F. Boring pits shall be kept dewatered, and pumps shall be attended on a 24-hour basis, if conditions so require. Close observation shall be maintained to detect any settlement or displacement of facilities during dewatering operations. Dewater into a sediment trap and comply with applicable environmental protection criteria specified elsewhere in these Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Casing Pipe:

1. Casing pipe shall be new steel casing pipe meeting the requirements of ASTM A139, Grade B, leakproof construction capable of withstanding Cooper E-80 loading for railroad crossing or AASHTO HS-20 wheel loading for road crossings, whichever is greater. Impact factor shall be 1.0. Pipe shall be seamless or have not more than one longitudinal weld.
2. Minimum wall thickness shall be as shown on the Details.
3. Casing pipe shall be designed for earth cover required for the work and live load including impact equal to Cooper E-80 railroad loading for railroad crossing and HS-20 wheel loading for roadway crossings.
4. If the casing pipe is furnished in sections and the casing pipe requires field welding, then casing pipe shall be furnished with plain ends, mill beveled for field butt welding. Field welded joints shall be performed by AWS D.1.1 certified welders and be full penetration single-vee groove, butt type welds around the entire circumference of the pipe. All welding shall receive non-destructive testing. Copies of test reports shall be submitted to the City.
5. Coatings: The exterior and interior surfaces of the casing pipe shall receive surface preparation conforming to SSPC-SP6. Provide Tnemec, Tneme-Tar, 2 coats, 8.3 dry mils per coat or equal.
6. If required to check settlement greater than 1 inch the CONTRACTOR shall provide an adequate number of 1½-inch or 2-inch holes shall be drilled 3 feet on center alternating 30 degrees within a vertical plane through the casing pipe, to check voids after the casing pipe is installed. The holes shall be tapped for plugs. Plugs shall be furnished and installed by the CONTRACTOR. Cost for installation of holes and plugs shall have been included in the Contract price bid.
7. If the CONTRACTOR elects not to grout to check settlement in excess of 1-inch, then the CONTRACTOR may install track supports as his expense.

B. Tunnel Liner Plate:
1. Tunnel liner plates, bolts and nuts shall conform to the requirements of the "Specification for Steel Tunnel Liner Plates" as developed by the American Association of State Highway and Transportation Officials, Committee on Bridges and Structures, latest revision.
2. Liner plate tunnel shall be designed for earth cover required for the work and live load, including impact, equal to Cooper E80 railroad loading for railroad crossings or HS-20 wheel loading for road crossings, whichever is greater.
3. Minimum liner plate thickness shall be 0.1345 inch.
4. Minimum movement of inertia shall be 0.0549 $inch^4$/inch.
5. Liner plates shall be galvanized in accordance with ASTM A 123 and coated with a bituminous coating.
6. Liner plates may be "2-flanged" or "4-flanged" but must not be mixed on any specific tunnel.
7. Nuts and bolts shall be hot dipped galvanized in accordance with ASTM A 153, latest revision.
8. Shape plates such the erection can be completely and readily effected from within the tunnel.
9. Provide plate dimensions of such size and within such tolerances that plates of similar curvature are interchangeable.

10. Punch all plates for bolting on both longitudinal and circumferential joints.
11. Fabricate each plate from one piece of metal, including circumferential and longitudinal flanges.
12. Provide all plates with circumferential flanged joints.
13. Provide either flanged or offset lap seam type longitudinal joints.
14. Circumferential bolt hole spacing:
    a. Space in accordance with manufacturer's recommended standard spacing.
    b. Space as a multiple of plate length so that plates having the same curvature are interchangeable and permit staggering of the longitudinal joints.
15. Longitudinal bolt holes spacing: Space in accordance with manufacturer's recommended standard spacing.
16. Provide tapped grout holes consisting of welded half-couplings with pipe plugs 2 inches minimum in diameter. Number, size, type and location of grout holes shall be shown on the (shop drawing) details of the liner plates and approved by the City; but shall not occur in less than 10 percent of plates. Additional holes shall be inserted in the field if necessary to make sure all voids are filled.

C. Cement Grout: Uniform mixture of cement and sand, in accordance with Section 03300.

D. Casing Spacers:
1. Provide bolt-on style casing spacers for positioning carrier pipe within tunnel or casing pipe and for electrically isolating the carrier pipe from the tunnel or casing pipe.
2. The casing spacers shall support the carrier pipe in the center of the tunnel or casing pipe.
3. Materials:
    a. Shell: Type 304 stainless steel with PVC liner.
    b. Runners: Ultra high molecular weight polymer supported by Type 304 stainless steel risers welded to the shell. All welds shall be passivated.
    c. Bolts and nuts: Type 304 stainless steel.
4. Spacer Width: 12 inches.
5. Extent: Per Manufacturer's recommendations.
6. Manufacturer:
    a. Cascade Waterworks Manufacturing Co.
    b. Pipeline Products Corporation
    c. Or equal.

PART 3 EXECUTION

3.1 GENERAL

A. Installation of the crossings shall be by jacking, boring, microtunneling or tunnel with liner plate and shall conform in all respects to the requirements contained herein and other applicable standards.

B. Installation shall be completed in presence of City's representative.

C. All welding shall be full circumferential penetration by a certified welder. Contractor shall complete a hot work permit for any welding work.

D. Lines and Grades: The CONTRACTOR is responsible for establishing and maintaining proper line and grade at each crossing.
   1. The CONTRACTOR shall periodically check his line and grade to assure conformance with line and grade within the tolerance indicated in this Section.
   2. Extra work required because of the CONTRACTOR'S failure to maintain the proper line and grade, as shown on the Plans, shall be performed, by the CONTRACTOR, at no additional cost to the City.

3.2 INSPECTION

A. As required by the City, VDOT, Railroad, or other regulatory authority.

3.3 PREPARATION

A. Work pits at each end of the crossings shall be sufficiently large to permit satisfactory installation of the casing pipe or tunnel liner plates. All excavation, backfill, sheeting, shoring, bracing, and dewatering shall comply with the applicable requirements of these Specifications and all Federal, State and local regulations.

B. The CONTRACTOR shall dispose of excess excavated material or drilling mud/cuttings in an approved disposal site at the expense of the CONTRACTOR.

C. Tolerances
   1. Casings shall be placed to within +/- 3 inches of the vertical and +/- 3 inches of the horizontal alignment.
   2. Steering directions made to the casing shall be carried out in such a manner that the joint to joint angle of any two adjacent sections does not exceed 0.5 degrees.
   3. The CONTRACTOR shall carry out operations to minimize settlement and / or heave of the ground and be responsible for damage due to settlement or heave from any construction induced activities. In the event of movement of the ground surface, structure, or facilities being detected and damage recorded, the City may order that the work be stopped and secured. Before proceeding, the CONTRACTOR shall correct any problems causing or resulting from such movement entirely at his own cost. If ground settlement

or heave occurs which might affect the accuracy of temporary or permanent benchmarks, it is the CONTRACTOR'S responsibility to monitor and report such movement to the City.

D. All excavations shall be adequately ventilated. Air monitoring of the pits and access locations shall be conducted by the CONTRACTOR on a continuous basis.

3.4 INSTALLATION

A. All excavated material from the construction shall be disposed of away from the construction site. No stockpiling of material on the job-site will be permitted. Material shall be removed at regular intervals not exceeding 24 hours.

B. The CONTRACTOR shall monitor all ground movements associated with the work and maintain these within permissible tolerances. A baseline survey shall be prepared by the CONTRACTOR prior to undertaking the work. Surveys from a bench mark to points around the excavations. Provide documentation on the pre-survey and post- survey for review by the City.

C. Installation of Steel Casing Pipe by Jacking:
   1. Install in accordance with current American Railroad Engineering Association Specifications for railroad crossings and VDOT Road and Bridge Standards for roadway crossings.
   2. Design bracing and backstops and use jacks of sufficient rating such that jacking can be accomplished in a continuous manner until the leading edge of the pipe reaches the final positions shown on the Plans.
   3. If voids develop around the casing pipe as it is jacked that are greater than the outside diameter of the pipe by approximately one inch, pump cement grout to fill all such voids, or fill by other means acceptable to the City, the railroad or VDOT, where applicable.
   4. Fill all voids as specified hereafter as soon as possible after completion of jacking operation.
   5. The operation shall be continuous until the casing is installed.

D. Installation of Steel Casing Pipe by Boring:
   1. The boring method shall consist of pushing the pipe into the fill with a boring auger rotating inside the pipe to remove the soil.
   2. Provide the front of the casing pipe with suitable mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe.
   3. The equipment and mechanical arrangements or devices used to bore and remove the earth shall be removable from within the casing pipe in the event an obstruction is encountered.
   4. The face of the cutting edge shall be arranged to provide reasonable obstruction to the free flow of soft or poor soil.
   5. Do not use water or other liquids to facilitate casing emplacement or spoil removal.

6. If voids develop around the casing pipe as it is bored that are greater than the outside diameter of the pipe by approximately one inch, pump cement grout to fill all such voids, or fill by others means acceptable to the City.
7. Fill all voids as specified hereinafter as soon as possible after completion of boring operation.
8. The operation shall be continuous until the casing is installed.

E. Installation of Tunnel Liner Plating:
1. Assemble plates in accordance with the manufacturer's recommendations.
2. Make all circumferential and longitudinal joint connections with specified nuts and bolts.
3. Mine tunnel by approved methods which will prevent loss of material outside the plate sections and as follows:
   a. Excavate for one course at a time.
   b. Place and securely bolt liner plates in sequence immediately following excavation for them, and prior to excavation for the next course.
   c. Where material is lost outside the plate sections, grout to completely fill all voids in a manner acceptable to the City, the railroad or VDOT, where applicable.
   d. Grout all voids full as close to the header as possible, using grout stops behind plates, if necessary.
   e. Provide and maintain a solid, approved bulkhead at the end of work, at the end of each day's operations.

F. Grouting:
1. Start at the lowest hole of each section to be grouted, grout holes above to remain open, and proceed upward progressively and, if possible, simultaneously on both sides of the casing or tunnel until all voids are completely filled with 1:4 cement grout as specified in Section 03300, Concrete.
2. Provide grout holes in addition to those specified where directed by the City to insure filling of all voids.
3. At any given location, grouting pressures shall not exceed one-half PSI for each foot of overburden in earth.

G. Obstructions: If an obstruction is encountered during installation to stop the forward action of the casing pipe, and it becomes evident that it is impossible to advance the pipe, the CONTRACTOR may choose either of the following procedures.
1. Operations will cease and the casing pipe shall be abandoned in place and filled completely with grout. The pipe location shall be changed to a location approved by the City and the crossing re-bored or re-jacked at the CONTRACTOR'S expense and at no additional cost to the City.
2. The CONTRACTOR may continue the casing pipe by tunneling and installation of tunnel liner plates as described herein. The continuation by the tunneling method shall be at the CONTRACTOR'S expense and at no additional cost to the City.

H. Installation of the Pipe:
   1. After completion of the steel casing pipe, the carrier pipe shall be installed and pressure tested by an approved method as specified in Section 15051 - Buried Piping Installation.
   2. Care shall be taken to prevent undue disturbances of the joints.
   3. Carrier pipe shall be blocked in place, using stainless steel casing spacers to secure it against movement at maximum spacing of 8 feet.
   4. The CONTRACTOR shall repair, replace or take whatever action is deemed necessary by the City to correct all disturbed joints at no additional cost to the City.

I. Wraparound End Seals:
   1. After the carrier pipe is installed in the tunnel or steel casing and successfully pressure tested, install wraparound end seal as shown in the details and as specified herein.
   2. Wraparound end seal shall be 1/8" thick synthetic rubber secured with T-304 stainless steel banding straps with a 100% non-magnetic worm gear mechanism as manufactured by Advance Products & Systems, LLC or equal approved by the City.
   3. Prior to the installation of bulkheads, the line shall be properly and sufficiently secured against flotation and against all movement which would disturb joints.
      a. The CONTRACTOR shall be responsible for all joints.
      b. The CONTRACTOR shall repair, replace, or take whatever action is deemed necessary by the City to correct all disturbed joints.
   4. On railroad crossings, a vent shall be installed in accordance with AREMA recommendations.

J. CONTRACTOR shall restore work site to the original conditions or better after operations are complete.

END OF SECTION

SECTION 02606

MANHOLES

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as specified and required to furnish and install all precast manholes.

B. General:
1. Manholes shall conform in shape, size, dimensions, material, and other respects to the details specified or as ordered by the City.
2. Cast-iron frames, grates and covers shall be provided by the CONTRACTOR and shall match standard details.
3. Construction of new Cast-in-Place manholes will not be permitted unless specifically approved by the City.
4. Masonry manholes will not be permitted.

C. Related Work Specified in Other Sections Includes:
1. Division 2 - Site
2. Division 15 - Mechanical

1.2 REFERENCE

A. Codes and standards referred to in this Section are:

1. ASTM C 139 - Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
2. ASTM C 140 - Method of Sampling and Testing Concrete Masonry Units
3. ASTM C 478 - Specification for Precast Reinforced Concrete Manhole Sections
4. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets [Metric]
5. ASTM C 923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
6. ASTM C 990 Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Sealants

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings showing design and construction details of precast concrete manholes, manhole connectors, and cast-iron frames, grates and covers for approval.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Take every precaution to prevent injury to the manhole sections during transportation and unloading. Unload manhole sections using skids, pipe hooks, rope slings, or suitable power equipment, if necessary, and keep the sections under control at all times. Do not allow the manhole sections to be dropped, dumped or dragged under any conditions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Precast Concrete Manhole
   a. Hanson Pipe & Products, Inc.
   b. Americast
2. Preformed Joint Sealing Compound:
   a. Ram-Nek, as manufactured by K.T. Snyder Company, Inc., Houston, TX
   b. Kent-Seal, as manufactured by Hamilton-Kent, Kent, OH
   c. ConSeal 102, as manufactured by Concrete Sealants, Inc., Tipp City, OH
3. Manhole Frames and Covers
   a. Capitol Foundry Virginia Inc, Virginia Beach, VA
   b. Neenah Foundry

2.2 PRECAST CONCRETE MANHOLES

A. Precast manholes shall conform to the details as specified herein.

B. Except where otherwise specified, precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C 478 except as modified herein.

C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.

D. Joints between manhole components shall be the tongue and groove type employing a paper backed butyl rubber rope and butyl rubber sheet joint sealant system in accordance with the requirements of ASTM C 990. O-ring rubber gasket shall not be permitted. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joint sealant shall provide the sole element in sealing the joint from either internal or external hydrostatic pressure.

E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5 inches.

F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.

G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.

H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured to provide the correct height with the fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than one foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

J. Unless otherwise directed or specified by the City, a precast eccentric cone shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

K. Manholes steps shall be corrosion-resistant and shall be 1/2-inch grade 60 steel reinforcing rod encapsulated in a copolymer polypropylene. The steps shall conform to the dimensions shown in the Standard Details. Manhole steps shall be aligned to minimize conflicts with future connections to manhole.

L. Precast Sanitary Manholes:

1. All concrete utilized in precast sanitary manholes shall be acid-resistant and have ConShield admixture added in accordance with the manufacturer's recommendations. The precast supplier shall provide written certification that ConShield was added per manufacturer's recommendation to all acid resistant

manholes delivered. All sections of manhole with ConShield shall be clearly marked by the supplier at the plant so that the OWNER and CONTRACTOR can identify those manholes with ConShield admixture.

2.3 SOURCE QUALITY CONTROL

A. Concrete Strength: Manhole sections will be inspected and tested by an independent, certified testing laboratory to establish the strength of the concrete and the adequacy of curing, to certify the date that the sections were cast and to confirm that the reinforcing steel has been properly placed. This inspection and testing will be performed by the laboratory at the manufacturing plant prior to shipment.

2.4 MISCELLANEOUS METALS

A. Metal frames and covers will be provided by the CONTRACTOR. The word "SEWER" shall be casted on manhole covers in accordance with the City's standards.

2.5 DROP CONNECTIONS

A. Drop connections shall be required for sewer mains and sewer laterals entering manholes with a vertical drop greater than 2 feet.

B. Exterior drop connections for manholes shall be constructed where shown or ordered and shall conform to the design and details shown. Pipe and fittings shall be ductile iron or PVC as shown in Drop Manhole details or otherwise approved. Concrete for pipe encasement shall be as specified under Section 03300. Concrete shall be bonded to manhole in the manner shown or otherwise approved by the City.

C. Interior drop manholes will only be allowed where specifically approved by the City. If allowed, provide a drop manhole cross piping arrangement as manufactured by GPK Products, Inc. or equal.

D. Drop stacks are to be external unless it can be demonstrated that no practical alternative exists. Drop stacks must discharge onto a prepared channel at no greater than 18 inches from the manhole invert. Drop stacks must be installed outside the manhole to a depth of 18 inches off the manhole invert.

PART 3 EXECUTION

3.1 DOGHOUSE MANHOLES

A. Doghouse manholes shall be installed according to the Standard Doghouse Manhole Detail.

3.2 MANHOLE BASES

A. Unless otherwise directed or specified by the City, precast bases shall be set on No. 57 stone foundation. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.3 PRECAST MANHOLE SECTIONS

A. Set sections vertical with sections in true alignment.

B. Install sections, joints and gaskets in accordance with manufacturer's recommendations.

3.4 MANHOLE CHANNELS

A. All invert channels through manholes shall be constructed of concrete or grout. Channels shall be properly formed to the sizes, cross sections, grades and shapes shown or as ordered. Benches shall be built up to the heights as shown or specified and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.5 GRADING RINGS

A. Manhole grading rings shall be used for all precast manholes where required. Grade rings shall be stacked to a maximum of 12 inches in height, constructed on the cone or flat section on which the manhole frame and cover shall be placed. The height of the grade rings shall be such as is necessary to bring the manhole frame to the proper grade. Where slope of grade differs from the slope of the manhole section, adjusting slope rings shall be utilized. Grade rings shall be constructed of HDPE or Polypropylene. In no cases shall precast concrete grade rings be utilized. Grade rings shall be manufactured by:
   1. Ladtech, Inc., Buffalo, MN
   2. Cretex Pro-Ring, Waukesha, WI

3.6 STUBS FOR FUTURE CONNECTIONS

A. As shown or required for connections, cast iron sleeves, ductile iron, PVC or reinforced concrete pipe stubs with approved watertight plugs shall be installed in manholes. Where pipe stubs, sleeves or couplings for future connections are shown or ordered, CONTRACTOR shall provide all materials and work for their construction.

3.7 GRADING AT MANHOLES

A. All manholes in unpaved areas shall be built as shown or directed to an elevation higher than the original ground. If no elevation for top of manhole is shown, install top of manhole 12 inches above finished grade. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level

of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground unless otherwise shown.

B. Manholes in paved areas shall be constructed to meet the final surface grade. Manholes shall not project above finished roadway pavements to prevent damage from snowplows.

C. CONTRACTOR shall be solely responsible for the proper height of all manholes necessary to reach the final grade at all locations. CONTRACTOR is cautioned that the City's review of Shop drawings for manhole components will be general in nature and CONTRACTOR shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.8 MANHOLE WATERTIGHTNESS

A. All manholes shall be free of visible leakage. Each manhole shall be tested for leaks and inspected unless otherwise directed by City, and all leaks shall be repaired in a manner subject to the City's approval. Doghouse manholes shall be tested prior to cutting host pipe. Manhole testing shall be accomplished by one of the following two methods:

1. Water Testing: Testing shall be accomplished by filling each manhole with water up to the top, with no allowable leakage over a 2-hour period. Testing shall be conducted after installation of each manhole, but prior to backfilling. Manholes shall be filled and allowed to sit up to 48 hours prior to beginning of the test to allow absorption. After testing, water shall be disposed of in a suitable manner as approved by the City.
2. Vacuum Testing:
    a. Vacuum testing shall be performed on all manholes where connecting pipes are less than 18-inch diameter. Vacuum testing for manholes with pipe size equal to 18-inch diameter or greater can be performed at Contractor's discretion. Water test shall be performed if vacuum test is not.
    b. Testing shall be accomplished by test (vacuum) in accordance with ASTM C 1244, latest edition for watertightness. Manhole shall also be visually inspected after backfilling. CONTRACTOR may backfill before testing with the understanding that any repairs must be made from the exterior of the manhole.
    c. Manholes shall be vacuum tested and shall have 10 inches of mercury vacuum applied to the manhole and the time measured for the vacuum to drop from 10 inches to 9 inches of mercury. Vacuum equipment shall be approved by the local agency and/or the City prior to its use.
    d. Written verification must be furnished that the following steps are followed:
        (1) The test method is only to be applied to precast concrete manholes.
        (2) Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.

(3) If a manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test.

3.9 FLEXIBLE MANHOLE CONNECTION AT MANHOLE BASE

A. Provide a flexible manhole connection between each pipe entering and exiting the manhole. The resilient flexible manhole connector shall conform to ASTM C443 and the stainless steel band shall be totally non-magnetic Series 304 Stainless. The joint shall be completely watertight. Provide flexible pipe-to-manhole connectors as manufactured by KOR-N-SEAL, by Trelleborg or equal.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03300

CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install cast-in-place concrete, reinforcement and related materials.

B. Related Work Specified in Other Sections Includes:

1. Section 02050 – Site Demolitions

C. Coordination: Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

D. General:
1. Class "A" concrete shall be steel reinforced.
2. Class "B" concrete shall be without steel reinforcing.
3. Steel Reinforcement: Includes bars, ties, supports and welded wire fabric.
4. Grout includes epoxy and cement-sand types.
5. Flowable fill used for designated voids and abandonment.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
1. Concrete Testing Service: If required by the City, CONTRACTOR shall employ acceptable testing laboratory to perform materials evaluation, testing and design of concrete mixes, sampling and testing during placement.
2. Certificates, signed by concrete producer and CONTRACTOR, may be submitted in lieu of material testing when acceptable to the City.
3. Quality Control: If required by the City, CONTRACTOR shall employ a testing laboratory to perform sampling and testing during concrete placement, as follows:
   a. Sampling: ASTM C 172.
   b. Slump: ASTM C 143, one test for each load at point of discharge.
   c. Air Content: ASTM C 31, one for each set of compressive strength specimens.
   d. Compressive Strength: ASTM C 39, one set for each 50 cubic yards or fraction thereof. Typically, one specimen shall be tested at 7 days, two specimens tested at 28 days. For concrete placement in roads, an additional specimen for a 1-day break shall be tested. When the total quantity of concrete is less than 50 cubic yards, the strength tests may

be waived by the City if field experience indicates evidence of satisfactory strength.

4. Report test results in writing to the City on same day tests are made.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ACI 301, Specifications for Structural Concrete for Buildings (includes ASTM Standards referred to herein except ASTM A 36).
2. ACI 304, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ACI 305, Hot Weather Concreting.
4. ACI 306, Cold Weather Concreting.
5. ACI 318, Building Code Requirements for Reinforced Concrete.
6. ACI 347, Guide to Formwork for Concrete.
7. ACI 350, Environmental Engineering Concrete Structures.
8. ASTM A 36, Specification for Structural Steel.
9. Concrete Reinforcing Steel Institute, Manual of Standard Practice, includes ASTM Standards referred to herein.

1.3 SUBMITTALS

A. Samples: Submit samples of materials as specified and may be requested by the City, including names, sources and descriptions.

B. Shop Drawings: Submit for approval the following:

1. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
2. Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Chapters 1 thru 7. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement.
3. The concrete materials and concrete mix designs proposed for use shall be submitted for approval. Include the results of all tests performed to qualify the materials and to establish the mix designs in accordance with ACI 301, 3.9. Submit written report to the City for each proposed concrete mix at least 15 days prior to start of Work. Do not begin concrete production until mixes have been reviewed and are acceptable to the City. Mix designs may be adjusted when material characteristics, job conditions, weather, test results or other circumstances warrant. Do not use revised concrete mixes until submitted to and accepted by the City.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. The City's review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of CONTRACTOR.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to insure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II.

B. Aggregates: ASTM C 33.
   1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank run sand and manufactured sand are not acceptable.
   2. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

C. Coarse Aggregate Size: Size to be ASTM C 33, Nos. 57 or 67, unless permitted otherwise by the City.

D. Water: Potable.

E. Air-Entraining Admixture: ASTM C 260.

F. Water-Reducing Admixture: ASTM C 494, Type A. Only use admixtures which have been tested and accepted in mix designs.

G. Water-Reducing High Range Admixture: ASTM C 494, Type F/G. High range water-reducer may be used at the CONTRACTOR's option. The admixture shall not contain more chloride ions than are contained in municipal drinking water. It shall be added only at job site to concrete in compliance with the manufacturer’s printed instructions

2.2 FORM MATERIALS

A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection.

B. Unexposed Concrete Surfaces: Suitable material to suit project conditions.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60.

B. Welded Wire Fabric: ASTM A 185.

C. Steel Wire: ASTM A 82.

D. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
   1. Use wire bar type supports complying with CRSI recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use supports with sand plates or horizontal runners where base materials will not support chair legs.
   3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports complying with CRSI, Manual of Standard Practice as follows:
      a. Either hot-dipped galvanized, plastic protected or stainless steel legs.

E. Slump Limits:
   1. Not more than 4 inches prior to adding high range water-reducer.
   2. Not more than 8 inches at point at placement after adding high range water-reducer.

2.4 RELATED MATERIALS

A. Moisture Barrier: Clear 8 mils thick polyethylene; polyethylene-coated barrier paper; 1/8-inch thick asphalt core membrane sheet.

B. Membrane-Forming Curing Compound: ASTM C 309, Type I.

2.5 GROUT

A. Nonshrink, Nonmetalic 100 percent Solids, High Strength Epoxy Grout:
   1. Use prepackaged solvent-free, moisture-insensitive, 3-component epoxy grouting system.
   2. Product and Manufacturer: Provide one of the following:
      a. Euco High Strength Grout, as manufactured by the Euclid Chemical Company, Cleveland, OH.
      b. Sikadur 42, Grout-Pak, as manufactured by the Sika Chemical Company, Lyndhurst, NJ.

c. Or equal.

B. Ordinary Cement-Sand Grout: Except where otherwise specified use 1 part cement to 3 parts sand complying with the following:
1. Cement: ASTM C 150, Type II.
2. Sand: ASTM C 33.

2.6 FLOWABLE FILL

A. Flowable fill for abandonment shall comply with the following minimum 50 PSI mix design:

COMPONENT	POUNDS PER CUBIC YARD (Saturated, Surface Dry)
Concrete Aggregate, Sand (ASTM C33)	639
Portland Cement, Type I/II (ASTM C150)	125
Fly Ash, Class F (ASTM C618)	1176
Water	626 (75 gallons)
Total Air (if air entrainment is used)	15% (+/- 1.5)

1. Water/Cement Ratio – 0.48 lbs/lbs.
2. Slump – Not Applicable
3. Concrete Unit Weight – 95.0 lbs/cubic feet
4. Fly ash for flowable fill may be approved for use provided it complies with the requirements of ASTM C618, Class F or Class C.

B. An option of excavatable flowable fill shall comply with the following Neat Cellular Concrete mix type. Mix description is 25 pcf wet cast density neat mix, 0.50 W:C slurry with Aerlite foam or approved equal. 24-hour hardness is 30 psi (average), ASTM C403. 28-day strength is 80 psi (average), ASTM C495.

1. Base slurry composition is as follows:

COMPONENT	POUNDS PER CUBIC YARD
Portland Cement, Type I/II	2048 pounds
Water	1024 pounds
Sand	0
Pozzolan	0
Density	113.77 PCF

2. Preformed foam: Aerlite, by Aerix Industries, Golden, CO or approved equal

3. Finished cellular concrete composition is as follows:

COMPONENT	POUNDS PER CUBIC YARD
Portland Cement, Type I/II	414 pounds
Water	207 pounds
Aerlite foam	21.5 cubic feet
Volume Percent Foam	79.78%
Expansion Ratio	4.95 times

4. Admixtures, Chilled Water, & Ice: ASTM C494 admixtures for retarding set may be used based on site-specific conditions. Chilled water and ice may be employed based on site-specific conditions and transit times.

PART 3 EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which Work is to be performed and notify the City in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the City.

3.2 FORMWORK

A. Formwork: Construct formwork so that concrete members and structures are correct size, shape, alignment, elevation and position, complying with ACI 347.

B. Provide openings in formwork to accommodate other Work. Accurately place and securely support items built into forms.

C. Clean and adjust forms prior to concrete placement. Apply form release agents or wet forms, as required. Retighten forms during and after concrete placement if required to eliminate mortar leaks.

3.3 REINFORCEMENT, JOINTS, AND EMBEDDED ITEMS

A. Comply with the applicable recommendations of specified codes and standards, and CRSI, Manual of Engineering and Placing Drawings, for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.

1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
2. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements for minimum lap of spliced bars.

F. Install welded wire fabric in as long lengths as practical, lapping at least one mesh.

G. Concrete shall not be placed until the installation of reinforcing steel is inspected and permission for placing concrete is granted by the City. All concrete placed in violation of this provision will be rejected.

H. Joints: Provide construction, isolation, and control joints as required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs on ground to stabilize differential settlement and random cracking.

I. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by cast-in-place concrete. Use setting diagrams, templates and instructions provided under other Sections and other contracts for locating and setting.

3.4 CONCRETE AND PLACEMENT

A. Proportioning and Design of Mix:
1. Minimum compressive strength at 28 days: 4000 psi.
2. Maximum water cement ratio by weight: 0.45.
3. Minimum cement content: 564 pounds per cubic yard.
4. Normal weight: 145 pounds per cubic foot.
5. Use air-entraining admixture in all concrete: provide not less than 4 percent nor more than 8 percent entrained air for concrete exposed to freezing and thawing, and from 2 percent to 4 percent for other concrete.
6. Calcium Chloride: Do not use calcium chloride in concrete, unless otherwise authorized in writing by ENGINEER. Do not use admixtures containing calcium chloride.

B. Job-Site Mixing: Use drum type batch machine mixer, mixing not less than 1-1/2 minutes for one cubic yard or smaller capacity. Increase mixing time at least 15 seconds for each additional cubic yard or fraction thereof.

C. Ready-Mixed Concrete: ASTM C 94.

D. Concrete Placement: Comply with ACI 304, placing concrete in a continuous operation within planned joints or sections. Do not begin placement until work of other trades affecting concrete is completed.

E. Consolidate placed concrete using mechanical vibrating equipment with hand rodding and tamping, so that concrete is worked around reinforcement and other embedded items and into all parts of forms.

F. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement, and curing.
   1. In hot weather comply with ACI 305.
   2. In cold weather comply with ACI 306.

3.5 QUALITY OF CONCRETE WORK

A. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.

B. All concrete in contact with earth, water, or exposed directly to the elements shall be watertight.

C. Cut out and properly replace to the extent ordered by the City, or repair to the satisfaction of the City, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Patches or plastering will not be acceptable.

D. Repair, removal, and replacement of defective concrete as ordered by the City shall be at no additional cost to the City.

3.6 CURING

A. Curing: Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing use of moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until forms are removed. Provide protection as required to prevent damage to exposed concrete surfaces.

3.7 GROUT PLACEMENT

A. General:
   1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until the City provides clarification.

2. Drypacking will not be permitted.
3. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full-time employee to aid in assuring proper use of the product under job conditions.
4. Placing grout shall conform to the temperature and weather limitations described above.

3.8 FLOWABLE FILL

A. General:
1. Designated voids to be filled with flowable fill.
2. The CONTRACTOR shall completely fill designated voids with flowable fill having a 28- day compressive strength between 50 and 150 psi.
3. Admixtures, including water reducing agents, plasticizers, and air entraining agents will be permitted in the mix design for flowable fill.
4. Prior to commencing any filling operations, the CONTRACTOR shall submit his proposed plan for filling and the proposed mix design for approval by the OWNER. The plan shall show the proposed locations of all fill pipes.

END OF SECTION

(NO TEXT THIS PAGE)

SECTION 15051

BURIED PIPING INSTALLATION

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to install and test all buried piping, fittings, and specials. The Work includes, but is not limited to, the following:
   1. All types and sizes of buried piping, except those specified under other Sections or other contracts.
   2. Supports, restraints, and thrust blocks.
   3. Pipe encasements.
   4. Work on or affecting existing piping.
   5. Testing.
   6. Cleaning.
   7. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the buried piping installation.

B. Related Work Specified in Other Sections Includes:
   1. Section 02151 – Shoring, Sheeting, and Bracing
   2. Section 02220 - Excavation and Backfill
   3. Section 02606 - Manholes
   4. Section 03300 - Concrete
   5. Section 15061 - Ductile Iron Pipe
   6. Section 15064 - PVC Pipe

1.2 REFERENCES

A. Codes and Standards referred to in this Section:

1.	ANSI B31.1	-	Power Piping
2.	ASTM D 2321	-	Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
3.	ASTM D 2467	-	Specification for Socket-type PVC Plastic Pipe Fittings, Schedule 80
4.	ASTM D 2774	-	Practice for Underground Installation of Thermo-plastic Pressure Piping
5.	AWWA C105	-	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
6.	AWWA C600	-	Installation of Ductile-Iron Water Mains and Their Appurtenances
7.	AWWA C606	-	Grooved and Shouldered Joints

8.	AWWA C900	-	Standard for PVC Pressure Pipe and Fabricated Fittings, 4 inches through 12 inches, for Water Transmission and Distribution
9.	AWWA M23	-	PVC - Design and Installation
10.	AWWA M41		Ductile Iron Pipe and Fittings
11.	ASCE MOP No. 37	-	Design and Construction of Sanitary and Storm Sewers

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Laying schedules for all pipe.
   2. Full details of piping, specials, manholes, joints, harnessing and thrust blocks, and connections to existing piping, structures, equipment and appurtenances.
   3. Subsurface utility warning/marking tape
   4. Subsurface utility tracing wire
   5. Polyethylene encasement

B. Tests:
   1. Submit description of required testing methods, procedures and apparatus.
   2. Prepare and submit report for each test.

C. Certificates: Submit certificates of compliance with referenced standards.

D. Record Drawings: Submit record drawings in accordance with the General Design Standards prior to the time of Final Completion.

1.4 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as follows:

B. Transportation and Delivery: Take every precaution to prevent injury to the pipe during transportation and delivery to the site.

C. Loading and Unloading: Take extreme care in loading and unloading the pipe and fittings.

   1. Work slowly with skids or suitable power equipment, and keep pipe under perfect control at all times.
   2. Under no condition is the pipe to be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe or coating.

D. Sling: When handling the pipe with a crane, use a suitable sling around the pipe.

1. Under no condition pass the sling through the pipe.
2. Use a nylon canvas type sling or other material designed to prevent damage to the pipe and coating.
3. When handling uncoated steel or ductile iron pipe, steel cables, chain or like slings are acceptable.

E. Damaged Piping: If in the process of transportation, handling, or laying, any pipe or fitting is damaged, replace or repair such pipe or pipes.

F. Blocking and Stakes: Provide suitable blocking and stakes installed to prevent pipe from rolling.
1. Obtain approval for the type of blocking and stakes, and the method of installation.

G. Storage for Gaskets: Store gaskets for pipe joints in a cool place and protect gaskets from light, sunlight, heat, oil, or grease until installed.
1. Do not use any gaskets showing signs of checking, weathering or other deterioration.
2. Do not use gasket material stored in excess of six months without approval.

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to applicable Pipe Sections for material specifications.

B. General:
1. Marking Piping:
a. Clearly mark each piece of pipe or fitting with a designation conforming to those shown on the laying schedule.
b. Cast or paint material, type and pressure designation on each piece of pipe or fitting 4 inches in diameter and larger.
c. Pipe and fittings smaller than 4 inches in diameter shall be clearly marked by manufacturer as to material, type and rating.

C. Subsurface Utility Warning Tape:
1. During the backfilling process, all sanitary sewer mains shall have a continuous warning tape placed immediately above them and throughout their length at a depth of twenty-four (24) below the ground level surface. Utility Warning Tape is not applicable to storm sewer.
2. Tape shall be of a durable, metalized, plastic film similar to Terra Tape for identification of buried sewer mains. Tape shall have a width of 6-inches and be bright green imprinted with the legend “Caution Sewer Line Buried Below” or as appropriate. Tape material shall be formulated from 100 percent virgin polyolefin resins. Resins shall be pigmential for chemical stability and resistance to sulfide staining (color fastness).

3. Tape shall be constructed by the mechanical (non-adhesive) lamination of two plies of three layer blown film in such a manner as to produce bi-axially oriented structure. The tape shall be able to provide a 700 percent elongation prior to rupture as per ASTM D882.
4. Tape shall be tied together (spliced) with knot to create a continuous warning tape throughout the length of the pipeline and associated branch lines, appurtenances, etc.

D. Subsurface Utility Tracing Wire:
1. In addition to the installation of warning tape, copper-tracing wire is to be installed with all sewer force mains. The tracing wire shall be taped, using electrical tape, on top of the pipe at ten (10) foot centers, for the total length of the pipe.
2. The tracing wire shall be 12 AWG (average wire gauge), solid core, copper wire (solid core meaning one (1) single continuous strand of copper wire). In addition, the wire insulating coating (jacket) shall be green in color and shall have 45 mils of polyethylene insulation thickness and high molecular weight. Also, the tracing wire shall be HMW – PE and rated for UL 600 V construction. The wire shall be suitable for wet or dry applications. The wire size (gauge) shall be continuously affixed (printed on) the entire length of all tracing wire coating and shall be easily read.
3. Where a splice if required, or when a three (3) way splice is necessary, the wires shall be joined together with an appropriate size (green) wire nut which shall then be placed inside a 3M brand Direct Bury Splice kit (DBR), or approved equal of appropriate size. No bare wire shall be left exposed anywhere. All wires shall be spliced to all other wires for continuous tracing wire system.
4. Test boxes, connected onto tracing wire system shall be required at the force main ends and where spacing exceed 500 feet. Test box locations shall be outside any street and curbing and as directed by the City.
5. No electrical connections of the tracing wire to any metal pipes or metal service lines will be allowed and care shall be taken to ensure that the tracing wire is not damaged during installation. The tracing wire will be tested for continuous signal (continuity test) across all main and service lines before asphalt is installed, and prior to sub grade preparation. Tracing wire must have a continuous signal before pipe is accepted.

E. Electronic Markers:
1. Ball type electronic markers shall be passive type as manufactured by 3M or Omni.
2. Sewer line markers shall be rated and color coded for sewer.

PART 3 EXECUTION

3.1 PREPARATION

A. Dry Trench Bottoms: Lay pipe only in dry trenches having a stable bottom.
   1. Where groundwater is encountered, make every effort to obtain a dry trench bottom.
   2. Ensure that ground water level in trench is at least 6 inches below bottom of pipe before laying piping. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete and protect and keep clean water pipe interiors and fittings.
   3. If a dry trench bottom has not been obtained due to improper or insufficient use of all known methods of trench dewatering, then excavate below grade and place sufficient select fill material or crushed stone over the trench bottom.
   4. If all efforts fail to obtain a stable dry trench bottom and it is determined that the trench bottom is unsuitable for pipe foundation, notify the OWNER.
   5. Perform trench excavation and backfill in accordance with Sections 02220 – Excavation and Backfill.

3.2 INSTALLATION

A. General:
   1. Install piping, joints, fittings, and appurtenances in accordance with the manufacturer’s recommendations and approved shop drawings.
   2. If there is a conflict between manufacturer's recommendations and the Specifications, request instructions from the City before proceeding.
   3. All trench excavations shall be inspected by the City prior to laying pipe. Notify the City in advance of excavating, bedding and pipe laying operations.
   4. Minimum cover over piping shall be 4 feet unless otherwise shown or approved by the City.
   5. Excavation in excess of that required or shown and which is not authorized by the City shall be replaced at CONTRACTOR'S expense with No. 21A stone. It shall be furnished, placed and compacted in accordance with the requirements of the applicable Section of Division 2.
   6. Concrete manhole connections shall be equipped with a sealant such that a positive watertight seal is established.
   7. No backfill shall be placed over concrete within 16 hours of placing.
   8. Ample time shall be given to the OWNER to obtain the exact location of each wye branch and chimney before it is covered. Wye branches and chimneys, which are covered before the City has had time to obtain their location, shall be exposed so that location measurements can be taken, at the expense of the CONTRACTOR.
   9. Concrete for encasements shall be as specified in Section 03300 – Concrete. No backfill shall be placed over this concrete within 16 hours of placing.

B. Manufacturer's Installation Specialist: When required by the City, provide the services of a competent installation specialist of the pipe manufacturer when pipe laying commences.

C. Separation of Sewers and Potable Water Pipe Lines:
   1. Horizontal and Vertical Separation:
      a. Wherever possible, existing potable water mains and service lines, and sanitary sewers shall be separated horizontally by a clear distance of not less than 10 feet.
      b. If local conditions preclude a clear horizontal separation of not less than 10 feet, the installation will be permitted provided the potable water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer. The sewers must cross under water mains at an elevation so the bottom of the potable water main is at least 18 inches above the top of the sewer. Sewer manholes shall be of watertight construction and tested in place.
      c. Comply with all applicable Virginia Department of Health Regulations.
   2. Crossings:
      a. In a crossing installation, sanitary sewers crossing water mains shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer main whenever possible. The Engineer should consider alternate alignments or locations for water mains, sewer mains, and storm sewers to provide the required vertical separation.
      b. When 18" of vertical separation is not possible, the sewer shall be constructed of ductile iron or C900 PVC pipe, centered at crossing, and pressure-tested in place without leakage prior to backfilling. The test pressure shall be 5 PSI, or a pressure greater than the pressure exerted by a column of water equal to the depth of the deepest section of the sewer being tested, whichever is greater. The test pressure shall be held for a minimum of 2 hours.
      c. Water mains passing under sanitary sewers shall be protected by providing the following:
         (1) A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main.
         (2) Adequate structural support for the sewers to prevent excessive deflection of the joints and settling on and breaking of the water mains.
         (3) A full section of AWWA approved water main piping centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer main.

D. Separation of Sewers and Other Utilities:
   1. Where the sanitary sewer is installed parallel to a storm sewer, there shall normally be a minimum of 5 feet of horizontal separation measured edge to edge between them. Under unusual conditions, this requirement may be reduced by the City. If a sanitary sewer is located more than 5 feet below the

bottom of a parallel storm sewer, DPU may require the horizontal distance between the pipes to be increased.

E. Plugs:
   1. Temporarily plug installed pipe not in service at the end of each day's work or other interruption to the installation of any pipeline. Plugging shall prevent the entry of animals, liquids or persons into the pipe or the entrance or insertion of deleterious materials.
   2. Install standard plugs into all bells at dead ends, tees or crosses. Cap all spigot ends.
   3. Fully secure and block all plugs and caps installed for pressure testing to withstand the specified test pressure.
   4. Where plugging is required for phasing of the Work or for subsequent connection of piping, install watertight, permanent type plugs.

F. Bedding Pipe: Bed pipe as specified below and in accordance with the details shown. Unless otherwise shown or required, use Class B - Compacted Granular Bedding as shown on Sanitary Sewer Details. Coordinate trench excavation and backfill with Section 02220 - Excavation and Backfill.
   1. Trench excavation and backfill, and bedding materials shall conform to the requirements of Section 02220 - Excavation and Backfill.
   2. Where the existing bedding material is deemed unsuitable by the City, remove and replace it with No. 57 stone.
   3. Excavate trenches below the pipe bottom by amount shown and specified. Remove all loose and unsuitable material from the trench bottom.
   4. Carefully and thoroughly compact all pipe bedding with hand held pneumatic compactors.
   5. Do not lay pipe until the City approves the bedding condition. If a conflict exists obtain clarification from the City before proceeding.
   6. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.

G. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of the standards listed below, where applicable:
      a. Ductile Iron Pipe: AWWA C600, AWWA C105.
      b. Polyvinyl Chloride Pipe: ASTM D 2321, AWWA C900
      c. ASCE Manual of Practice No. 37.
   2. Install all pipe accurately to line and grade unless otherwise approved by the City. Remove and relay pipes that are not laid correctly.
   3. Slope piping uniformly between elevations shown.
   4. Ensure that ground water level in trench is at least 6 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Protect and keep pipe fittings and interiors clean.
   5. Make adjustments to bring pipe to line and grade by scraping away or filling in select fill material under the body of the pipe.

6. Start laying pipe at lowest point and proceed towards the higher elevations, unless otherwise approved by the City.
7. Place bell and spigot pipe so that bells face the direction of laying, unless otherwise approved by the City.
8. Bring the faces of the spigot ends and the bells of pipes into fair contact and firmly and completely show the pipe home.
9. Excavate around joints in bedding and lay pipe so that the barrel bears uniformly on the trench bottom.
10. Deflections at joints, if allowed, shall not exceed 75 percent of the amount allowed by the pipe manufacturer.
11. Carefully examine all pipe, fittings and specials for cracks, damage or other defects while suspended above the trench before installation. Immediately remove defective materials from site.
12. Inspect interior of all pipe and fittings and completely clean all dirt, gravel, sand, debris or other foreign material from pipe interior and joint recesses before it is moved into the trench. Bell and spigot mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before the pipe is laid.
13. Field cut pipe, where required, with a machine specially designed for cutting piping. Make cuts carefully, without damage to pipe or lining, and with a smooth end at right angles to the axis of pipe. Cut ends on push-on joint shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.
14. Blocking under piping will not be permitted unless specifically approved by the OWNER for special conditions. If permitted, conform to requirements of AWWA C600.
15. Touch up protective coatings in a satisfactory manner prior to backfilling.
16. CONTRACTOR shall notify the City in advance of backfilling operations.
17. On steep slopes, take measures acceptable to the City to prevent movement of the pipe during installation.
18. Exercise care to avoid flotation when installing pipe in cast-in-place concrete.
19. Install detectable utility warning tape 24-inches below the ground surface along the entire length of the installed pipe.
20. For sewer force mains, install tracing wire system, taping wire to top of pipe with electrical tape at ten foot centers for total length of pipe.

H. Polyethylene Encasement:
1. Provide polyethylene encasement for ductile iron pipe where shown to prevent contact between the pipe and surrounding bedding material and backfill.
2. Polyethylene may be supplied in tubes or in sheet material.
3. Polyethylene encasement materials and installation shall be in accordance with the requirements of AWWA C105.

I. Jointing Pipe:
1. Ductile Iron Mechanical Joint Pipe:

a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
b. Lubricate the plain ends and gasket with soapy water or an approved pipe lubricant, in accordance with AWWA C111, just prior to slipping the gasket onto the plain end of the joint assembly.
c. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
d. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
f. Insert bolts and hand tighten nuts.
g. Prime all bolts by dipping with bituminous coating, except the threads. Coat threads immediately prior to installation of nuts.
h. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs)
6 -24	3/4	75-90
30-36	1	100-120
42-48	1-1/4	120-150

2. Ductile Iron Push-On Joint Pipe:
a. Prior to assembling the joints, the last 8 inches of the exterior surface of the spigot and the interior surface of the bell shall be thoroughly cleaned with a wire brush, except where joints are lined or coated with a special protective lining or coating.
b. Rubber gaskets shall be wiped clean and flexed until resilient. Refer to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
c. Insert gasket into joint recess and smooth out the entire circumference of the gasket to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe.
d. Immediately prior to joint assembly, apply a thin film of approved lubricant to the surface of the gasket which will come in contact with the entering spigot end of pipe. CONTRACTOR may, at his option, apply a thin film of lubricant to the outside of the spigot of the entering pipe.
e. For assembly, center spigot in the pipe bell and push pipe forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, carefully check the gasket for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. When more than a reasonable amount of force is required to

assemble the joint, the spigot end of the pipe shall be removed to verify the proper positioning of the rubber gasket. Gaskets that have been scoured or otherwise damaged shall not be used.

f. Maintain an adequate supply of gaskets and joint lubricant at the site at all times when pipe jointing operations are in progress.

3. Proprietary Joints: Pipe which utilizes proprietary joints shall be installed in strict accordance with the manufacturer's instructions.

4. Flanged Joints:
   a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by the OWNER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Bolts shall be tightened in a sequence which will insure equal distribution of bolt loads.
   c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly.
   e. After assembly, coat all bolts and nuts with two 8-mil coats of a high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.

5. PVC Pipe Push-On Joints:
   a. Bevel all field-cut pipe, remove all burrs and provide a reference mark the correct distance from the pipe end.
   b. Clean the pipe end and the bell thoroughly before making the joint. Insert the O-ring gasket, making certain it is properly oriented. Lubricate the spigot well with an approved lubricant; do not lubricate the bell or O-ring. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell.

J. Concrete Cradle

1. General: When a concrete cradle is to be provided as directed or specified by the City, lay the pipe to grade by supporting each section on concrete blocks located near each end.
   a. Shape the tops of the blocks to fit the outside diameter of the pipe.
   b. Set the blocks approximately 3/8 inch low.
   c. Place the pipe on the blocks on a layer of stiff mortar of sufficient thickness to bring the pipes to exact grade.
   d. Timber blocking, of a type approved, may be employed in place of concrete blocks.

2. Cradle: Place concrete cradle, on one side only, until it has risen above the invert on the other side, after which deposit the remainder of the concrete on both sides to the pipe spring line.
   a. Prevent movement of the pipe during concrete placement.

K. Concrete Encasement: When concrete encasement is to be provided as directed or specified by the City, lay and block the pipeline and place concrete as specified for concrete cradle.
   1. Continue the placing of concrete to provide complete encasement to the dimensions directed or specified by the City.

L. Backfilling:
   1. The first foot of cover over newly installed pipe shall be No. 21A stone.
   2. Conform to the applicable requirements of Section 02220.
   3. Place backfill as construction progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of fill.

M. Transitions from One Type of Pipe to Another: Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

N. Closures: Provide all closure pieces shown or required to complete the Work.

O. Alignment and Grade:
   1. The CONTRACTOR shall not deviate from the line and grade indicated on the Drawings, except if authorized by the City.
   2. Pipe shall be installed on a straight line between manholes without dips or bends.
   3. A laser shall be used to maintain line and grade. A copy of the laser calibration shall be provided for each separate job prior to beginning pipe installation.
   4. The maximum deviation of any invert from plan grade shall be within +/-0.05 feet.

P. Installation and Acceptance of Electronic Markers:
   1. Passive electronic markers (ball type) shall be installed on all sewer gravity mains and sewer force mains
   2. Locations for electronic markers shall be as shown on Standard Details.
      a. Minimum distance between markers shall be 6 feet.
      b. Markers shall be a minimum of 4 inches above the pipe.
      c. Markers shall have a maximum of 3 feet of cover.
      d. When pipe joints are deflected, place markers at the pipe joint beginning and ending the deflection and at intermediate joints for every 1 foot (maximum) of deflection.
      e. Locations for markers on gravity sewer lines shall be in accordance with the following:
         (1) Service Tee at the main
         (2) Casing ends
         (3) Maximum 100 feet of metallic pipe and 50 feet for non-metallic pipe
         (4) All points where sewer crosses over or under other utilities
      f. Locations for markers on sewer force mains shall be in accordance with the following:
         (1) Valves

(2) Bends
(3) Deflections (begin, end, max of each 1 foot of deflection)
(4) Pipe vertical adjustments (beginning and end)
(5) Casing ends
(6) Maximum of 100 feet on metallic pipe and 50 feet for non-metallic pipe
(7) All points where sewer crosses over or under utilities

3. Electronic Marker Balls shall be rated for sewer (green) and shall be installed in accordance with manufacturer's recommendations and the following to ensure that marker is installed over centerline of pipe.
   a. Hand place at least 6 inches of backfill material over marker ball to ensure that it stays in place.
   b. Locations of marker balls shall be as shown on the Standard Details.
4. Acceptance of Electronic Marker Ball Installation
   a. Contractor shall certify in writing that all electronic markers are in place prior to paving.
   b. Prior to Substantial Completion, contractor shall demonstrate to DPU that all markers are installed as required and are working properly. Any missing or non-functioning Electronic Marker Balls shall be replaced by the contractor prior to substantial completion.
   c. The locations of all markers shall be shown on as-built drawings.

3.3 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
1. Locations of existing piping shown should be considered approximate.
2. CONTRACTOR shall determine the true location of existing piping to which connections are to be made, and location of other facilities which could be disturbed during excavation operations, or which may be affected by CONTRACTOR'S Work in anyway.

3.4 CONNECTIONS TO PIPING

A. Service Connections to New Mains:
1. Connections to new sanitary sewer mains shall be made with a factory tee as shown on Details P-5, P-5A, P-5B.

B. Service Connections to Existing Mains:
1. Service connections that are 8-inch and greater shall have a doghouse manhole installed at the sewer main.
2. Connections to existing ductile iron or cast-iron sewer mains shall be made by cutting in a factory tee to match the material of the existing main. A length of existing pipe shall be field cut, removed, and a new tee installed. The ends of the existing pipe shall be field cut to obtain a square plain end that is at a right angle to the line of the pipe. Connections to the existing main piping shall be in accordance with Section 3.3.C.
3. Connections to existing PVC, concrete, or HDPE sewer shall be made by a cored connection. Connection to sewer mains shall be made by coring an

opening in the main sewer to receive the cored tee fitting using a hole saw for HDPE and diamond bit for concrete sewers. Pneumatic devices or hammering knock out methods are not acceptable. The size of the cored opening shall be limited to one half the diameter of the main line. Inserted cored type tee connections shall be a City-approved adapter for specific installation. Inserted cored type tee connections shall be installed in accordance with the manufacturer's recommendations. Care shall be taken to ensure that no portion of the lateral protrudes into the inner circumference of the sewer main and all debris which may have accumulated in the sewer main while making the connection is completely removed. All cored openings shall be a minimum of 12 inches away from existing sewer connections.

4. Connections to existing brick or segmented block sewer shall be made in accordance with Detail P-8. The existing sewer shall be exposed and a hole cut with a rotary core drill equipped with a diamond bit. The hole shall be made as small as practical to accommodate the lateral pipe. A short bell section of piping shall be inserted into the opening, and the connection packed with non-shrink grout in accordance with Detail P-8.
5. Any deviations from City guidelines shall require approval from DPU Director or his designee.

C. Connections between Proposed and Existing Sewer Main Piping:
1. Manholes shall be installed at all new intersecting mains.
2. Connections to existing ductile iron, cast iron, or PVC sewer mains shall be made with a long solid sleeve type coupling.
3. Connections to existing clay or concrete sewer mains shall be made with a flexible elastomeric non-shear coupling similar to Fernco Strong Back RC Series repair coupling or approved equal.
4. Connections to other materials shall be as detailed on the plans.

3.5 INSPECTION AND TESTING:

Inspection and testing procedures shall be completed prior to putting sewer in service and prior to release of bond/surety.

A. General:
1. Test all gravity and force main piping except as otherwise authorized by the City.
2. New gravity sewers shall be subjected to visual and CCTV inspection testing, deflection testing, and leakage (low pressure air) testing.
3. Sewer force mains shall be tested in accordance with the requirements established for water system testing.
4. All flushing, air and vacuum testing procedures shall conform to this section and applicable sections of the Commonwealth of Virginia SCAT Regulations, latest edition.
5. Notify the City Construction Inspector 48 hours (2 working days) in advance of testing.
6. Provide all testing apparatus, including pumps, hoses, gages, and fittings.

7. Unless otherwise noted, pipelines shall hold specified test pressure for two hours.
8. Repair/replace and retest pipelines which fail to hold specified test pressure or which exceed the allowable leakage rate at no additional cost to the City.
9. Conduct all tests in the presence of the City Construction Inspector.
10. Advise local authorities having jurisdiction if their presence is required during testing.
11. All testing activities require compliance with OSHA in regard to confined space entry.

B. General Pressure Test Procedure:
1. Complete backfill and compaction at least to the pipe centerline before testing, unless otherwise required or approved by the City.
2. Thoroughly clean and flush all piping prior to inspection
3. For water leakage test, fill section to be tested slowly with water and expel all air. Install corporation cocks, if necessary, to remove all air.
4. Test only one section of pipe at a time.

C. Visual and CCTV Inspection:
1. Prior to leakage and air testing, complete visual inspection of the sewer main and manholes. Visual inspection shall consist of the following:
   a. Inspection of piping connection to manholes for visible leaks
   b. Inspection to see if the lines are free of debris
   c. CCTV inspection
   d. Check of alignment and grade by introducing sufficient water into the line to verify the absence of sags in the line
   e. Mirror test the line

2. The CONTRACTOR shall provide video camera (CCTV) inspection on 100% of the pipelines installed. The inspection shall be completed within seven (7) days after the installation of the pipeline. CCTV inspection shall be performed in accordance with NASSCO standards. The CONTRACTOR shall perform a video inspection of the new pipe at no additional cost to the City.

D. Low Pressure Air Testing:
1. Full line low pressure air testing shall be limited to pipeline diameters 27-inch diameter and smaller.
2. Joint isolation low pressure air testing in combination with infiltration/exfiltration testing shall be used for pipeline diameters larger than 27-inches.
3. Clean pipeline of debris and water prior to beginning test.
4. CONTRACTOR shall furnish test plugs, test gages, stop watches, air compressors, and personnel, and all required miscellaneous equipment to complete the test. Test shall be conducted in accordance with ASTM C828, ASTM C924, or ASTM F1417, latest editions as applicable.
5. Determine the test duration for the section under test by computation from the applicable formulas shown in ASTM C828, ASTM C924, and ASTM F1417

(latest editions). The pressure-holding time is based on an average holding pressure of 3 psi gage or a drop from 3.5 psi to 2.5 psi gage.

6. Determine groundwater elevation if the piping is located below the water table elevation.
7. If ground water elevation is above the elevation of the pipe, increase test pressures to compensate for the water pressure. If ground water elevation is unknown, assume ground water elevation is at ground surface.
8. Add air until the internal air pressure of the sewer line is raised to approximately 4.0 psi gage. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize.
9. When the pressure has stabilized and is at or above the starting test pressure at 3.5 psi gage, commence the test. Before starting the test, the pressure may be allowed to drop to 3.5 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 1.0 psi gage during the test period, the line shall be presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 1.0 psig drop has not occurred.

E. Allowable Deflection Test:

1. Pipe deflection measured not less than 90 days after the backfill has been completed as specified shall not exceed 5 percent. Deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
2. Deflection shall be measured with a riding mandrel (Go/No Go) device cylindrical in shape and constructed with a minimum of 9 evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the OWNER for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines.
3. Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the OWNER and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the OWNER. Retested pipe shall not deflect more than 4 percent.

F. Leakage (Infiltration/Exfiltration) Testing:

1. Conduct infiltration/exfiltration leakage test for full sewer (manhole to manhole) replacements larger than 30-inches. Note: this test shall only be performed on new construction or complete sewer replacements, including laterals (if applicable).
2. Infiltration test shall only be performed if the level of groundwater is at least four (4) feet above the top of the sewer main along the entire section of pipeline to be tested. Exfiltration testing shall only be performed if the sewer main can be subjected to a minimum of four (4) feet of head above the top of the sewer main as measured at the upstream manhole of the section being tested. Measurements shall be made every hour for a minimum of three hours to determine the amount of infiltration/exfiltration.
3. Allowable leakage shall be 25 gallons per day per mile of sewer per inch of pipe diameter. There shall be no visible leaks.

3.6 CLEANING

A. Cleaning:
   1. Thoroughly clean all piping and flush prior to placing in service in a manner approved by the OWNER.
   2. Piping 24 inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.

END OF SECTION

SECTION 15061

DUCTILE IRON PIPE

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish ductile iron pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation and completion of pipelines to be constructed.
2. Provide flanged, plain end or rubber gaskets (mechanical joint) of the types, sizes and classes as directed or specified by the City.

B. Related Work Specified in Other Sections Includes:
1. Section 02220 - Excavation and Backfill
2. Section 15051 - Buried Piping Installation.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	AWWA C110/A21.10	-	Ductile-Iron and Gray-Iron Fittings 3 In. Through 48 In., for Water and Other Liquids
2.	AWWA C111/A21.11	-	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
3.	AWWA C150/A21.50	-	Thickness Design of Ductile-Iron Pipe
4.	AWWA C151/A21.51	-	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
5.	AWWA C153/A21.53	-	Ductile-Iron Compact Fittings, 3 In. Through 12 In., for Water and Other Liquids
6.	ANSI B18.2.1	-	Square and Hex Bolts and Screws Inch Series, Including Hex Cap Screws and Lag Screws
7.	ANSI B18.2.2	-	Square and Hex Nuts
8.	ASME B16.1	-	Cast Iron Pipe Flanges and Flanged Fittings
9.	ASTM A 307	-	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
10.	ASTM A 354	-	Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners

1.3 SUBMITTALS

A. As directed or specified by the City, submit the following product data and information:
   1. Catalog data for pipe, joints, fittings, sleeves, and harnessing.

B. As directed or specified by the City, submit the following shop drawings:
   1. Pipe joints, fittings, and sleeves.
   2. Fully dimensioned drawings of piping layouts, including fittings, couplings, sleeves, valves, supports, and anchors. Label pipe size, materials, type, and class on drawings and include the limits of each reach of restrained joints. Provide cross sections showing elevations of pipes, fittings, sleeves, and valves.
   3. Provide an alignment survey and laying schedule as required and specified by the City. Cross reference the laying schedule to identification marks on pipeline pieces.

C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, lining, coatings, specials and sleeves in accordance with this Section.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of 5 years of experience producing ductile iron pipe and fittings, and shall show evidence of at least 5 installations in satisfactory operation.
   2. Ductile iron pipe and fittings shall be the product of one manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Section 15051 - Buried Piping Installation.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Joints shall be as shown on the Drawings and specified. If not shown or specified, provide push-on or mechanical joints for buried piping and flanged joints for exposed piping. Couplings shall be provided on pipe with plain or grooved ends where shown or where approved by the City.

B. Non-flanged pipe:
   1. Conform to AWWA C151 for material, pressure, dimensions, tolerances, tests, markings and other requirements.

a. Pressure and Thickness: Unless otherwise shown, use Pressure Class 250 for pipe 14 inches in diameter or greater, and minimum 350 for pipe less than 14 inches in diameter.
b. Mechanical Joints: Conform to AWWA C111.
(1) Glands: Ductile iron.
(2) Gaskets: Plain Tip.
(3) Bolts and Nuts: High strength, low alloy steel.
c. Push-On Joints: Conform to AWWA C111.
(1) Gaskets: Molded rubber.
(2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.

2. Mechanical Joint Fittings: Conform to AWWA C110 or C153.
a. Pressure Rating: 350 psi.
b. Material: Cast iron or ductile iron.
c. Glands: Use cast-iron glands with cast-iron fittings and ductile-iron glands with ductile iron fittings.
d. Gaskets: As specified above for joints.
e. Bolts and Nuts: As specified above for joints.

3. Coatings and Linings:
a. Pipe and fittings shall have corrosion resistant lining. Lining shall be Protecto 401 ceramic epoxy, or approved equal, and shop applied in strict accordance with the manufacturer's recommendations to cover the inner surface of the ductile iron pipe and fittings.
b. Buried pipe and fittings shall be coated on the outside with a bituminous coating, approximately 1-mil thick in accordance with AWWA C110, C111, C115, C151, or C153 as applicable. Exposed pipe shall be prime coated. Any damaged areas shall be coated with a minimum of 2 mils of an approved bituminous coating.

4. Joint Restraints for use on Ductile Iron Sewer Mains:
a. Push-on Joints: For push-on joint type, the restrained joint system shall be a manufacturer's standard restrained joint system such as Griffin Pipe SnapLok, US Pipe TR-Flex, or American Pipe Flex-Ring, or approved equal.
b. Mechanical Joints: For mechanical joint type pipe, the restrained joint system shall be a manufacturer's standard restrained joint system such as EBBA Iron Series 1100 MegaLug retainer glands, Ford Meter Box Series 1400 retainer glands, or approved equal.

C. Specials:
1. Transition Pieces:
a. Furnish suitable transition pieces (adapters) for connections to existing piping.
b. Unless shown on the Drawings, CONTRACTOR shall expose existing piping to determine material, dimensions and other data required for transition pieces.

2. Taps:
a. Provide taps where shown or required for small diameter pipe connections.

b. Where pipe wall thickness or tap diameter will not permit the engagement of full threads, provide a tapping saddle conforming to the requirement specified herein.

2.2 MARKING PIPING

A. All pipeline materials shall be stamped, marked or identified with the following information:
   1. Name or trademark of the manufacturer.
   2. Pipe class and specification designation.
   3. Size and length dimensions.
   4. Date and place of manufacture.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all ductile iron pipe, fittings and appurtenance in accordance with the manufacturer's recommendations and as specified in Section 15051 - Buried Piping Installation.

END OF SECTION

SECTION 15064

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 GENERAL

1.1 SUMMARY

A. Scope:
1. CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to install and test PVC piping, fittings and specials necessary to complete the Work.
2. Installation of piping shall be in accordance with Section 15051 - Buried Piping Installation.

B. Related Work Specified in Other Sections Includes:
1. Section 02220 - Excavation and Backfill
2. Section 15051 - Buried Piping Installation

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ASTM D1248	-	Polyethylene Plastics Molding and Extrusion Materials
2.	ASTM D1598	-	Test for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
3.	ASTM D1599	-	Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings
4.	ASTM D1784	-	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
5.	ASTM D1785	-	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
6.	ASTM D2122	-	Determining Dimensions of Thermoplastic Pipe and Fittings
7.	ASTM D2321	-	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Application.
8.	ASTM D2412	-	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plater Loading
9.	ASTM D2467	-	Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings
10.	ASTM D2564	-	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

11.	ASTM D3034	-	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
12.	ASTM D3035	-	Polyethylene Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
13.	ASTM D3139	-	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
14.	ASTM D3212	-	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
15.	ASTM D3261	-	Butt Heat Fusion Polyethylene, Plastic Fittings for Polyethylene and Plastic Pipe and Tubing
16.	ASTM D3350	-	Polyethylene Plastic Pipe and Fitting Materials
17.	ASTM F477	-	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
18.	ASTM F679	-	Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
19.	ASTM F714		Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
20.	NSF 14	-	National Sanitation Foundation Standard No. 14
21.	PPI	-	Plastic Pipe Institute Piping Components and Related Materials
22.	ANSI	-	American National Standards Institute
23.	AWWA C900	-	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch
24.	AWWA C905	-	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch through 48 inch
25.	AWWA C906	-	Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch for Water Distribution and Transmission

1.3 SYSTEM DESCRIPTION

A. The equipment and materials specified herein are intended to be of standard types for use in transporting sewage.

B. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

1.4 SUBMITTALS

A. As directed by the City, submit the following product data and information:
   1. Submit the name of the pipe and fitting manufacturers and a list of materials to be furnished by each manufacturer. Also, include information on local representative for each manufacturer, if product is sold through a distributor, product brochures and samples.

B. As directed by the City, submit the following shop drawings:
   1. Shop Drawings including piping layouts and schedules shall include dimensioning, fittings, types and locations of valves and appurtenances, joint details, methods and location of supports, anchorage, gasket material, grade of material and all other pertinent technical information for all items to be furnished to complete work specified herein.

C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, lining, coatings, specials and sleeves in accordance with this Section.
   1. Prior to each shipment of pipe, certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM, NSF and AWWA Standards specified herein shall be submitted.
   2. Submit certified results of all shop tests for approval.

1.5 QUALITY ASSURANCE

A. PVC pipe, fittings, and all incidentals shall be furnished by one supplier.

B. Shop Tests: Piping manufacturer shall maintain continuous quality control program. All plastic molding materials used to manufacture pipe and fittings under this Section shall be tested for conformance to ASTM D1784.

C. In addition, all pipe to be installed may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The CONTRACTOR shall require the manufacturers cooperation in these inspections.

D. Inspections of the pipe may also be made by other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once, and replaced at the CONTRACTORS expense.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Section 15051 - Buried Piping Installation.

B. All items shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the City, at the CONTRACTOR’s expense.

C. PVC items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting and unloading items to prevent injury to the items. All items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer’s instructions, referenced standards and as specified herein.

D. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

E. While stored, pipe shall be adequately supported from below at not more than 3-ft intervals to prevent deformation. The pipe shall be stored in stacks no higher than that given in the following table:

Pipe Diameter (inches)	Max. No. of Rows Stacked
8 or less	5
12 to 21	4
24 to 30	3

F. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup or direct or indirect sunlight will not be permitted. DPU reserves the right to reject pipe which has been stored outside more than six months and/or has obvious signs of sun bleaching.

G. If any defective item is discovered after it has been installed, it shall be removed from the job site and replaced with an exact replacement item in a satisfactory manner by the CONTRACTOR, at the CONTRACTOR's own expense. All pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing.

H. In handling the items, use special devices and methods as required to achieve the results specified herein. No un-cushioned devices shall be used in handling the item.

PART 2 PRODUCTS

2.1 MATERIALS

A. PVC Pipe and Fittings (Gravity Sewer Service Lateral Connections diameters 6 inches):
   1. Pipe and fittings: SDR-26 as required by the City, conforming to ASTM D3034 and ASTM D1784.
   2. Joints: Integral bell elastomeric gasketed joints, conforming to ASTM D 3212.
   3. Color: Green

B. PVC Pipe and Fittings (Gravity Sewer Mains):
   1. Pipe and fittings (diameters 8-inches through 15-inches): SDR-26, conforming to ASTM D3034 and D1784

2. Pipe and fittings (diameters 18-inches through 30-inches): wall thickness T-1 or as shown on the plans, conforming to ASTM F679
3. Joints: Integral bell elastomeric gasketed joints, conforming to ASTM D 3212.
4. Product and Manufacturer: Provide one of the following:
   a. North American Specialty Products
   b. JM Eagle
   c. North American Pipe Corporation
   d. Or equal.
5. Color: Green
6. Saddles: Provide saddles as manufactured by:
   a. Sealtite Model H with bell end for SDR-35 PVC
   b. ROMAC CB Sewer saddle
   c. Or equal.

C. PVC Pipe and Fittings (AWWA C-900/C-905 Pressure Piping for Gravity Sewer Applications):
1. Pipe: DR25 unless otherwise required by the City conforming to the requirements of AWWA C900/C905.
2. Fittings: Conform to ASTM D 1784.
3. Joints: Push-on type with a factory assembled elastomeric ring in the integral bell-end. O-ring gaskets shall conform to ASTM F477. Joint material including gaskets and lubricants shall conform to AWWA C900/C905 and ASTM D3139.
4. Color: Green
5. Pipe shall bear the seal of approval by the NSF.
6. Product and Manufacturer: Provide one of the following:
   a. Diamond Plastics
   b. JM Eagle
   c. Or equal.

2.2 MARKING FOR IDENTIFICATION

A. All pipeline materials shall be stamped, marked or identified with the following information:
1. Name or trademark of the manufacturer
2. Pipe class and specification designation
3. Size and length dimensions
4. Date and place of manufacture
5. Pipe 24-inches and larger shall also be marked on its interior as above

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all pipes, fittings and specials in accordance with the manufacturer's recommendations and as specified Section 15051 – Buried Piping Installation.

3.2 FIELD QUALITY CONTROL

A. Inspection: CONTRACTOR shall inspect all piping to assure that piping is free from defects in material and workmanship. The compatibility of all pipe and fittings shall be verified.

B. Tests: If required or directed by the City, subject the installed sewer pipe to field tests, as specified in Section 15051 – Buried Piping Installation.

END OF SECTION

IV. SANITARY SEWER DETAILS

DETAILS

CITY OF RICHMOND
DEPARTMENT OF PUBLIC UTILITIES
SEWER DESIGN GUIDELINES

LIST OF DETAILS

P-9	New Connection to Existing CIPP Lined Pipe
P-10	Tee Insert Connection
P-11	Lateral Abandonment
P-12	Pipe Abandonment
P-13	Clay Dam
P-14	PVC Pipe Air Pressure Test Table
P-15	Electronic Marker Placement for Gravity Sewer
P-16	Electronic Marker Placement for Pressure Mains

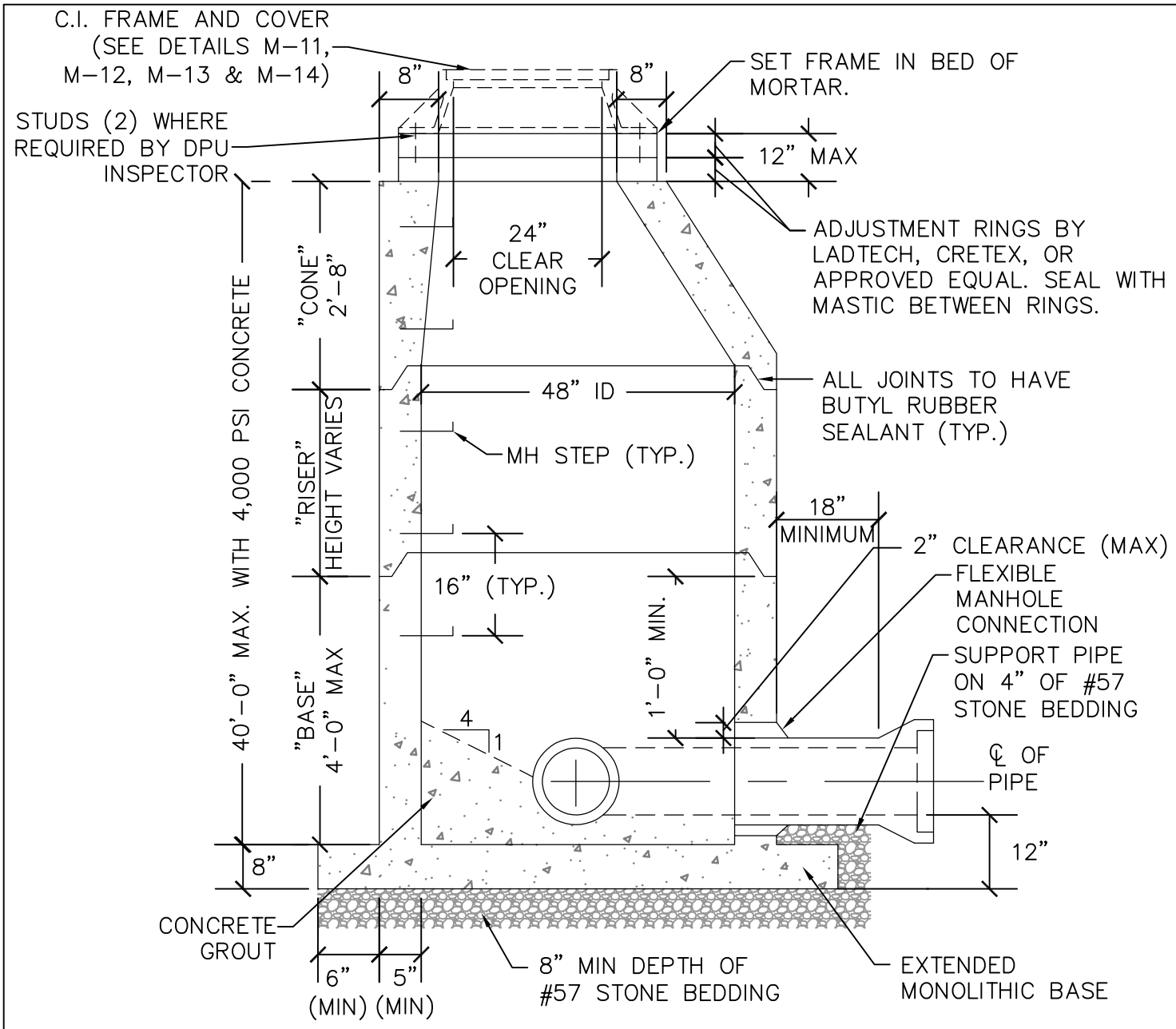
Alternative Detail (shall only be used with prior written approval by DPU Deputy Director or Designee):

A-1	Pipe Encasement

SEWER NOTES:

1. ALL CONSTRUCTION AND MATERIALS FOR SEWER SYSTEMS SHALL CONFORM WITH THE CITY OF RICHMOND DEPARTMENT OF PUBLIC UTILITIES (DPU) SANITARY SEWER SYSTEM STANDARDS APPLICABLE AT THE TIME OF RELEASE TO CONSTRUCTION.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING DPU TO SCHEDULE A PRE-CONSTRUCTION MEETING AT LEAST 48 HOURS PRIOR TO BEGINNING ANY WORK.
3. THE CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS FOR THE WORK.
4. EXISTING UTILITIES ACROSS OR ALONG THE LINE OF THE PROPOSED WORK ARE SHOWN ONLY IN AN APPROXIMATE LOCATION ON THE PLANS. CONTRACTOR SHALL, ON HIS OWN INITIATIVE AND NO ADDITIONAL COST, LOCATE ALL UNDERGROUND LINES AND STRUCTURES AS NECESSARY. CONTRACTOR SHALL CALL "MISS-UTILITY" AT 811 PRIOR TO START OF CONSTRUCTION. CONTRACTOR WILL BE RESPONSIBLE FOR ANY DAMAGE TO UNDERGROUND LINES OR STRUCTURES.
5. CONTRACTOR SHALL BEAR ALL COSTS ASSOCIATED WITH RELOCATING, SUPPORTING AND MAINTAINING SEWER SERVICE TO ALL CUSTOMERS DURING CONSTRUCTION.
6. CONTRACTOR SHALL CONTACT DPU IMMEDIATELY IN THE EVENT OF ANY SEWAGE SPILLS AND OVERFLOWS. CONTRACTOR SHALL PROVIDE DPU WITH DOCUMENTATION ON THE SPILL AND OVERFLOW INCLUDING DATE, TIME, DURATION, ESTIMATED AMOUNT, LOCATION, CORRECTIVE ACTION, AND CAUSE OF SPILL AND OVERFLOW WITHIN FIVE CALENDAR DAYS.
7. CONTRACTOR SHALL INCLUDE IN APPLICABLE BID PRICE, COST OF LOCATING AND UNCOVERING ALL SEWER MANHOLES AFTER COMPLETION OF ALL PAVING AND TO ADJUST THEM TO THE FINAL ROAD GRADES. CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR CLEANING OUT SEWER MAINS FOR FINAL INSPECTION, IF NECESSARY.
8. NO STRUCTURES OR PLANTING OF TREES SHALL BE PERMITTED IN UTILITY EASEMENTS.
9. VANDALPROOF / WATERTIGHT COVERS SHALL BE USED ON ALL MANHOLES IN EASEMENTS AND IN FLOODPLAINS.
10. FINAL ACCEPTANCE OF WORK BY DPU SHALL NOT BE MADE UNTIL ALL WORK SHOWN ON THE APPROVED UTILITY PLANS IS COMPLETED, INCLUDING PAVING, GRADING, AND ALL REQUIRED ADJUSTMENTS.
11. THE CONTRACTOR SHALL SCHEDULE ALL WORK INVOLVING THE EXISTING SEWER SYSTEMS, TIE INS, SHUTDOWNS OR REPAIRS WITH DPU AND AFFECTED PARTIES 48 HOURS IN ADVANCE, UNLESS SPECIFICALLY APPROVED BY DPU FOR EMERGENCY SITUATIONS.
12. MONITORING MANHOLES SHALL BE INSTALLED ON ALL SEWER LATERALS WHERE NON-DOMESTIC OR STRONG WASTE WILL BE POTENTIALLY DISCHARGED TO THE PUBLIC SEWER SYSTEM. IF MONITORING MANHOLES ARE NOT PROVIDED WITH THE INITIAL CONSTRUCTION, DPU MAY REQUIRE THAT THE OWNER ADD A MONITORING MANHOLE, AT THE OWNERS COST, SHOULD THE USE OF THE FACILITY CHANGE, SHOULD THE CHARACTERISTICS OF THE WASTE DISCHARGED BE CHANGED, SHOULD REGULATIONS CHANGE, OR SHOULD DPU DETERMINE FOR ANY REASON WHAT SO EVER, IN ITS SOLE JUDGEMENT, THAT A MONITORING MANHOLE IS NECESSARY TO PROTECT THE CITY'S SEWER SYSTEM OR TREATMENT FACILITIES.
13. PIPING OR MATERIALS BEING REPLACED OR REMOVED AS PART OF WORK SHALL BE PROPERLY DISPOSED OF AT THE CONTRACTOR'S EXPENSE.
14. NO STAGING OF EQUIPMENT OR STOCKPILING OF MATERIAL SHALL OCCUR WITHIN 75 FEET OF ANY STREAM, WITHIN LIMITS OF WETLANDS, OR WITHIN THE 100 YEAR FLOODPLAIN.
15. CONTRACTOR SHALL BE RESPONSIBLE FOR THE MEANS AND METHODS AND SEQUENCE OF CONSTRUCTION FOR THE WORK AND ALL COSTS FOR THE SAME. CONTRACTOR SHALL UTILIZE THE INFORMATION PROVIDED IN THE CONTRACT DOCUMENTS, VISIT THE SITE, MAKE INDEPENDENT INVESTIGATIONS AS DEEMED NECESSARY TO DETERMINE THE CONDITIONS AFFECTING THE COST OF THE WORK, AND MAKE PROVISIONS AS NECESSARY.

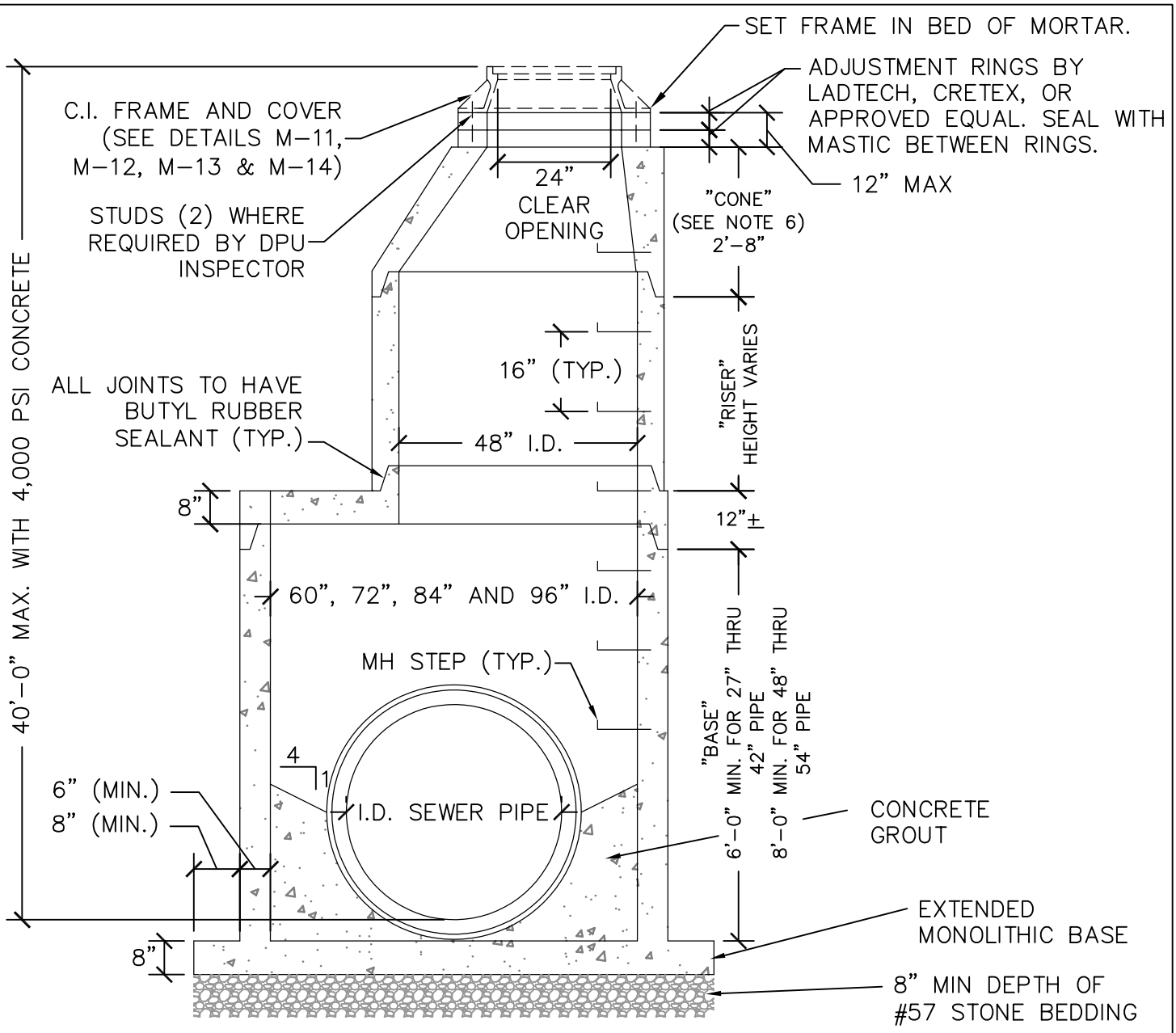
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD SEWER NOTES NOT TO SCALE	REV. 12/21 G-1



NOTES:

1. STONE BEDDING SHALL EXTEND TO THE OUTER BOUNDARY OF ALL UNDISTURBED AREAS SURROUNDING THE MANHOLE.
2. FOR SEWERS GREATER THAN 24" SEE DETAIL M-2.
3. EXCAVATION PAYLINE EXTENDS 6" OUTSIDE THE LARGEST DIAMETER OF THE MANHOLE, ALL AROUND.
4. MANHOLE SHALL BE RATED FOR H20 LOADING IN PAVEMENT OR AREAS SUBJECT TO VEHICULAR TRAFFIC.
5. LATERAL INVERTS SHALL BE NO MORE THAN 2'-0" ABOVE INVERT OUT. NO MORE THAN 3 LATERALS PER MANHOLE.
6. PRECAST CONCRETE MANHOLES SHALL BE IN COMPLIANCE WITH ASTM C-478.
7. INVERT SHAPING SHALL BE IN ACCORDANCE WITH DETAIL M-14
8. SEALANTS FOR MANHOLE SECTION JOINTS SHALL BE IN COMPLIANCE WITH ASTM C990. JOINTS SHALL BE WATER TIGHT.

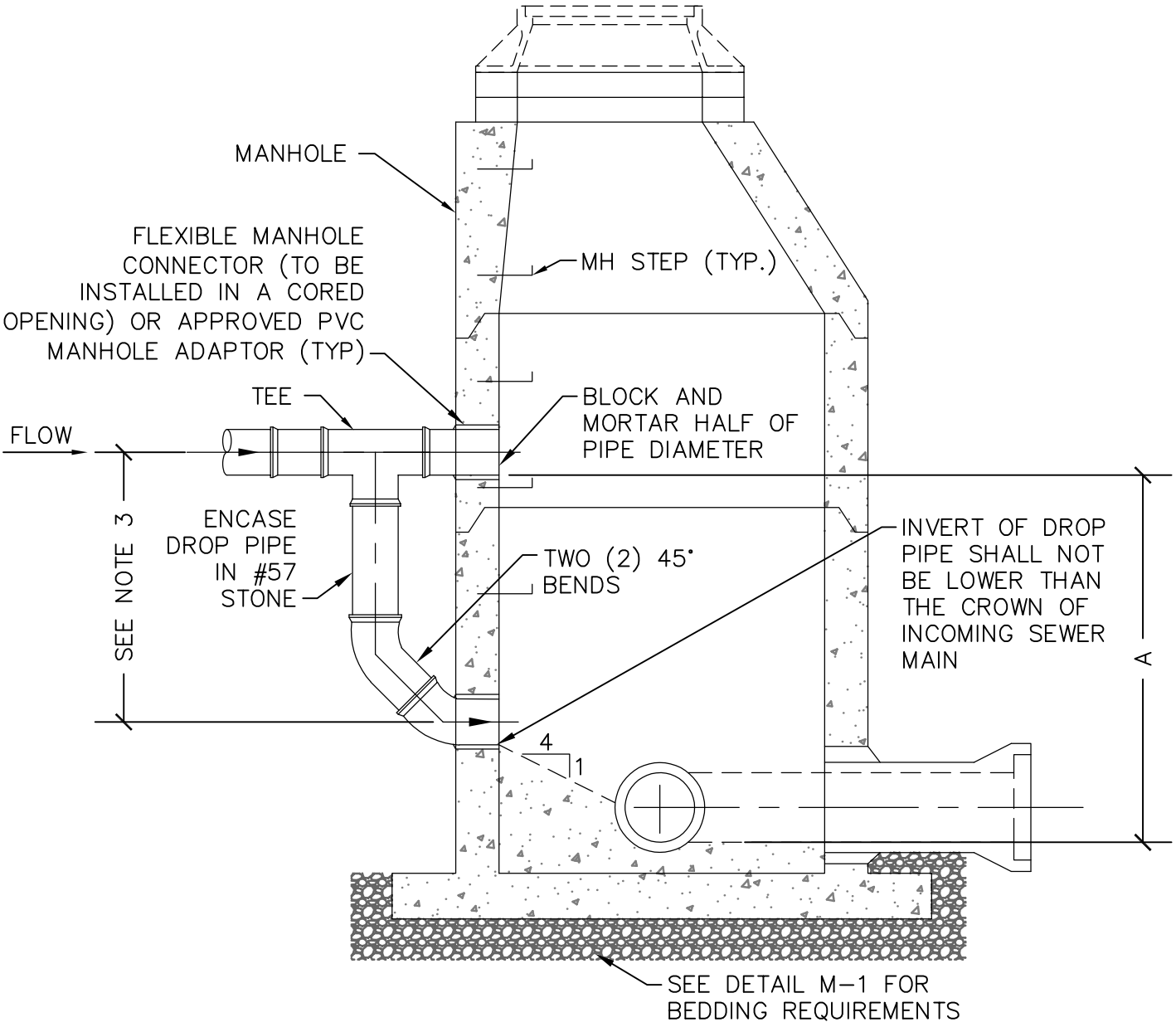
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD PRECAST CONCRETE MANHOLE SEWERS 8" TO 24" NOT TO SCALE	REV. 12/21 M-1



NOTES:

1. STONE BEDDING SHALL EXTEND TO THE OUTER BOUNDARY OF ALL UNDISTURBED AREAS SURROUNDING THE MANHOLE.
2. EXCAVATION PAYLINE EXTENDS 6" OUTSIDE THE LARGEST DIAMETER OF THE MANHOLE, ALL AROUND.
3. MANHOLE SHALL BE RATED FOR H20 LOADING IN PAVEMENT OR AREAS SUBJECT TO VEHICULAR TRAFFIC.
4. LATERAL INVERTS SHALL BE NO MORE THAN 2'-0" ABOVE INVERT OUT. NO MORE THAN 3 LATERALS PER MANHOLE.
5. PRECAST CONCRETE MANHOLES SHALL BE IN COMPLIANCE WITH ASTM C-478.
6. SEALANTS FOR MANHOLE SECTION JOINTS SHALL BE IN COMPLIANCE WITH ASTM C990. JOINTS SHALL BE WATER TIGHT.

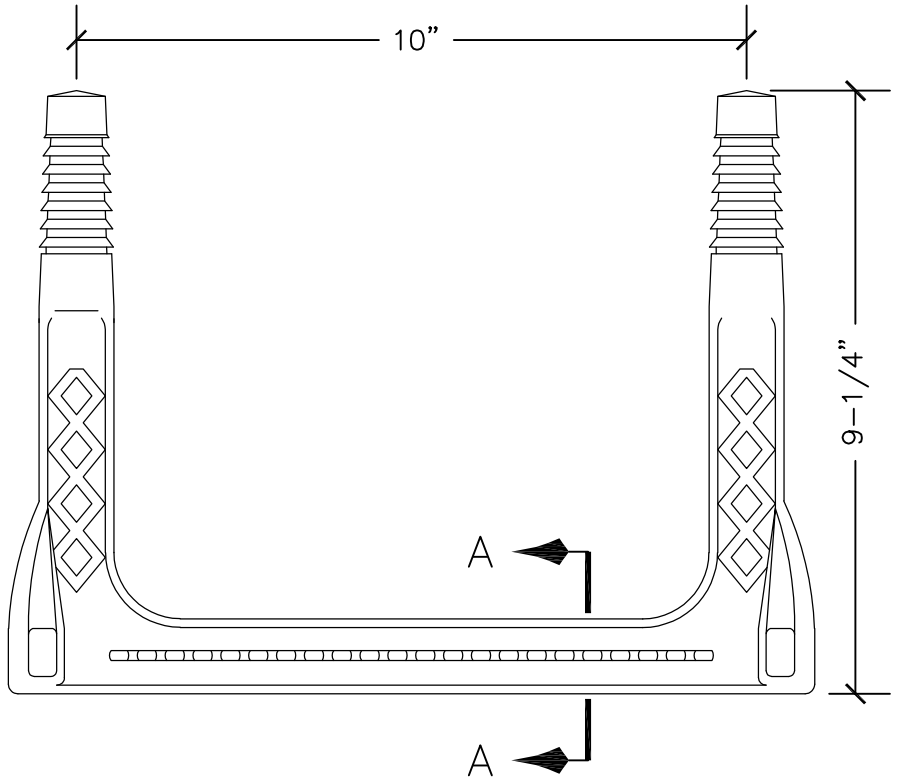
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD PRECAST CONCRETE MANHOLE SEWERS 27" TO 64" NOT TO SCALE	REV. 12/21 M-2

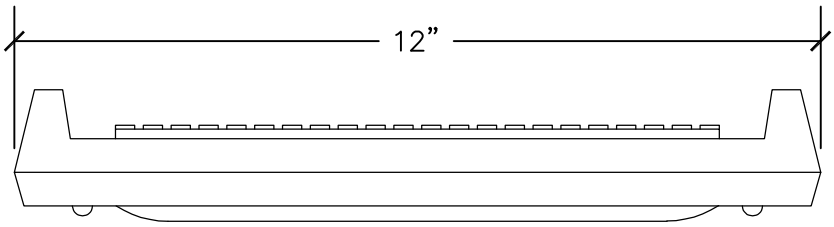


NOTES:

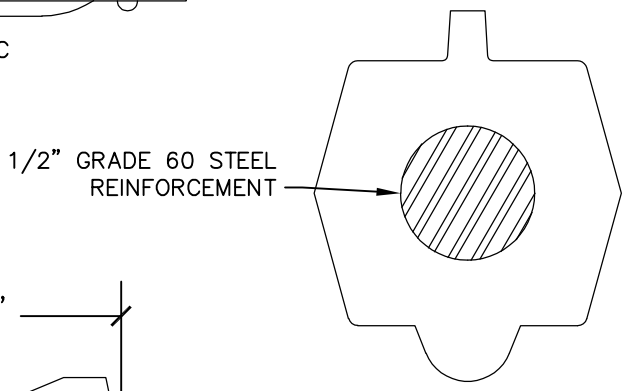
1. WHERE "A" IS GREATER THAN 2'-0" USE STANDARD EXTERIOR DROP MANHOLE.
2. PIPE MATERIAL SHALL BE DI. PROVIDE RESTRAINED JOINTS.
3. PROVIDE STAINLESS STEEL STRAPS EVERY 3'-0" FOR DROPS GREATER THAN 6'-0".
4. SEE M-1 FOR ADDITIONAL MANHOLE NOTES AND DETAILS.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA EXTERIOR DROP MANHOLE NOT TO SCALE	REV. 12/21 M-3

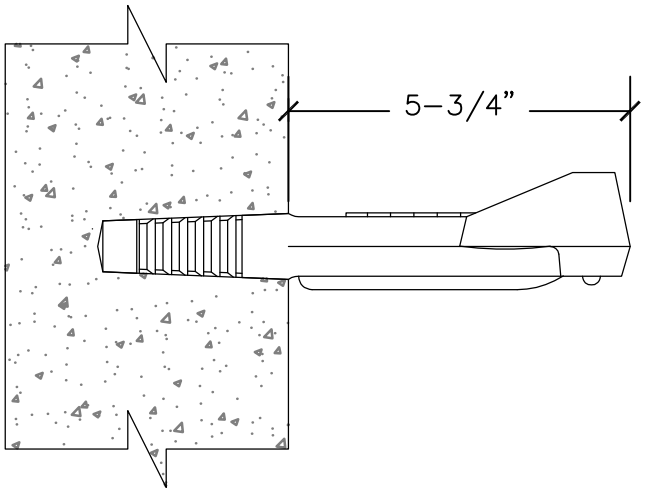




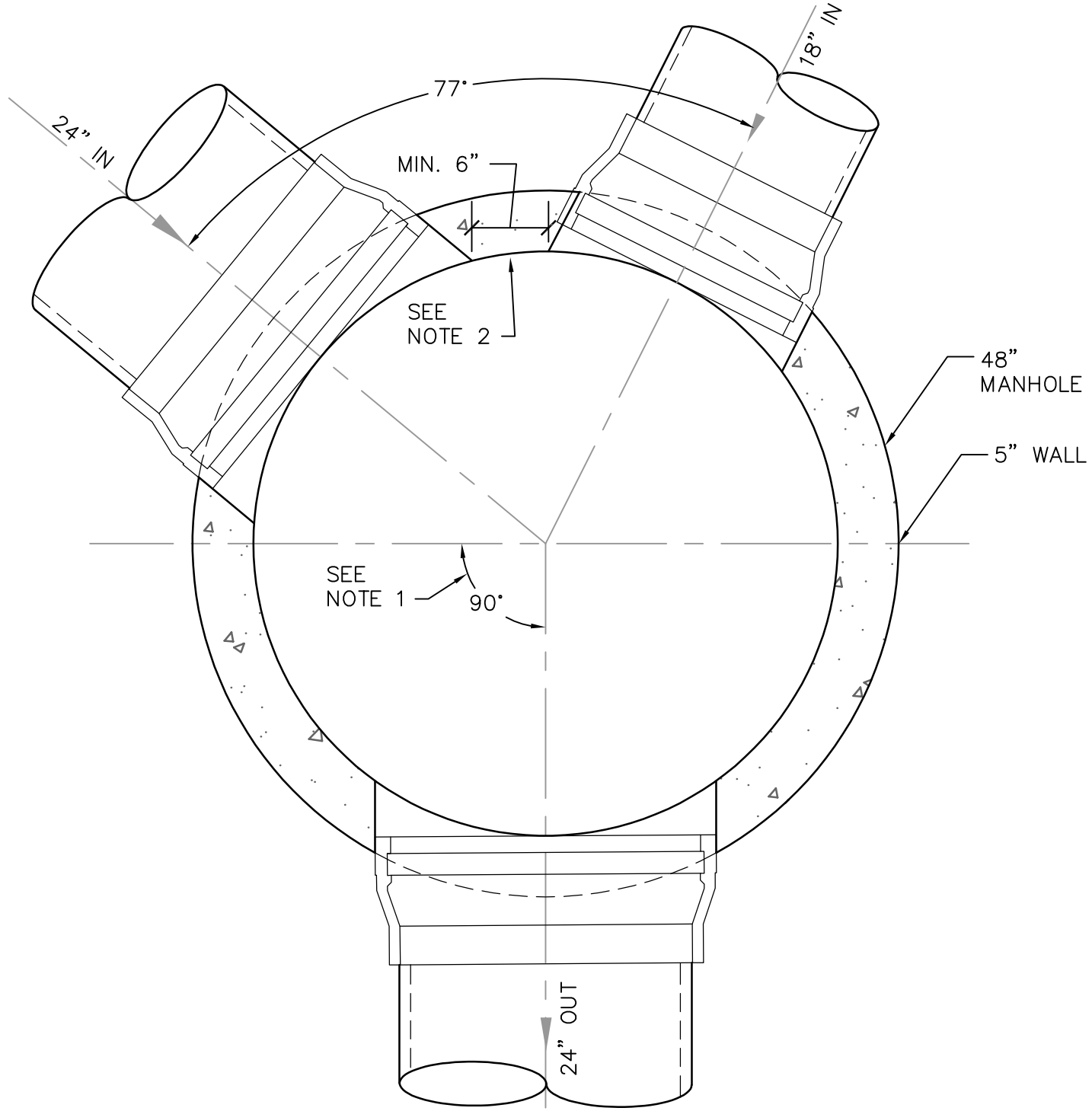
COPOLYMER POLYPROPYLENE PLASTIC



SECTION A



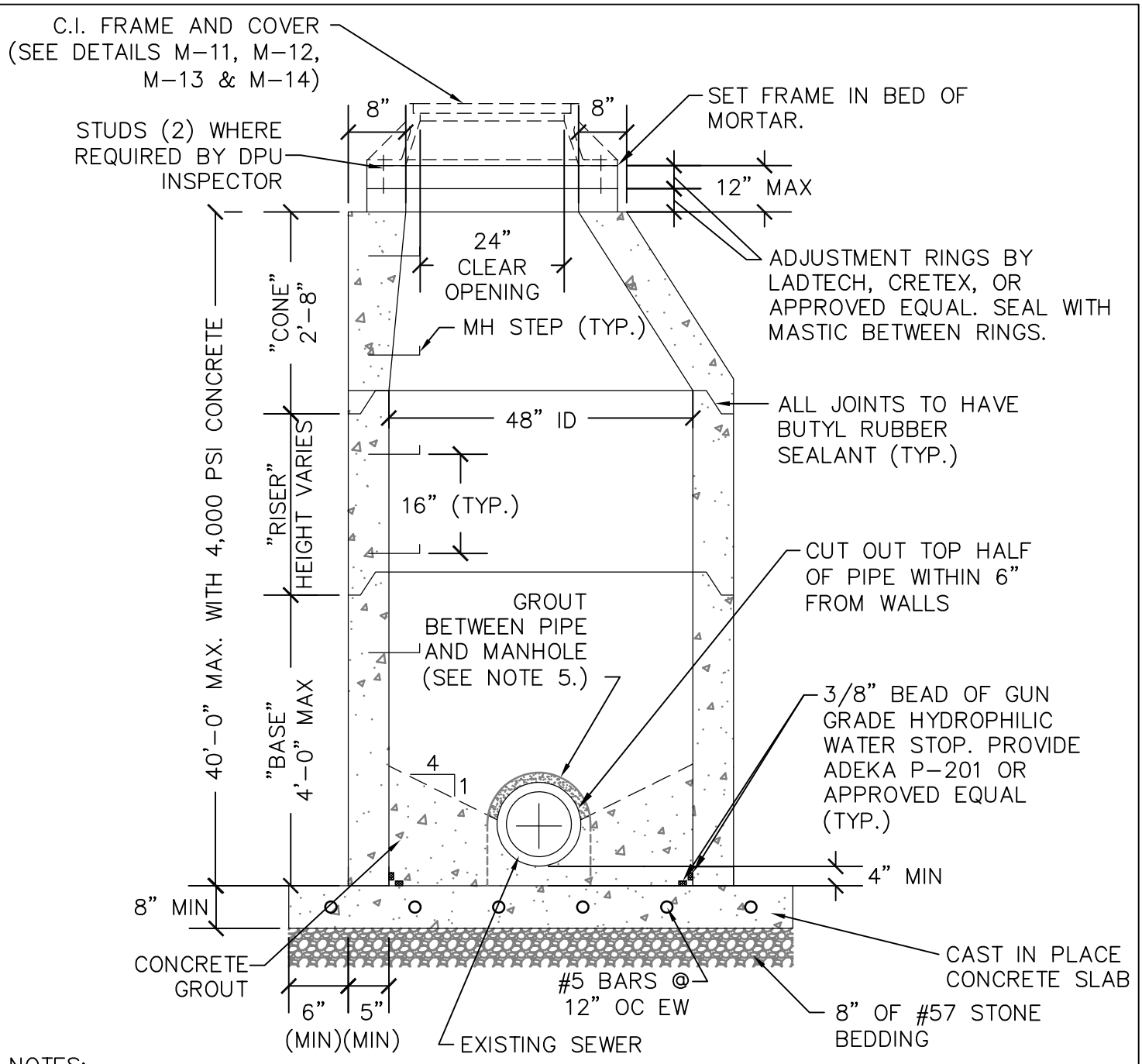
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD MANHOLE STEP NOT TO SCALE	REV. 12/21 M-4



NOTES:

1. MIN. ANGLE BETWEEN INFLUENT AND EFFLUENT PIPES IS 90° UNLESS OTHERWISE APPROVED BY DPU.
2. MIN. SEPARATION BETWEEN INFLUENT PIPE HOLES SHALL BE 6 INCHES UNLESS OTHERWISE APPROVED BY FLEXIBLE CONNECTOR MANUFACTURER.
3. PIPE SIZES LESS THAN OR EQUAL TO 30" DIAMETER ARE ASSUMED TO BE SDR 26 PVC PIPE.
4. PIPE SIZES GREATER THAN 30" IN DIAMETER ARE ASSUMED TO BE DUCTILE IRON PIPE. OTHER MATERIALS TO BE APPROVED BY DPU.
5. EXAMPLE ABOVE: ALL SDR 26 PVC PIPE. MIN. ANGLE OF 77° BETWEEN INFLUENT PIPES RESULTS IN MIN. 6 INCHES OF INTERIOR MANHOLE WALL BETWEEN INFLUENT PIPE HOLES.

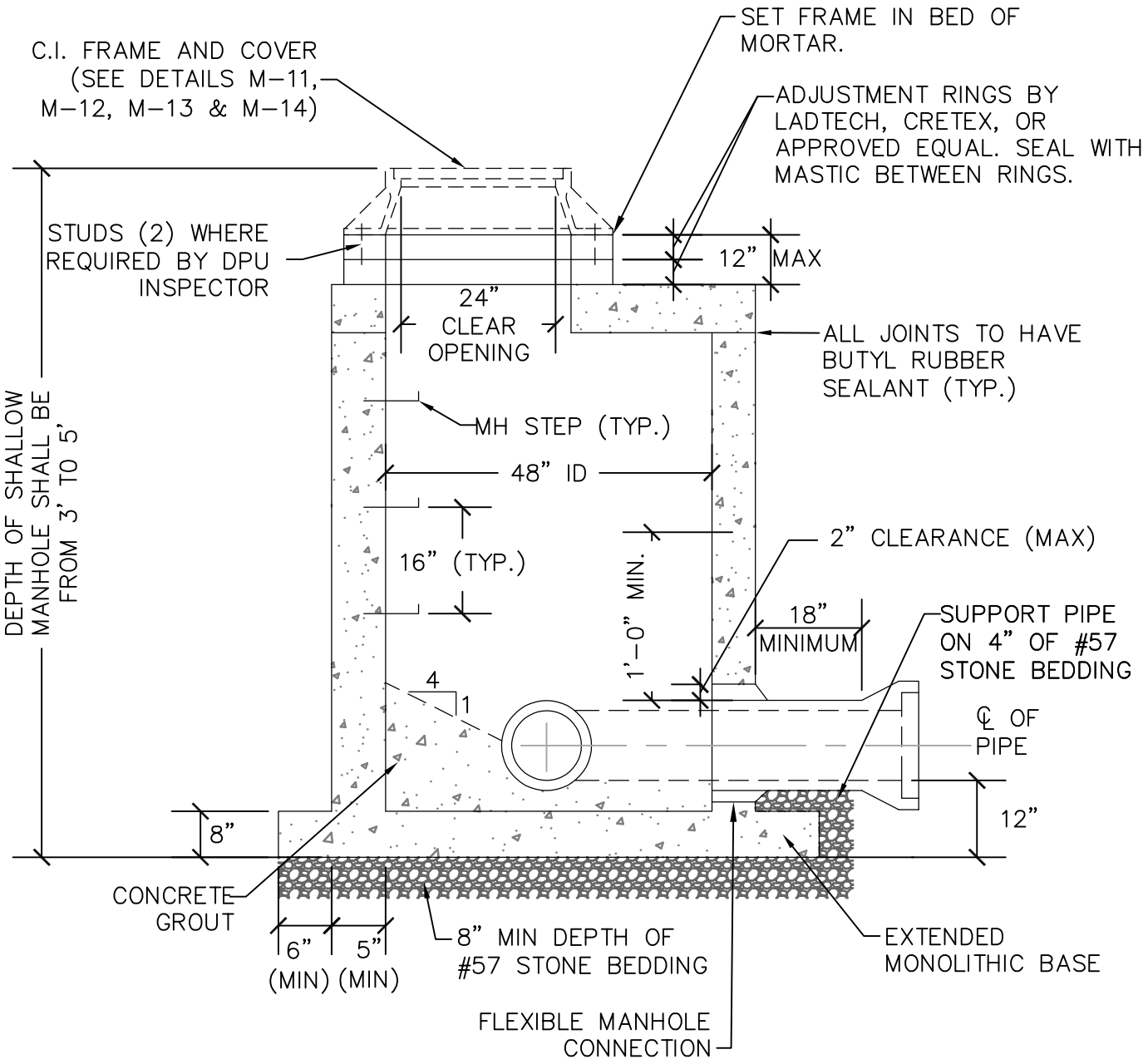
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA MANHOLE MINIMUM ANGLE EXAMPLE NOT TO SCALE	REV. 12/21 M-5



NOTES:

1. STONE BEDDING SHALL EXTEND TO THE OUTER BOUNDARY OF ALL UNDISTURBED AREAS SURROUNDING THE MANHOLE
2. EXCAVATION PAYLINE EXTENDS 6" OUTSIDE THE LARGEST DIAMETER OF THE MANHOLE, ALL AROUND.
3. CONTACT MANHOLE MANUFACTURER FOR ADDITIONAL WALL THICKNESS REQUIRED AT MANHOLE DEPTHS GREATER THAN 15'–0".
4. MANHOLE SHALL BE RATED FOR H20 LOADING IN PAVEMENT OR AREAS SUBJECT TO VEHICULAR TRAFFIC.
5. USE HIGH–STRENGTH NON–SHRINK HYDRAULIC CEMENT GROUT BETWEEN MH AND PIPE.
6. DOGHOUSE OPENING SHALL HAVE A RADIUS EQUIVALENT TO THE O.D. OF THE PIPE PLUS 2" AND A HEIGHT EQUIVALENT TO THE O.D. OF PIPE PLUS 4".
7. CONCRETE SLAB SHALL BE FIELD POURED UNDER EXISTING SEWER AND REINFORCED WITH #5 REBAR AT 12" O.C. EACH WAY. ALL REBAR SHALL HAVE 1–1/2" MINIMUM COVER. CONCRETE TO BE CLASS A–3.

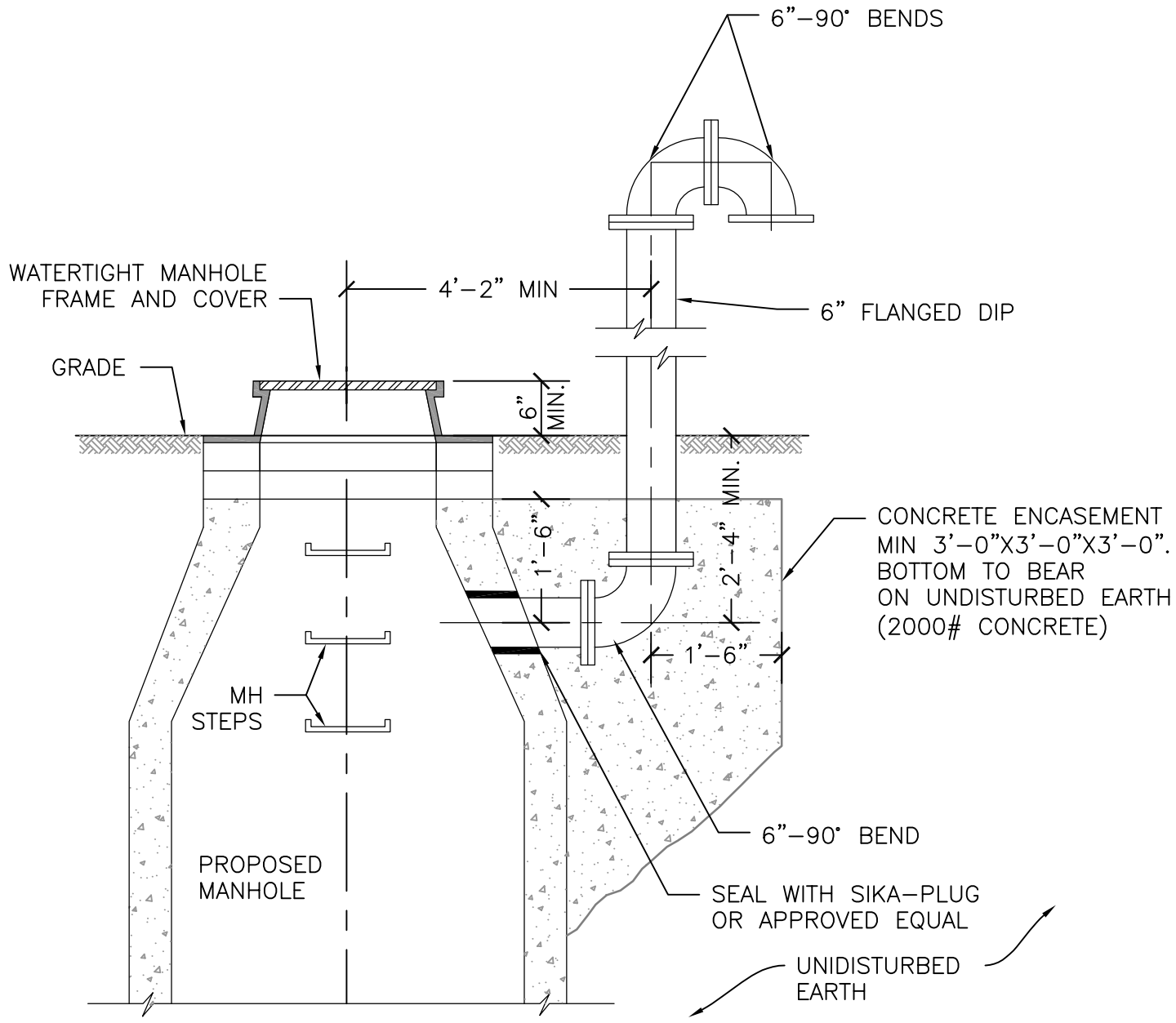
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD DOG–HOUSE MANHOLE NOT TO SCALE	REV. 12/21 M–6



NOTES:

1. STONE BEDDING SHALL EXTEND TO THE OUTER BOUNDARY OF ALL UNDISTURBED AREAS SURROUNDING THE MANHOLE.
2. FOR SEWERS GREATER THAN 24" SEE DETAIL M–2.
3. EXCAVATION PAYLINE EXTENDS 6" OUTSIDE THE LARGEST DIAMETER OF THE MANHOLE, ALL AROUND.
4. MANHOLE SHALL BE RATED FOR H20 LOADING IN PAVEMENT OR AREAS SUBJECT TO VEHICULAR TRAFFIC.
5. LATERAL INVERTS SHALL BE NO MORE THAN 2'–0" ABOVE INVERT OUT. NO MORE THAN 3 LATERALS PER MANHOLE.
6. PRECAST CONCRETE MANHOLES SHALL BE IN COMPLIANCE WITH ASTM C–478.
7. INVERT SHAPING SHALL BE IN ACCORDANCE WITH DETAIL M–14.
8. SEALANTS FOR MANHOLE SECTION JOINTS SHALL BE IN COMPLIANCE WITH ASTM C990. JOINTS SHALL BE WATER TIGHT.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA SHALLOW MANHOLE NOT TO SCALE	REV. 12/21 M–7



NOTES:

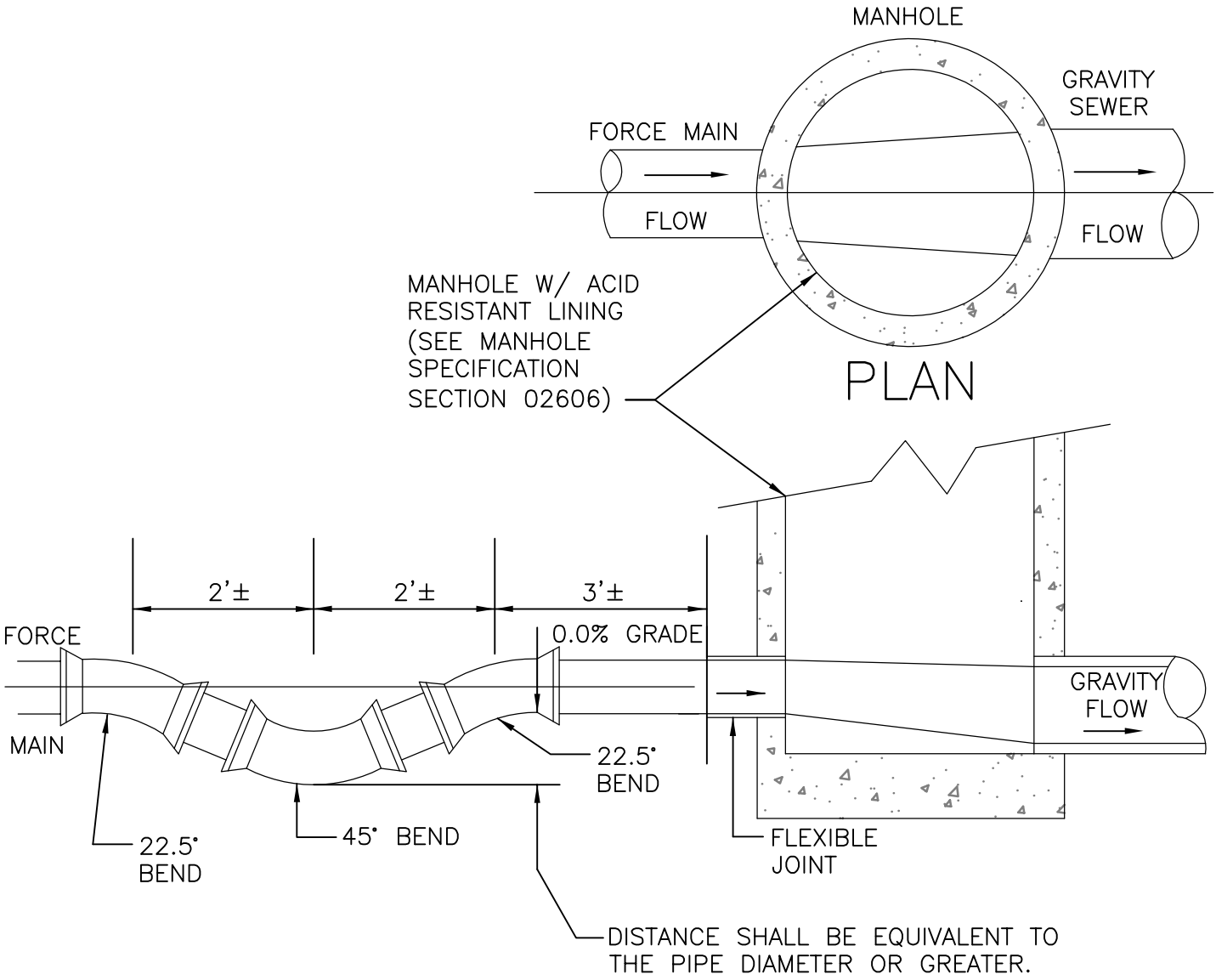
1. WHERE WATERTIGHT FRAME AND COVERS ARE USED, UNVENTILATED LENGTH OF SEWER SHALL NOT EXCEED 1,000 FEET. MANHOLE COVERS SHALL BE SET MIN. 6" ABOVE 100 YEAR FLOOD ELEVATION AND NO MORE THAN 48 INCHES ABOVE GROUND LEVEL.

2. AIR VENT SHALL BE SET MIN. 6" ABOVE 100 YEAR FLOOD ELEVATION. IF TOP ELEVATION OF VENT IS LESS THAN 8'–0" ABOVE GROUND LINE, THE (2) 6" 90° BENDS WILL BE REQUIRED. 8'–0" AND HIGHER ABOVE THE GROUND LINE WILL NOT REQUIRE FITTINGS (OPEN TO ATMOSPHERE).

3. PAINT EXPOSED PORTION OF PIPE WITH GREEN RUST INHIBITIVE PAINT.

4. VENT SHALL BE LOCATED OPPOSITE MANHOLE FRAME AND COVER.

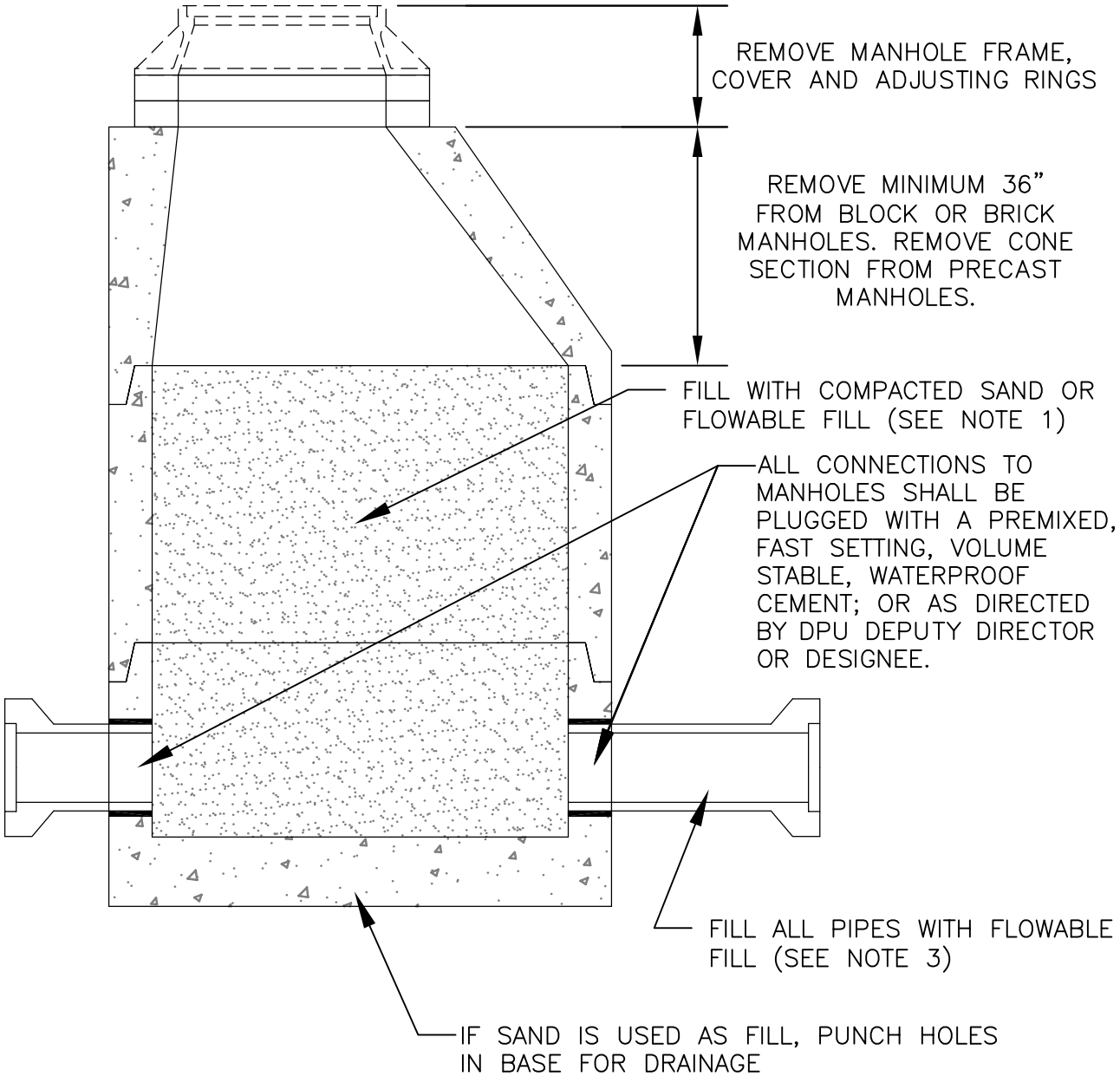
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA MANHOLE VENT NOT TO SCALE	REV. 12/21 M–8



NOTES:

1. PROVIDE VENT PER DETAIL M–7.
2. SEE DETAIL M–14 FOR INVERT SHAPING.
3. FOR PRIVATE FORCE MAINS THE DISCHARGE MANHOLE SHALL BE LOCATED AT THE PROPERTY LINE.
4. ALL FITTINGS SHALL BE RESTRAINED JOINT.
5. PROVIDE TEST STATION BOX FOR TRACER WIRE MINIMUM 1' OUTSIDE MANHOLE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA FORCE MAIN DISCHARGE NOT TO SCALE	REV. 12/21 M–9



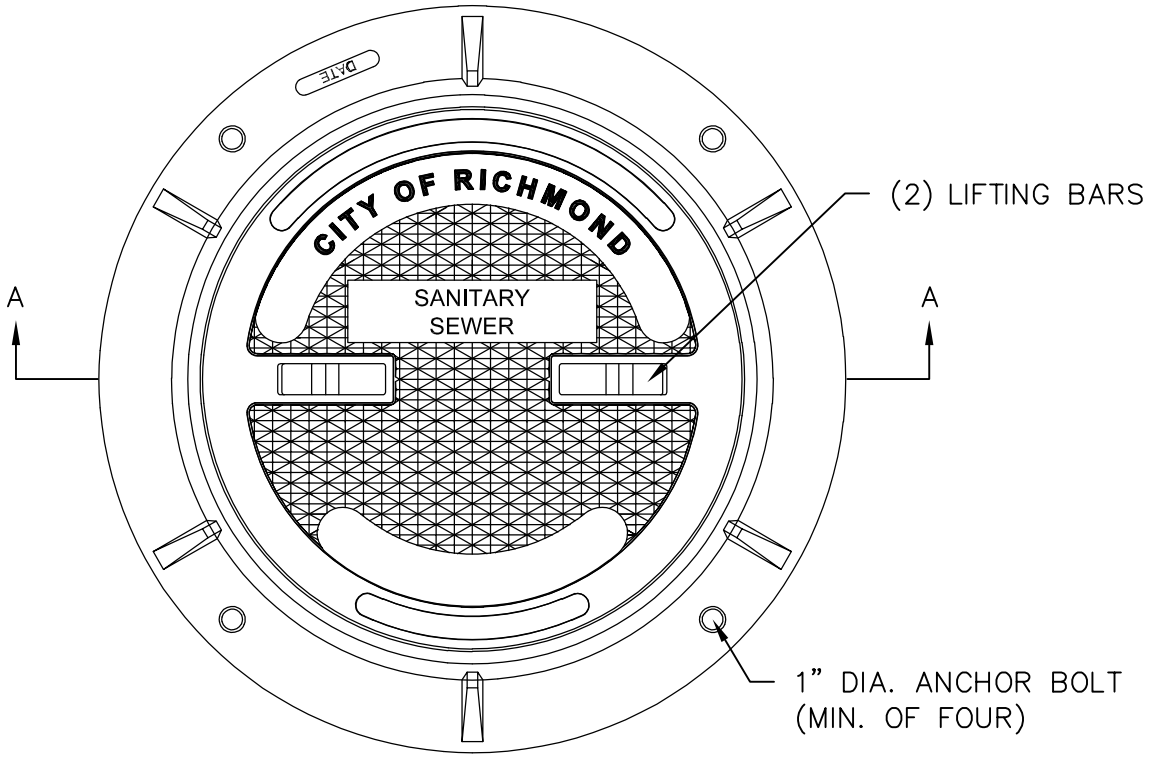
NOTES:

1. FLOWABLE FILL REQUIRED IN STREETS AND AREAS SUBJECT TO VEHICULAR TRAFFIC.

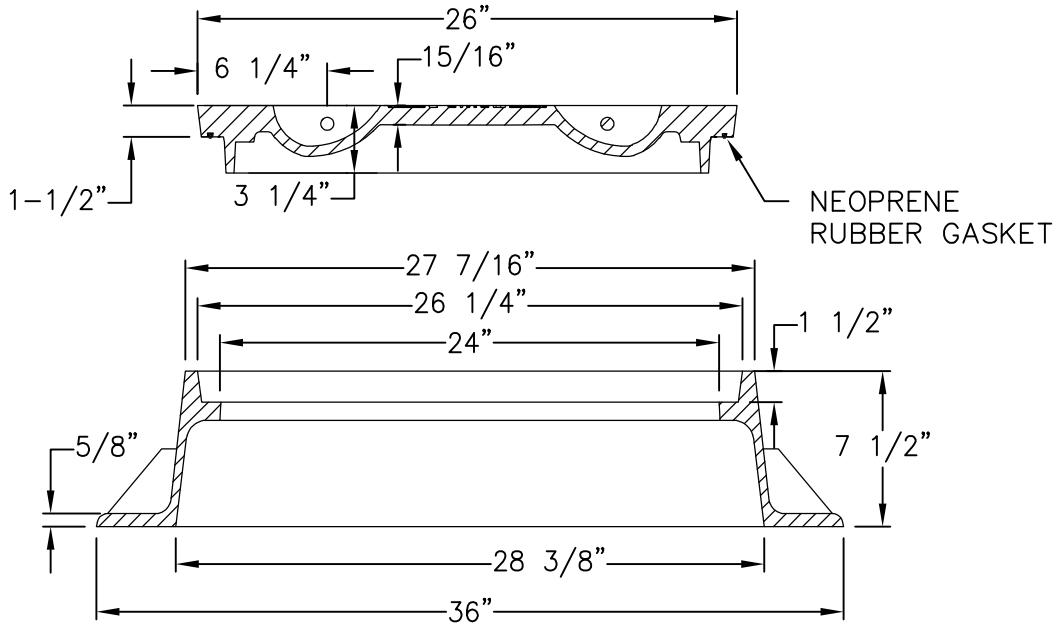
2. WHERE MANHOLE IS LOCATED IN PAVEMENT, PAVEMENT WILL BE RESTORED IN ACCORDANCE WITH DPW STANDARDS OR VDOT STANDARDS. FOR MANHOLES NOT LOCATED IN PAVEMENT, AREA WILL BE GRADED AND RESTORED SIMILAR TO SURROUNDING CONDITIONS.

3. WHERE PIPES ARE TO BE ABANDONED, SERVICE CONNECTION(S) SHALL BE CUT OFF AND CAPPED AND THE PIPE SHALL BE VENTED TO ENSURE THE ENTIRE PIPE IS FILLED.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA ABANDONMENT OF MANHOLES NOT TO SCALE	REV. 12/09 M–10



PLAN

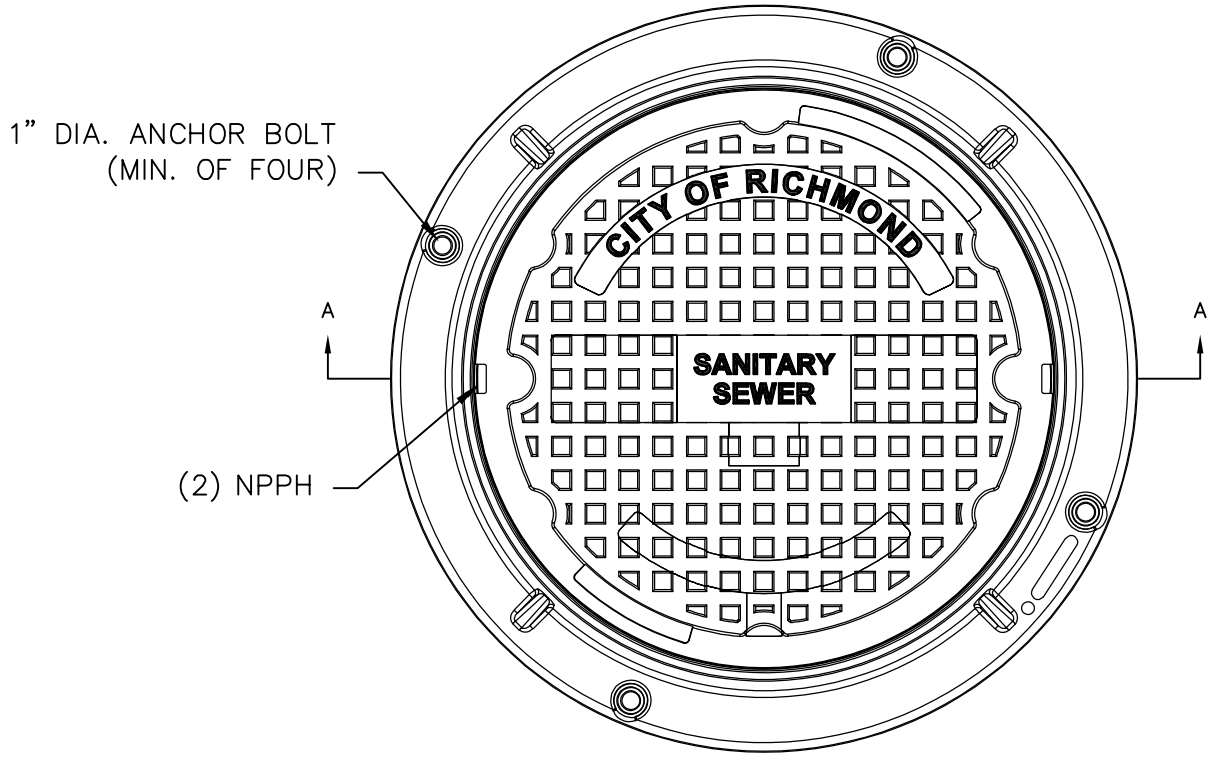


SECTION A–A

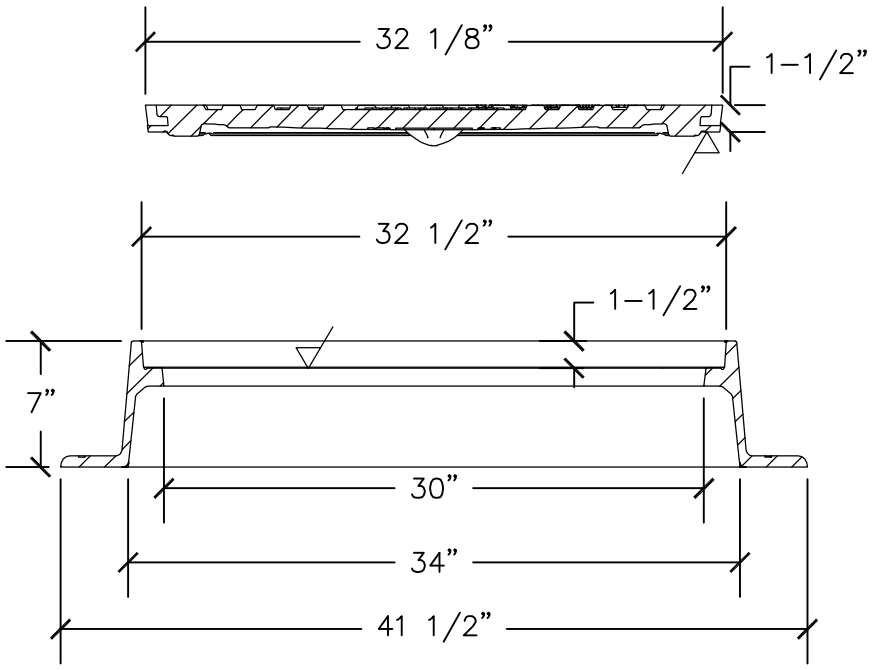
NOTES:

1. ALL GRAY IRON CASTINGS SHALL CONFORM TO ASTM A–48, CLASS 30 AND SHALL BE OF UNIFORM QUALITY. CASTING SHALL BE HEAVY DUTY.
2. ALL CASTING DIMENSIONS SHALL HAVE A TOLERANCE OF 1/8"±.
3. ALL CASTINGS SHALL BE CLEANED BY SHOT BLASTING AND HAND CHIPPING USING STANDARD INDUSTRY PRACTICES PRIOR TO SHOP APPLICATION OF ASPHALTIC COATING, BY DIPPING.
4. SURFACE BETWEEN FRAME AND COVER SHALL BE MACHINE FINISHED.
5. MANHOLE FRAME AND COVER SHALL BE US FOUNDRY USF 759 RING & NR COVER OR APPROVED EQUAL.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD FRAME AND COVER NOT TO SCALE	REV. 12/21 M–11



PLAN

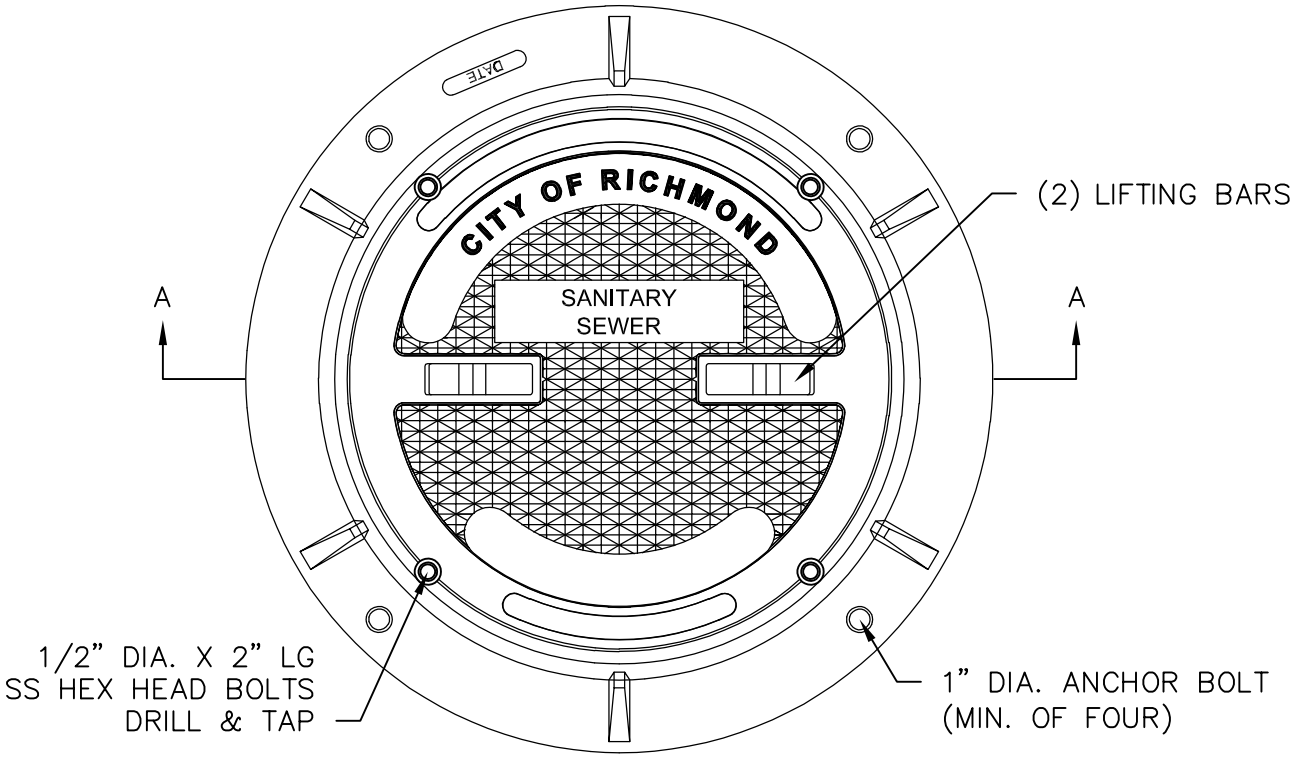


SECTION A–A

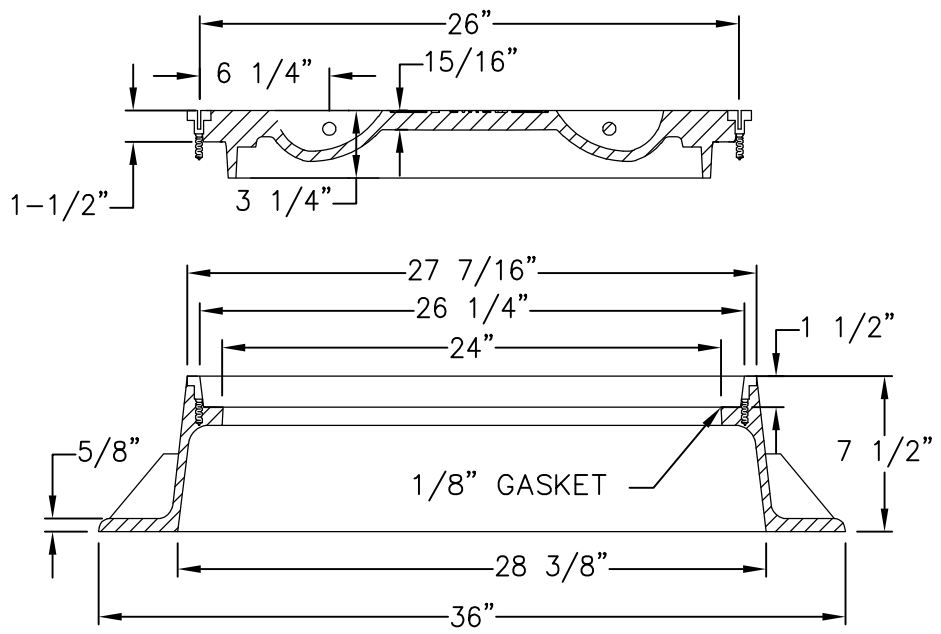
NOTES:

1. ALL GRAY IRON CASTINGS SHALL CONFORM TO ASTM A–48, CLASS 30 AND SHALL BE OF UNIFORM QUALITY. CASTING SHALL BE HEAVY DUTY.
2. ALL CASTING DIMENSIONS SHALL HAVE A TOLERANCE OF 1/8"±.
3. ALL CASTINGS SHALL BE CLEANED BY SHOT BLASTING AND HAND CHIPPING USING STANDARD INDUSTRY PRACTICES PRIOR TO SHOP APPLICATION OF ASPHALTIC COATING, BY DIPPING.
4. SURFACE BETWEEN FRAME AND COVER SHALL BE MACHINE FINISHED.
5. MANHOLE FRAME AND COVER SHALL BE US FOUNDRY USF 230 RING & AA–1 COVER OR APPROVED EQUAL.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA LARGE DIAMETER FRAME AND COVER NOT TO SCALE	REV. 12/21 M–12



PLAN

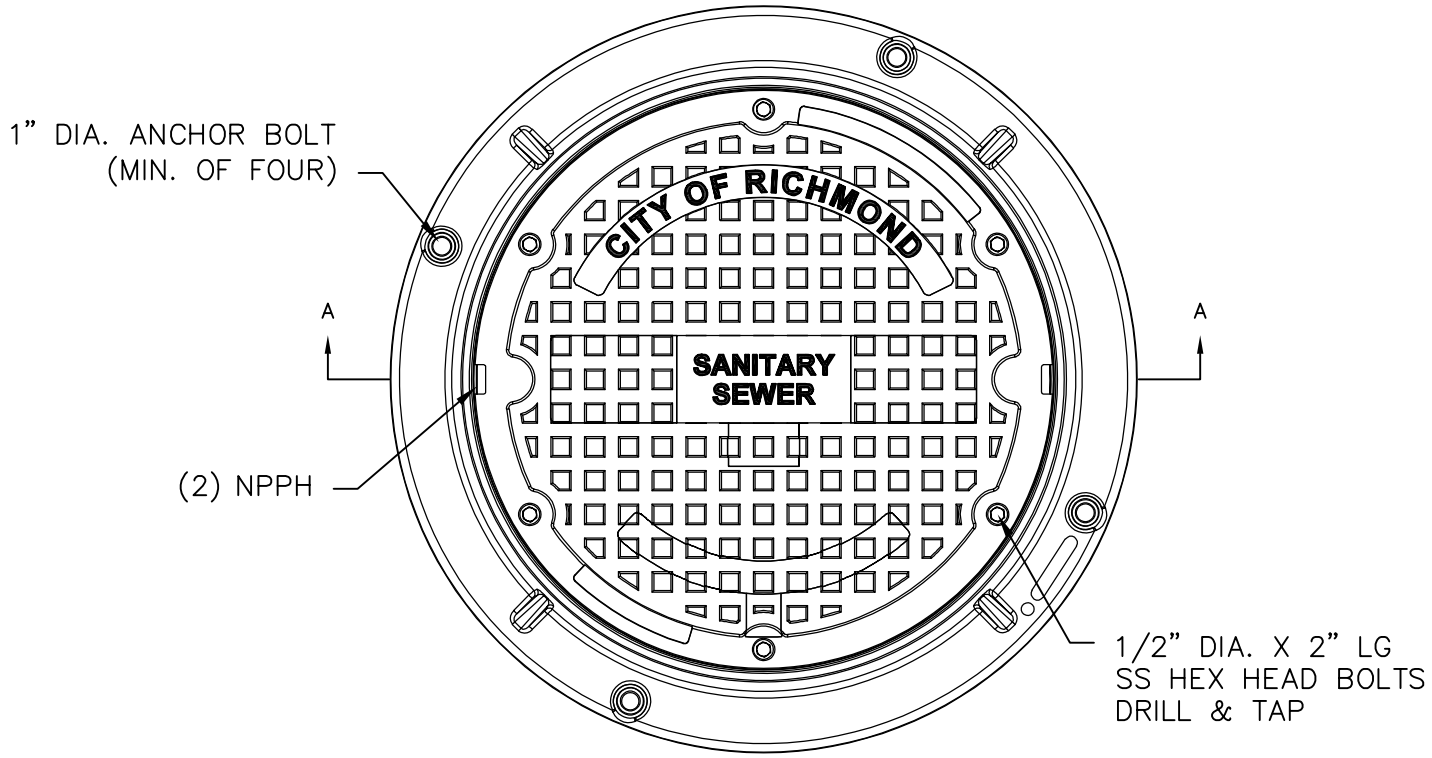


SECTION A–A

NOTES:

1. ALL GRAY IRON CASTINGS SHALL CONFORM TO ASTM A–48, CLASS 30 AND SHALL BE OF UNIFORM QUALITY. CASTING SHALL BE HEAVY DUTY.
2. ALL CASTING DIMENSIONS SHALL HAVE A TOLERANCE OF 1/8"±.
3. ALL CASTINGS SHALL BE CLEANED BY SHOT BLASTING AND HAND CHIPPING USING STANDARD INDUSTRY PRACTICES PRIOR TO SHOP APPLICATION OF ASPHALTIC COATING, BY DIPPING.
4. SURFACE BETWEEN FRAME AND COVER SHALL BE MACHINE FINISHED.
5. INSTALL (4) FOUR HEXAGONAL HEAD BOLTS AT 90°.
6. MANHOLE FRAME AND COVER SHALL BE US FOUNDRY USF 759 RING & NR COVER BWT OR APPROVED EQUAL.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STANDARD VANDAL PROOF/WATERTIGHT FRAME AND COVER NOT TO SCALE	REV. 12/21 M–13



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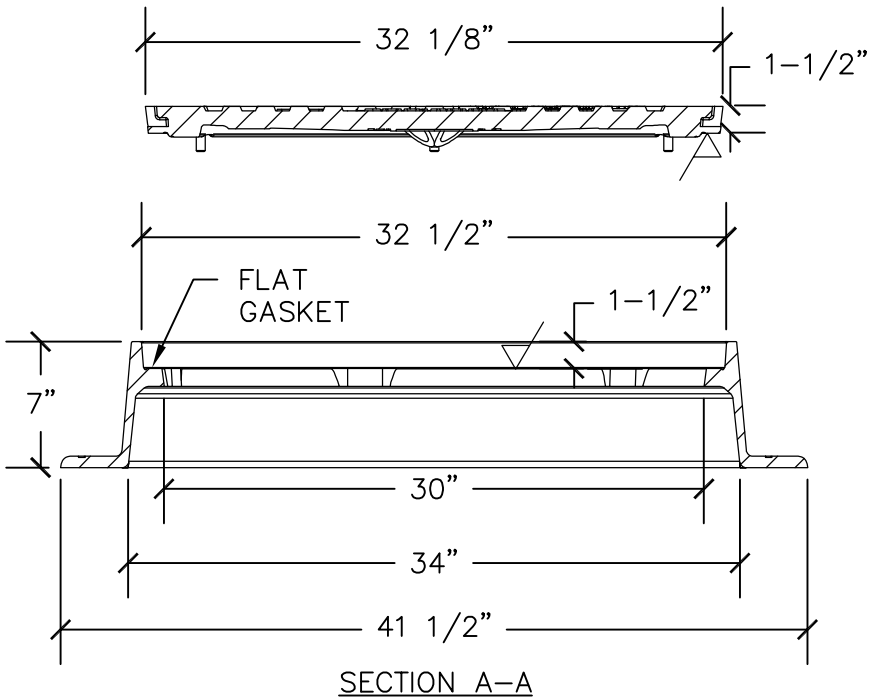
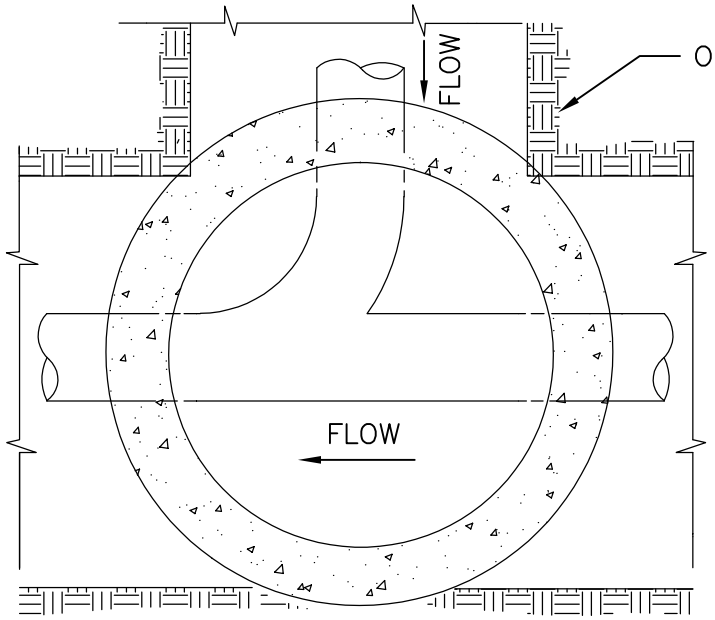


SECTION A-A

NOTES:

1. ALL GRAY IRON CASTINGS SHALL CONFORM TO ASTM A-48, CLASS 30 AND SHALL BE OF UNIFORM QUALITY. CASTING SHALL BE HEAVY DUTY.
2. ALL CASTING DIMENSIONS SHALL HAVE A TOLERANCE OF 1/8"±.
3. ALL CASTINGS SHALL BE CLEANED BY SHOT BLASTING AND HAND CHIPPING USING STANDARD INDUSTRY PRACTICES PRIOR TO SHOP APPLICATION OF ASPHALTIC COATING, BY DIPPING.
4. SURFACE BETWEEN FRAME AND COVER SHALL BE MACHINE FINISHED.
5. MANHOLE FRAME AND COVER SHALL BE US FOUNDRY USF 230 RING & AA-1 COVER 6BWT OR APPROVED EQUAL.

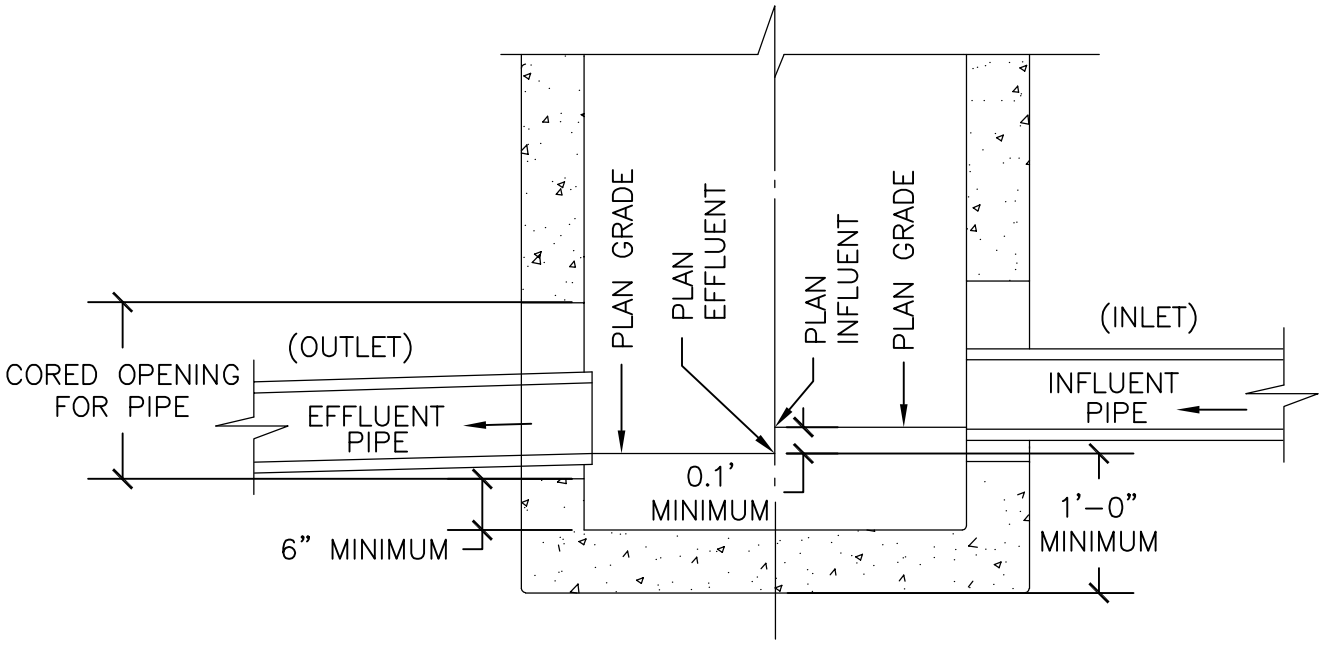
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA LARGE DIAMETER VANDAL PROOF/WATERTIGHT FRAME AND COVER NOT TO SCALE	REV. 12/21 M-14



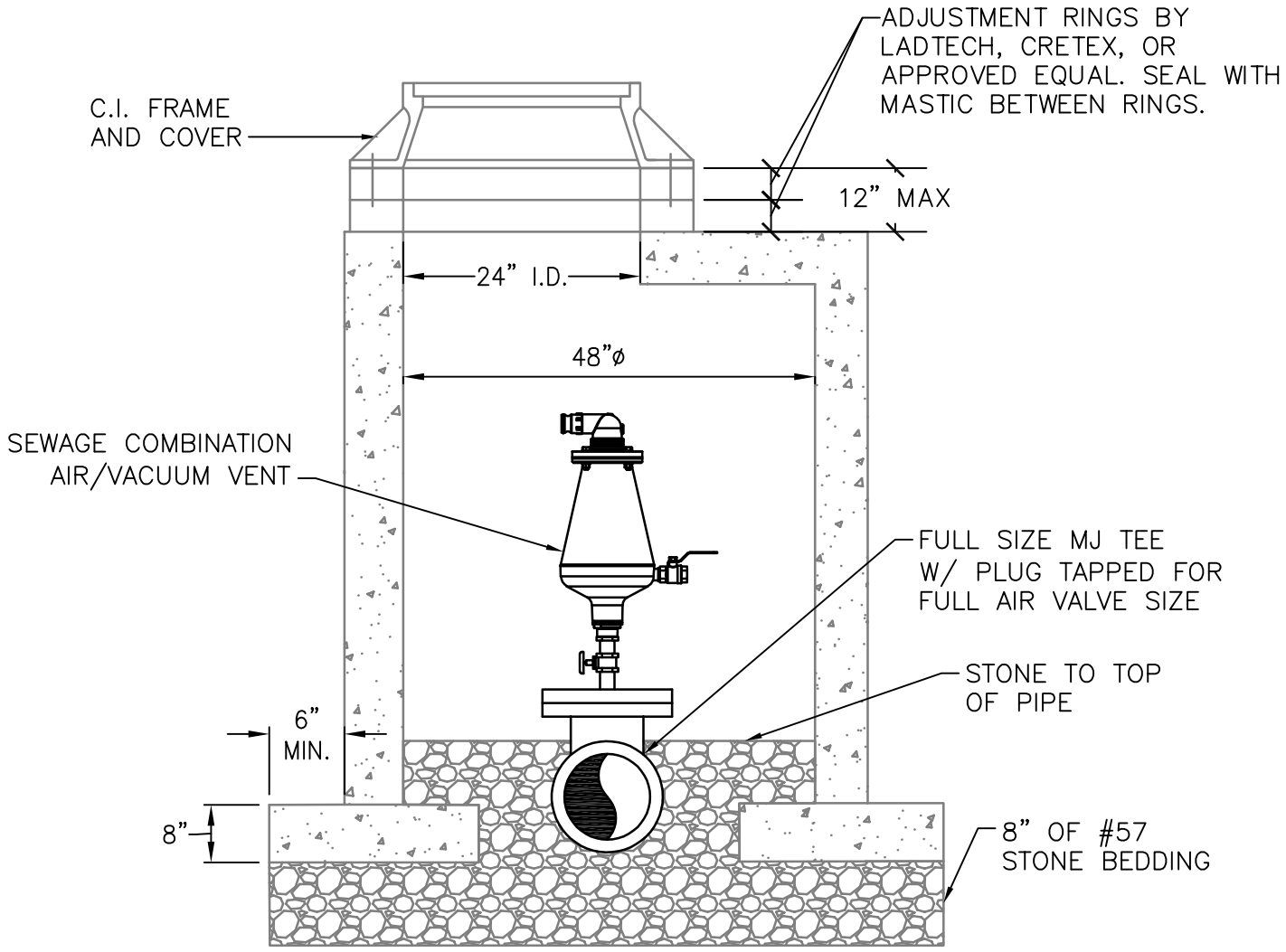
PLAN INVERT

NOTE:

1. THE EFFLUENT ELEVATION SHOWN AT A MANHOLE IS ESTABLISHED FROM THE INFLUENT ELEVATION OF THE MANHOLE IMMEDIATELY DOWNSTREAM. ELEVATIONS SHOWN APPLY AT THE ℄ OF MANHOLES & ARE BASED ON THE HORIZONTAL DISTANCE, ℄ TO ℄ M.H. USING PERCENT OF GRADE INDICATED.
2. INVERT CHANNEL WIDTH SHALL BE EQUAL TO THE CONTRIBUTING PIPE'S I.D.
3. INVERT CHANNEL HEIGHT SHALL BE EQUAL TO THE 75% OF THE CONTRIBUTING PIPE'S I.D.
4. SLOPE BENCH TOWARDS CHANNEL AT 2" PER FOOT MIN.
5. BENCH AND CHANNELS SHALL BE FORMED USING 3,000 PSI CONCRETE OR HIGH STRENGTH NON SHRINK GROUT.
6. PROVIDE GROUT ABOVE PROTRUDING PIPES IN MANHOLES.



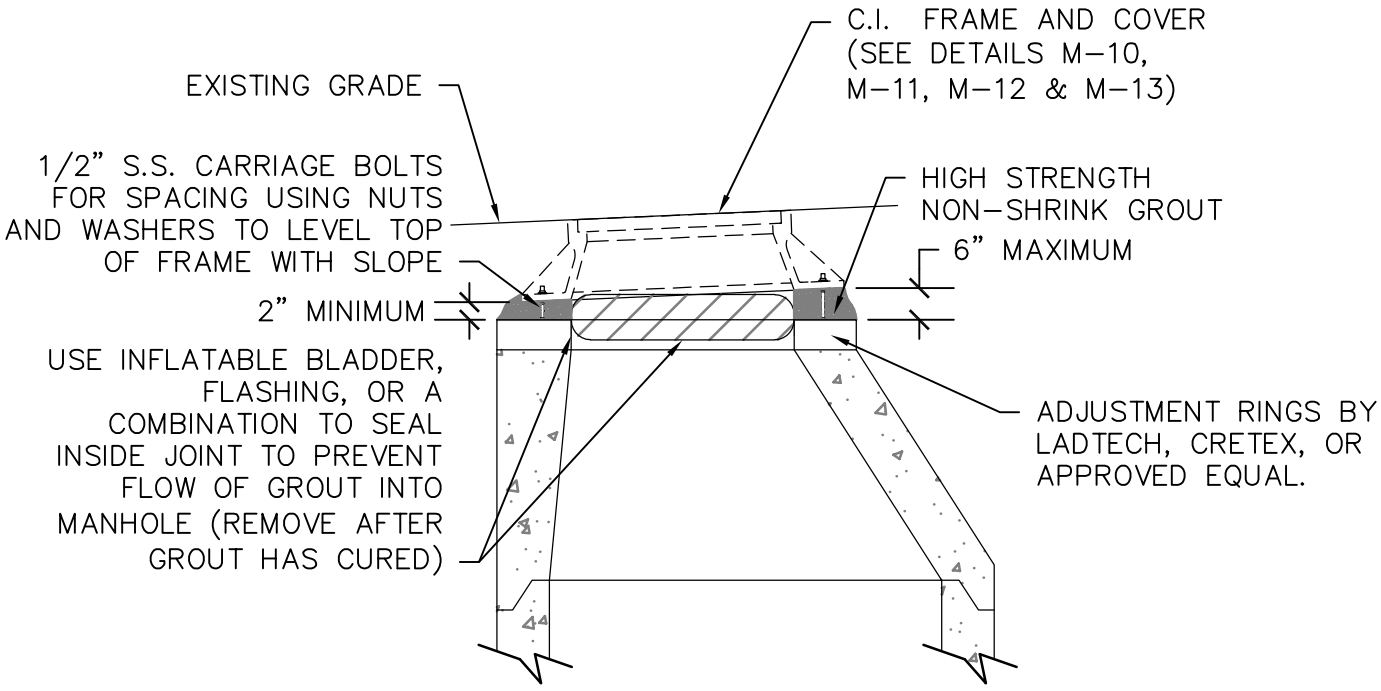
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA INVERT SHAPING NOT TO SCALE	REV. 02/18 M–15



NOTES

1. STONE BEDDING SHALL EXTEND TO THE OUTER BOUNDARY OF ALL UNDISTURBED AREAS SURROUNDING THE MANHOLE.
2. M.J. TEE SHALL HAVE RESTRAINED JOINTS ON EACH END.
3. INSTALL FULL PIPE LENGTH ON EACH SIDE OF TEE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA AIR RELEASE VALVE MANHOLE NOT TO SCALE	REV. 12/21 M–16



NOTES:
1. MANHOLE FRAME AND COVER SHALL COME FURNISHED WITH ANCHOR BOLT LOCATIONS.
2. STAINLESS STEEL BOLTS, NUTS, AND WASHERS SHALL BE USED TO LEVEL MANHOLE FRAME AND COVER.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA ANGLED MANHOLE FRAME AND COVER INSTALLATION NOT TO SCALE	REV. 12/21 M–17

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS

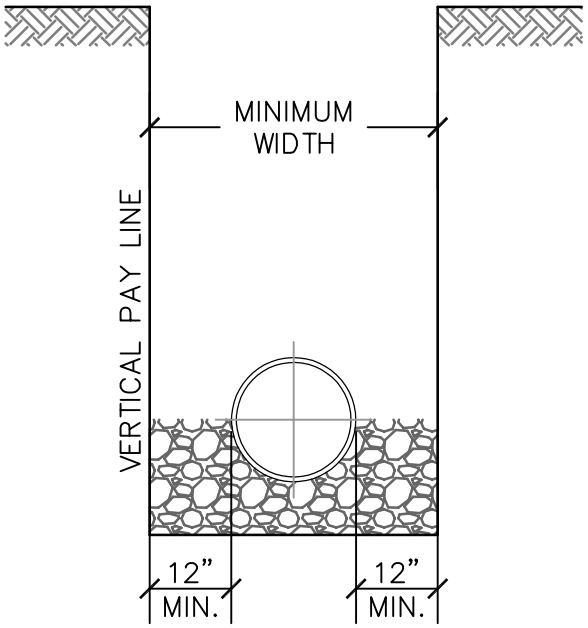
DEPTH	DIAMETER (IN)								
	30	33	36	42	48	54	60	66	72
	TIME (SECONDS)								
<4	6	7	7	9	10	12	13	15	16
6	9	10	11	13	15	18	20	22	25
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

NOTES:

1. THE TEST HEAD SHALL BE PLACED AT THE TOP OF THE MANHOLE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMENDATIONS.
2. A VACUUM OF 10 IN. OF MERCURY SHALL BE DRAWN ON THE MANHOLE, THE VALVE ON THE VACUUM LINE OF THE TEST HEAD CLOSED, AND THE VACUUM PUMP SHUT OFF. THE TIME SHALL BE MEASURED FOR THE VACUUM TO DROP TO 9 IN. OF MERCURY.
3. THE MANHOLE SHALL PASS IF THE TIME FOR THE VACUUM READING TO DROP FROM 10 IN. OF MERCURY MEETS OR EXCEEDS THE VALUES INDICATED ABOVE.
4. IF THE MANHOLE FAILS THE INITIAL TEST, NECESSARY REPAIRS SHALL BE MADE BY AN APPROVED METHOD. THE MANHOLE SHALL THEN BE RETESTED UNTIL A SATISFACTORY TEST IS OBTAINED.
5. ABOVE TABLE AND METHOD IS BASED ON ASTM C1244–11.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA MANHOLE VACUUM TEST TABLE NOT TO SCALE	REV. 04/17 M–18

PIPE SIZE	OUTER DIAMETER OF PIPE (SEE NOTE 2)	MIN TRENCH WIDTH (FT)
6"	6.63	2.55
8"	8.62	2.72
10"	10.75	2.90
12"	12.75	3.06
14"	14.00	3.17
16"	16.00	3.33
18"	18.00	3.50
20"	20.00	3.67
24"	24.00	4.00
30"	30.00	4.50

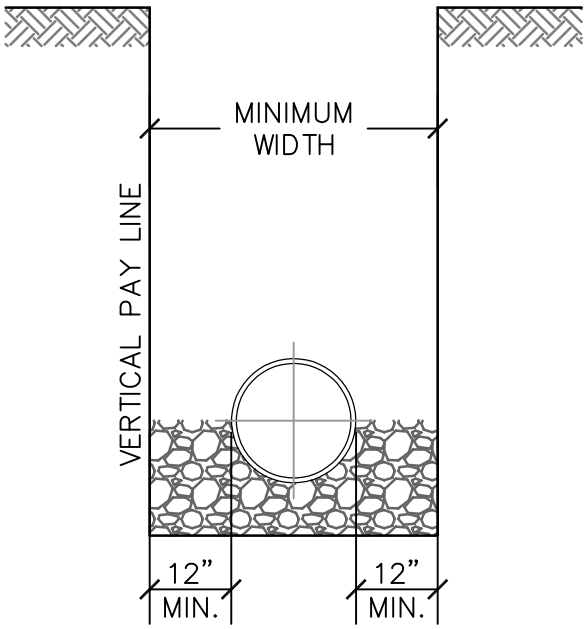


NOTES:

1. DIMENSIONS ALLOWED FOR SEWER EXCAVATIONS FOR SDR 26 PVC.
2. FOR DEPTHS GREATER THAN 30' CONTACT THE DPU FOR ALLOWABLE EXCAVATIONS.
4. CONTRACTOR IS RESPONSIBLE FOR COMPLYING WITH ALL OSHA REQUIREMENTS.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA PIPELINE EXCAVATION FOR PVC NOT TO SCALE	REV. 12/21 P–1A

PIPE SIZE	OUTER DIAMETER OF PIPE (SEE NOTE 2)	MIN TRENCH WIDTH (FT)
6"	6.90	2.58
8"	9.05	2.75
10"	11.10	2.93
12"	13.20	3.10
14"	15.30	3.28
16"	17.40	3.45
18"	19.50	3.63
20"	21.60	3.80
24"	25.80	4.15
30"	32.00	4.67
36"	38.30	5.19
42"	44.50	5.71
48"	50.80	6.23
54"	57.56	6.80
60"	61.61	7.13
64"	65.67	7.47



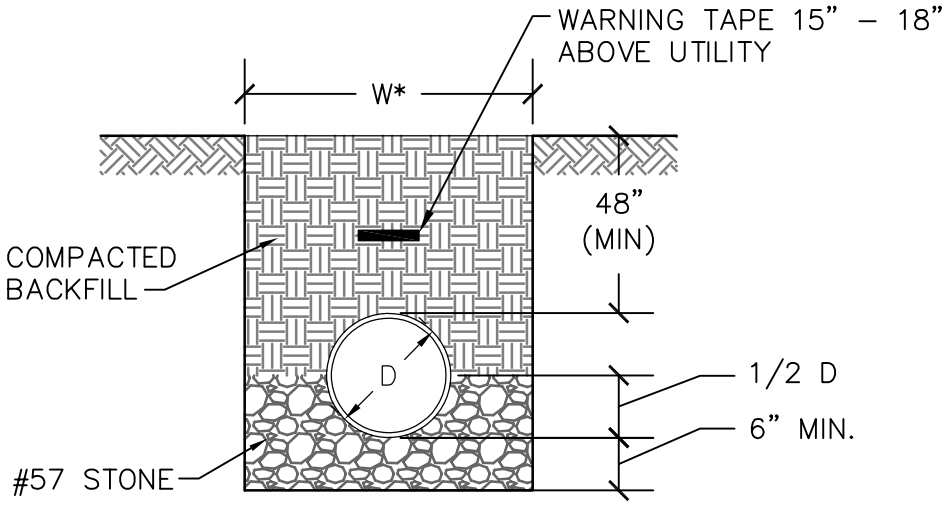
NOTES:

1. DIMENSIONS ALLOWED FOR SEWER EXCAVATIONS FOR DIP.

2. FOR DEPTHS GREATER THAN 30' CONTACT THE DPU FOR ALLOWABLE EXCAVATIONS.

4. CONTRACTOR IS RESPONSIBLE FOR COMPLYING WITH ALL OSHA REQUIREMENTS.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA PIPELINE EXCAVATION FOR DIP NOT TO SCALE	REV. 12/21 P-1B

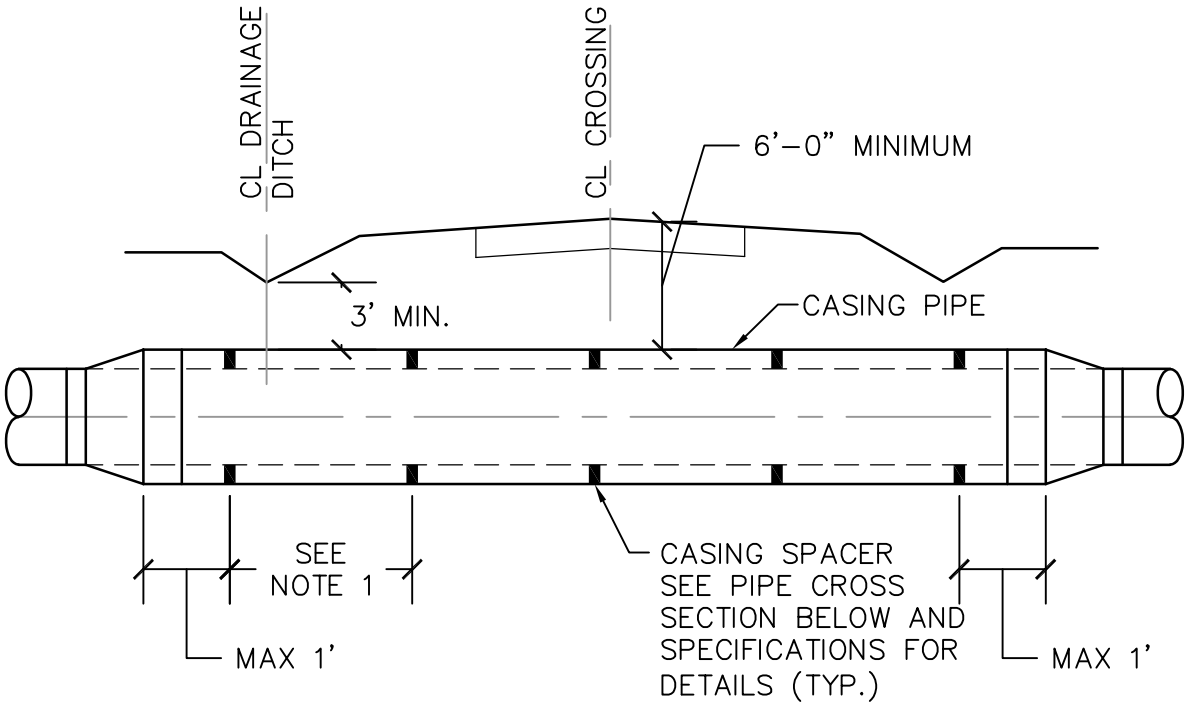


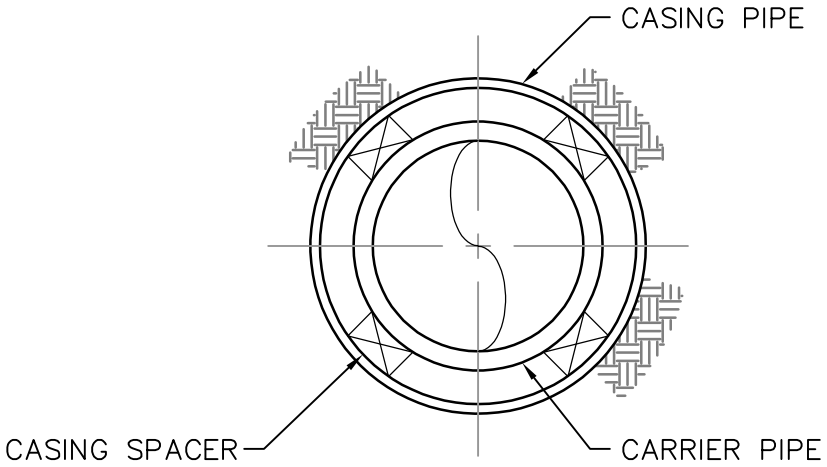
COMPACTED GRANULAR BEDDING
CLASS B

NOTES:

1. * FOR "W" SEE DETAILS P–1A AND P–1B.
2. USE CLASS B COMPACTED GRANULAR BEDDING UNLESS OTHERWISE DIRECTED BY DPU TECHNICAL SERVICES DIVISION.
3. TRENCH, BACKFILL AND STREET RESTORATION SHALL BE IN ACCORDANCE WITH CITY OF RICHMOND DEPARTMENT OF PUBLIC WORKS AND/OR VDOT REQUIREMENTS.
4. DI PIPE IS REQUIRED IN AREAS WITH LESS THAN 48" OF COVER.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA SEWER BEDDING NOT TO SCALE	REV. 04/17 P–2





PIPE CROSS SECTION

NOTES:

1. THREE SETS OF CASING SPACERS SHALL BE ATTACHED TO EACH LENGTH OF CARRIER PIPE WITH ONE SET AT THE CENTER AND ONE SET NOT MORE THAN 12" FROM EACH END.
2. CARRIER PIPE WITHIN BORES SHALL BE DUCTILE IRON CLASS 52 RESTRAINED JOINT AND SHALL EXTEND FROM MANHOLE TO MANHOLE FOR GRAVITY SEWERS OR EXTEND ONE FULL PIPE LENGTH BEYOND THE CASING ON EACH SIDE FOR PRESSURE PIPES.
3. FOR CASING SIZES AND ALLOWABLE MATERIALS, SEE DETAIL P-3B.
4. PROVIDE CASING VENT FOR RAILROAD CROSSINGS IN ACCORDANCE WITH THE RAILROAD OWNER'S REQUIREMENTS.
5. CASING PIPE SHALL BE SEALED BY USE OF WRAPAROUND END SEALS.
6. CASING LENGTH SHALL BE DETERMINED BY FIELD CONDITIONS.

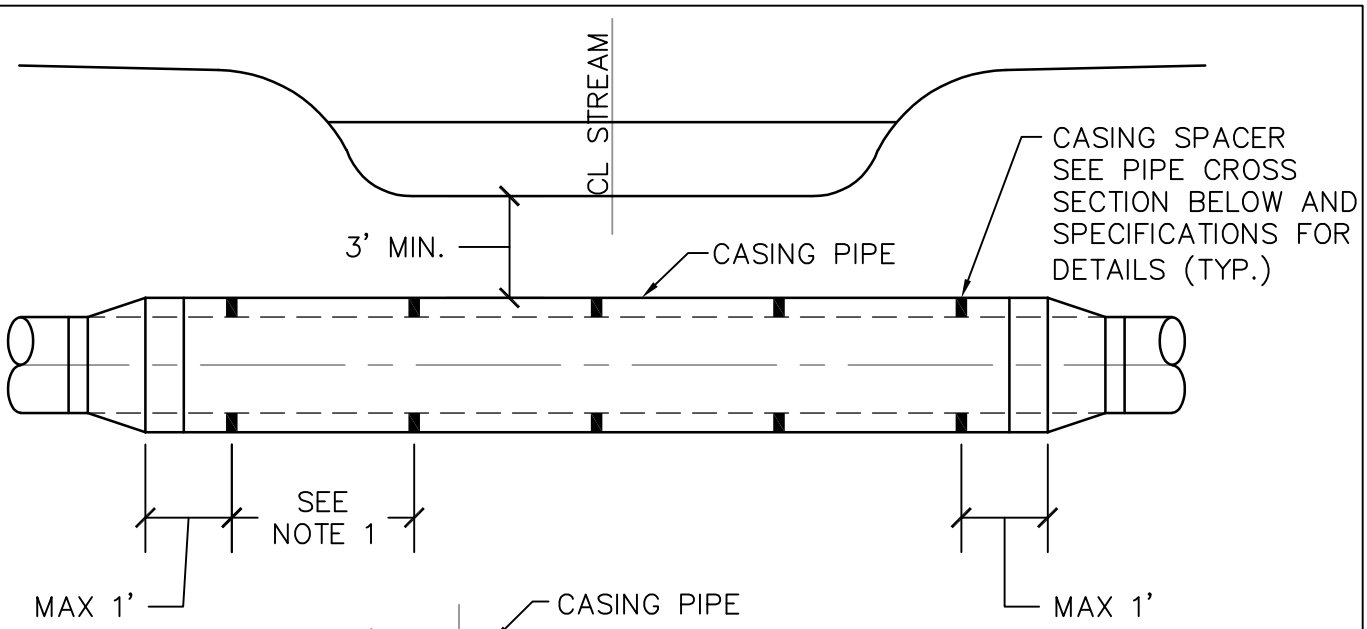
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA CASING PIPE NOT TO SCALE	REV. 02/18 P-3A

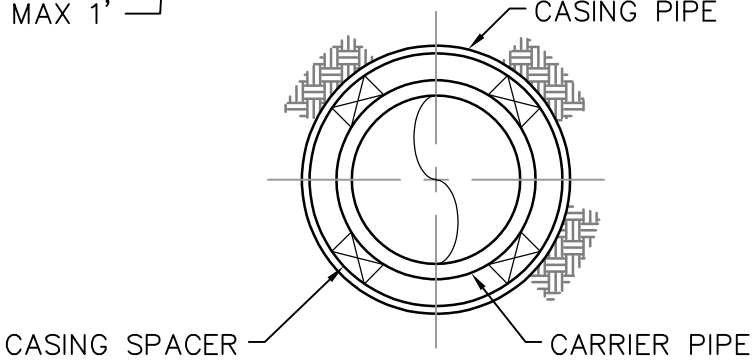
PIPE CASING			
CARRIER PIPE NOMINAL DIA.	PIPE CASING MINIMUM DIAMETER	MINIMUM WALL THICKNESS	
		CRITERIA WITHIN RAILROAD RIGHT OF WAY	CRITERIA WITHIN CITY OR VDOT RIGHT OF WAY
		STEEL WITH PROTECTIVE COATING	STEEL
6"	16"	0.281"	0.500"
8"	20"	0.375"	0.500"
10"	20"	0.375"	0.500"
12"	24"	0.375"	0.500"
15"	24"	0.375"	0.500"
16"	24"	0.375"	0.500"
18"	30"	0.500"	0.500"
20"	30"	0.500"	0.500"
21"	30"	0.500"	0.500"
24"	36"	0.563"	0.500"
30"	42"	0.625"	0.500"
33"	42"	0.625"	0.500"
36"	48"	0.688"	0.500"
42"	54"	0.781"	0.500"

NOTES:

1. SLOPES THROUGH BORES SHALL NOT BE BASED ON MINIMUM GRADE UNLESS IT IS THE ONLY SLOPE AVAILABLE.
2. INCREASING THICKNESS OF CASING MUST BE CONSIDERED WHERE BORE LENGTHS EXCEED 125 FEET.
3. WHEN USING STEEL CASING, A MINIMUM OF 0.375" THICKNESS IS REQUIRED WHEN GROUND COVER OVER PIPE EXCEEDS 15 FEET.
4. WHERE RESTRAINING DEVICES ARE REQUIRED FOR THE CARRIER PIPE, THE CASING PIPE SHALL BE INCREASED AS NECESSARY.
5. SPIRAL WELD CASING PIPE IS NOT ACCEPTABLE.
6. STEEL SHALL CONFORM TO ASTM A139 GRADE B, WITH A MINIMUM YIELD STRENGTH OF 35,000 PSI.
7. FOR CARRIER PIPES GREATER THAN 42", CASING PIPE SIZE AND THICKNESS SHALL BE DESIGNED BASED UPON PROJECT SPECIFIC PARAMETERS, INCLUDING THE FOLLOWING: DEPTH OF BURY, SOIL CONDITIONS, WATER TABLE ELEVATION, EASE OF INSTALLATION, EASE OF REMOVAL, AND UTILITY CONFLICTS. CASING PIPE WALL THICKNESS SHALL NOT BE LESS THAN 0.500" FOR CARRIER PIPES GREATER THAN 42".

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA CASING PIPE REQUIREMENTS NOT TO SCALE	REV. 02/18 P-3B





PIPE CROSS SECTION

PIPE CASING		
CARRIER PIPE NOMINAL DIA.	PIPE CASING MINIMUM DIAMETER	MIN. WALL THICKNESS
6"	16"	0.250"
8"	20"	0.250"
10"	20"	0.250"
12"	24"	0.250"
15"	24"	0.250"
16"	24"	0.250"
18"	30"	0.375"
20"	30"	0.375"
21"	30"	0.375"
24"	36"	0.375"
30"	42"	0.500"
33"	42"	0.500"
36"	48"	0.500"
42"	54"	0.500"

NOTES:

1. THREE SETS OF CASING SPACERS SHALL BE ATTACHED TO EACH LENGTH OF CARRIER PIPE WITH ONE SET AT THE CENTER AND ONE SET NOT MORE THAN 12" FROM EACH END.

2. CARRIER PIPE WITHIN BORES SHALL BE CLASS 52 DUCTILE IRON RESTRAINED JOINT AND SHALL EXTEND FROM MANHOLE TO MANHOLE FOR GRAVITY SEWERS OR EXTEND ONE FULL PIPE LENGTH BEYOND THE CASING ON EACH SIDE FOR PRESSURE PIPES.

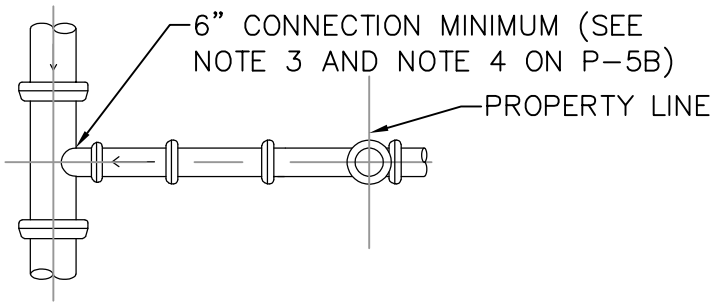
3. CASING PIPE SHALL BE STEEL.

4. CASING PIPE SHALL BE SEALED BY USE OF WRAPAROUND END SEALS.

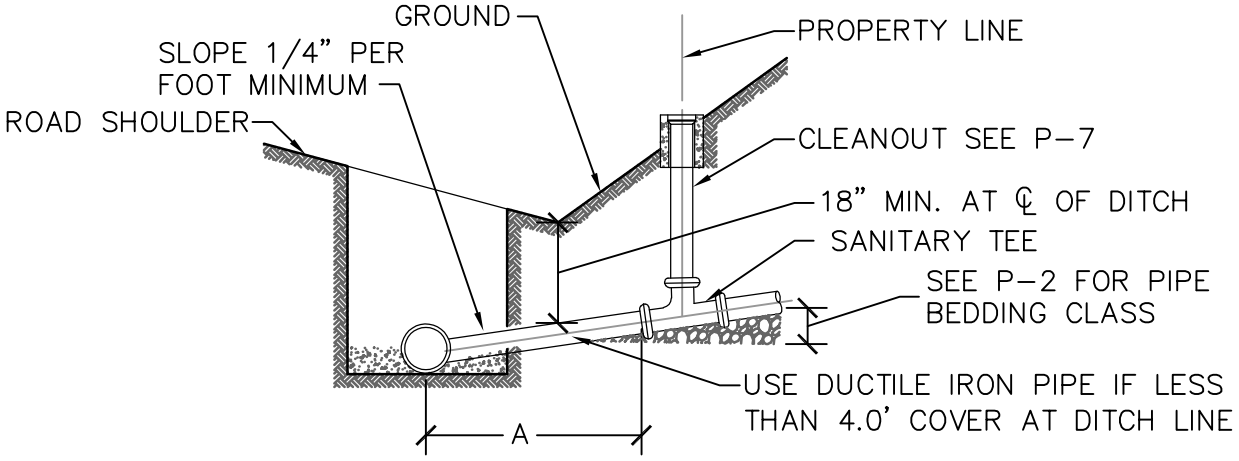
5. CASING LENGTH SHALL BE DETERMINED BY FIELD CONDITIONS.

6. FOR CARRIER PIPES GREATER THAN 42", CASING PIPE SIZE AND THICKNESS SHALL BE DESIGNED BASED UPON PROJECT SPECIFIC PARAMETERS, INCLUDING THE FOLLOWING: DEPTH OF BURY, SOIL CONDITIONS, WATER TABLE ELEVATION, EASE OF INSTALLATION, EASE OF REMOVAL, AND UTILITY CONFLICTS. CASING PIPE WALL THICKNESS SHALL NOT BE LESS THAN 0.500" FOR CARRIER PIPES GREATER THAN 42".

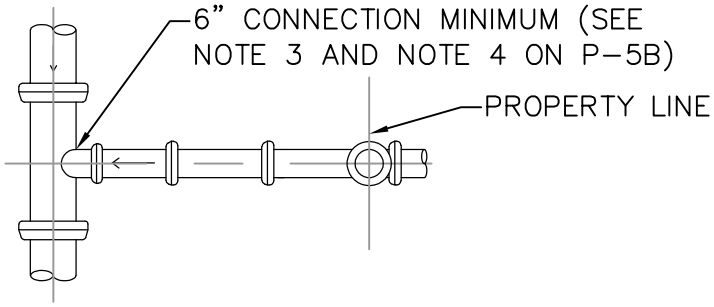
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STREAM CROSSING CASING PIPE NOT TO SCALE	REV. 12/21 P-4



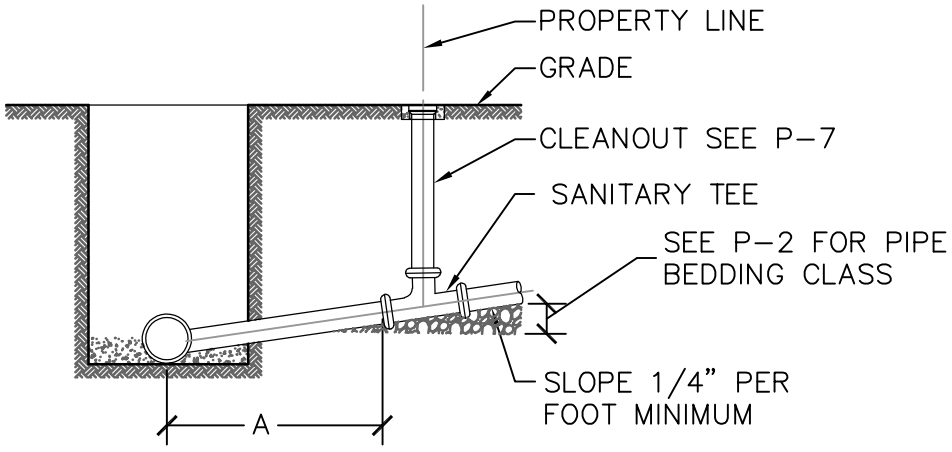
DITCH CROSSING PLAN



DITCH CROSSING SECTION



STANDARD LATERAL CONNECTION PLAN

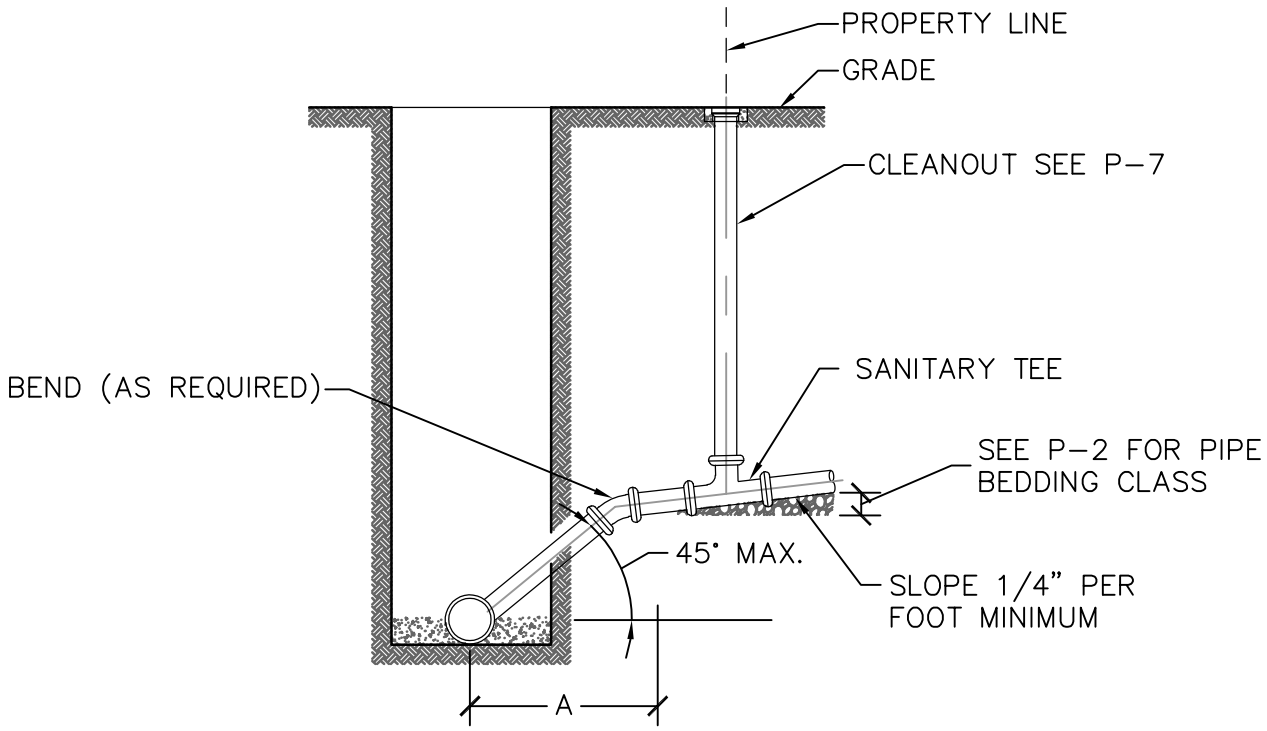


NOTE:

SEE NOTES ON DETAIL P-5B

STANDARD LATERAL CONNECTION SECTION

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA SEWER LATERAL CONNECTIONS NOT TO SCALE	REV. 12/21 P-5A

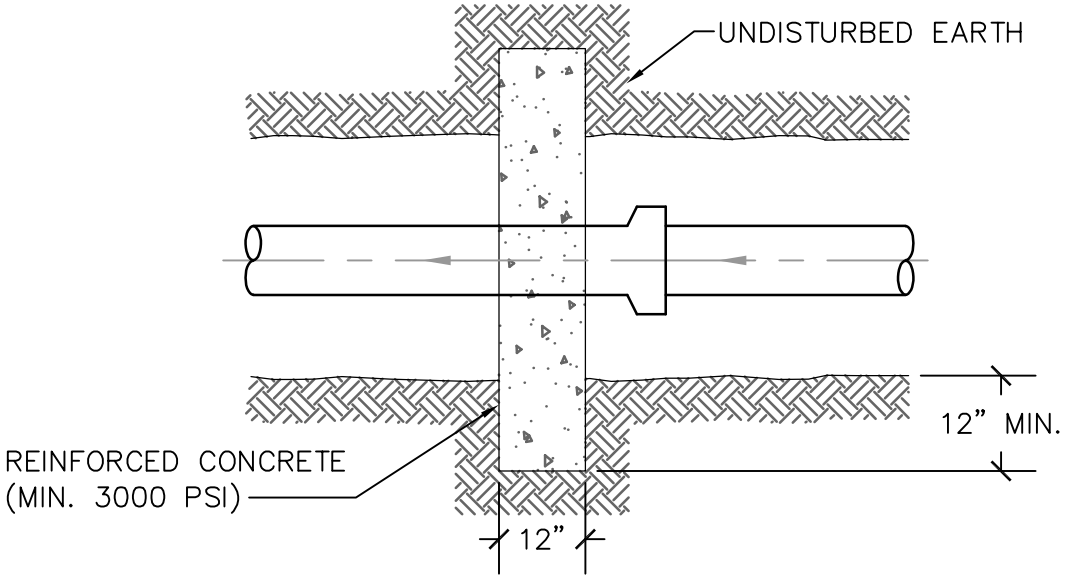


DEEP LATERAL CONNECTION SECTION

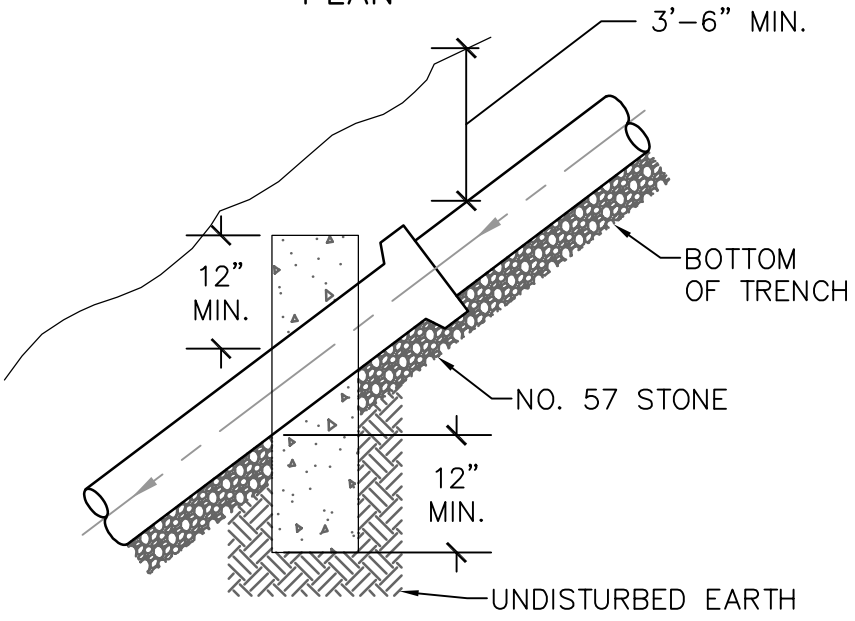
NOTES:

1. A STANDARD LATERAL CONNECTION IS CLASSIFIED AS A DEEP HOUSE CONNECTION WHEN THE DEPTH OF COVER AT THE PROPERTY LINE EXCEEDS 15'.
2. LATERALS GREATER THAN 15' DEEP SHALL BE DUCTILE IRON.
3. HOUSE CONNECTION SHALL BE LAID AT AN ANGLE NOT GREATER THAN 45° FROM HORIZONTAL.
4. ALL CONNECTIONS TO MAIN SHALL BE FULL TEES UNLESS OTHERWISE DIRECTED BY DPU DIRECTOR OR DESIGNEE.
5. IF HOST PIPE IS LESS THAN 12", TAPPING SADDLE SHALL BE USED WITH LESS THAN 1" INTRUSION.
6. CLEANOUT SHALL BE INSTALLED AT THE PROPERTY LINE. CLEANOUT IS CITY OWNED AND MAINTAINED.
7. WHERE MAIN LINE DEPTH IS LESS THAN 12', CONTRACTOR SHALL LAY CONNECTION AS SHOWN, PROVIDED THE ELEVATION OF CONNECTION AT THE PROPERTY LINE IS SUCH THAT THE LOT IS SERVED PROPERLY.
8. WHEN THE DISTANCE 'A' IS SUCH THAT AN ADDITIONAL PIPE JOINT IS REQUIRED AND THE PIPE SLOPE IS GREATER THAN 20°, CONTRACTOR SHALL PROVIDE ANCHORAGE IN ACCORDANCE WITH DETAIL P-6.
9. LATERAL MATERIAL IN ACCORDANCE WITH "SANITARY SEWER DESIGN STANDARDS AND PROCEDURES."

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA SEWER LATERAL CONNECTIONS NOT TO SCALE	REV. 12/21 P-5B



PLAN



ELEVATION

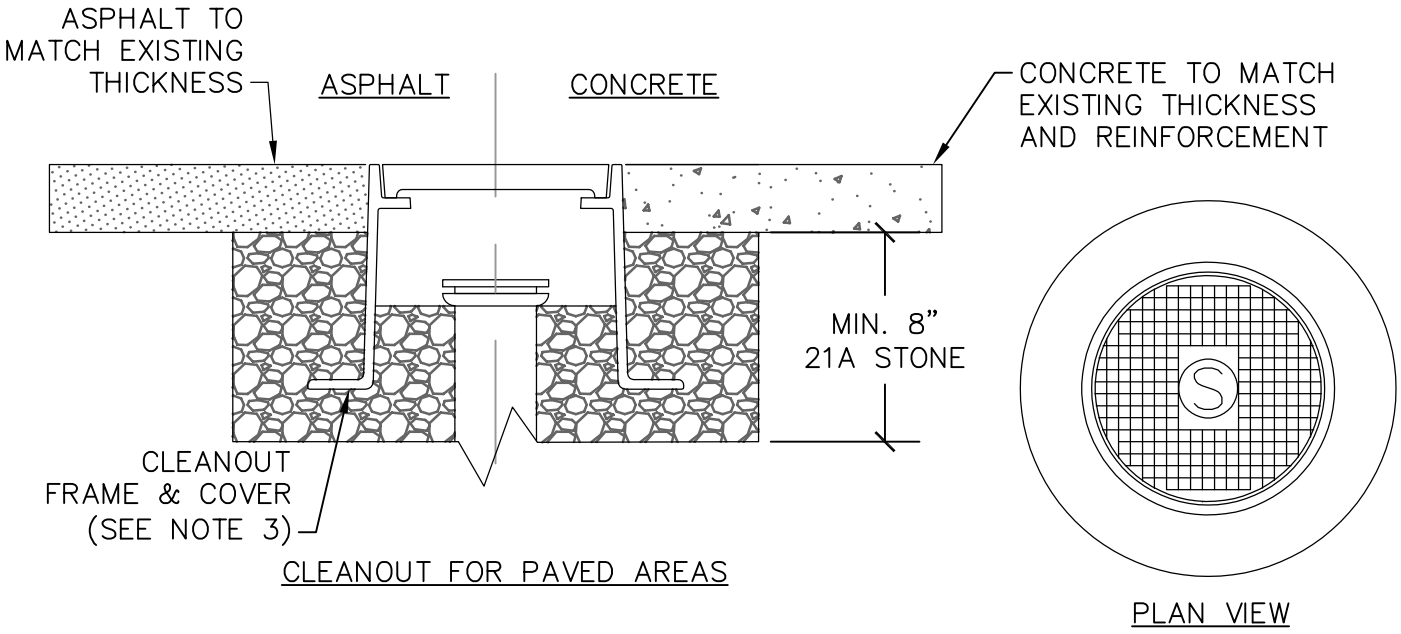
NOTES:

1. SIDES AND BOTTOM OF CONCRETE ANCHOR TO BE POURED AGAINST UNDISTURBED EARTH.

2. SPACING FOR ANCHORS:
   SLOPES: 20%–30% – EVERY 2 LENGTHS OF PIPE
   35%–50% – EVERY 1 1/2 LENGTHS OF PIPE
   OVER 50% – EVERY LENGTH OF PIPE

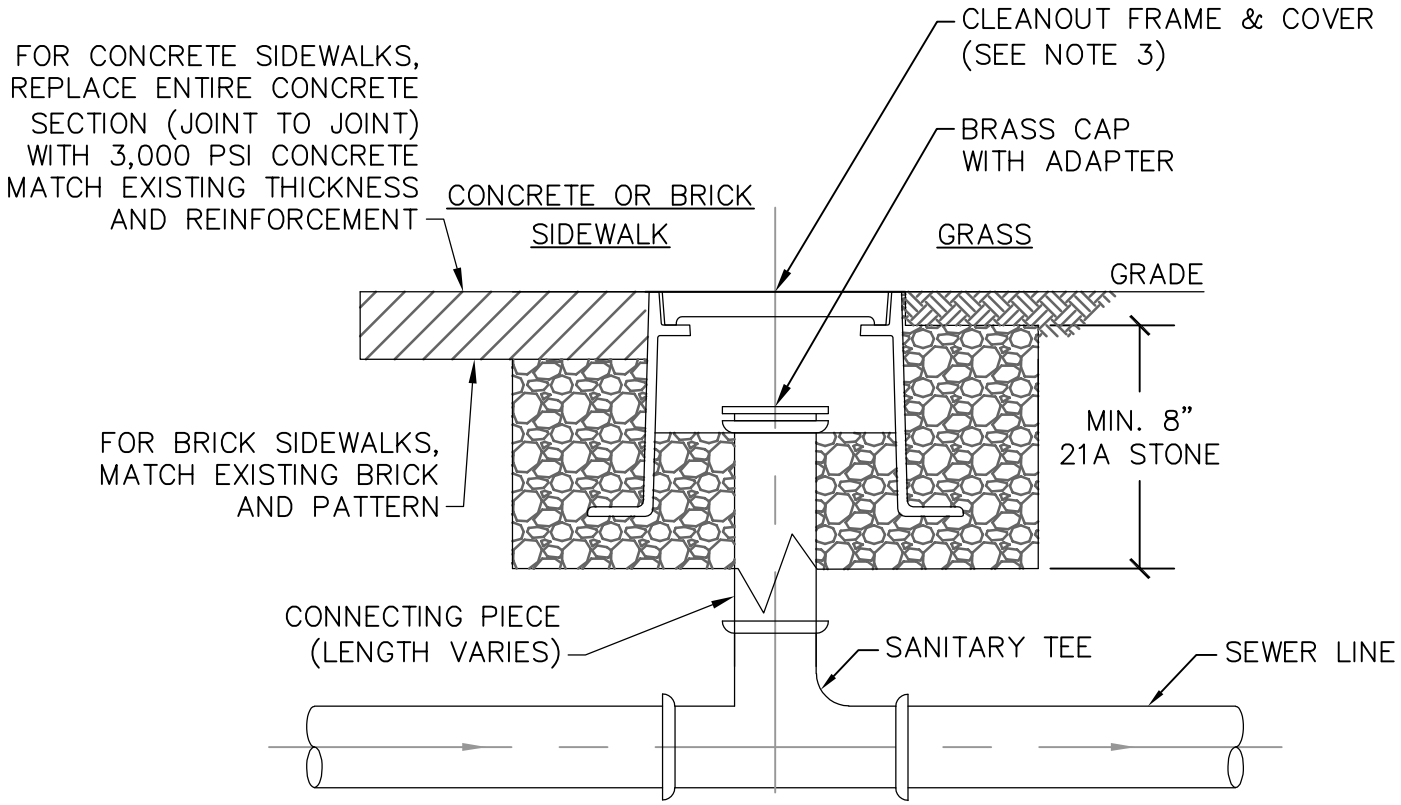
3. CONTACT DPU FOR REINFORCEMENT DETAILS.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA SEWER ANCHORAGE IN SLOPES GREATER THAN 20% NOT TO SCALE	REV. 12/09 P–6



CLEANOUT FOR PAVED AREAS

PLAN VIEW

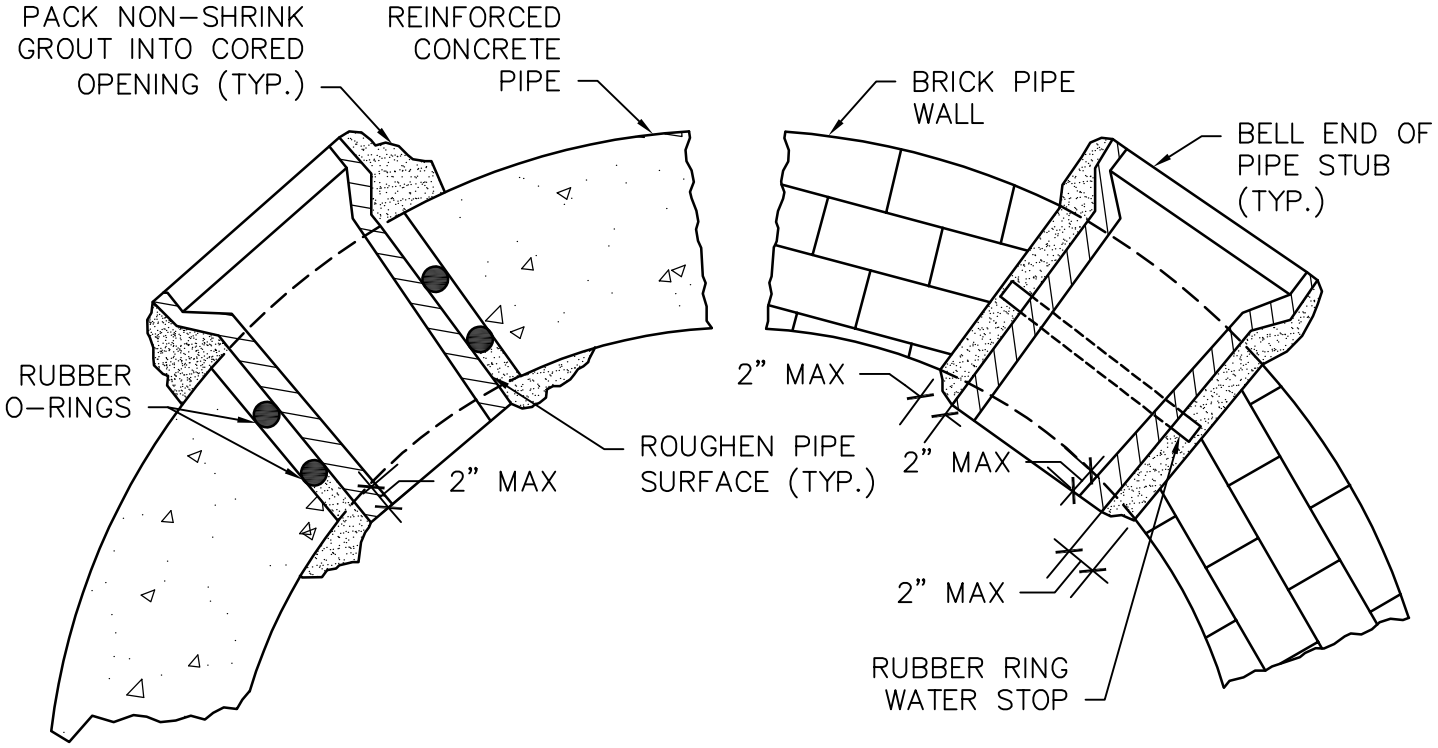


CLEANOUT FOR SIDEWALKS AND UNPAVED AREAS

NOTES:

1. CLEANOUT CAP SHALL BE BRASS.
2. CLEANOUT SHALL BE 6" OR LARGER UNLESS OTHERWISE APPROVED BY DPU DEPUTY DIRECTOR OR DESIGNEE.
3. IF CLEANOUT IS OUTSIDE OF RIGHT-OF-WAY, PROVIDE STANDARD CLEANOUT FRAME AND COVER (CAPITAL FOUNDRY PCO-1*MOD OR APPROVED EQUAL). IF CLEANOUT IS IN RIGHT-OF-WAY, PROVIDE A TRAFFIC RATED CLEANOUT FRAME AND COVER (CAPITOL FOUNDRY VB-9*S OR APPROVED EQUAL).
4. ENSURE PIPE IS NOT ENCASED IN CONCRETE.

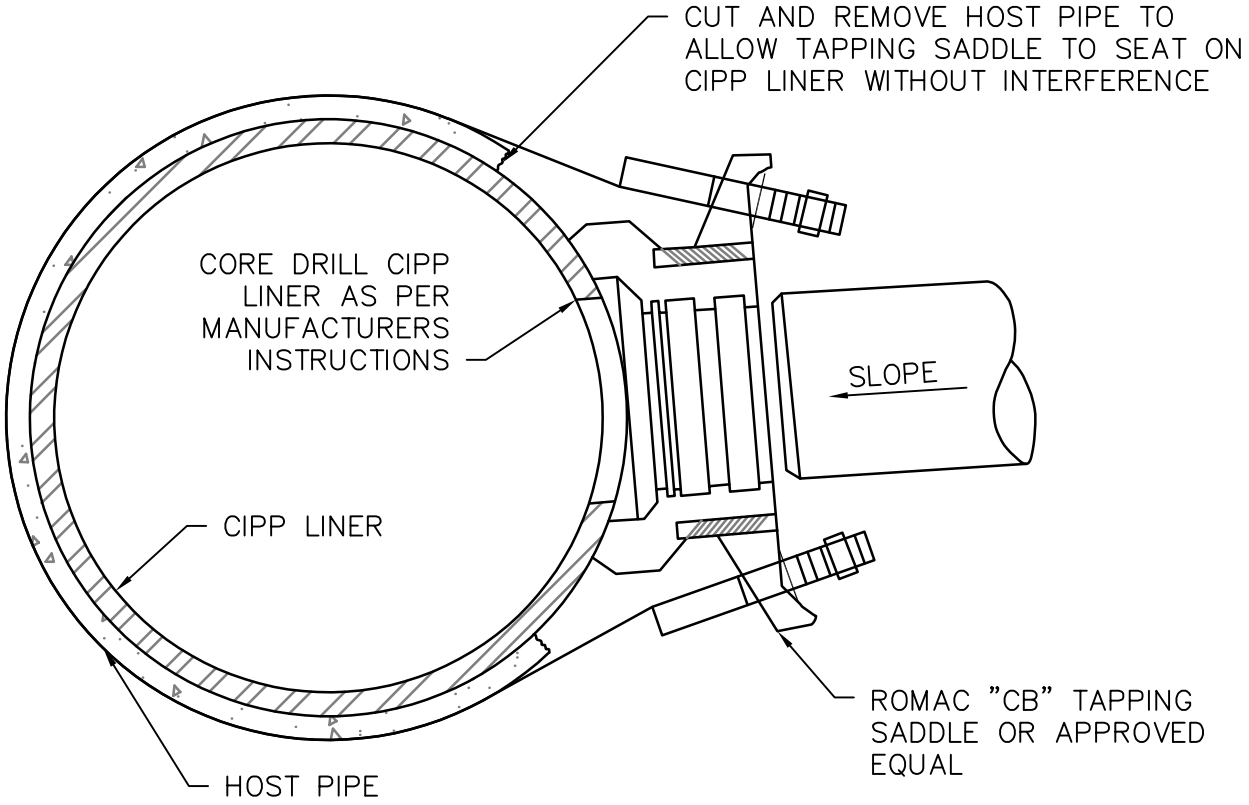
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA CLEANOUT NOT TO SCALE	REV. 02/18 P-7



NOTES:

1. STUB CONNECTION TO EXISTING SEWER IS APPLICABLE FOR REINFORCED CONCRETE OR BRICK.
2. OPENING SHALL BE FORMED BY CORE DRILL, UNLESS APPROVED OTHERWISE BY RICHMOND DPU PERSONNEL.
3. FOR BRICK PIPE, MAX OPENING SHALL BE O.D. PLUS 4" IF CUT IN FIELD.

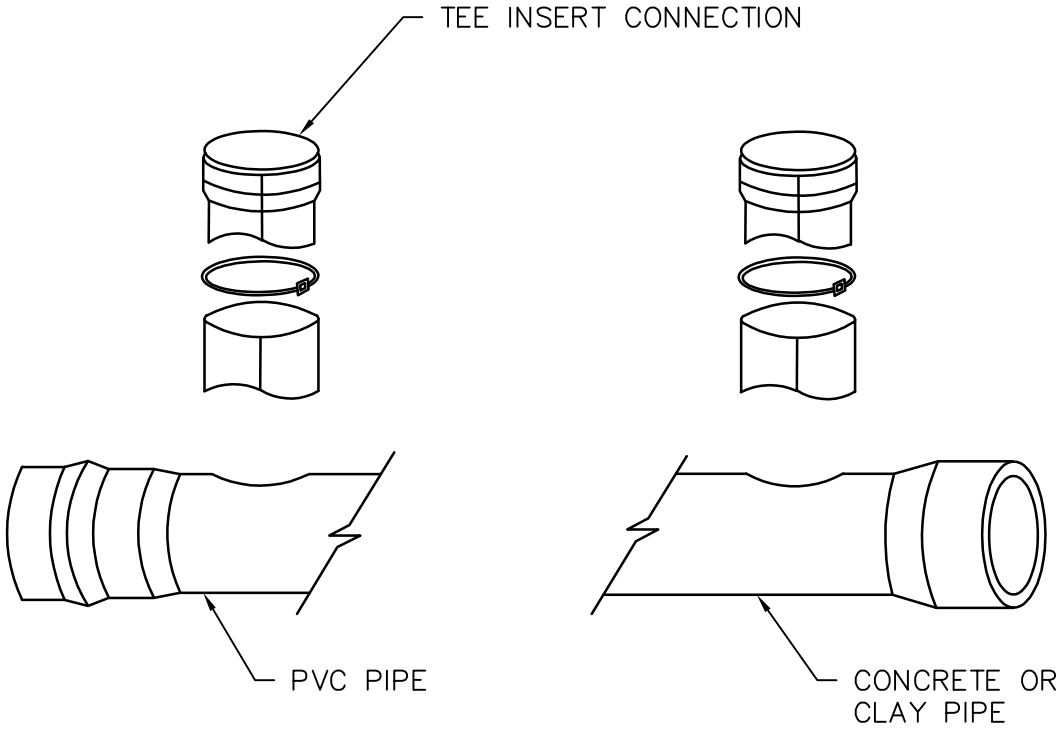
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA STUB CONNECTION TO EXISTING SEWER NOT TO SCALE	REV. 02/18 P-8



NOTES:

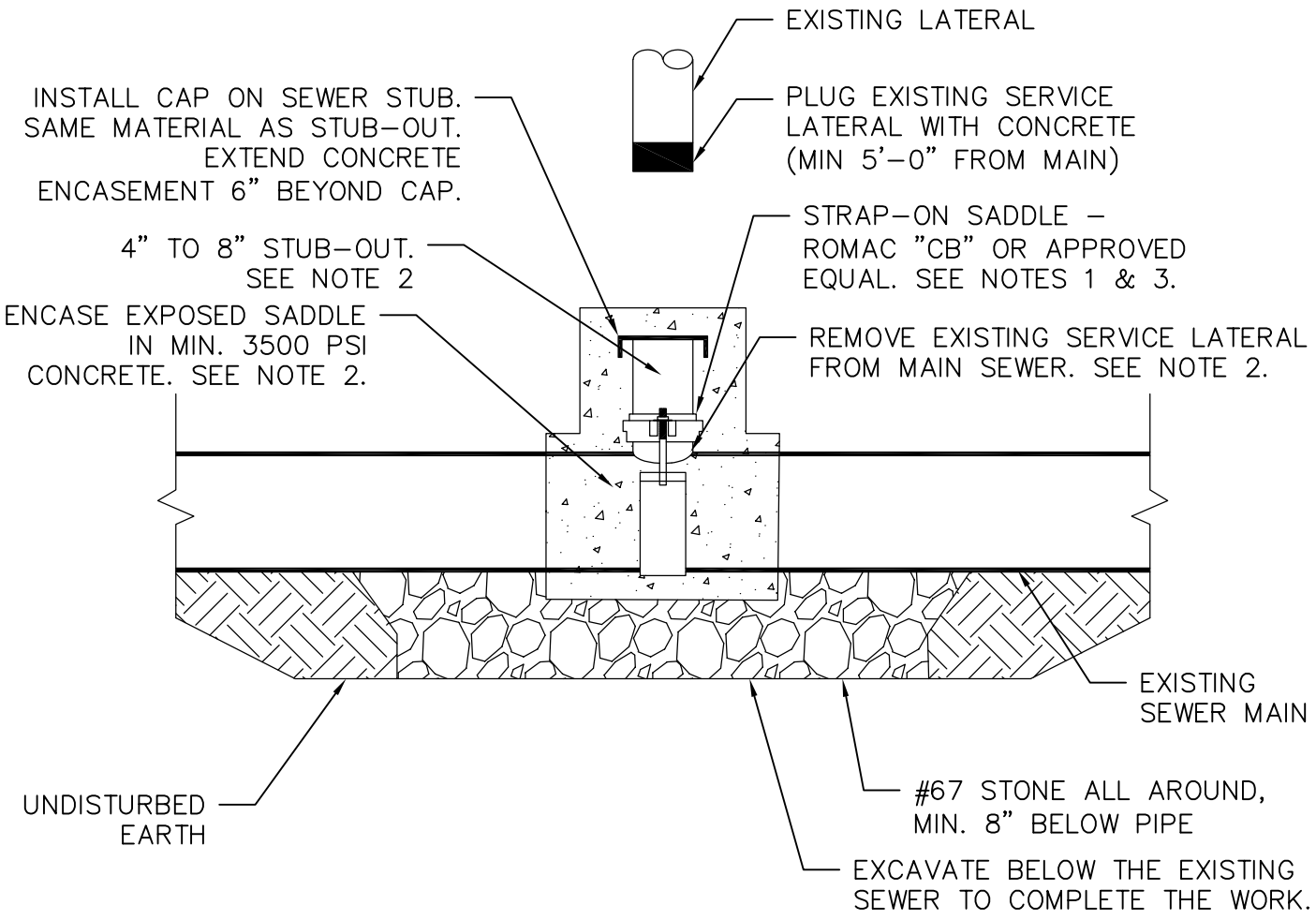
1. NOTIFY OWNER BEFORE INTERRUPTING SERVICE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA NEW CONNECTION TO EXISTING CIPP–LINED PIPE NOT TO SCALE	REV. 02/18 P–9



NOTES:
1. INSTALL TEE INSERTS ACCORDING TO MANUFACTURER'S RECOMMENDATIONS.
2. NOTIFY ALL AFFECTED PARTIES BEFORE INTERRUPTING SERVICE.
3. ENSURE TEE INSERT IS COMPATIBLE WITH BOTH THE PIPE BEING TAPPED AND WITH LATERAL LINE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA TEE INSERT CONNECTION NOT TO SCALE	REV. 04/17 P–10



NOTES:

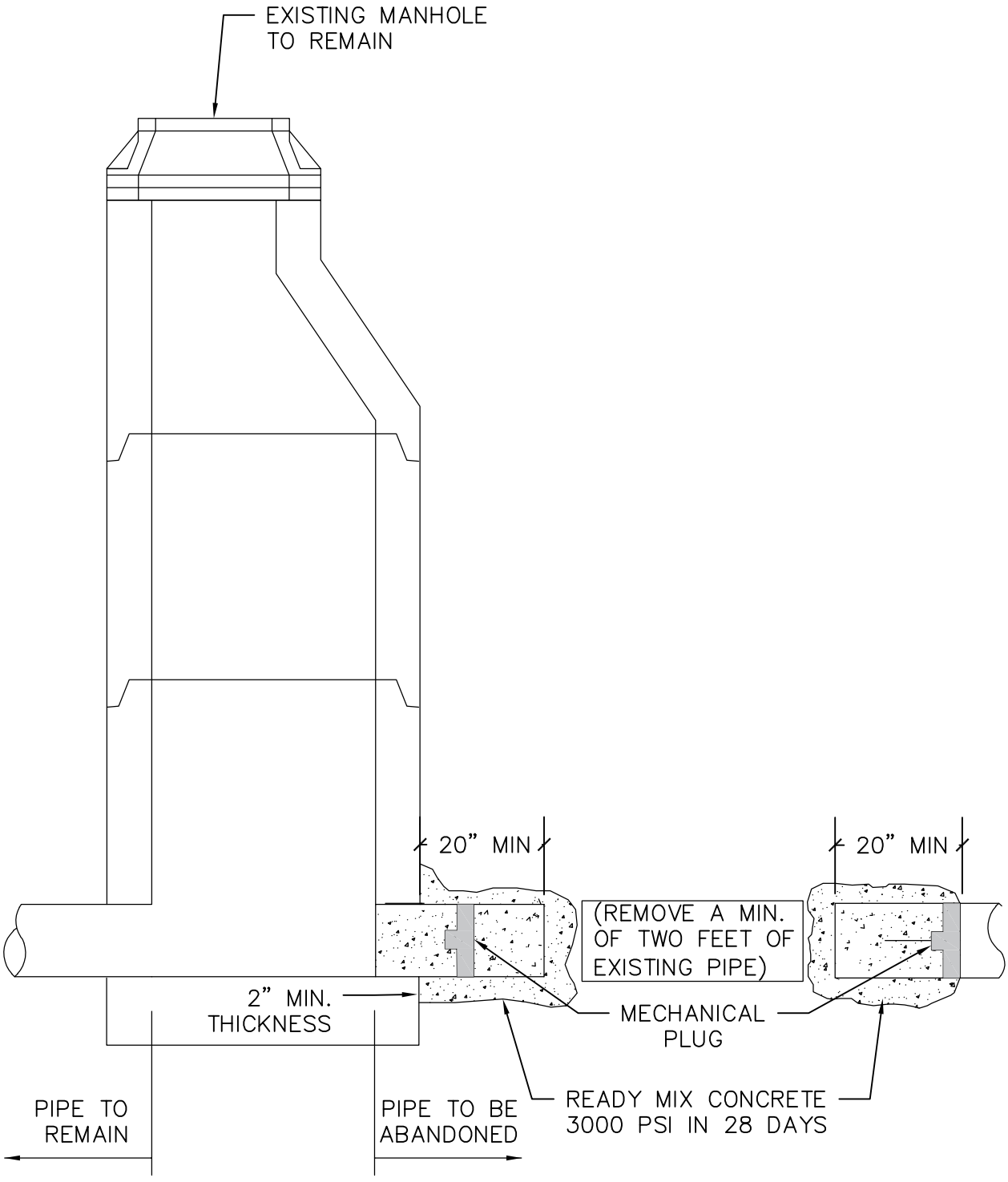
1. REFER TO THIS DETAIL WHEN ABANDONING EXISTING SERVICE LATERALS. SERVICE LATERALS SHALL BE ABANDONED WHEN A NEW LATERAL IS BEING INSTALLED TO SERVE A PROPERTY AND THE NEW LATERAL IS BEING CONNECTED TO THE MAIN SEWER AT A DIFFERENT LOCATION, A BUILDING IS BEING DEMOLISHED, OR AS DIRECTED BY THE UTILITIES ENGINEER. CONTACT DPU A MINIMUM OF 48 HOURS IN ADVANCE FOR INSPECTION PRIOR TO BACKFILL.

2. TO ABANDON THE EXISTING SERVICE LATERAL AT THE MAIN SEWER, CAREFULLY REMOVE THE LATERAL FROM THE MAIN SEWER, CUT THE EXISTING LATERAL AT LEAST 5' FROM THE MAIN SEWER, PLUG THE REMAINING PIPE END WITH CONCRETE, INSTALL A SADDLE AND 4" TO 8" LONG STUB–OUT. INSTALL A CAP ON THE STUB–OUT AND ENCASE THE SADDLE, STUB–OUT AND CAP IN MIN. 3500 PSI CONCRETE – ENCASEMENT TO EXTEND 8" EACH SIDE OF THE LATERAL/SADDLE AND 6" BEYOND THE CAP. BACKFILL AS SPECIFIED.

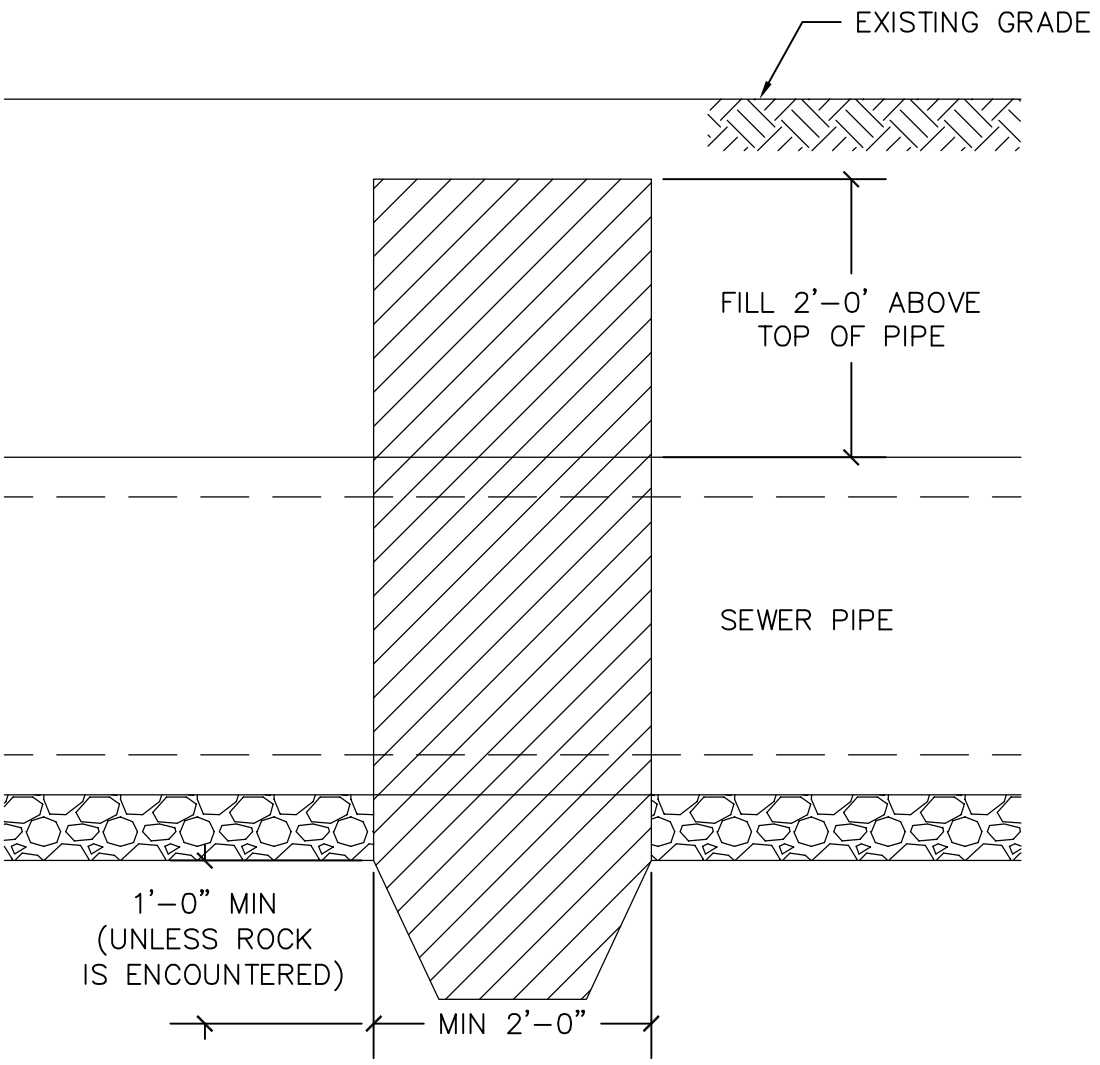
3. SUPPORT THE EXISTING SEWER DURING THIS WORK.

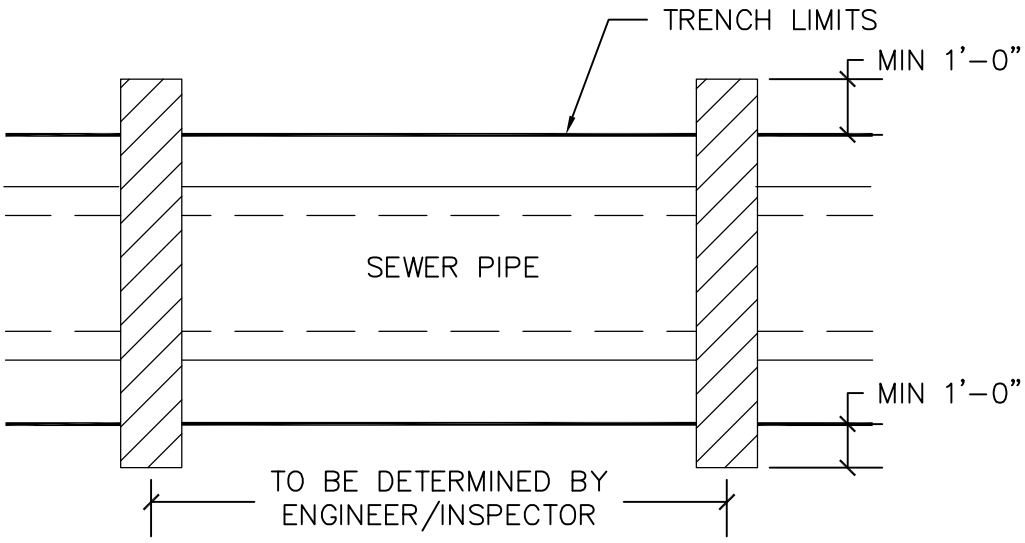
4. IF EXISTING SADDLE IS PRESENT, REUSE EXISTING SADDLE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA LATERAL ABANDONMENT NOT TO SCALE	REV. 12/21 P–11



DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA PIPE ABANDONMENT NOT TO SCALE	REV. 12/21 P–12





PLAN VIEW

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA CLAY DAM NOT TO SCALE	REV. 12/21 P–13

DEPARTMENT OF PUBLIC UTILITIES

PVC PIPE AIR PRESSURE TEST TABLE

CITY OF RICHMOND, VIRGINIA

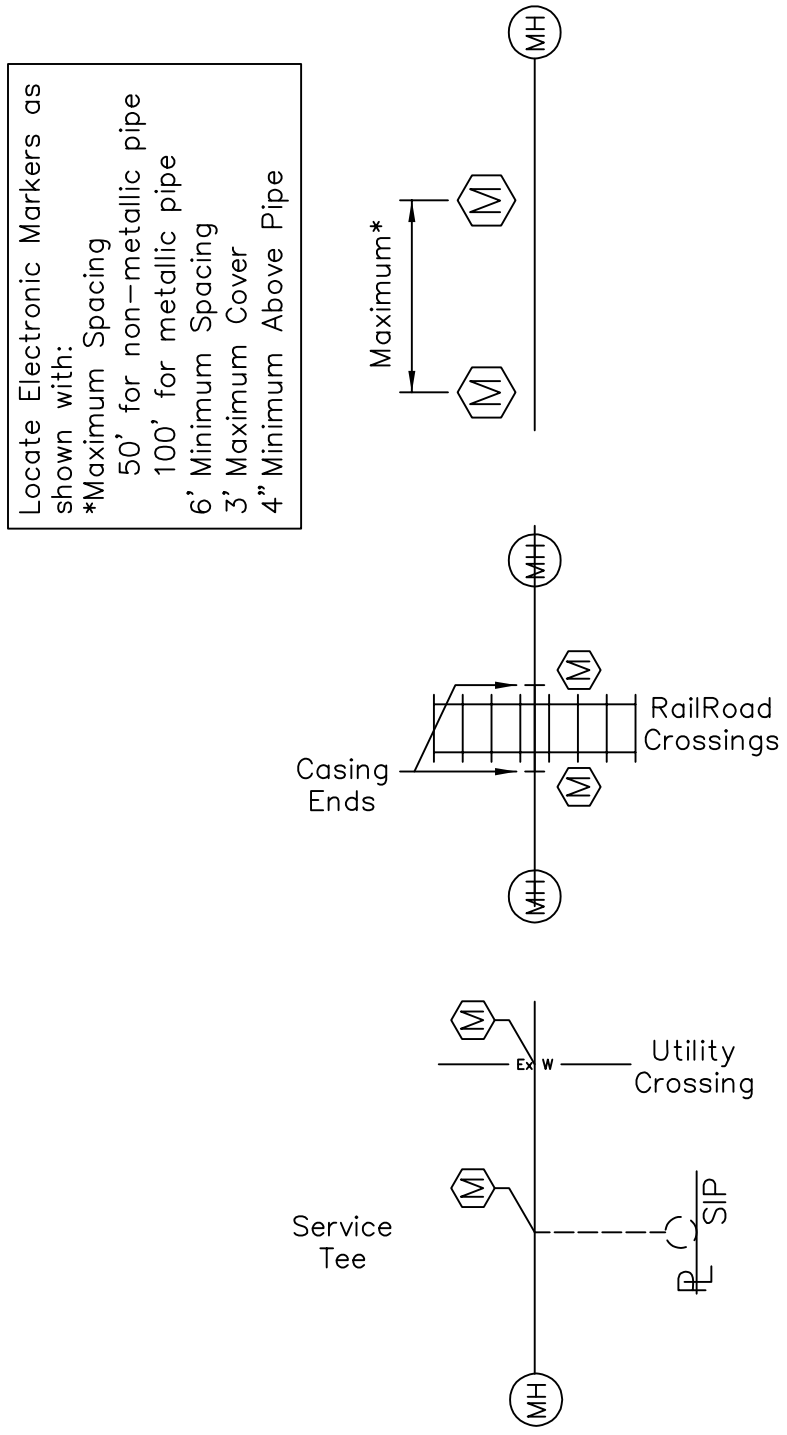
NOT TO SCALE

PIPE DIAMETER (IN)	MIN TIME MIN: SEC	LENGTH FOR MIN TIME (FT)	TIME FOR LONGER LENGTH (S)	SPECIFICATION TIME FOR LENGTH IN FEET (MIN: SEC)							
				100	150	200	250	300	350	400	450
4	3: 46	597	0.380 L	3: 46	3: 46	3: 46	3: 46	3: 46	3: 46	3: 46	3: 46
6	5: 40	398	0.854 L	5: 40	5: 40	5: 40	5: 40	5: 40	5: 40	5: 42	6: 24
8	7: 34	298	1.520 L	7: 34	7: 34	7: 34	7: 34	7: 36	8: 52	10: 08	11: 24
10	9: 26	239	2.374 L	9: 26	9: 26	9: 26	9: 53	11: 52	13: 51	15: 49	17: 48
12	11: 20	199	3.418 L	11: 20	11: 20	11: 24	14: 15	17: 05	19: 56	22: 47	25: 38
15	14: 10	159	5.342 L	14: 10	14: 10	17: 48	22: 15	26: 42	31: 09	35: 36	40: 04
18	17: 00	133	7.692 L	17: 00	19: 13	25: 38	32: 03	38: 27	44: 52	51: 16	57: 41
21	19: 50	114	10.470 L	19: 50	26: 10	34: 54	43: 37	52: 21	61: 00	69: 48	78: 31
24	22: 40	99	13.674 L	22: 47	34: 11	45: 34	56: 58	68: 22	79: 46	91: 10	102: 33
27	25: 30	88	17.306 L	28: 51	43: 16	57: 41	72: 07	86: 32	100: 57	115: 22	129: 48
30	28: 20	80	21.366 L	35: 37	53: 25	71: 13	89: 02	106: 50	124: 38	142: 26	160: 15
33	31: 10	72	25.852 L	43: 05	64: 38	86: 10	107: 43	129: 16	150: 43	172: 21	193: 53
36	34: 00	66	30.768 L	51: 17	76: 55	102: 34	128: 12	153: 50	179: 29	205: 07	230: 46
42	39: 48	57	41.883 L	69: 48	104: 42	139: 37	174: 30	209: 24	244: 19	279: 19	314: 07
48	45: 34	50	54.705 L	91: 10	136: 45	182: 21	227: 55	273: 31	319: 06	364: 42	410: 17
54	51: 02	44	69.236 L	115: 24	173: 05	230: 47	288: 29	346: 11	403: 53	461: 34	519: 16
60	56: 40	40	85.476 L	142: 28	213: 41	284: 55	356: 09	427: 23	498: 37	569: 50	641: 04

NOTES:

1. TABLE BASED ON ASTM F1417–11A (2015).
2. TESTING SHALL BE DONE IN ACCORDANCE WITH ASTM F1417–11A (2015).
3. VALUES BASE ON MINIMUM TIME FOR 1.0 PSIG PRESSURE DROP

Locate Electronic Markers as shown with:
*Maximum Spacing
50' for non-metallic pipe
100' for metallic pipe
6' Minimum Spacing
3' Maximum Cover
4" Minimum Above Pipe



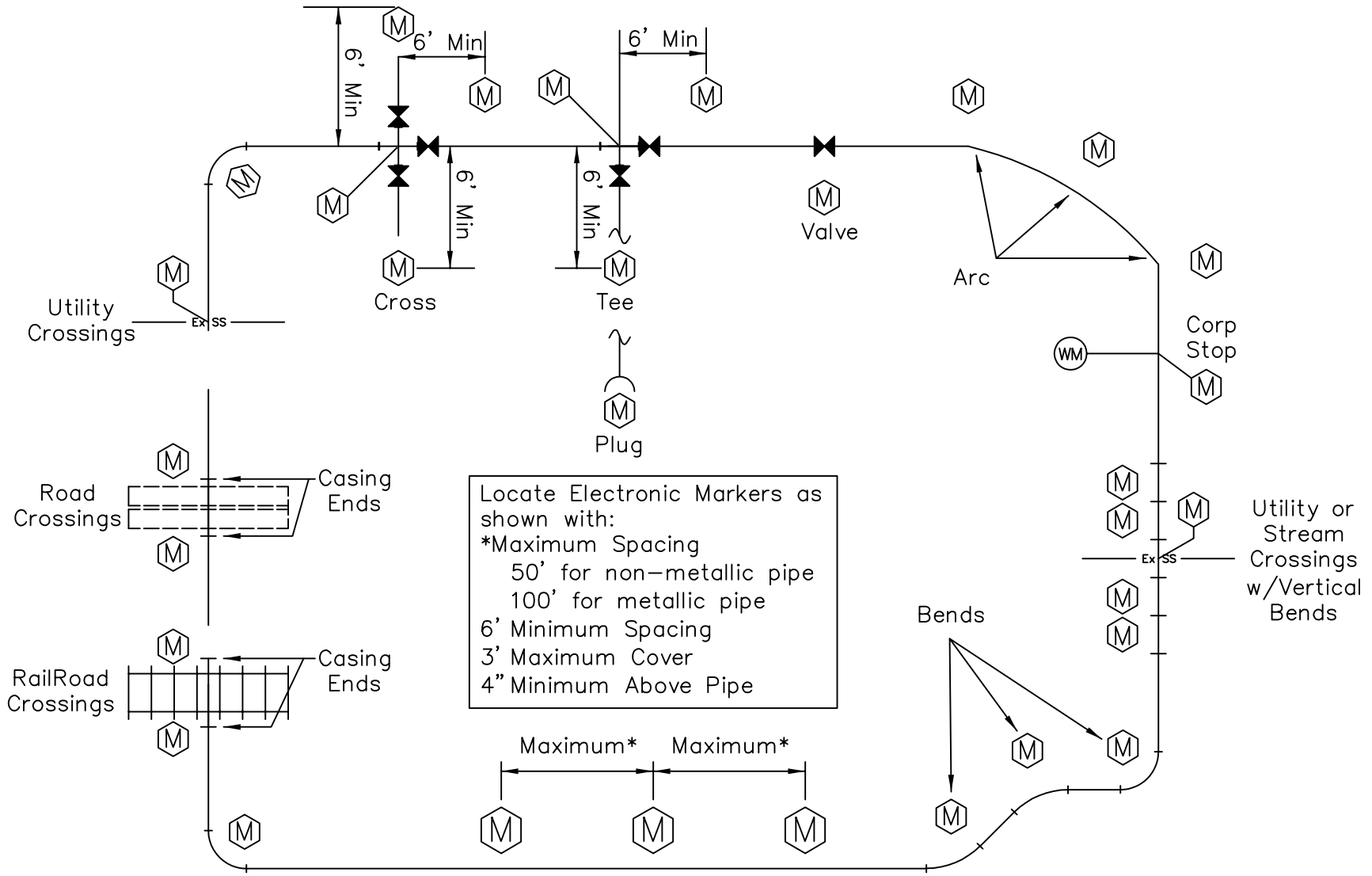
DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA ELECTRONIC MARKER PLACEMENT FOR GRAVITY SEWER NOT TO SCALE	REV. 12/21 P-15

DEPARTMENT OF PUBLIC UTILITIES

CITY OF RICHMOND, VIRGINIA

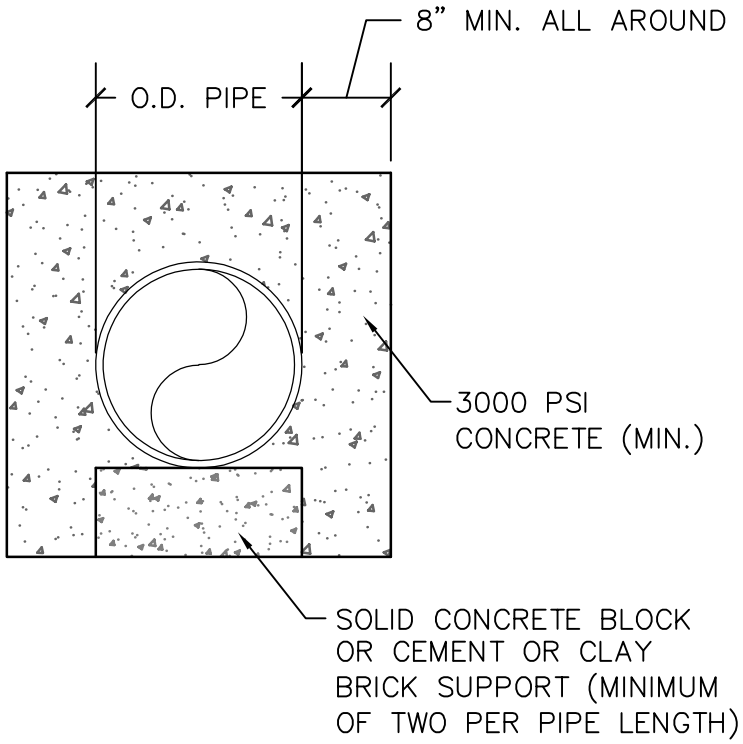
ELECTRONIC MARKER PLACEMENT FOR PRESSURE MAINS

NOT TO SCALE



REV. 12/21

P-16



NOTE:

1. SHALL ONLY BE USED WITH PRIOR WRITTEN APPROVAL BY DPU DEPUTY DIRECTOR OR DESIGNEE.

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA PIPE ENCASEMENT NOT TO SCALE	REV. 12/09 A–1

APPENDICES

CITY OF RICHMOND
DEPARTMENT OF PUBLIC UTILITIES
SEWER DESIGN GUIDELINES

LIST OF APPENDICES

APPENDIX A

ENGINEERING REPORT (SEE SECTION 1.1.2)

PROJECT _____

LOCATION _____ SPS (BASIN) _____

USE _____ ACREAGE _____

EQUIVALENT POPULATION_____ POPULATION DENSITY _____

IS PROJECT PHASED YES NO (CIRCLE ONE)

SANITARY SEWER DESIGN:

DESIGN BASIS _____ SOURCE_____

NUMBER OF UNITS _____

AVERAGE DESIGN FLOW (ON-SITE) _____

OFF-SITE FLOW CONTRIBUTION (AVERAGE) _____

AVERAGE DESIGN FLOW (TOTAL)_____

PEAK FLOW _____ PEAKING FACTOR _____

DOWNSTREAM MH: SEWER SHEET _____ MANHOLE NUMBER _____

ATTACH FLOW ANALYSIS CALCULATION
ATTACHE SEWER LAYOUT MAP

SEWAGE PUMPING STATIONS AND FORCE MAINS:

A MEETING WITH THE DEPARTMENT OF PUBLIC UTILITIES IS REQUIRED TO DETERMINE THE REQUIREMENTS FOR ASSESSMENT OF THE SERVICE AREA AND SCOPE OF THIS ENGINEERING REPORT.

CERTIFICATION:

I HEREBY CERTIFY THAT THIS ENGINEERING REPORT AND ATTACHED CALCULATIONS HAVE BEEN PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

_____ _____
Signature Certificate Number

_____ _____
Name Typed or Printed Date

APPENDIX B (SEE SECTION 2.2.3)

Manhole #		Area (Acres)		Population Density of Area	Domestic Flow (MGD)		Industrial Flow (MGD)			Population	Total Flow Maximum		Length in Feet	Slope (%)	Type of Pipe		Diameter of Pipe	Capacity of Pipe (Full)						Velocity Feet/Sec			Elevation of		Remarks
From	To		Total		Average Daily For Year	Peak Flow Factor	Peak Flow	Average	Maximum		MGD	CFS						MGD	CFS								Upper End	Lower End	
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

APPENDIX C

ENGINEERS CHECKLIST FOR SEWER PLANS

I. Title Page

A. _____ Engineer's or Class B Surveyor's Seal and Signature

B. _____ Project Name

C. _____ Vicinity Sketch (complete in detail)

D. _____ Table of Estimated Quantities (including breakdown of type of pipe)

E. _____ Title Block

F. _____ Tax Map and Parcel Numbers

G. _____ Council District

H. _____ Name, Address, and Phone Number of Developer/Owner.

I. _____ Legend of sanitary sewer lines, other utilities and structures existing and proposed ground and pavement profile. Profile information must be shown on profile sheet.

J. _____ Certification statement of the lot numbers, block letters/numbers and road names, etc. from City Assessors Office

II. General

A. _____ The utility plan includes an overall plan of the sewer layout, including any phasing of the development

B. _____ A subdivision plat indexed to sheet numbers.

C. _____ Engineer and/or Surveyor has notified all property owners prior to performing any design and/or surveying work (copy of such notification is attached).

III. Standards

A. _____ Sewer Notes (as a minimum., reference has been made to City specifications and details)

B. _____ Vertical scale is 1" = 5' or 1" = 10'; and horizontal scale is 1"=50' or as approved by the City. A "bar" scale is shown on each sheet.

C. All sewer designs conform to the latest City, State and Federal regulations or standards.

D. Plan and Profile sheets are on 24" x 36" paper.

E. Scale drawings are accurate to within +/- 2% for vertical and horizontal scales.

IV. Plans

A. Utility Plans

1. All water, sewer, road, and drainage structures are shown on one plan sheet, where applicable. May require larger scale to adequately obtain horizontal integrity.

2. All plans include:

a. Existing water and/or sewer lines are properly labeled with size and with horizontal and vertical distances referenced on the plan.

b. A bench mark is required on the site plan. Identify the horizontal and vertical datum used.

c. Horizontal and vertical scale shown on each sheet.

d. All existing easements are shown accurately and proposed utility easements are shown on plans. The existing easements reflect accurate recordation information.

e. All existing and proposed storm sewer lines, gas, telephone, power, and other utility lines, which cross or rim parallel to the sewer lines are shown with exact horizontal and vertical separations given, where applicable. Subsurface exploration has been performed where potential conflicts exist, where applicable.

f. Adjacent road and drainage projects are shown as required.

g. Consideration has been given to areas where roads and drainage structures may be lowered in the future.

h. Road names, state route numbers, and right-of-way widths are shown.

i. Plan and profile are drawn in the same direction. Stations will ascend from left to right.

j. Proposed sewer lines are shown with reference distances from right of way, boundary, buildings, other utility lines, etc.

k. All property lines and property markers (stones, rods, pins, pipes, monuments, etc.) are shown.

l. ___ Location of existing houses, buildings, fences, wells and other structures are shown on plans. In lawn or kept areas, trees and shrubs in the easements are shown (size and type).

m. ___ All designs conform to the latest City and State erosion control and sedimentation rules, regulations and ordinances.

n. ___ The engineer understands that he/she is responsible for coordinating the utility design and construction work with other engineers where their projects connect or are affected by other projects.

o. ___ Locations of special features (conc. Encasement, rip-rap, stabilization at creek crossings, clay dams, etc.).

p. ___ Detail drawings of all stream crossings and storm sewer outlets, with elevations of the stream bed and high (100 year flood elevation) and normal water elevations.

q. ___ Proper labeling of subdivision (lot, block, street names, subdivision boundaries, etc.).

r. ___ Adjacent property owner name(s) are shown on plans.

s. ___ All fill and cut areas are shown within the area of the existing and proposed sewer lines.

t. ___ Necessary easement plats onsite and/or offsite have been submitted for processing.

u. ___ Pavement replacement detail, boring detail, etc. are shown on all plans.

v. ___ Location and dimensions of all sewer service connections are shown.

w. ___ Proposed, existing, and original ground elevations are shown.

x. ___ Municipal, subdivision and/or drainage area boundaries are shown.

y. ___ North Arrow is reflected on all plan sheets. Identify source and reference used.

z. ___ Miss Utility notation is shown.

aa. ___ Engineer understands that any changes made to the sewer design will require a submittal to the Department of Public Utilities for review and approval of the revised sewer plans reflecting those changes.

bb. ___ All revisions include an explanation either on the plans or by separate transmittal.

cc.___ Plans have been submitted to the adjoining municipality for review and approval where applicable. A copy of the transmittal letter is attached to the checklist.

dd.___ If horizontal bore is required, bore location, length of bore, pit location (average 8' x 35') are shown and shown in relation to all existing and/or proposed utilities on plan and profile.

ee.___ Alignment of utility in existing VDOT right of way is consistent with City guidelines. A copy of a transmittal letter to VDOT for their review is attached. Engineer understands that letter of approval from VDOT is required prior to final utility plan approval.

ff.___ Clay dams or other acceptable designs are shown at the appropriate locations to avoid water from creek and/or lake being diverted along pipe bedding.

gg.___ Engineer has contacted Virginia Power to obtain exact location of power lines and received as-built information. Utility plans reflect this information and is in accordance with the "Overhead High Voltage Line Safety Act".

3. Sanitary Sewer Plans

a.___ All sanitary sewer plans are labeled with size, grade, length, direction of flow, and type & class of pipes (with backup calculations on the type & class pipe needed, where applicable).

b.___ Manholes are labeled with top and invert elevations; coordinates; and locations, size and inverts of drop stacks when a vertical drop exceeds 2 feet.

c.___ Deflection angles at all manholes or bearings of all lines are shown on the plans.

d.___ All minimum finished floor elevations and basement elevations are to be shown on plans, where applicable.

e.___ A sewerage drainage area map with hydraulic analysis is included in plans.

f.___ The engineer has field verified the inverts of the existing manhole(s). Where invert elevations are different from the as-built plan, the engineer has verified his survey work and notified the Department of Utilities of the discrepancy.

g.___ All manholes are designed to an elevation above the 100 year flood plain elevation as set forth in the design standards, unless otherwise approved by the Department of Public Utilities.

h.___ Reference all manholes in easements.

i.___ Ground coverage over sewer pipe meets minimum criteria.

j.___ Engineer has put a notation that a backwater valve is to be used where the building with a finished floor elevation of the building is below the top elevation of the nearest upgrade manhole from the building connection.

k.___ Where the sewer lines are in excess of 15' deep, the Engineer has identified where the sewer lateral must be installed in accordance with the standard details and the appropriate notes are reflected on the plans.

l.___ A NOTE stating that the contractor must field verify the inverts of all existing manholes, gas lines, other utility lines prior to the start of construction.

m.___ All "%" slopes are divisible by 4 to the nearest hundredth where possible.

n.___ Greater than 0.4% minimum slope has been used whenever possible.

o.___ Solid lines have been used for proposed sewers, short dashed lines for existing sewer and labeled future sewer or portions covered under other phases of construction.

p.___ A minimum of ten (10) feet horizontal separation is maintained between sewer lines, sewer laterals and water meters or water blow-off devices (flushing hydrants) and between sewer line and storm drainage structures.

q.___ All calculations have been checked for accuracy.

r.___ All pipes between manholes are of like material and class.

s.___ All temporary and/or permanent silt basins are shown and the sewer lines and manholes have been designed around these structures.

t.___ All existing sewer laterals are shown on the plans, with station, length and depth, as depicted on the as built plans.

u.___ All sewer lines are designed with the entry into the manhole by the proposed sewer lines at an angle of 90 degrees or greater to the downstream line, or if an exception has been granted, the engineer has increased the drop through the manhole to compensate for the reduced angle and has provided a blowup detail for the appropriate invert shaping that achieves the same results as a 90 degrees or greater entry.

v.___ The crowns of all sewer lines enter the manholes at crown's level or higher as specified in the design standards.

w.___ Whenever connecting sewer lateral to an existing sewer line, Engineer has put on the plans the proper notation that "the contractor must use a mechanical hole cutter when tapping the existing sewer line and that an approved saddle shall be used and the appropriate lots affected by this have been identified in the note.

x.___ Where new manholes are proposed over existing lines, distance from the new manhole to the two existing manholes is shown; inverts of the manhole and each existing manhole are shown; slope of existing line from new manhole to upstream and downstream existing manholes is shown.

y.___ Where future extensions are necessary, these lines are reflected on the plan.

z.___ All manholes proposed within areas where vehicles travel are to be located either on center line of road or center of traveling lane.

aa.___ Sampling manholes are required for new facilities currently regulated by local or federal industrial waste pretreatment laws. Examples of these commercial facilities include restaurants, car washes, auto repair shops, and laundromats to name a few. Appropriate measures have been included in the design to allow for sampling of industrial waste. A sampling manhole shall be provided at the property line to facilitate random 24-hour composite sampling. In those cases where a private manhole on site can be utilized for this function, adequate provisions will be agreed upon to facilitate sampling. Provisions include ingress/egress to the private manhole, ability to sample, and adequate space to set a 24-hour composite sampler. Existing on site manholes, possibly inside buildings, will be approved on a case by case basis.

bb.___ At all existing manholes, the engineer has identified the manhole number as shown on the City's/DPU's GIS or as assigned by DPU.

Date: _____.

Engineering Firm: _____.

Engineer's Name: _____.

APPENDIX D

REVIEW PROCEDURES FOR SEWER PLANS
(Developer Projects)

Prior to construction of public sewer facilities and issuance of any building permits, sewer plans must be submitted to and approved by the Department of Public Utilities.

1. It is required for sewer projects that the engineer arranges a meeting with the Department of Public Utilities to discuss the approach to be taken to obtain sewer service. All sewer systems must be sized properly and the location designed to provide sewer availability to the entire service area. An overall sewer plan shall be submitted for development.

2. The engineer is required to submit three (3) sets of sewer plans directly to the Department of Public Utilities for review and approval. The submittal of a site plan through the Planning Department is not sufficient for review of the extension and/or relocation of the sewer systems, therefore, sewer plans are required to be submitted prior to or at the same time site plans are submitted to the planning Department.

3. The sewer plans must be designed by a Professional Engineer in Civil Engineering or Professional Surveyor with a Class B license who is registered by the State of Virginia- The plans must conform to the City's latest overall sewer master plan and the Engineers Checklist for Water and Sewer Plans (see Appendix 4).

4. Prior to approving the sewer plans, the Department of Public Utilities must approve the erosion control plan for sanitary sewer installations.

5. The engineer shall coordinate the location of all proposed sewer lines within all existing and proposed road rights-of-way with regard to existing and proposed roads and drainage structures. In addition, coordination shall be made with other appropriate utility companies and agencies, i.e., Virginia Power, C&P, gas companies, railroad rights-of-way, VDOT, State Health Department, etc. with regard to their existing easements, rights-of-way, and facilities.

6. The engineer must submit a copy of the checklist with his/her certification that the plans reflect all applicable items on the checklist. The plans will be reviewed and a review letter will be sent to the engineer with a copy to the developer. When the revisions are made, the engineer must resubmit the plans for final review. A letter of approval will be sent when all the City criteria are met. Four sets of additional plans shall be sent once all the approvals are granted for construction purposes.

7. The contractor must give the applicable Inspection office at least 48 hours notice before construction may begin. After receipt of a work in street permit, a preconstruction meeting shall be scheduled by the contractor with the applicable Inspection office.

APPENDIX E

SITE PLAN REQUIREMENTS FOR SEWER MAIN LINE EXTENSIONS

1. The location of the existing sewer main must be shown on the site plan. Existing easement must be shown on the site plan.
2. The exact location of the existing sewer (lateral) connection must be shown, making referenced to the length, depth and station location of the sewer lateral and the relationship of the sewer services and appurtenances with the existing, proposed and future buildings, etc.
3. Sewer main extensions located within the site property limits shall be reviewed by Department of Public Utilities to determine the need for a public sewer easement. A sewer installation on the site serving one owner/parcel is anticipated to be private sewer and therefore no public utility easement would be required. A sewer installation serving additional properties beyond the site or serving more than one owner on the site is anticipated to require a public utility easement. Proposed sewer line easements must be shown on the site plan and Engineer needs to make sure there are no buildings or other permanent structures encroaching onto easements. Also, if there are any other type of structures and/or activities proposed, i.e., storm sewers, retaining walls, grading, curb and gutter, concrete paving, obstacles (garbage pads, light posts, and other utility lines), etc. the Engineer shall make site design changes and take appropriate measures to protect existing water and/or sewer line and appurtenances.
4. Proposed plumbing from building to sewer connection must be shown.
5. When the site plan reflects the installation of a new sewer connection, the appropriate notes outlining the Utilities Department's requirements for installing a connection must be shown on the plan. The point where the utilities contractor stops his work and the plumber begins needs to be clearly denoted on the plan.
6. Site plan needs to clearly reflect the proposed "Fill" and "Cut" areas. Engineer is to analyze how it will affect the existing and/or proposed sewers and submit his evaluation and recommendation with the site plan in writing for review and approval by the Department of Public Utilities.
7. Adjustment of any privately owned sewer appurtenances will require notes, i.e., notifying the Bureau of Permits and Inspections at 804-646-6955 to inspect any adjustments, that an acceptable licensed Utilities Contractor perform all utility work, etc.
8. Engineer must be aware of where proposed and future sewer extensions are needed and show this information on the plans and reflect sufficient easement width for future water and/or sewer extensions. A separate easement plat needs to be submitted to the Department of Public Utilities and an agreement prepared by the Developer working with the City Attorney’s office to obtain necessary signatures. All offsite utility easements required where the proposed extensions are needed to serve the site must be recorded prior to the release of the building permit. Normally, the site plan will not be approved until the offsite easement is dedicated.

9. Where additional Road Right-of-Way and/or widening is proposed, the site plan needs to reflect the extension of the existing sewer (lateral) connection just beyond new Right-of-Way line.

10. Schematic Plans will be reviewed by the Department of Utilities. As a minimum, all plans must reflect the following information:

- Vicinity map - scale 1:2000
- Tax map and parcel number(s)
- Development name
- Conceptual layout of sewer
- Existing easement, including deed book and page number
- Proposed easements

APPENDIX F

SITE PLAN CHECKLIST

PROJECT _____.

SEWERSHED ID # _____DATE _____.

UTILITIES

1. ____ The site plan shows the sewer lines and how this project will connect to the sewer system.

2. ____ Site Utilization Survey Form Appendix G has been submitted.

3. ____ The plan needs to show the location of any existing or installed sewer infrastructure.

4. ____ The site plan designates that a utilities contractor will install the 6-inch connection to the edge of the right-of-way or sewer easement and show the plumber starting his work from that point.

5. ____ The site plan reflects any necessary adjustment of the existing manhole tops and notes that the utilities contractor needs to give the Department of Public Utilities Inspector 48 hours notice prior to starting work.

6. ____ The site plan shows the location of the sewer easement and an easement plat has been submitted to the Department of Public Utilities.

7. ____ Where industrial waste is a possible influent to the public sewer system, the engineer has incorporated appropriate measures on the plans, i.e. sampling points, metering stations, etc.

APPENDIX G

SITE UTILIZATION SURVEY

Please complete this form and submit to the Department of Public Utilities, Technical Services Division.

Name of Proposed Company:_____

Proposed Site Location:_____

City Project Number:_____

Type of Company Activity:_____Commercial
_____Residential
_____Office
_____Manufacturing/Industrial
_____Food Service
_____Warehouse/Distribution
_____Service Related
_____Other : _____

Description of Company Activity: _____
_____
_____

S. I. C. Code:_____

If manufacturing, description of products, by-products and waste products generated:
_____
_____
_____

Company Contact Person:

Name:_____

Title:_____

Address:_____

Phone Number:_____

Fax Number:_____

APPENDIX H

OVERALL SYSTEM PLAN REQUIREMENTS

Checklist for overall system plan submittal requirements.

I. General plan requirements shall include:

A. Location of all existing utilities with the size and material identified. Also, the nearest appurtenance such as a manhole, sewer lateral, and valve should be shown.

B. Show accurate locations of all existing utility easements. The easement should note the proper width, and permanent/temporary status.

C. Indicate any existing and proposed utilities which may cause a conflict.

D. Identify all existing and proposed roadways with the name and right-of-way widths noted.

E. Adjacent property owners' names should be shown.

F. Proposed, existing, and original ground elevations should be shown at 2-foot vertical contour intervals. Also, indicate any permanent or established benchmarks within the area.

G. All plans shall have a north directional arrow. Identify source and reference used.

II. Wastewater: Design support information shall be submitted on or attached with overall plan. This information is listed below.

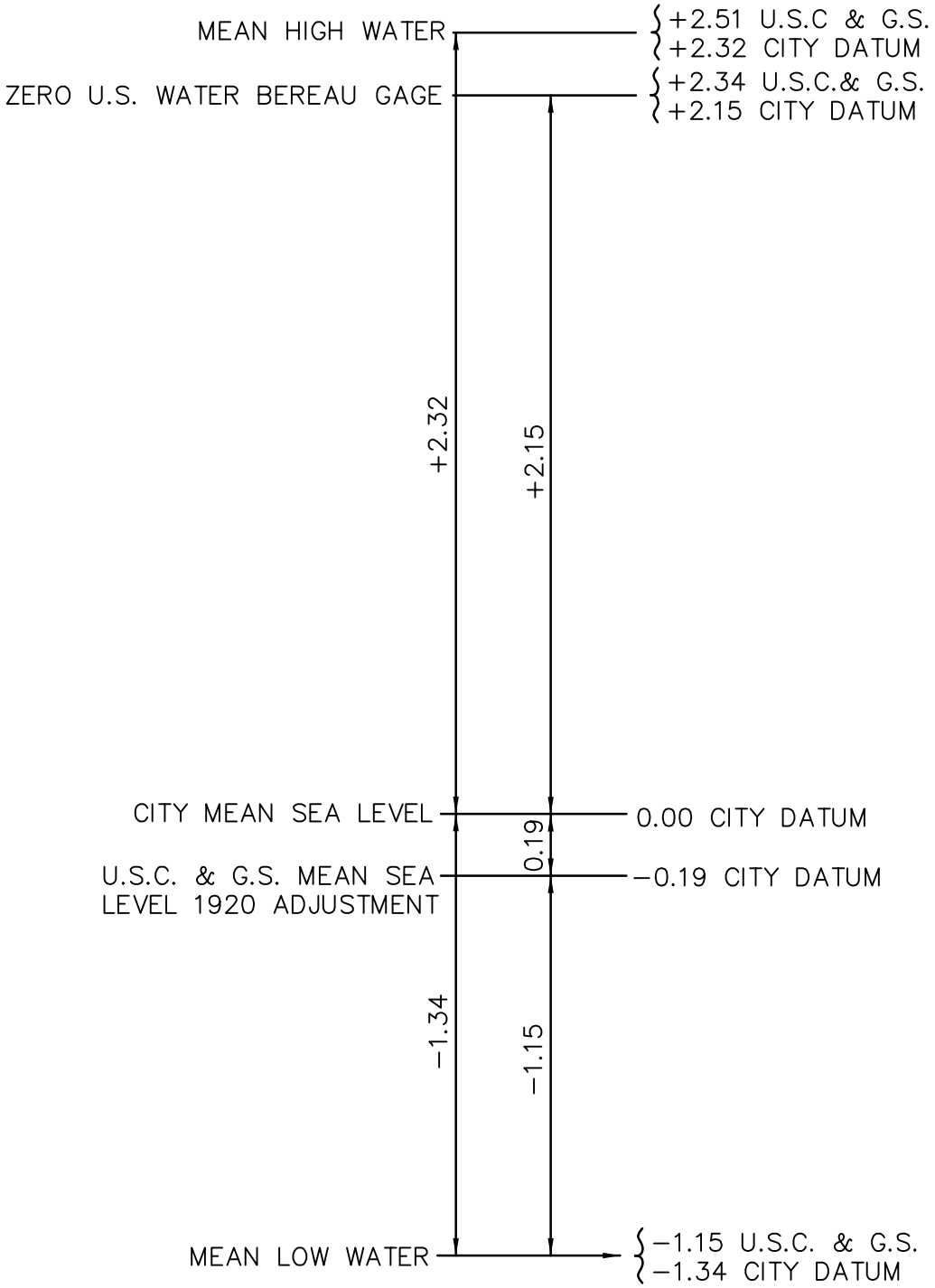
A. The layout and size of all proposed wastewater lines.

B. Show all existing manholes to which the proposed system will connect.

C. Indicate all proposed future connection points and the proposed easements for all adjacent properties.

D. A detailed hydraulic analysis for the proposed system, including the overall service area, shall accompany the plans. Also, include all of the appropriate land use densities for each area. The analysis should

cover the upstream adjacent properties and, as deemed necessary, any portions of the downstream system.



NOTES:

1. CITY DATUM IS 0.19 LOWER THAN U.S.C. AND G.S.
2. CITY ELEV. = 0.19

DEPARTMENT OF PUBLIC UTILITIES	CITY OF RICHMOND, VIRGINIA CITY DATUM (CHART NO. 23) NOT TO SCALE	REV. 12/09 APPENDIX I