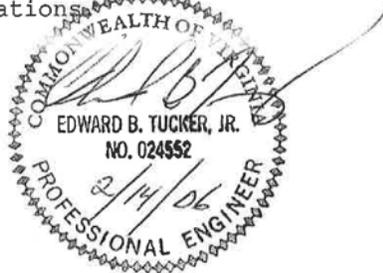


TOWN OF WARRENTON'S
WARRENTON, VIRGINIA

PUBLIC
FACILITIES
MANUAL

ADOPTED BY TOWN COUNCIL - FEBRUARY 14, 2006
EFFECTIVE - FEBRUARY 14, 2006

I have reviewed the Public Facilities Manual and to the best of my knowledge I have found it to be consistent with applicable State Regulations.



EDWARD B. TUCKER, JR., P.E.
DIRECTOR PUBLIC WORKS/UTILITIES

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SECTION 010 DEFINITIONS

1. The term "Town" means the Town of Warrenton, Virginia.

2. The term "Engineer" means either the Director of Public Works or the Director of Public Utilities for Warrenton, or their authorized representatives.

3. The term "Contractor" means the person or persons, partnership, firm or corporation who performs the construction work for a project.

4. The term "Standard Design Criteria" means the Engineering Standards and requirements established by the Town to provide for adequate design of a project.

5. The term "Drawings" means all drawings pertaining to the project, including the Project Drawings and the Standard Details.
 - a. The term "Project Drawings" means the drawings which show the locations, character, dimensions and details of the work to be performed for a particular project.

 - b. The term "Standard Details" means the applicable drawings contained in the current issue of Standard Details for Water main and Sanitary Sewer

Construction, Warrenton, Virginia.

6. The term "Specifications" means and shall include the standard specifications, the special provisions and all written agreements and instructions pertaining to the performance of the work and to the quality of the materials to be furnished for a particular project.
 - a. The term "Standard Specifications" means the specifications as contained in the current issue of Standard Specifications for Water main, Sanitary Sewer, Storm Drain and Street Construction, Warrenton, Virginia.
 - b. The term "Special Provisions" means the written statements modifying or supplementing the requirements of the standard specifications for conditions or requirements peculiar to the project.

7. The term "Work" of the contractor includes labor or materials or both. Where "as shown," "as indicated," "as detailed," or words of similar import are used, it shall be understood that reference is made to the drawings unless stated otherwise. Where "as directed," "as required," "as permitted," "approved," or words of similar import are used, it shall be understood that the direction, requirements, permission, approval or acceptance of the engineer is intended unless stated otherwise. As used herein "provide" shall be understood to mean "provide complete in place," that is furnish and install."

8. Inspector - refers to the Town of Warrenton Inspector unless noted otherwise.

THE TOWN OF WARRENTON

PUBLIC FACILITIES MANUAL

EMPOWERING ORDINANCES

SECTION 020 AUTHORITY

AUTHORITY

This Public Facilities Manual is authorized under Title 15.2 of the Code of Virginia and other applicable titles and sections of the Code. The Public Facilities Manual shall be incorporated into, and made a part of the Subdivision Ordinance of the Town of Warrenton in Virginia as if set forth therein in its entirety, and shall have the full force and effect of Town ordinance.

TITLE

This portion of the Subdivision Ordinance contained herein shall hereafter be known as, referred to, and entitled:

"THE TOWN OF WARRENTON"

PUBLIC FACILITIES MANUAL

It shall consist of Sections 010 through Section 1100 inclusive with attached standards and appendices as adopted by the Town Council on and as amended from time to time.

PURPOSE

The purpose of the Public Facilities Manual is to establish standards for design and construction of public facilities constructed as a portion of subdivisions or development plans within the corporate limits. The standards herein pertaining to utilities shall apply with equal force to those areas beyond the corporate limits where the Town has agreed to extend public utilities.

This manual is intended to promote and encourage orderly and quality development within the Town.

The provisions of the Public Facilities Manual and the Zoning and Subdivision Ordinances shall be the minimum requirements for the submission, preparation, and recordation of all development plans and subdivision plats.

SECTION 100.00 EXCAVATION AND BACKFILL FOR UTILITIES

101.00 SCOPE OF WORK:

The work includes clearing, grubbing, excavating, backfilling and related work required for installation of water mains, sanitary sewers and storm drains. A permit is required by the "Town" under any situation of trenching or boring within the right-of-way by any utility. Forty-eight (48) hours notice is required.

102.00 CLEARING:

The area to be cleared shall be the minimum width reasonably required for access to the work and for the construction of the pipelines. Clearing shall consist of the felling and the satisfactory disposal of the trees and other vegetation in the area. Individual trees, groups of trees and other vegetation, which are adjacent to the cleared area and are not removed, shall be thoroughly protected from damage incident to the construction operations. Clearing operations shall be conducted so as to prevent damage to trees left standing, and to provide for the safety of employees and others. All material resulting from the clearing operations shall be completely removed and disposed of by the Contractor. Burning will not be permitted.

103.00 CLASSIFICATION OF EXCAVATION:

- A. Common excavation shall comprise all materials not classified as rock excavation and shall include clay, silt, sand, muck, gravel, hard pan, loose shale, loose stone in masses, and boulders measuring less than one half (1/2) cubic yard in volume.

- B. Rock is considered to be all material that cannot be removed with a Caterpillar Model No. 215D-LC track hoe, or equivalent, equipped with a 120 hp flywheel and a short-tip radius rock bucket with 25,000-lbs bucket curling force. An example of rock excavation is material that is removed with the use of Hoe Ram or Blasting.

*Note: All blasting shall conform to VDOT Specifications 107.11 and 303.04, The Public Facilities Manual, and the 1996 BOCA National Fire Prevention Code Chapter 30.

104.00 EXCAVATION:

- A. The work shall include all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified or directed. During excavation, material suitable for backfilling shall be piled in an orderly manner at sufficient distances from the banks of the trenches to avoid overloading and to prevent slides or cave-ins. All excavated materials which are not required or are unsuitable for backfill shall be removed and disposed of by the Contractor. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations; any water

accumulating therein shall be removed by pumping, well pointing, or other approved methods. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections. Not less than twenty-five (25') feet and no more than one hundred (100') feet of trench shall be open in advance of pipe laying except as specifically approved.

- B. Trenches above the top of pipe shall be of the necessary width for the proper laying of pipe, and the banks shall be as nearly vertical as practicable. The width of trench below the top of the pipe shall not exceed the width indicated in the Standard Details. The bottom of the trench or top of bedding material shall be accurately graded to provide uniform bearing and support for each section of pipe and shall be shaped so that at least the bottom quadrant of the pipe rests on firm bearing for as nearly the full length of the barrel as proper joint operations will permit. Bell holes and depressions as required for the joint shall be dug after the trench bottom has been graded and shall be only of such length, depth and width as required for properly making the particular type of joint.

- C. Where the trench bottom occurs in rock, the rock shall be excavated to an overdepth of not less than six inches (6") below the bottom of the pipe. The overdepth shall be backfilled with improved bedding material as shown in the Standard Details and per the Virginia Department of Road and Bridge Specifications, Section 523.03(a).

- D. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with improved bedding material.
- E. Excavation overdepths shall be backfilled with improved bedding material.
- F. Excavation for manholes and similar structures shall be sufficient to leave at least twelve inches (12") in the clear between their outer surfaces and the embankment or timber which may be used to hold and protect the banks. Any overdepths of excavation below such appurtenances shall be backfilled with improved bedding.

105.00 EXCAVATION AND PREPARATION OF TRENCH

- A. Location: Pipe shall not be placed under pavement, curb and gutter and sidewalk. A minimum of two (2') feet clearance between these structures and the water pipe shall be required, except under authorization of the Engineer. Also, all road crossings shall be placed in a metal conduit or casing approved by the Engineer per Drawing W-12.
- B. Width: Width shall be sufficient to allow layout without walking or standing on the pipe and shall not be less than six (6") inches on each side of the pipe's largest diameter. The maximum clear width at the top of the pipe

shall not be more than the outside diameter of the pipe plus two (2') feet.

- C. Bell Holes: Bell holes shall be excavated to accommodate each bell.

- D. Rock Excavation: Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least eight (8") inches below and on each side of all pipe, valves, and fittings. (See Virginia Department of Transportation Road and Bridge Specifications, Article 523.03(a). Before the pipe is laid, the subgrade shall be made by backfilling with approved material and shall be tamped and graded. Commercial stone, if used, shall be VDOT No. 26 for ductile iron pipe.

- E. Excavation to Grade: The trench shall be excavated so as to provide a uniform and continuous bearing and support for the pipe on solid and undisturbed ground between bell holes. Any part of the bottom of the trench excavated below the specified grade shall be brought back to grade with approved material, thoroughly compacted. The finished subgrade shall be prepared accurately by means of hand tools.

- F. Unsuitable Material: Wet or otherwise unsuitable soil at the subgrade shall be removed and replaced with approved sound materials at no cost to the OWNER. Excess or unsuitable material shall be disposed of by the CONTRACTOR.

- G. Topsoil Storage: Topsoil to be used in backfilling shall be stockpiled separately from other backfill materials.

- H. Pumping, Bailing & Draining: The CONTRACTOR shall remove any water which may accumulate or be found in the trenches or other excavations and shall keep the excavations clear of water while work is being installed.

- I. Road Crossing: All Town paved road crossings shall be made by boring, jacking, or tunneling. If the crossing cannot be made by any of the above methods, the Contractor must contact the Town for permission to cut the road. Wherever pavement is permitted to be cut, not over one-half width shall be disturbed at one time; and on crossings, the first opening shall be completely restored to satisfactory travelable condition before the second half can be opened. Where the pavement is disturbed, or deemed weakened, it, in its entirety, or such portions of it as deemed desirable by the Town shall be restored or replaced in a manner directed by and to the satisfaction of the Town.

When pavement must be cut, the cut shall be made in a straight line, parallel to the pipe and six inches (6") wider than the trench on each side, so that an undisturbed shoulder will be provided under the new work. Sidewalks or curbs and gutter disturbed by construction shall be removed and replaced at existing joints. (Cutting shall be with pavement saw.)

Placement of excavated material on existing pavement shall be avoided. No cleated equipment shall be used on pavements. Road drainage shall not be clogged, and

shoulders, ditches, road-side drainage facilities and pavement affected by trenching operations shall be maintained in a condition satisfactory to the Town. Entrances shall not be blocked except for short periods as arranged with the property owner, and ingress and egress to adjacent property shall be maintained at all times.

106.00 BRACING AND SHEETING TRENCHES

- A. Open-cut trenches shall be sheeted and braced as required by any governing state laws, municipal ordinances and OSHA, as may be necessary to protect life, property or the work. When close sheeting is required, it shall be driven as to prevent adjacent soil from entering the trench below or through such sheeting. Where sheeting and bracing are used, the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, tested for defects and repaired if necessary, and the earth around it compacted to a depth of two feet (2') over the top of the pipe. Trenching shall not be removed when trench depth is greater than five feet (5').

- B. Where trenches are excavated without the use and aid of sheeting and bracing, upon the first sign or indication of cave-in, sheeting shall be furnished and installed by the Contractor. The Contractor shall support the sides and ends of all excavations wherever necessary or directed with braces, sheeting, shores, or stringers of the quality and character required for structural safety. All sheeting shall be put in place or driven by men skilled in such work and shall be so arranged that it may be withdrawn as backfilling proceeds, without injury to the piping laid or structures built under the contract or to any road bed or adjacent structure or property. If, in the opinion of the Engineer, the material furnished for sheeting excavations is not of proper quality or

sufficient size or is not properly placed to insure the safety of the work or of adjacent structures or property, the Contractor shall upon notice forthwith procure and place satisfactory sheeting, or place said sheeting in a satisfactory manner; upon his failure to do so, the work may be ordered stopped until said notice shall have been complied with.

- C. All sheeting and bracing in excavations shall be withdrawn as the backfilling is being done, except where and to such extent as the Engineer shall order that said sheeting be left in place or where he shall permit the same to be left in place at the Contractor's request. The Contractor shall cut off any sheeting left in place to a depth of eighteen inches (18") below finished grade and shall remove the material cut off.

- D. Wherever necessary in quicksand or soft ground or for the protection of any structure or property, sheeting shall be driven to such a depth below the bottom of the trench as may be required or directed.

107.00 BLASTING

- A. General: All blasting shall be done in accordance with state and local laws and regulations by skilled operators, and precautions shall be taken to prevent damage. The State Fire Marshal's Office is to be notified at least three (3) days prior to blasting operation.

- B. Quantity of explosives: No person shall use in a blasting operation a quantity of explosive greater than necessary to rend or separate the rock, and the Engineer shall have the authority to limit the maximum quantity of explosives

to be used. A permit may be required by the "Town" for the storage and handling of explosives.

C. Protection of blasts:

1. Immediately after loading and tamping the hole, and before fixing the blast, the material to be blasted shall be covered on all exposed sides with material and/or such means as necessary to prevent injury to persons and/or damage to exposed property. The Engineer may prohibit blasting where, in his opinion, the protection provided is inadequate.
2. After the protection has been applied, the blast shall be fired without unnecessary delay.

D. Method of detonation: No person shall explode, or attempt to explode, blasting powder or high explosives unless it is done with a suitable electric blasting machine. Delay on action primers or caps will not be permitted. Electric current from lighting or power lines or from a battery shall not be used for blasting purposes. At least three (3) minutes before firing a blast, the blaster shall give warning thereof by causing a competent man, carrying a red flag, to be stationed at a reasonable distance from the blast at each avenue of approach.

E. Restriction on time: No person shall conduct blasting operations between the hours of 5:00 pm and 8:00 am nor at any time on Sundays or holidays, except under authority of the Engineer.

F. Protections of adjoining structures and utilities: The blasting of material contiguous to any structure or

utility shall be so conducted as not to cause damage thereto, and if necessary for proper protection, walls and other supports shall be shored. Rotten or decomposed rock shall be removed only by the use of picks and bars. When blasting in the vicinity of a structure or utility is unavoidable, only light face blasts, with short lines of low resistance and small charges, shall be used.

- G. Damage: Any injury or damage resulting from blasting shall be the Contractor's responsibility.

- H. All blasting operations are to be in accordance with the U. S. B. C. and the BOCA National Fire Prevention Code, Chapter 30. (See Virginia Department of Transportation Road and Bridge Specifications, Section 107.11 and 303.04.)

108.00 TRENCH BACKFILLING

- A. Backfill materials: The excavations shall be carefully backfilled with excavated materials approved for backfilling. The approved backfill material, except as otherwise specified, shall consist of earth, loam, sandy clay, sand and gravel, soft shale or other approved materials, free from clods, stones or rocks, ashes or cinders, organic material or other such material which is unsuitable for backfilling.

- B. Improved bedding material: Where specified or directed, sand or washed gravel conforming to ASTM Specification #57's C33, Gradation No. 78's (1/2 inch (1/2") or smaller), shall be placed to properly support the pipe.

C. Borrow material: When sufficient approved backfill is not available from the excavated material to complete the back-filling of trenches and when additional backfill material is required to fill areas indicated on the drawings or as directed, the Contractor shall furnish approved fill material from sources off the site and place the material as indicated or directed.

D. Pipelines:

1. All trenches shall be backfilled by hand from the bottom of the trench to the centerline of the pipe with approved material placed in layers of three inches (3") and compacted by hand or by approved mechanical tampers or other approved means. Backfilling material shall be deposited in the trench for its full width on each side of the pipe, fittings and appurtenances, simultaneously.

2. Backfilling over pipe: From the centerline of the pipe, fittings and appurtenances to a depth of twelve inches (12") above the top of the pipe, the trench shall be backfilled by hand in six inch (6") layers and thoroughly compacted, using special care to avoid injuring or moving the pipe, or damaging any coatings on the pipe. No stone larger than one inch (1") shall be placed in first twelve inches (12") above pipe.

3. Backfilling to grade:

a. The equipment and method used for compaction of backfill shall be subject to the approval

of the Engineer. Vibratory roller shall not be used within eighteen inches (18") above pipe.

- b. Where the excavation is in a travel right-of-way or paved area, backfill above the twelve inch (12") depth specified above shall be accomplished in layers not exceeding six inches (6") in depth, and each layer shall be thoroughly compacted to ninety-five percent (95%) of maximum density at optimum moisture as determined by AASHO Standard T99.
 - c. Where the excavation is in a lawn or other similar type area, backfill above the twelve inch (12") depth specified above shall be compacted in twelve inch (12") layers to eighty-five percent (85%) of maximum density at optimum moisture as determined by AASHO Standard T99.
 - d. Where the excavation is not in a traveled right-of-way, paved area, a lawn or other similar type area, backfill above the twelve inch (12") depth specified above may be accomplished by machine when no harm will result therefrom. The surface of the backfill shall be mounded over to allow for future settlement.
4. Compaction tests for sewer and water lines are to be taken as follows in the travel rights of way or paved area: Ninety-five (95 percent).

- a. Minimum one (1) compaction test between each manhole section at the twelve inch (12") elevation above the sewer line, or every one hundred foot (100') distance between manholes; whichever, is the greater number of compaction tests needed. Water line construction, compaction test every one hundred foot (100') distance at the twelve inch (12") elevation above the water line. Minimum of one (1) compaction test needed at twelve inch (12") elevation above water line.

- b. Minimum one (1) compaction test between each manhole section at the final aggregate base nine inches (9") below the final bituminous surface course finished elevation or every one hundred foot (100') distance between manholes and one hundred foot (100') of water line; whichever is the greater number of compaction tests needed for the sewer line construction and water line construction shall be required.

- c. Minimum one (1) compaction test at final grade area under each manhole base unit.

The Contractor shall employ a reputable testing laboratory at the Contractor's expense, approved by the Engineer.

- d. Backfilling over PVC Pipe shall be in accordance with the standard detail E-2, and the provisions of this specification.
- E. Structures: After completion of foundations, footings, walls and other construction below the elevation of the

final grades and prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris. Backfill shall be placed in horizontal layers not in excess of six inches (6") in thickness. Each layer shall be compacted by hand or machine tampers or by other suitable equipment to a density as specified herein before trench backfill. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structure, and all slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent such wedging action.

- F. Moisture content: Backfill material shall be moistened or aerated as necessary to obtain a moisture content within one percent, over or under, of the optimum moisture content for the particular material, as determined by AASHO Standard T99.

- G. Backfilling of excavations shall follow the installation of the pipe or structure as closely as practicable. The Engineer shall be empowered to stop the excavation or other work and require the backfilling of any open trench or other excavation at any time if in his opinion such action is warranted. If the Contractor shall refuse or fail to backfill such excavation completely within eight (8) hours after being so directed, the Engineer shall be authorized to have the work done by others and all costs shall be charged to the Contractor.

109.00 MAINTENANCE OF TRENCHES

- A. The Contractor shall maintain at his own expense all refilled excavations and pavement in proper condition until the end of the one (1) year period following the date of final acceptance of the work. All depressions appearing shall be properly refilled, brought to grade

and pavement restored. If the Contractor shall fail to do so within a reasonable time after the receipt of written notice from the Engineer, the Engineer may refill said depressions; and the cost thereof shall be charged to the Contractor. In case of emergency, the Engineer may refill any dangerous depression without giving previous notice to the Contractor and the cost of so doing shall be charged to the Contractor.

- B. The Contractor shall be responsible for any injury or damage that may result from improper maintenance of any refilled excavation at any time previous to the end of the one (1) year period mentioned hereinbefore.

110.00 BACKFILLING

- A. Materials: All backfill material shall be free from mud, refuse, construction debris, organic material, boulders, stones over one half inch (1/2"), frozen or otherwise unsuitable material. From one foot (1') above the top of the pipe to the original ground elevation, however, material containing stones up to six inches (6") maximum for PVC pipe (eight inches (8") maximum for ductile iron pipe) in their greatest dimension may be used, unless otherwise specified. The Contractor may backfill with the excavated material provided it meets the conditions as stated above with the following exception. If PVC pipe is used for waterlines it shall be protected in a select material backfill from six inches (6") below the pipe to six inches (6") above the bell in all areas with a VDOT No. 10 stone or an alternative method approved by the engineer. Refer to Drawing No. E-1.
- B. Initial Backfill: All trenches shall be backfilled by hand with approved material in layers not exceeding four inches (4") from the bottom of the trench to the

centerline of the pipe. Special care shall be taken to backfill under the pipe and to tamp this material into place to provide a firm bed. Material shall be deposited on both sides of the pipe simultaneously and compacted into place by tamping. From the centerline of the pipe to a depth of one foot (1') above the pipe, the trench shall be backfilled by hand in six inch (6") layers and thoroughly compacted. Approved mechanical methods may be used to backfill from the centerline on ductile iron pipe. Either hand or pneumatic tampers may be used in this operation.

- C. Backfilling to Grade: The remainder of backfilling may be placed by machine and shall be carried up evenly on both sides of the trench in increments of one foot (1'), except in Town rights-of-way where layers shall be no greater than six inches (6") thick and shall be compacted to a minimum of ninety-five percent (95%) density. Each layer of earth shall be compacted into place by tamping before the next layer is applied. A hydro hammer shall not be used to compact the layers on other than ductile iron pipe unless there is a minimum of three feet (3') of cover. All pipelines shall have a minimum of eighteen inches (18") of cover before any rolling equipment is used. Damage to pipeline or other structures resulting from compaction shall be corrected by the Contractor without expense to the Owner. Detectable mylar marking tape shall be installed over all polyvinyl chloride pipe. The marking tape shall be buried four inches to six inches (4" - 6") below the finished surface.

In areas where settlement is not critical and where approved by the Engineer, an alternate method of backfilling may be employed. Compaction by water shall not be permitted on Town rights-of-way.

111.00 CONCRETE CRADLE, CAP OR ENCASEMENT:

Where indicated or directed, concrete cradle, cap or encasement shall be provided to properly support and/or protect the pipe. Dimensions and strength of concrete to be approved by Engineer. Field mix is not allowed. Refer to Drawing No. E-1.

112.00 TEST FOR DISPLACEMENT OF PIPE LINES:

Pipe lines will be checked by the Engineer to determine whether any displacement of the pipe has occurred after the trench has been backfilled and tamped as specified. If the check shows poor alignment, displaced pipe, or any other defects, the defects indicated by the Engineer shall be remedied by the Contractor.

113.00 RESTORATION OF PROPERTY AND STRUCTURES:

- A. Unless specified or directed otherwise, all property and structures within the limits of work shall be cleaned up and restored to a condition at least equal to that existing prior to construction. All property and structures outside the limits of work and items within the limits of work that are not to be disturbed shall be adequately protected to prevent damage during construction. Any damage resulting from the construction shall be repaired by the Contractor.

- B. All unpaved areas disturbed by the work shall be restored by topsoiling and seeding except areas indicated on the drawings or specified to be sodded. Slopes greater than 4:1 shall be sodded. Work shall be done in accordance with the Virginia Department of Transportation Road and Bridge Specifications. Maximum slope permitted is 2:1.

- C. All utility cuts in the existing pavement are to be patched immediately after backfill. Prior to use of the utility, the existing road is to be milled and overlaid with two inches (2") of top course asphalt twenty-five feet (25') in each direction from the center of utility. Restoration of pavement is specified in Section 500.00 "Restoration of Pavement."

114.00 EXISTING UNDERGROUND CONSTRUCTION

- A. The locations of all underground utilities shown on the drawings and on utility records should be considered approximate. The exact location of utilities within the area of work must be determined by the Contractor during construction. Care shall be exercised during such location work to avoid damaging and/or disrupting the affected utility.

The Contractor shall be responsible for repairing damage to any utility caused by his work.

- B. Where existing underground utilities or other construction appears to be in close proximity to proposed construction, or when approaching existing utilities or structures for connections, the trench must be opened a sufficient distance ahead of the work or test pits made to verify the exact location and inverts of the utility to allow for possible changes in line or grade.
- C. When it is necessary to excavate near or in any way interfere with any sewer, water service, drain pipe, catch basin, culvert, or other structures, the Contractor shall maintain the same in working order and shall repair

and make good any damage done during the progress of the work. All service connections and appurtenances to individual premises may not be shown on drawings and it shall be the Contractor's responsibility to determine the exact location of and maintain these connections.

- D. Where existing utilities cross the trench excavation, they shall be adequately supported and protected from damage due to construction as indicated or directed. All subject to approval by the Engineer. Care shall be taken to insure that the existing utility grades and alignment are maintained and that the pipe joints are not disturbed. Backfill shall be carefully placed and tamped to prevent damage or future settlement. Any damage or misalignment of the utilities due to construction or settlement shall be repaired by the Contractor.

115.00 GRADING:

Finish grading shall be done to establish the new grades where indicated and to re-establish existing grades where new grades are not indicated. The grades shall be formed to easy contours, sloping away from all buildings, and shall provide proper drainage. Proper allowance shall be made for the depth of topsoil or pavement when applicable.

116.00 CLEAN UP:

The Contractor shall at all times keep the job cleaned up as the work progresses. Immediately following backfilling, he shall "broom" or otherwise clean the surfaces of paved streets. All surplus material shall be removed and disposed of. If at any time during the course of the work the cleaning up and restoration operation in any given area should become

delinquent in the opinion of the Engineer, he may order the work of pipe laying be stopped until such delinquent cleaning up and restoration is completed. A pressure-wash may be required at the direction of the inspector on site. All material, rock and debris over 4" in diameter shall be removed prior to reseeding trench.

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SECTION 200.00

WATER MAINS

SECTION 200.00 WATER MAINS

200.01 GENERAL:

This section covers the Standard Design Criteria, Standard Specifications and Standard Details for Water and Sewer Design Criteria for the Town of Warrenton requirements unless special design is required. The strictest standard requirements will govern in the Standard Design Criteria, Standard Specifications and Standard Details for Water Main, and Sanitary Sewer. All proposed projects and their designs, calculations, supporting data, plans and specifications shall be approved by the Town prior to commencing construction. These design guidelines and specifications apply to water mains in the Town up to twelve inches (12") in diameter.

201.00 WATER MAIN DESIGN

- A. The size of mains and location of valves shall be as approved by the Town. The minimum size of mains serving fire hydrants shall be six inches (6").

- B. Horizontal location: The main shall be located not less than ten feet (10') horizontally from a sewer. If the waterline is at least eighteen inches (18") above the sewer, the horizontal separation may be reduced. Mains should be located a reasonable distance from gutter pans.

- C. Vertical location: The main shall be three and one half feet (3.5') minimum below finished grade or three feet (3') minimum below existing ground in areas to be filled. Maximum depth not to exceed six feet (6'), unless approved by Town Engineer.
- D. Fire hydrants shall be spaced seven hundred feet (700') maximum in residential areas and two hundred and fifty feet (250') maximum in commercial areas. Not more than one fire hydrant shall be located on any six inch (6") I. D. dead end main.
- E. All fire hydrant leads shall be valved at the tee off the main and the valve and hydrant shall be suspended to the main *with* megalugs or a tie rod system.
- F. All fittings shall have "megalug" style mechanical joint fasteners, EBBA Iron, or approved equal, and reaction blocking in accordance with the Standard Details.
- G. Water mains in streets to be extended in the future shall be constructed to a two foot (2') minimum beyond the limits of paving.
- H. Water mains shall be looped whenever possible. Fire hydrants shall be provided at the end of all dead end mains.
- I. Cross-connection and backflow prevention will conform to Standard Design and Specifications as outlined in the Town of Warrenton's Cross-Connection and Backflow Prevention Policy.

- J. All other utilities such as fiber optics, telephone, power, cable, etc. and trees shall be placed a minimum of five feet (5') horizontally from all water mains.

- K. All "T's" will have three gate valves installed, one on each leg. All crosses will have four gate valves, one on each leg.

- L. Trees and permanent structures are not allowed in water/sewer easements.

202.00 WATER MAIN SPECIFICATIONS

202.01 SCOPE OF WORK:

The work includes providing all piping, fittings, valves, valve boxes, hydrants, anchorage, and all other appurtenances required for a complete water distribution system.

202.02 MATERIALS:

- A. All materials shall be suitable for one hundred and fifty pounds per square inch (150 psi) water working pressure unless indicated otherwise.

- B. Ductile iron pipe shall conform to AWWA Standard Class 52. Ductile iron fittings shall conform to AWWA Standard C110. Pipe and fitting shall be cement lined and shall have mechanical joints or push-on joints conforming to AWWA Standard C111.

- C. Class of Pipe: The minimum thickness of ductile iron pipe shall be Class 52 in accordance with AWWA Standard H1 or H3.
- D. Fittings: All fittings must be connected using Megalugs mechanical fasteners or approved equal and reaction blocking. Solid Class A concrete blocking may be used against undisturbed earth in place of pouring reaction blocks in addition to tag mechanical fastener. All push joint pipe must be restrained for one full joint from any fitting or use Korlock Style locking gaskets.
- E. GATE VALVES: Valves shall be cast iron body, resilient seated with reinforced rubber seat ring or permanently bonded disc, and machined seating surface, brass or bronze non-rising stems, and complying with AWWA C.509. Body shall be self centering or shall have guides for alignment of wedge disc and have internal and external epoxy coating approved for potable water. Working pressure shall be at least two hundred pounds per square inch (200 psi) for valves twelve inches (12") in diameter and smaller. Set three (3) valves at all "T" intersections and four (4) valves at all crosses. Valves shall have "O" ring seals and shall open left (counter clockwise) with a two inch (2") square wrench nut. Valve ends shall be of mechanical joint type with all bolts, glands, and rubber gaskets and accessories furnished with the valve. Valves shall be Mueller or equal. Valves smaller than four inches (4") shall have screw ends and are to be a gate type valve.
- F. VALVE BOXES: Adjustable cast iron valve boxes of suitable diameter, length, and design shall be furnished and installed for all buried valves. Boxes shall be two piece slip type. All valve boxes placed in the pavement shall be Bingham & Taylor Model #8250, or

approved equal. The word "water" shall be stamped on cover.

- G. TIE RODS REPLACEMENTS: Three quarters of an inch (3/4") all thread steel rods for hydrant clamping shall be galvanized or otherwise rustproof treated. Compatible tie bolts and nuts or clamps shall be similarly rustproof treated. Reinforcing steel shall not be accepted.

- H. METALLIC MARKING TAPE: Detectable mylar marking tape shall be similar to Lineguard, Inc. utility marking tape, Type II or approved equal. The tape shall bear the printed identification "Caution: Water Line Below." The printing shall be under mylar (reverse printed) so as to be readable through the clear mylar. The tape shall be "Blue" in color and shall be two inches (2") or one and one half inches (1-1/2") in width, supplied in one thousand (1,000') foot rolls. Tape shall be twelve to eighteen inches (12"-18") below finished grade. (In addition to the above, locating wire may be required by the Engineer.)

- I. Valve boxes shall be cast iron two-piece slip type consisting of a lid with the word "water" stamped on it; a top section in which the lid rests in and a flared bottom section. This box shall be a minimum thickness of three-sixteenths of an inch (3/16").

- J. Fire hydrants shall be dry top, dry barrel, compression type with valve opening of five and one quarter inches (5-1/4"), double O-ring seals and safety flange, stem coupling and sleeve, and shall conform to AWWA Standard C502. Hydrant valve shall close with the water pressure. Hydrants shall have two (2) two and one half inch (2-1/2") hose nozzles and one (1) four and one half inch (4-1/2") pumper nozzle with National Standard threads, six

inch (6") mechanical joint inlet connection, National Standard one and one half inch (1-1/2") pentagon operating nut and outlet nozzle cap nuts, chains on outlet nozzle caps, and harnessing lugs. Hydrants shall open to the left (counterclockwise). Hydrants shall be Mueller Co. No. A-423 Centurion or approved equal.

K. Copper pipe shall conform to Federal Specification WW-T-799, Type K, with wrought copper fittings and BOCA Plumbing Code.

L. Corporation stops and curb stops shall conform to AWWA requirements and shall be suitable for copper service pipe. Stops shall be Mueller or approved equal.

M. SERVICE CONNECTIONS

1. Service Lines shall be three quarter inch (3/4") (unless otherwise indicated) Type "K" seamless, soft copper tubing, having the ability to be flared and in conformance with ASTM Specification B-88. Adapters shall be supplied as needed in reconnecting existing services.

2. Corporation Stop: Corporation stops shall be three quarter inch (3/4") (unless otherwise indicated) with inlet threads conforming to AWWA C-800, commonly known as the "Mueller" thread, and the outlet compatible with service pipe similar to Mueller No. H-1500 for copper service.

3. Tapping Saddles: Saddles shall have cc tap, be made of malleable material and have flat straps. Rubber gaskets shall be required for all pipe sizes and

classes. Lead gaskets will not be allowed. Saddles shall provide full support around the circumference of the pipe and have a bearing area of sufficient width along the axis of the pipe, one and one half inch (1-1/2") minimum. Saddles shall not have lugs that will dig into the pipe when the saddle is tightened. The U-bolt type of strap that does not provide sufficient bearing area will not be allowed. Saddles shall be as the Dresser No. 91 double strap for C. I. diameters, or approved equal.

4. All one and one-half inch (1½") or greater services require a reducing tee in the main, brass nipple, two inch (2") gate valve accessible at the finished grade. The gate valve should be on the right-of-way side of the meter vault approximately two feet (2'). Saddle taps can only be used on one inch (1") or smaller services.

- N. A post indicator valve shall be required on the exterior of all buildings equipped with a sprinkler system.

202.03 FACTORY TESTS AND COMPLIANCE STATEMENTS:

Pipe, valves and hydrants proposed for use shall be factory tested in accordance with the requirements of the applicable AWWA Standard referenced herein. The Contractor shall furnish sworn statements from the manufacturers that the inspection and tests specified in the referenced standards have been made and that the results of such inspection and tests, as well as the basic materials, manufacturing and assembly, comply with the requirements of the applicable standard. In addition, actual test results shall be submitted to the Engineer as directed. No pipe, valve or hydrant shall be considered for use in the contract until the manufacturer's certifications,

and test results when required, have been approved by the Engineer.

202.04 CATALOG DATA AND CERTIFIED DRAWINGS:

Maintenance, replacement and lubrication information shall be furnished by the Contractor for valves and hydrants, as directed by the Engineer.

202.05 HANDLING PIPE AND ACCESSORIES:

Pipe, fittings, valves and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Pipe shall be handled so that the coating and lining will not be damaged. Damaged coating and lining shall be cause for rejection of the pipe and shall be replaced or repaired.

202.06 LAYING PIPE:

- A. Installation of pipe and fittings shall be in accordance with AWWA Standard C600 and the most current edition of the International Plumbing Code, except as specified or indicated otherwise. The water main shall be laid to a true uniform line and grade from elevations indicated or directed. Unless indicated otherwise, the depth of

trench shall be sufficient to provide a minimum cover over the top of the pipe of three and one half feet (3.5') from the existing or proposed ground surface and to avoid interference of the pipeline with other utilities. Pipe shall be laid on continuous grades as indicated or directed to avoid sags or crests in the line.

- B. The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner, without damage to the pipe, so as to leave a smooth end at right angles to the axis of the pipe. Care shall be taken to avoid damaging the lining. Flame cutting of cast iron pipe with oxyacetylene torch will not be permitted.
- C. Immediately before lowering the pipe in to the trench, the interior lining and exterior coating will be visually inspected. Pipe with damaged lining or coating shall not be installed.
- D. Proper implements, tools and facilities for water main construction shall be provided and used. All pipes, fittings and valves shall be lowered carefully into the trenches by means of derricks, ropes or other suitable equipment. Under no circumstances shall water main materials be dropped or dumped into the trenches. All pipe shall be installed with the bell ends facing the direction of laying and in accordance with the recommendations of the manufacturers of the pipe.
- E. Where it becomes necessary to deflect the line of pipe, in either a vertical or horizontal plane, to avoid obstructions, or in locations where long-radius curves are permitted, the amount of deflection shall not exceed that specified in AWWA Standard C600 or paragraph 2-17.

Section 4. Deflection at Joints: (most strict standard will govern).

F. Deflection at Joints: Maximum deflections for joints will be as follows:

Pipe Size	Ductile Iron (Mechanical)				Ductile Iron (Push-On)			
	Allowable Defl. In Inches				Allowable Defl. In Inches			
	12'	16'	18'	20'	12'	16'	18'	20'
	Lengths				Lengths			
4"	21	28	31	34	12	17	19	21
6"	18	24	27	30	12	17	19	21
8"	13	18	20	22	12	17	19	21
10"	13	18	20	22	12	17	19	21
12"	13	18	20	22	12	17	19	21
16"	9	12	13.5	15	7.5	10	11	12

Flexible pipe may be curved in the trench to the limits recommended by the manufacturer.

- G. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, a heavy, tightly woven canvas bag of suitable size shall be placed over each end of the pipe before lowering the pipe into the adjacent pipe. During laying operations, no debris, tools, clothing or other material shall be placed in the pipe.

- H. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other approved means. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

- I. Crossings Through Casings: When special conditions require use of casings, care shall be taken to insure that the pipeline is well secured by rods, clamps and/or concrete anchors as shown on the drawings. Other methods of securing the pipe proposed by the Contractor will be considered by the Engineer. Before pushing the pipe through the casing, chocks or skids shall be strapped to the pipe barrel to keep the pipe centered in the casing and to prevent damage when installation is made. Care shall be taken to insure that all joints are fully seated prior to installing concrete thrust blocks. (See Standard Detail W-12, page 134)

202.07 SEPARATION OF WATER LINES AND SEWERS

- A. Parallel Installation: Water lines shall normally be separated from sanitary sewers horizontally by a distance of ten feet (10'). This distance shall be measured edge to edge. When local conditions prevent a horizontal separation of ten feet (10'), the bottom of the water line shall be at least eighteen inches (18") above the top of the sewer. Where this vertical separation cannot be obtained, the sanitary sewer shall be constructed of AWWA approved water pipe in accordance with Section 202.02 of this manual, pressure tested in place to fifty pounds per square inch (50 psi) without leakage prior to backfilling.
- B. Crossings: Water lines crossing house sewers, storm sewers, or sanitary sewers shall be laid to provide a separation of at least eighteen inches (18") between the bottom of the water line and the top of the sewer. If this vertical separation is not possible, sanitary sewers shall be constructed and tested as noted in Paragraph A of this section.

When local conditions require water lines to pass under such sewers, adequate structural support shall be provided for the sewer to prevent excessive deflection. Also, the length of water pipe shall be centered at the point of crossing, and a vertical separation of at least eighteen inches (18") shall be provided between the bottom of the sewer and the top of the water line. In this case, sanitary sewers passing over shall be constructed and tested as noted in Paragraph A of this section. No joint shall be allowed closer than eight feet (8') from the crossing of any new or existing sewer line.

- C. No water line shall pass through or come into contact with any part of a sewer or sewer manhole. No water line shall pass under any part of a sanitary or storm sewer manhole.
- D. No utilities can be placed closer than 5 feet (5') from any water mains or services.
- E. No trees or permanent structures are allowed in the waterline easement.

202.08 JOINTING:

- A. Before joints are made the pipe shall be well bedded on a firm foundation and no pipe shall be brought into position until the preceding length has been thoroughly embedded and secured in place. Any defects due to settlement shall be made good by the Contractor at his own expense. Bell holes shall be dug sufficiently large to insure the making of proper joints.
- B. Ductile iron pipe shall be jointed in full accordance with AWWA Standard C600, the manufacturer's recommendations and the following requirements:
 - 1. Push-on joints shall be thoroughly cleaned; the rubber gasket inserted in the bell socket; a thin film of approved gasket lubricant applied; the spigot end of the pipe centered into the socket; and the joint completed by forcing the spigot end to the bottom of the socket by a jack-type tool or other approved device.

2. Mechanical joints shall be thoroughly cleaned and, in addition, gasket and spigot shall be lubricated. The gland shall then be placed on the spigot end, followed by the gasket, as furnished by the pipe manufacturer, and the pipe end seated and centered in the socket. The gasket shall then be seated in the socket, gland moved into position and bolts and nuts loosely assembled by hand and then tightened with a wrench.

202.09 ANCHORAGE:

- A. All plugs, caps, tees, bends and inserting valves in water mains shall be provided with reaction blocking. Reaction blocking shall consist of concrete thrust blocks as shown on the Standard Details. All valves for connections to future lines, all fire hydrants and related valves, and other fittings or valves so indicated shall be anchored by "megalug" style mechanical fasteners or approved equal and reaction blocking as shown on the drawings or Standard Details.
- B. Reaction backing at connections to existing mains shall be made with high early strength concrete. In the event that line pressure must be restored less than forty-eight (48) hours after the placement of reaction backing at these connections, the Contractor shall provide temporary deadmen and/or other similar devices as required to maintain stability of the water mains.

202.10 INSTALLING VALVES AND FITTINGS:

- A. Valves, fittings, plugs and caps shall be installed and jointed to pipe in the manner hereinbefore specified for laying and jointed pipe. Valve boxes shall be provided for each buried gate valve, shall not transmit shock or stress to the valve, and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or such other level as may be directed.
- B. Inserting valves and tapping sleeves and valves shall be installed in accordance with the valve manufacturer's recommendations.
- C. All valves eight feet (8') or deeper require valve extensions to within two feet (2') of finished grade.

202.11 SETTING FIRE HYDRANTS:

Each hydrant shall be connected to the main with a six inch (6") water line controlled by an independent six inch (6") gate valve. Hydrants shall stand plumb with nozzles at least eighteen inches (18") above the ground. Drainage fill shall be provided at the base of the hydrants as indicated in the Standard Details. After installation the hydrant shall be painted with two (2) coats of approved red hydrant enamel. Hydrants installed on lines greater than eight feet (8') deep must have a valve extension installed.

202.12 CONNECTION TO EXISTING MAINS:

The Contractor shall connect new water mains to the existing mains by cutting in three (3) valves for tees and four (4) for crosses only, except under authorization of the Engineer. The

location of the existing main shall be verified before commencing any work on the connection. Shutdowns in service will be scheduled with all citizens and businesses affected and operation of any valves on the existing system shall be done only as directed by the Engineer. The Contractor shall notify the Engineer two (2) weeks prior to scheduling work on existing water mains.

202.13 INSPECTION AND TESTS:

All pipes shall be tested and inspected for soundness before being incorporated in the work. After installation, all piping shall be inspected before backfilling. All mains which are installed under this contract shall be subjected to a hydrostatic test of one hundred and fifty percent (150%) of the working pressure one hundred and fifty pounds per square inch (150 psi minimum) for not less than two (2) hours, in accordance with AWWA Standard C600, during which time the leakage loss shall not exceed the rate computed from the formula contained in AWWA Standard C600. The test shall be made only under the supervision of the Engineer or his/her representative. The Contractor shall provide all equipment and perform all work required for testing. If any section under test shows leakage in excess of the allowable amount, the Contractor shall make such repairs to the line as are required to bring the loss within the stipulated limits.

202.14 RESPONSIBILITY FOR STERILIZATION AND FLUSHING OF MAINS:

- A. All water mains shall be flushed and disinfected in accordance with AWWA Standard C601. The Contractor shall provide all materials and equipment and perform all work required for sterilization and flushing.

- B. Disinfecting Water Mains: Water mains and accessories shall be disinfected in accordance with AWWA C.601. Care shall be taken to minimize entrance of foreign material into pipe, fittings and valves. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug. The main shall be flushed prior to disinfection with sufficient flow to produce a velocity of 2.5 fps. No site for flushing shall be chosen unless it has been determined that drainage is adequate at the site.

A chlorine application by an approved method shall be made using water from the existing distribution system of water supply. The initial chlorine concentration in the water to be used shall be a minimum of fifty (50) mg/l available chlorine. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time all valves and hydrants in the section treated shall be operated. At the end of this period, the treated water shall contain no less than twenty-five (25) mg/l chlorine throughout, and final flushing shall follow to insure that the chlorine concentration is no higher than that generally prevailing in the system.

After final flushing and before the water main is placed in service, two (2) consecutive samples shall be collected at twenty-four (24) hour intervals for each two thousand feet (2,000') of line. These samples shall be tested for bacteriologic quality by a certified laboratory and shall show the absence of coliform "organisms before the system can be placed into service. Samples will be collected by contractor's personnel through the use of sample taps supplied by the Contractor for the line sections noted.

202.15 WATER FOR STERILIZATION, FLUSHING AND TESTING:

Water will be furnished to the Contractor from the existing water system at no charge to the Contractor. Water usage shall be scheduled with the Engineer to result in a minimum interference to water service throughout the existing water system. Temporary connections to the existing water system shall be provided and removed by the Contractor and shall include approved means to prevent backflow and possible contamination of the existing water system.

202.16 ABANDONING EXISTING WATER MAINS:

All existing water mains not required in the completed system shall be drained and abandoned. Abandoned mains and appurtenances that conflict with proposed construction shall be removed as required. Abandoned mains not removed shall be capped at all open ends.

202.17 WATER SERVICE INSTALLATION:

Where indicated on the drawings or directed by the Engineer, the Contractor shall install new water service lines or reconnect existing water service lines to the new main. The water service shall consist of a corporation stop tapped into the new main, Type K copper service line, a curb stop where required and connection to the existing service line. New service lines shall be terminated with a curb stop two feet (2') from the property line and the measured distance from a side property line shall be recorded with the Engineer.

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SECTION 300.00

SANITARY SEWER MAINS

SECTION 300.00 SANITARY SEWER MAINS

300.01 GENERAL:

This manual covers the Standard Design Criteria, Standard Specifications and Standard Details for Water and Sewer Design Criteria for the Town of Warrenton requirements unless special design is required. The strictest standard requirements will govern in the Standard Design Criteria, Standard Specifications and Standard Details for Water Main, and Sanitary Sewer. All proposed projects and their designs, calculations, supporting data, plans and specifications shall be approved by the Town prior to commencing construction.

301.00 SANITARY SEWER MAIN DESIGN

- A. Sanitary sewers shall be designed using Manning's formula with a roughness coefficient (n) of 0.013 and with a minimum velocity of two feet (2.0') per second. Public sewers shall be eight inches (8") minimum with a 0.5% grade. Terminal lines shall have a minimum slope of 1.00%.

- B. Sewers shall be built to a sufficient depth to serve existing or proposed house cellars with a 2.0% minimum slope for sewer laterals. Laterals shall be four inches (4") minimum. If cellar elevations are not set, the sewer must be at a depth which will serve cellars six feet (6)' below street grade (10' minimum depth of sewer). Minimum cover shall be three feet (3').

- C. Horizontal location: In general the sewer shall be located in legally established right-of-way or street and shall be equidistant from property line or curb lines. Sewers shall be not less than ten feet (10') horizontally from waterline. If the waterline is located at least one foot above the sewer, the horizontal distance may be reduced. Sewers shall be located a reasonable distance from gutter pans. Manholes shall be located clear of walks, edge of pavement and ditch line. Vertical location: The top of the sewer shall be at least eighteen inches (18") below the bottom of the waterline. No utilities are to be located within five feet (5') of any sewer main or lateral.
- D. Location: Manholes shall be installed at the end of each line of eight inches (8") diameter or greater; at all changes in grade, size or alignment; at all intersections; and at distance not greater than four hundred feet (400') for sewers fifteen inches (15") or less and five hundred feet (500') for sewers eighteen inches (18") to thirty inches (30"), except that distances up to six hundred (600') may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Slightly greater spacing may be permitted in larger sewers and in those carrying a settled effluent. Manholes are not to be placed in drainage swales or ditches. No trees or permanent structures are allowed within the sewer easement.
- E. Minimum Dimensions: The minimum base inside diameter of manholes shall be forty-eight inches (48"). The minimum diameter for a manhole with more than two pipes is sixty inches (60"). The minimum clear opening in the manhole frame shall be twenty-four inches (24"). Larger base diameters are preferred.

- F. Foundation: The manhole foundation shall be adequately designed to support the manhole and any superimposed loads that may occur.

- G. Flow Channel: The flow channel through manholes should be such shape and slope to provide smooth transition between inlet and outlet sewers and to reduce turbulence. Benches shall be sloped to the channel to prevent accumulation of solids.

- H. Watertightness: Watertight manhole covers are to be used whenever the manhole tops may be flooded. As a minimum, watertight manhole covers are to be used to the elevation of the twenty-five (25) year flood/wave action. Construction methods and materials at all wall and bottom construction shall ensure watertightness.

- I. Connections: Line connections directly to the manhole or to short stubs integral with the manhole shall be made with flexible joints. Flexible joints are joints which permit the manhole to settle without destroying the watertight integrity of the line connections.

- J. Ventilation: Ventilation of gravity sewer systems shall be provided where continuous watertight sections greater than one thousand feet (1,000') in length are incurred.

- K. Frames, Covers and Steps: Frames, covers and steps shall be designed to accommodate prevailing site conditions (e.g., matching grade and cross slope of finished street section) and to provide for a safe installation. All frame and covers are to be H-20 Highway rated.

- L. Inside Drop Pipe: An inside drop pipe, in accordance to the S-11 Standard Drawing, should be provided for a sewer entering a manhole at an elevation of twenty-four inches (24") or more above the manhole invert or as may otherwise be required to conform to the use of standard fittings in the dropping construction. Where the difference in elevation between the incoming sewer and the manhole invert is less than twenty-four inches (24"), the invert shall be filleted to prevent solids deposition. All manholes are considered confined spaces and must meet all OSHA requirements, including a minimum of forty-eight inches (48") of clear space.
- M. Location of Sewers in Relation to Streams, Estuaries, Lakes, Reservoirs: The tops 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, one foot (1') of suitable cover shall be provided where the stream is located in rock and three feet (3') of suitable cover in other material. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to stream channel. In paved channels, the top of the sewer lines should be placed below the bottom of channel pavement. Sewers shall remain fully operational during twenty-five (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 one hundred (100) year flood/wave action. Sewers located along streams shall be located outside of the stream bed wherever possible and sufficiently removed therefrom to provide for future possible channel widening. All manholes near streams will require watertight frame and covers.

- N. Sewers Crossing Streams, Estuaries, Lakes, and Reservoirs: Sewers entering or crossing the streams shall be constructed of watertight pipe. The pipe and joints shall be tested in place, shall exhibit "0" infiltration, and shall be designed, constructed and protected against anticipated hydraulic and physical, longitudinal, vertical and horizontal loads and erosion and impact. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Such sewers on piers shall be constructed in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade.
- O. Inverted Siphons: Inverted siphons shall have not less than two (2) barrels, with a minimum pipe size of six inches (6") and shall be provided with necessary appurtenances for convenient flushing and maintenance; the manholes shall be designed to facilitate cleaning; and, in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least three feet (3.0') per second for average flows. The inlet and outlet details shall be arranged so that normal flow is diverted to one (1) barrel and so that either barrel may be removed for service or cleaning.
- P. Water Supply Interconnections: There shall be no physical connection between a drinking water supply and a sewer or appurtenance thereto.
- Q. Relation to Water Works Structures: No general statement can be made to cover all conditions; however, for public wells or other public water supply sources and structures, sewers shall meet the requirements of the Virginia Waterworks regulations with respect to minimum distances from water supply wells or other water supply

sources and structures. No sewer line shall pass within fifty feet (50') 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 current editions of the Waterworks Regulations and the requirements contained in "Rules and Regulations of the Board of Health, Commonwealth of Virginia, Governing the Disposal of Sewage" as basic design references. The proposed design shall identify and adequately address the protection of all potable water supply structures within one hundred feet (100') of the proposed project."

302.00 SANITARY SEWER SPECIFICATIONS

302.01 SCOPE OF WORK:

The work includes providing all piping, manholes and other appurtenances required for a complete sanitary sewer system.

302.02 MATERIALS:

- A. The type and class of pipe shall be indicated on the drawings or in the Special Provisions.

- B. Polyvinyl Chlorine pipe (Schedule 40) for house sewer shall conform to ASTM D 3034 as modified herein. Joints shall be elastomeric gasket joints resulting in watertight seals.

- C. Brick shall conform to ASTM Specification C32, Grade MA or ASTM Specification C62, Grade SW.
- D. Precast concrete manhole sections shall conform to ASTM Specification C478. Joints shall be made with O-ring type rubber gaskets conforming to ASTM Specification C443 or C361.
- E. Mortar shall be one part of Portland cement conforming to ASTM Specification C150, Type II, and two (2) parts of said conforming to ASTM Specification C144, with enough water added to produce mortar of the proper consistency for the type of joint. For brickwork, lime may be added to the mortar in the amount of not more than twenty-five percent (25%) of the volume of cement.
- F. Grout shall conform to the requirements specified for mortar except that the proportion shall be one part of Portland cement and three parts of sand.
- G. All frame and covers to be H-20 Rated, and have "sanitary sewer" stamped on the cover.
- H. Polyvinyl chloride pipe and fittings four inches (4") through fifteen inches (15") in diameter shall meet the requirements of ASTM D 3034 as modified herein (Schedule 40 minimum). All fittings to be Harco or approved equal.
 - 1. Pipe with blisters, bubbles, cuts or scrapes on inside or outside surfaces, which appreciably damage the wall thickness or other imperfections

which impair the performance or life of the pipe will be rejected.

2. Joints shall be elastomeric gasket joints resulting in watertight seals.

302.03 FACTORY TESTS:

- A. Pipe proposed for use shall be factory-tested in accordance with the requirements of the applicable Specification referenced hereinbefore for the pipe.
- B. The Contractor shall furnish sworn statements from the pipe manufacturers that the inspection and tests specified in the referenced standards, including basic tests required by the standard and option tests as specified herein, have been made and that the results of such inspections and tests comply with the requirements of the applicable standard. In addition, actual test results shall be submitted to the Engineer as directed. No pipe shall be considered for use on the project until the manufacturer's certification, and test results when required, have been approved by the Engineer.

302.04 HYDROSTATIC TEST:

If requested by the Engineer a hydrostatic test shall be performed on the types of pipe and joints proposed by the Contractor prior to any pipe laying. The test shall be performed on at least two (2) sample joints for each size and type of pipe furnished. The possibility of some water being absorbed by the pipe will be taken into consideration. The test shall require the pipe and joint

to show no leakage when subjected to water pressure of ten pounds per square inch (10 psi) for ten (10) minutes.

Any joint or section of pipe proved unsatisfactory by this test will serve as cause for rejection and their installation will be prohibited in the contract work.

302.05 SEPARATION OF WATER LINES AND SEWERS:

- A. Parallel Installation: Water lines shall normally be separated from sanitary sewers horizontally by a distance of ten feet (10'). This distance shall be measured edge to edge. When local conditions prevent a horizontal separation of ten feet (10'), the bottom of the water line shall be at least eighteen inches (18") above the top of the sewer. Where this vertical separation cannot be obtained, the sanitary sewer shall be constructed of AWWA approved water pipe, in accordance with Section 202.02 of this manual, pressure tested in place to fifty pounds per square inch (50 psi) without leakage prior to backfilling. If a sewer manhole does not meet the above separation, then it shall be of watertight construction and tested in place with zero (0) leakage.
- B. Crossing: Water lines crossing house sewers, storm sewers, or sanitary sewers shall be laid to provide a separation of at least eighteen inches (18") between the bottom of the waterline and the top of the sewer. If this separation is not possible, sanitary sewers shall be constructed and tested as noted in Paragraph A of this section. Parallel Installation.

When local conditions require water lines to pass under such sewers, adequate structural support shall be provided for the sewer to prevent excessive deflection. Also, the length of water pipe shall be centered at the

point of crossing, and a vertical separation of at least eighteen inches (18") shall be provided between the bottom of the sewer and the top of the water line. In this case, sanitary sewers passing over shall be constructed and tested as noted in Section A. (Parallel Installation). No joint shall be allowed closer than eight (8) feet from the crossing of any new or existing sewer line.

- C. No water pipe shall pass through or come into contact with any part of a sewer or sewer manhole.

302.06 LAYING PIPE:

- A. Pipe shall be laid to a true uniform line and grade from elevations indicated or as directed. Such grades and elevations shall indicate the position of the invert of the pipe. Not less than three (3) batter boards, or their equivalent, shall be maintained between any two (2) manholes at all times during the pipe laying operations. All work shall be done in strict accordance with the recommendations of the manufacturer of the pipe.
- B. Pipe laying shall proceed up-grade with the spigot ends pointing in the direction of flow. Each section of pipe shall be laid in such a manner as to form a close concentric joint with the adjoining sections and to prevent sudden offsets in the flow line. Each section of pipe, as it is laid, shall be backfilled sufficiently to hold it firmly in place.
- C. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall

be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed.

- D. All trenches and other excavations shall be kept free of water during construction and until final inspection. No pipe shall be laid in water, nor shall water be allowed to rise over the pipe joints until the joints are tight. It is not intended by this stipulation that a dry trench will be required, but it is intended that water which might in any way have a harmful effect on the joint shall be excluded from the excavations.

- E. At times when work is not in progress, open ends of pipe and fittings shall be securely closed with approved plugs or caps to prevent trench water, earth or other substances from entering the pipes or fittings.

- F. All pipe and fittings shall be handled with care at all times to avoid damage. All such materials shall be carefully inspected for defects before being lowered into the trench.

- G. METALLIC MARKING TAPE: Detectable mylar marking tape shall be similar to Lineguard, Inc. utility marking tape, Type II or approved equal. The tape shall bear the printed identification "Caution: Water Line Below." The printing shall be under mylar (reverse printed) so as to be readable through the clear mylar. The tape shall be "Blue" in color and shall be two inches (2") or one and one half inches (1-1/2") in width, supplied in one thousand (1,000') foot rolls. Tape shall be twelve to eighteen inches (12"-18") below finished grade. (In addition to the above, locating wire may be required by the Engineer.)

302.07 JOINTING:

- A. General: The Contractor shall obtain the field services of experienced and qualified representatives of the manufacturer whose products are approved for the work to instruct the Contractor's personnel in the proper jointing procedure to be used to secure the best possible joints with the materials selected. The pipe manufacturer shall furnish the contractor and the Engineer a suitable manual covering the recommended procedure for pipe jointing.
- B. Joints shall be installed in strict accordance with the recommendations of the pipe manufacturer.
- C. Joints between any nonmetallic sewer pipe and cast iron pipe, and between new and existing lines shall provide a tight connection and shall be made with standard adapters or other approved methods.

302.08 CONNECTIONS TO EXISTING MANHOLES:

Pipe connections to existing manholes shall be made by core drill opening and installation of a Kor-N-Seal style boot in such a manner that the finished work will conform as nearly as practicable to the essential applicable requirements for new manholes, including all necessary concrete work, cutting, shaping and rechanneling. The connection of the sewer line into the manhole is to be made by a press seal gasket.

302.09 MANHOLES:

- A. Manholes shall be constructed of precast concrete manhole sections in accordance with the contract drawings and the Standard Details complete with frames and covers and step. (See Drawing S-2). Solid concrete block may be used with all joints bonded.

- B. The invert channels shall be smooth and semi-circular in shape, conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. The invert channels in cast-in-place bases shall be dorned directly in the concrete of the base or shall be built up with brick and mortar or grout. The invert channels in precast bases shall be formed with Class A concrete. Floor of the manhole outside of the channels shall be smooth and shall slope toward the channels not less than one inch per foot or more than two inches per foot.

- C. Precast manhole bases, risers and tops shall conform to the requirements of ASTM Specification C478, the Standard Details and the following requirements:
 - 1. Joints shall be of the O-ring rubber gasket type, designed to compress between spigot and the bell rings when the unit is lowered into the section previously installed. Joints shall conform to ASTM Specification C443 or C361.

 - 2. Base sections shall be precast and shall be of the "tub" type that extends above the top of the pipe. Base sections and risers shall be furnished for installation with bell end up.

3. Precast manholes shall be manufactured by the Hanson Pipe and Products, Americast Corporation or approved equal.
 4. The entire annular space shall be sealed with no less than one inch of a quick setting hydraulic compound (mastic) similar and equal to Waterplug as made by Standard Dry Wall Products, Inc., mixed and applied in accordance with the manufacturer's instructions.
 5. The hole where sewer line enters manhole wall a rubber boot shall be used between the sewer line and the manhole wall allowing zero infiltration and exfiltration. Two adjustable hose clamps shall be used to seal the pipe to the Kor-n-seal boot, or approved equal, allowing zero infiltration.
- D. Frames and covers shall conform to the Standard Details. All casting shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers shall fit the frames in any position, and if found to rattle under traffic, shall be replaced. Frames and covers shall be set so that the top of the cover will be flush with or higher than the finished grade as directed. All frame and covers are to be H-20 rated.
- E. Manhole steps shall be plastic or rubber type material or approved equal. The steps shall have a depressed tread or side walls. The step shall project not less than five inches (5") from the inner surface of the wall and shall be firmly anchored to the wall. Steps set in vertical alignment shall be not less than twelve inches (12") wide and steps set in staggered alignment shall not be less than seven inches (7") wide.

- F. Exterior and interior surfaces of manhole shall be coated with an asphalt type material or approved equal which will allow zero infiltration.
- G. A flexible, all-weather joint sealant, thickness to be recommended by manufacturer. (M-30, Flex-Tyte Butyl by Delta Pipe Products) of approved equal, is to be used between all manhole joints, manhole frames and tops of manholes.
- H. Lift holes shall be located on the exterior of the manhole.

302.10 ABANDONING EXISTING SEWERS AND APPURTENANCES:

Existing sewers and appurtenances not required in the completed system shall be abandoned as indicated or directed. Abandoned pipe not removed by new construction shall be plugged with approved stoppers at open ends. Abandoned manholes shall be removed to a depth of not less than two feet (2') below existing grade, filled with approved material and capped as shown on the drawings or as directed. Frames and covers shall be removed from abandoned manholes and delivered to the Town.

302.11 MAINTAINING SEWER SERVICE:

The Contractor shall conduct his operations so as to maintain, at all times, sewer service in the existing system draining through the project. Proper coordination between construction, testing, and replacement or abandonment of sewers will be required so as not to interrupt or block the flow in the sewer system. No existing sewers shall be taken

out of service and abandoned until authorized by the Engineer. When necessary to pump sewage in replacing or connecting to existing sewers, the material pumped shall be carried by means of hose or other watertight conveyors shall not be allowed to flow onto or over the surface. The Contractor shall provide all such temporary facilities required to maintain the sewer service and shall remove the temporary facilities when no longer needed.

302.12 TESTS FOR SYSTEM LEAKAGE:

The Contractor shall prove the watertightness of the sewer system or portions thereof by one of the following tests, at such times as the Engineer may direct.

A. All tests shall be made only under the supervision of the Engineer. The Contractor shall provide all water plugs, weirs and other labor and equipment required for the test and shall make repairs necessary until test results are satisfactory.

B. Low pressure air test:

1. Gravity sewer lines must be tested under low air pressure in accordance with procedures outlined in ASTM C828 Standard Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines after Completion of backfill and approval of compaction.

2. The sanitary sewers and manholes shall be inspected prior to testing and discernible water leaks and debris shall be eliminated.
- C. Infiltration Test: The Contractor shall carefully measure the flow of water at the nearest down-grade manhole. Three (3) series of measurements shall be made at not less than one (1) hour intervals, and the results shall be reduced to an average. This average shall then be computed so as to apply for the twenty-four (24) hour period. Infiltration shall not exceed a rate of one hundred (100) gallons per inch of pipe diameter per mile per day for any section of the system or two thousand four hundred (2,400) gallons per day per mile maximum.
- D. Exfiltration Test: The sewer shall be subjected to a minimum of four feet (4') of head, or head to the top of the manhole, whichever is the lesser, above the crown of the pipe at the upstream manhole of the section being tested. The infiltration test shall be allowed only when it can be shown that the hydrostatic head outside the pipe is a minimum of four feet (4') above the crown of the pipe from the entire length of the pipe being tested. Leakage shall not exceed the maximum rated allowed for infiltration.
- E. Precast Manholes: Manhole Test
1. This test method is only applicable to precast concrete manholes.

2. Manholes should be tested after assembly and prior to backfilling.

3. Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.

4. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specification for which performance information has been provided by the manufacturer and approved by the Bureau.

5. A measured vacuum of ten inches (10") of mercury shall be established in the manhole. The time for the vacuum to drop to nine inches (9") of mercury shall be recorded.

6. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from ten inches (10") to nine inches (9") of mercury. The maximum allowable leakage rate for a four foot (4') diameter manhole shall be in accordance with the following:

<u>Manhole Depth</u>	<u>Minimum Elapsed Time for a Pressure Change of</u>
	<u>1 Inch Hg</u>
10 ft. or less	60 seconds
>10 ft. but <15 ft.	75 seconds

>15 ft. but <25 ft. 90 seconds

For manholes five feet (5') in diameter, add an additional fifteen (15) seconds and for manholes six feet (6') in diameter, add an additional thirty (30) seconds to the time requirements for four foot (4') diameter manholes.

7. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.

8. If a manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

302.13 HOUSE CONNECTIONS:

A. Connection Appurtenances:

1. Thimble for connection to twelve inch (12") and larger unreinforced concrete, and vitrified clay pipe shall be a Fernco coupling with brick supports at each pipe end, or approved equal. At connection of PVC house connection to main of another material, provide Fernco coupling or approved equal, as required for water tight seal and as directed by the Engineer.

2. Cast iron saddles for connection of four inch (4") through ten inch (10") house connections to main line sewer shall be Romac CBR30 or approved equal. Connect to existing PVC main with rubber gasketed tee and straps as indicated on the Standard Detail, provide approved adaptor or coupling and Fernco gasket where required for watertight seal and as directed by the Engineer. Provide Fernco adaptor on PVC house connection at property line or approved equal.

B. Connection Methods:

1. Connect sewer house connections to main lines according to Standard Details. On four inch (4") and six inch (6") house connections provide concrete and transit tee as indicated on the Standard Details. Provide concrete "Y" branch for all other concrete house connections. Provide T's for vitrified clay pipe house connections. Provide PVC "Y" branch for all PVC house connections.
2. Installation of saddles and tapping of existing mains shall be performed only by the Town of Warrenton personnel or approved contractor.

3. All house connections will enter at the base of the cleanout. No house side connections may enter the vertical portion of the cleanout.
4. Do not backfill connection until the Engineer has completed his inspection.
5. Clean-out will be provided at the following locations:
 - a. At the street rights-of-way line
 - b. At the utility easement line
 - c. In accordance with the USBC Plumbing Code
 - d. Spacing to be every fifty feet (50') for a four inch (4") line and every one hundred feet (100') for a line greater than four inches (4").

- e. All cleanouts will be protected by a Bingham and Taylor Model #8250 cast iron flush-mounted inspection box or approved equal, stamped "sewer" standpipe to be protected from vertical loading. Valve boxes need to be made in America, not imported model. (See Drawing S-12)

302.14 CCTV INSPECTIONS:

Prior to a building sewer lateral being tied into a sanitary sewer main and before the first water meter is installed in a subdivision or shopping center, all gravity sanitary sewer mains and storm mains shall be televised by robotic CCTV. The format shall be in digital color .mpgs compatible with the latest Town of Warrenton media, which is currently Windows Media Player. All videos shall be recorded in compliance with the latest NASSCO (National Association of Sewer Service Companies) standards. The video contractor shall be PACP (Pipeline Assessment Certification Program) certified. The video media shall be submitted to the Town of Warrenton's Utilities Technician for review prior to continuing work.

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SECTION 400.00

CONCRETE WORK

SECTION 400.00 CONCRETE WORK

400.01 SCOPE OF WORK:

The work includes the class of concrete indicated or required for completion of the project.

401.00 MATERIALS:

- A. Portland cement shall conform to ASTM Specification C150, Type, II.

- B. Aggregates, both fine and course, shall conform to ASTM Specification C33, natural sand and crushed rock, except that crushed limestone fines may be substituted for natural sand if approved in writing by the Engineer. Course aggregate for reinforced work shall be Size No. 57.

- C. Water used in mixing concrete shall be clean and free from detrimental amounts of acids, alkalis or organic substances.

- D. Reinforcing bars shall be billet-steel, intermediate or hard grade, conforming to ASTM Specification A615 or rail steel bard conforming to ASTM Specification A616. Mesh reinforcement shall be welded steel wire fabric conforming to ASTM Designation A185. Major structures, such as, bridge decks, pier caps, box culvers, etc. to utilize "epoxy-coated" reinforcing steel.

- E. Air-entraining agent shall conform to ASTM Specification C260 and AASHTO M154 and shall be of a type that is compatible with the Portland cement.

402.00 CONCRETE CLASS:

- A. Class A concrete shall be proportioned to produce a compressive strength in twenty-eight (28) days of not less than three thousand (3,000) pounds per square inch, shall contain not more than six (6) gallons of water per sack of cement, and shall be used for reinforced concrete except as indicated otherwise. Six (6) ninety-four (94) pound sacks of concrete shall be used per C. Y.
- B. Class B concrete shall be proportioned to produce a compressive strength in twenty-eight (28) days of not less than two thousand two hundred (2,200) pounds per square inch, shall contain not more than seven (7) gallons of water per sack of cement, and shall be used for non-reinforced concrete except as indicated otherwise.
- C. All materials and processes required to attain the results specified herein shall conform, in general, to ACI Bulletin 613 "Recommended Practice for Selecting Proportions for Concrete." Placement of reinforcement shall be in accordance with the recommendations contained in ACI bulletin 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures." Copies of these bulletins shall be kept on file at the job site.
- D. Forms for concrete shall be made of good quality, sound surfaced material. Forms shall be carefully erected to

correct dimensions and rigidly braced to prevent bulging or deflection during pouring of concrete. Forms must not be removed until concrete has had ample time to set and must be thoroughly cleaned before reusing.

- E. All materials and methods shall be approved by the Engineer. Coarse aggregate shall be used in the greatest amount consistent with required workability. Concrete may be transit-mix, subject to the conditions described above. Test cylinders, if and when required by the Engineer, shall be prepared and tested at the Contractor's expense. Slump cones shall be provided by the Contractor and the slump shall be between one and one half inches (1-1/2") and four and one half inches (4-1/2").

- F. Air-entrained concrete shall be used in curbs, gutters, walks, inlet slabs, and in all other work exposed to freezing action. The air-entraining agent shall be added at the mixer in such quantity as to produce an air content of four and one half percent (4.5%) plus or minus one and one half percent (1.5%) of the volume of the concrete when measured in accordance with ASTM Specification C173 (Volumetric) or ASTM Specification C231 (Pressure). The Contractor shall make air content tests when requested by the Engineer.

403.00 PLACING CONCRETE:

Concrete shall be handled from mixer or transport vehicle to place of final deposit in a continuous manner and as rapidly as practicable. Concrete which has attained its initial set or has contained its water content for more than one and one half (1-1/2) hours shall not be used in the work. Concrete shall not be allowed to drop freely more than five feet (5') in unexposed work nor more than three feet (3') in exposed

work; where greater drops are required, a tremie or other approved means shall be employed. The discharge of the tremies shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than twelve inches (12") thick, and the spacing of the tremies shall be such that segregation does not occur. Immediately after depositing, the concrete shall be compacted by thoroughly agitating in an approved manner to force out air pockets, to work the mixture into corners and around reinforcement and inserts and to prevent the formation of voids. Tapping or other external vibration of forms will not be permitted. Concrete shall only be mixed or placed when the existing or probable ambient temperature is forty degrees (40 F) and rising. Concrete which is found to have been frozen shall be completely removed from the work and replaced with new concrete.

404.00 CURING AND FINISHING:

All concrete shall be protected from premature drying during the curing period, in an approved manner. In exposed work, all metal ties and form spreaders shall be cut back to a depth of not less than one half inch (1/2") and all the holes pointed up flush. All honeycombs and porous surfaces shall be cut back to solid concrete and the spaced filled flush with 1:3 cement and sand grout.

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SECTION 500.00

RESTORATION OF PAVEMENT

SECTION 500.00 RESTORATION OF PAVEMENT

500.01 SCOPE OF WORK:

The work includes providing all excavation, backfill and materials and performing all operations in connection with the restoration of pavement.

501.00 RESTORATION OF PAVEMENT:

- A. All existing pavement disturbed by the installation of the work shall be restored as hereinafter specified. Materials and methods of construction shall conform to applicable provisions of the Virginia Department of Transportation Road and Bridge Specifications. Pavement which shows signs of failure or other defects after completion of restoration shall be removed and replaced by the Contractor at his own expense.

- B. All utility cuts require two inch (2") mill and overlay for a distance of twenty-five feet (25') from center of utility in each direction.

- C. Where trenches have been opened in any roadway or street that is a part of the State of Virginia highway system, the pavement shall be restored in accordance with the requirements of the Virginia Department of Transportation, except that in no case shall the paving restoration be less than required for Class "A" Restoration below.

- D. Where trenches have been opened in any roadway or street other than those part of the State of Virginia highway system. The pavement shall be restored as per Class B restoration below.

502.00 WATERMAIN, SANITARY SEWER, STORM DRAIN AND STREET CONSTRUCTION

GENERAL:

1. Class "A" Restoration: The existing paved surface shall be cut (by saw cut only) vertically and horizontally in a smooth straight line to present a neat appearance. The paved surface shall be removed and all cut edges shall be tacked with CRS-2 or RC-250 Asphalt Materials or approved equal. The application of the tack shall be under the direction of the Town Engineer or his authorized representative. The trench shall be backfilled as specified and the top eighteen inches (18") of the trench shall be filled with twelve inch (12") aggregate base course (compacted to ninety-five percent (95%) by AASHO Standard T99) of 21A or approved equal, four inches (4") BM-2 Bituminous base course and a two inch (2") minimum SM-2A bituminous surface course.

2. Class "B" Restoration: The existing paved surface shall be cut (by saw only) vertically and horizontally in a smooth straight line to present a near appearance. The paved surface shall be removed and all cut edges shall be tacked with CRS-2 or RC-250 Asphalt Material or approved equal. The application of the tack shall be under the

direction of the Town Engineer or his authorized representative. The trench shall be backfilled as specified and the top ten inches (10") of the trench shall be filled with a six inch (6") aggregate base course (Compacted to ninety-five percent (95%) by AASHO Standard T99) of 21A or approved equal, and a four inch (4") minimum BM-2 Bituminous base course. This paving shall be maintained on grade until the Town Engineer or his authorized representative directs that permanent surface course shall be placed. The permanent surface course shall be double bituminous surface treatment bonded to match the existing pavement with an eight inch (8") overlap on each side of the trench edges.

3. Time Frame for Restoration: All Class "A" or Class "B" restoration shall be completed the same day of excavation unless approved otherwise by the Town Engineer or his authorized representative.
4. Compaction of sub-grade or aggregate base to be minimum of ninety-five percent (95%) theoretical maximum density as per Section 320 of the Virginia Department of Transportation Road and Bridge Specifications.
5. Compaction of bituminous asphalt to be an average of ninety-five percent (95%) within guidelines of Section 320 above.
6. Concrete curbs, gutters, driveways and walks shall be restored to the size, type and shape as required to match existing conditions. Damaged sections shall be replaced with complete new sections or

squares; patching of damaged sections will not be permitted.

7. Brick, cobble or other types of pavement shall be restored to match the existing pavement.
8. Unpaved Roads: All unpaved roads or traveled rights-of-way shall be restored with a twelve inch (12") minimum soil aggregate surface course, Gradation "C", properly compacted and bonded.
9. Unless specified otherwise on contracts funded by the "Town", the pavement width for payment for trenches, manholes, structures or pipeline excavations and associated restorations, shall be limited to the diameter of the pipe or structure, plus three foot (3') maximum regardless of the depth of the trench.

503.00 MAINTENANCE OF RESTORED PAVEMENT:

- A. The Contractor shall maintain at his own expense all refilled excavations and restored pavement in proper condition until the end of the one (1) year period following the date of final acceptance of the work. All depressions appearing shall be properly refilled, brought to grade and pavement restored. If the Contractor shall fail to do so within a reasonable time after the receipt of written notice from the Engineer, the Engineer may refill and restore said depressions and the cost thereof shall be charged to the Contractor. In case of emergency, the Owner may refill and restore any dangerous depressions without giving previous notice to the

Contractor and the cost of so doing shall be charged to the Contractor.

- B. The Contractor shall be responsible for any injury or damage that may result from improper maintenance of any refilled excavations at any time previous to the end of the above mentioned one (1) year period.

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SECTION 600.00

STORM SEWER

SECTION 600.00 STORM SEWER

601.00 GENERAL:

All storm water collection and management facilities shall be designed and constructed in accordance with the most current Stormwater Management Ordinance of the Town, the Virginia Stormwater Management Regulations and the Northern Virginia BMP Handbook. All storm water collection and management facilities are to meet the most current versions of the "Drainage Manual", the "Road Designs and Standards", and the "Road and Bridge Specifications: of the Virginia Department of Transportation.

Storm drainage systems shall be designed on the basis of ultimate development of the tributary watershed. The proposed land use shown on the comprehensive plan shall be used as the basis for determining runoff. The review of all storm drainage systems shall be approved by the Director of Public Works.

601.01 REFERENCES

The following documents are included by reference for storm drainage design within the Town of Warrenton limits:

- a. The Virginia Department of Transportation Drainage Manual prepared by the Location and Design Division, Hydraulic Section, adopted January 1, 1980, as amended, Virginia Department of Transportation.

- b. The Virginia Department of Transportation Road and Bridge Specifications, latest edition.

- c. Urban Stormwater Management, Course "C". The Virginia Soil and Water Conservation Commission, 203 Governor Street, Suite 206, Richmond, VA 23219.

601.02 GENERAL REQUIREMENTS

The drainage system shall be designed:

- a. To generally honor all natural drainage divides and create no adverse impact on downstream properties.

- b. To account for all off-site and on-site surface water.

- c. To convey discharge surface waters to a natural watercourse; i.e., a natural watercourse at the natural elevation.
- d. To convey and discharge surface waters to a storm water detention facility of sufficient capacity to accommodate the design-year event.
- e. To protect residences and other occupied structures from being inundated with storm water.

The owner or Developer may continue to discharge storm water as sheet flow (non-concentrated) into a lower-lying property if at the same location and:

- a. The post-development peak rate based on documentation and computations, including sheet flow, does not exceed the predevelopment peak rate; and
- b. If the above conditions are not met, the developer must provide a drainage system satisfactory to the Director, to preclude adverse impacts upon adjacent or downstream properties.

The Owner or Developer may not discharge storm water which has been artificially concentrated by a pipe, culvert, channel, or other drainage structure, onto or through lands of another without first obtaining and transferring to the Town a permanent storm drainage easement to guarantee continuity of an outfall from the point of discharge to the nearest natural watercourse.

If off-site downstream construction and easements are required to construct an adequate channel outfall, no permits shall be issued until such storm drainage easements, extending to the nearest natural watercourse have been obtained and recorded. It will be the responsibility of the Developer to obtain all off-site easements.

Generally there may not be a reduction in pipe size along the direction of flow except for SWM purposes.

602.00 HYDROLOGY

Equations presented herein are those that are most often used. Specific references for methods used are provided for the designer. The designer may choose to use methods other than those provided; however, the validity and applicability of those methods must be demonstrated and references provided. Concentrated flows for the ten-year event in excess of four (4) cubic feet per second (cfs), shall be conveyed by a designed storm drainage system or adequate existing natural channel.

602.01 PEAK DISCHARGE (METHODOLOGY)

- A. Rational Method (P=C CIA)
 - 1. Use for watersheds up to 200 acres.
 - 2. Refer to Drainage Manual for details.

- a. Time of Concentration (t)
 - Overland Flow Time (up to 2000 feet)
 - (Drawing No. D-10)
 - Channel Flow Time (Drawing No. D-11)

- b. Rainfall Intensity (II)
 - Rainfall Intensity Curve (Drawing No. D-12)

- c. Runoff Coefficients (C) (Drawing No. D-13)

- d. Correction Factor for Ground Saturation (Cf)
 - 10-year storm or less: 1.0
 - 25-year storm: 1.1
 - 50-year storm: 1.2
 - 100-year storm: 1.25

B. Anderson Method ($Q=230 KRA^{x-0.48}T$)

- 1. Use for Watersheds over 200 acres.

- 2. Refer to Drainage Manual for details.
 - a. The exponent x in the equation shall be:
 - 1.0 from 200 acres to 1 square mile

0.82 for over 1 square mile

C. TR-55 (Peak Discharge Method)

1. Use for watersheds with a time of concentration of 2 hours or more.
2. Refer to TR-55 for details.

D. TR-20

1. Use for watersheds larger than 1 square mile.
2. Refer to TR-20 and NEH-4 for details.
 - a. Sub-areas should not exceed 200 acres.

E. Stormwater Management Model (SWMM)

1. Watersheds are a function of inlet location.
2. Refer to SWMM MANUAL for details.
3. Runoff output must show agreement to within 10% of other method, A-D above.

602.02 HYDROGRAPHS (METHODOLOGY)

- A. Modified Rational
 - 1. Use for watersheds up to 200 acres.
 - 2. Refer to the Drainage Manual.

- B. Unit Hydrograph (2 hour duration storm)
 - 1. Watershed limitations are the same as those outlined in Section 602.01. The overall drainage area can be broken into 200 acre sub-areas such that the peak runoff rate for each sub-area is computed by the Rational Method.
 - 2. Refer to NEH-4 and Drawing No. D-14 for details.

- C. TR-55 (Tabular Method)
 - 1. Use for watersheds with up to a two (2) hour time of concentration. Lesser times of concentration can be obtained using s-curve techniques.
 - 2. Refer to TR-55 for details.

- D. TR-20

1. All watersheds.
2. Sub-areas should not exceed 200 acres.
3. Refer to NEH-4 for details.

602.03 DESIGN STORMS

A. Culvert and Bridges:

1. Primary/Arterial Highways.
 - a. 25-year storm, minimum
2. Secondary/Non-Arterial Highways.
 - a. 10-year storm, minimum

B. Stormwater Management Facilities:

All storm water management facilities will be designed and constructed to the latest version of the "Virginia Stormwater Management Regulations, the Northern Virginia BMP Handbook, and the Virginia Erosion and Sediment Control Handbook" at the minimum. The Town Engineer may

enforce stricter design or construction at his discretion.

1. Principal Spillway

- a. Design to release a post development peak 2-year and 10-year storm at a maximum of the predevelopment 2-year peak and 10-year rate, respectively.

2. Emergency Spillway

- a. Design storm based on dam height and impoundment size, refer to Drawing No. D-15. Height of dam will be measured from the downstream toe of the dam to the top of the embankment.
- b. One foot of freeboard will be provided above the 100-year storm peak discharge. Principal spillways having areas less than 24 square inches shall be considered as inoperative.

3. The point of discharge shall be to a channel, storm sewer, natural water course, or other adequate channel.

C. Storm Sewers

1. Pipe
 - a. 10-year storm, minimum

2. Inlets
 - a. 2-year storm, minimum and a maximum spread of no more than 8 feet (8') from the curb line. However, the designer should always be aware of the potential for flooding on adjacent property resulting from overtaxed inlets and should increase his design storm accordingly.

603.00 HYDRAULICS

603.01 CULVERTS

- A. Refer to Drainage Manual and NEH-5 for detail discussions on designing culverts. The culvert design Drawing No. D-40 shall be completed showing both head and tail water conditions.

- B. Size and Length Restrictions:
 1. 15 inches, minimum equivalent diameter.

 2. 15 inches to 42 inches equivalent diameter.

- a. 300 feet for pipes (24") in diameter and smaller.
- b. 400 feet maximum length for pipes greater than (24") in diameter.

C. Headwater Depth Restrictions:

1. The most restrictive of the following conditions for headwater depth shall govern the size of the culvert.
 - a. Headwater/culvert diameter = 1.0 to 1.5
 - b. Headwater depth shall be at least 18 inches below the shoulder of a public road and equal to the shoulder for culvert parallel to a public road.
 - c. Maintain the existing 100-year floodplain elevation (Federal Insurance Agency or those required by these regulations) by more than one (1) foot.
 - d. Must obtain drainage easements to encompass the headwater pool for a 100-year storm. If the 100-year flood level on adjacent properties (not owned by the developer) remains unchanged after installing the culvert, this drainage easement requirement will be waived.

D. Material:

1. All culverts to be maintained by the Town shall be concrete if placed in the roadway or parking lots and may be Smooth-double wall High Density Polyethylene if placed in grass covered areas that are not to receive vehicular traffic with Classification or gauge based on the design load.
2. Driveway culverts are to be constructed of bituminous coated corrugate metal pipe a minimum of 24 feet long.
3. All appurtenances such as end sections and endwalls shall conform to the most current version of the VDOT Standards and VDOT Specifications.
4. The joints are to be sealed of all pipes with any portion of the hydraulic gradeline above the pipe.

E. Plan and Profile Requirements:

1. Scale:

Horizontal: 1"=50', maximum

Vertical: 1"=10', maximum

2. Delineate culverts and appurtenances with:
 - a. Flow direction arrows.

- b. VDOT Std. Designation.
 - c. Pipe size, material, classification, gauge, slope, length.
 - d. Hydraulic Gradeline.
 - e. Invert elevations, maximum design head and tail water depth, design flow, and design cover.
 - 1) Minimum cover shall conform to VDOT Standards.
3. Planimetric and topographic information shall include:
- a. Existing and finished grades.
4. Utility crossings
- a. Show all utility crossings in plan and profile
 - b. Refer to State Health Department Regulations for sewer and water conflicts, otherwise, provide an 18 inch minimum vertical separation.

5. Easements (must agree with plat)
 - a. Must be recorded on either the subdivision plat for the development or on a recorded individual parcel plat.
 - b. Refer to Drawing No. D-17 for required easement width.
6. Bench mark with elevation and description referenced to the NAVD88.
7. A north arrow referenced to true north.
8. Details
 - a. Special designs other than VDOT Standards shall be certified by a Professional Engineer licensed in the Commonwealth of Virginia and are subject to the approval by the Town Engineer.

603.02 OPEN CHANNELS

- A. Refer to Drainage Manual, NEH-5, Northern Virginia BMP Handbook, and the Erosion and Sediment Control Handbook for detailed discussion on designing open channels.

B. General

1. Design Criteria

a. Watersheds up to one (1) square mile.

1) Full bank capacity: 10-year storm.

2) Lining to withstand the 2-year storm velocity.

a) Acceptable velocity limits for various types of lining are shown on Drawing No. D-16.

b. Watersheds in excess of one (1) square mile.

1) Full bank capacity: 10-year storm with a one foot (1') freeboard must be confined within the easement or right of way.

2) Lining to withstand the 10-year storm velocity. If there is a potential for catastrophic failure (i.e. dams, etc.), the lining shall withstand the 100 year storm velocity, otherwise use the 10-year storm velocity. Acceptable velocity limits for various types of lining are shown on Drawing No. D-16.

2. Design Methodology

a. Manning's Equation

1) Usage

a) Uniform channel cross-section

b) Uniform channel slope

c) Natural cross-sections at specific locations

i) No downstream obstructions

ii) Relatively uniform cross-section and slope

b. Backwater Analysis (Step Method)

1) A backwater analysis shall be used in the following situations:

a) Non-uniform channel slope

b) Non-uniform cross-section

evaluations

c) Multiple cross-section evaluations

i) Downstream obstruction

ii) Hydraulic jumps

iii) Transitional structure

iiii) Floodplain evaluations

2) Acceptable computer models are:

a) HEC-2

b) WSPRO

c. Critical Depth: Since supercritical flows include wave action, air bulking, and splash; all channel computations shall include critical depth calculations.

For supercritical flow (flow depth less than the computed critical depth), provide freeboard H in feet.

- a) $H=0.25V(d)$
V=velocity (fps)
d=maximum depth (ft)

d. Super elevation through bend/curves

- 1) For open channels in a bend/curve, the design depth shall be increased by H, with

- a) $H= 2.3 V /g \text{ Log } (R/R)$
H= Super elevation (ft)
V= Average velocity (fps)
g= 32.2 ft/sec
R= Outside radius (ft)
R= Inside radius (ft)

C. Plan and Profile Requirements

- 1. Scale: Horizontal: 1"=50', maximum
Vertical: 1"=10', maximum
- 2. Delineate open channel and appurtenances with:
 - a. Flow direction arrows

- b. VDOT Standard designation
 - c. Stations
 - d. Invert elevations, design depth, design flow, velocity, and grades (ft/ft)
 - e. Lining by station
 - f. Minimum Grades (Man made channels)
 - 1) Grass and Rip-rap
 - a) 1 percent (0.01 ft/ft) or greater
 - 2) Paved (Concrete or Bituminous)
 - a) 0.5 percent (0.005 ft/ft) or greater
 - g. Typical Section
3. Planimetric and topographic information shall include:
- a. Existing and finished grades
4. Utility crossings

- a. Show all utility crossings in plan and profile.
 - b. Refer to State Health Department Regulations for sewer and water conflicts. Otherwise, provide a minimum cover for utilities of 42 inches, where 42 inch cover cannot be met encase in concrete.
5. Easements (must agree with plat)
- a. Must be recorded on either the subdivision plat for the development or on a recorded individual parcel plat.
 - b. Refer to Drawing No. D-17 for required easement width.
6. Bench mark elevation and description referenced to NAVD88.
7. A north arrow referenced to true north.
8. Details
- a. Special designs other than VDOT Standard shall be certified by a Professional Engineer licensed in the Commonwealth of Virginia.

603.03 STORM SEWERS

- A. Refer to Drainage Manual and NEH-5 for detail discussions on design procedures.

- B. Size and length restrictions between manholes:
 - 1. 15 inches, minimum size

 - 2. 15 inches to 42 inches
 - a. 300 feet maximum length for pipes between 15" and 24" in diameter.

 - b. 400 feet maximum length for pipes greater than 24" in diameter.

 - 3. 48 inches and larger
 - a. 500 feet maximum between structures.

- C. Materials:
 - 1. All appurtenances such as manholes, inlets, etc. shall conform to VDOT Standards and VDOT Specifications.

2. Only reinforced concrete pipe may be used for roadway culverts. HDPE Pipe may be used in areas where no vehicular traffic is expected and bituminous coated corrugated metal pipe may only be used for driveway culverts.

3. All pipes used for the construction of storm sewer systems shall be concrete. Concrete pipe, whether designated for use within the right-of-way of a public street or thoroughfare or beyond the limits of a street right-of-way, shall meet the three-edge-bearing strength test requirements for ASTM C76 [Class III Beyond R/W Class IV in R/W] reinforced concrete pipe, latest revision. Culvert pipe classed as "seconds" by the manufacturer or pipe which has been rejected from another project shall not be permitted for use. Class will be increased above these requirements based on height of cover. The laying length shall not be less than three (3) feet.

D. Plan and Profile:

1. Scale: Horizontal: 1"=50', maximum
Vertical: 1"=10', maximum

2. Delineate storm sewers and appurtenances with:
 - a. Flow direction arrows.

 - b. VDOT Standard designation.

- c. Pipe size, material, classification, gauge, slope, and length.
 - d. Invert elevations, top elevations, design depth, hydraulic gradeline, design flow, design cover, invert shaping in inlets and manholes.
 - 1) Minimum cover shall be required to VDOT Standards and Specifications.
 - e. Manholes and inlets numbered.
3. Planimetric and topographic information shall include:
- a. Existing and finished grades
 - b. Watershed map of area with the watershed boundaries shown on a 1"=200' scale map having a contour interval not less than 5 feet.
4. Utility crossings
- a. Show all utility crossings in plan and profile.

b. Refer to State Health Department Regulations for sewer and water conflicts. Otherwise, provide a minimum separation of 18 inches.

5. Easements (must agree with plat)

a. Must be recorded on either the subdivision plat for the development or on a recorded individual parcel plat.

b. Refer to Drawing No. D-17 for required easement width.

6. Bench mark elevation and description referenced to NAVD88.

7. A north arrow referenced to true north.

8. Details

a. Special designs other than VDOT Standards shall be certified by a Professional Engineer licensed in the Commonwealth of Virginia and upon approval of the Town Engineer.

9. For all storm sewers the hydraulic grade line shall be computed and shown on the pipe profile.

E. Anchors

Anchors will be required to prevent sliding when the slope exceeds 16%, and adequate erosion control shall be installed at the outlet to prevent undermining of the endwall. A cut-off wall will be required at outfalls of pipes systems exceeding 16% slopes. (Slopes over 20% are not acceptable unless specifically approved by the Director of Public Works.

F. Inlet Design Criteria

The spread of water on roadway pavements shall be limited to eight (8) feet from the face of curb.

G. Grate Inlets and Yard Inlets

Grate and yard inlets in a sump locations shall be designed assuming 50% clogging. These inlets operate as weirs at shallow depths and as an orifice at greater depths. Grates of larger dimension and grates with more open area; i.e., with less space occupied by lateral and longitudinal bars, will operate as weirs to greater depths than smaller grates or grates with less open area. Refer to Virginia Department of Transportation Drainage Manual, Chapter 4, Section 6.3, for specific grate inlet design.

Grate inlets are prohibited within commercial and residential driveway entrances.

H. Conveyance Channels

Man-made channels are typically trapezoidal or other geometric sections and may be either natural or artificially lined. Hydraulic capacity shall be determined by the procedure outlined in Chapter 5 of the Virginia Erosion and Sediment Control Handbook. The computed velocity shall approximate the assumed velocity used to determine the Mannings's "n" value.

All open channels shall be designed to contain the ten-year event. Plans shall account for overland relief resulting from less frequent events.

Stormwater conveyance channels conveying more than fifteen (15) cubic feet per second are prohibited within or through residential subdivisions and in no case shall the top width of the channel on an adjacent non-residential property be within twenty-five (25) feet of a residential property line.

I. Lot Drainage Swales

Swales for lot drainage shall conform to the standards for grass-lined conveyance channels based on the ten-year event.

An inlet shall be provided to intercept lot drainage flow when any of the following conditions apply:

- a. The lot drainage swale extends more than 200 feet.
- b. The lot drainage swale conveys more than three (3) cubic feet per second.

- c. The Drainage area includes three (3) or more adjacent lots.

Lot drainage swales shall not discharge in excess of two (2) cubic feet per second based on the two-year event.

J. Grading Alternatives

In the past, lot grading plans have been submitted in which several lots were graded so that they drained toward a general area of the rear yards, and the said drainage would then run in an open swale through the rear yard to some point where the swale was brought between two adjacent house, then flowing over the sidewalk and into the street gutter to be subsequently intercepted by a curb inlet.

Few problems seem to arise with this method of routing stormwater if the volume of water so routed is relatively small. However, utilizing the side yards between houses as a route for a significant amount of surface water can create problems. Also, the discharge of such significant volumes of water at one point across the sidewalk or in yards is undesirable.

Lot grading should be handled as follows:

- A. Install an adequate yard inlet (or yard inlets at intervals) in the mid-block drainage swale with the stormwater being intercepted by the yard inlet and carried in an underground storm drainage pipe

system between houses to connect with the storm sewer system in the street.

- B. When water is collected in a mid-block drainage swale, the overlot grading should be designed such that it is frequently routed towards the street between houses so that only two lots drain between one pair of adjacent houses, rather than bringing the entire volume of stormwater to the street between one adjacent pair of houses. This method may not be adequate and yard inlets may be required by the Director.

- C. Lot grading plans for subdivision houses should be designed so that if stormwater is collected in a mid-block swale along the rear yards and routed toward the street in an open swale running between two adjacent houses, the maximum allowable watershed area for such a surface swale passing between two adjacent houses shall be one (1.0) acre or two lots.

603.04 INLET AND OUTLET PROTECTION

- A. Applicability
 - 1. Inlet and outlet protection shall be provided for all culverts, storm sewers, open channels, spillways, etc.

- B. An evaluation shall be performed for each proposed development to assure compliance with State Law and Town Code concerning stormwater management.

Stormwater management must be verified with engineering calculations for the design-year event as defined herein, in accordance with the procedures outlined in the Virginia Erosion and Sediment Control Handbook, latest edition, or other methods approved by the Director.

An adequate outfall within the town shall be defined as:

- 1. A well defined (i.e., with bed and banks) natural or manmade channel which is capable of conveying the post development for the design-year event, as defined herein for the particular shed in which the development is proposed, without eroding or overtopping its banks. The 2-year frequency storm should be used for a natural channel and a 10-year frequency should be used for a manmade channel. The channel should not overtop the banks or exceed the permissible velocity of the channel lining.

C. Standard End Walls and Endsections

- a. A four (4') foot tall fence or protective railing shall be installed at the top of the end section or integrally on top of the endwall for the portion of the wall where the drop is greater than three feet (3').
- b. The protective railing must have no opening greater than six inches.

- c. The protective railing must be of corrosion resistant material and must not obstruct the overland relief.
- d. All storm sewer pipes or systems including energy dissipating devices shall be constructed to the back of property line to protect adjacent properties. Where a storm system terminates at a rear property line above the toe of a fill slope, the storm sewer system shall be continued to the toe of the slope either by means of additional sewer pipe or paved ditch.

D. Erosion Protection

1. Culvert or Conduit Outlet

a. Length

- 1) Refer to Drawings Nos. D-23 & 24

b. Material

<u>Outlet Velocity</u>	<u>Material</u>
0-4 fps.....	Sod Protection
4-10 fps.....	EC-1, Type A (See Drawing No. D-16 for exceptions)
10-18 fps.....	EC-1, Type B
18 + fps.....	Special Design Dissipater

2. Open Channels

<u>Channel Velocity</u>	<u>Material</u>
0-4 fps.....	Sod Protection (See Drawing No. D-16 for exceptions)
4-7 fps.....	EC-3, Type A
7-10 fps.....	EC-3, Type B
10-14 fps.....	EC-1, Type A
14-19 fps.....	EC-1, Type B (Refer to the Drainage Manual)
19 + fps.....	Special Design

3. Plans

- a. Shall be shown on appropriate plan and profiles. (e.g.; Outlet protection for culverts should be shown with culvert plans.)
- b. Provide details
 - 1) Stone size and/or type
 - 2) Depth, length, cross-section

603.05 DESIGN METHODOLOGY

A. Detention Basins

1. Refer to section 602.02 for design hydrographs and section 602.03 for applicable design storms. Refer to Northern Virginia BMP Handbook, Figure 3.1 for a typical cross section.
2. Refer to NEH-4, DRAINAGE MANUAL or SWMM Manual for routing procedures.
3. Emergency Spillway Design
 - a. Preference should be given to Broad Crested Weirs. Refer to Drawing No. D-20 & 21 for design details.
4. Principal Spillways
 - a. Preference should be given to sharp-edged orifices. Refer to Drawing No. D-22 for design details.
 - b. Anti-Seep Collars:

Anti-seep collars shall be installed around all conduits through earth fills of all wet ponds and for all dry ponds whose draw down time exceed twenty-four (24) hours.

Impoundment structures incorporating anti-seep collars shall use the design criteria in the Virginia Erosion & Sediment Control Handbook, Latest Edition, and the following:

1. Sufficient collars shall be placed to increase the seepage length along the conduit by a minimum of 15% of the pipe length located within the saturation zone.
2. The assumed normal saturation zone shall be determined by projecting a line with a slope of four (4) horizontal to one (1) vertical from the point where the normal water elevation touches the upstream slope of the fill to appoint where this line intersects the invert of the conduit. All fill located below this line may be assumed to be saturated.
3. For ponds that are normally dry, the starting elevation shall be the maximum water surface elevation in the pond when the principal spillway storm is routed through the structure.
4. Maximum collar spacing shall be fourteen (14) times the minimum projection of the collar measured perpendicular to the pipe.
5. Minimum collar spacing shall be five (5) times the minimum projection of the collar measured perpendicular to the pipe.
6. All anti-seep collars and their connections to the conduit shall be water tight. Antivortex Devices. Drop inlet spillways are to have adequate antivortex devices.

5. Embankment/Dam Design

- a. Actual design, construction, and as-built plans shall be certified by a Professional Engineer licensed in the Commonwealth of

Virginia and shall be in accordance with the Virginia Department of Conservation, Dam Safety Section. Where the dam embankment is part of a roadway, the design shall conform to Chapter 7 of the Drainage Manual.

6. Miscellaneous

- a. Stormwater management easements shall extend 15 feet outside the maximum pool stage and toe of embankment/dam or to a public road right of way. When a facility is next to a public road right of way, the owner/developer must define a method of maintenance acceptable to the Town of Warrenton.
- b. If the facility is over four (4) feet deep, takes over two (2) hours to drain, has interior slopes in excess of 3(H):1(V), or is in a medium to high density residential area, permanent fencing shall be required.
- c. Minimum slope of basin "floor" shall be one (1) percent to principal spillway. (Does not apply to "wet" ponds.)

B. Infiltration Trenches

1. The use of infiltration trenches shall be limited to areas where runoff will be relatively free of chemicals and silt. The use of "grass filter" strips between small parking areas and infiltration trenches may be used to refuse chemicals and silt sufficiently to protect the groundwater from

chemicals and the trenches from clogging with silt. Refer to Northern Virginia BMP Handbook, Chapter 4 - Infiltration Trenches and Drawing No.D-28 in these regulations.

2. Refer to Section 602.02 for the design hydrographs and section 602.03 for applicable design storms.
3. Refer to NEH-4 or Northern Virginia BMP Handbook for routing procedures.
4. Determination of Infiltration Rates shall be by a soil scientist licensed by the Commonwealth of Virginia.
5. Infiltration trenches shall be constructed in accordance with Fig. 4.1 of the Northern Virginia BMP Handbook.
6. The site grading plan shall show a means of draining an infiltration trench if the trench is surcharged.
7. Under no circumstances shall an infiltration trench take more than forty-eight (48) hours to completely drain.

C. Underground Detention General Requirements

1. All underground detention facilities shall have prior approval of the Director.

2. Private underground stormwater management facilities utilizing corrugated metal pipe (CMP) will be approved, if the conditions listed below are satisfied:
 - A. Pipe must be aluminum CMP or aluminized steel CMP.
 - B. All access structures, manholes, inlets, and control structures must be reinforced concrete meeting Virginia Department of Transportation standards.
 - C. Calculations must be submitted to demonstrate that the structure will withstand the expected traffic loading in paved area.
 - D. All construction details must be provided.
 - E. Structures must not be placed under the main site accessways or within ten (10) feet of the public right-of-way.

Underground systems conveyed to the Town must be constructed entirely of reinforced concrete.

3. Design Criteria

Underground detention shall be a closed tank or pipe system.

Sediment traps and trash racks shall be provided. These should be placed near maintenance access points.

All underground facilities shall have at least two (2) points of access to facilitate maintenance. The Director may require additional access points if it is necessary for the required maintenance.

All underground detention facilities shall have spillways designed to accommodate the design-year event, while providing detention for the 2-year event as required.

All facilities shall provide for adequate overland relief for runoff in excess of the ten-year event. Routing of the 100-year event through the underground detention facility is not required.

Peak runoff rates from the facility shall be less than or equal to both of the design-years' pre-development runoff rates.

For single conduit facilities that carry off off-site water or those to be publicly maintained, easements shall be determined and recorded based on a vertical one-to-one slope starting at the tank's invert and extending around the perimeter of the tank.

For large facilities with multiple conduits, an easement shall be provided which shall extend from the outside vertical edge of the conduit at a one-to-one slope to finished grade to allow for major replacements.

All underground retention basin shall be constructed of RCP or HDPE double-wall pipe, no corrugated metal pipe may be used regardless of coating, unless approved by the Director.

D. Best Management Practices and Stormwater Quality (BMP)

All development or redevelopment within the Chesapeake Bay Preservation Act Overlay District or within the Occoquan Reservoir Watershed shall incorporate water quality measures (Best Management Practices) designed to reduce the amount of water pollution generated thru nonpoint sources.

The SWCB and other agencies have developed manuals for BMP's which set forth an economically feasible program to control nonpoint source pollution in State waters. Developers and engineers are encouraged to refer to these Manuals or to seek other better methods to achieve the same goal.

The most current edition of the "BMP Handbook for the Occoquan Watershed" prepared by the Northern Virginia Planning District Commission (NVPDC) shall be used in and reviewing BMP facilities.

E. POLLUTION LOADS

To provide for effective pollutant removal, required BMP volume shall be provided in facilities distributed properly within the site when required by the Director.

Pollutant Removal Rates for Dry Ponds

TABLE 1
 Average Annual Pollutant Removal Rates
 For Extended Detention Dry Ponds
 (Source: NVPDC, November 1979)

Land Use Nitrogen Percent	Sediment Percent	Total Phosphorus Percent
Large Lot Single Family 21 (½ Acre +)(12 Percent Impervious)	88	33
Medium Density Single Family 35 (Less than ½ Acre) (25 Percent Impervious)	89	40
Townhouse/Garden Apartment 36 (40 Percent Impervious)	88	48
High Rise Residential/Industrial 23 (70 Percent Impervious)	93	43

Shopping Center

24

94

47

(90 Percent Impervious)

F. METHODS TO ACHIEVE THE ABOVE GOALS

The following methods are considered acceptable:

1. Structural measures that store stormwater and rely upon solid settling processes to remove pollutants (minor modifications could practically convert a stormwater detention facility to a multipurpose facility satisfying both water quality and quantity needs). Extended detention ponds and wet ponds are examples of acceptable structural measures.
2. Volume control BMP like porous pavement, modular pavement, and infiltration pits or trenches (when the soil permeability allows it) is also encouraged for use.
3. Entering into a joint effort with other developers to provide appropriate multi-site facilities.
4. Entering into an agreement with the City, subject to prior approval by the Director of Public Works, which provides for a financial contribution for off-site SWM and BMP. Such contributions shall be held by the City and used only for SWM and BMP facilities within the major drainage basin within which the developer's project is located. The City itself may construct such facilities, or may use the contributions to reimburse developers who provide SWM facilities in excess of their own needs.

5. For a redevelopment site that is completely impervious as currently developed, restoring a minimum of 20% of the site to vegetated open space.
6. Preservation of existing or indigenous vegetation in conjunction with minimizing impervious cover.
 - a. In accordance with the C.B.P. Area Designation and Management Regulations (VR-173-02-01), the 100 foot buffer area is deemed to achieve a 75% reduction of sediments and a 40% reduction of nutrients. To achieve this effectiveness the method of flow over and through the buffer must be of a nature (generally sheet flow) that promotes sedimentation and nutrient uptake. A large drainage area resulting in high volumes or velocities flowing through a concentrated swale cannot be rationalized to have this effectiveness. Research has indicated that concentrated flows are not treated effectively in natural open spaces.
 - b. Large lot residential subdivisions (five (5) acre lots) are considered to meet these criteria.
 - c. For non-regional facilities, a one-for-one credit for those facilities serving off-site developed areas, which are not served by other BMP facilities, may be earned. These credits may be used to compensate for uncontrolled on-site areas, provided the total area served by compensation does not exceed 30 percent of the total site.

G. DESIGN CRITERIA

BMP volumes may also be determined using percentages impervious pursuant to BMP handbook guidelines.

H. BMP VOLUME CRITERIA

Dry Ponds: Dry ponds may be considered BMP facilities when they provide a minimum of 50% of the BMP storage volume for the upstream drainage area.

Wet Ponds: Wet ponds may be considered BMP facilities if the normal pond volume is a minimum of three (3) times the required BMP volume, or storage is provided above the wet pool elevation.

Open Area Credit. In areas not draining to a BMP facility, it is possible to receive BMP credit if the runoff is discharged by sheet flow over undeveloped, undisturbed open spaces.

Sediment Disposal. An on-site disposal area for pond sediment should be delineated on plans. It shall be sized to receive a minimum of two dredging cycles. The dredging cycle for extended detention dry ponds is once every five (5) to ten (10) years and for wet ponds, every fifteen (15) to twenty (20) years.

Extended detention dry ponds provide pollutant removal capability due to prolonged release periods (minimum forty (40) hours, maximum forty-eight (48) hours.)

I. EXTENDED DETENTION BMP WET PONDS

Extended detention BMP wet ponds provide for a more efficient removal of pollutants due to the increased

sediment settlement and by discharging the flow from below the water surface.

Soil permeability should be evaluated to determine the ability of the pond site to maintain a permanent pool of water.

Inadequate base flow can lead to nuisance situations such as unattractive vegetation and the development of mosquito breeding areas.

The use of aquatic plants located within a shallow portion of the pond is recommended to increase nutrient removal on a case by case basis.

If the soil at the pond site is too permeable to hold water, steps must be taken to reduce the seepage by sealing the floor of the pond.

Sealing may be done by using a clay blanket which contains a well graded mixture of soil containing at least 20% clay. The clay blanket must have a minimum thickness of twelve (12) inches and be spread uniformly in layers of six (6) to eight (8) inches. These layers are to be compacted under optimum moisture conditions using a sheepsfoot roller.

The use of man-made plastic pond lining may be allowed with prior approval of the Director. In such cases, details shall be made as part of the submission describing the exact type of liner.

For additional design criteria and examples of BMP facilities, refer to the BMP handbook for the Occoquan Watershed, Northern Virginia Planning District Commission, Annandale, Virginia, August 1987.

J. FACILITIES NOT ALLOWED

Underground structures which detain flows and provide no in-ground percolation or have not been documented to reduce pollution loads are not allowed.

K. OTHER STORMWATER MANAGEMENT FACILITIES

1. The developer's engineer shall provide documentation as to the applicability and design of alternative stormwater management facilities such as percolation trenches, rooftop storage, etc.
2. Alternative methods will be reviewed and approved based on individual project merits.

L. Plans

1. Scale: 1"=30' up to five (5) acres, otherwise 1"=50'
2. Existing and proposed contours with sufficient spot elevations to adequately describe the project.
 - a. Maximum contour interval of two feet (2').

3. For detention/retention basins.
 - a. Principal spillway; plan view and cross-sections
 - b. Emergency spillway; plan view and cross-sections
 - c. Access Road
 - 1) Maximum grade of 18%
 - d. Fencing
 - e. Low flow channel
 - f. Other features such as headwalls, trash racks, etc.
4. Easement limits with metes and bounds description.
5. Adjoining buildings, roads, drainage facilities, etc. impacted by the stormwater management facility.
6. Bench mark elevation with description referenced to NAVD88.

7. Certification by a Professional Engineer, or Land Surveyor Class III, B, as to "As-built" condition.

8. Details

a. Provide details for all items not in the VDOT Standards.

b. Details must be certified by a Professional Engineer licensed in the Commonwealth of Virginia.

M. Easement

1. All easements must be recorded on either the subdivision plat for the development or on a recorded individual parcel plat.

2. Easement Limit

a. Refer to Drawing No. D-17 and Section 603.05, Subsection A.6.

604.00 PIPE SIZING

Mannings formula shall be used to correlate velocity, slope and friction for determining flow in storm drains and ditches.

The roughness coefficient to be used in these formulas shall be as follows:

Concrete pipes	0.013
Smooth Wall PVC (HDPE)	0.012
Monolithic concrete in boxes, channels, etc.	0.015
Corrugated metal pipes with asphalt coating and paved inverts (with 1/2" corrugations)	0.021
Corrugated metal pipe arches with asphalt coating and paved inverts (with 1/2" corrugations)	0.019

Where drains are composed of more than one (1) of the above mentioned materials, a composite roughness coefficient must be determined in proportion to the wetted perimeter of the different materials.

605.00 VALLEY GUTTERS

Generally all drainage at intersections will be intercepted by inlets. However, a flow not to exceed two (2.0) cfs may be permitted to flow through an intersection provided a concrete valley gutter is provided.

606.00 PIPE ALIGNMENT

Pipe twenty-four inches (24") in diameter and smaller shall be laid on straight lines and grades. For pipes twenty-seven inches (27") in diameter and larger, horizontal and vertical curves may be used provided the joint openings do not exceed one-third (1/3) the depth of the groove. On short radius curves, pipe with mitered joints may be used.

607.00 STRUCTURAL CONSIDERATIONS

Structures located under existing or proposed paving shall be designed for an HS-20 truck load in accordance with the requirements set forth in the latest edition of the VDOT Road and Bridges Standards and Specifications and the Standard AASHTO Specifications for Highway Bridges.

Structures located behind curbs or in other areas where heavy vehicles are not expected to operate shall be designed for the Standard H-10 truck loading plus 20% impact with a minimum of one foot (1') of cover.

Reinforced concrete box culverts located behind curbs or in other areas where heavy vehicles are not expected to operate shall be designed for a five (5) ton wheel load plus 30% impact.

608.00 MAINTENANCE OF STORM SEWER AND STORMWATER MANAGEMENT SYSTEMS

A. Easements

Easements shall be dedicated when the natural drainageways are altered. Drainage easements are required for the maintenance of storm sewer systems, for open channels for a stormwater conveyance system, for improved drainageways, for access to stormwater management facilities, for stormwater management facilities or for a storm sewer system located on private property. Furthermore, drainage easements are intended to restrict private property owners from disturbing land contained in the easement in such a manner as to alter the drainageway to the detriment of neighbors upstream or downstream. Similarly, easements for underground pipes assure that no other permanent structures will be built over them. Easements shall conform to the requirements of Drawing No. D-17 of these regulations.

All required easements in favor of the Town of Warrenton shall be recorded among the land records of Fauquier County, prior to release of any security as detailed in Section 402.02 of these regulations.

B. Maintenance

A Maintenance Agreement consisting of a document similar to the BMP Handbook, App. 6-2, or a document with similar regulations, is required for all stormwater management facilities.

All maintenance shall be carried out in accordance these regulations.

This section defines the responsibility for maintenance of storm drainage and stormwater management facilities located in the dedicated easements. Public maintenance responsibility will not be accepted for retention facilities with a permanent pool, or for underground storage tanks.

The developer shall be responsible for performing the following maintenance on non-regional stormwater management facilities until the owner/HOA takes over the system:

1. Mowing of grass when grass exceeds six (6) inches in length.
2. Removing debris from the facilities.
3. Removing silt from the facilities.
4. Fence maintenance.

For owner maintained facilities, the maintenance agreement shall require the owner to provide for annual inspections to be performed by a professional engineer familiar with the design and operation of SWM/BMP facilities who shall provide a report addressing the matters set out in this section. The required cleaning, repairs, and reconstruction of the facilities should also be performed under the direction of registered professionals. The

inspection report shall include the observations, measurements, or tests which were performed, and the schedule for repairs when needed. The reports shall also include the inspector's qualifications. The certified reports shall be forwarded to the Department of Public Works before June 30 of each year. The Department of Public Works will review reports, and comment on the inspector's conclusions, and may perform inspections or maintenance as necessary.

The Town reserves the right to enter the property to inspect the stormwater managements systems. If repairs or maintenance is needed, the owner shall be advised by certified mail of the items necessary to complete such repairs or perform such maintenance. Failure to make such repairs or to perform such maintenance within 10 days of the receipt of the mailing, shall be just and sufficient cause for the Town to make all repairs or to perform maintenance at the Owner's expense.

In case of an emergency, the Town has the right to immediately enter the property and make repairs or provide emergency maintenance to remedy the situation. These repairs or this maintenance shall be done at the owner's expense. An emergency shall be constituted if a person or the adjoining property owner's health or property is endangered by flood water produced by a stormwater facility.

C. Single family, townhouse, and condominium developments.

The maintenance of the storm sewer systems and stormwater management facilities located in properly dedicated easements will be the responsibility of the related Homeowners' Association or property owner. The Town may accept maintenance responsibility for storm drainage

facilities which are in open common areas with adequate access, all subject to written application and consideration on an individual basis.

The following note shall be added to the easement plat:

"The Homeowners' Association or property owner of this development by signature indicated hereon assumes the maintenance responsibility of the storm drainage system and of the stormwater management facility located therein, and contained within an easement properly dedicated."

The note shall be modified accordingly where maintenance of the storm sewer system is accepted by the Town. The Town shall make a determination in each case whether it would be in the Public's interest to dedicate the easement to the Town.

- D. Offices, shopping centers, rental multi-family dwelling, mobile home parks, commercial, industrial and institutional development.

For maintenance of storm drainage systems and stormwater management facilities located in commercial, office, industrial, rental multi-family dwellings, mobile home parks or similar uses, the following note shall be added to the plat:

"The owner of the fee title to the property on which an easement is shown is responsible for the maintenance of the storm drainage and stormwater management facilities located therein."

608.01 DISCLAIMER OF LIABILITY

The degree of flood and drainage protection required by these standards is considered reasonable for regulatory purposes. Larger floods or unusual circumstances may occur on rare occasions, or flood heights may be increased by man made or natural causes, such as bridge openings restricted by debris. These regulations do not imply that areas outside the 100 year flood plain or land used permitted within such districts will be free from flooding or flood damages. Additionally, the grant of a permit, or approval of a site, subdivision or land development plan in an identified flood hazard area shall not constitute a representation, guarantee or warranty of any kind by any official or employee of the Town of Warrenton of the practicality or safety of the proposed use and shall create no liability upon the Town, its officials or employees.

609.00 STORM DRAINAGE SYSTEM SPECIFICATIONS

609.01 SCOPE OF WORK

The work includes providing all piping, ditches, inlets, manholes, and other appurtenances required for a complete storm drainage system.

609.02 MATERIALS:

- A. Reinforced concrete pipe and fittings shall conform to ASTM Specifications C76, class as indicated. Cement used

in the manufacture of the pipe shall conform to ASTM Specification C150, Type II. Joints shall be made with

O-ring type rubber gaskets conforming to ASTM Specification C443.

- B. Corrugated metal pipe and pipe arches for culverts shall conform to the provisions of Section 240 of the Road and Bridge Specifications of the Virginia Department of Transportation.
- C. Class of Pipe: The class of reinforced concrete pipe and the gauge of corrugated metal pipe shall be as indicated on the drawings or in the Special Provisions.

Minimum class III pipe shall be used in accordance to the road and bridge standards of the Virginia Department of Transportation.

- D. Precast concrete manhole sections shall conform to ASTM Specification C478. Joints shall be made with O-ring type rubber gaskets conforming to ASTM Specification C443 or C361.
- E. Brick shall conform to ASTM Specification C32, Grade MA or ASTM Specification C62, Grade SW.
- F. Precast concrete segmental blocks shall conform to ASTM Specification C139. Cement used in the manufacture of the blocks shall conform to ASTM Specification C150, Type II.
- G. Mortar shall be one part of Portland cement conforming to ASTM Specification C150, Type II, and two parts of sand conforming to ASTM Specification C144, with enough water added to produce mortar of the proper consistency for the type of joint. For brickwork, lime may be added to the mortar in the amount of not more than 25% of the volume of cement.
- H. Grout shall conform to the requirements specified for mortar except that the proportion shall be one (1) part of Portland cement and three parts of sand.
- I. High Density Polyethylene (HDPE) smooth wall pipe shall conform to AASHTO M-294.

609.03 CONSTRUCTION METHODS:

- A. Storm drains and culverts shall be constructed in accordance with Section 302 of the Virginia Department of Transportation, Road and Bridge Specifications.
- B. Inlets and manholes shall be constructed in accordance with Section 503 of the Virginia Department of Highways and Transportation, Road and Bridge Specifications.
- C. Paved ditches shall be constructed in accordance with Section 502 of the Virginia Department of Transportation, Road and Bridge Specifications.
- D. Curb and combination curb and gutter shall be constructed in accordance with Standard CG-2 & CG-6 of the Virginia Department of Transportation, Road and Bridge Standards.

609.04 CCTV INSPECTIONS:

Prior to a building sewer lateral being tied into a sanitary sewer main and before the first water meter is installed in a subdivision or shopping center, all gravity sanitary sewer mains and storm mains shall be televised by robotic CCTV. The format shall be in digital color .mpgs compatible with the latest Town of Warrenton media, which is currently Windows Media Player. All videos shall be recorded in compliance with the latest NASSCO (National Association of Sewer Service Companies) standards. The video contractor shall be PACP (Pipeline Assessment Certification Program) certified. The video media shall be submitted to the Town of Warrenton's Utilities Technician for review prior to continuing work.

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SECTION 700.00

STREET DESIGN CONSTRUCTION

SECTION 700.00 STREET DESIGN CONSTRUCTION

700.01 GENERAL

All streets shall be designed and constructed in accordance with the design standards and criteria of the Town of Warrenton. Where no Town standards or criteria exist, the "Road Design Manual", "Road Designs and Standards", "Entrance Standards" and the "Subdivision Manual of the Virginia Department of Transportation" shall apply. All private streets must be designed and constructed to the minimum VDOT Secondary Street Standards.

701.00 STREET DESIGN

The allowable capacity in vehicles per day shall be based on the projected annual average daily traffic, (ADT).

All street designs shall be based upon rolling terrain and a minimum subgrade CBR value of three (3). Special base and pavement design will be required for subgrades with a CBR value lower than three (3).

The minimum grade for streets without curb and gutter shall be one percent (1.0%). The minimum grade for streets with curb and gutter shall be one half percent (0.5%).

Parabolic vertical curves shall be used on crests and in sags to provide the minimum stopping sight distances required by the geometric design standards for the various classes of streets. The required length of vertical curve on crests

shall be line of sight, which is based on a height of eye of three and one-half feet (3.50') and a height of object of two feet (2.0'). The required length of vertical curve in sags shall be based on headlight height of two feet (2.0') and a one (1) degree upward divergence of the headlight beam. The minimum length of vertical curve shall be one hundred feet (100').

All street intersections and commercial entrances are to meet standard sight distance requirements. The sight distance length is based on a height of the eye of three and one-half feet (3.50') and a height of the object of three and one-half feet (3.50'), see sheet R-1 for required site distance lengths.

The maximum degrees of curvature for horizontal curves shown in the geometric design standards are based on the arc definition and refer to the street centerline. Horizontal curves shall be designed to provide adequate sight distance based on the minimum stopping and intersection sight distances given in the geometric design standards, including consideration of street gradients.

Landing grades must be provided at all thoroughfares and collector streets, in accordance with Standard Detail "Intersection Landing Requirements."

The minimum cul-de-sac radii shall be forty-five feet (45'), measured to edge of pavement or face of curb.

A. Temporary turnarounds and stub streets: A turnaround should be provided for any temporary or stub street longer than 150' from the point of intersection to the end of pavement. Any portion of the turnaround outside

the dedicated right of way for the stub street may be placed in an easement.

- B. Alternative turnarounds for private streets only: "T" and "Branch" type turnarounds may be considered for short private streets less than 500' in length. Private streets greater than 500' in length must have a cul-de-sac with a minimum 30' radius. Ref. Drawing No. R-12.

All private roadways will be built to VDOT minimum standards, including right-of-way or easement width.

The strictest standard requirements will govern in the Street Design Criteria.

702.00 STREET CONSTRUCTION

702.01 SCOPE OF WORK:

The work includes providing all clearing and grubbing, excavation and embankment, grading and preparing subgrade, aggregate base course, bituminous base and surface courses, curb and gutter, walks, entrances, seeding, sodding and other incidental work required for roadway construction.

702.02 MATERIALS AND CONSTRUCTION METHODS:

- A. All materials and construction shall be in accordance with the Virginia Department of Transportation, Road and Bridge Specifications and the Virginia Department of

Transportation, Road Designs and Standards except as modified by the Town of Warrenton Standards or the Contract Drawings and Specifications.

- B. The right-of-way must be fully cleared, all utilities must be in place, the roadway must be graded to the proposed typical section and all compaction requirements must be met prior to the application of any paving materials.

- C. All unpaved areas within the right-of-way limits and/or limits of work shall be topsoiled and seeded unless indicated to be sodded. The project will not be given final acceptance until a proper growth of grass has been established.

- D. Curb cut ramp (handicap ramp) shall be constructed in accordance with Standard CG-12 of the Virginia Department of Transportation, Road and Bridge Standards.

- E. When a proposed street is an extension of or connects with an existing street, a centerline profile of the existing street should be provided for a minimum distance of three hundred (300) feet to insure proper grade tie.

- F. When a proposed street intersects with an existing street, a centerline profile of the existing street in both directions shall be provided for a minimum of three hundred (300) feet. The requirements of Section 707.00 must be provided.

- G. If a cul-de-sac is to be used as a turnaround at the temporary end of a street, final grading of the proposed extension, for a distance of three hundred (300) feet

beyond the property line shall be shown on the grading plan.

H. Street name signs, stop signs and street markings shall be posted at the following locations:

A. All street intersections.

B. At the entrance to a parking bay for the residential units.

These signs, or approved temporary signs, shall be installed prior to the occupancy of any house or unit being served by the street.

I. Prior to the release of the performance bond, during the emergencies that could endanger the public health, safety and welfare, the Director of Public Works may require the developer of a site development project to provide the additional safety features such as:

"No parking signs"

"Speed limit signs"

"Stop signs"

"Pavement markings"

"Traffic barricades"

And any other emergency measures that may be necessary for the safety of the traveling public. These emergency items are to be installed at the developer's expense.

- J. Prior to the acceptance of a street into the State Secondary System, the developer is required to post the necessary traffic control signs inclusive of pavement markings, for the safety of the traveling public. Traffic control signs shall conform to the current VDOT standards and the current edition of the Manual on Uniform Traffic Control Devices.
- K. Street name signs shall be located at intersections such that they can be seen from the major (higher VPD) road at a reasonable distance.
- L. Private streets shall be platted such that all lot owners are assured perpetual right of access to the State maintained road. The final recorded plat shall note each private street as "privately owned and privately maintained by the lot owner(s)". The final plat shall also provide an adequate easement for ingress, egress, maintenance of utilities, and public agencies including Police and Fire Departments to allow them to carry out their duties. Travelways that provide access to multi-structure commercial, industrial, and residential developments must also provide this emergency access easement.
- M. The plat recorded for residential subdivisions being served by private roads where allowed shall contain the following statement in a highlighted box:

"The road serving this development is private and is not eligible for acceptance into the State System unless designed and constructed in accordance with State and Town of Warrenton Standards. Maintenance of the road, including snow removal, is not a public responsibility."

- N. Any street within a subdivision which is not intended to be incorporated into the State System shall be identified with a sign attached to the street sign or address sign (for pipestems) stating "Private Road Not Public Maintained". Signs are paid for by the developer.

702.03 INSPECTION AND TESTING:

- A. Only materials meeting the requirements of these specifications shall be used. They may be subjected to inspection and testing at any time during the progress of their preparation or use and each of the materials shall be subject to approval by the Engineer at the source of supply or upon delivery, as applicable. Any work in which untested materials are used without approval may be considered as unacceptable and the work may be disapproved by the Engineer.
- B. The Contractor shall employ a reputable testing laboratory approved by the Engineer to perform the tests herein specified and to certify the results of the tests. Samples for testing shall be furnished by the Contractor at his expense and will be taken as directed by the testing laboratory or the Engineer. Any nuclear density gauge used for testing shall be calibrated prior to use. The minimum distance for any roller pattern shall be three hundred feet (300').

C. The following Schedule of Tests shall be followed unless modified by the Engineer.

<u>Material</u>	<u>Type of Test</u>	<u>No. Required</u>
Subgrade	AASHO Maximum Density T-99 - Method A Field Density ASTM D2167	1 each type mat'l 1 per 2000 S.Y.
Aggregate Base	AASHO Maximum Density T-99 - Method A Field Density ASTM D2167	1 per job 1 per 2000 S.Y.
Bituminous Concrete	AASHO Maximum Density T-99 Field Density ASTM D2167	1 per job 1 per 2000 S.Y.
Portland Cement Concrete	Slump Concrete Cylinders	1 each truck As Directed
<u>Location</u>	<u>Type of Test</u>	<u>No. Required</u>
Final grade area under each structure unit	AASHO Maximum Density T-99 - Method A Field Density ASTM D2167	1 per structure minimum
Final grade area under curb & gutter	AASHO Maximum Density T-99 - Method A Field Density ASTM D2167	1 per 100 LF minimum

Final grade area under storm culverts	AASHO Maximum Density T-99 - Method A Field Density ASTM D2167	1 per 100 LF minimum
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SECTION 800.00

INSTALLATION OF WATER METER SETTERS AND BOXES

**SECTION 800.00 INSTALLATION OF WATER METER SETTERS AND
BOXES**

800.01 INSTALLATION REQUIREMENTS

A. Water meter setters must have a locking wing inlet ball valve and an A.S.S.E. approved, cartridge style dual check valve on outlet. The following laying span dimensions shall be maintained on the setter before a meter is installed;

For 5/8" meters7 3/4"
For 5/8" X 3/4" meters.7 3/4"
For 1" meters11"
For 1 1/2" meters13 1/4"
For 2" meters17 1/4"

B. The following clearance distances are required between the meter box lid and the top of the meter setter valve;

1. For 5/8" meters16 to 18 inches.
2. For 5/8" X 3/4" meters.16 to 18 inches.
3. For 1" meters16 to 18 inches.
4. For 1 1/2" meters17 to 21 inches.
5. For 2" meters17 to 21 inches.
6. For 3" and larger meters.36 to 48 inches.

- C. The meter setter shall be set in the center of the meter box, allowing unobstructed operation of the inlet valve and accessible maintenance of the dual check valve.
- D. The type of water meter box and meter setter shall be first approved by the Town before installation.
- E. Meter boxes shall be installed with the top of the box at final grade. No meter boxes shall be set in asphalt or concrete.
- F. Meter boxes shall be installed so as to conform to the contour slope of the grade around the box.
- G. No unauthorized work shall be performed in any water meter box after initial installation. A violation of this will be considered an act of tampering with Town property. (Virginia Code Section 18.2-163)
- H. The use of a "jumper" or any other device that would allow water to be used from the Town's water system, is forbidden and any person using such device will be guilty of a Class 1 misdemeanor (VA Code 18.2-163)
- I. Only after a Town meter has been set, will any contractor or plumber test a new service line to a building with water.
- J. In either a permanent or temporary water connection, a shut-off valve shall be installed by the developer on the

customer's side of the meter box before a meter is installed. (See drawings W-19 and W-20)

- K. Location of the water meter box shall be approved by the Town prior to installation. No meter box will be set within 4 feet (4') of a driveway.
- L. No plants, shrubs or trees shall be planted within a four foot (4') radius of any water meter box.
- M. No meter boxes will be installed in utility strips where parking is adjacent to utility strips. A one foot (1') grass buffer is required around all meter boxes.
- N. For water meter settings of 5/8", 5/8" X 3/4", see Drawing W-9.
- O. For water meter settings of one and a half inches (1 1/2") and two inches (2"), see Drawing W-13.
- P. For water meter settings of three inches (3") and larger, see Drawing W-14.
- Q. A water meter may be set upon an approved preliminary inspection by the Town's site inspector. However, the installation of the meter box and meter setter must be within plus or minus four inches (4") of final yard grade. Tap fees and meter fees must also be paid. A temporary account must be set up with the Town's Water Accounts Clerk prior to a temporary setting of a meter.

- R. The Town has template meters (or "dummy" meters) that can be leased for contractor use to assure proper alignment of meter setters. The contractor is responsible for the proper alignment of all meter setters.
- S. Address and lot number must be clearly posted on each building before a meter will be installed.
- T. Meter boxes are not to be covered by any material or the meter will not be installed.

800.02 FEES

- A. Hydrant meters may not be in Town or on Town fire hydrant.
- B. All availability fees, meter fees and deposits shall be paid and a complete cross-connection inspection of the premises conducted, before a water meter is installed. (With exception to Q above.)

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SECTION 900.00

CONSTRUCTION PERMITS

SECTION 900.00 CONSTRUCTION PERMITS

900.01 GENERAL

No water main, sanitary sewer, storm drain or street shall be constructed on, added to, or altered without the issuance of a construction permit by the Town of Warrenton, Virginia. The following requirements and procedures have been adopted in order to secure uniformity in the planning and design of all water mains, sanitary sewers, storm drains and streets within the jurisdiction of the Town of Warrenton.

900.02 SUBMISSION REQUIREMENTS

A. General

Plans shall be prepared in pencil or ink on paper or linen tracings suitable for ready reproduction, with a maximum size of twenty-four inches by thirty-six inches (24" x 36") and a minimum size of eighteen inches by twenty-four inches (18" x 24"). A scale of one inch equaling fifty feet (1" = 50') horizontally and one inch equaling five feet (1" = 5') vertically shall normally be used for general drawings. A scale of one quarter inch equaling one foot or three eighths of an inch equaling one foot (1/4" = 1' or 3/8" = 1') is preferred for details of special structures. All calculations and supporting data shall be a minimum size of eight and one half inches by eleven inches (8 1/2" x 11").

Each submission shall be accompanied by a "check list for a construction permit." Plans and calculations shall bear the stamp and signature of a Professional Engineer (or Land Surveyor where applicable) registered by the State of Virginia. All design shall be in accordance with the Town's standards and any deviation from these standards must be noted by the Engineer.

B. Construction Plans

Plans shall clearly show all existing and proposed construction including street paving and other improvements, storm drains, sewers, water mains, water and sewer services, gas mains, poles, conduits, streams, property lines, easements, rights-of-way, property ownership where applicable, and other pertinent data. All proposed water mains, sanitary sewers, storm drains and their appurtenances shall be plainly located by dimensions from street centerline stationing in new streets and from property lines or existing structures in existing streets. The type and size of all proposed pipe and type of each proposed structure shall be clearly called out on the plans. Plans shall also indicate the following: Alignment data, limits of right-of-way, limits of construction, construction details, bench mark data and approved street name.

Profiles of proposed sanitary sewers and storm drains shall indicate the size and class of pipe, rate of grade, and invert elevations at the ends of each pipe in all manholes, inlets, and special structures. Profiles of proposed water mains shall indicate the size and class of pipe invert elevation at all high points, low points and critical utility crossings. The existing ground, original ground in the case of newly graded areas and proposed ground or pavement over the proposed pipes and the approved of proposed street grades shall be shown. The elevation, location and time of all underground

structures which will be crossed by proposed construction shall be obtained from the field surveys or the records of such structures and shown on the profile. Elevations shall be based on Town of Warrenton datum (U.S.C. & G.S. 1929 MSL).

Structural details of any structures which are not Town of Warrenton, Virginia Department of Highways and Transportation or other recognized standards shall be shown on the plans, and computations must be submitted to show that they have adequate strength and/or hydraulic efficiency. Structural foundations may require the stamp of a registered Professional Engineer.

In all cases, proper foundations shall be provided for proposed structures. Acceptable methods for supporting structures on unstable ground or fresh fill, where such construction is not avoidable, shall be shown on the construction plans.

C. Storm Drainage Design

1. Drainage Area Map

A copy of a map on which all areas tributary to the proposed construction are outlined, including the subdivision of major areas, to indicate the area tributary to each inlet structure shall be submitted. Flow of surface waters shall be indicated either by contours or a sufficient number of arrows pointing in the direction of flow. This map shall show existing and proposed streets, storm drain structures labeled with the same identifying marks are shown on the construction plans and zoning, as well as sufficient information

concerning adjacent major streets to properly locate the area under consideration. The scale of the map must be no smaller than one inch equaling two hundred feet (1" = 200') except where large areas requiring no subdivision for inlet design are involved. The size of the map must be no larger than twenty-four inches by thirty-six inches (24" x 36").

2. Inlet Computations

A tabulation of the data used for selection of inlet types, using the same identifying marks for structures as shown on the construction plan.

3. Pipe Size Computations

A tabulation of the data used for the selection of pipe sizes, using the same identifying marks for structures as shown on the construction plan.

4. Hydraulic Gradient Plotting

A print of pipe profiles showing the position of the hydraulic gradient by means of a colored line, as referred to in the Design Criteria.

5. Computations

Computations of runoff coefficients, ditch velocities, hydraulic gradient, structural designs and other features of the design where applicable.

D. Water mains and Sewers

The applicant shall submit to the Town a layout of proposed water mains, hydrants, valves, sanitary sewers and manholes. The layout should also indicate the number, type and location of existing and proposed houses and buildings to be served by the proposed water main or sewer extension, the probable number of persons who will regularly use the buildings, including both immediate and future construction.

900.03 REVIEW PROCEDURE

A. Submittal of Data

Six (6) copies of all plans, maps, computations and other required data shall be submitted to the Town Engineer. A copy of the "Check List for a Construction Permit" must accompany each submittal.

B. Review by the Town

A minimum of four (4) weeks must be allowed for the Town's review. The Town will review the plans and will return one (1) set of plans to the applicant marked either "Approved" or "Revise and Resubmit." The applicant shall make the necessary revisions and resubmit as per the original submission. The applicant may

discuss the requested revisions with the agent for the Town and may appeal any decision of the Town's Agent to the Town Council.

C. Approved Plans

A copy of the approved plans must be kept at the construction site during the entire construction period and be made available to the Town's Agent upon request.

D. Final Inspection and Acceptance

Upon completion of the work the Contractor shall request, in writing, for a final inspection. The application shall certify that the work has been completed according to the approved plans and specifications, that the construction site has been cleaned up and restored and that all right-of-way markers have been set and clearly marked. The Contractor shall submit with the application for final inspection three (3) sets of prints and one (1) reproducible tracing clearly marked to show the "As Built" construction. The Contractor shall be responsible for the proper maintenance of the work until the Town issues a written acceptance of the work.

900.04 CONSTRUCTION/UTILITY PERMIT
CHECK LIST

(A Construction/Utility Permit is required for all site improvement work within any right-of-way or easement and for all utility work performed in the repair, replacement, relocation, construction or connection to, or modification of, any street or sidewalk, sanitary or storm sewer, water or gas mains, and any electric transmission or telecommunications lines.)

DATE:

CONTROL:

PROJECT:

LOCATION:

ARCHITECT/ENGINEER:

ADDRESS:

PHONE:

	<u>Included</u>	<u>Not Applicable</u>
1. Generalized narrative describing nature & scope of proposed project	_____	
2. Vicinity map & sheet index	_____	
3. Sheet size 24" x 36" (maximum)	_____	
4. Survey plat	_____	
5. Layout plan	_____	
6. Grading plan with 2' contour intervals	_____	
7. Drainage area map	_____	
8. Storm water runoff computations	_____	

- 9. Inlet & hydraulic computations _____
- 10. Storm drain plan & profile _____
- 11. Sanitary sewer plan & profile _____
- 12. Water main plan & profile _____
- 13. Structure computations _____
- 14. Cross sections _____
- 15. Street plan & profile _____
- 16. Compaction notations _____
- 17. Typical street section _____
- 18. Sidewalk, curb & gutter sections _____
- 19. Street, sidewalk, curb & gutter
disturbance & restoration bond _____
- 20. Traffic safety plan _____
- 21. 15'-20' wide utility easements _____
- 22. Six (6) copies of plans _____
- 23. Temporary construction easements _____
- 24. Fees paid _____
- 25. Date applicant attended _____
- 26. List of Subcontractors & phone
numbers _____
- 27. Standard Details _____

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SECTION 1000.00

HIGHLIGHTS OF UNDERGROUND UTILITIES DAMAGE PREVENTION ACT

2. Location of proposed work
 3. Office and field telephone numbers of excavator, demolisher, to whomever notification can be given
 4. Nature of proposed work
 5. Name of person for who work is being performed
 6. Approximate date and time work is to begin
- D. The utilities are to participate in a pre-construction meeting held by the state, county or municipality.
- E. If the utility has not marked existing facilities within the time limit, the contractor may begin excavation three (3) hours after an additional notice to the utility.
- F. Color coding of the utilities are below:
- | | | | | | |
|-----------|---|--------|----------|---|--------|
| Electric | - | Red | Cable TV | - | Orange |
| Gas | - | Yellow | Water | - | Blue |
| Steam | - | Yellow | Sewer | - | Green |
| Telephone | - | Orange | | | |

- G. Re-excavation (for maintenance, for example) within the limits of the original excavation does not require notification.

- H. For excavation within two (2) feet of a marked utility location, the contractor shall take precautions to not damage the existing facilities; he shall properly protect the existing utility while backfilling. The utility is to be notified immediately of any damage or disturbance of existing facilities. The contractor shall not backfill until the existing utilities have been repaired.

- I. The contractor is liable for damage to any properly marked utility if he has not adequately protected the utility.

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SECTION 1100.00

ADDITIONAL REGULATIONS ACCEPTED AND ENFORCED

**SECTION 1100.00 ADDITIONAL REGULATIONS ACCEPTED AND
ENFORCED**

1100.01 GENERAL

UNDERGROUND STORAGE TANKS

- I. STATE WATER CONTROL BOARD - VR 680-13-02

- II. U.S.B.C. LAW (VIRGINIA CODE TITLE 36, CHAPTER 6)

- III. U.S.B.C. (DEPARTMENT OF HOUSING AND COMMERCIAL
DEVELOPMENT) CODE SECTION 627.0 ADDENDUM I

- IV. U.S.B.C. N. F. P. C. ARTICLE 28 (1990)

- V. CURRENT EPA REGULATIONS FOR U. S. T.'s

EROSION AND SEDIMENTATION CONTROLS

- I. VIRGINIA EROSION AND SEDIMENTATION CONTROL HANDBOOK
VIRGINIA SOIL AND WATER CONSERVATION COMMISSION

- II. VIRGINIA EROSION AND SEDIMENTATION CONTROL REGULATIONS

(ADOPTED BY SOIL AND WATER CONSERVATION BOARD ON JULY 11,
1990 EFFECTIVE SEPTEMBER 13, 1990) VR 625.02.00

- III. VIRGINIA EROSION AND SEDIMENTATION CONTROL LAW - TITLE
10, CHAPTER 5, ARTICLE 4 (VIRGINIA CODE)

- IV. TOWN OF WARRENTON ZONING AND SUBDIVISION ORDINANCE

ARTICLE 5, EROSION AND SEDIMENT CONTROL (ADOPTED MARCH
1991)

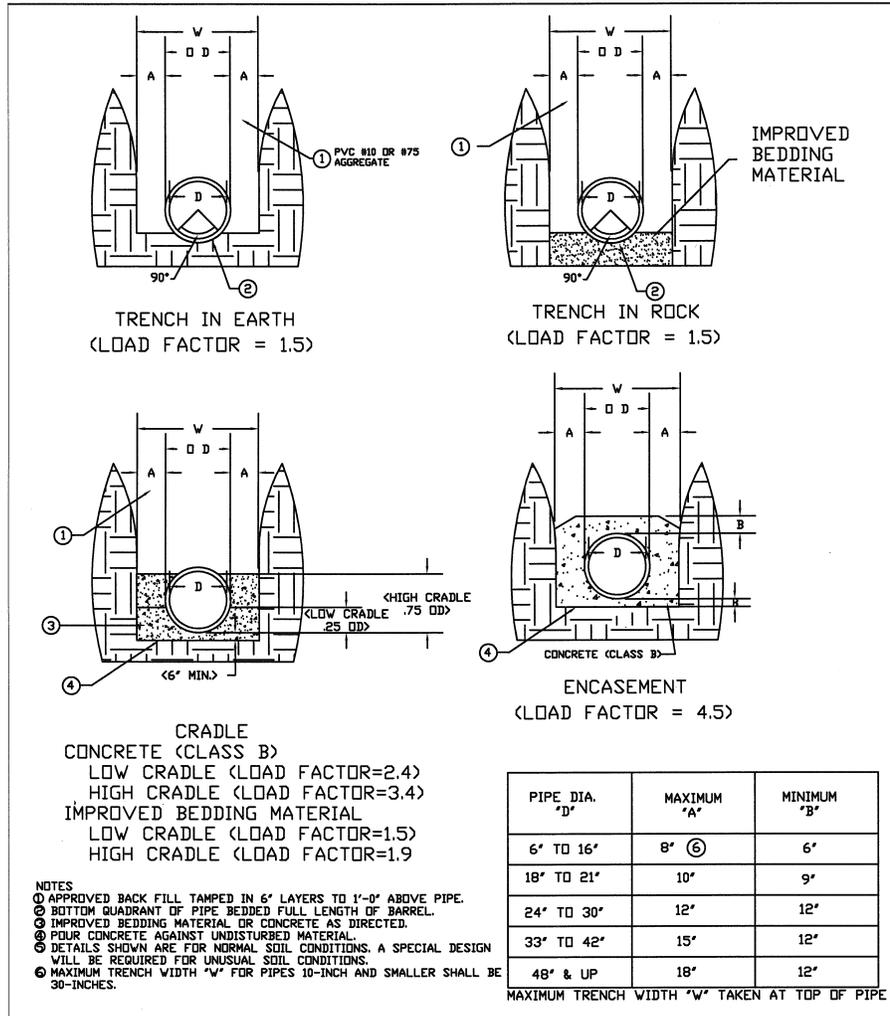
- V. VIRGINIA DEPARTMENT OF TRANSPORTATION ROAD AND BRIDGE
SPECIFICATIONS, SECTION 303.02

NOTE: All approved revisions to the above standards are recognized
and enforced by the Town of Warrenton.

1101.00 APPLICABILITY OF ADDITIONAL STANDARDS

Any standard referenced in this manual is accepted. When such
standards impose a more stringent requirement than noted in
this manual the more stringent requirement will govern.

Figure 1: E-1 Pipe Trench and Bedding Details



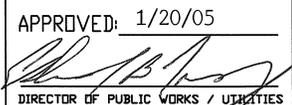
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	PIPE TRENCH BEDDING DETAIL	DRAWING NO: E-1
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Figure 2: S-2 Standard Manhole w/ Frame & Cover (4 foot I.D.)

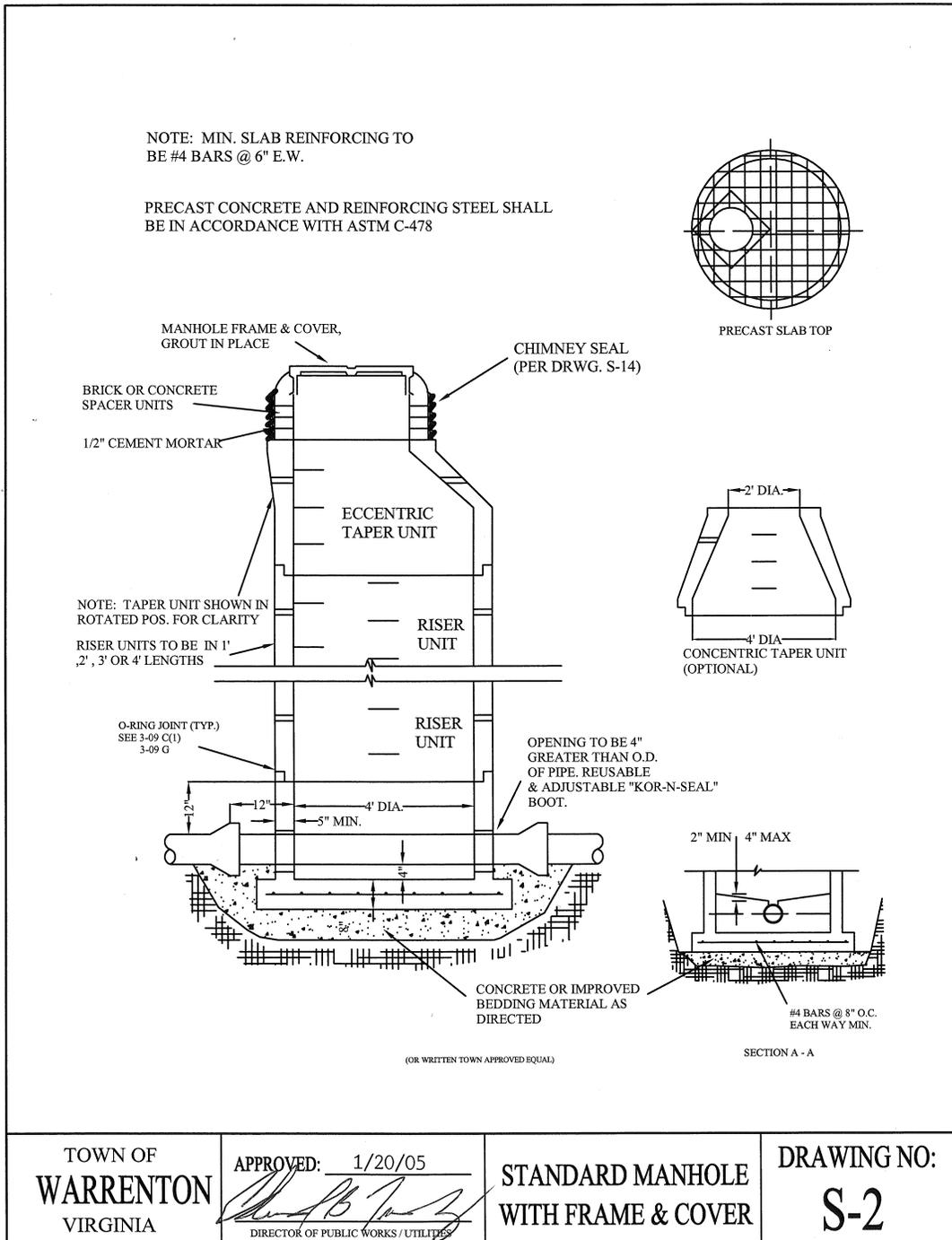


Figure 4: S-6 Watertight Manhole Frame & Cover

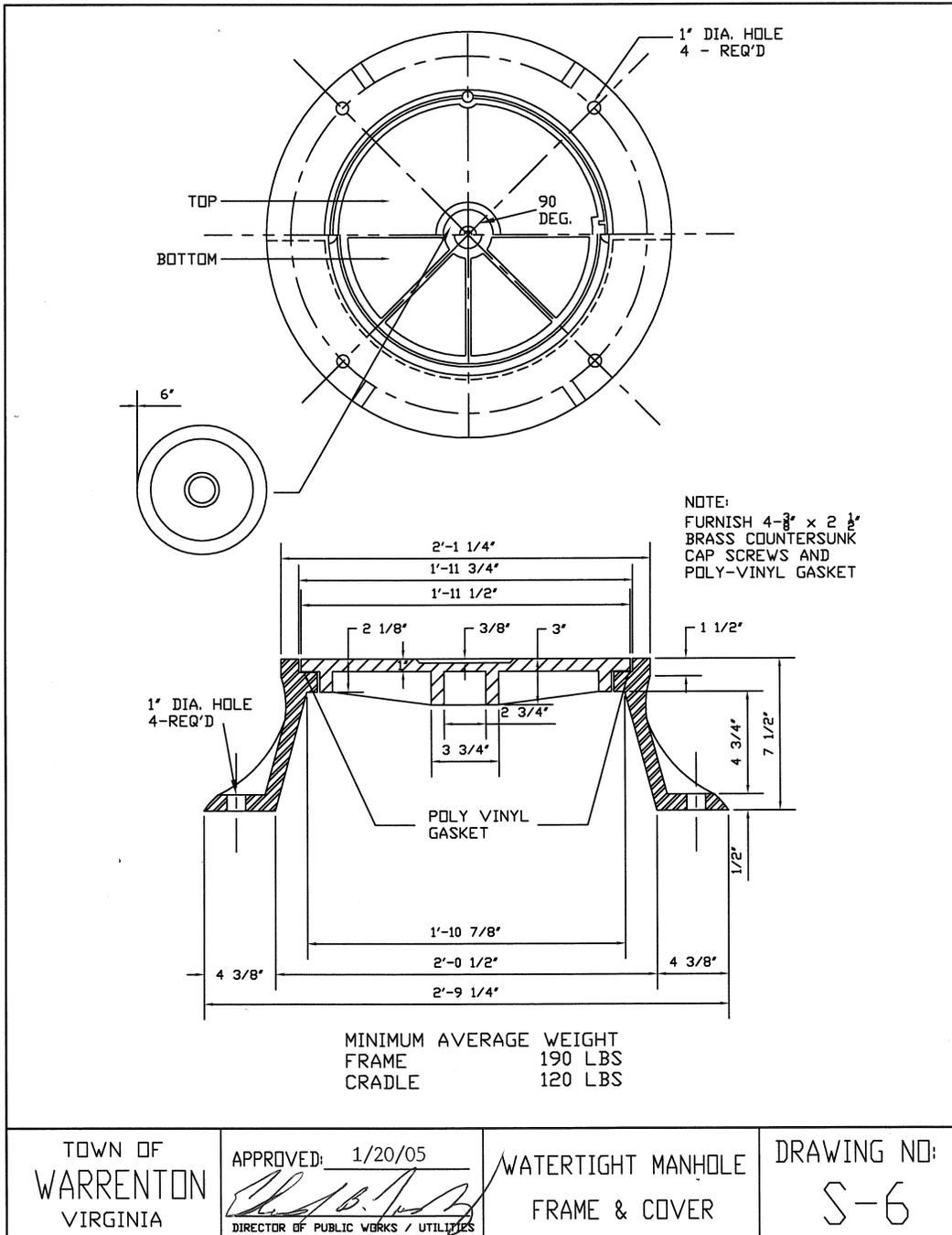
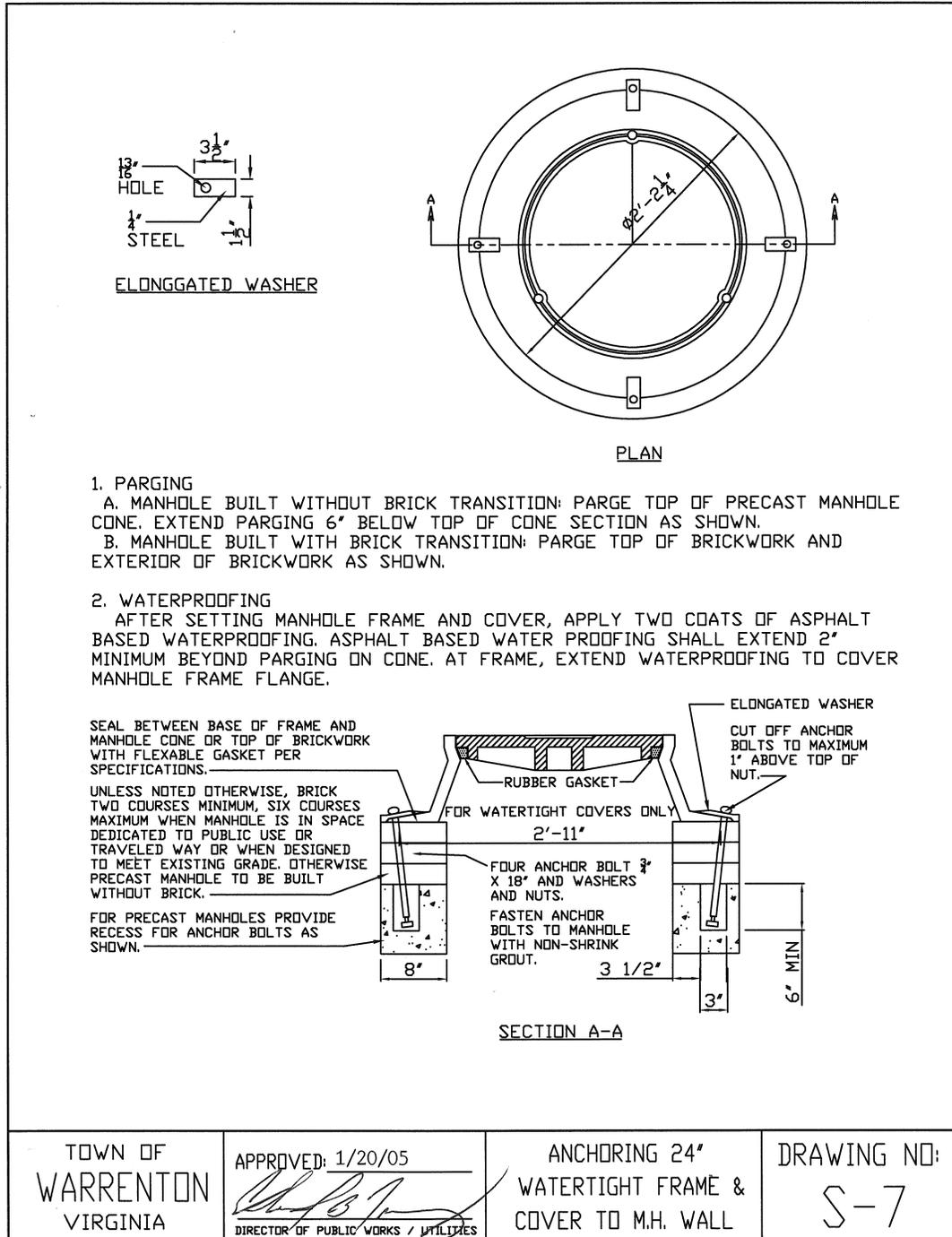


Figure 5: S-7 Anchoring 24" Watertight Frame and Cover to Manhole



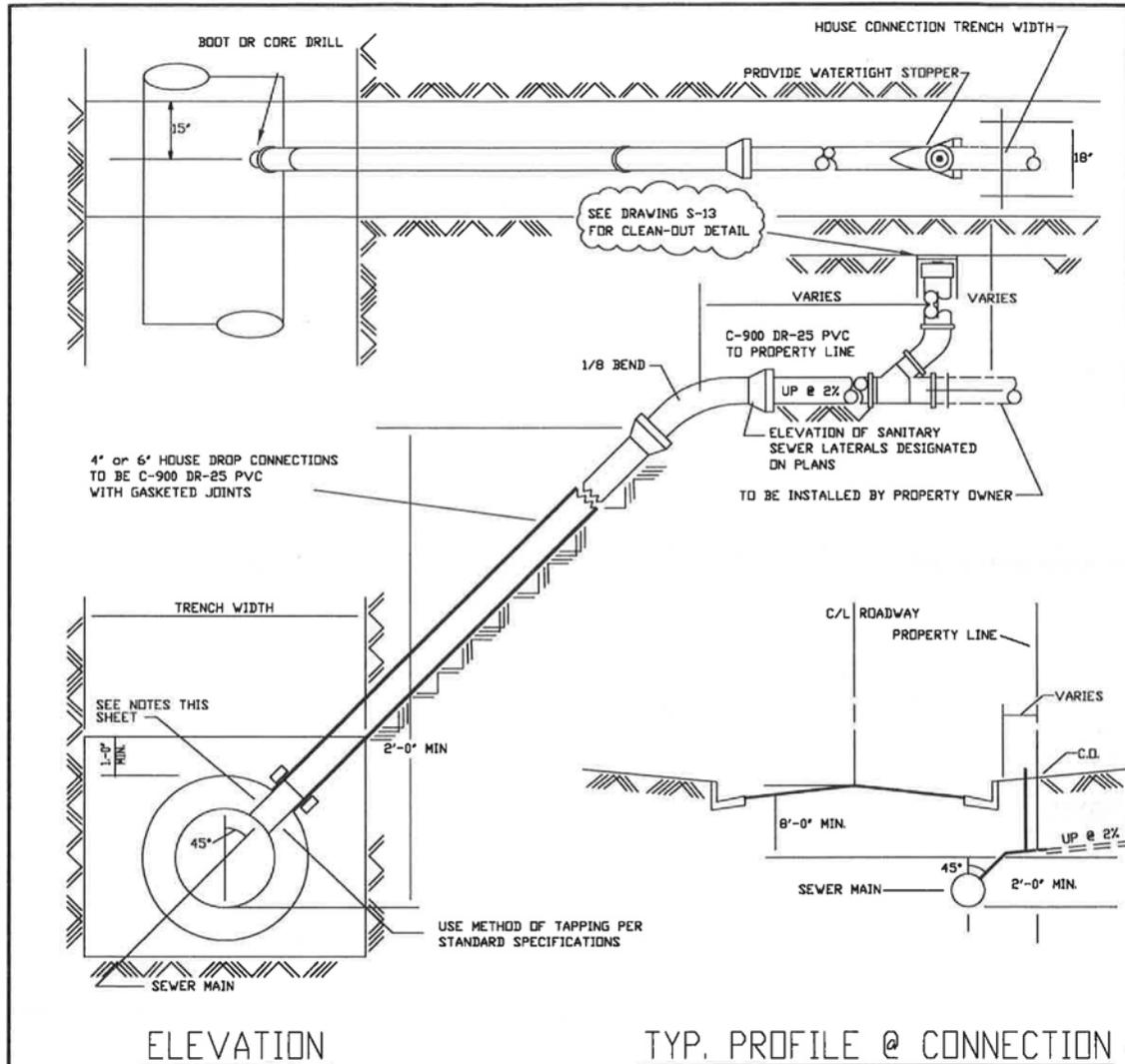
TOWN OF
WARRENTON
VIRGINIA

APPROVED: 1/20/05
[Signature]
DIRECTOR OF PUBLIC WORKS / UTILITIES

ANCHORING 24"
WATERTIGHT FRAME &
COVER TO M.H. WALL

DRAWING NO:
S-7

Figure 6: S-8 Sanitary Sewer Laterals



NOTES:

1. (A) CONN. TO 4" SEWER MAIN TO BE TEE OR THIMBLE
 (B) CONN. TO 6", 8", AND 10" SEWER MAIN TO BE SADDLE
 (C) CONN. TO 12" & LARGER SEWER MAIN TO BE THIMBLE EPOXY THIMBLE TO MAIN LINE
2. PVC PIPE - CONN. TO 4" THRU 15" SEWER MAIN TO BE SADDLE
3. FOR PROPOSED SEWER MAINS, CONTRACTOR MAY USE PREFABRICATED TEES, SEE DETAIL S-9
4. CLEAN OUT SHALL BE INSTALLED AT PROPERTY LINE WITH 45° WYE, 45° BELL X SPIGOT ELBOW & CLEANOUT CAP, ECT
5. SPACING OF CLEANOUTS TO BE EVERY 50' FOR 4" OR 100' FOR PIPE LARGER THAN 4" DIA.
6. PROPERTY LATERAL MUST ENTER AT BOTTOM OF CLEAN-OUT, NOT INTO STACK SECTION.

<p>TOWN OF WARRENTON VIRGINIA</p>	<p>Date: 7/10/12 <i>[Signature]</i> APPROVED</p>	<p>SANITARY SEWER LATERALS</p>	<p>DRAWING # S-8</p>
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Figure 7: S-9 Sewer House Connections

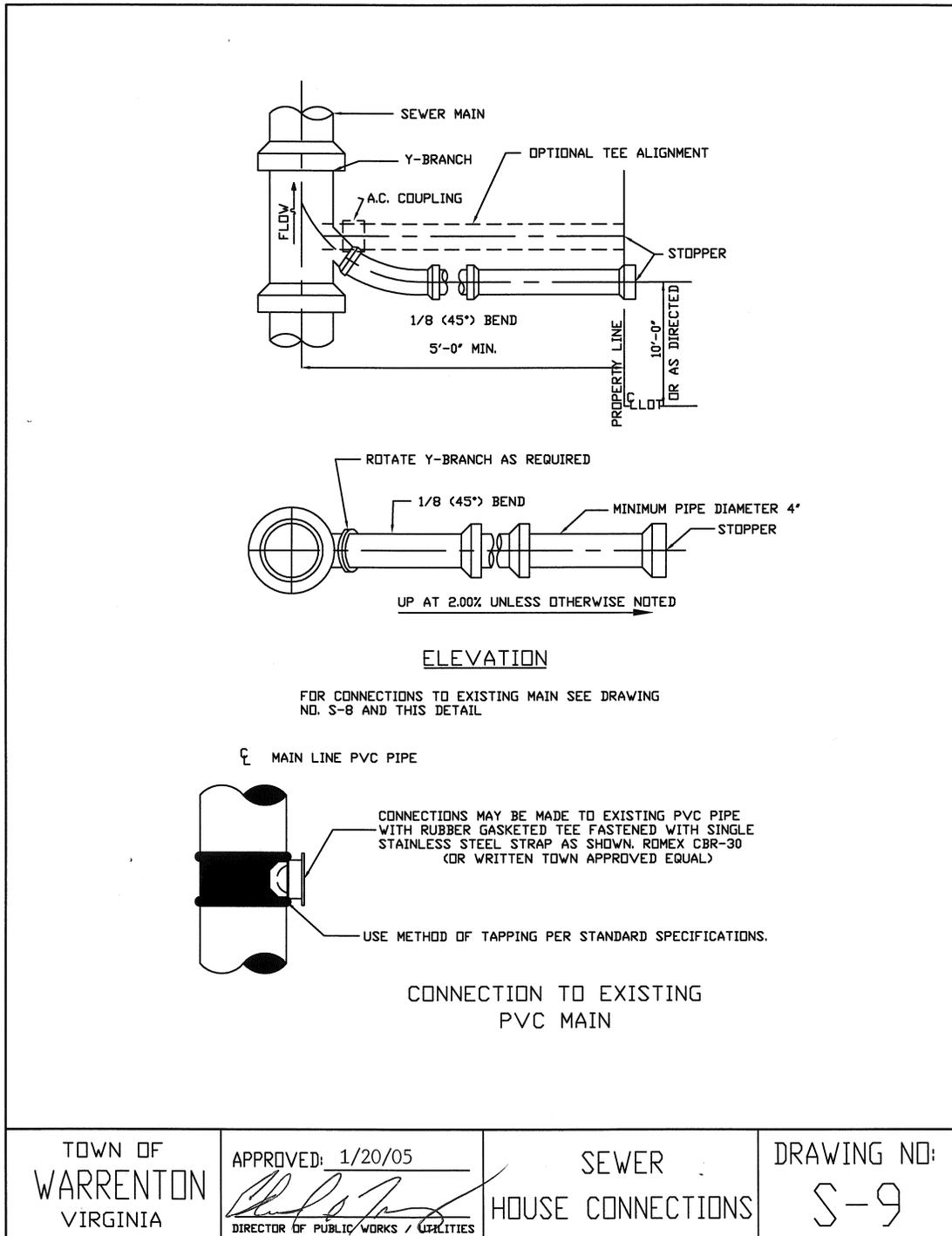


Figure 8: S-10 Special Manhole Grading

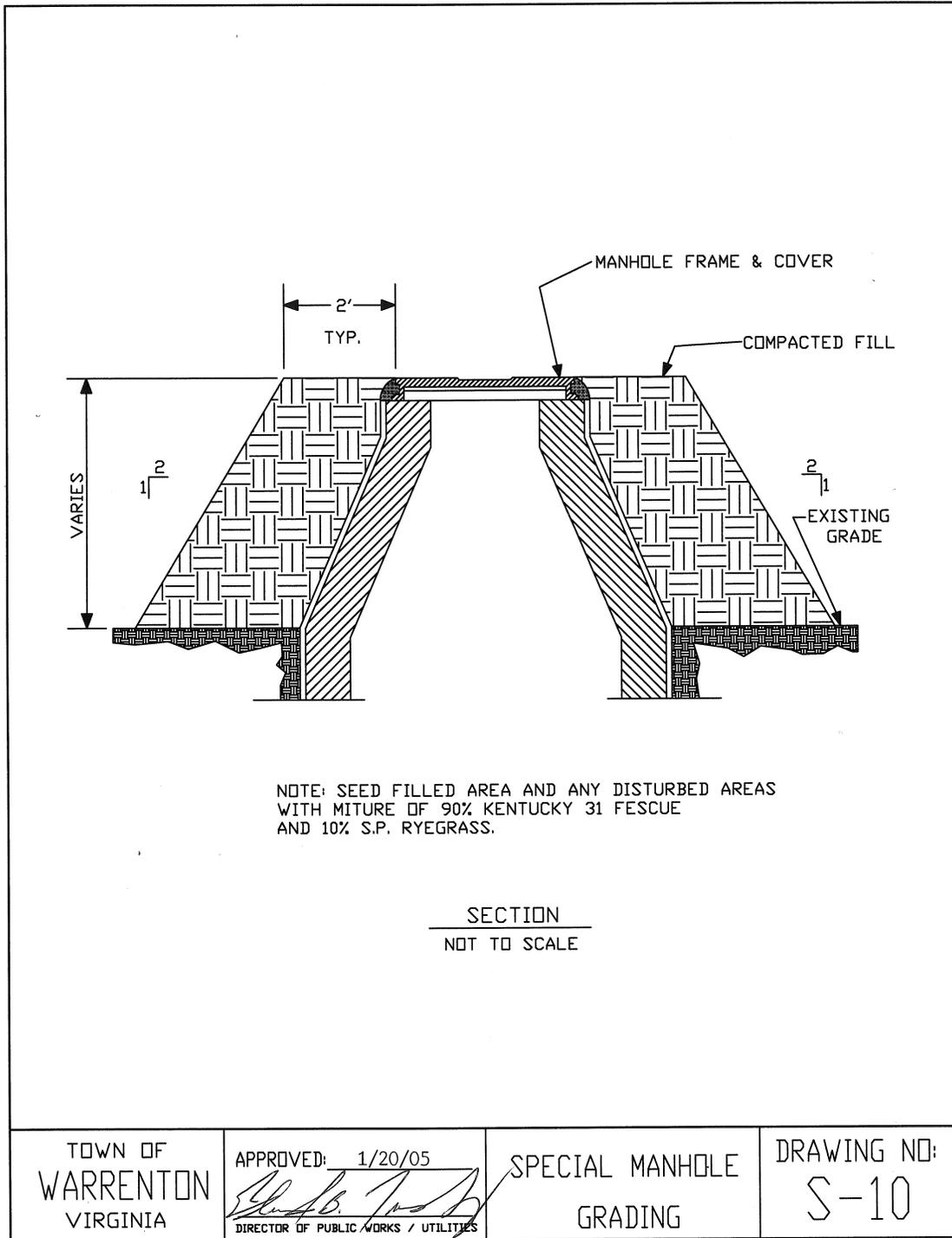


Figure 9: S-11 Inside Drop Manhole Connection

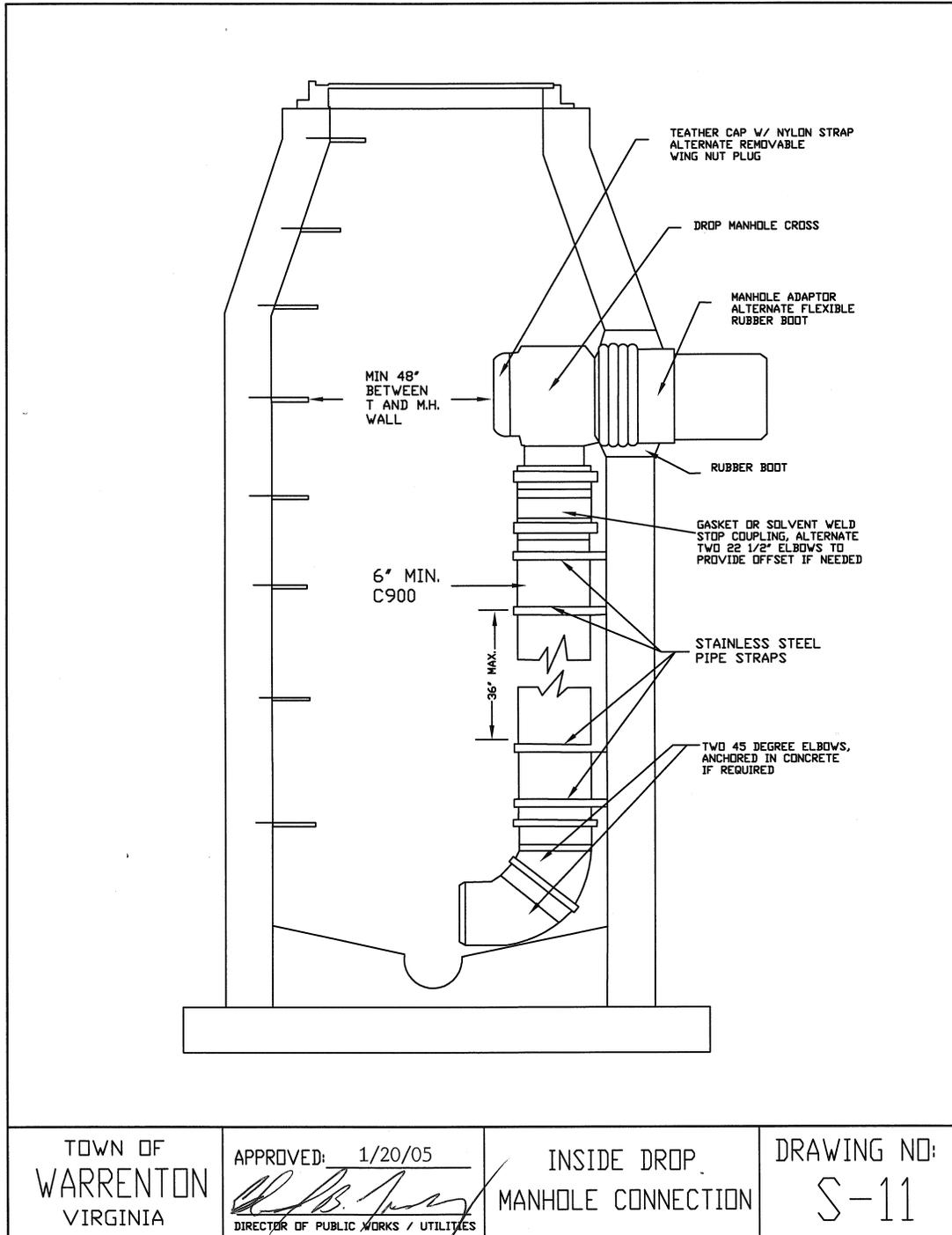


Figure 10: S-12 Sanitary Sewer Detail in Roadway

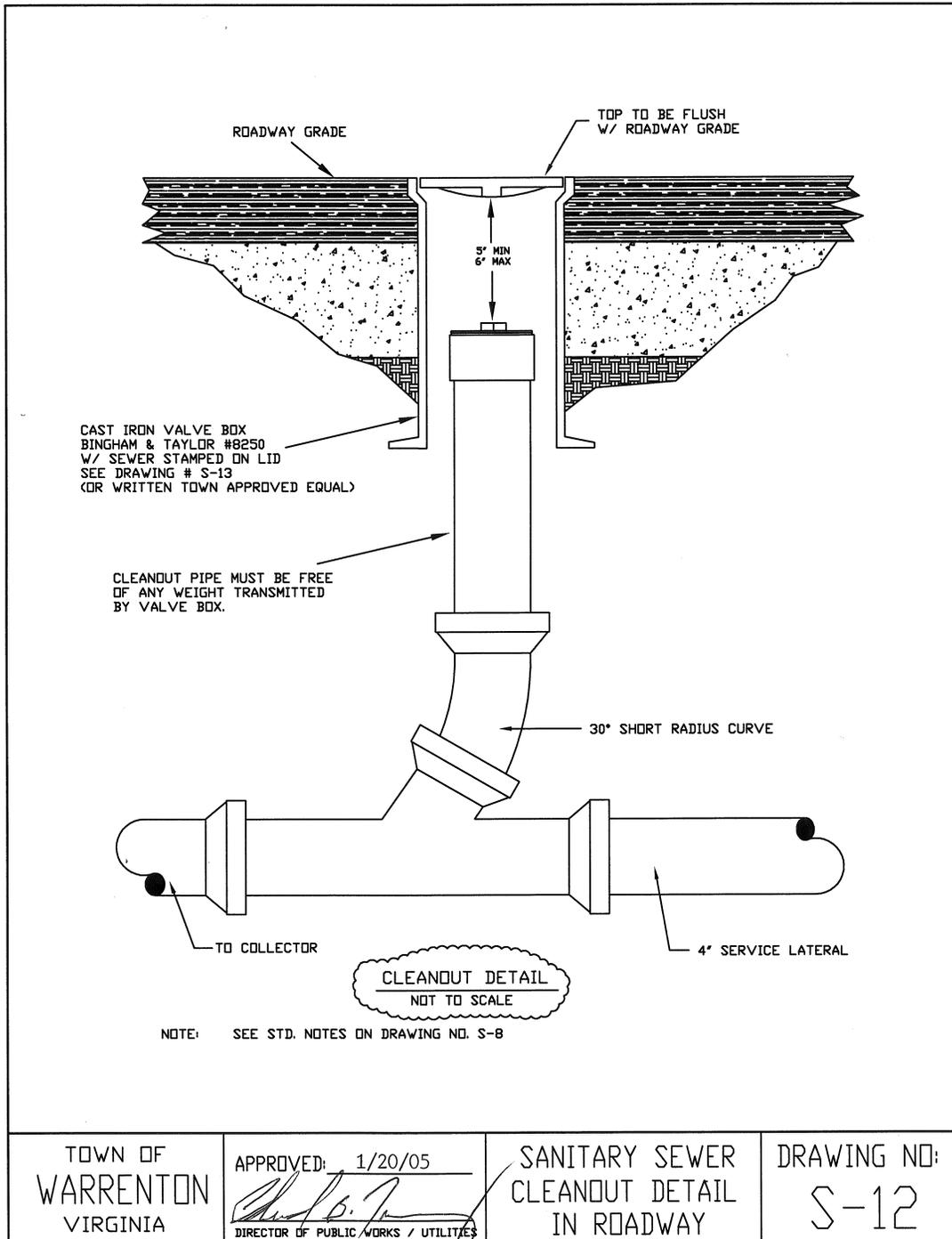


Figure 11: S-13 Cleanout Cover Assembly for 4" Cleanouts

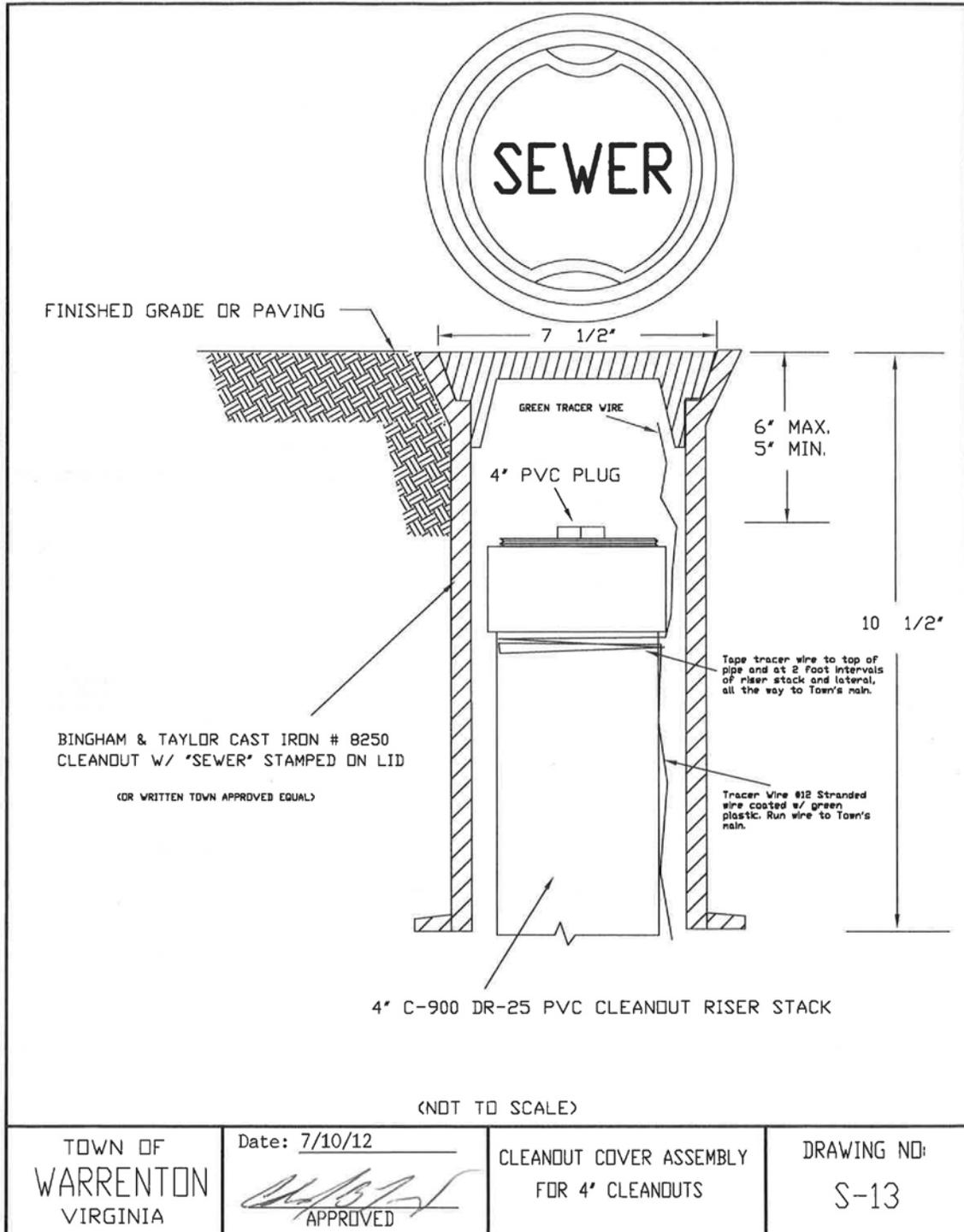


Figure 12: S-14 External Manhole Chimney Seal

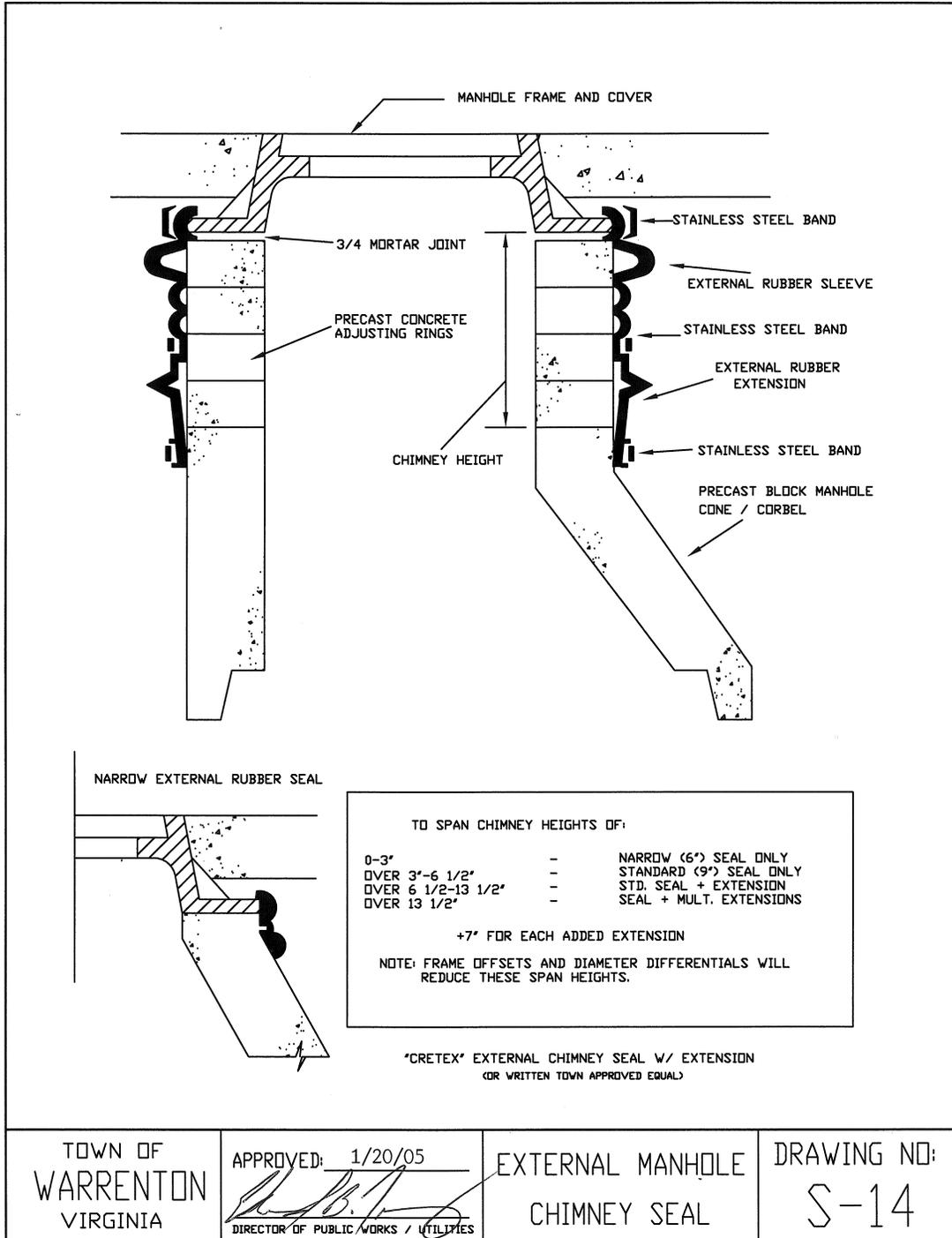
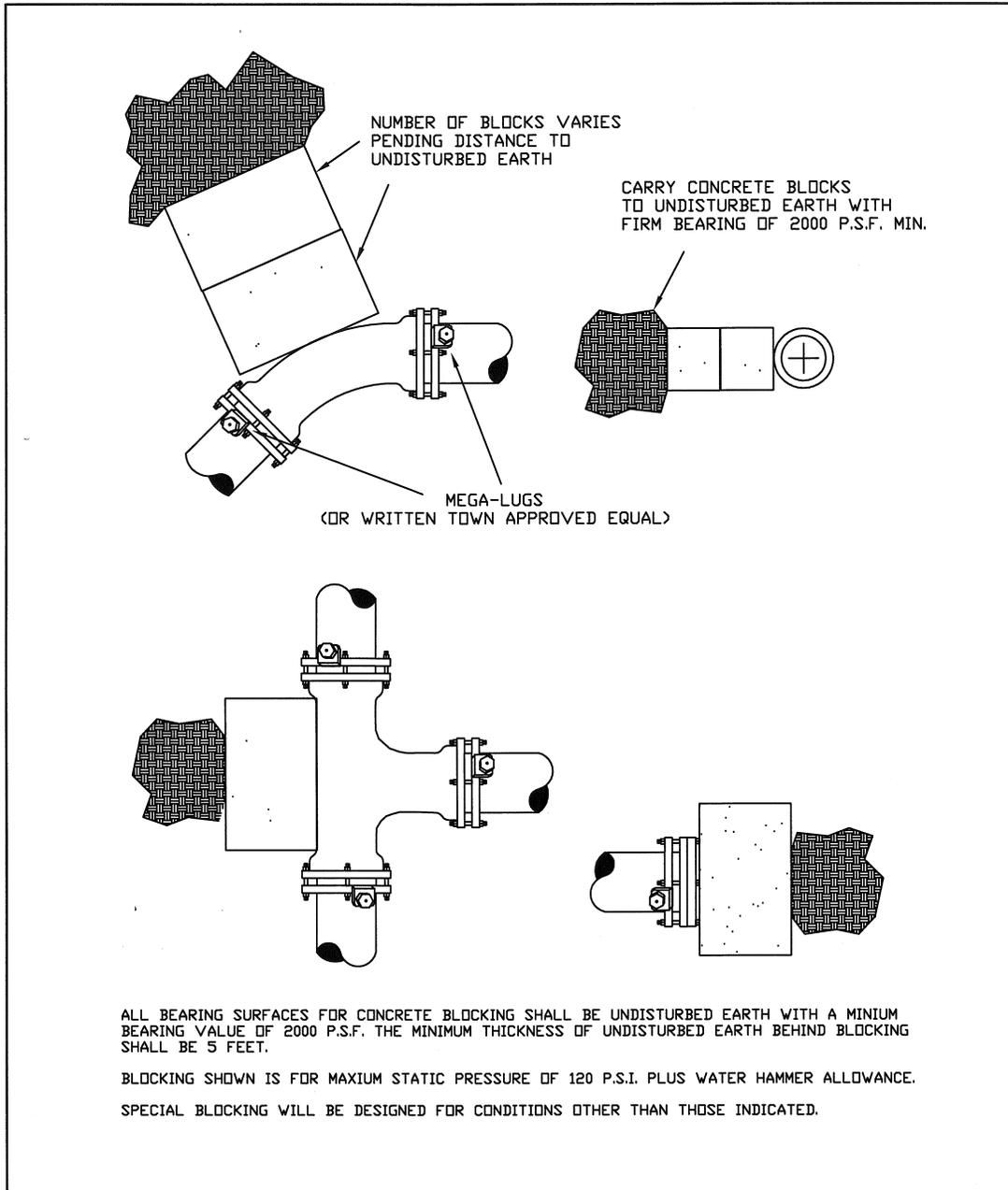


Figure 13: W-1 Concrete Blocking for Horizontal Bends



<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: 1/20/05 <i>[Signature]</i> DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>CONCRETE BLOCKING FOR ALL BENDS, TEES, CAPS & PLUGS</p>	<p>DRAWING NO: W-1</p>
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Figure 14: W-5 Fire Hydrant Setting

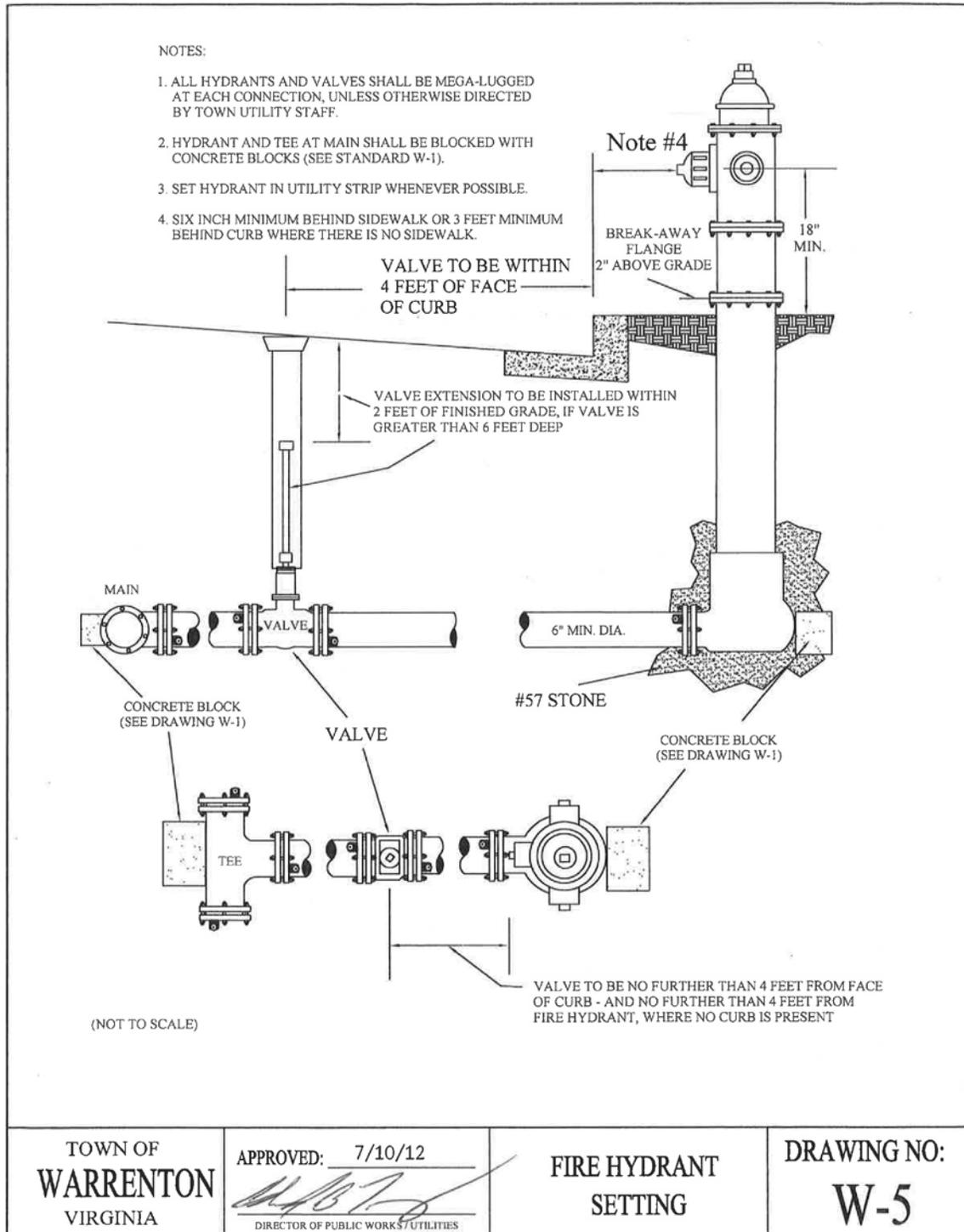


Figure 15: W-9 Water Service Connection 5/8" x 3/4"

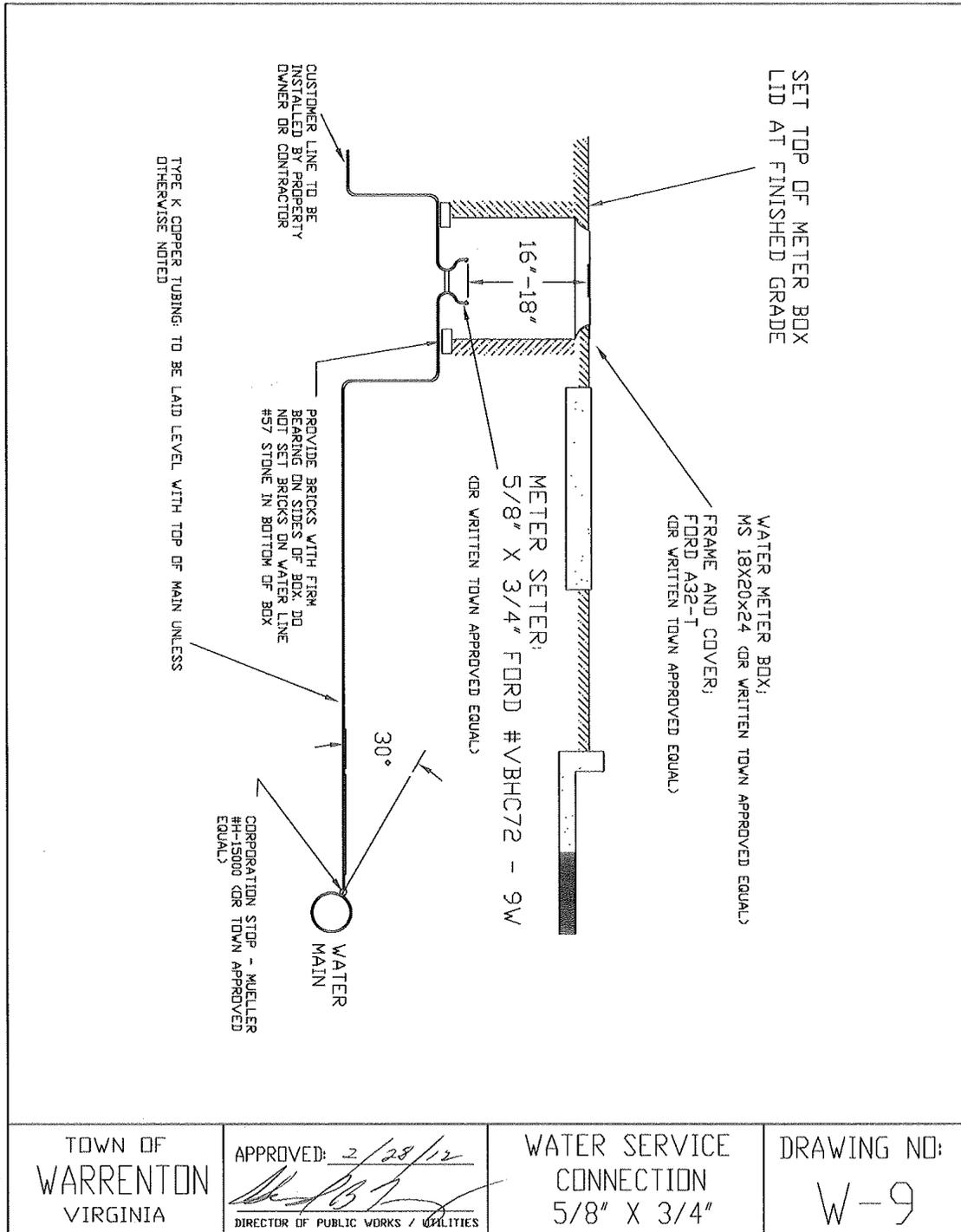


Figure 16: W-11 Air Relief Valve

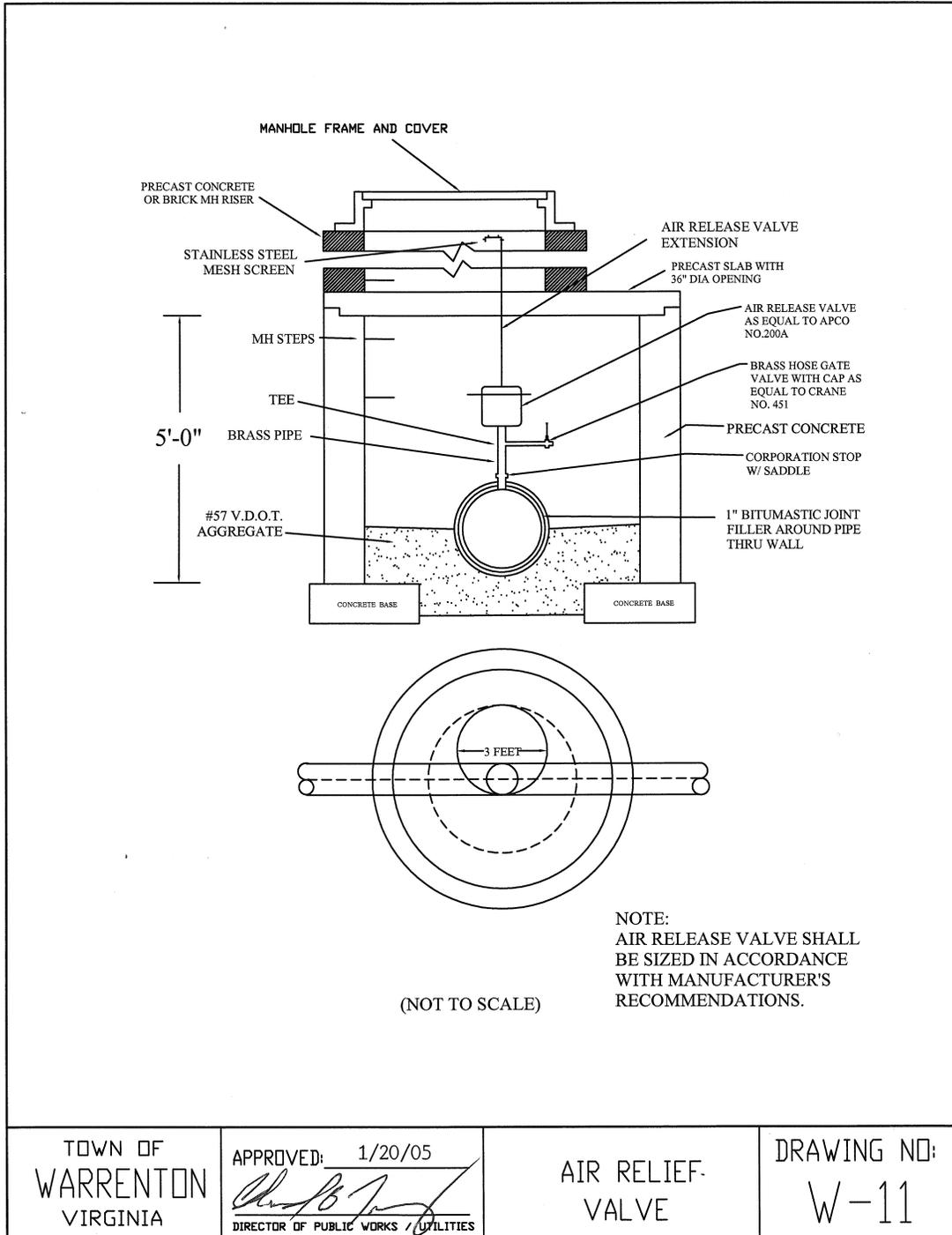


Figure 17: W-12 Sealed Casing Installation

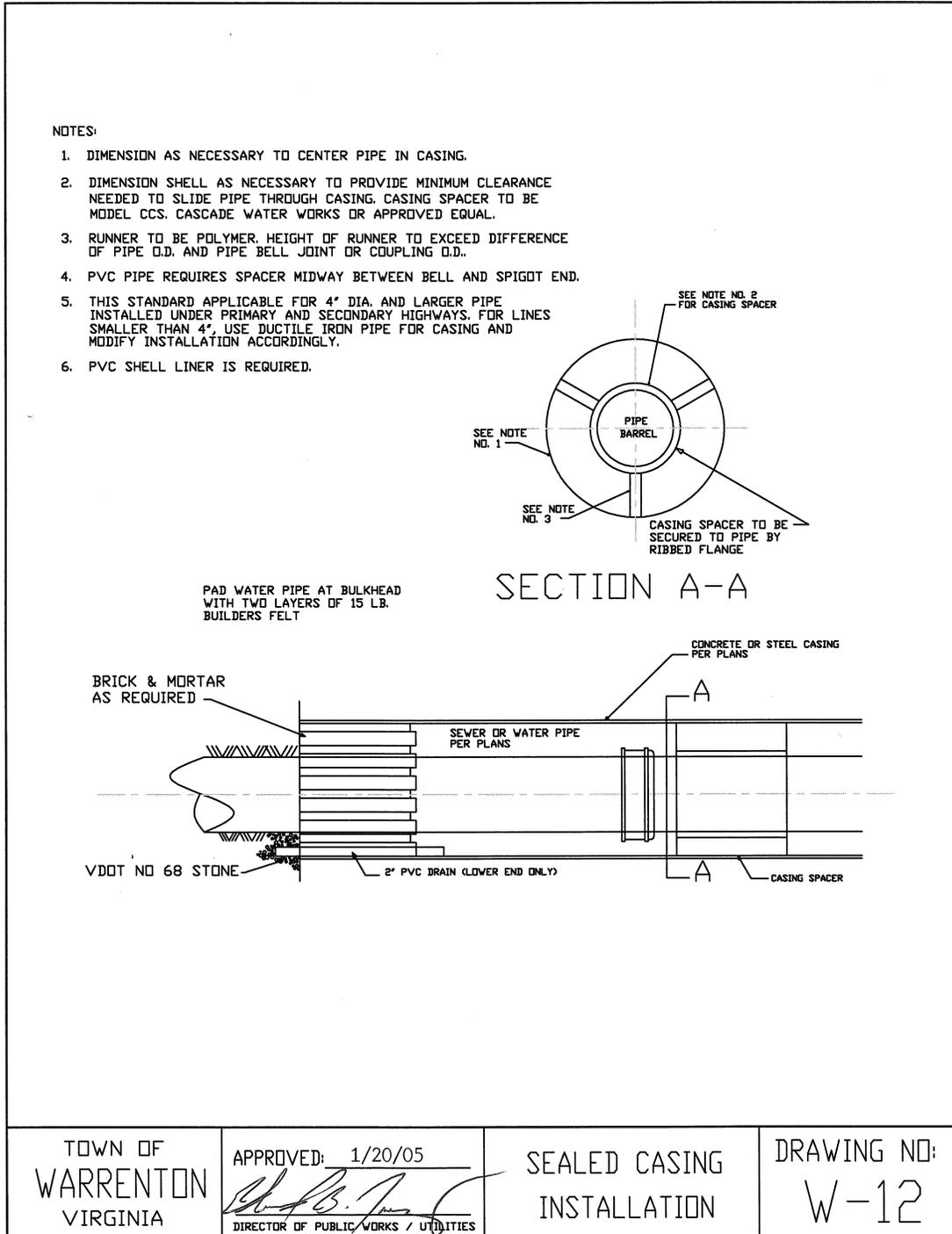


Figure 18: W-13 Water Meter Setting Detail for 1", 1.5" and 2" Meters

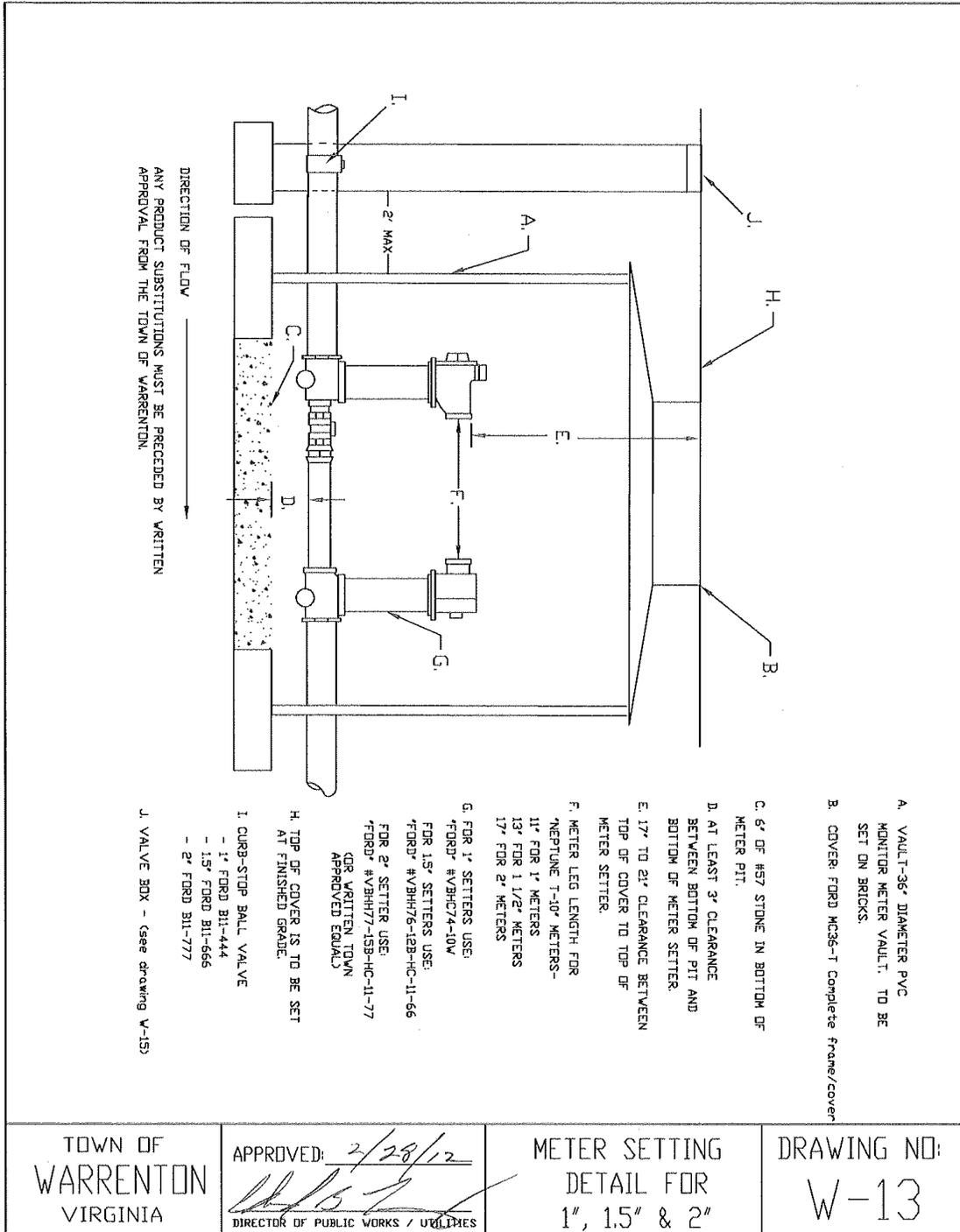
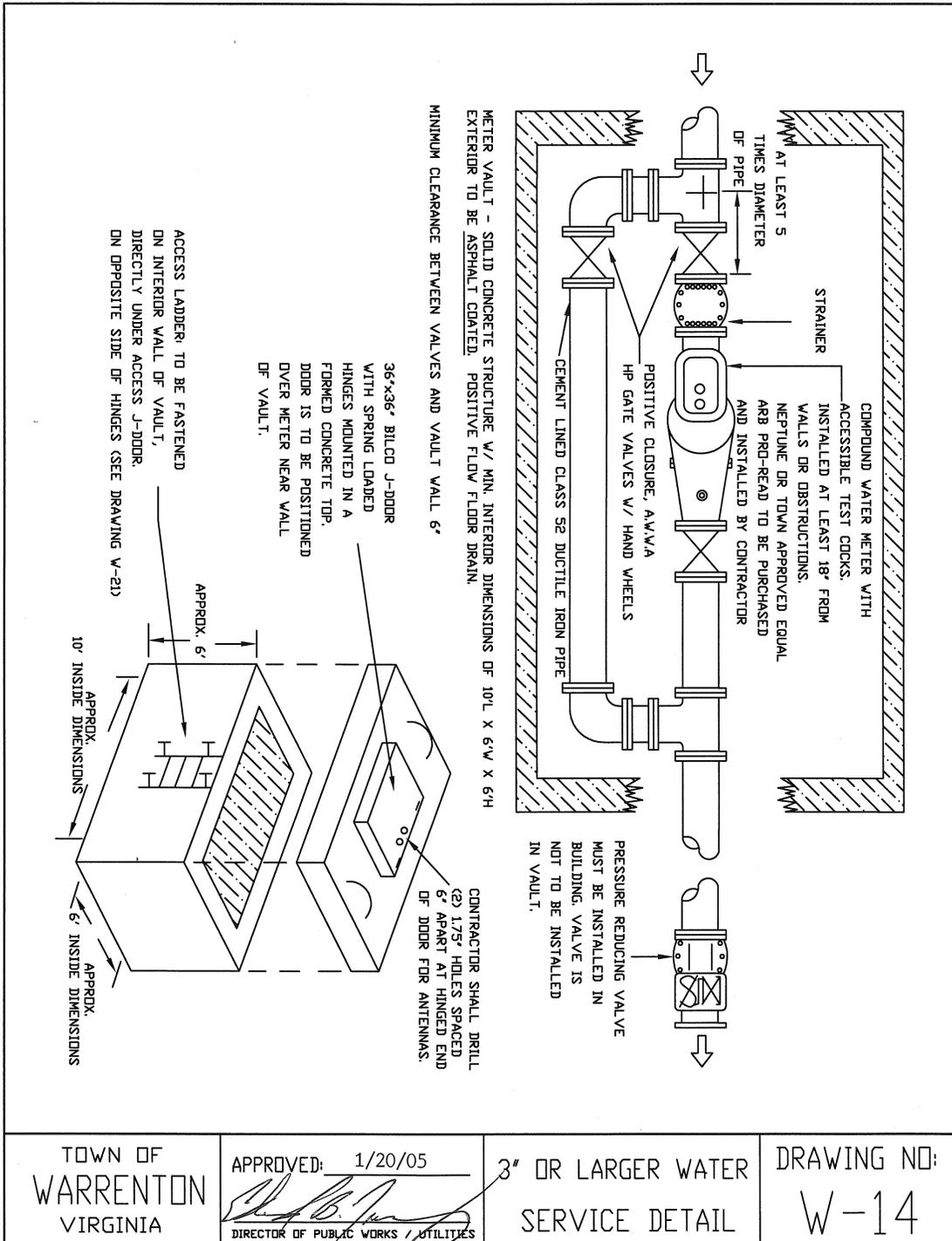


Figure 19: W-14 Water Service Sketch for 3" or Larger Meters



TOWN OF
WARRENTON
VIRGINIA

APPROVED: 1/20/05
[Signature]
DIRECTOR OF PUBLIC WORKS / UTILITIES

3" OR LARGER WATER
SERVICE DETAIL

DRAWING NO:
W-14

Figure 20: W-15 Valve Box Installation for PVC Pipe

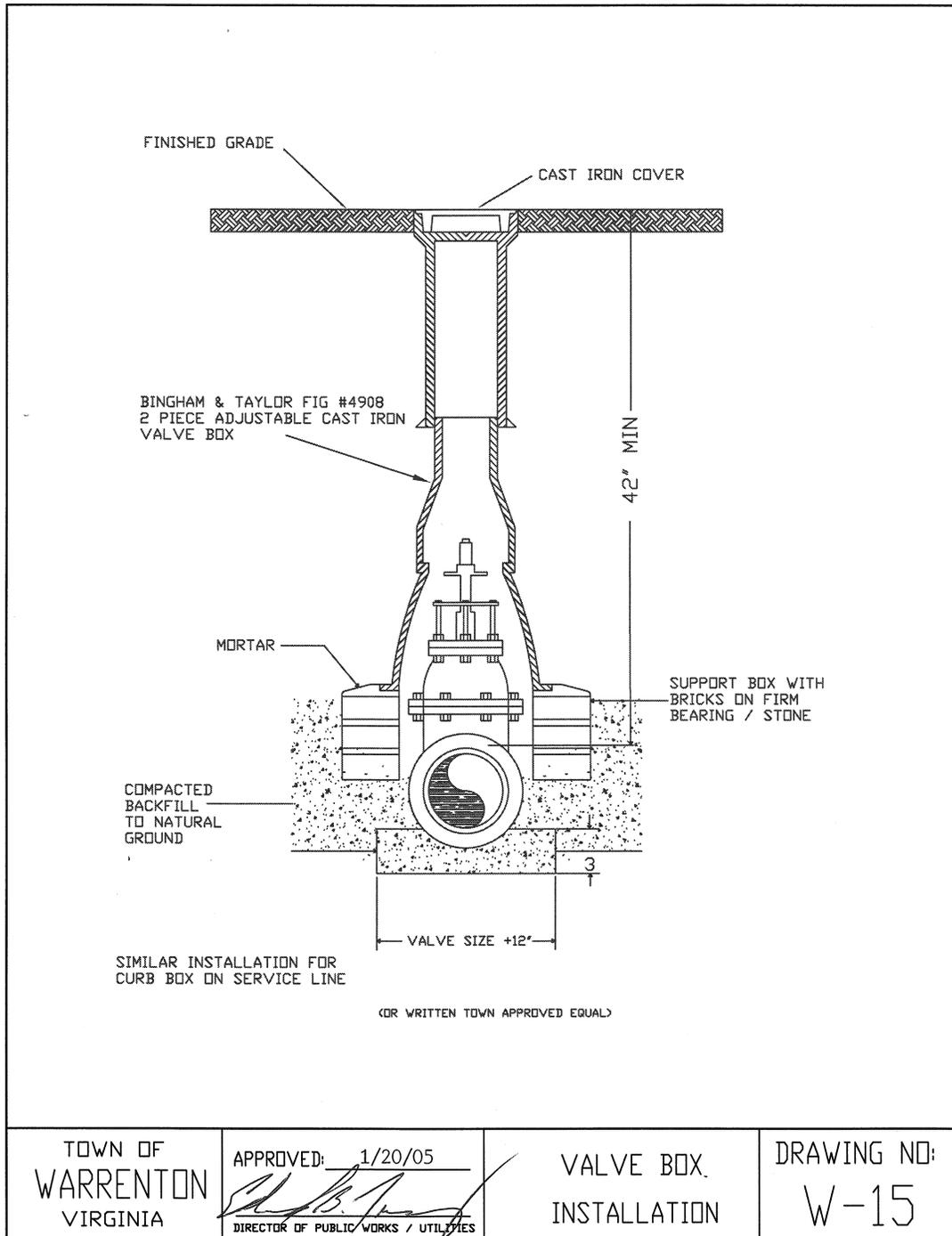
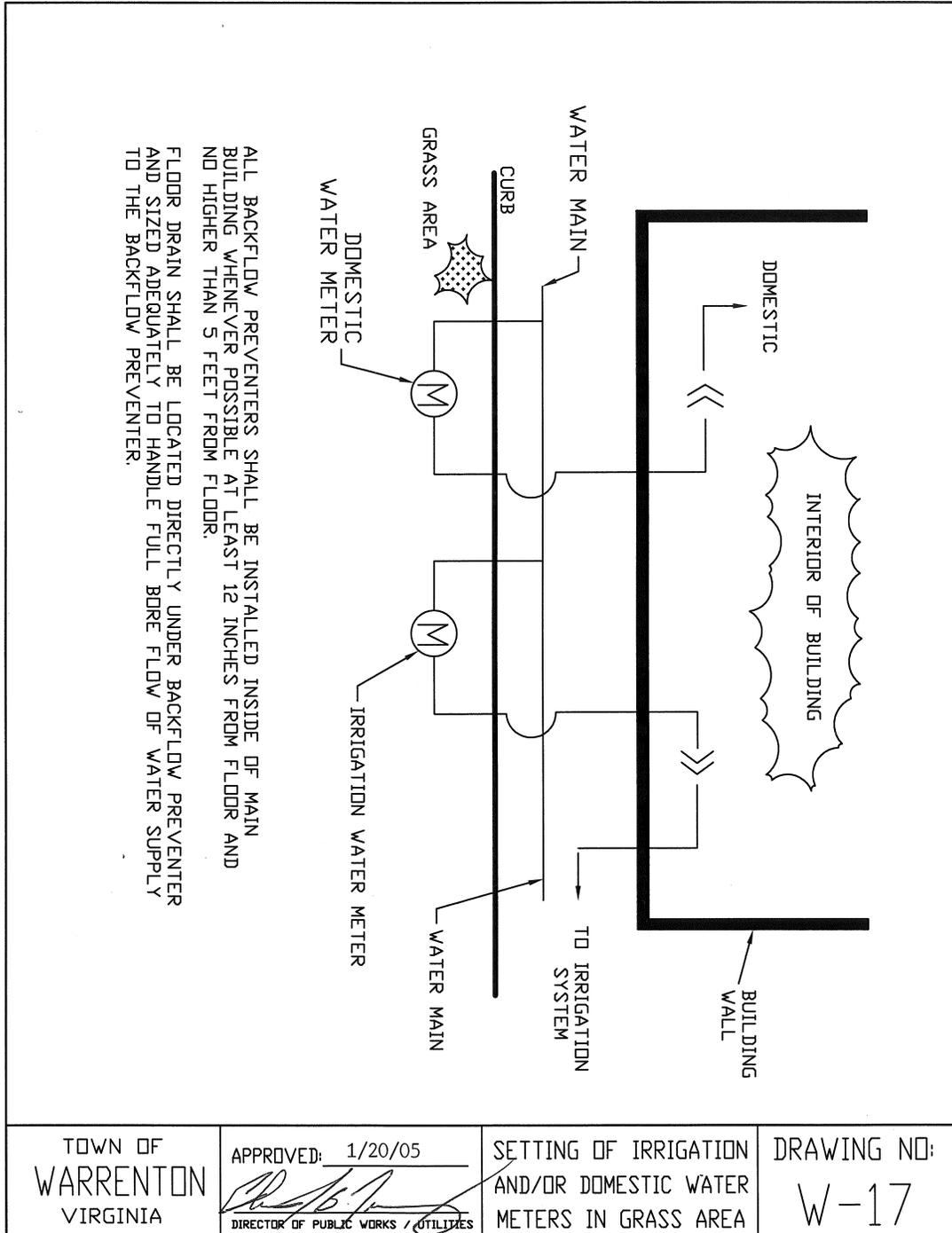


Figure 21: W-17 Setting of Irrigation and/or Domestic Water Meters in Grass Areas



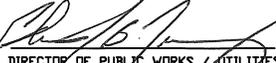
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	SETTING OF IRRIGATION AND/OR DOMESTIC WATER METERS IN GRASS AREA	DRAWING NO: W-17
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Figure 22: W-18 Setting of Fire Line Backflow Preventer

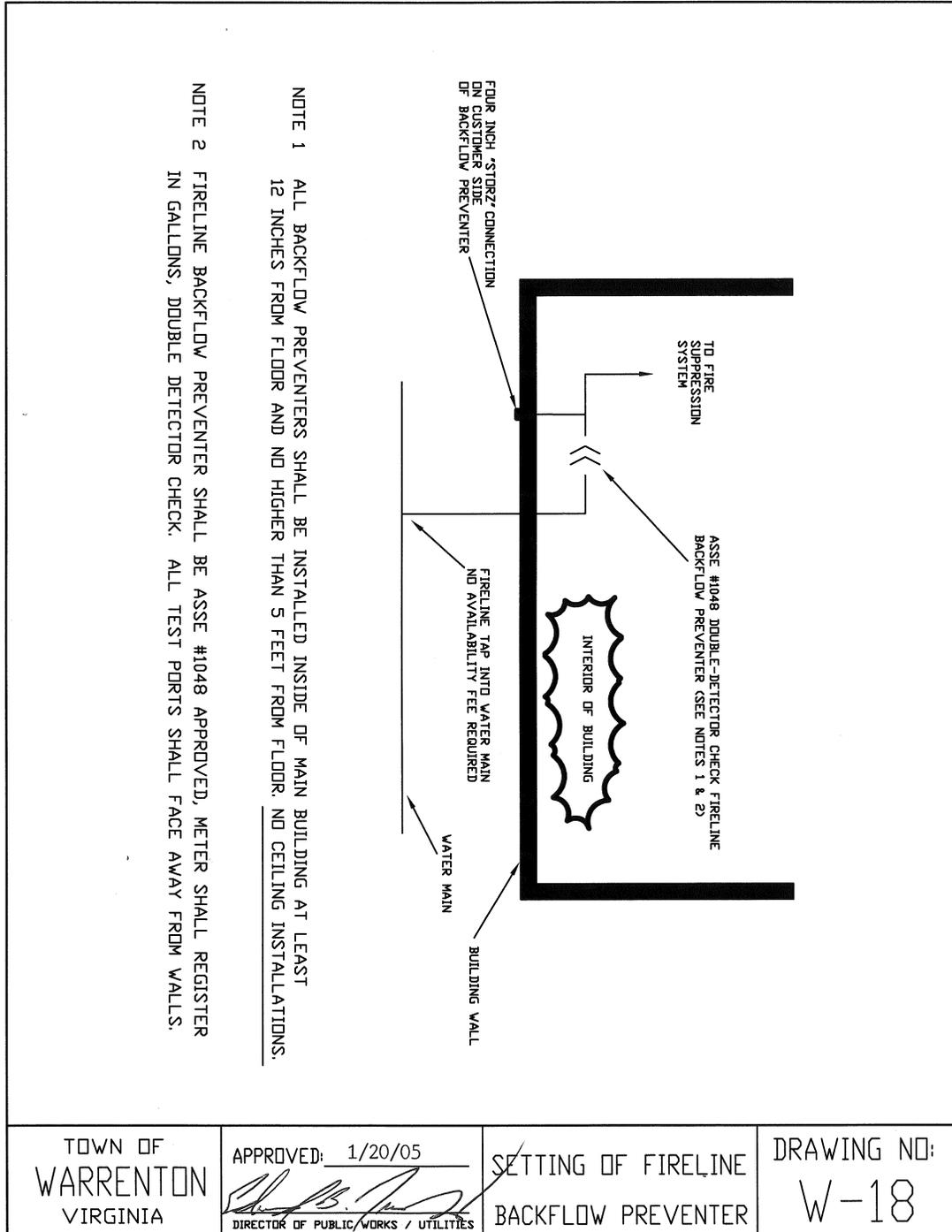


Figure 23: W-19 Temporary Water Service Option #1

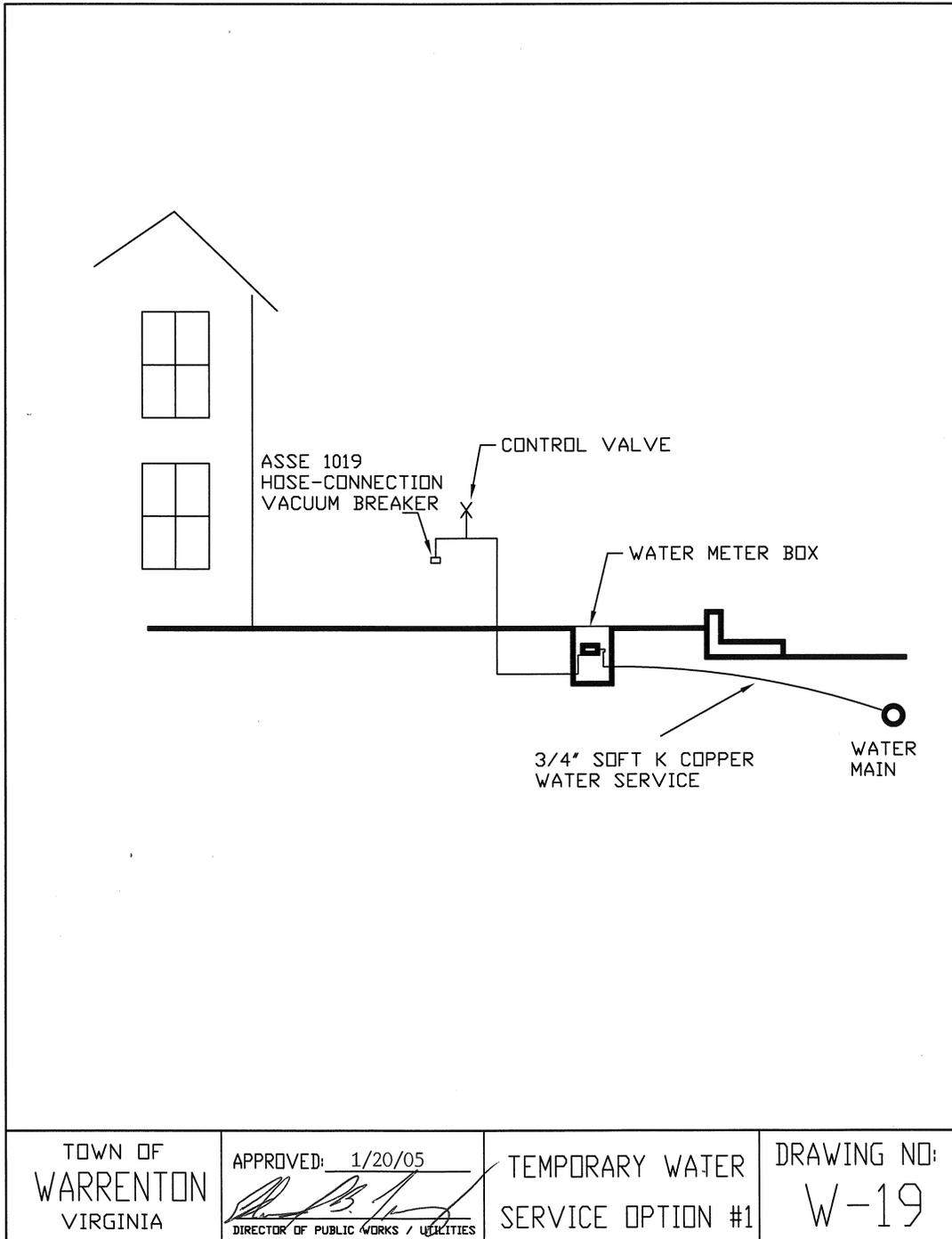
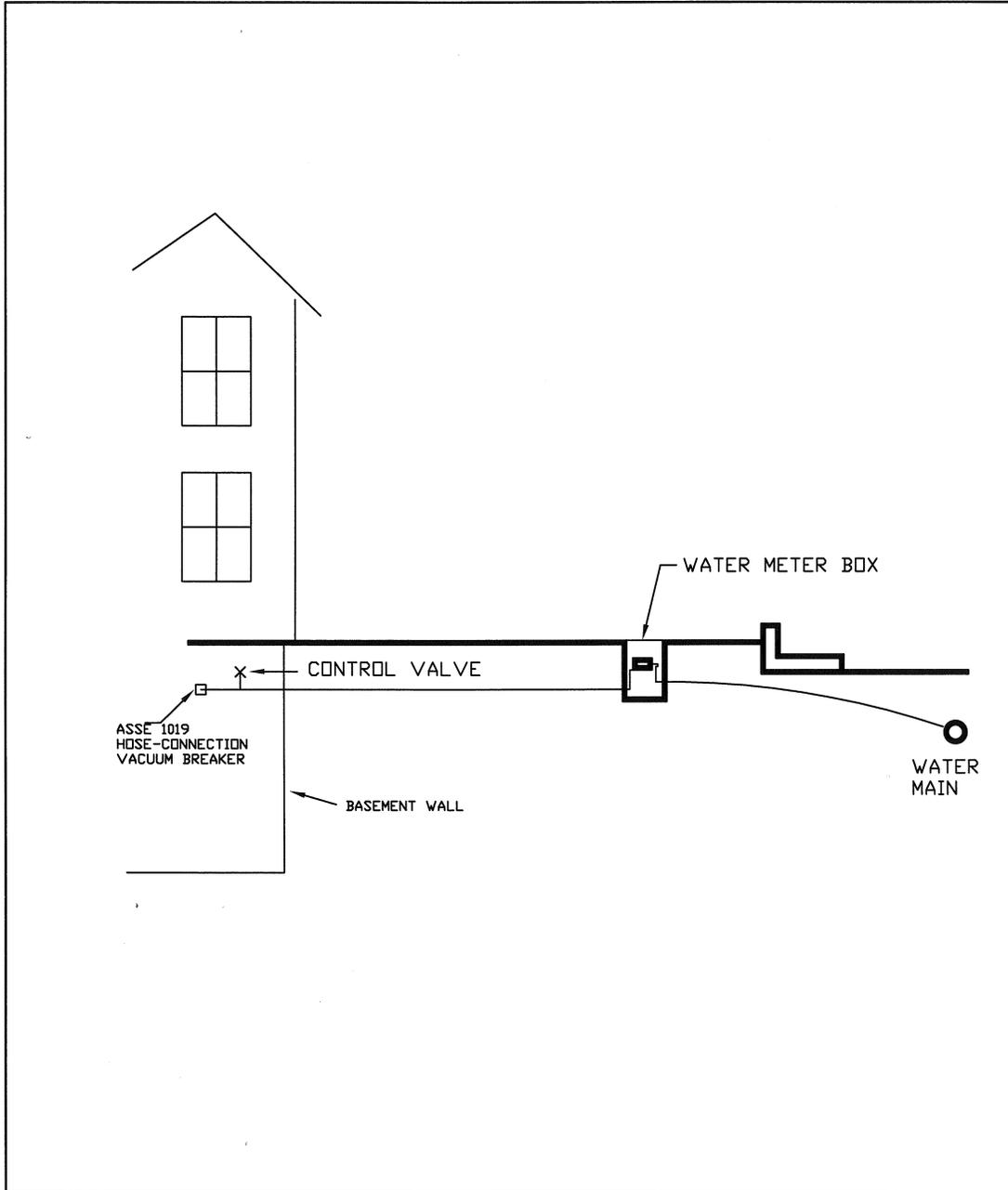


Figure 24: W-20 Temporary Water Service Option #2



TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05 <i>[Signature]</i> DIRECTOR OF PUBLIC WORKS / UTILITIES	TEMPORARY WATER SERVICE OPTION #2	DRAWING NO: W-20
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Figure 25: W-21 Ladder for Meter Vault

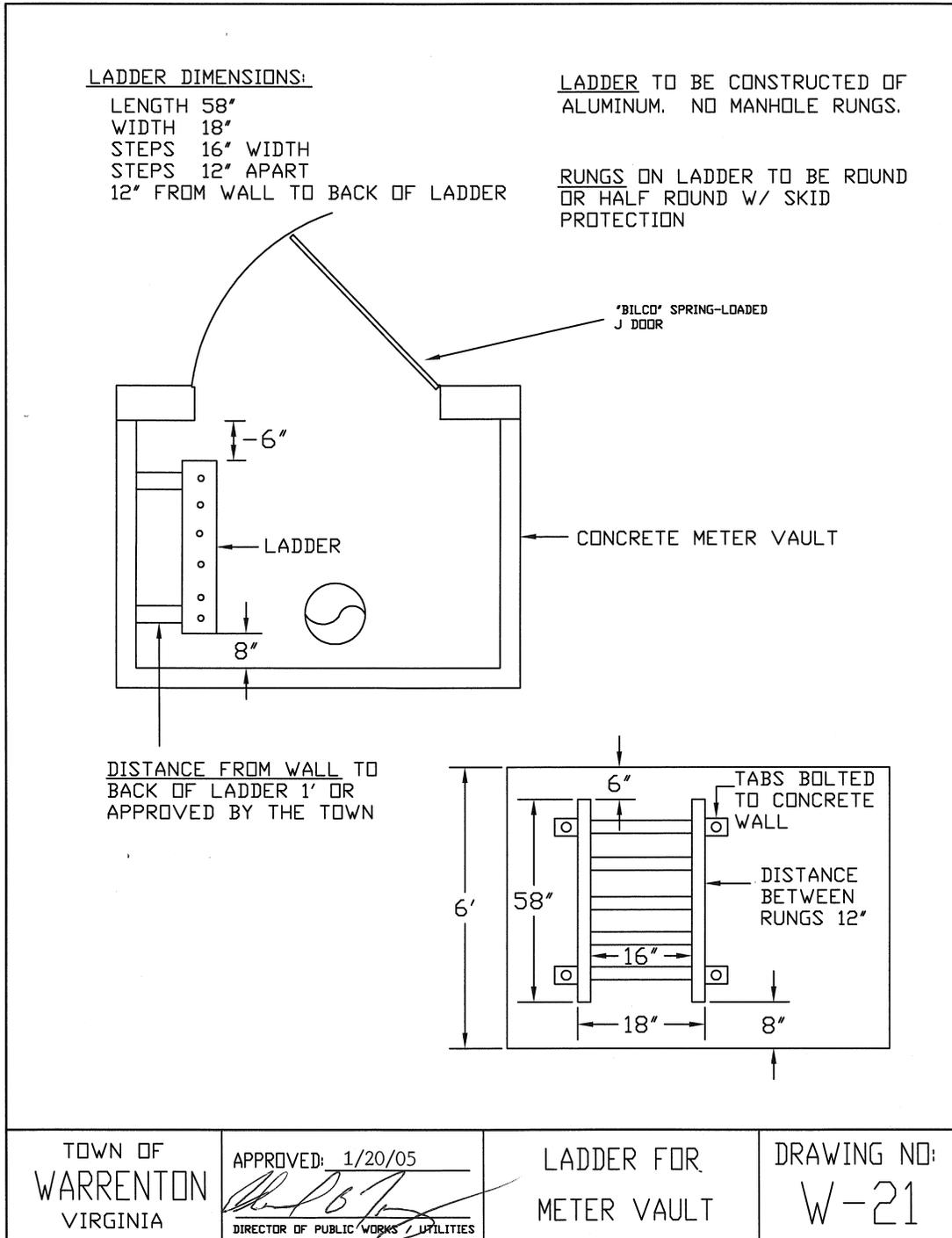
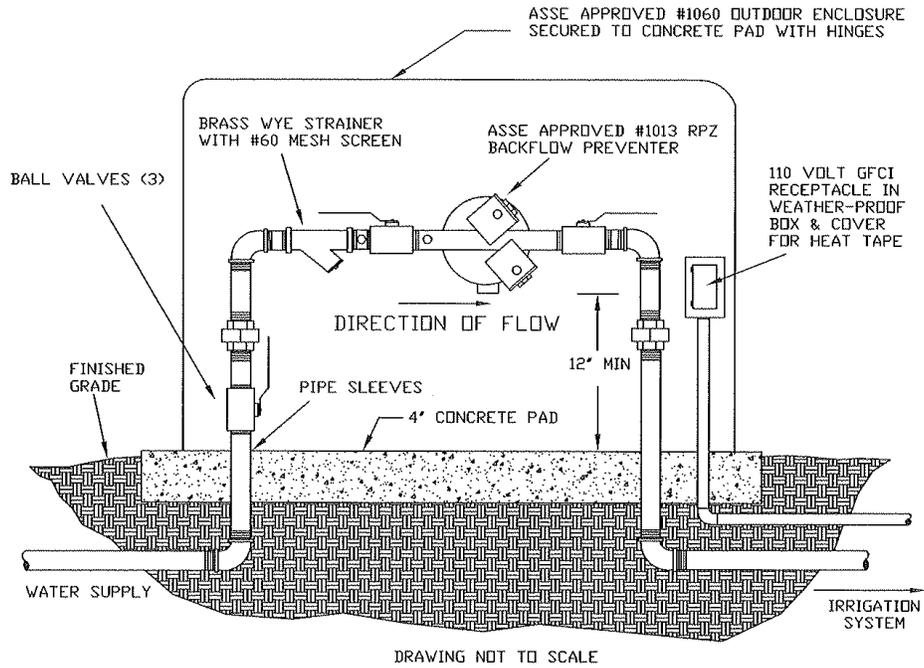


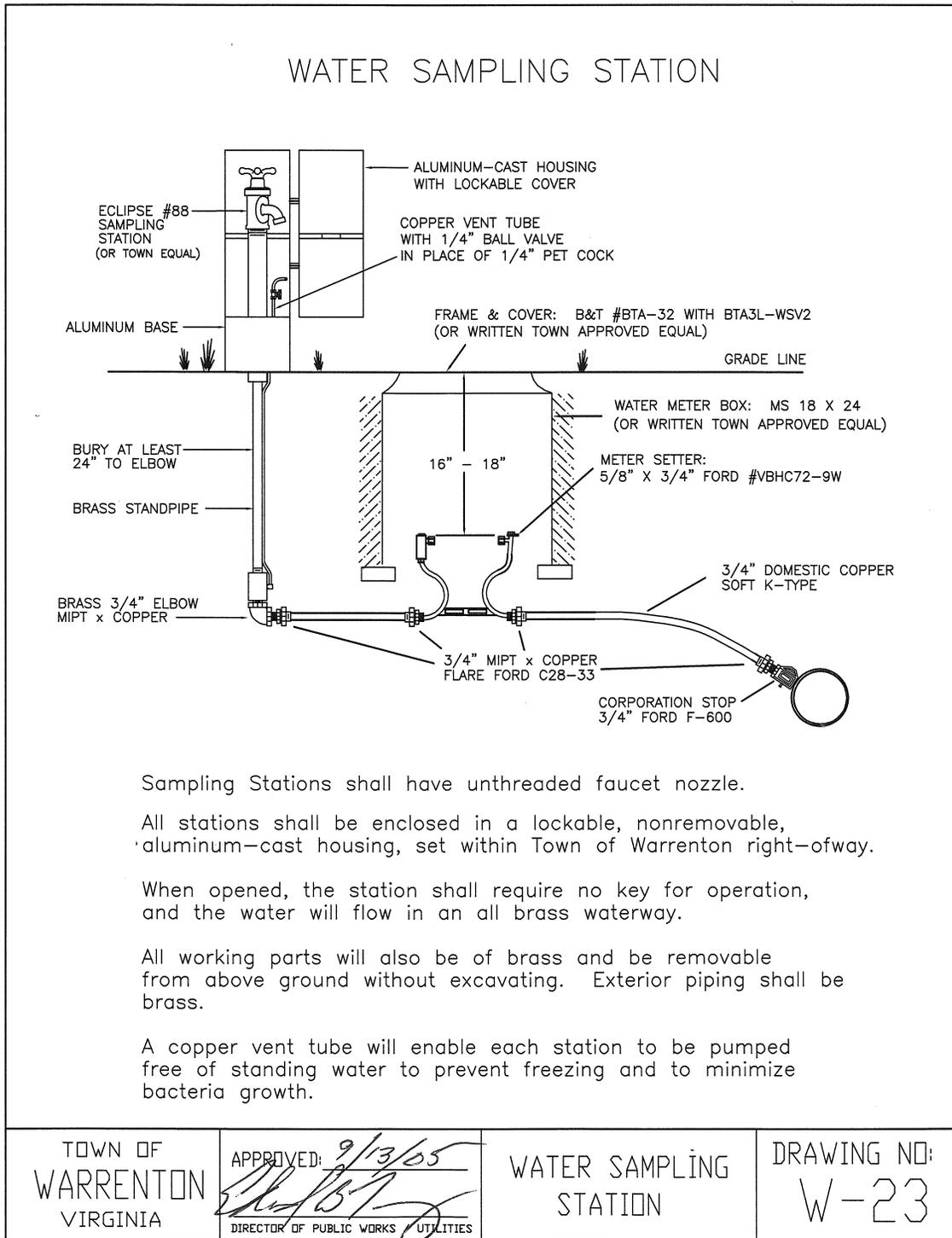
Figure 26: W-22 Outdoor Enclosure for Backflow Preventer



1. ENCLOSURE SHALL BE ASSE #1060 APPROVED.
2. RPZ BACKFLOW PREVENTER SHALL BE ASSE #1013 APPROVED AND BE WRAPPED WITH HEAT TAPE.
3. SET ENCLOSURE SO THAT IT OPENS TO EXPOSE TEST PORTS ON BACKFLOW PREVENTER FOR TESTING.
4. SET ENCLOSURE AT LEAST 6 FEET FROM EDGE OF CURB OR PROTECT ENCLOSURE WITH DUCTILE IRON BOLLARDS.
5. IRRIGATION AND DOMESTIC BACKFLOW PREVENTERS SHALL BE INSTALLED INDOORS WHENEVER POSSIBLE.
6. DEPTH OF WATER SERVICE PIPE SHALL BE 30" MINIMUM BELOW FINISHED GRADE.

<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: <u>3/8/09</u> <i>[Signature]</i> DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>OUTDOOR ENCLOSURE FOR BACKFLOW PREVENTER</p>	<p>DRAWING NO: W-22</p>
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Figure 27: W-23 Water Sampling Station



Sampling Stations shall have unthreaded faucet nozzle.

All stations shall be enclosed in a lockable, nonremovable, aluminum-cast housing, set within Town of Warrenton right-of-way.

When opened, the station shall require no key for operation, and the water will flow in an all brass waterway.

All working parts will also be of brass and be removable from above ground without excavating. Exterior piping shall be brass.

A copper vent tube will enable each station to be pumped free of standing water to prevent freezing and to minimize bacteria growth.

Figure 29: D-1 Standard Storm Drain Inlet

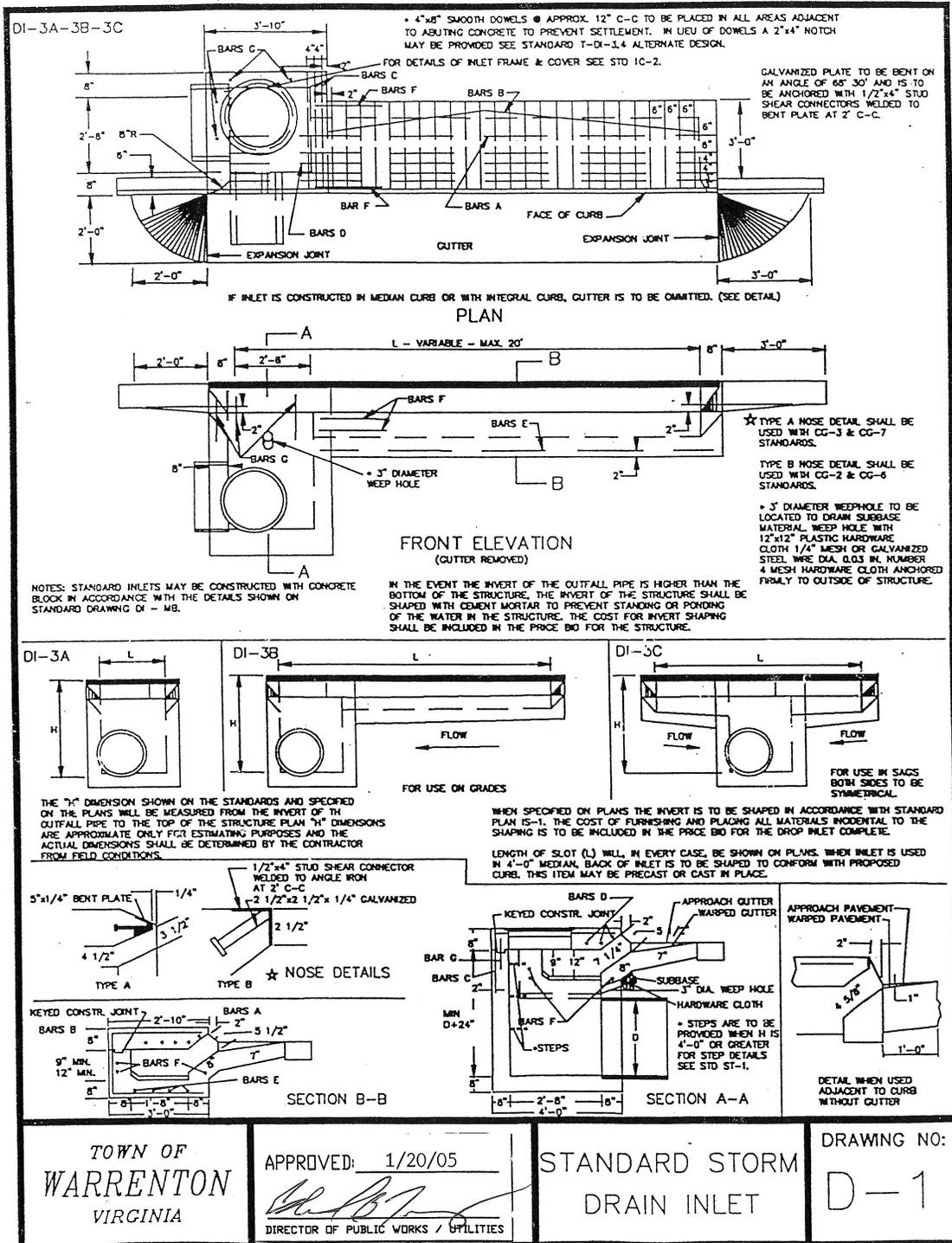


Figure 30: D-2 Standard Inlet Frame and Cover

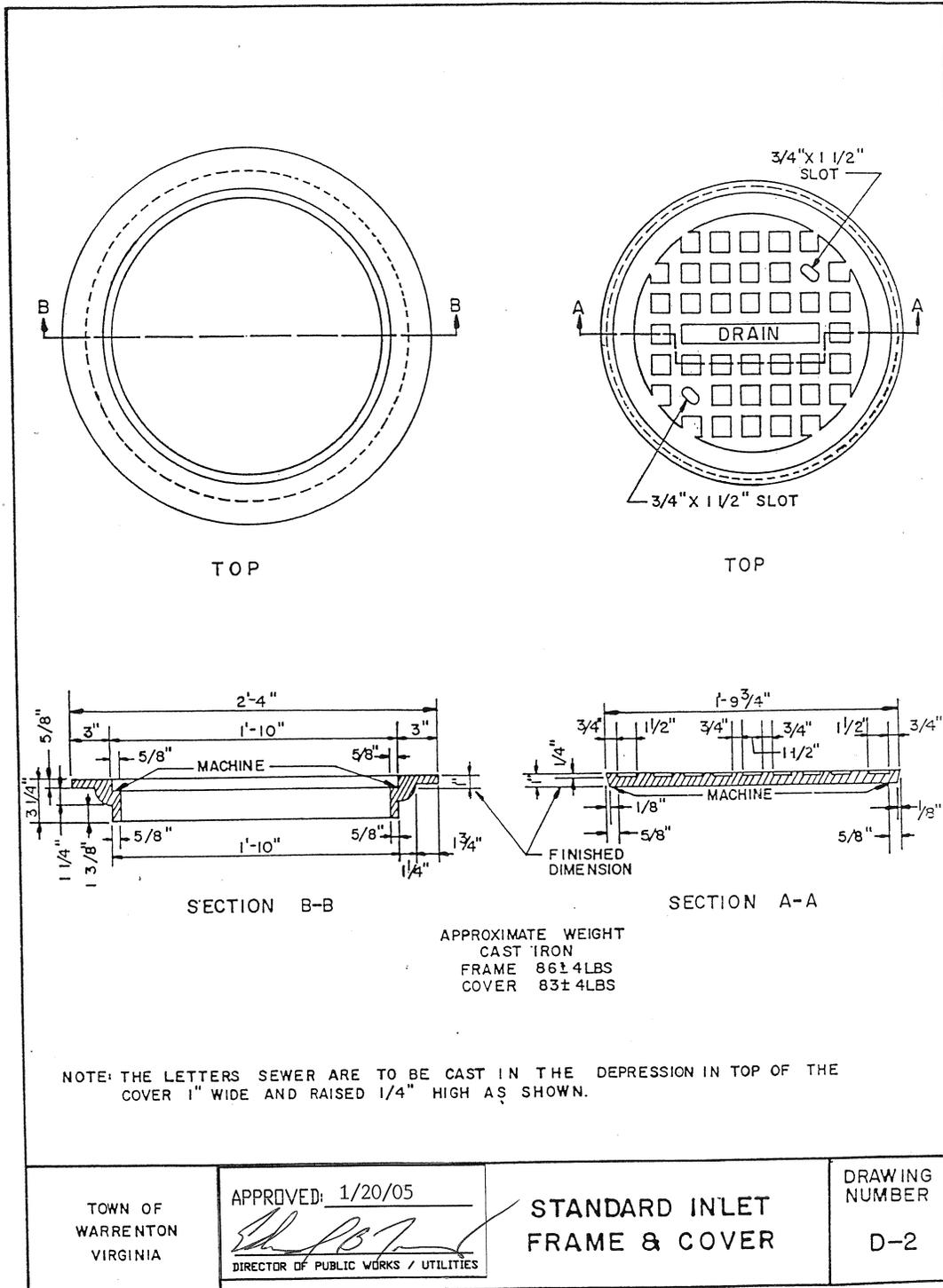


Figure 31: D-3 Instructions for Use of Drawing No. D-4

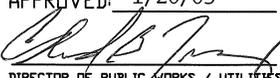
<p><u>INSTRUCTIONS FOR USING DRAWING IN D-4</u></p> <p>DRAWING NO. D-4 APPLIES TO CURB INLETS ON A CONTINUOUS GRADE.</p> <p>TO USE DRAWING NO. D-4 FOR CURB OPENING INLETS THE FOLLOWING STEPS MUST BE TAKEN:</p> <p>1. FOR CG-6 CURB REFER TO DRAWING NO. D-4 TO DETERMINE THE SPREAD(T). FOR CG-2 CURB REFER TO CHART NO.2 IN VDOT DRAINAGE MANUAL, P. 4-42, REV. 12-86</p> <p>2. DETERMINE SW/SX, SW= GUTTER SLOPE, SX= PAVEMENT CROSS SLOPE, DETERMINE W/T.</p> <p>3. REFER TO DRAWING NO. D-9, READ EO.</p> <p>4. USING A= 1IN. FOR CG-2, USING A= 3.5IN. FOR CG-6, DETERMINE S'W.</p> <p>5. DETERMINE SE, , SE=SX+S'W EO.</p> <p>6. USING DRAWING NO. D-4, DETERMINE LT FOR 100% INTERCEPTION. IF LESS THAN 100% OF FLOW IS TO BE INTERCEPTED, USE $E=1-(1-L/LT)^{1.8}$ TO DETERMINE EFFICIENCY OF INLET.</p> <p>REVISED BY MICHAEL BROWN</p>			
<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>INSTRUCTIONS FOR USING DRAWING # D-4</p>	<p>DRAWING NO: D-3</p>

Figure 32: D-4 Curb-opening and Drain Inlet Length

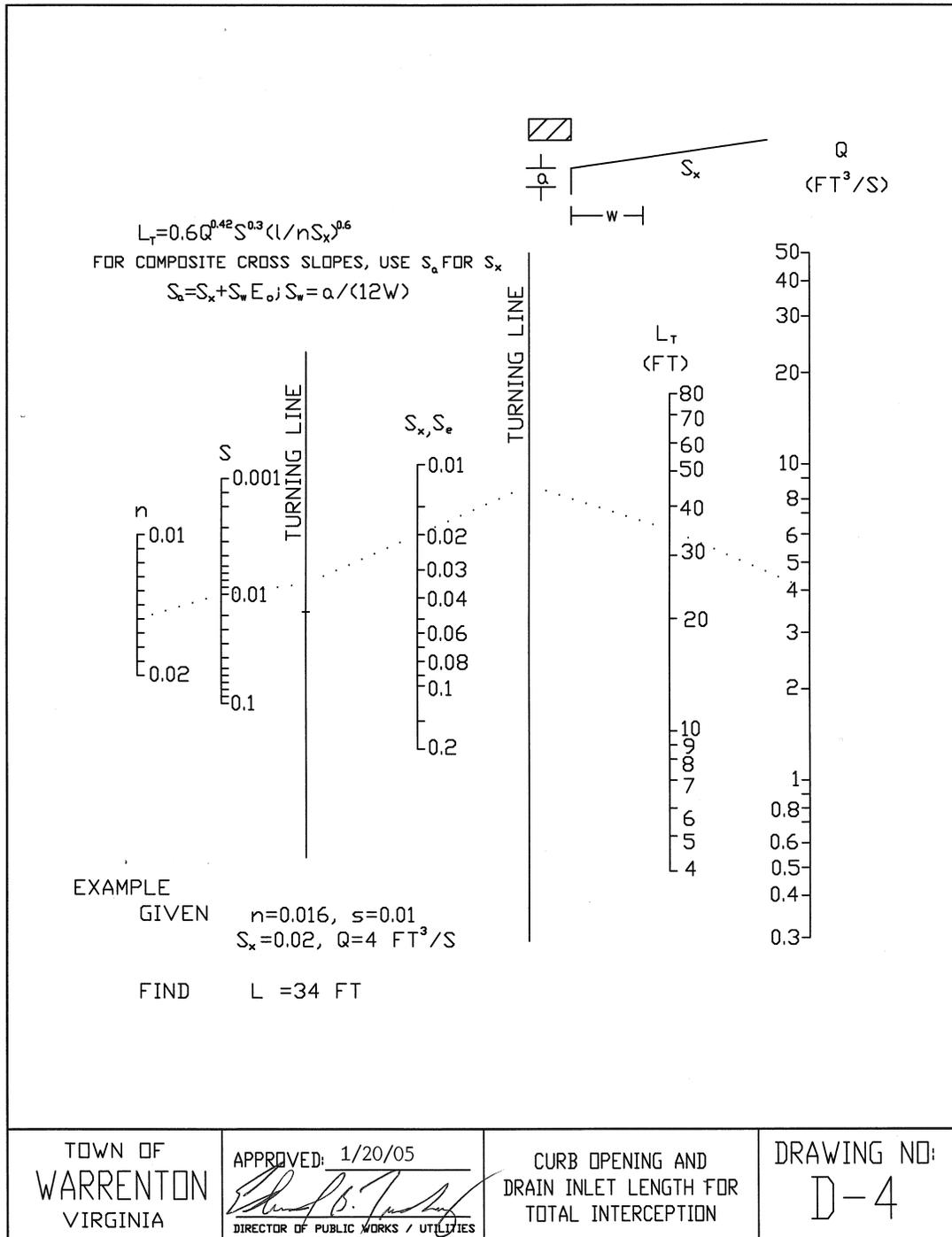


Figure 33: D-5 Instructions for Drawing #D-6

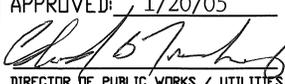
<p><u>INSTRUCTIONS FOR USE WITH DRAWING NO. D-6</u></p> <p>DRAWING NO. DE-6 APPLIES TO CAPACITY OF CURB OPENING INLETS IN SUMP LOCATION.</p> <p>THIS NOMOGRAPH SOLVES INLET CAPACITY PROBLEMS TO CURB OPENING INLETS AT POINT IN THE GRADE.</p> <p>THE FOLLOWING STEPS SHOULD BE TAKEN TO USE THIS NOMOGRAPH.</p> <p>DETERMINE P, $P=L=13W$</p> <p>FROM DRAWING D-6, READ DEPTH(D)</p> <p>CHECK FOR WEIR OPERATION $D < 1.2H$ IF INLET OPERATING AS AN ORIFICE SEE P.4-66 VDOT DRAINAGE MANUAL</p> <p>$T = \text{SPREAD} = D/SX$ $SX = \text{PAVEMENT CROSS SLOPE}$</p> <p>T SHOULD BE LIMITED TO THE WIDTH OF ONE HALF OF THE TRAVEL WAY IN EACH DIRECTION OR 8 TO 10 FEET.</p>			
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	INSTRUCTIONS FOR DRAWING # D-6	DRAWING NO: D-5

Figure 34: D-6 Depressed Curb Opening Inlet

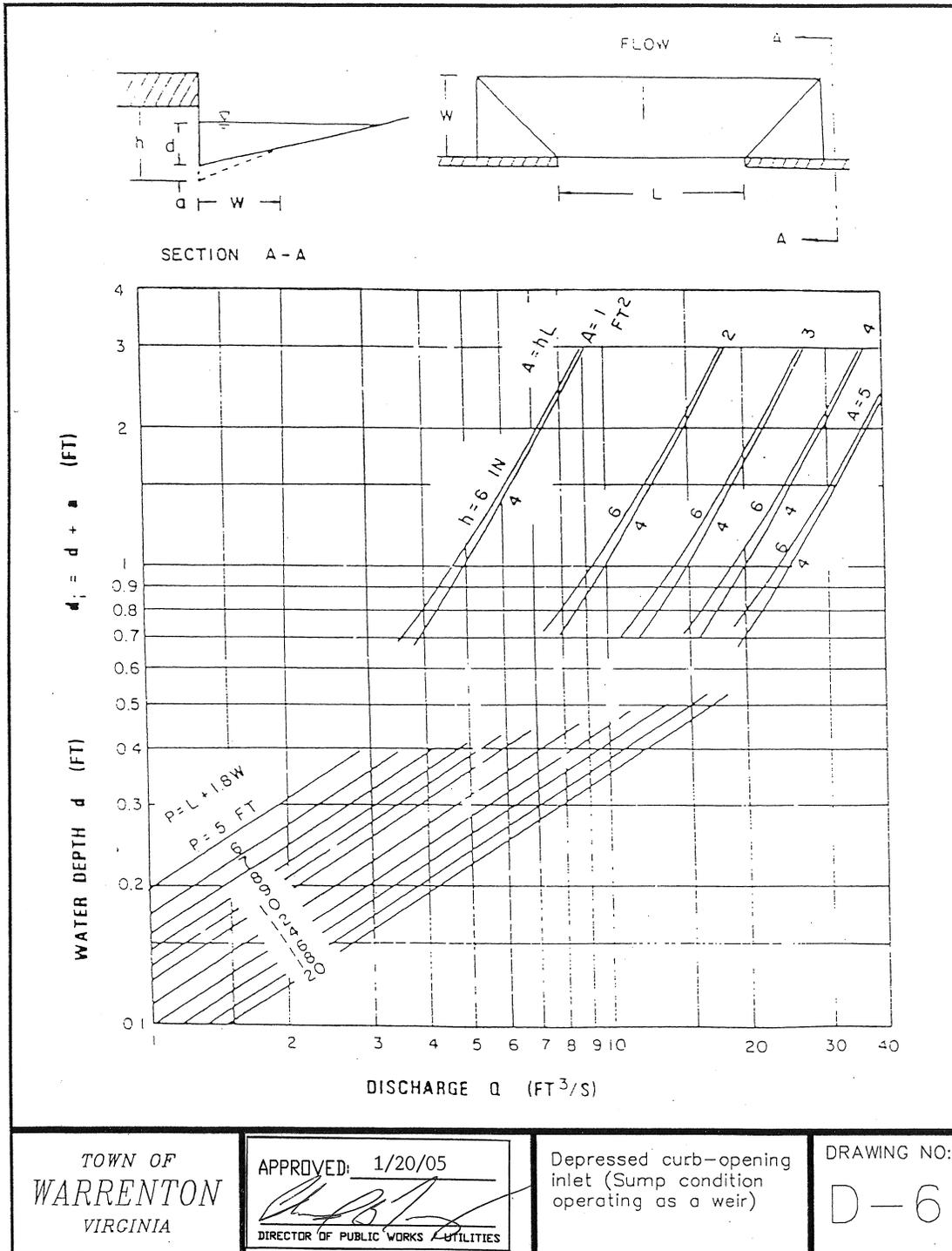
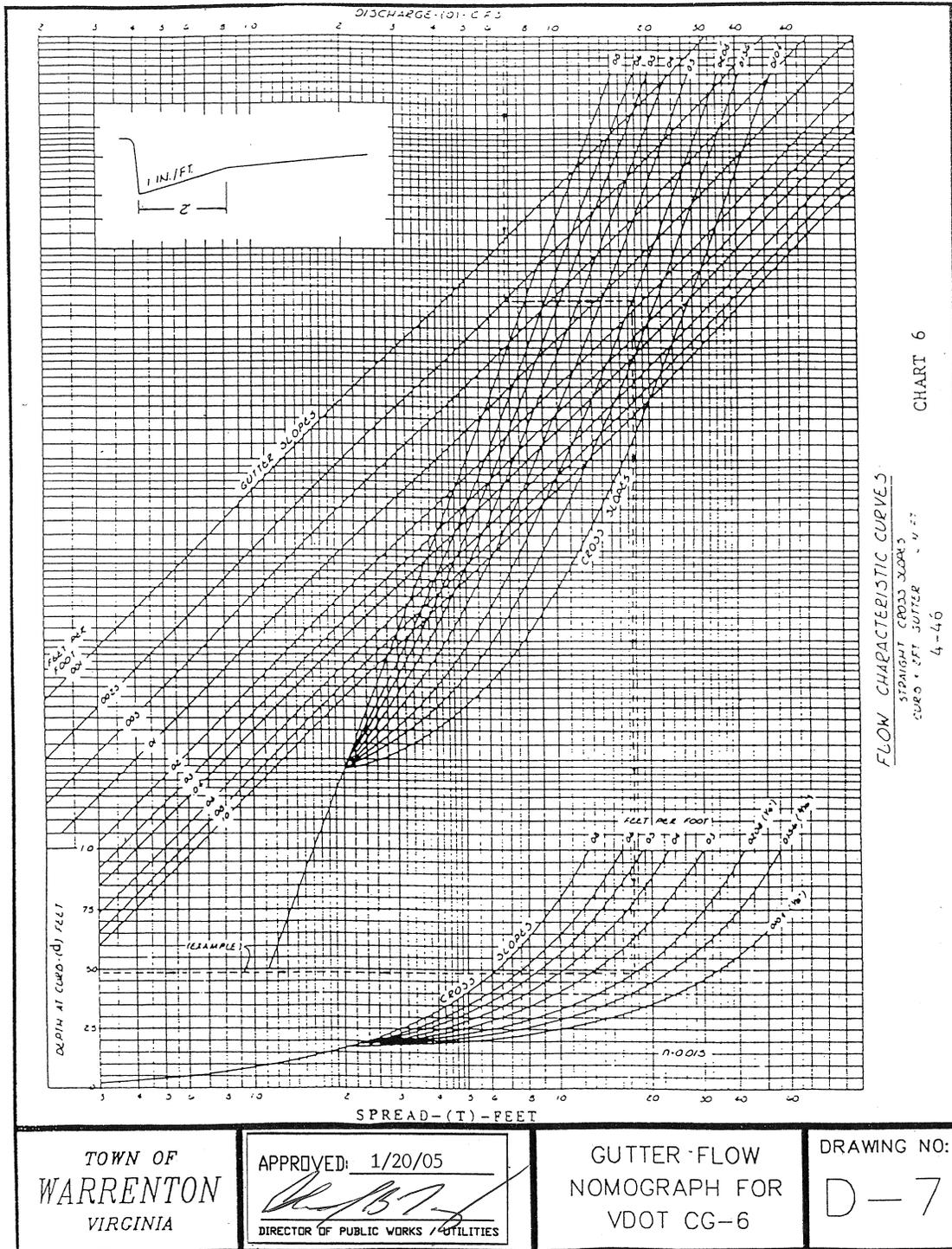


Figure 35: D-7 Gutter Flow Nomograph For VDOT CG-6



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GUTTER FLOW
NOMOGRAPH FOR
VDOT CG-6

DRAWING NO:
D-7

Figure 36: D-8 Gutter Flow Nomograph for Composite Gutter

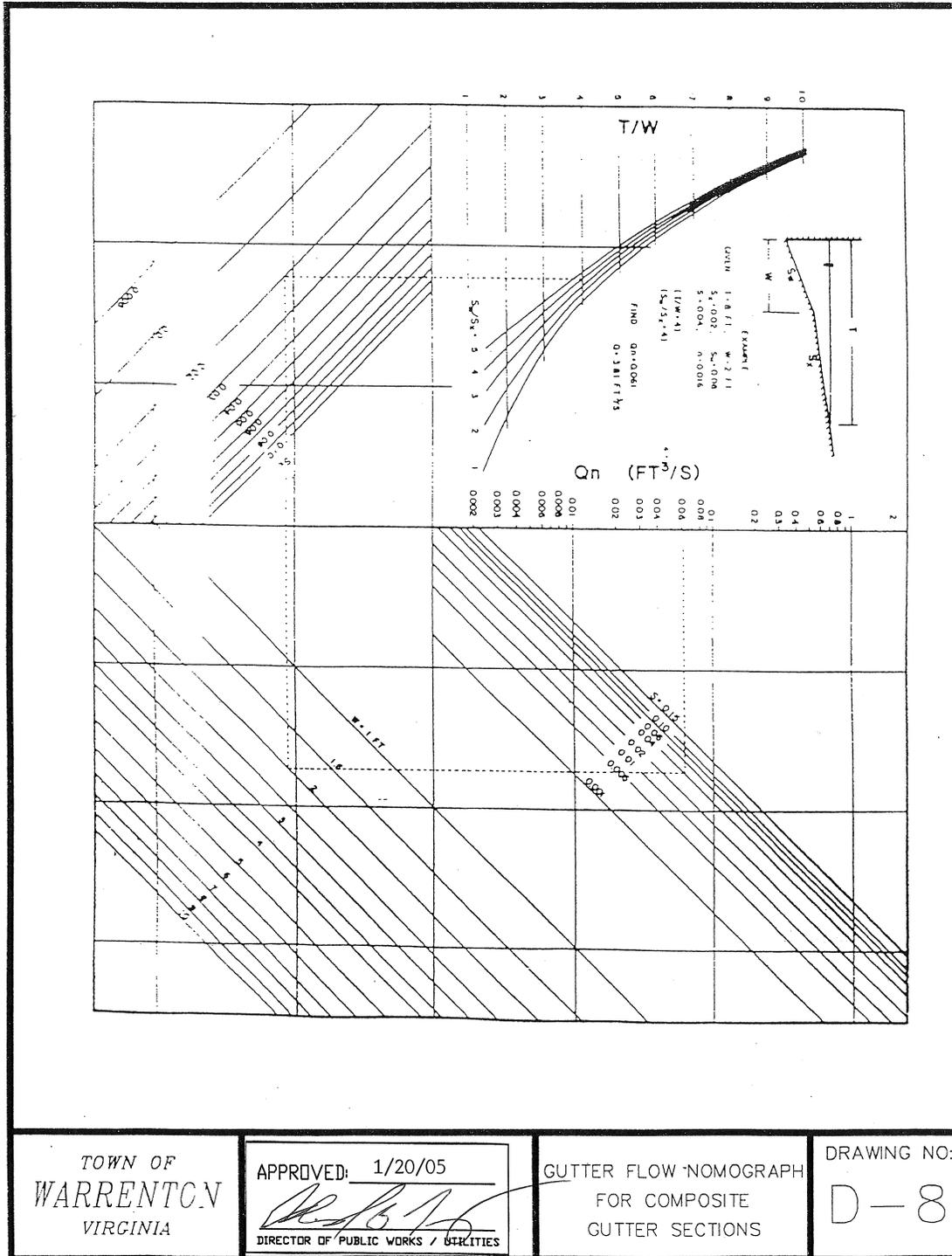


Figure 37: D-9 Gutter Flow Ratio

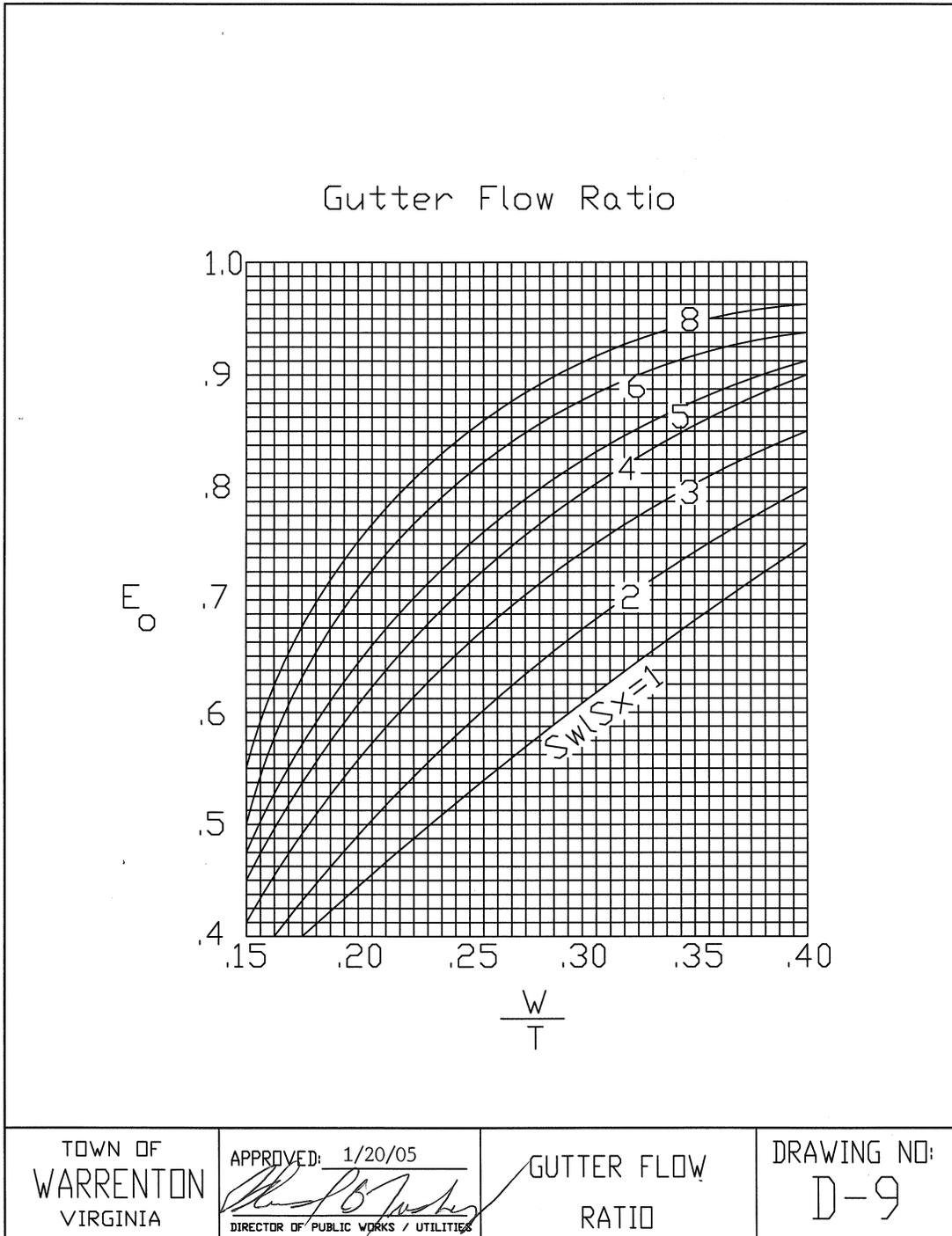
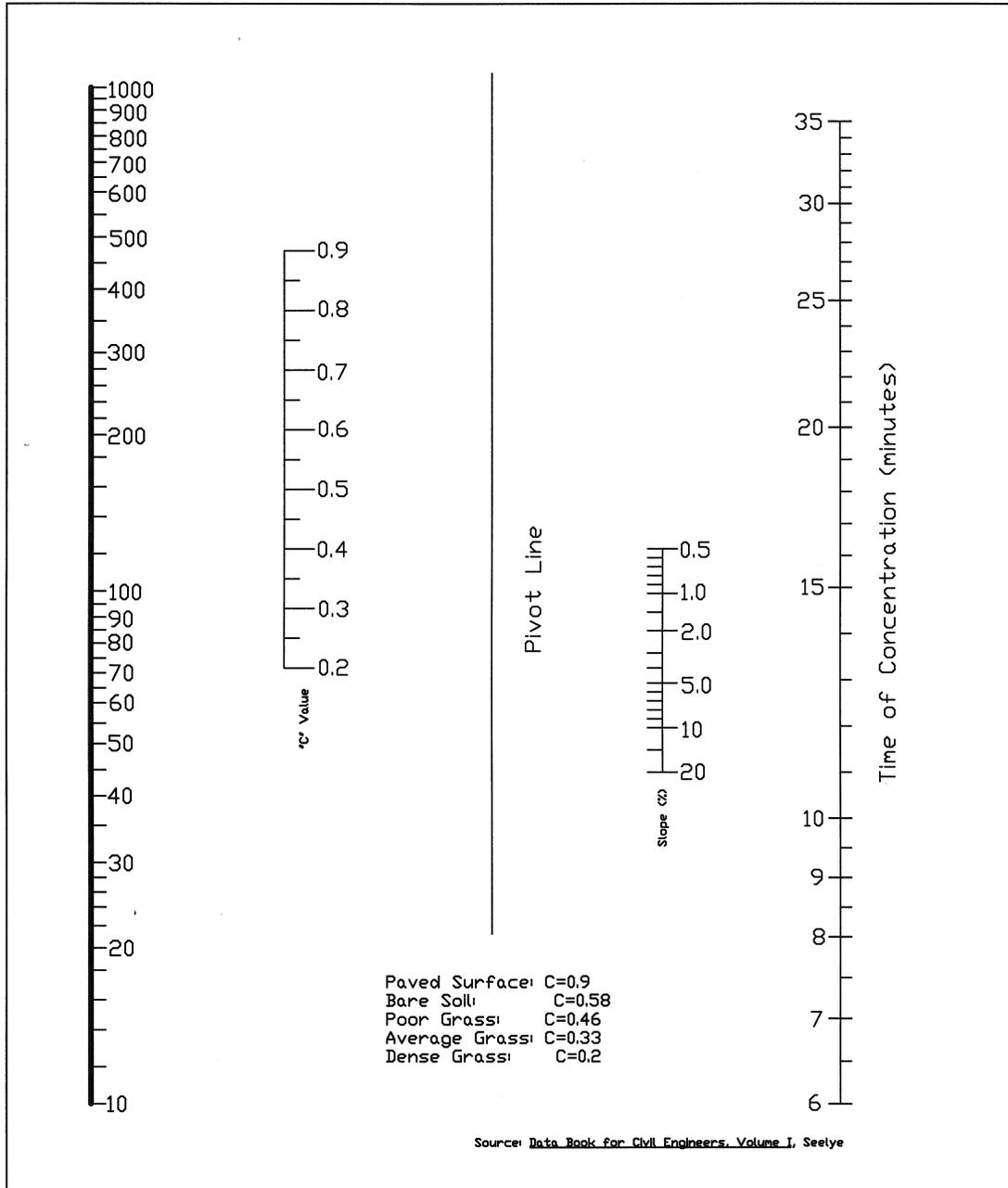


Figure 38: D-10 Overland Flow Time



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Figure 39: D-11 Channel Flow Time

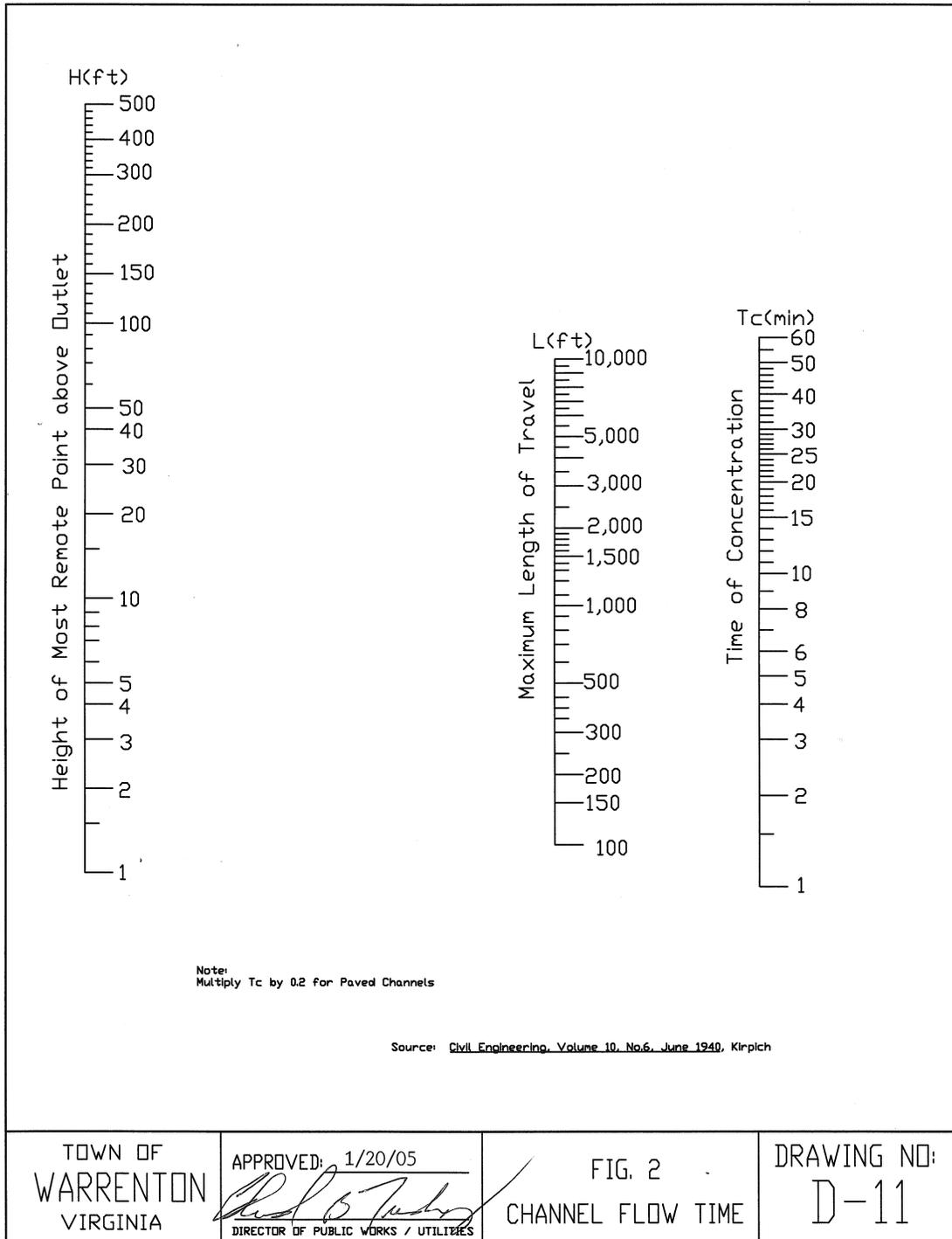


Figure 40: D-12 Rainfall Intensity Curve

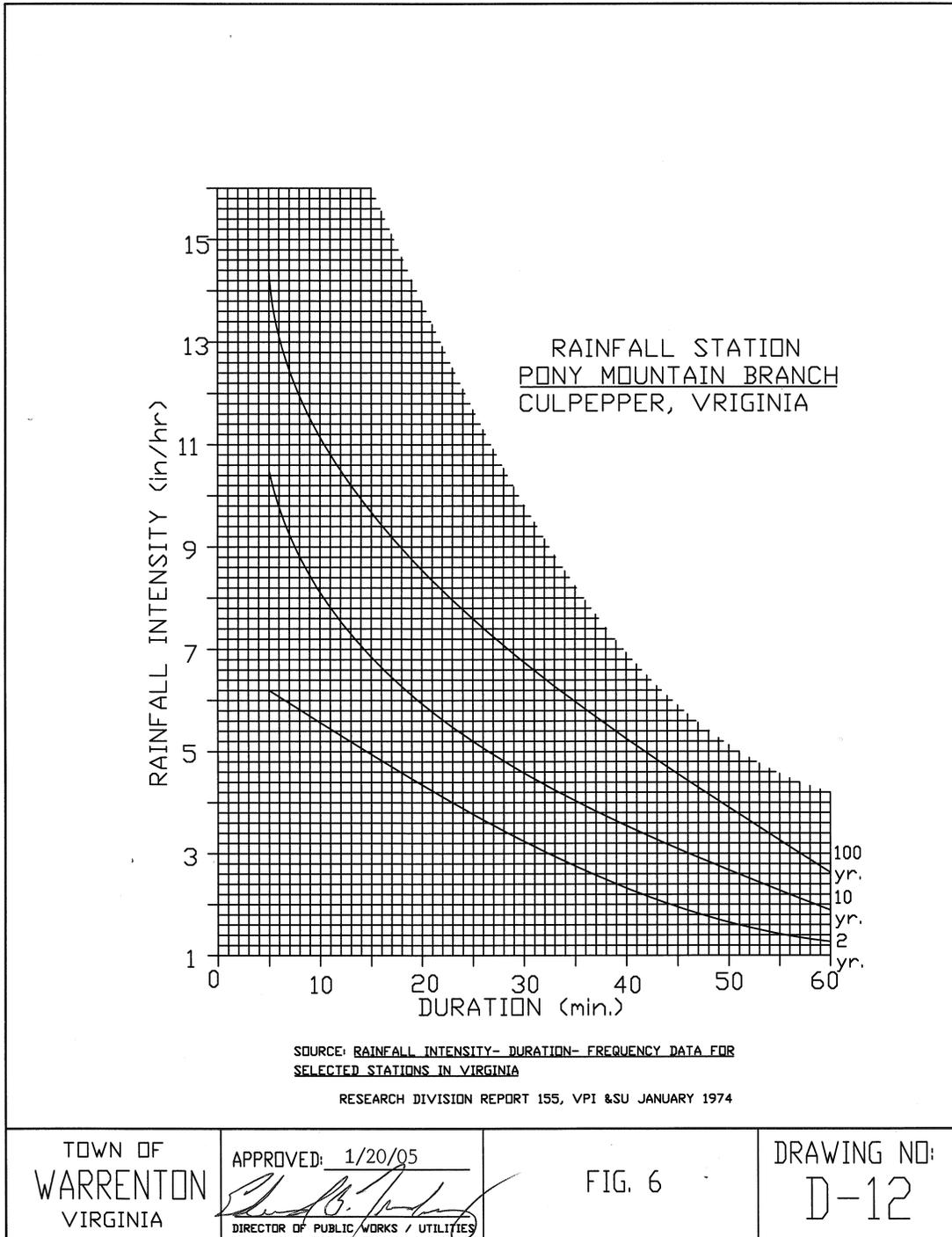


Figure 41: D-13 Runoff Coefficients

Ground Cover	C
Streets:	0.9
Roofs	0.9
Lawns (Sandy Soil)	
Flat, 2%	0.05 - 0.10
Average, 2 to 7%	0.10 - 0.15
Steep, +7%	0.15 - 0.20
Lawns (Heavy Soil)	
Flat, 2%	0.15 - 0.20
Average, 2 to 7%	0.20 - 0.25
Steep, +7%	0.25 - 0.35
Forest	0.20 - 0.30
Pasture	0.35 - 0.45
Cultivated Areas	0.5 - 0.7
Grass Channels	0.5
Steep Slopes (2:1)	0.7

Land Use	C
Business & Industrial	0.7 - 0.9
Institutional	0.5 - 0.6
Residential	
Single Family	
10,000 sf lot	0.40 - 0.50
12,000 sf lot	0.40 - 0.45
17,000 sf lot	0.35 - 0.45
1/2 acre lot	0.30 - 0.40
Multi-Family	0.65 - 0.75
Parks	0.20 - 0.35

Note: Ground Cover "C" values are to be used for on-site while Land Use "C" values shall be used for off-site drainage areas only.

Sources: VDOT Drainage Manual & Design and Construction of Sanitary and Storm Sewers, ASCE

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FIG. 4.
RUNOFF
COEFFICIENTS

DRAWING NO.

D-13

Figure 42: D-14 Unit Hydrograph

Time Ratio		Discharge Ratio	Mass Curve
t/t_p	t/t_c	q/Q	
0.0	0.00	0.00	0.00
0.1	0.07	0.03	0.001
0.2	0.13	0.10	0.006
0.3	0.20	0.19	0.017
0.4	0.27	0.31	0.035
0.5	0.33	0.47	0.065
0.6	0.40	0.66	0.107
0.7	0.47	0.82	0.163
0.8	0.53	0.93	0.228
0.9	0.60	0.99	0.300
1.0	0.67	1.00	0.375
1.1	0.73	0.99	0.450
1.2	0.80	0.93	0.522
1.3	0.87	0.86	0.589
1.4	0.93	0.78	0.650
1.5	1.00	0.68	0.705
1.6	1.07	0.56	0.751
1.7	1.13	0.46	0.790
1.8	1.20	0.39	0.822
1.9	1.27	0.33	0.849
2.0	1.33	0.28	0.871
2.2	1.47	0.21	0.908
2.4	1.60	0.15	0.934
2.6	1.73	0.11	0.953
2.8	1.87	0.08	0.967
3.0	2.00	0.06	0.977
3.2	2.13	0.04	0.984
3.4	2.27	0.03	0.989
3.6	2.40	0.02	0.993
3.8	2.53	0.015	0.995
4.0	2.67	0.01	0.997
4.5	3.00	0.005	0.999
5.0	3.33	0.00	1.000

Variables:
 t = hydrograph time
 t_c = time of concentration
 t_p = time of hydrograph peak
 q = hydrograph flow
 Q = peak flows (cfs)

Source: National Engineering Handbook Volume 4 - Hydrology,
 U.S. Department of Agriculture - Soil Conservation Service

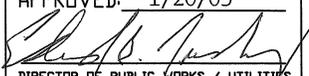
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	FIG 5 UNIT HYDROGRAPH	DRAWING NO: D-14
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Figure 43: D-15 Spillway Design Storm

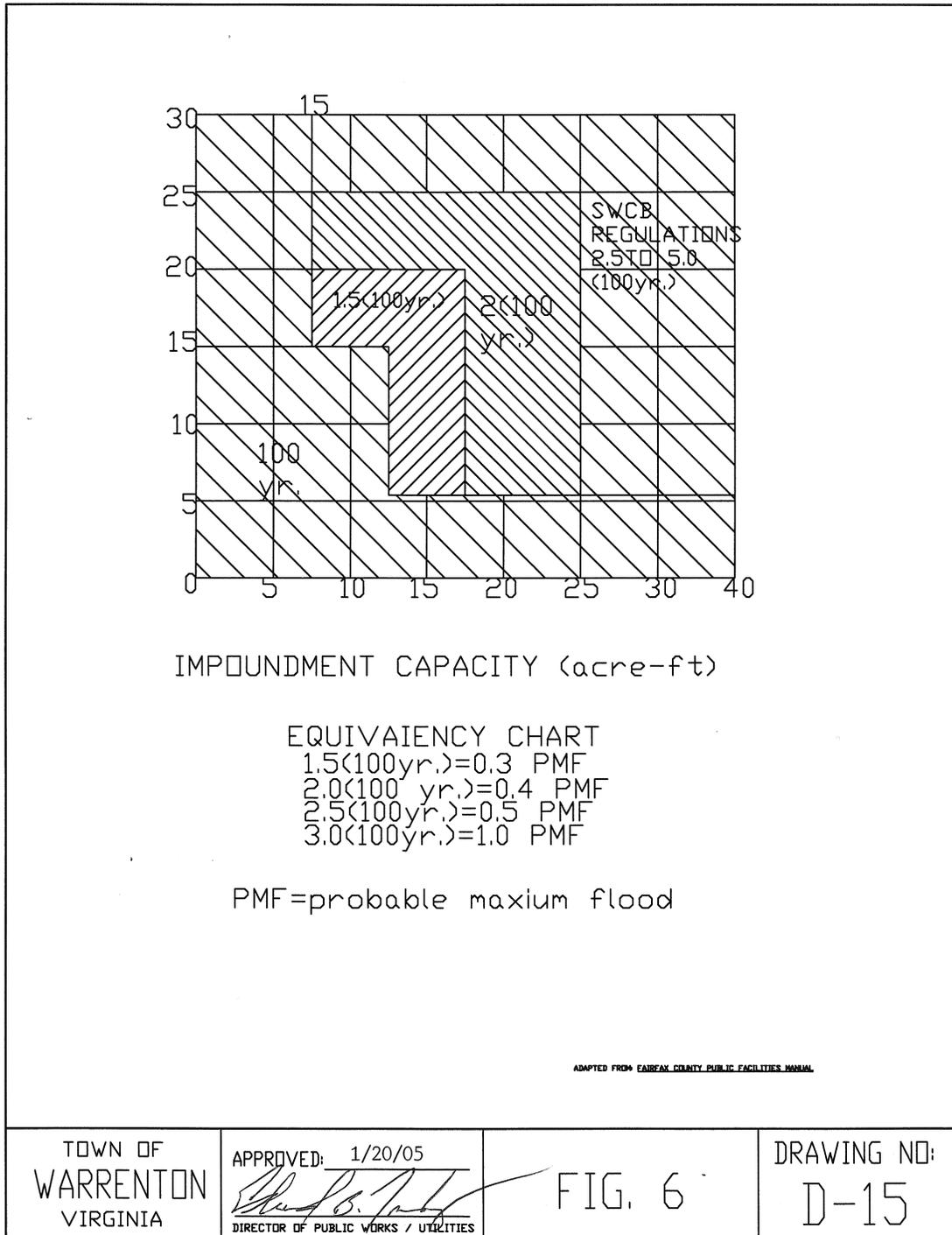


Figure 44: D-16 Channel Velocity Limits

Channels with Erodible Linings

Soil Type or Lining	Permissible Velocity
Fine Sand (noncolloidal)	2.5 fps
Sandy Loam (noncolloidal)	2.5 fps
Silt Loam (noncolloidal)	3.0 fps
Ordinary Firm Loam	3.5 fps
Fine Gravel	5.0 fps
Stiff Clay (very colloidal)	5.0 fps
Graded, Loam to Cobble (noncolloidal)	5.0 fps
Graded, Silt to Cobbles (noncolloidal)	5.5 fps
Alluvial Silts (noncolloidal)	3.5 fps
Alluvial Silts (colloidal)	5.0 fps
Coarse Gravel (noncolloidal)	6.0 fps
Cobble and Shingles	5.5 fps
Shales and Hard Pan	6.0 fps

Note: Channels with erodible linings apply to temporary channels, while
Channels with grass cover apply to permanent channels

Channels with Uniform Stand of Grass Cover

Cover	Slope Range (%)	Permissible Velocity Range
Bermuda Grass	0 - 5	5.0 - 6.0 fps
Fescue	5 - 10	4.0 - 5.0 fps
Kentucky Bluegrass	10 +	3.0 - 4.0 fps
Grass Mixture	0 - 5	3.0 - 4.0 fps
	5 - 10	2.5 - 3.0 fps
Weeping Lovegrass	0 - 5	2.0 - 3.0 fps
Kudzu		
Alfalfa		
Crabgrass		
Common Lespedeza		
Sudan Grass		

* Higher Velocity shall be for Erosion Resistant Soils while
Lower Velocity shall be used for Highly Erodible Soils
(Erodibility Factor, K, greater than 0.35)

Source: Design of Roadside Channels, U. S. Department of Commerce

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Figure 45: D-17 Drainage Easement Width

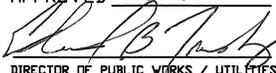
<p>Pipes*</p> <p>48"</p> <p>Provide 20' minimum width for the first 5' depth** with an additional 4' width for each additional 1' depth or part thereof.</p>			
<p>Ditches:</p> <p>5' width</p> <p>Provide 15' minimum width.</p> <p>> 5' width</p> <p>Provide 15' minimum width plus the width of the ditch for the design storm. The easement shall be offset such that a 10' easement width provided on one side of the ditch.</p>			
<p>* Pipe Sizes are for Equivelent Round</p> <p>Pipe Diameter using Manning's Equation of the same slope.</p> <p>** Depth is from ground syrface to pipe invert.</p>			
<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: 1/20/05</p>  <p>DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>FIG 8 DRAINAGE EASEMENT WIDTH</p>	<p>DRAWING NO: D-17</p>

Figure 46: D-18 N Values for Grass Channels

RETARDENCE	COVER	CONDITION
A	Reed Canarygrass Bermudagrass Mixture Tall Fescue Lespedeza Sericea	Excellent stand, tall (36") Good stand, tall (12") Good stand, unmowed(18") Good stand, not woody tall (18")
B	Grass-legun Mixture Tall Fescue or Orchard Grass Ree Canarygrass weeping Love grass	Good stand, uncut (20") Good stand, mowed (12-15") Good stand, mowed (13")
C	Bermuda grass Mixture, Redtop Grass-legume mixture - fall, spring (Orchard Grass, Redtop, Italian Rye grass and Common Lespedeza) Lespedeza sericea Kentucky Bluegrass Kentucky 31 Tall Fescue	Good stand, mowed (6") Good stand, headed (13-20") Good stand, uncut (6-8") Good stand, headed (6-12") Good stand, headed (3-12")
D	Bermuda Mixture, Red Fescue Grass-legume mixture - fall, spring (Orchard Grass, Redtop, Italian Rye grass and Common lespedeza) Lespedeza Sericea Kentucky Bluegrass Kentucky 31 Tall Fescue	Good stand, cut (2-3") Good stand, headed (12-18") Good stand, uncut (4-5") After cutting (up to 2") Very good stand before cutting Good stand cut (up to 2 ½")
E	Bermuda Mixture Bermuda Mixture	Good stand, cut (up to 1 ½ ") Burned stubble

Source: Grassed Waterways and Outlets, Field Engineering Manual
US Soil Conservation Service, Coyle, J. J.

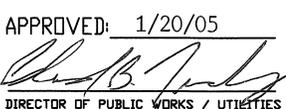
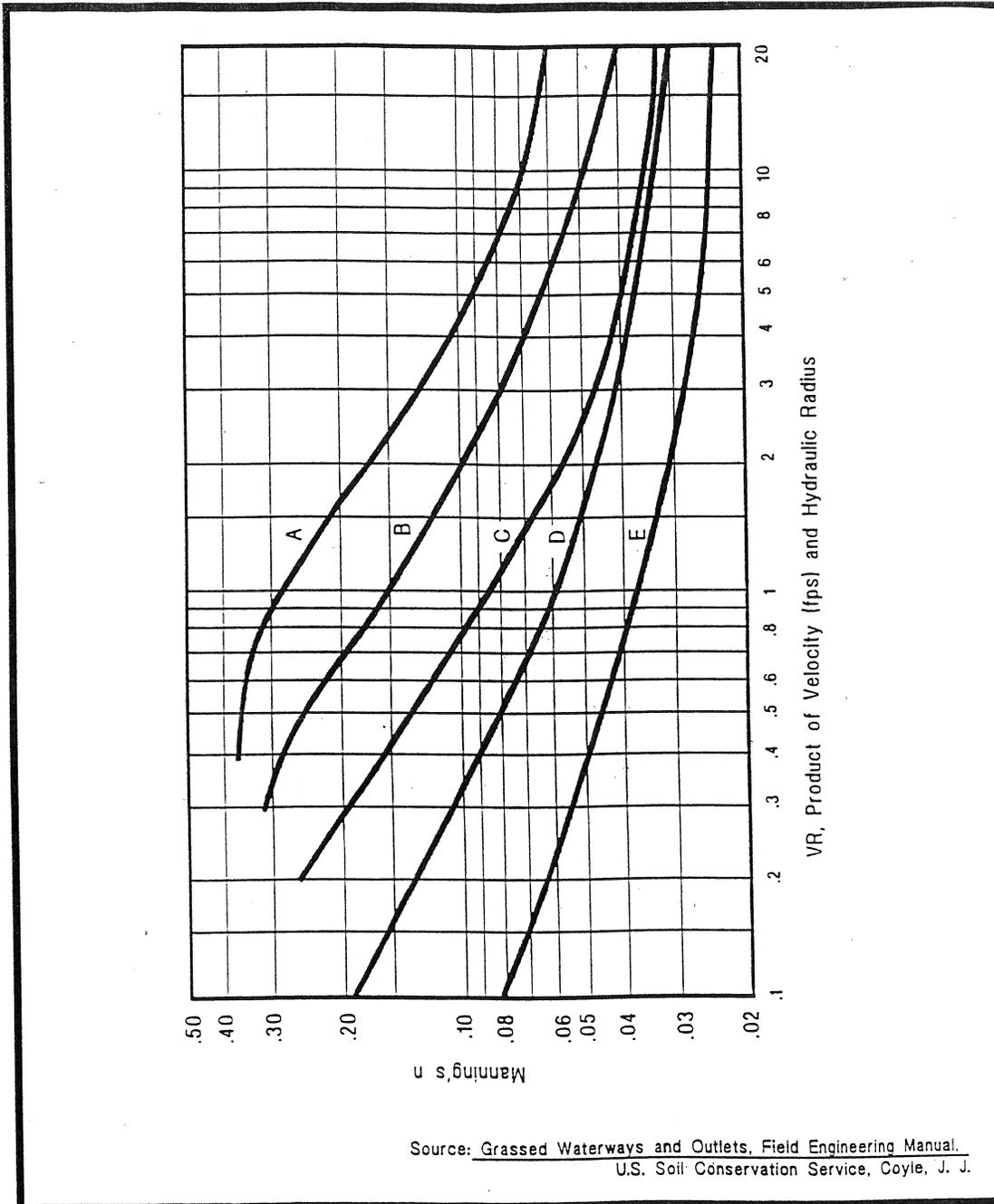
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	FIG. 9 N VALUES GRASS CHANNELS	DRAWING NO: D-18
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Figure 47: D-19 N Values for Grass Ditch

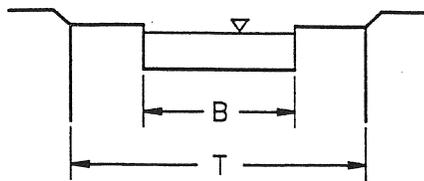


<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: 1/20/05 <i>[Signature]</i> DIRECTOR OF PUBLIC WORKS & UTILITIES</p>	<p>FIG. 9-A N VALUES, GRASS DITCH</p>	<p>DRAWING NO. D-19</p>
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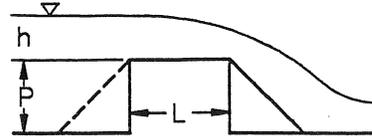
Figure 48: D-20 Emergency Spillway Design

EMERGENCY SPILLWAY DESIGN

RECTANGULAR OPENNING:



SHARP CRESTED



BROAD CRESTED

BROAD CRESTED WEIR:

$$Q = C B h^{1.5} \quad \text{Limitation: } h/(h+P) \leq 0.35$$

See FIG. 14 for values of C

SHARP CRESTED WEIR:

$$Q = C B h^{1.5} \quad \text{Limitation: } h/L \geq 3.0$$

B/T	C
1.0	3.221 + 0.401 (h/P)
0.9	3.205 + 0.342 (h/P)
0.8	3.194 + 0.241 (h/P)
0.7	3.183 + 0.161 (h/P)
0.6	3.173 + 0.096 (h/P)
0.5	3.167 + 0.056 (h/P)
0.4	3.162 + 0.031 (h/P)
0.3	3.156 + 0.011 (h/P)
0.2	3.151 + 0.010 (h/P)
0.1	3.146 + 0.011 (h/P)
0.0	3.140 + 0.012 (h/P)

Source: Open Channel Hydraulics, French

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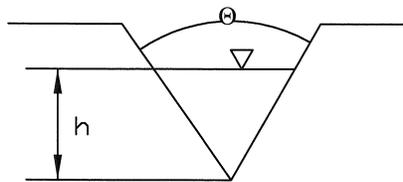
FIG. 10
SPILLWAY DESIGN

DRAWING NO.

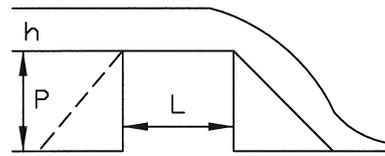
D-20

Figure 49: D-21 Emergency Spillway Design

EMERGENCY SPILLWAY DESIGN



SHARP CRESTED



BROAD CRESTED

BROAD CRESTED WEIR:

$$Q = C \times \tan (1/2 \theta) h^{2.5}$$

See FIG. 15 for values of C

UPSTREAM SLOPE	X
Horizontal: Vertical	2.32
1/2: 1	2.48
1: 1	2.66
2: 1	2.69
3: 1	2.71
4: 1	2.73

SHARP CRESTED WEIR:

$$Q = 4.28 C \tan (1/2 \theta) h^{2.5}$$

See FIG. 16 for values of C

Source: Open Channel Hydraulics, French

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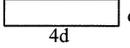
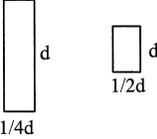
FIG. 10-A
SPILLWAY DESIGN

DRAWING NO:
D-21

Figure 50: D-22 Principal Spillway Design

PRINCIPAL SPILLWAY DESIGN
SHARP-EDGED ORIFICE

$$Q = CA\sqrt{2gh}$$

SHAPE	C
	0.60
	0.61
	0.60
	0.61
	0.62
	0.60



Source: Hydraulics, King, Wisler & Woodburn

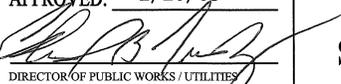
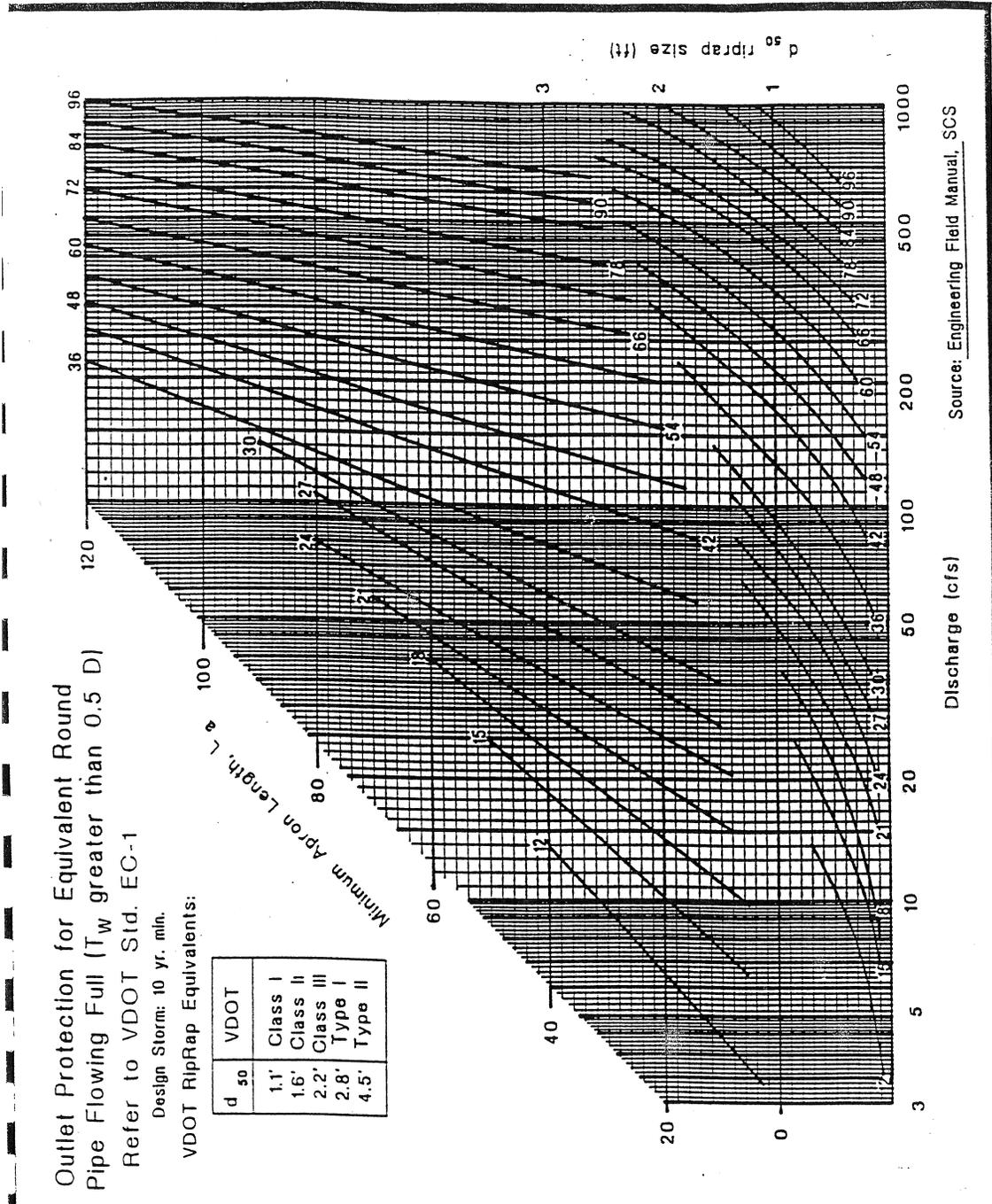
<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>FIG. 11 SPILLWAY DESIGN</p>	<p>DRAWING NO: D-22</p>
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Figure 51: D-23 Outlet Protection



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FIG. 12
 OUTLET
 PROTECTION

DRAWING NO.
 D-23

Figure 52: D-24 Outlet Protection

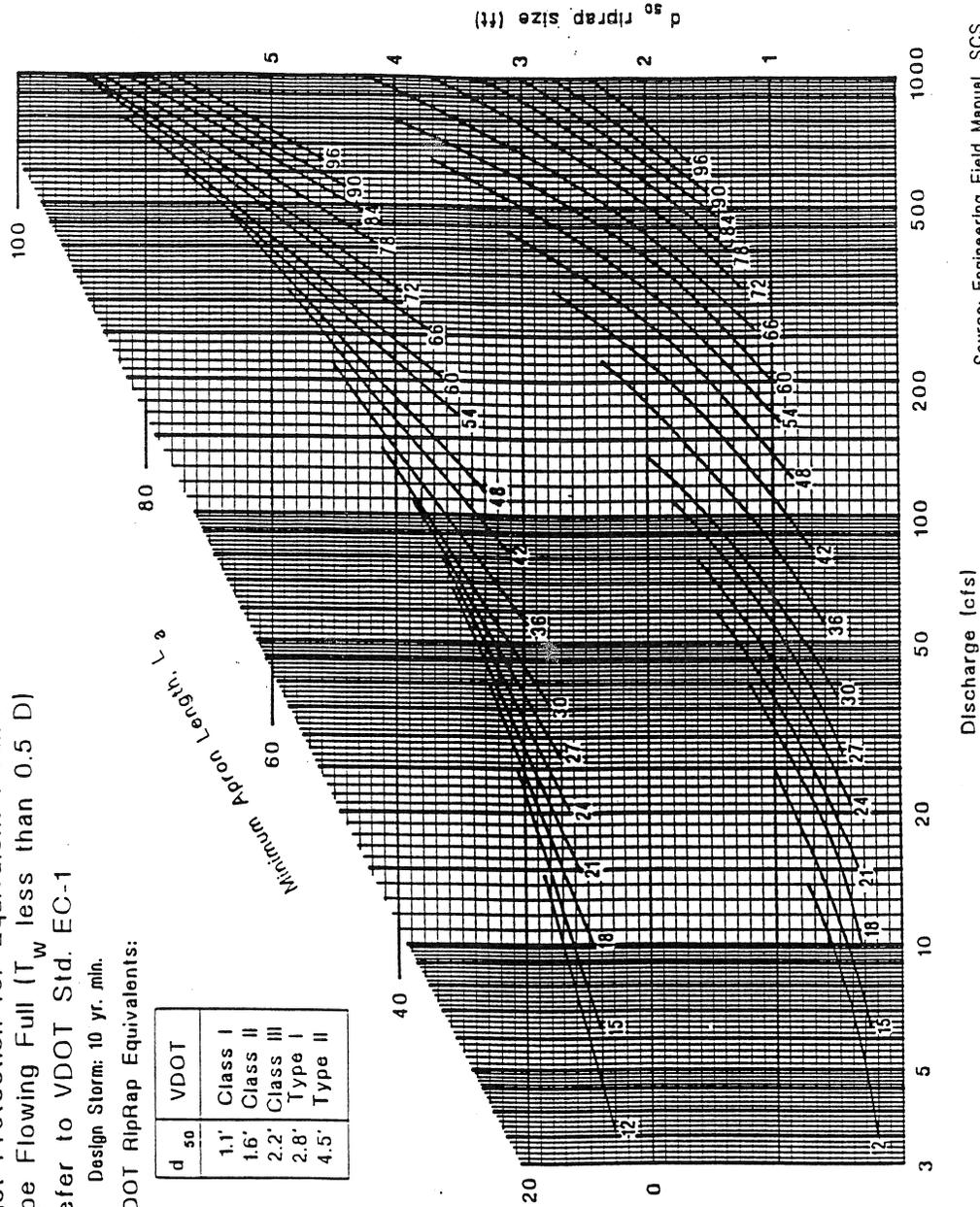
Outlet Protection for Equivalent Round
Pipe Flowing Full (T_w less than 0.5 D)

Refer to VDOT Std. EC-1

Design Storm: 10 yr. min.

VDOT RipRap Equivalents:

d_{50}	VDOT
1.1'	Class I
1.6'	Class II
2.2'	Class III
2.8'	Type I
4.5'	Type II



Source: Engineering Field Manual, SCS

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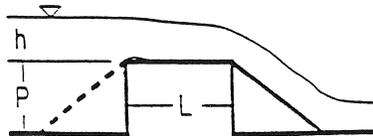
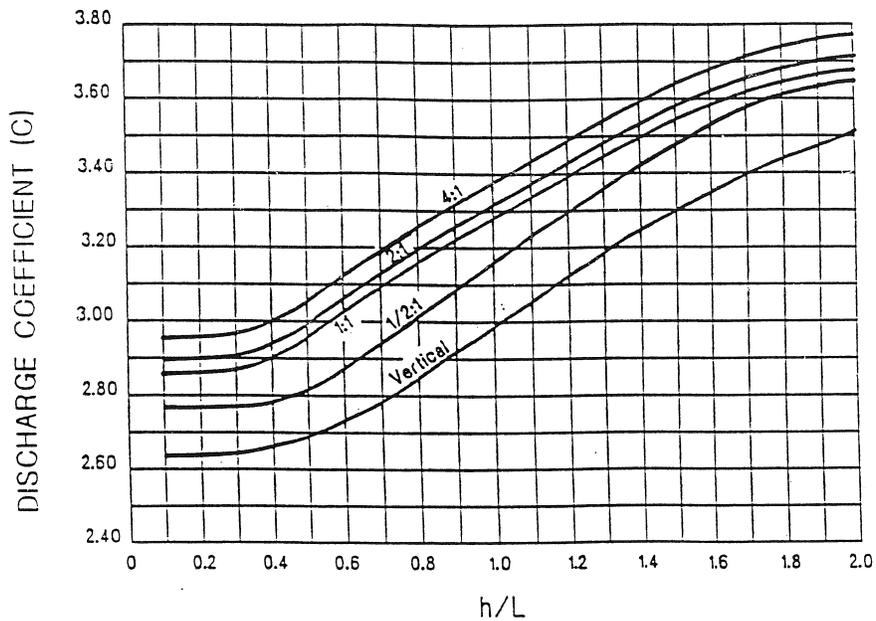
[Signature]
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FIG. 13
OUTLET
PROTECTION

DRAWING NO.
D-24

Figure 53: D-25 Discharge Coefficients for Rectangular Broad Crested Weirs

DISCHARGE COEFFICIENTS (C) FOR RECTANGULAR BROAD CRESTED WEIRS



Source: Discharge Measurement Structures, Bos (ed.)

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FIG. 14
DISCHARGE
COEFFICIENTS

DRAWING NO.

D-25

Figure 54: D-26 Discharge Coefficients for Triangular Broad Crested Weirs

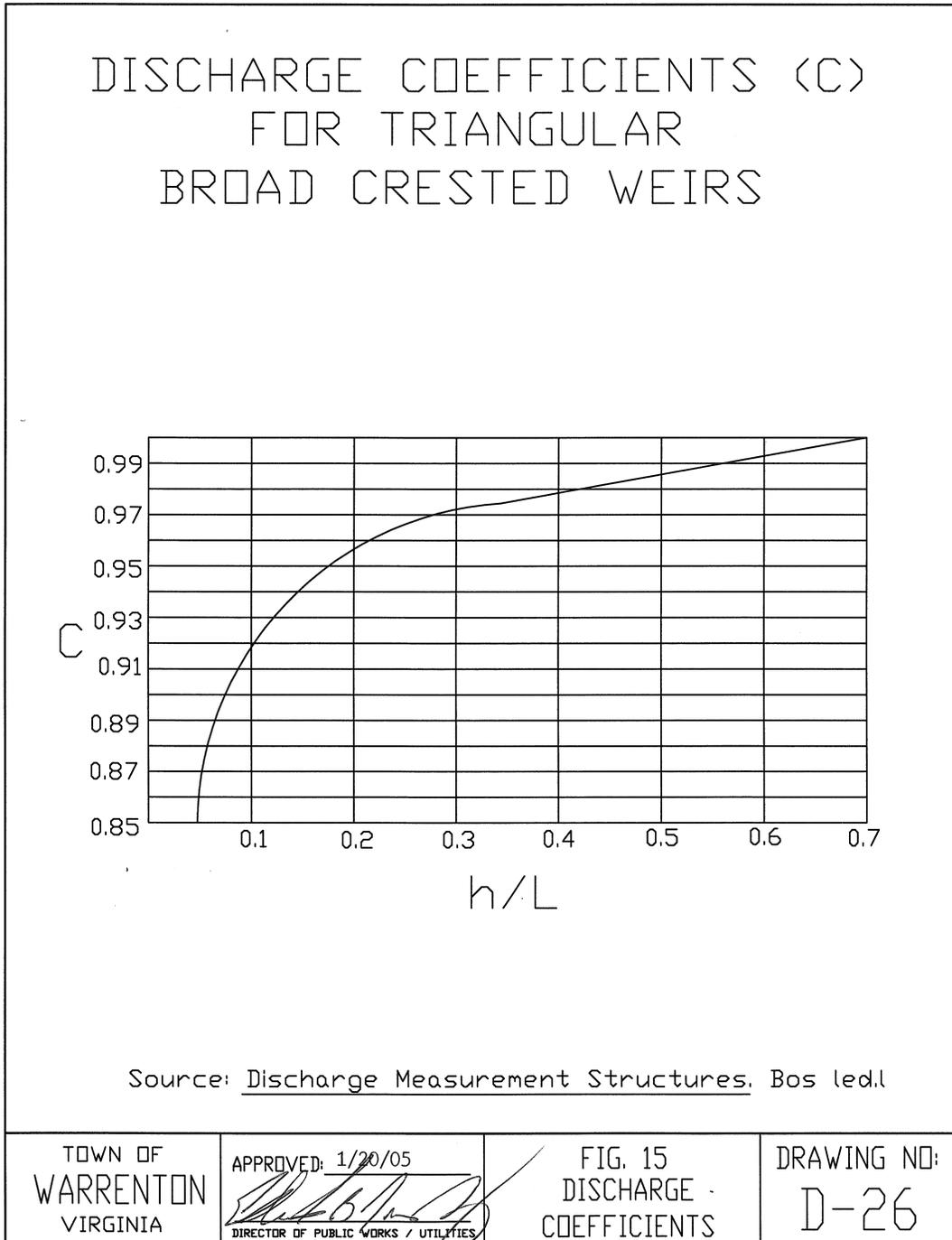
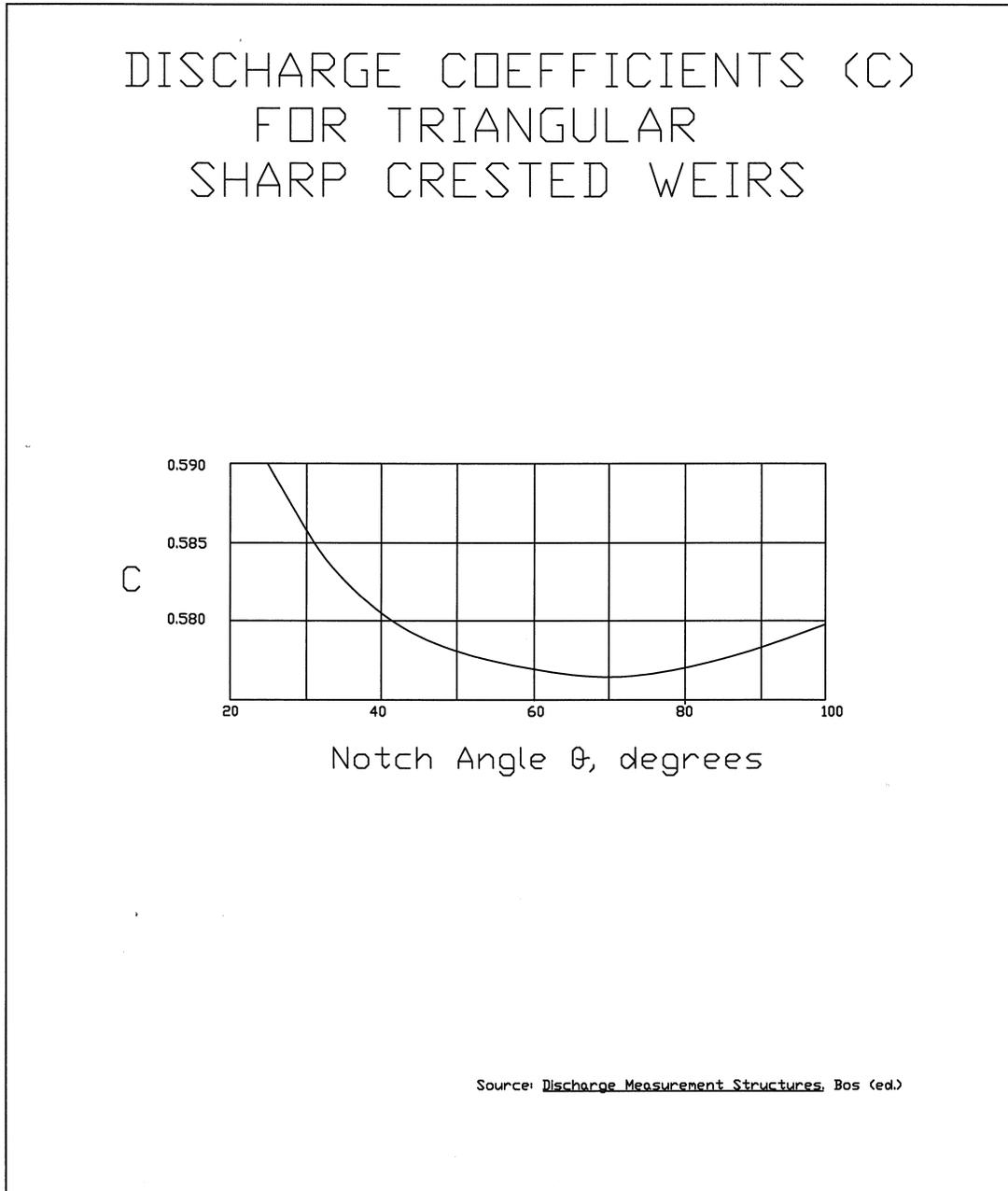


Figure 55: D-27 Discharge Coefficients for Triangular Sharp Crested Weirs



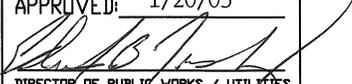
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	FIG. 16 DISCHARGE COEFFICIENTS	DRAWING NO: D-27
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Figure 56: D-28 Infiltration Trenches

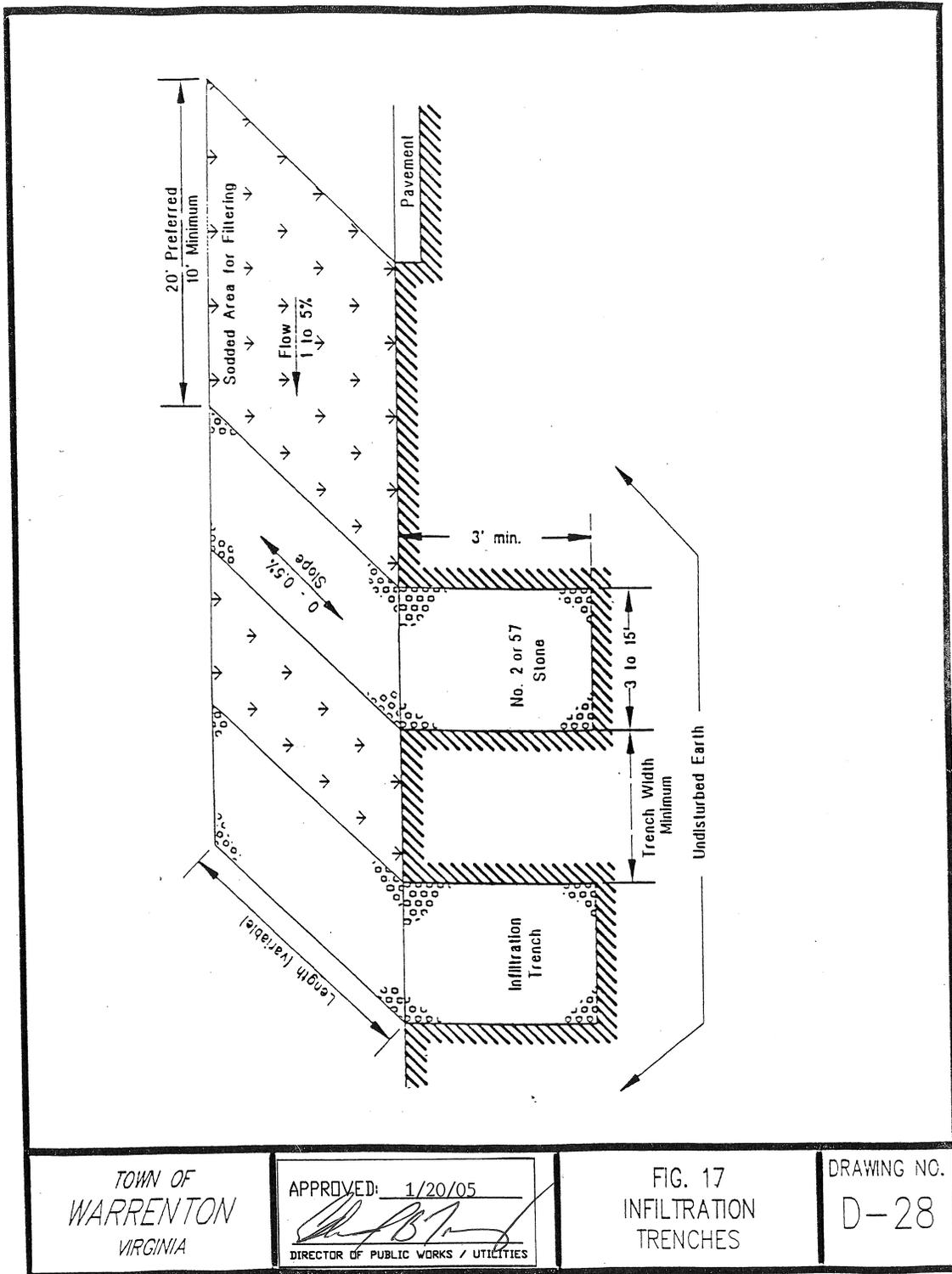


Figure 57: D-29 Rational Method

Rational Method

$$Q = Cf(CA)I$$

PROJECT NAME: _____
 SUB-AREA: _____

COVER	AREA (AC)	C	CA
E AREA		E CA	

TIME OF CONCENTRATION:
 OVERLAND: (FIG.1) T_o = _____ MIN.
 LENGTH OF TRAVEL: _____
 "C" VALUE: _____
 SLOPE: _____
 CHANNEL: (FIG.2)
 LENGTH OF TRAVEL: _____ T = _____ MIN.
 HEIGHT: _____ T_c = _____ MIN.

Cf	* CA	* 1	
1.0			Q2
1.0			Q5
1.0			Q10
1.1			Q25
1.2			Q50
1.25			Q100

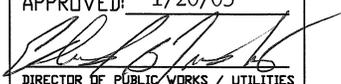
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	RATIONAL METHOD	DRAWING NO: D-29
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Figure 58: D-30 Anderson Method

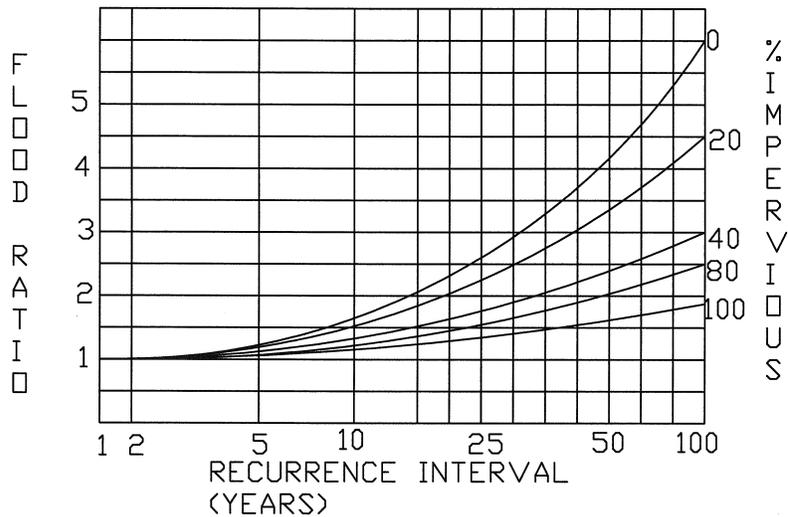
<h2>ANDERSON METHOD</h2>			
PROJECT NAME: _____			
SUB-AREA: _____			
AREA (SIZE): _____			
X: _____			
IMPERVIOUSNESS (%): _____			
K: _____			
FLOOD RATIO:			
100: _____			
50: _____			
25: _____			
10: _____			
5: _____			
2: _____			
% STORM SEWERED:			
L(mi.): _____			
S(ft./mi.): _____			
LAG TIME (T): _____			
Q(100): _____			
Q(50): _____			
Q(25): _____			
Q(10): _____			
Q(5): _____			
Q(2): _____			
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	ANDERSON METHOD	DRAWING NO: D-30

Figure 59: D-31 Anderson Method

ANDERSON METHOD

$$Q = R(230)K A 6X T^{-0.48}$$

R= FLOOD RATIO- SEE GRAPH BELOW
 K= COEFFICIENT OF IMPERVIOUSNESS
 $1.00 + 0.015(I)$
 WHERE I IS THE PERCENTAGE OF BASIN COVERED WITH IMPERVIOUS SURFACE
 X=BASIN SIZE FACTOR
 1.00 FOR UP TO 1 SQ. MI.
 .82 FOR OVER 1 SQ. MI.
 A= BASIN AREA IN SQ. MI.
 T= LAG TIME IN HOURS
 $4.64(L \backslash S)^{.42}$ FOR NATURAL BASINS
 $.90(L \backslash S)^{.50}$ FOR 50% SEWWEWS BASINS
 $.56(L \backslash S)^{.52}$ FOR 100% SEWERED BASINS
 L=BASIN LENGTH IN MILES
 S= BASIN SLOPE (FT/MI) BETWEEN POINTS 10 AND 85% OF L FROM SITE



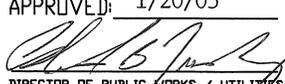
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	ANDERSON METHOD	DRAWING NO: D-31
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Figure 60: D-32 Anderson Method

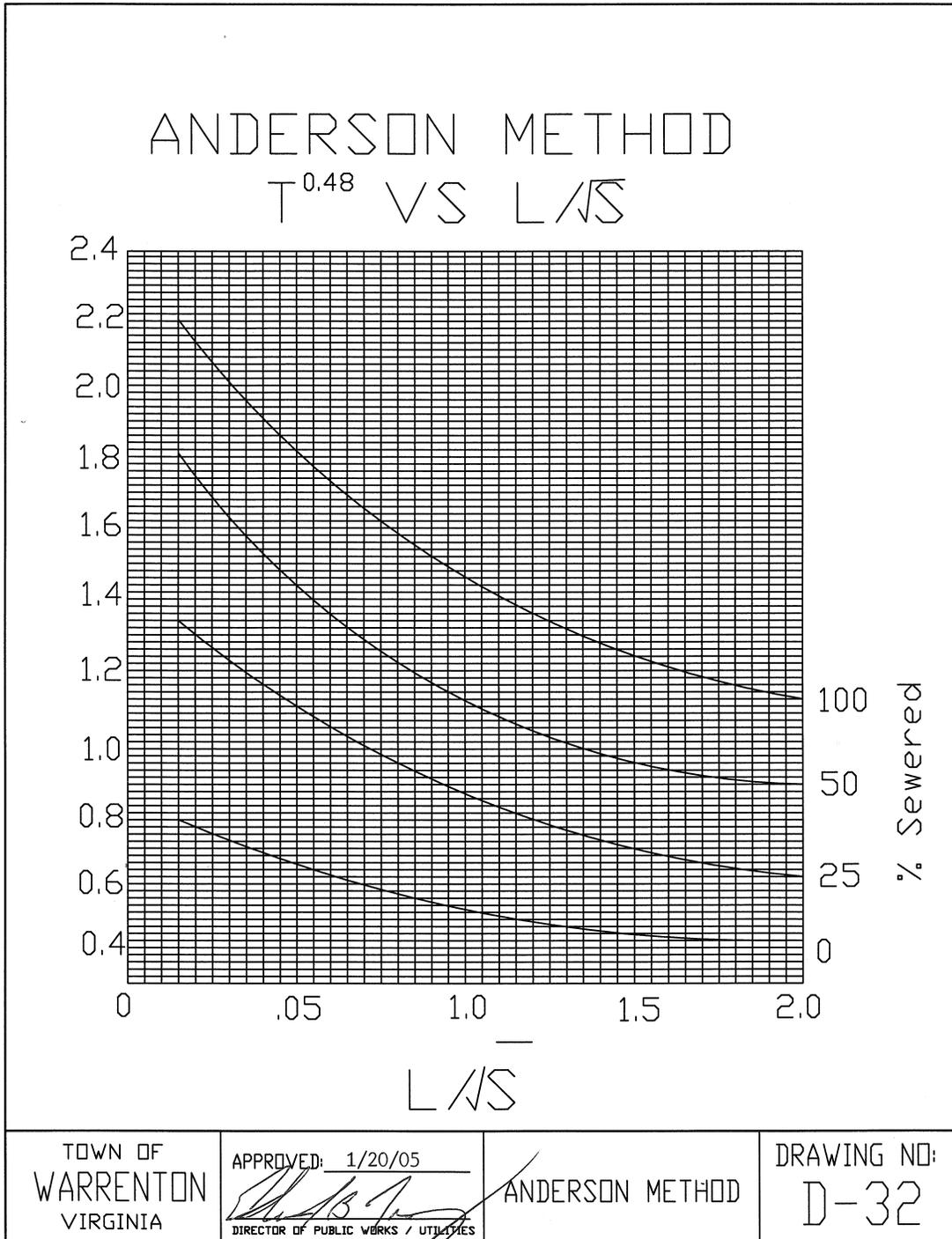


Figure 61: D-33 Peak Discharge Method TR-55

TR-55 Lag-Tc Peak Discharge Method

Project: _____
Location: _____

Sheet ___ of ___

_____ in. (24 hour)
(-yr freq)
Rainfall

_____ Runoff Curve No.

_____ ft. Hydraulic Length

_____ % Watershed Slope

_____ % Hydr. Lngth. Modified

_____ % Impervious Area

_____ sq mi Drainage Area

_____ % Ponds, Swamps

1.67
Constant X

_____ hr
Basic Lag X

_____ Hydr. Lngth Adj. X

_____ Imp. Area Adj. =

_____ hr
Tc

_____ in. Runoff Volume X

_____ csm/in Basic Peak Disch. X

_____ sq mi Drainage Area X

_____ Pond. Swamps Adj. =

ADJUSTED PEAK DISCHARGED _____ cfs

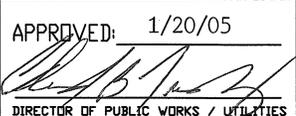
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	PEAK DISCHARGE METHOD	DRAWING NO: D-33
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Figure 62: D-34 Tabular Hydrograph (TR-55)

TR-55 Tabular Hydrograph

Project: _____
 Location: _____
 _____ Sheet ____ of ____

Drainage Area (a): _____ sq. mi.
 Storm Frequency: _____ years
 24-Hour Design Rainfall (P): _____ inches
 Developed CN: _____
 Resultant Runoff (Q): _____ inches
 A x Q: _____ sq. mi. - inches
 Developed Tc: _____ inches

Time (hr.)	q (CSM / in)	Flow (cfs)
11		
11.5		
11.7		
11.8		
11.9		
12		
12.1		
12.2		
12.3		
12.4		
12.5		
12.6		
12.7		
12.8		
12.9		
13		
13.2		
13.5		
14		
14.5		
15		
16		
18		
20		

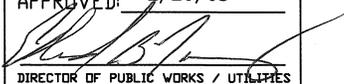
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	TABULAR HYDROGRAPH	DRAWING NO: D-34
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Figure 63: D-35 Runoff Curve Numbers

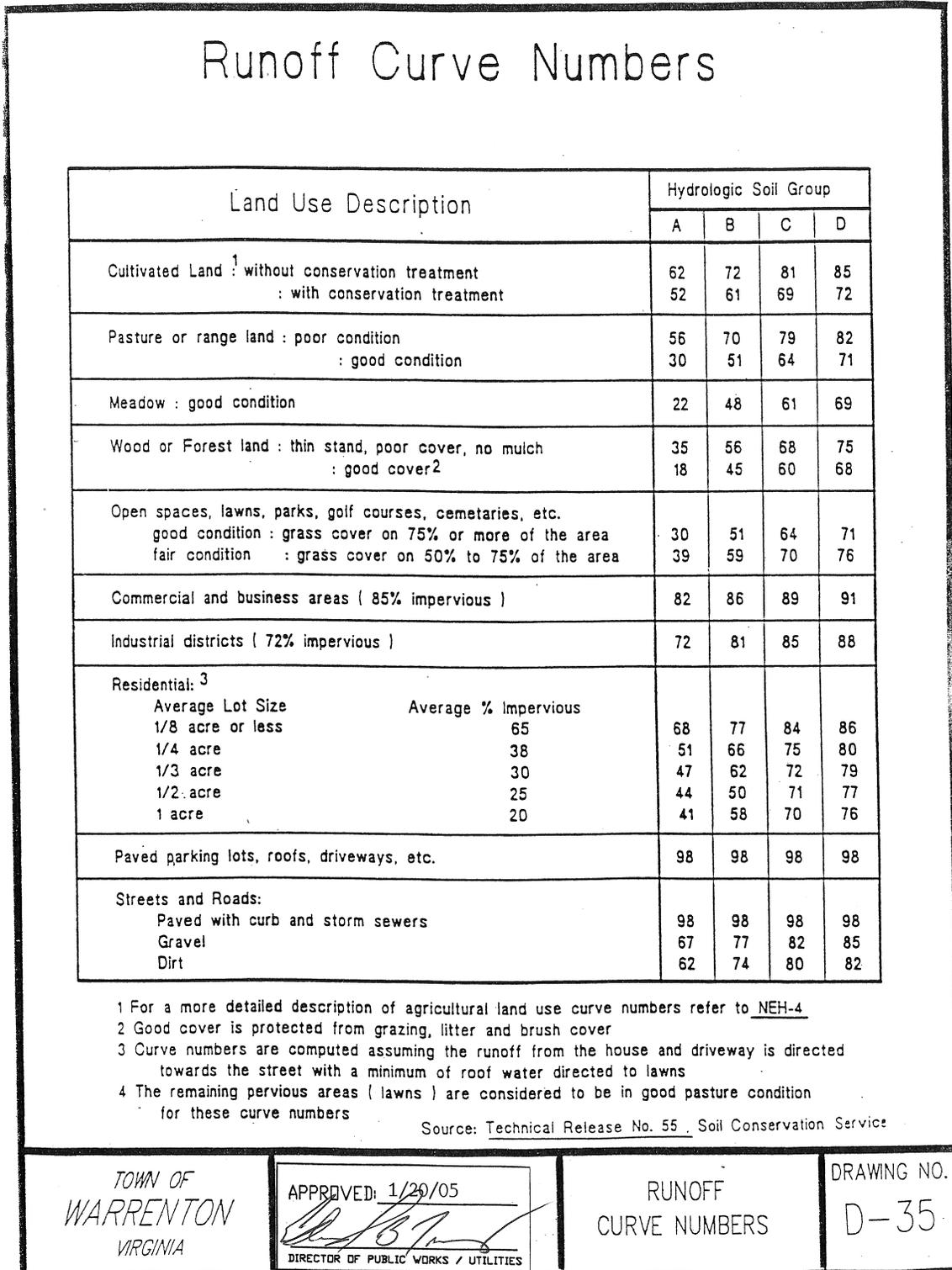


Figure 64: D-36 Design Rainfalls

Design Rainfalls							
Storm Duration (hr.)							
Freq.	24	12	6	3	2	1	0.5
100	7.5	6.6	5.2	4.3	4.0	3.2	2.6
50	6.6	5.6	4.7	3.9	3.6	2.9	2.5
25	5.8	5.2	4.2	3.5	3.1	2.7	2.0
10	5.0	4.3	3.5	3.0	2.7	2.2	1.7
5	4.4	3.7	3.1	2.5	2.3	1.9	1.4
2	3.4	3.0	2.5	2.0	1.8	1.4	1.2
1	2.8	2.45	2.0	1.6	1.4	1.1	0.9
PMP ^x			28.				

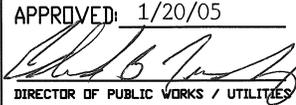
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	DESIGN RAINFALLS	DRAWING NO: D-36
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Figure 69: R-1 Street Design Criteria

GEOMETRIC DESIGN									
			CURVE DATA		MINIMUM SIGHT DISTANCE		CURB AND GUTTER ROADWAYS		
PROJECTED TRAFFIC VOLUME (ADT)	MINIMUM DESIGN SPEED (MPH)	MINIMUM CENTERLINE RADIUS (FEET)	SUPER-ELEVATION	SUGGESTED MAXIMUM GRADE (%)	STOPPING SIGHT DISTANCE (FEET)	INTERSECTION SIGHT DISTANCE (FEET)	MINIMUM WIDTH (CURB TO CURB) (FEET)	CLEAR ZONE (FEET)	MINIMUM RIGHT OF WAY (FEET)
< 400	25	200	NONE	10	155	280	29 (1)	6	50(2)
401 - 1500	25	200	NONE	10	155	280	29 (1)	6	55
1501 - 2000	30	335	NONE	10	200	335	36 (3)	8	60
2001 - 4000	30	335	NONE	10	200	335	48	6	80
NOTES: FOR STREETS WITH VOLUMES OVER 4000 OR SERVING HEAVY COMMERCIAL OR INDUSTRIAL TRAFFIC; USE THE APPROPRIATE GEOMETRIC DESIGN STANDARD.(SEE VDOT ROAD DESIGN DESIGN MANUAL)					1. 24 FEET ALLOWED ONLY UPON TOWN COUNCIL WAIVER. (Parking 1 side only). 2. 40 FEET ALLOWED ONLY UPON TOWN COUNCIL WAIVER. 3. 26 FEET ALLOWED WITH NO PARKING ONLY UPON TOWN COUNCIL WAIVER.				

NOTES:

1. MINIMUM GRADE OF ANY STREET WITH CURB & GUTTER IS 0.5%; WITH SHOULDER AND DITCH IS 1.0%
2. RIGHT OF WAY MUST BE CLEARED TO FULL WIDTH, ALL UTILITIES IN PLACE AND FINE GRADED TO TRUE TYPICAL SECTION PRIOR TO APPLICATION OF ANY PAVING MATERIALS.
3. FOR ANY ROADWAY CLASSIFIED AS A MAJOR COLLECTOR OR AN ARTERIAL ROADWAY, THE RIGHT OF WAY SHALL BE DETERMINED BY THE ENGINEER, BASED ON THE NUMBER OF PROPOSED LANES, MEDIAN WIDTH, AND SLOPE DESIGN.
4. DESIGN SPEED MINIMUM FOR LOCAL ROADWAYS SHALL BE 25 MPH WITH DESIGN SPEEDS FOR OTHER ROAD CLASSIFICATIONS TO BE DETERMINED BY THE ENGINEER.

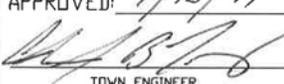
TOWN OF WARRENTON VIRGINIA	APPROVED: <u>7/10/14</u>  TOWN ENGINEER	PUBLIC STREET DESIGN CURB AND GUTTER ROADWAY	DRAWING NO: R-1
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Figure 70: R-1A Street Design Criteria

GEOMETRIC DESIGNS										
			CURVE DATA		MINIMUM SIGHT DISTANCE		SHOULDER AND DITCH ROADWAYS			
PROJECTED TRAFFIC VOLUME (ADT)	MINIMUM DESIGN SPEED (MPH)	MINIMUM CENTER LINE RADIUS (FEET)	SUPER. ELEV.	MAX. GRADE (%)	STOPPING SIGHT DISTANCE (FEET)	INTER-SECTION SIGHT DISTANCE (FEET)	MINIMUM PAVEMENT WIDTH (FEET)	MINIMUM GRADED SHOULDER WIDTH (FEET)	CLEAR ZONE FROM EP (2) (FEET)	MINIMUM RIGHT OF WAY (FEET)
< 400	25	200	NONE	10	155	280	24	5 (1)	6	30
401 - 1500	25	200	NONE	10	155	280	24	8	7	55
1501 - 2000	30	335	NONE	10	200	335	36	9	10	60
2001 - 4000	30	335	NONE	10	200	335	48	11	12	80

NOTES:
 FOR STREETS WITH VOLUMES OVER 4000 OR SERVING HEAVY COMMERCIAL OR INDUSTRIAL TRAFFIC; USE THE APPROPRIATE GEOMETRIC DESIGN STANDARD.(SEE VDOT ROAD DESIGN DESIGN MANUAL)
 ALL SHOULDER AND DITCH SECTION REQUIRE TOWN COUNCIL APPROVAL.

1.WHEN THERE ARE PEDESTRIAN FACILITIES PROVIDED BEYOND DITCHES , THE SHOULDER WIDTH MAY BE REDUCED TO A MINIMUM OF 2 FEET.
 2.CLEAR ZONE WIDTH MAY BE REDUCED WITH THE CONCURRENCE OF THE ENGINEER WHERE TERRAIN OR SOCIAL/ENVIRONMENTAL IMPACT CONSIDERATIONS ARE APPROPRIATE..

NOTES:

1. MINIMUM GRADE OF ANY STREET WITH CURB & GUTTER IS 0.5%; WITH SHOULDER AND DITCH IS 1.0%
2. RIGHT OF WAY MUST BE CLEARED TO FULL WIDTH, ALL UTILITIES IN PLACE AND FINE GRADED TO TRUE TYPICAL SECTION PRIOR TO APPLICATION OF ANY PAVING MATERIALS.
3. FOR ANY ROADWAY CLASSIFIED AS A MAJOR COLLECTOR OR AN ARTERIAL ROADWAY, THE RIGHT OF WAY SHALL BE DETERMINED BY THE ENGINEER, BASED ON THE NUMBER OF PROPOSED LANES, MEDIAN WIDTH, AND SLOPE DESIGN.
4. DESIGN SPEED MINIMUM FOR LOCAL ROADWAYS SHALL BE 25 MPH WITH DESIGN SPEEDS FOR OTHER ROAD CLASSIFICATIONS TO BE DETERMINED BY THE ENGINEER.

TOWN OF WARRENTON VIRGINIA	APPROVED: <u>7/10/14</u>  DIRECTOR OF PUBLIC WORKS / UTILITIES	STREET DESIGN CRITERIA	DRAWING NO: R-1(A)
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Figure 71: R-2 Typical Section-Street with Curb and Gutter

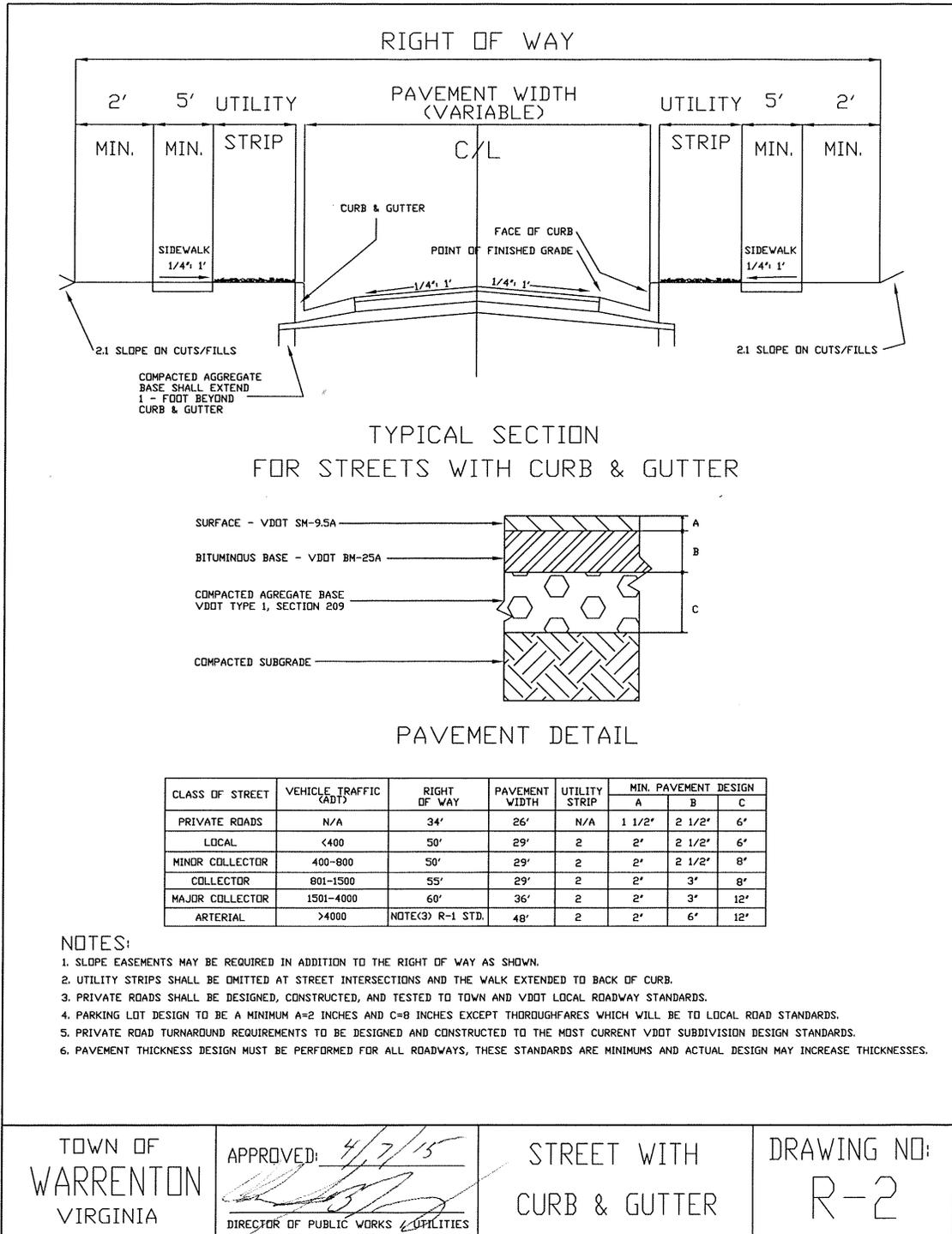


Figure 72: R-3 Typical Section-Street without Curb and Gutter

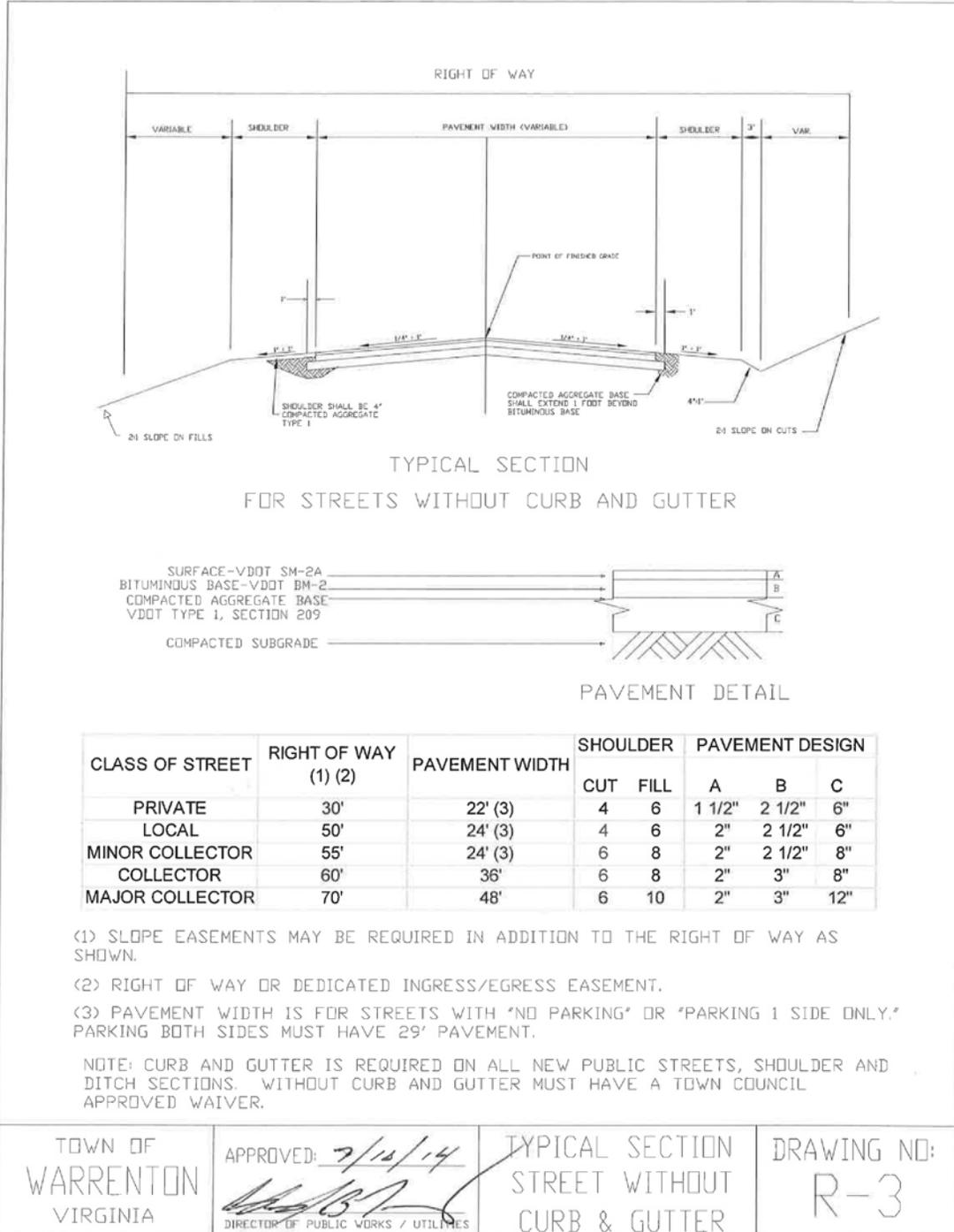


Figure 73: R-4 Combination Curb and Gutter – Curbing - Sidewalk

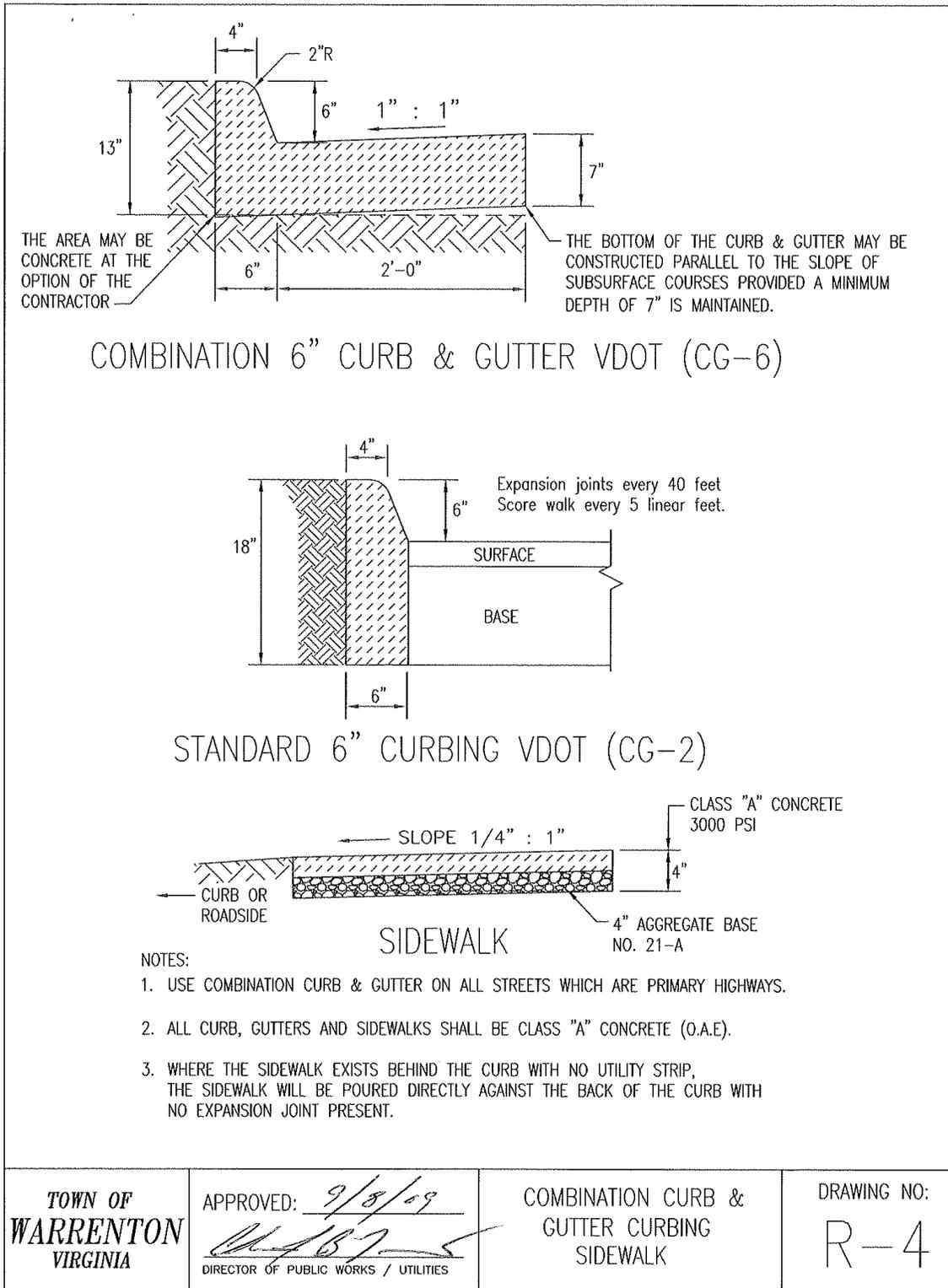


Figure 74: R-5 Private Entrance – Street with Curb and Gutter

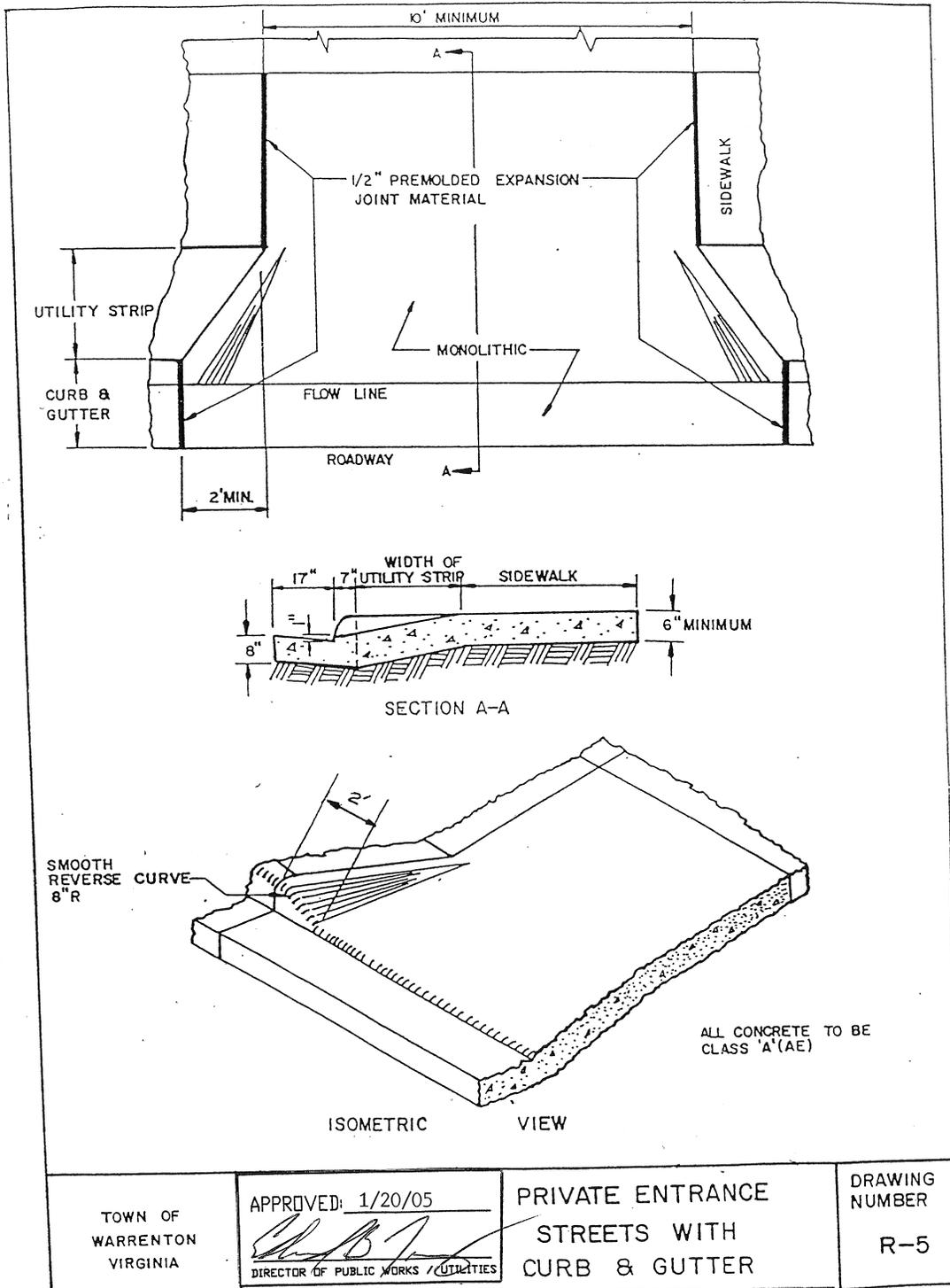


Figure 75: R-6 Entrance – Streets without Curb and Gutter

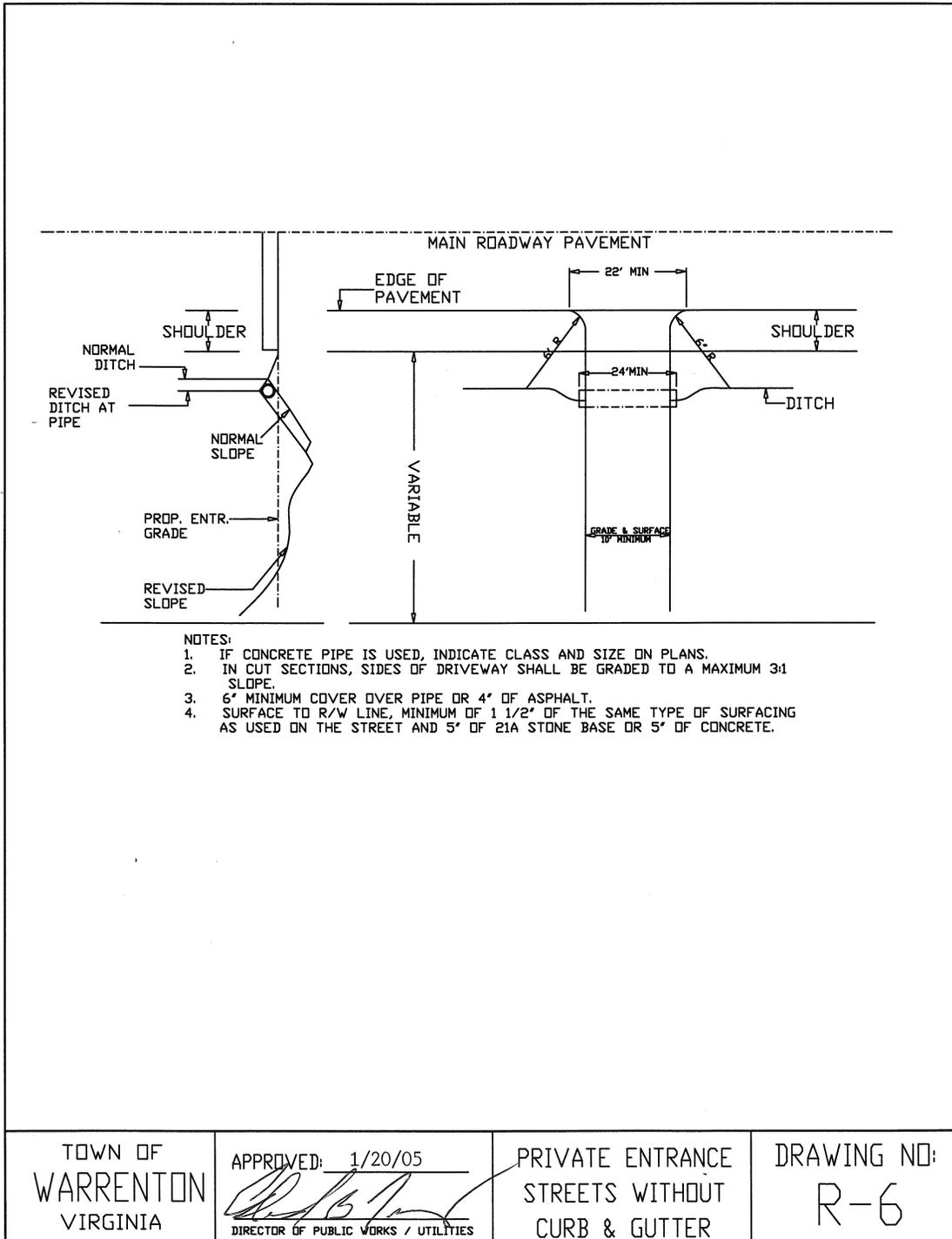
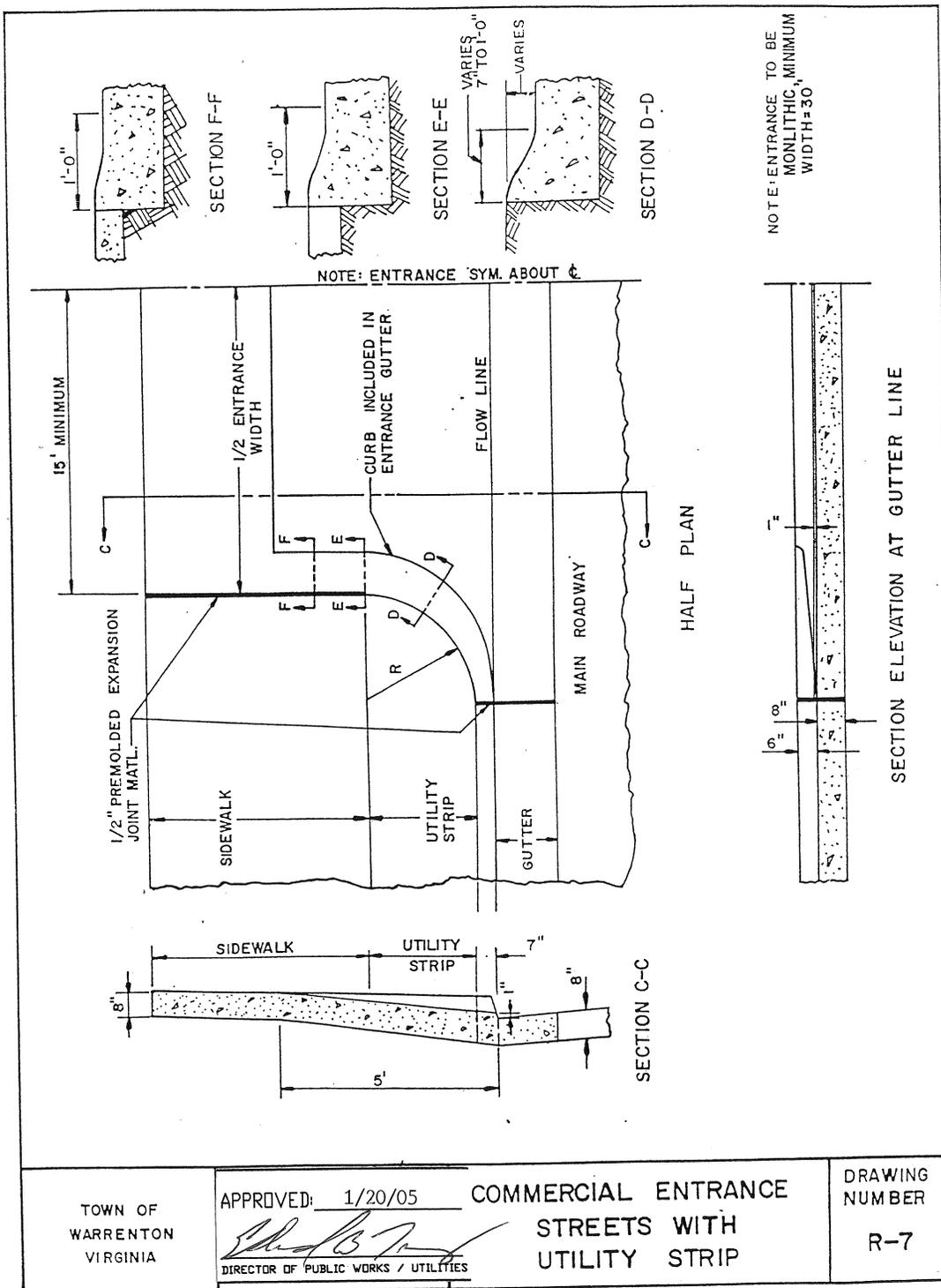


Figure 76: R-7 Commercial Entrance – Streets with Utility strips



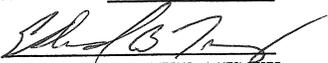
TOWN OF WARRENTON VIRGINIA	APPROVED: 1/20/05  DIRECTOR OF PUBLIC WORKS / UTILITIES	COMMERCIAL ENTRANCE STREETS WITH UTILITY STRIP DRAWING NUMBER R-7
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Figure 77: R-8 Commercial Entrance – Street without Utility Strips

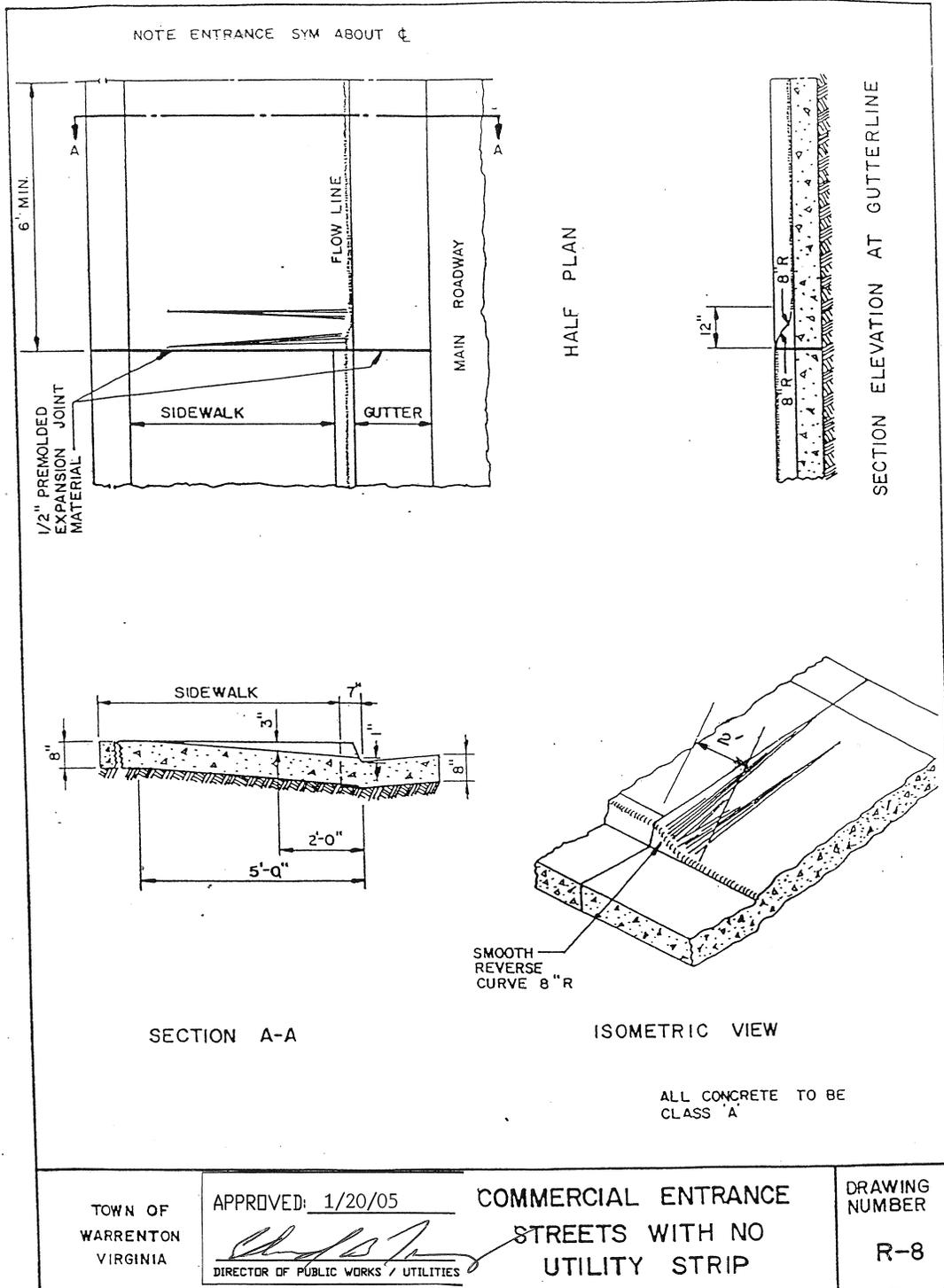


Figure 78: R-9 Intersection Landing Requirements

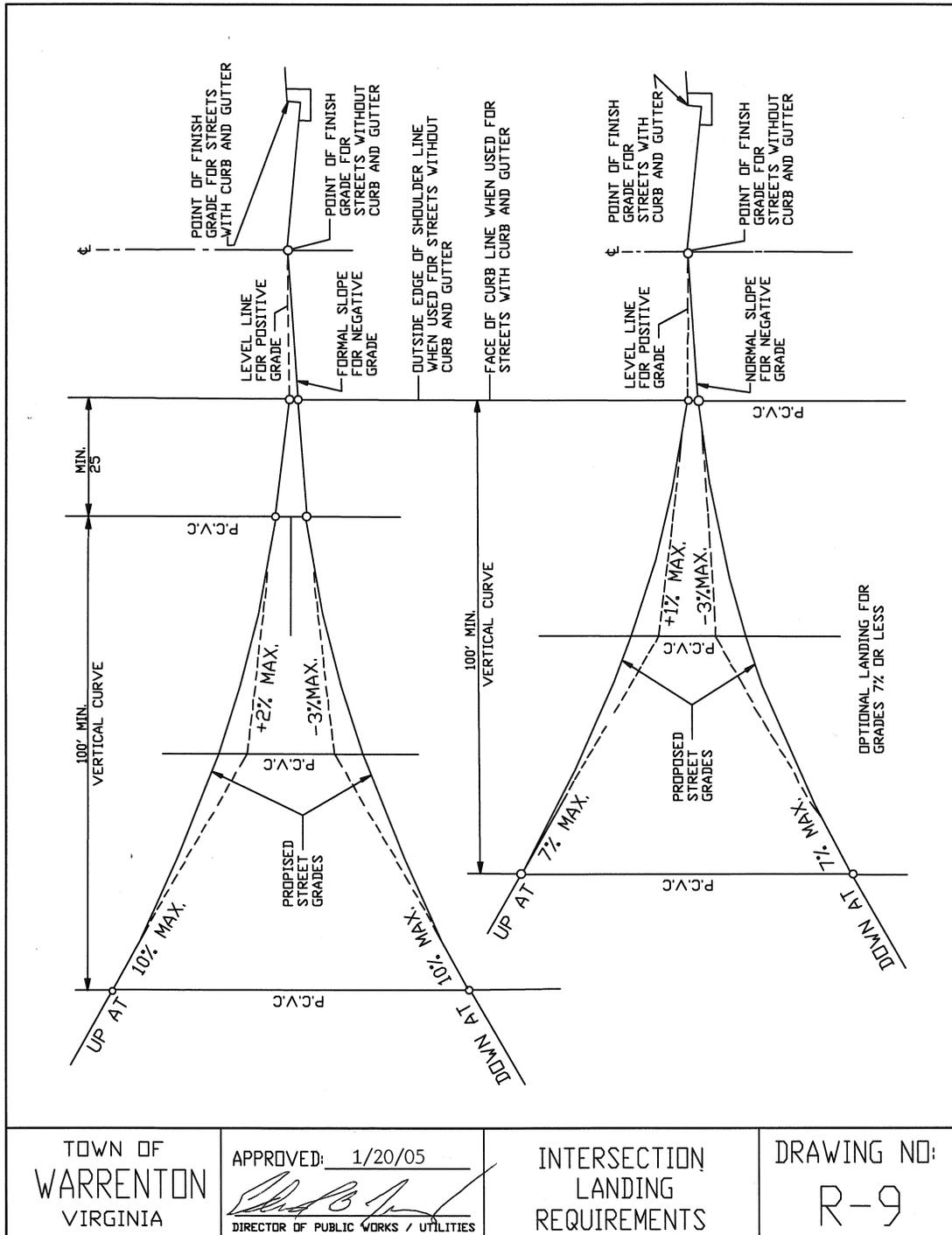


Figure 79: R-10 Street Name Signs

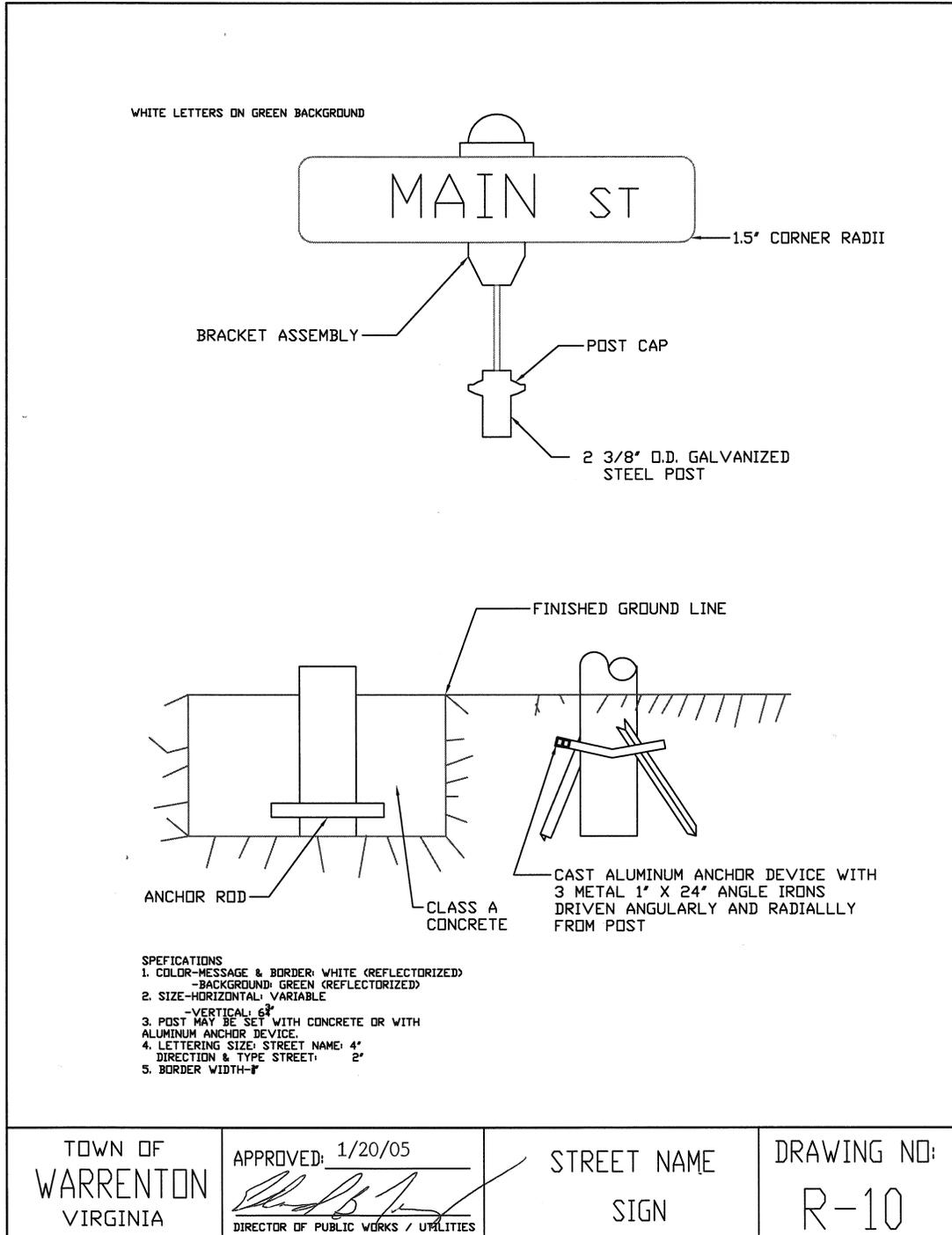


Figure 80: R-11 Private and Commercial Entrances – Streets with Curb and Gutter

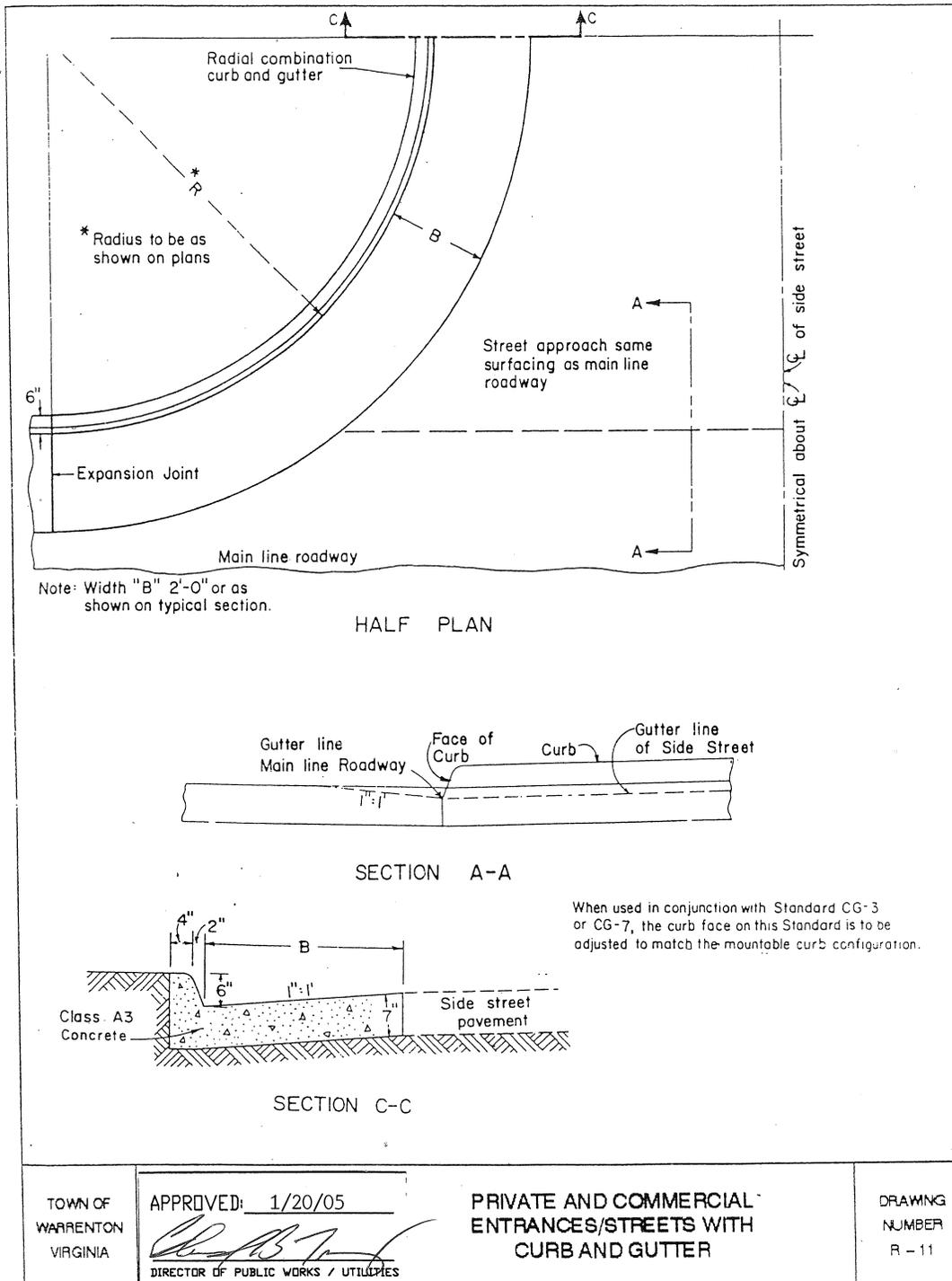


Figure 81: R-12 Private Road Cul-de-Sac and Turnaround

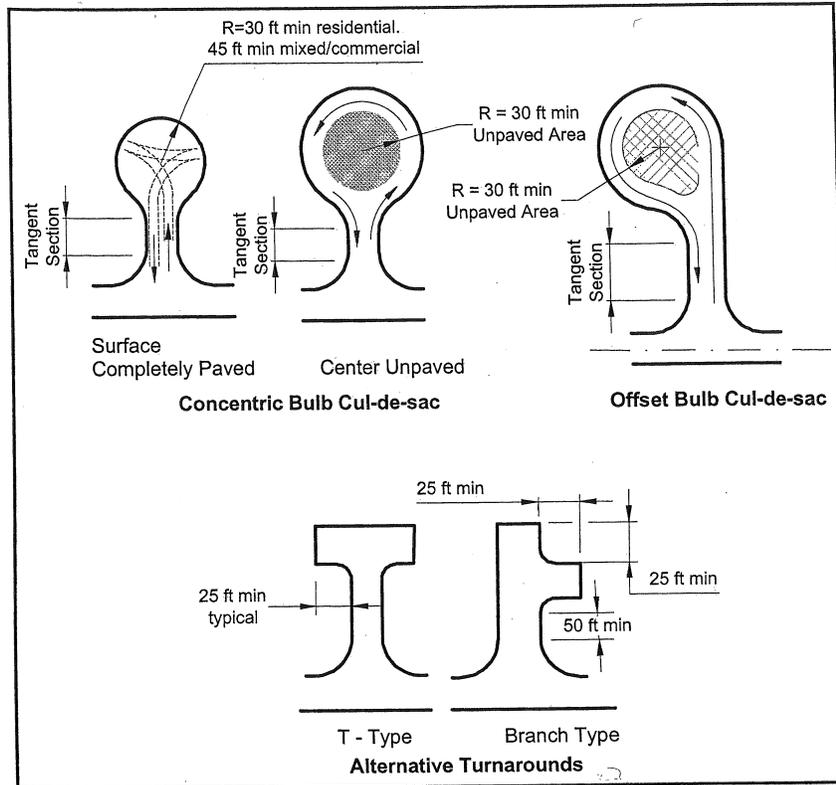


Figure 4 - Cul-de-sac details

From VDOT Road Design Manual: Appendix B: Subdivision Street Design Guide

<p>TOWN OF WARRENTON VIRGINIA</p>	<p>APPROVED: <u>3/8/05</u> <i>[Signature]</i> DIRECTOR OF PUBLIC WORKS / UTILITIES</p>	<p>PRIVATE ROAD CUL-DE-SAC AND TURNAROUND</p>	<p>DRAWING NO: R-12</p>
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