

PUBLIC FACILITIES MANUAL

CITY OF MANASSAS PARK

VIRGINIA

Adopted September 16, 1997

CITY OF MANASSAS PARK
PUBLIC FACILITIES MANUAL
TABLE OF CONTENTS

Article I.....Administrative

Article II.....Water Distribution System

Article III.....Sanitary Sewer System

Article IV.....Streets

Article V.....Storm Drainage System

Article VI.....Miscellaneous Design Standards

Supplement A - Fee Schedule

ARTICLE I

ADMINISTRATIVE

TABLE OF CONTENTS

	<u>Page</u>
SECTION 100.00 GENERAL INFORMATION - PURPOSE	I-1
100.01 Coordination With Other Laws	I-1
100.02 Effective Date	I-1
100.03 Enforcement and Penalties	I-1
100.04 Plan Review Process - Overview	I-2
100.05 Development Process	I-2
100.06 Sketch Plans/Preliminary Site Plans	I-3
100.07 Preliminary Subdivision Plat	I-3
100.08 Final Subdivision Plat	I-4
100.09 Final Subdivision Plat Requirements	I-5
100.10 Final Subdivision Plat Revision	I-6
100.11 Fee Schedule/Final Subdivision Plat	I-7
100.12 Recordation of Approved Final Subdivision Plat	I-7
100.13 Site Plan and Construction Drawings	I-7
100.14 Site Plan Requirements	I-8
100.15 Fee Schedule - Site Plans	I-10
100.16 Site Plans - Validity	I-10
100.17 Waivers	I-11
100.18 Erosion and Sediment Control Plans	I-11
100.19 Erosion and Sediment Control Plan Narrative Requirements	I-11
100.20 Erosion and Sediment Control Plan Revisions	I-11
100.21 Fee Schedule - Erosion and Sediment Control Plans	I-11
100.22 Clearing and Grading Permit Requirements	I-11
100.23 Fee Schedule - Clearing and Grading Permit	I-12
100.24 Bonds, Agreements and Escrows	I-12
100.25 Types of Security	I-12
100.26 Bond Review	I-13
100.27 Bond Extensions or Reductions	I-13
100.28 Bond Default	I-14
100.29 Release of Security	I-14
100.30 Fee Schedule - Bonds and Agreements	I-15
100.31 Record Drawings	I-16

ARTICLE I

ADMINISTRATIVE

100.00 GENERAL INFORMATION - PURPOSE

The Public Facilities Manual (the PFM) for the City of Manassas Park serves these purposes:

- A. To set forth design guidelines and standards for facilities constructed in association with new development and with reconstruction/rehabilitation projects in the City of Manassas Park.
- B. To assist the public and particularly the development community (i.e., contractors, builders, engineers, architects), in understanding laws, technical regulations, rules and policies which apply to development projects constructed within the City of Manassas Park.
- C. To facilitate orderly development through standardization of public and private facilities requirements and the associated plans review process.

100.01 Coordination With Other Laws; Interpretation: The PFM supplements all State and City codes and ordinance provisions applicable to land development. Nothing contained in the PFM shall be deemed to waive other requirements of existing codes or regulations, including the Zoning, Fire, Health, and the Virginia Uniform Statewide Building Code. Where the provisions of this PFM with existing codes or regulations, the more stringent requirement shall apply. Unless otherwise specified in this PFM, the Director shall mean the Director of Public Works for the City of Manassas Park. The term "City" shall mean the City of Manassas Park, Virginia. The current specifications contained in the Virginia Department of Transportation ("VDOT") Road and Bridge Specifications shall govern all workmanship, material, seasonal limitations and construction procedures in conjunction with this PFM.

100.02 Effective Date: The effective date of the revised Public Facilities Manual shall be the date following its adoption by the Governing Body of the City. This manual supersedes the Public Facilities Manual dated March 17, 1987.

100.03 Enforcement and Penalties: This PFM is an ordinance and shall have the force and effect of law. Any person or entity, including the owner of property on which there is construction activity

regulated under this manual, who or which fails to comply with a violation notice and stop work order issued pursuant to Chapter 31, Article VIII of the Manassas Park Code shall be guilty of a Class 1 misdemeanor. Provisions of this manual shall be administered jointly and cooperatively by the Director of Public Works and the Zoning Administrator for the City.

- 100.04 Plan Review Process - Overview: The subdivision, site and construction plans review processes for land located in the City of Manassas Park are the primary means by which the City oversees the nature of site development. Plats and plans are submitted to the Planning and Zoning Office where they are first reviewed for completeness. The plans are then circulated for review for compliance with City ordinances that govern land use and site development. Through plat and plan review, the City endeavors to ensure that proposed development includes safeguards that help protect the environment and the health and safety of the citizens.

All proposed development or land disturbance activities conducted in the City must proceed through the plan review phase. Whenever any physical improvements are to be constructed, such as storm or sanitary sewers, water mains, streets, curb and gutter, or any land-disturbing activity is proposed, the work must be covered by a site or construction plan approved by the City, a validly recorded subdivision plat and an erosion and siltation control plan approved by the City.

In addition, the developer must enter into an agreement with the City to construct the improvements specified in the approved plans and must post a bond to cover the cost of completing the improvements. A similar bond and agreement is also required for erosion and siltation control measures.

- 100.05 Development Process - Overview:

- A. After required subdivision plats are approved by the City and recorded by the developer, bonds posted and agreements signed, a pre-construction meeting between City officials and developers/engineers is required to assure understanding and compliance with standards established by this manual and the approved plats and plans.
- B. After the necessary bonds and agreements are finalized and signed by all parties, clearing and grading, construction, and utility permits must be obtained from the Zoning Administrator before starting any

work on the site. These permits authorize the developer to begin clearing the site and constructing the public or private improvements and utilities. No work may begin on the buildings or other structures until building permits are issued.

- C. The developer must advise the Director of Public Works 24 hours in advance of any construction or land-disturbing activity related to public facilities or which may directly affect such facilities. This advisory does not supersede or modify any requirement for approved plans, bonds or permits.

100.06 Sketch Plans/Preliminary Site Plans: Submission of a sketch plan or preliminary site plan is at the discretion of the applicant. If the submission is made, applicable fees shall be paid and the sketch plan or preliminary plan shall include the following items:

- a topographic base map showing the property;
- the proposed street layout showing the name, location, and dimensions of all streets entering the property, adjacent to the property, or terminating at the boundary of the property;
- a schematic with dimensions, showing the proposed uses of land and open space; and
- payment of fee (See Supplement A) in accordance with notice of acceptance for processing.

100.07 Preliminary Subdivision Plats: Preliminary subdivision plats are drawings prepared by a Virginia registered engineer or Virginia licensed land surveyor showing a proposed subdivision of land. These drawings show the proposed layout of lots, street widths, and proposed open space and other items specified in the City subdivision ordinance and this PFM.

- A. Preliminary Subdivision Plat Submissions.
The following items must be submitted with the preliminary subdivision plan to the Office of Planning and Zoning:
 - twenty copies of the preliminary plat;
 - copies of all conditions approved in the rezoning, proffers, variances or conditional use permits applicable to the property, and
 - payment of fee (see Supplement A) in accordance with notice of acceptance for processing. The preliminary plat must be signed and sealed by a professional engineer or land surveyor licensed to do business in Virginia.
- B. Preliminary Subdivision Plat Requirements

Identifications: Names of subdivision, owner, subdivider, person preparing drawings, date of drawings, number of sheets, north arrow and scale. If true north is used, method of determination must be shown.

Location of Subdivision: Vicinity map of proposed subdivision by an inset map at a scale of not less than one inch equals two thousand feet (1"=2000') showing adjoining roads, their names and route numbers, towns, subdivisions, watershed areas and other landmarks .

Topography of site: Shown with maximum two (2') contour intervals and showing physical features such as tree lines, streams, wetland areas, existing utilities, etc. Scale of drawings shall not be less than one inch equals one hundred feet (1"=100').

Boundaries of Subdivision: The boundary survey or existing survey of record of the property by bearings and distances (provided such survey shows a closure with an accuracy of not less than one in ten thousand (1:10,000)), with reference to a known, permanent monument.

Other Subdivision Data:

Total acreage, acreage of subdivided area, number and approximate area and frontage of all building sites, existing buildings within the boundaries of the tract, names of all property owners of the tract and adjoining properties and their respective owners property lines .

C. Fee Schedule - Preliminary Subdivision :
See Supplement A for applicable fee schedules.

D. Preliminary Subdivision Plat Review: An approved preliminary subdivision plan is valid for six (6) months from the date of its approval by the Commission. Minor revisions may be made to the preliminary subdivision plan, but a material revision to a preliminary subdivision plan will require a new full review of the proposal. Approval of the preliminary plan does not guarantee approval of the final subdivision plat.

100.08 Final Subdivision Plats: A final subdivision plat is the final boundary survey drawing by a Virginia registered engineer or Virginia licensed surveyor of a proposed subdivision of land which has been reviewed by City staff to ensure that it conforms to all applicable zoning and subdivision ordinance requirements and the requirements of this PFM and approved by the City of Manassas

Park Planning Commission. A final subdivision plat must bear the signature of the Zoning Administrator, which evidences its approval by the City. It must then be recorded with the Clerk of the Circuit Court, Prince William County, upon approval, so that lots can be legally sold and building permits lawfully issued for those lots. A certified copy of the recorded plat shall be filed with the Zoning Administrator prior to application for a building permit.

100.09 Final Subdivision Plat Requirements: A final subdivision plat shall be clearly and legibly drawn in ink upon stable and reproducible plastic or linen material at a scale not less than one inch equals one hundred feet (1"=100') on sheets having a size of not more than eighteen (18) inches by twenty-four (24) inches. In addition to the requirements for the preliminary subdivision plat, the final subdivision plat shall include the following:

Approval Space: A signature block measuring three (3) inches by five (5) inches shall be reserved for the use of the approving authority.

Surveyor's Certificate: Certificates signed by Virginia licensed surveyor or Virginia registered engineer setting forth the source of title of the owner(s) of the land being subdivided and the place of record of the last instrument in the chain of title. This certificate is required by state law.

Owner's Consent to Subdivide: A statement by the owner(s) of the land that the subdivision as it appears on the plat is made with the free consent and in accordance with the desires of all of the owner(s), proprietors and trustees (if any) of the land which is signed by all of the owners, proprietors, and trustees (if any) and is duly acknowledged before an officer authorized to take acknowledgements of deed, and to notarize the plat. This consent is required by state law and must use the statutory language.

Identification of Tracts: When the subdivision consists of land acquired from more than one source of title, the outlines of the various tracts shall be placed on the plat. The Surveyor's Certificate must identify all owners and sources of title.

Streets, Public Facilities, Utilities: The accurate location and dimensions by bearings and distances with all curve data of all proposed lots and streets, boundaries and the identification of all proposed or existing easements, parks, school sites; public and

private streets (including their names, route numbers, and right-of-way widths), utilities, (such as electric, telecommunications and other services, sanitary sewers, storm drains, water mains, manholes and underground conduits including their size and type) water courses and their names and the identification of property owners by name and their property lines, both within and adjoining.

Street and Subdivision Naming: The names of existing subdivisions and streets shall not be duplicated and, where possible, similar sounding names shall be avoided for purposes of clarity.

Subsequent street and/or subdivision name changes must be properly recorded to assure accurate records.

Floodplain: Delineation of any FEMA 100 year floodplain limits and wetlands.

Deed of Subdivision: A Deed of Dedication, Subdivision and Easements which corresponds to the final subdivision plat must be submitted for review and approved as to form by the City Attorney prior to approval of the final subdivision plat by the Planning Commission.

Property Owners' Association: The Declaration of Covenants, Conditions and Restrictions, the Articles of Incorporation and Bylaws of the applicable property owners association shall be submitted for review and approval as to form by the City Attorney prior to approval of the final subdivision plat by the Planning Commission.

Summary Table: A summary table listing the existing zoning of the property, total site area, number of lots, average lot area, total area of courts and streets to be dedicated and all open space dedications shall be indicated on the final subdivision plat.

Curve Table: The data of all curves shall be shown in detail at the curve data table containing the following: delta, radius, arc, tangent, chord and chord bearings.

100.10 **Final Subdivision Plat Revision:** Any changes to the final subdivision plat after its recordation can only be done by recording a plat and of correction or a plat corresponding deed of resubdivision. A plat of correction must be prepared by a Virginia registered engineer or Virginia licensed surveyor and again reviewed and approved by the City to verify that it is a technical correction and

that it complies with applicable subdivision ordinance requirements lot owners and is consented to by all affected lot owners. The submission of a plat or resubdivision must include, among other things, certified statements from all affected property owners that they concur in the resubdivision.

100.11 Fee Schedule - Final Subdivision Plat:
See Supplement A for applicable fee schedules.

100.12 Recordation of Approved Final Subdivision Plat: A final subdivision plat must be approved by the Governing Body and then recorded in the Circuit Court in order to finalize and make a subdivision of land legal. The plat must be accompanied by a proper deed of subdivision, dedication and easement.

Landowner is responsible for delivering the original final subdivision plat, and one (1) copy of the plat, together with the deed of subdivision and appropriate property owners' association documents to the Office of the Clerk of the Circuit Court of Prince William County, Virginia and paying the recordation fee. The Clerk then assigns an instrument number to the transaction. The plat and documents will then be copied, recorded and entered into the land records. Recordation of an approved final subdivision plat must occur within six (6) months of its approval by the City or it will by law automatically become void.

The owner is responsible for accomplishing the recordation process. A certified copy of the recorded plat shall be filed with the Zoning Administrator prior to application for a building permit.

100.13 Site Plan and Construction Drawings: Site plans and construction drawings are required for every development of land in the City. The site plan must be prepared by a Virginia registered engineer, Virginia licensed land surveyor, or registered architect and approved by the Zoning Administrator after review and recommendation by City staff. Nine (9) copies are submitted to the Planning and Zoning Office where the copies are distributed to appropriate City and other agencies for review.

Agency comments will be provided to the applicant by the contact person in the Office of Planning and Zoning. Following any required revisions to site plans, the applicant will submit such revised plans along with bond estimates for required public or private facilities and soil erosion control measures.

Once the Office of Planning and Zoning recommends site plan for approval by the Planning Commission, the applicant must complete the bond, escrow, and agreement process before the site plan can be approved for permit.

100.14

Site Plan Requirements:

- (1) Location of the tract by an insert map at a scale of not less than one inch equals two thousand feet (1"=2000') indicating the scale, the north arrow, and such information as the names and numbers of adjoining roads, streams, and bodies of water, railroads, subdivisions, or other landmarks sufficient to clearly identify the location of the property.
- (2) A boundary survey of the tract by bearings and distances certified by a licensed land surveyor.
- (3) A certificate signed by the Virginia licensed surveyor or Virginia registered engineer setting forth the source of title of the owner(s) of the tract and the place of record of the last instrument in the chain of title.
- (4) All existing property lines; existing streets and easements, their names, numbers and width; the locations and sizes of existing sanitary and storm sewers, gas lines, water mains, culverts and other utilities and their easements; existing buildings; existing watercourses, waterways or lakes and their names; and other existing physical features in or adjoining the project.
- (5) Existing zoning and zoning district boundaries of the property in question and of immediately surrounding properties.
- (6) The present uses of all contiguous or abutting property.
- (7) Existing topography with a maximum of two (2) foot contour intervals. Where existing ground is on a slope of less than two (2) percent, either one (1) foot contour or spot elevations, where necessary, but not more than fifty (50) feet apart in both directions.
- (8) Proposed changes in zoning, if any.
- (9) The locations, dimensions, and character of construction of all proposed streets, alleys, driveways, and the locations, types, and sizes of vehicular entrances to the site. (Refer to Section 400, Street Design Standards and Specifications.)
- (10) The locations, dimensions and character of all proposed and existing off-street parking, loading spaces and walkways indicating type of surfacing, size, angle of stalls, widths of aisles, and a specified schedule showing the number and types (e.g., compact, standard, handicapped) of parking spaces provided.
- (11) All proposed water and sanitary sewer facilities, indicating all

- pipe sizes, types, and grades and where connection is to be made to City or to other utility systems; all proposed gas lines and other utilities and their easements. Fire flow and water modeling calculations shall be submitted for review and approval for extension of water mains. (Refer to Section 200, Water Distribution Systems and Section 300, Sanitary Sewers.)
- (12) The proposed location, general use, number of floors, height and floor area for each building, accessory and main, and where applicable, the number, sizes, and types of dwelling units.
 - (13) Proposed finished grading by contours supplemented where necessary by spot elevations.
 - (14) Provisions for the adequate disposition of natural and storm water in accordance with design criteria and construction standards of the City, including storm drainage calculations and profiles for ditches, catch basins and pipes of proposed storm drainage systems and their connection to associated existing systems or drainage control facilities. (Refer to Section 500, Storm Drainage Systems.)
 - (15) Provisions for the adequate control of erosion and sedimentation, in accordance with the requirements of Chapter 8 of the City Code, indicating the proposed temporary and permanent control practices and measures that will be implemented during all phases of clearing, grading, and construction.
 - (16) Delineation of any FEMA 100 year floodplain limits.
 - (17) Locations, types, sizes and heights of all proposed fencing, retaining walls and screen planting where required under the provisions of this manual, the Zoning Ordinance and applicable covenants.
 - (18) The location of wooded areas on the property, and the location of those trees and wooded areas that will be retained.
 - (19) A landscape plan, drawn to scale, including dimensions and distances and the locations, types, sizes, and descriptions of all proposed landscape materials.
 - (20) The locations and dimensions of all proposed recreation, open space, and required amenities and improvements, including details of disposition.
 - (21) The locations, character, sizes, heights and orientations of all proposed signs and outdoor lighting systems.
 - (22) All features and elements of a site plan shall, in all respects, conform to all applicable provisions and standards of the Code of Virginia (1950), as amended, the City Code, and this manual, and the respective standards of the Virginia

Department of Transportation and the Virginia Department of Health.

- (23) A cross-section showing proposed street construction, depth and type of base, type of surface, and other street construction information.
- (24) A profile or contour map showing the proposed grades for all streets and drainage facilities, including the elevations of existing and proposed ground surface at all street intersections and at points of major grade change along the center of streets, together with the proposed connecting grade lines.
- (25) All conditional use permit requirements, variance requirements and rezoning case numbers and proffers, if applicable.
- (26) All parcels of land to be dedicated for public use and the condition of dedication.
- (27) The name and address of the landowner or developer, the north arrow, date of drawing, scale of drawing (not to exceed one inch equals one hundred feet [1"=100'], signature block 3 inches wide by 5 inches high for use by the approving authority.

100.15 Fee Schedule - Site Plans:

See Supplement A for applicable fee schedules.

Minor changes to a site plan may be made at any time prior to approval of the site plan by the Planning Commission without requiring the payment of additional fees, provided that the scope and character of these changes do not materially alter the proposal. Changes to a site plan made after its approval by the Planning Commission and review by City staff require payment of a fee as indicated in fee schedule (see Supplement A). Substantive changes or revisions to an approved site plan involve the same review and approval process as that for the original site plan submission.

100.16 Site Plans - Validity: A site plan approval is valid for a period of five years from the date of its approval. The approval can be extended for an additional one-year period upon timely application for extension by the landowner. Unless otherwise noted herein, the Director may extend the time limitations set forth herein when he is satisfied with actual proof that the developer is proceeding with due diligence, but that a problem beyond the developer's control prevented the developer's meeting such time limitations. Such extensions may be granted only when the developer notifies the Director of his inability to meet such time limitations before the time limitation expires. Once the site plans are officially approved and applicable bonds posted, the building permits can be obtained,

and the applicant can proceed with the authorized development. For townhouse projects with individual ownership of the lots, the approved final subdivision plat must be recorded before development can be authorized.

- 100.17 Waivers: All standards set forth in this manual are required unless specifically waived by vote of the City Governing Body.
- 100.18 Erosion and Sediment Control Plans: Erosion and sediment control plans are required for any land-disturbing activity unless excepted by Chapter 8 of the City Code. A "land-disturbing activity" is defined in § 8-4 of the City Code.
- In general, erosion and sediment control plans show the existing and proposed grade conditions; limits of clearing; and erosion and siltation controls during site development and construction. Erosion and sediment control plans and techniques must conform to the requirements set forth in Chapter 8 of the City Code. Approved standards, specifications and criteria for control techniques to be utilized in preparing the plan are set forth in the latest edition of the Virginia Erosion and Sediment Control Handbook. Erosion and sediment control plans must be approved by the City Engineer before building permits can be issued.
- If the required grading and erosion and sediment control information is not included on a submitted site or construction plan, a separate erosion and sediment control plan shall be prepared by a Virginia registered engineer or Virginia licensed surveyor, showing the required items. Fifteen (15) copies of the plan are submitted to the Planning and Zoning Office for review.
- 100.19 Erosion and Sediment Control Plan Narrative Requirements: Refer to Virginia Erosion and Sediment Control Handbook, latest edition.
- 100.20 Erosion and Sediment Control Plan Revisions: Erosion and sediment control plans may be revised at any time. The procedure for a plan revision is the same as for the original submission. If the parcel in question is subject to a contract of sale, the contract purchaser must concur in the requested change.
- 100.21 Fee Schedule - Erosion and Sediment Control Plans:
See Supplement A for applicable fee schedule.
- 100.22 Clearing and Grading Permit Requirements: Prior to obtaining a

clearing and grading permit, an erosion and sediment control plan must be submitted and approved by the City Engineer.

100.23 Fee Schedule - Clearing and Grading Permit:
See Supplement A for applicable fee schedule.

100.24 Bonds, Agreements and Escrows: Developers must enter into an agreement with the City to construct the required physical improvements, both public and private, shown on approved site plans and subdivision plats and associated erosion and sediment control plans. A surety bond from an acceptable surety company or an equivalent instrument (as provided in Section 15.1-4555(A) of the Code of Virginia, payable to the City of Manassas Park must be posted to guarantee the performance of the terms of these agreements.

The Agreement for the Construction of Physical Improvements provides for the construction of all physical improvements and facilities shown on the approved plans within a specified time period and for compliance by the developer with other construction-related provisions contained in the agreement. The Erosion and Sediment Control Agreement provides for installation and maintenance of temporary and permanent erosion control devices and improvements.

Agreements and bonds for property improvements including grading, erosion and sediment control, sanitary sewer, water lines, storm sewers, streets, public sidewalks or parking lots shall be required for all projects within public right-of-way or becoming the responsibility of the City for maintenance. Satisfactory security shall also be posted for proposed private streets, vehicular ingress and egress, critical slopes stabilization and storm water management facilities. Agreements and bonds shall comply with the requirements of Section 31-40 and Section 21-65(11) of the Code of the City of Manassas Park and shall be in an amount equal to one hundred and twenty percent (120%) of the total cost of the improvements determined by the administrator.

100.25 Types of Security: Four types of bonds are acceptable as security by the City:

- (1) Corporate Bond. This surety is furnished by a corporation (such as an insurance company) which guarantees the full amount of the bond.
- (2) Cash Escrow. Under this type of surety, the face amount of the bond is deposited in cash with the City Treasurer. Selected U.S.

Treasury and Federal agency securities also may be accepted.

(3) Letter of Credit. This surety is furnished by a bank or savings institution and allows the City to draw on developer funds in the event of default. Letters of credit must be irrevocable and drawn on a financial institution located in Northern Virginia.

(4) Set-Aside Letter. This surety is furnished by the developer's lender and sets aside funds in the developer's account.

100.26 Bond Review: The completion of the bonding process occurs after the required site plan or subdivision plat has been approved by City authorities. However, some of the steps can be started while the site plan or construction plan is being reviewed by City staff. The developer's engineer must submit cost sheets for the bondable private or public improvements. The City Engineer will review the amount submitted for the necessary bond and escrow, verify the estimate and determine the final figure. The City requires security equal to 120 percent of the cost of the work, which means that 20 percent additional cost be added to the final construction cost to cover contingencies for administrative and engineering costs.

After the City staff has completed the review of the construction plan or site plan, approved the estimated cost of constructing the bonded improvements, and reviewed the amount of time estimated by the developer to complete these improvements, a bonding packet, which contains the required agreements, bond forms and other documents, is sent to the developer for his completion and execution by all necessary parties. The signed and completed documents and security are returned to the Office of Planning and Zoning where they are checked for accuracy. Only when the bonds, agreements, and escrows are completed and approved, can the site or construction plans receive final approval.

100.27 Bond Extensions or Reductions: If the site improvements required under an agreement cannot be completed within the time period stipulated in the agreement, the applicant may request an initial extension of time of not more than six (6) months or may apply for a replacement agreement and bond. A written request for an extension is made to the Zoning Administrator, stating the reasons that prevented the completion of the required improvements. The first extension can be granted by the Zoning Administrator. Any subsequent extensions must be approved by the Governing Body of the City.

The developer may apply for a replacement agreement and bond,

rather than an extension of time. The following conditions apply to bond reduction requests:

- A. Developers may apply for up to three (3) bond reductions per twelve (12) month period of time, for each project.
- B. Bond reduction requests may not exceed the cost attributable to the percentage of work completed nor exceed 80 percent of the original face amount of the bond.
- C. The City may retain a minimum of twenty (20) percent of the bond amount until the project is completed and granted final approval.
- D. The bond reduction request will be reviewed by the City Engineer and is subject to final approval by the City Manager or designee.
Following completion, approval and execution of a reduced bond and replacement agreement, the original bonds and agreements are released to the developer.

100.28 Bond Default: If the site improvements required under an agreement have not been completed within the time period specified in the agreement or extension, the agreement is in default. Approximately sixty (60) days before the completion date stated in the agreement, designated City staff will evaluate the status of the project to determine whether the required work will be completed within the specified time period.

Approximately thirty (30) days prior to the completion date specified in the agreement, the City will notify the developer and the surety if it appears that the agreement is about to be in default.

After the agreement is in default, the City will notify the surety of the default, and within 45 days after issuance of the notice, the surety must advise the City of its plans for completion of the improvements. The City Attorney and the City Manager or designated representative shall evaluate the response of the surety and determine the appropriate action. If the surety fails to timely or adequately respond, the City may institute legal action against the developer and the surety.

100.29 Release of Security: Prior to the release of the security for site improvements, the developer may file a maintenance bond in an

amount not less than five (5%) percent of the improvement bond in order to assure the continual, satisfactory condition of the required improvements for a period of one (1) year after the date of their acceptance by the City.

Agreements, security, and any related escrows are released and returned by the City when all of the work covered by them has been satisfactorily completed in accordance with the governing plans and specifications, accepted by the City and the maintenance bond posted.

The release process must be initiated by the developer letter to the City stating the work has been completed and requesting inspection and acceptance of the improvements, release from his agreement and return of the security. Notice of the request for release is circulated to other agencies to ensure that:

- A. VDOT or the City, as applicable, has accepted all dedicated streets into their system for future maintenance and reimbursement.
- B. All applicable code violations have been remedied.
- C. All sanitary sewer lines and water lines have been accepted by the City or other appropriate authority.
- D. All fees have been collected.
- E. All record drawings have been approved.
- F. All physical improvements covered by the agreement have been inspected, approved and accepted.
- G. All water agreements have been satisfied.
- H. All necessary maintenance bonds have been received and approved.
- I. All conditions of litigation have been met.

Before the security is released, certain reviews are performed to ensure that other code requirements have been satisfied.

100.30 Fee Schedule - Bonds and Agreements: There is currently no fee

for approval of an initial agreement and bond; the cost of staff time is included in the fees established for site and construction plan approval. However, fees are imposed for agreement extension applications and bond reduction requests. See supplement A for applicable fee schedule.

100.31 Record Drawings: The plan of completed construction is known as "record drawings" and must include, at minimum, the following pertinent information:

- A. Boundaries of the site.
- B. Final and actual location of all buildings, showing building footprint, setbacks, size, height, and address numbers which have been posted.
- C. All storm sewer and sanitary sewer lines shall include pipe sizes, lengths and percent of slope, top and invert elevations of all structures, detention and retention facilities, locations of grease traps, sanitary sewer cleanouts, parking space dimensions and count, locations of fire hydrants and top elevations.
- D. Deed book and page number of plats and deeds accomplishing dedication and easements shown on the plan, indicating the respective dedication or easement.
- E. Certification by the Virginia registered engineer or Virginia licensed surveyor, who prepared the record drawings, indicating that the record drawings conform with the approved plan, depicts actual conditions on the site and bears his signature and Virginia registration number.
- F. Location of underground and overhead utility easements including telephone, electric, gas lines, storm, water and sanitary sewer lines (with sizes) and other physical improvements. Five (5) copies of the certified record drawings(s) must be submitted to the City.

After all of the above reviews have been performed, the Planning and Zoning Administrator shall authorize the release of the agreement and bond.

END OF SECTION

ARTICLE II

WATER DISTRIBUTION SYSTEM

TABLE OF CONTENTS

	<u>Page</u>
SECTION 201.00 GENERAL REQUIREMENTS	II-1
201.01 Conformance and Interpretation	II-1
201.02 Water Quality Requirements	II-1
201.03 Easements	II-1
SECTION 202.00 DESIGN STANDARDS	II-1
202.01 Capacity to Serve	II-1
202.02 Capacity Design Criteria	II-2
202.03 Distribution System Layout Criteria	II-3
SECTION 203.00 MATERIALS AND EQUIPMENT	II-7
203.01 Ductile Cast Iron Mechanical Joint Pipe	II-7
203.02 Ductile Cast Iron Pipe - "Push-On" Joint	II-8
203.03 Cast Iron Pipe Fittings	II-8
203.04 Gate Valves	II-8
203.05 Fire Hydrants	II-9
203.06 Valve Boxes	II-10
203.07 Water Service Connections	II-10
203.08 Wet Taps	II-11
203.09 Large Water Meter Installations	II-11
SECTION 204.00 CONSTRUCTION STANDARDS	II-11
204.01 Installation of Water Mains, Fittings, and Appurtenances	II-11
204.02 Excavation, Bedding, and Backfill	II-11
204.03 Blasting	II-14
204.04 Bends and Elbows	II-14
204.05 Testing and Sterilizing Main During Construction	II-14
204.06 Flushing of Mains	II-14
204.07 Acceptance Tests	II-14
204.08 Repairs	II-15
204.09 Disinfection of Lines	II-15
204.10 Protection of Existing Improvements	II-15
204.11 Safety of Public	II-15
204.12 Cleanup and Restoration	II-17
SECTION 205.00 TYPICAL DETAILS	II-18

ARTICLE II

WATER DISTRIBUTION SYSTEM

201.00 GENERAL REQUIREMENTS

- 201.01 Conformance and Interpretation: Authority for discretionary provisions for water design shall rest with the Director of Public Works for the City of Manassas Park, who when necessary shall request and obtain the advice of the City Engineer. All materials, equipment and construction not currently covered in this PFM shall be in accordance with the applicable American Waterworks Association Standards or other recognized standards acceptable to the Director of Public Works.
- 201.02 Water Quality Requirements: All water furnished for domestic, commercial, or industrial consumption shall be of such quality as to meet all requirements of the Virginia Department of Health.
- 201.03 Easements: When deemed necessary by the Director of Public Works, and in order to assume maximum utilization of the water system, it will be required that appropriate easements shall be obtained for access to or extension of a public utility.

202.00 DESIGN STANDARDS

- 202.01 Capacity to Serve: The water distribution system and any extensions thereof shall have adequate capacity to supply the normal (average) and peak hour demands of all customers - domestic, public, commercial and industrial - while maintaining a pressure of not less than 30 pounds per square inch at all points of delivery. In addition, the system shall be capable of delivering on the day of maximum customer demand, flows required for fire protection to at least one point within 300 feet of each building to be served or proposed to be served by such system and extension, while maintaining a residual pressure of not less than 20 pounds per square inch at the point of service. Flows required for fire protection shall be determined in accordance with the "Standard Schedule for Grading Cities and Towns of the United States" of the American Insurance Association, New York, New York, but shall not be less than the following:

A. Industrial and Mercantile Districts	3,000 gpm
B. Apartments and Town Houses	2,000 gpm
C. Schools, Elementary	2,500 gpm
D. Schools, Secondary and High	3,000 gpm
E. Residential	1,750 gpm
F. Minimum (applicable to sparsely developed residential areas)	1,000 gpm

The Virginia Insurance Rating Bureau shall be consulted regarding fire protection flows required for high value regional mercantile districts, university campuses, etc.

202.02 Capacity Design Criteria: The following criteria will be used in estimating demands for water and accomplishing hydraulic design of the system.

A. Average day, maximum day and peak hour demands to be used in system hydraulic design will be estimated using the following parameters:

1. Residential Population
 - a. Single Family House
N = number of dwelling units x 4.0
 - b. Townhouse
N = number of dwelling units x 3.6
 - c. Apartment
N = number of dwelling units x 3.0
2. Average daily water demand of residential population in gallons per day (g.p.d.)
R = N x 100
3. Average daily commercial and industrial water demand in g.p.d.
C = no. of commercial and industrial employees x 100*
4. Average daily school water demand in g.p.d.
S = number of staff employees and students x 20
5. Average daily water demand in g.p.d.
A = R + C + S

- 6. Maximum daily water demand in g.p.d.
 $M = A \times 1.5$ for high pressure zone
- 7. Peak hour demand in g.p.d.
 $P = M \times 1.5$ for high pressure zone
- 8. Peak hour demand in gallons per minute (g.p.m.)
 $P = M \times 1.5/1440$

*Note: Appropriate additional water demand allowances shall be made for commercial and/or industrial establishments of types having water demands in excess of 100 g.p.d. per employee.

- B. When water distribution system extensions are to be made, the landowner shall first determine the quantity of water required and then obtain from the City the hydraulic gradient for the point of connection to the City's system while providing said demands. Distribution piping design will be based upon providing capacities and service pressures in accordance with these standards from the supply design gradient furnished by the City.
- C. Hydraulic design of distribution piping will be based on pipe carrying capacities consistent with head losses determined in accordance with the following:

<u>Pipe Diameter</u>	Hazel-Williams Coefficient <u>"C"</u>
6"	100
8"	110
10"	115
12" and greater	120

202.03 Distribution System Layout Criteria:

- A. Secondary loops and cross mains with diameters less than 12" shall be spaced not more than 1,000 feet apart with no dead-end length exceeding 500 feet for any 6 inch main. No mains shall be less than 6 inches inside diameter (I.D.).
- B. All mains, branches and dead-ends shall be equipped with blow-offs and/or hydrants of adequate size and number to develop a velocity in the main of at least 2.5 feet per second. Branches of 5 feet in

length or less from the tee or cross to valve, or blind flange or plug need not be equipped with a blow-off provided a tablet of chlorine releasing compound is installed and fixed in place in the branch during construction.

- C. Automatic combination air-vacuum release valves shall be installed at the high points of water mains 16-inches I.D. and larger, where accumulation of air may interfere with flow. Blow-offs will be required at low points of lines 16-inches I.D. and larger. Air vacuum release valves and blow-offs will be installed in all other main sizes as required. Water mains 16-inches I.D. and larger shall not be tapped for individual services. Individual services shall be supplied from distribution mains connected to secondary feeders.
- D. Valves shall be installed at the intersections of water lines. Generally, three (3) valves will be used at crosses and two (2) valves at tees. A valve shall also be installed every one thousand feet (1000') on distribution mains. Additional valves may be required at the discretion of the Director of Public Works.
- E. A valve shall be installed at the public right-of-way line or water easement line wherever a private extension connects with the public water system.
- F. Fire hydrants shall be located on the distribution system as follows:
 - 1. In water systems and extensions serving one - or two-family residential areas, fire hydrants shall be located and installed so that there will be at least one hydrant within 300 feet of the farthest point of a wall of any building (existing or proposed in ultimate development) serviced by said system or extension.
 - 2. Hydrants along streets or roads on which one - or two family residences front shall be spaced not more than 500 feet apart.
 - 3. In commercial, industrial, apartment, and town house areas, fire hydrants shall be provided as required to meet the fire protection standards of the American Insurance Association. In no case shall more than 300 feet of fire hose be required to reach any point at the base of any exterior building wall from the nearest fire hydrant or from each of the hydrants required to supply the stipulated fire flow.

4. Not more than one fire hydrant shall be located on any 6-inch I.D. dead-end main and said fire hydrant shall be located not more than 300 feet from a looped main.

- G. Backflow Preventer: A Watt #7 Dual Check Backflow Preventer or equal double check valve shall be installed at the meter as shown on plate IIA of this PFM.

- H. Water sample tap shall be provided as required by the Director of Public Works.

- I. Separation of water lines and sanitary sewers shall be as follows:
 1. General: The following factors shall be considered in providing adequate separation:
 - (a) Materials and types of joints for water and sewer pipes.
 - (b) Soil Conditions.
 - (c) Service branch connections into the water line and sewer lines.
 - (d) Compensating variations on the horizontal and vertical separations.
 - (e) Space for repairs and alterations of water and sewer pipes.
 - (f) Offsetting of pipes around manholes.
 - (g) Standards & recommendations by Virginia Department of Health.

 2. Parallel Installation:
 - (a) Normal Conditions - Water lines shall be laid horizontal to provide a separation of at least 10 feet from a sewer or sewer manhole, measured edge-to-edge, whenever possible.
 - (b) Unusual Conditions - When local conditions prevent a horizontal separation of 10 feet between water and sewer lines and facilities, the water line may be laid closer to a sewer provided that:
 - (1) The bottom of the water line is at least eighteen inches (18") above the top of the sewer or
 - (2) Where this vertical separation cannot be obtained, the sewer shall be constructed of mechanical joint water pipe and pressure-tested in place to 50 psi without leakage prior to backfilling.

3. Crossing Installation:
 - (a) Normal Conditions - Water lines crossing sewers shall be laid to provide a vertical separation of at least 18" between the bottom of the water line and the top of sewer line whenever possible.
 - (b) Unusual Conditions - When local conditions prevent a vertical separation described in 3(a) above, the following construction shall be used:
 - (1) Sewers passing over or under a water line shall be constructed of the materials described in 2(b)(2).
 - (2) Water lines passing under sewers shall, in addition, be protected by providing:
 - (aa) A vertical separation of at least 18" between the bottom of the sewer and the top of the water lines.
 - (bb) Adequate structural support for the sewers to prevent excessive deflection of the joints and settling on or breaking of the water line.
 - (cc) The length of the water line be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.
4. Storm Sewers or Sewer Manholes: No water lines shall pass through or come in contact with any part of a sewer or sewer manhole.

J. Minimum Pipe Cover:

All mains smaller than 16-inches I.D. shall be laid with a minimum cover of 36 inches from top of pipe to finished ground surface grade, except that at obstructions which cannot be relocated or modified, the cover may be reduced as necessary for short lengths (10 to 20 feet) to pass over the obstruction using three (3) flexible joints in the offset within a length of approximately eight (8) feet, but in no case shall depth of cover be less than 24 inches.

Approved bedding material shall be used wherever cover is less than 36 inches and shall completely encase pipe. No tees, valves, or house service corporation cocks shall be installed in mains with less than 36 inches of cover. All mains 16-inch I.D. and larger shall be laid with a minimum cover of 42 inches from top of pipe to finished ground surface grade. Where for any size pipe the depth of cover would be less than 24 inches over top of pipe at an obstruction, the water main shall pass under the obstruction and clear the obstruction by at least one foot (1') and shall be completely encased in concrete

up to the bottom of the obstruction with not less than 6 inches of concrete at the bottom and sides of the pipe.

- K. Surface Water Crossings: Surface water crossings, both over and under water, present special problems and should be discussed with the City before final site and construction plans are prepared and, in addition to project specific requirements for such crossings, shall meet the following criteria: .
1. Above Water Crossing: A pipe crossing above water shall be:
 - (a) adequately supported,
 - (b) adequately protected from damage from freezing,
 - (c) readily accessible for repair or replacement, and
 - (d) located above 100-year flood level.
 2. Underwater Crossing:
 - (a) The pipes shall be of special construction, having flexible watertight joints.
 - (b) Valves shall be provided at both ends of the water crossing so that the section can be isolated for tests or repairs; the valves shall be easily accessible and not subject to flooding.
 - (c) Sample taps shall be available at each end of the crossing and at a reasonable distance from each side of the crossing.
 - (d) Permanent taps shall be made for testing and locating leaks.

203.00 MATERIALS AND EQUIPMENT

All pipe for water main construction shall be ductile iron pressure pipe of the "push-on" joint or "mechanical joint" variety, conforming to ANSI A21-51 (AWWA C151, latest revision). Thickness class shall be class 52 for all pipe twelve inches (12") or less in diameter and class 51 for all pipe greater than twelve inches (12") in diameter.

- 203.01 Ductile Iron Standard Mechanical Joint Pipe: All ductile iron standard mechanical joint water pipe shall conform to ANSI Specification A21.51 and shall be double lined with cement mortar and have a protective exterior coating. Linings and protective coatings equal to "Enameline" with tar coating on the exterior will be considered as a satisfactory lining and coating for the water pipe; however, any substitution in pipe lining and/or coating from the

ANSI A21.4 must first be specifically approved by the Director of Public Works. Joints and gaskets of standard mechanical joint pipe shall conform to ANSI Specification A21.11.

High-strength ductile iron tee-head bolts, hex nuts, ductile iron glands and rubber gaskets shall be as furnished by the pipe manufacturer.

In making connections of ductile iron pipe using the standard mechanical joint, the gland followed by the rubber gasket shall be placed over the plain end of the pipe, which shall be carefully inserted and aligned into the socket end of the pipe line. The gasket shall then be pushed into position so that it is evenly seated in the socket. The gland shall then be moved into position against the face of the gasket, bolts inserted and made finger tight. The bolts shall then be tightened up by using a ratchet wrench not less than fourteen inches (14") in length. All other requirements concerning bedding, alignment, and cleaning of the pipe before making the joint shall be followed.

- 203.02 Ductile Iron Pipe - "Push On" Joint: All "push-on" or "slip" joint pipe shall conform to the requirements of Section 203.01 for mechanical joints in regard to strength, class protection coating, and all other criteria.
- 203.03 Pipe Fittings: Fittings for ductile iron pipes shall be ductile iron or gray cast iron in accordance with AWWA Specifications C111 or C153, latest revision, with a minimum pressure rating of three hundred fifty (350) pounds per square inch. All pipe fittings shall be restrained with megalugs.
- 203.04 Gate Valves: All gate valves shall be of superior quality cast iron body with double disc parallel seat with full bronze mount. All gate valves shall withstand a working pressure of at least one hundred and fifty (150) pounds per square inch and shall be in strict conformance to applicable AWWA Standards. The wrench nut shall turn to the left (counter clock-wise) to open valve. The valves shall be arranged to fit into pipe lines having standardized mechanical joints or slip joints. The gate valves shall be Mueller No. A-2380-20, or approved equal and shall be installed as shown in the Construction Standards. On valves sixteen inches (16) or larger, butterfly valves conforming to AWWA C-504 may be used.

Resilient seat wedge valves shall be used for valves twelve (12) inches and smaller. Resilient seat wedge valves shall conform to AWWA C509 and shall be approved by the Director of Public Works.

Valve ends shall be mechanical joint (MJ) in accordance with AWWA C111. The valve body will be fusion-bonded epoxy coated in accordance with AWWA C550.

203.05 Fire Hydrants: All hydrants shall be Mueller Centurion, Dresser 500 Traffic Model, Darling Model B-50-B, Quick Pix Kennedy K81-A or approved equal. Hydrants shall be of the compression type with main valve openings of not less than five inches (5") in diameter. Hydrants shall have a cast iron body with full bronze trim and shall withstand a hydrostatic test pressure of three hundred (300) pounds per square inch. Hydrants shall have a six inch (6") connection base for setting with a minimum of thirty-six inch (36") cover on connection pipe. Hydrants shall be equipped with hose connections as follows:

Two each 2 1/2", N.S.T. hose connections.
One each 4 1/2", N.S.T. pumper connection.

Hydrants shall be operated by a National Standard one and one-half inch (1½") pentagon shaped, operating nut, which opens counter-clockwise. The direction of opening shall be clearly marked by an arrow cast on the outside of the hydrant. Hydrants shall be connected to the main with a six inch (6") ductile iron pipe and shall be controlled by an independent six inch (6") gate valve. The six inch (6") gate valve shall be located as near to the service main is practical. Where the six inch (6") hydrant service line is longer than fifty feet (50'), a second six inch (6") gate valve shall be located not less than one foot (1') nor more than six feet (6') from the hydrant.

All hydrant barrels shall be painted chrome yellow, reflective paint (or approved equal) on the bonnet, and all two and one-half inch (2½") and four and one-half inch (4½") caps of the hydrant shall be painted as follows:

Fire flow 1000 gpm and over	GREEN
Fire flow 500-1000 gpm	ORANGE
Fire flow less than 500 gpm	RED

The four and one-half inch (4½") connection shall face the street,

travel lane, service drive, or other vehicular travelway.

- 203.06 Valve Boxes: All valve boxes, base extensions, and the head and cover shall be of cast iron. Valve boxes shall be of the Mueller sliding type, with 5.25 inch shaft and round head marked "Water". The shaft diameter shall not be less than five inches (5"). The valve boxes shall have a minimum range of extension to fit two inch (2") to twelve inch (12") valves inclusive, placed on mains at depths of three feet (3') to five feet (5') of cover in order that the top cover of the valve box is set to finished grade. Valve boxes shall be Mueller Company 10364 or approved equal. Valve boxes shall be centered over the valve screw and set plumb.

All valves in which the operating nut is greater than five feet below the normal ground or road surface shall be provided with extension stems to bring the operating nut to within five feet of the finished grade. The extension stem shall be provided with a 2-inch square operating nut on top and a coupling to connect the extension to the operating nut of the valve. A stem guide shall be provided to keep the valve stem extensions concentric with the valve box. Extension stems shall be the same diameter as the valve stem unless otherwise specified.

- 203.07 Water Service Connections: The water meter box and accessories therein necessary for meter installation shall be furnished and installed by the developer or owner. They shall be located within the utility strip located between the curb and sidewalk whenever curbs and sidewalks are required within the subdivision. When curbs and sidewalks are not required, water meter boxes and accessories shall be set just within the right-of-way at the property line as shown on the approved subdivision plat or site plan, unless otherwise approved by the Director.

The water meter box top shall have the connection for the wiring for the remote sensor (see plate II-A). The City reserves the rights to install water meters with its own forces and to establish appropriate procedures for the handling and installation of water meters. The City shall have the option of supplying any and all size water meters for installation within its service area or, in lieu thereof, of establishing a list of approved water meter types and manufacturers for use by the developer or owner in supplying its own water meters. The cost of such meters shall in all cases be borne by the developer or owner. Details for meters three inches (3") in diameter and larger shall be submitted to the City Engineer for review and

approval prior to installation. All water services pipe from main connections to the meter box assembly shall be K type copper. All connections shall use flare or silver floss fittings at the discretion of the City. The minimum size service connection shall be "K" type copper, three-quarters inch (3/4") I.D.

- 203.08 Wet Taps: All wet taps require the prior approval of the Director of Public Works. Sleeve and valve assemblies shall be tested at one hundred fifty (150) pounds per square inch for ten (10) minutes before the actual tap is made.

Wet taps shall employ a Mueller No. H-615 cast iron mechanical joint sleeve, a fabricated steel with epoxy coating as manufactured by Rockwell International or other fitting specifically designed for this purpose as approved by the Director of Public Works or the City Engineer.

- 203.09 Large Meter Installations: Water meters one and one-half inches (1½") and larger shall be installed with a by-pass in order to isolate the meter for repairs. Plans for the installation of three inch (3") and larger meters will be submitted to the City Engineer for review and approval.

204.00 CONSTRUCTION STANDARDS

- 204.01 Installation of Water Mains, Fittings, and Appurtenances: All installations of public or private water systems shall be made in accordance with the American Water Works Association Standards C600 or latest revision for "Installation of Ductile-Iron Water Mains" and with any special applicable supplementary instructions issued by the manufacturers of the equipment being installed. Pertinent parts of AWWA Standards C600 shall also be applicable as shall manufacturers' instructions for installation of copper pipe, or other pipe material specified by the City.

204.02 Excavation, Bedding & Backfill:

- A. Clearing: The site shall be cleared of all lumber, tree stumps, brush and rubbish, which shall be removed or disposed of off-site by the landowner in accordance with applicable law.
- B. General: During excavation operations, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent

slides or cave-ins. All excavated material not suitable and/or required for backfill shall be removed and disposed of in an approved manner. Such grading shall be performed in a manner which prevents water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by methods approved by the Director. All excavations shall be made by open cut unless otherwise specified.

- C. Trench Excavation: The width of the trench at any point below the top of the pipe shall not exceed the structural design assumption width. The width of the trench above the top of the pipe may be as wide as necessary for sheeting and bracing and the proper performance of the work. All trench walls shall be kept as nearly vertical as is possible. Excavation at valve vaults and similar structures shall be sufficient to leave at least twelve inches (12") clear between their outer surfaces and the embankment or sheeting. Minimum clearance between the side of trench and pipe shall be six inches (6").
- D. Pipe Installed in Trenches: Pipe to be located at elevations below the existing ground level shall be installed in trenches with Class A,B, or C pipe bedding as shown in Plate II-U. Granular material under and around the pipe shall be placed in six-inch (6") layers and compacted by rodding, spading or with approved vibratory equipment to obtain not less than eighty percent (80%) relative density as determined by ASTM Method D2049.
- E. Pipe Installed in Embankment: Pipe to be located at elevations above the existing ground level shall be installed in trenches excavated after embankment has been constructed to a minimum elevation of one foot (1') above the proposed top of pipe.
- F. Pipe Bedding Material: The pipe shall be bedded from the trench subgrade to the pipe springline in granular material consisting of gravel, crushed gravel, or crushed stone meeting the requirements of ASTM Designation C33, Gradation 67 (3/4-inch to No. 4).
- G. Foundation in Poor Soil: Whenever the soil at the trench subgrade elevation is soft, unstable or saturated with water, such unsuitable material must be removed and the trench sub-grade stabilized with a granular stabilization material. Maximum size of granular material shall be two inches (2"). Depth of stabilization shall be as necessary to construct a firm subgrade for pipe bedding material. Concrete cradle shall be provided when necessary to bridge highly unstable soils.

- H. Backfill: All material used for backfilling of trenches shall be free of excessive amounts of deleterious materials such as all organic matter, frozen clods and sticky masses of clay and gumbo which are difficult to properly compact. Any rock materials used for backfill shall be no longer than four inches (4") in greatest dimension, and shall not be placed within twelve inches (12") of the installed pipe in any direction. Material as specified for pipe bedding may be substituted for backfill material defined above from top of pipe bedding to twelve inches (12") above top of pipe.
1. Backfill shall be placed in six-inch (6") layers from top of pipe bedding to a point at least twelve inches (12") above the top of pipe. Above this point, backfill shall be deposited in layers of a thickness which will permit compaction to a density as specified hereinafter.
 2. The layers of material shall be compacted to a density of at least ninety percent (90%) of the maximum density as determined by the AASHO Standard Test (AASHO Designation T99) wherever the pipe is installed in open fields or in areas which carry no vehicular traffic. The top portion of the backfill areas which are to be resodded shall be composed of topsoil at least six inches (6") in depth and level with the adjoining sodded areas.
 3. The layers of material shall be compacted to a density of at least ninety-five percent (95%) of the maximum density at optimum moisture content as determined by the AASHO Standard Test (AASHO Designation T99) under all pavements and for future pavements. Pavement shall not be restored over trenches until the backfill material has been tested and determined to be satisfactory according to the tests. Pavement restoration shall be in accordance with Section 204.12 of this PFM.
- I. Sheeting and Bracing: All trenches and excavation shall be properly sheeted and braced for the safety of personnel and/or protection of the work; and/or to maintain the maximum trench widths permitted; and/or to prevent the disturbance or settlement of adjacent foundations or structures.

When so required by the City, sheeting shall be left in place by cutting off the exposed portions no higher than one foot (1') below finished surface grade and no lower than one foot (1') above the top

of the pipe. The requirement of sheeting and/or bracing left in place shall not create an obligation or liability of the City in any manner.

- 204.03 Blasting: Blasting, where required, shall be done with care in accordance with all applicable Federal, State, and local laws, ordinances, and regulations, and shall not be done within a distance of twenty-five feet (25') from previously laid pipe line or a previously installed structure if, in the opinion of the City, the safety or soundness of existing facilities are in any manner endangered.
- 204.04 Bends and Elbows: All bends and elbows of six-inch (6") I.D. or larger shall be installed with suitable concrete thrust blocks poured in place with the concrete deposited against firm, undisturbed earth.
- 204.05 Testing and Sterilizing Main During Construction: Not more than 4000 feet of main shall be installed without testing and sterilization. Contractor shall not proceed with construction until such portion of main has been approved by the City.
- 204.06 Flushing of Mains: All lines shall be thoroughly flushed through the blow-offs and/or hydrants provided in accordance with AWWA C601 immediately prior to testing for final acceptance by the City. Water used will be estimated by the City and charged at cost to the developer or contractor installing the main.
- 204.07 Acceptance Tests: The City shall be permitted access to the construction work at any time for inspection of the work and construction methods. Work not conforming to the requirements of this PFM and the approved plans shall be adequate basis for rejection of project until the non-conforming work is corrected to the satisfaction of the City.
- A. Hydrostatic Testing of Water Mains: Water mains shall be tested by the procedure outlined in American Water Works Association Standard C600, or latest revision, Section 13 - Hydrostatic Tests, with the following modifications:
1. Pressure tests shall be conducted at one hundred fifty percent (150%) of normal operating pressure as specified by the City.
 2. Leakage tests shall be conducted at the maximum operating pressure for the locality as specified by the City.

- 204.08 Repairs: Water mains not meeting requirements of this PFM shall be replaced or repaired to the satisfaction of the City. Defective materials shall be completely removed and replaced with new materials.
- 204.09 Disinfection of Water Lines: The Developer shall sterilize the lines and have them tested for bacteria before requesting connection for service. The sterilization will be in accordance with the latest revisions of AWWA Standard C601. At least two (2) consecutive (24-hour interval) satisfactory bacteriological samples must be obtained from the distribution system before the system can be placed into service. Corporation cocks shall be provided for sterilization at locations designated by the City.
- 204.10 Protection of Existing Improvements: During construction operations, care shall be exercised by the parties performing the work to protect, brace, support and maintain all underground pipes, conduits, drains and other underground structures uncovered or otherwise affected by the construction work being performed. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires and other surface structures, together with all sod and shrubs in yards and parking lots crossed by or adjacent to the water main under construction shall be maintained and, if removed or otherwise damaged, shall be replaced or restored to their original condition. All replacements of such underground and surface structures or parts thereof shall be made with new materials. All damage resulting from construction operations to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges or other public or private property or facility, regardless of location or character, shall be the responsibility of the landowner, its contractor and subcontractors. Satisfactory arrangements shall be made without delay with the owner or owners of, or the agency or authority having jurisdiction over, the damaged property, surface, structure or facility concerning its repair or replacement and payment of costs incurred in connection with said damage.
- 204.11 Safety of Public:
- A. Maintenance of Traffic: Construction operations shall be scheduled by the landowner and contractor so as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, use or interfere with roads, driveways or walks, whether public or private, suitable and safe bridges, detours or other temporary expedients for the

accommodation of public and private travel shall be promptly provided and continuously maintained. The landowner is responsible for obtaining all permits, easements, licenses and other permission for crossing, using or interfering with the property of others and for providing satisfactory notice to owners before exercising any rights under such approvals.

B. Barricades and Lights:

1. All streets, roads, highways and other public thoroughfares which are closed to traffic, under the authority of a proper permit, shall be protected by means of effective barricades being located at the nearest intersecting public highway or street on each side of the blocked section of such public thoroughfare.
2. All open trenches and other excavations shall be provided with suitable barriers, signs and lights to the extent that adequate protection is provided to the public against accident by reason of such open construction. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.
3. All barricades and obstructions shall be illuminated by means of acceptable warning lights at night and all lights used for this purpose shall be kept burning from sunset to sunrise. Materials stored upon or alongside public streets, roads and highways shall be placed and the work at all times shall be conducted so as to cause the minimum obstruction, danger and inconvenience to the traveling public.
4. All barricades, signs, warning lights and other protective devices shall be installed and maintained in conformity with applicable laws, regulations, codes and ordinances and, where within public thoroughfare rights-of-way, as required by the authority having jurisdiction.

C. Operations Along Streets and Highways:

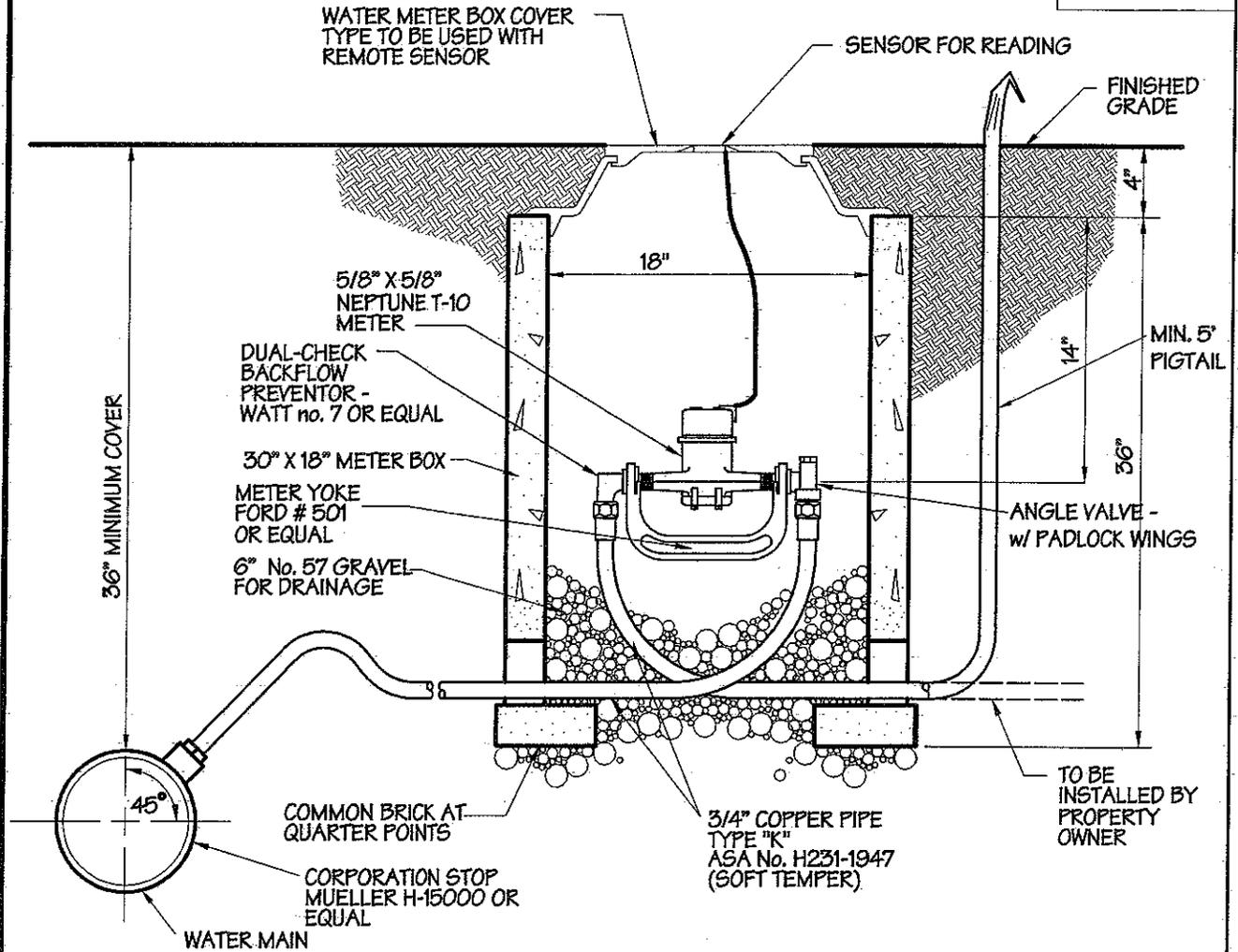
1. No equipment, pipeline or excavated materials shall be stored on the pavement or on shoulders of uncurbed roads or in ditches or at other locations which may obstruct traffic or drainage.

2. Construction operations shall be confined to an area no more than one thousand feet (1,000') of work under construction with a maximum open trench of three hundred feet (300'). The term "work under construction" shall include, without limitation, all operations between start of excavation of the trench to final tamping of backfill and/or restoration of pavement to public use. Traffic shall not be obstructed in more than one lane during construction operations. The length of one-lane traffic shall be limited to three hundred feet (300'). Two (2) flagmen, at minimum, shall be provided to control traffic. Sufficient advance warning signs of construction shall be provided. All obstructions shall be removed and the pavement cleaned at all road crossings at the end of each day's operation.
 3. All pipe strung along the right-of-way shall be blocked to prevent movement.
- D. Construction Operations Within Highways and Streets: Where water main will be installed in existing paving, the trench shall be backfilled with 21-A material tamped to ninety-five percent (95%) compaction. The backfill shall be completed with minimum rolled 3" BM-2 and 1 1/2" SM-2A asphalt material. The Director of Public Works shall be notified prior to commencing any work within the right-of-way.
- 204.12 Cleanup and Restoration: The City will not accept any construction where public or private property has not been restored to a condition at least equal to its condition immediately before commencement of construction. All debris, rock or other waste shall be removed and deposited by the landowner - off-site in accordance with applicable laws at approved locations and, where required by the City, covered with twelve inches (12") of earth.

END OF SECTION

ARTICLE II
WATER DISTRIBUTION SYSTEM
SECTION 205.00 - TYPICAL DETAILS

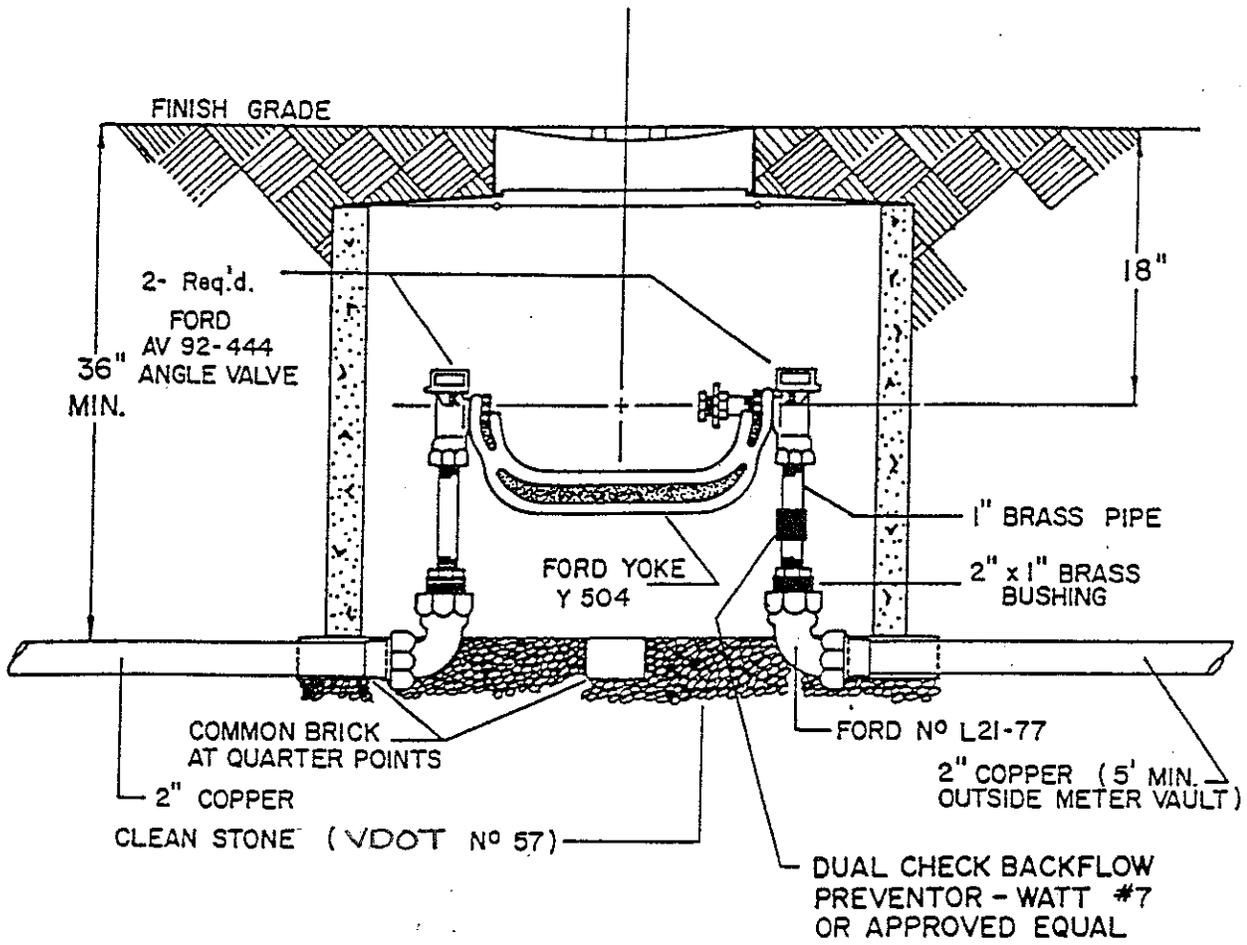
DETAIL	<u>PLATE</u>
5/8" Water Meter Box Detail	II-A
1" Water Meter	II-B
1-1/2" and 2" Water Meter, Typical Service Connection	II-C
Gate or Butterfly Valve and Valve Box	II-D
Blow-Off Assembly	II-E
Permanent Blow-Off Assembly	II-F
2" Air Release Valve	II-G
Fire Hydrant	II-H
Buttress for 11-1/4° Horizontal Bend	II-I
Buttress for 22-1/2° Horizontal Bend	II-J
Buttress for 45° Horizontal Bend	II-K
Buttress for 90° Horizontal Bend	II-L
Buttress for 11-1/4°, 22-1/2°, and 45° Lower Vertical Bends	II-M
Anchorage for 11-1/4°, 22-1/2°, and 45° Upper Vertical Bends	II-N
Buttresses for Tees, Plugs and Caps	II-O
Dead End Anchor	II-P
Mechanical Joint Retainer Gland	II-Q
Joint Restraint Device	II-R
Pipe Bedding and Encasement at Stream Crossings	II-S
Pavement Patching Detail	II-T



NOTES

1. ALL WATER METERS SHALL REGISTER IN GALLONS
2. 36" OF COVER SHALL BE REQUIRED ON COPPER SERVICE FROM DISTRIBUTION MAIN TO METER BOX.
3. METER BOX SHOULD BE ONE PIECE CONSTRUCTION OF CONCRETE OR RIGID FIBERGLASS (NOT ORANGEBOURG).
4. ALL FITINGS SHALL BE FLARED. SOLDERED FITTINGS WILL NOT BE PERMITTED
5. SERVICE LINE LEAVING METER BOX SHALL BE STUBBED OUT WITH COPPER LINE, MIN. 5' IN LENGTH.
6. COMBINATION ANGLE VALVE AND BACKFLOW PREVENTER REQUIRED.
7. COPPER LINE FROM CORPORATION STOP TO ANGLE VALVE SHALL BE ONE CONTINUOUS LINE WITHOUT ANY COUPLINGS.
8. ALL MATERIALS TO BE FURNISHED AND INSTALLED BY CONTRACTOR EXCEPT WATER METER AND SENSOR
9. METER AND SENSOR TO BE FURNISHED BY PROPERTY OWNER AND INSTALLED BY C.O.M.P.

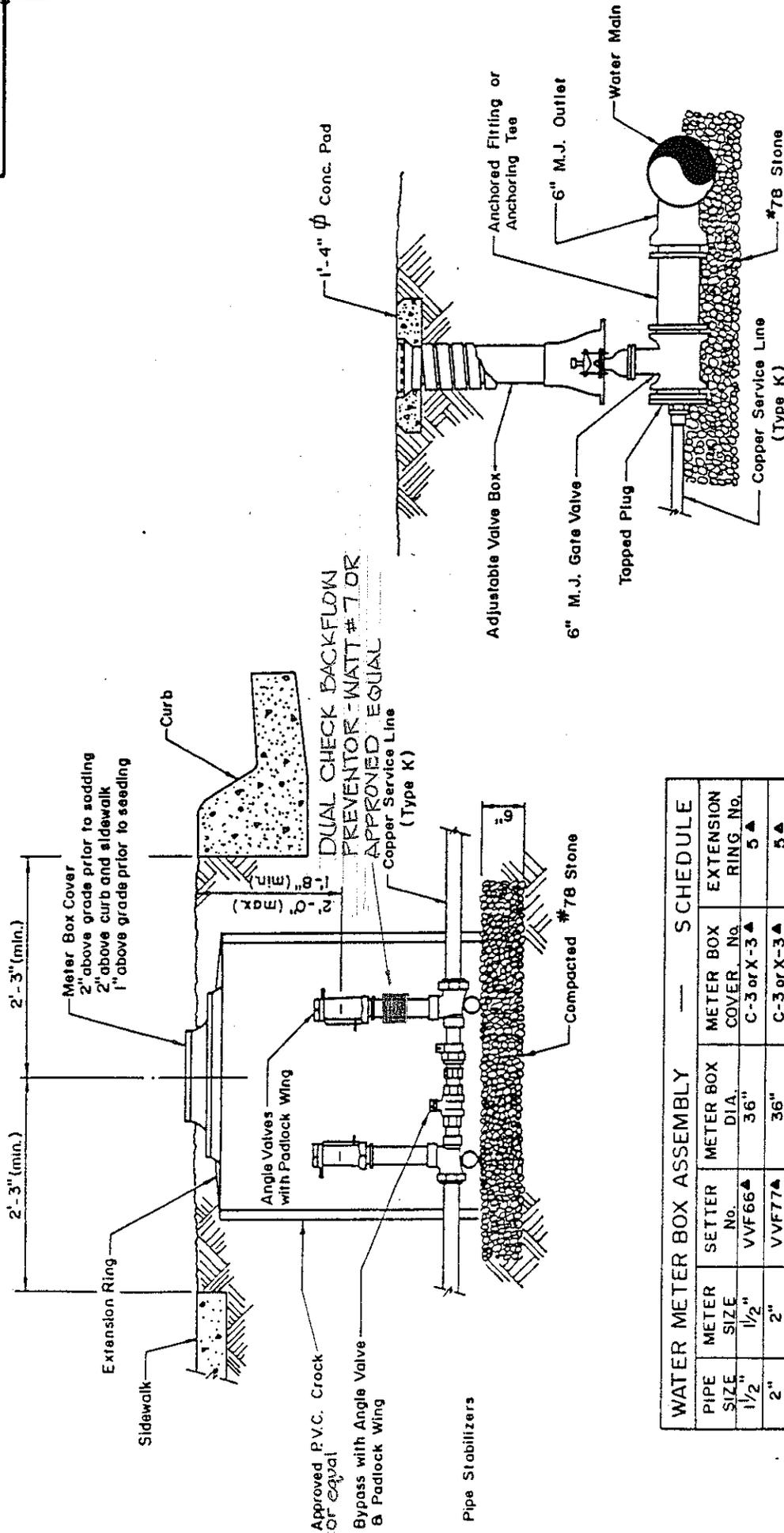
5/8" WATER METER BOX DETAIL



NOTES:

1. ONE PIECE BOX 24" x 30" (1" METER) MUST BE USED.
2. LID SHALL BE FORD "MONITOR" WITH PENTAGON NUT
3. INSTALLER MAY SUBSTITUTE TYPE "K" SOFT COPPER FOR BRASS SHOWN, PROVIDED APPROPRIATE FITTINGS AND VALVES ARE USED.
4. METER BOX MATERIAL: CONCRETE, PVC OR RIGID FRP.

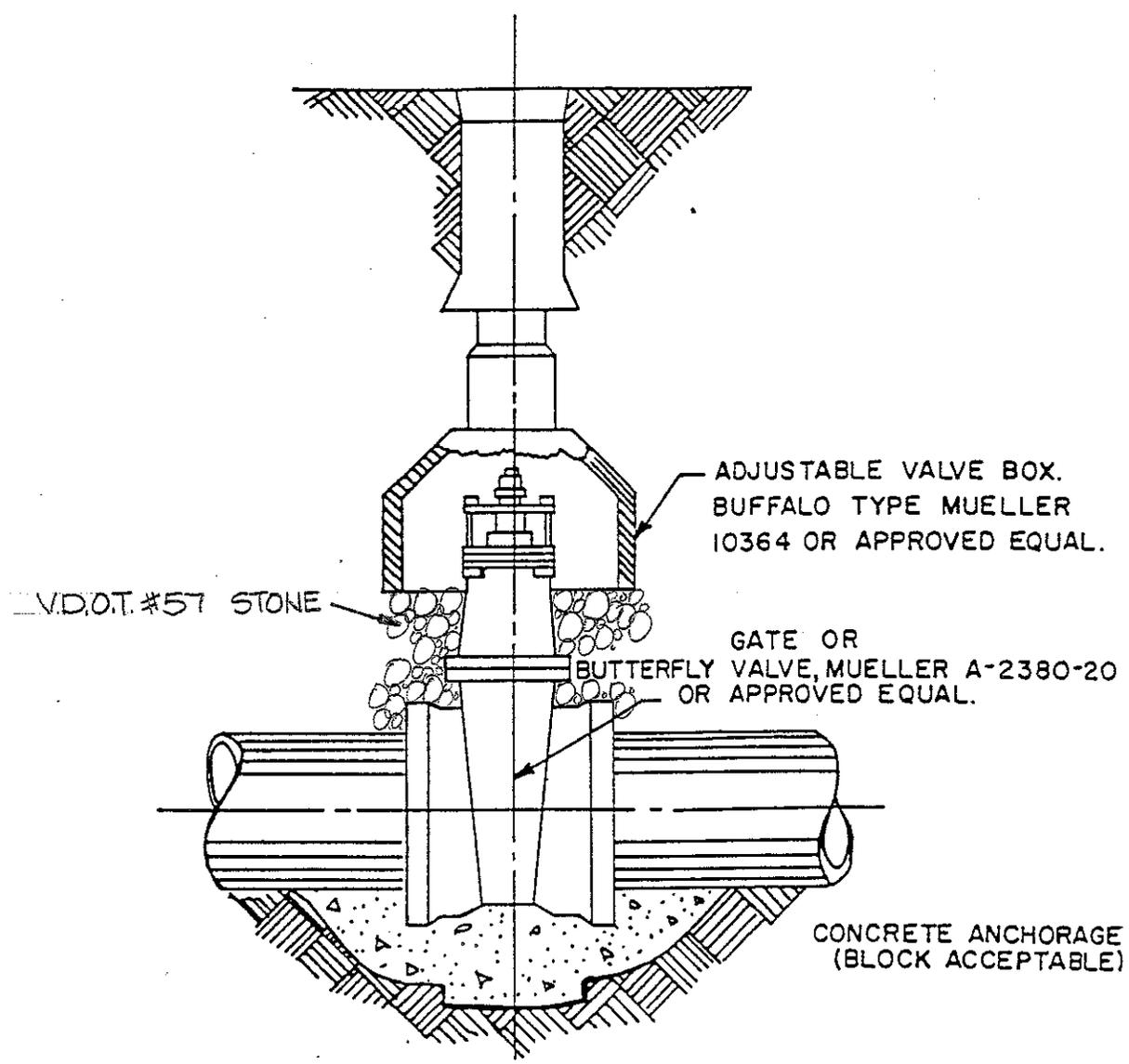
1" WATER METER



WATER METER BOX ASSEMBLY		— SCHEDULE	
PIPE SIZE	SETTER No.	METER BOX DIA.	METER BOX COVER No.
1 1/2"	VVF66▲	36"	C-3 or X-3▲
2"	VVF77▲	36"	C-3 or X-3▲
			EXTENSION RING No.
			5▲

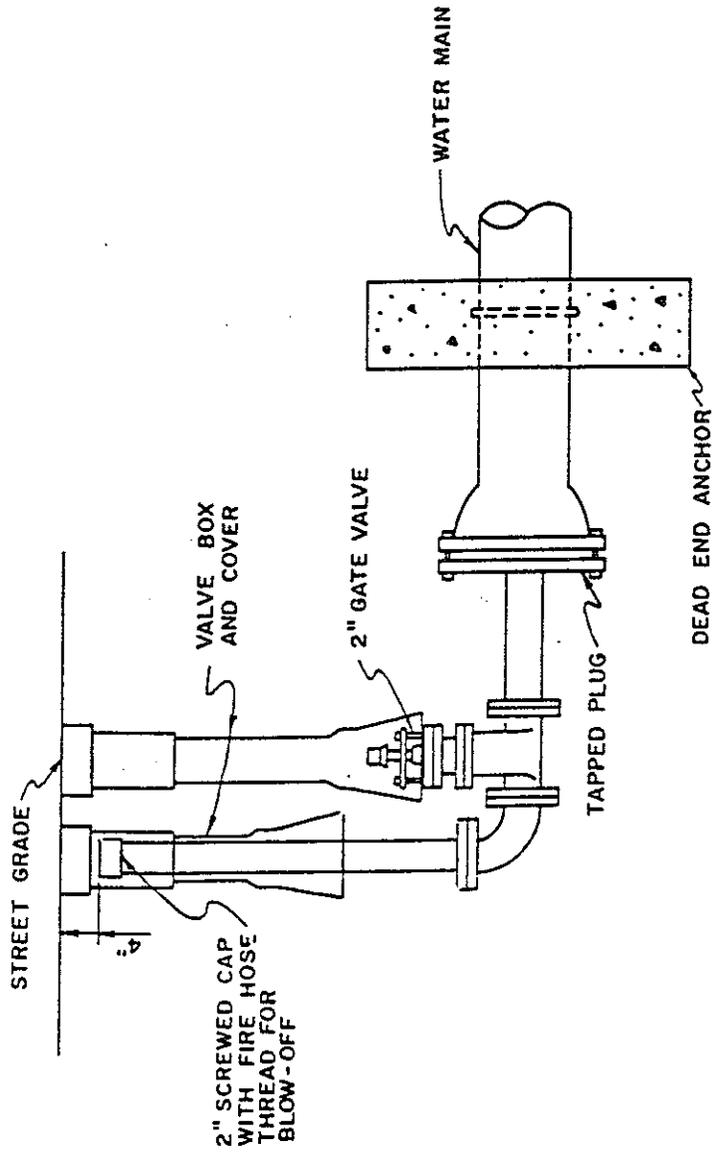
▲ Denotes FORD METER BOX CO. part numbers.
 Approved equals will be accepted

1 1/2" AND 2" WATER METER, TYPICAL SERVICE CONNECTION

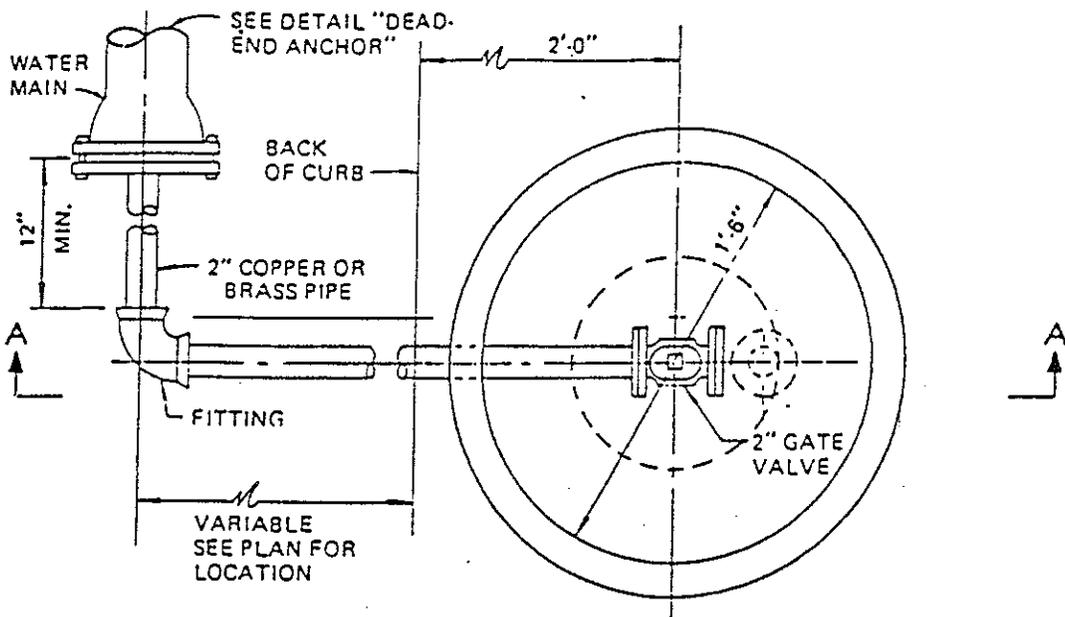


VALVE AND PIPE SHALL HAVE SAME NOMINAL DIAMETER

GATE OR BUTTERFLY VALVE AND VALVE BOX

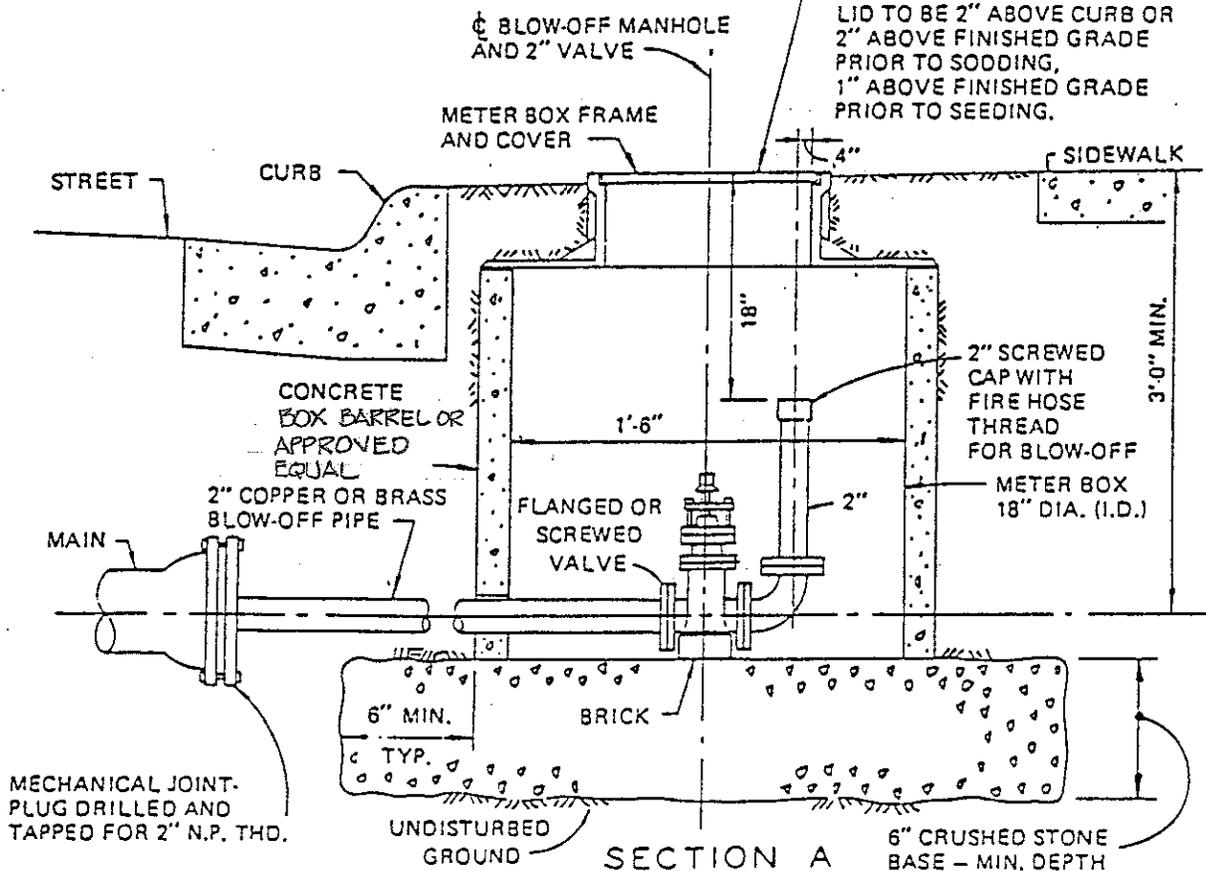


TEMPORARY BLOWOFF ASSEMBLY

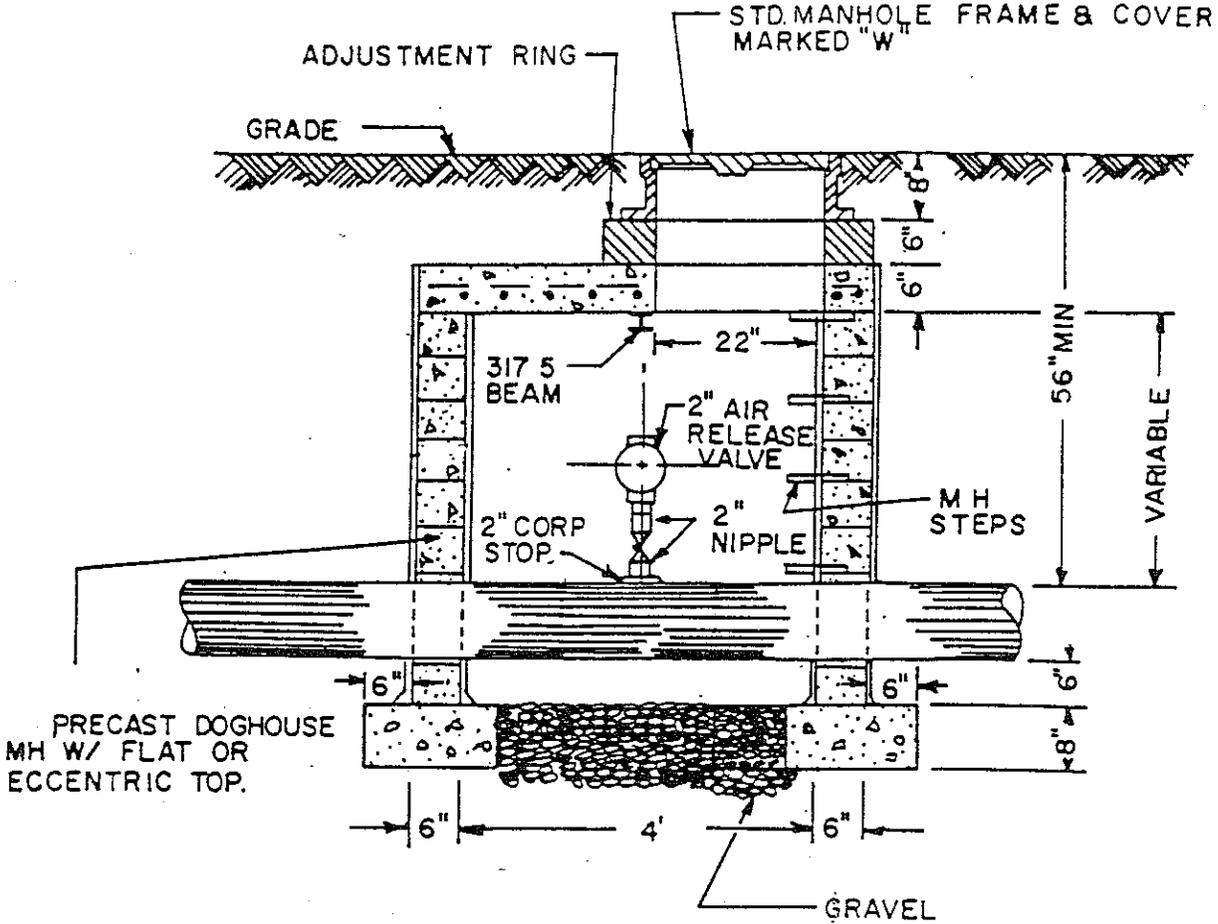


PLAN

FORD METER BOX CO.
 FRAME & COVER NO. X-32
 LID TO BE 2" ABOVE CURB OR
 2" ABOVE FINISHED GRADE
 PRIOR TO SODDING,
 1" ABOVE FINISHED GRADE
 PRIOR TO SEEDING.



PERMANENT BLOW-OFF ASSEMBLY



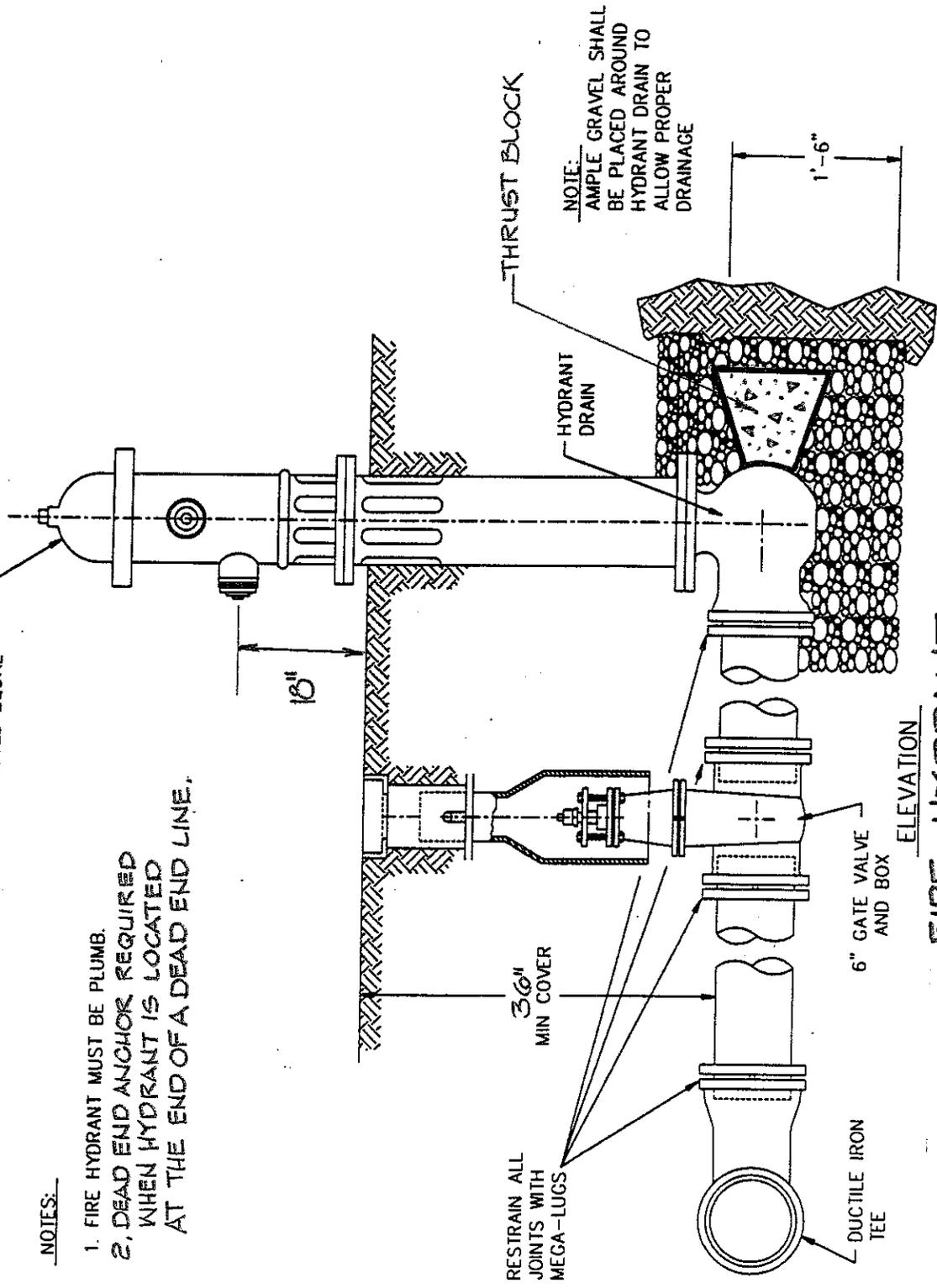
AIR RELEASE VALVE SHALL BE SIMPLEX TYPE "AV", "CRISPIN UNIVERSAL" OR APPROVED EQUAL. VALVE SHALL HAVE 2" DIAMETER SCREWED CONNECTION AND SHALL FUNCTION AT WORKING PRESSURES UP TO 150 PSI.

2" AIR RELEASE VALVE

MUELLER CENTURION
KENNEDY MODEL K-81-A
OR APPROVED EQUAL

NOTES:

1. FIRE HYDRANT MUST BE PLUMB.
2. DEAD END ANCHOR REQUIRED WHEN HYDRANT IS LOCATED AT THE END OF A DEAD END LINE.



RESTRAIN ALL JOINTS WITH MEGA-LUGS

36" MIN COVER

6" GATE VALVE AND BOX

DUCTILE IRON TEE

ELEVATION

FIRE HYDRANT

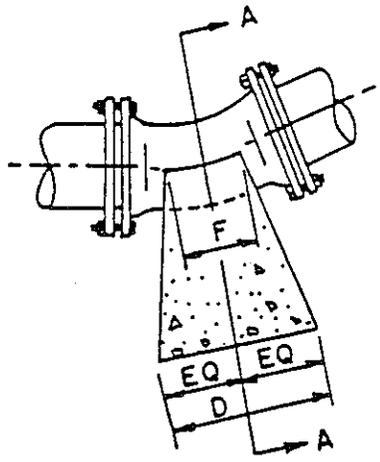
THRUST BLOCK

HYDRANT DRAIN

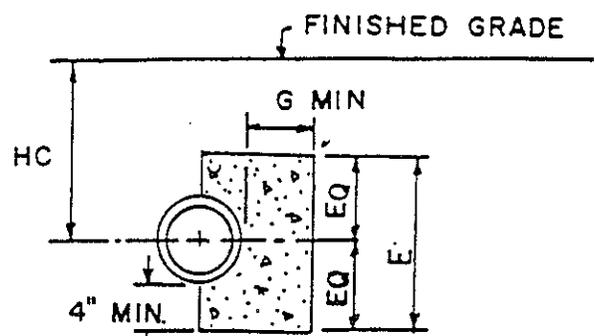
NOTE:
AMPLE GRAVEL SHALL BE PLACED AROUND HYDRANT DRAIN TO ALLOW PROPER DRAINAGE

1'-6"

16"



PLAN



SECTION AA

CARRY CONCRETE TO UNDISTURBED EARTH OR FIRM SUBGRADE

SOIL PROPERTIES	SIZE	Concrete Block Dimensions At 150 PSI Pressure				Add To Dimension D For Each Add. 50 Psi. Pressure Up To 300 Psi	Adjustment For Conc. Area For Different Height HC To Be Measured From Grade To C of Pipe			
		D	E	F	G		Up to 8'	8' 1" to 12'	12' 1" to 16'	16' 1" to 20'
CS = 1000 PSF φ = 15° SOFT SILTY CLAY & BETTER	3"	4"	1'	4"	6"	2"	CONC. BLOCK AREA 1.0 x D x E	CONC. BLOCK AREA 0.875 x D x E	CONC. BLOCK AREA 0.75 x D x E	CONC. BLOCK AREA 0.625 x D x E
	4"	4"	1'	4"	6"	2"				
	6"	6"	1' 2"	6"	7"	2"				
	8"	8"	1' 4"	8"	7"	2"				
	10"	9"	1' 6"	8"	8"	4"				
	12"	1'	1' 8"	1'	9"	4"				
	15"	1' 3"	2'	1'	9"	6"				
	20"	1' 3"	2' 6"	1'	10"	6"				
	24"	1' 6"	3'	1'	1'	6"				
30"	2'	3' 6"	1' 4"	1' 2"	9"					
CS = 0 φ = 15° LOOSE SILTY SAND	3"	10"	1' 6"	6"	9"	2"	CONC. BLOCK AREA 1.0 x D x E	CONC. BLOCK AREA 0.5 x D x E	CONC. BLOCK AREA 0.375 x D x E	CONC. BLOCK AREA 0.25 x D x E
	4"	1'	2'	6"	9"	2"				
	6"	1' 6"	2'	6"	1'	2"				
	8"	2' 4"	2'	8"	1'	2"				
	10"	2' 6"	2' 3"	8"	1'	4"				
	12"	3' 4"	2' 6"	1'	1'	4"				
	16"	4' 2"	3'	1'	1' 6"	6"				
	20"	4' 6"	3' 6"	1'	1' 6"	6"				
	24"	5' 8"	4'	1' 6"	1' 6"	6"				
30"	7'	5'	2'	1' 6"	9"					

DIMENSION D & E SHALL BE ADJUSTED FOR REQUIRED AREA.
 DIMENSION F & G SHALL REMAIN SAME.
 DIMENSION D SHALL BE ADJUSTED FOR REQUIRED PRESSURE IN EXCESS OF 150 PSI BEFORE MAKING ADJUSTMENT FOR HEIGHT.

BUTTRESS FOR 11 1/2° HORIZONTAL BEND

SOIL PROPERTIES	SIZE	CONCRETE BLOCK DIMENSIONS AT 150 PSI PRESSURE				ADD TO DIMENSION D FOR EACH ADD. 50 PSI PRESSURE UP TO 300 PSI.	Adjustment For Conc. Area For Different Height HC To Be Measured From Grade To C Of Pipe			
		D	E	F	G		Up To 8'0"	8' To 12'0"	12' To 16'0"	16' To 20'0"
CS = 1000 PSF φ = 15° SOFT SILTY CLAY OR BETTER	3'	6"	1'0"	6"	7"	2"	CONC. BLOCK AREA = 1.0 x D x E	C.B.A. = 0.875 x D x E	C.B.A. = 0.75 x D x E	C.B.A. = 0.625 x D x E
	4'	6"	1'0"	6"	7"	2"				
	6'	8"	1'2"	6"	8"	2"				
	8'	1'0"	1'4"	8"	8"	4"				
	10'	1'3"	1'6"	8"	10"	4"				
	12'	1'6"	1'8"	1'0"	1'0"	6"				
	16'	2'0"	2'0"	1'0"	1'3"	6"				
	20'	2'6"	2'6"	1'0"	1'6"	9"				
	24'	3'0"	3'0"	1'0"	1'6"	9"				
30'	4'0"	3'6"	1'4"	1'9"	1'0"					
CS = 0 φ = 15° LOOSE SILTY SAND	3'	1'0"	1'6"	6"	9"	2"	CONC. BLOCK AREA = 1.0 x D x E	C.B.A. = 0.5 x D x E	C.B.A. = 0.375 x D x E	C.B.A. = 0.25 x D x E
	4'	1'6"	2'0"	6"	9"	2"				
	6'	2'0"	2'0"	6"	1'0"	2"				
	8'	3'4"	2'0"	8"	1'0"	4"				
	10'	4'2"	2'3"	8"	1'0"	4"				
	12'	4'8"	2'9"	1'0"	1'6"	6"				
	16'	5'9"	3'6"	1'0"	1'6"	6"				
	20'	7'10"	4'0"	1'0"	2'0"	9"				
	24'	9'10"	5'0"	1'6"	2'0"	9"				
30'	11'8"	6'0"	2'0"	2'0"	1'0"					

DIMENSION D & E SHALL BE ADJUSTED FOR REQUIRED AREA.
 DIMENSION F & G SHALL REMAIN SAME.
 DIMENSION D SHALL BE ADJUSTED FOR REQUIRED PRESSURE IN EXCESS OF 150 PSI BEFORE MAKING ADJUSTMENT FOR HEIGHT.

NOTES

1. FC = 3000 PSI AT 28 DAYS.
2. CS = SOIL COHESION IN PSF AND φ = ANGLE OF INTERNAL FRICTION.
3. CARRY ALL BEARING SURFACES TO UNDISTURBED GROUND OR FIRM SUBGRADE.

BUTTRESS FOR 22½° HORIZONTAL BEND

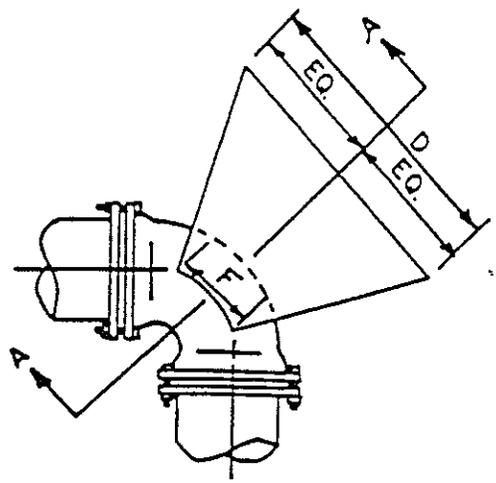
SOIL PROPERTIES	SIZE	Concrete Block Dimensions At 150 PSI Pressure				Add To Dimension D For Each Add 50 PSI Pressure Up To 300PSI	Adjustment For Conc. Area For Different Height HC To Be Measured From Grade To C Of Pipe			
		D	E	F	G		Up To 8'	8'1" To 12'	12'1" To 16'	16'1" To 20'
CS= 1000 PSF φ= 15° SOFT SILTY CLAY OR BETTER	3'	9"	1'0"	6"	6"	4"	CONC. BLOCK AREA 1.0 x D x E	CBA 0.875 x D x E	CBA 0.75 x D x E	CBA 0.625 x D x E
	4'	9"	1'0"	6"	6"	4"				
	6'	1'0"	1'2"	6"	8"	4"				
	8'	1'6"	1'4"	8"	9"	6"				
	10'	2'0"	1'6"	8"	10"	6"				
	12'	2'6"	1'8"	1'0"	1'0"	9"				
	16'	3'6"	2'6"	1'0"	1'3"	9"				
	20'	4'8"	2'6"	1'0"	1'4"	1'4"				
	24'	5'0"	3'0"	1'0"	1'9"	2'0"				
	30'	6'0"	4'0"	1'4"	2'3"	2'0"				
CS= 0 φ= 15° LOOSE SILTY SAND	3'	1'6"	1'6"	6"	1'0"	4"	CONC. BLOCK AREA 1.0 x D x E	CBA 0.5 x D x E	CBA 0.375 x D x E	CBA 0.25 x D x E
	4'	2'0"	2'0"	6"	1'0"	4"				
	6'	3'0"	2'0"	6"	1'0"	4"				
	8'	4'0"	2'6"	8"	1'0"	6"				
	10'	6'0"	2'6"	8"	1'0"	6"				
	12'	7'0"	3'0"	1'0"	1'6"	9"				
	16'	11'0"	4'0"	1'0"	1'6"	9"				
	20'	11'8"	5'0"	1'0"	2'0"	1'4"				
	24'	12'6"	6'0"	1'6"	2'0"	2'0"				
	30'	20'0"	6'0"	2'0"	2'6"	2'0"				

DIMENSION D & E SHALL BE ADJUSTED FOR REQUIRED AREA.

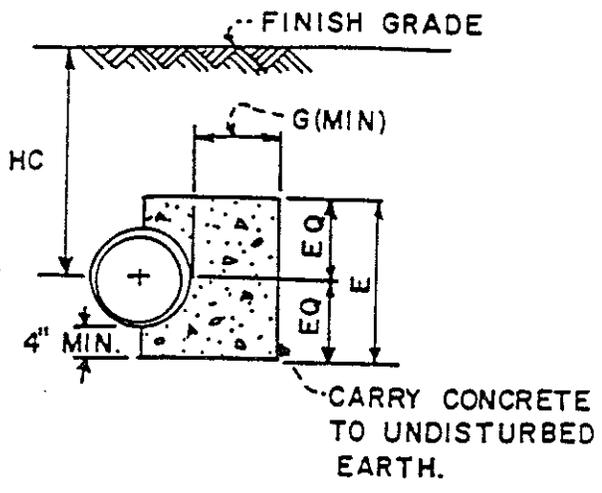
DIMENSION F & G SHALL REMAIN SAME.

DIMENSION D SHALL BE ADJUSTED FOR REQUIRED PRESSURE IN EXCESS OF 150 PSI BEFORE MAKING ADJUSTMENT FOR HEIGHT.

BUTTRESS FOR 45° HORIZONTAL BEND



PLAN

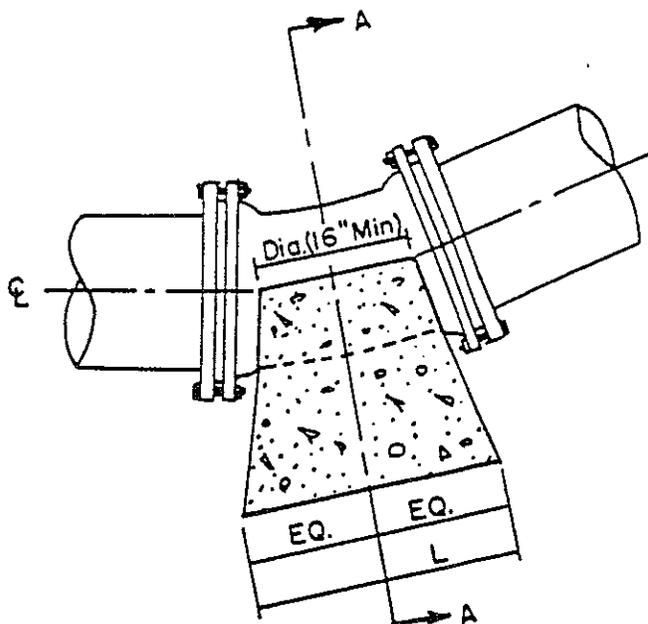


SECTION AA

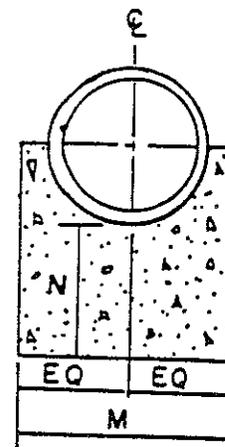
Soil Properties	SIZE	Concrete Block Dimensions At 150 PSI Pressure				Add To Dimension D For Each Addl. 50 PSI Pressure Up To 300 PSI	Adjustment For Conc. Area For Different Height (HC) To Be Measured From Grade To C of Pipe			
		D	E	F	G		Up To 8' 0"	8' 1" To 12'	12' 1" To 16'	16' 1" To 20'
CS = 1000 PSF 0 = 15° SOFT SILTY CLAY OR BETTER	3'	1' 0"	1' 0"	6"	1' 0"	6"	CONC. BLOCK AREA 1.0 x D x E	C.B.A. 0.875 x D x E	C.B.A. 0.75 x D x E	C.B.A. 0.625 x D x E
	4'	1' 4"	1' 0"	6"	1' 0"	6"				
	6'	1' 9"	1' 2"	6"	1' 6"	6"				
	8'	2' 6"	1' 4"	8"	1' 6"	9"				
	10'	3' 0"	2' 0"	10"	1' 6"	9"				
	12'	4' 0"	2' 0"	1' 0"	1' 6"	1' 0"				
	16'	5' 0"	2' 6"	1' 4"	1' 9"	1' 0"				
	20'	6' 0"	3' 4"	1' 8"	1' 9"	2' 0"				
	24'	7' 3"	4' 0"	2' 0"	2' 0"	2' 6"				
30'	9' 0"	5' 0"	2' 6"	2' 0"	3' 0"					
CS = 0 0 = 15° LOOSE SILTY SAND	3'	2' 6"	2' 0"	8"	1' 0"	6"	CONC. BLOCK AREA 1.0 x D x E	C.B.A. 0.5 x D x E	C.B.A. 0.375 x D x E	C.B.A. 0.25 x D x E
	4'	3' 4"	2' 0"	8"	1' 0"	6"				
	6'	5' 2"	2' 0"	1' 0"	1' 6"	6"				
	8'	6' 8"	2' 6"	1' 0"	1' 6"	9"				
	10'	10' 0"	3' 0"	1' 6"	1' 6"	9"				
	12'	10' 0"	4' 0"	1' 6"	2' 0"	1' 0"				
	16'	12' 6"	5' 0"	2' 0"	2' 0"	1' 0"				
	20'	15' 10"	6' 0"	2' 0"	2' 0"	2' 0"				
	24'									
30'										

DIMENSION D & E SHALL BE ADJUSTED FOR REQUIRED AREA.
 DIMENSION F & G SHALL REMAIN SAME.
 DIMENSION D SHALL BE ADJUSTED FOR REQUIRED PRESSURE IN EXCESS OF 150 PSI BEFORE MAKING ADJUSTMENT FOR HEIGHT.
 SPECIAL DESIGN REQUIRED.

BUTTRESS FOR 90° HORIZONTAL BEND



ELEVATION



SECTION

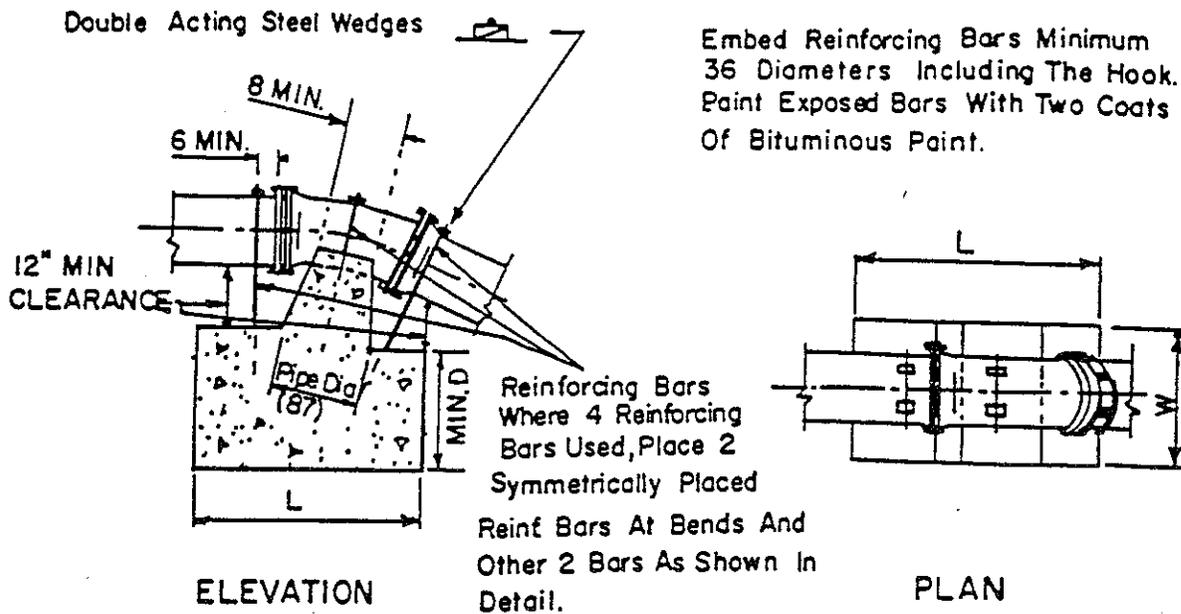
BUTTRESS FOR LOWER VERTICAL BENDS											
BEND		SIZE									
		3"	4"	6"	8"	10"	12"	16"	20"	24"	30"
11 1/4°	L	6"	6"	6"	8"	8"	8"	1'1"	1'5"	1'10"	2'8"
	M	1'0"	1'0"	1'2"	1'4"	1'6"	2'0"	2'4"	2'8"	3'0"	3'4"
	N	8"	8"	8"	8"	8"	8"	9"	10"	12'	1'2"
22 1/2°	L	6"	6"	10"	11"	1'3"	1'4"	2'1"	2'9"	3'7"	3'3"
	M	1'0"	1'0"	1'2"	1'4"	1'6"	2'0"	2'4"	2'8"	3'0"	3'2"
	N	8"	8"	8"	8"	9"	9"	12"	1'2"	1'4"	1'6"
45°	L	10"	1'0"	1'2"	1'9"	2'5"	2'8"	4'0"	5'6"	6'0"	8'2"
	M	1'0"	1'0"	1'2"	1'4"	1'6"	2'0"	2'4"	2'8"	3'6"	4'0"
	N	8"	8"	8"	8"	12"	1'2"	1'6"	2'0"	2'6"	3'0"

NOTES: 1. $F_c = 3000$ PSI AT 28 DAYS.

2. CARRY ALL BEARING SURFACES TO UNDISTURBED EARTH OR FIRM SUBGRADE.

3. THE BUTTRESS DIMENSIONS ARE BASED ON THE WATER PRESSURE OF 150 PSI. AND SOIL BEARING PRESSURE OF 2500 PSI. WHERE THE WATER PRESSURE AND SOIL BEARING PRESSURE IS DIFFERENT, THE AREA OF CONCRETE BLOCK (I.E. L&M) SHALL BE PROPORTIONED ACCORDINGLY. AREA ADJUSTMENT FOR REQUIRED PRESSURE SHALL BE MADE FIRST BEFORE MAKING ADJUSTMENT FOR SOIL BEARING PRESSURE.

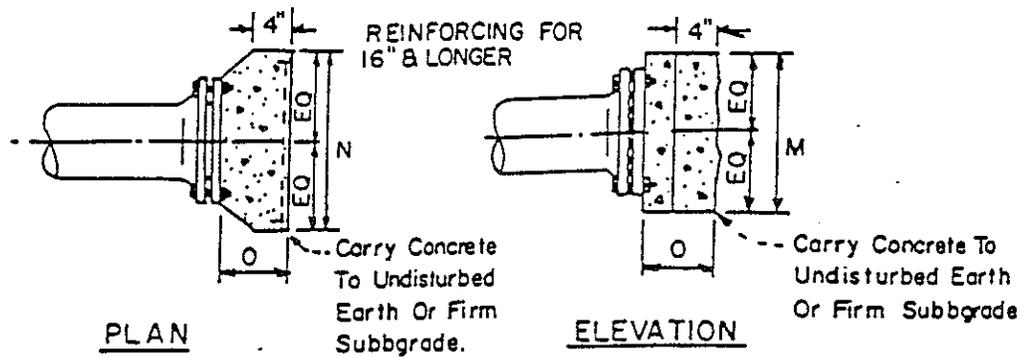
BUTTRESS FOR 11 1/4°, 22 1/2°, AND 45° LOWER VERTICAL BENDS



BEND		SIZE									
		3"	4"	6"	8"	10"	12"	16"	20"	24"	30"
11 1/4°	L	1'6"	1'6"	2'0"	2'0"	2'3"	2'6"	3'3"	4'0"	4'6"	5'0"
	W	1'6"	1'6"	2'0"	2'0"	2'3"	2'6"	3'3"	4'0"	4'6"	5'0"
	D	1'6"	1'6"	1'6"	2'0"	2'0"	2'3"	2'6"	2'6"	3'0"	3'0"
	Reinf. Bars No & Size	3#5	3#5	3#5	3#6	3#6	3#6	3#6	3#8	3#8	3#8
22 1/2°	L	1'6"	2'0"	2'6"	2'9"	3'6"	4'0"	4'6"	5'6"	6'0"	7'0"
	W	1'6"	2'0"	2'6"	2'9"	3'6"	4'0"	4'6"	5'6"	6'0"	7'0"
	D	1'6"	1'6"	2'0"	2'3"	2'3"	2'6"	3'0"	3'6"	4'0"	4'6"
	Reinf. Bars No & Size	3#5	3#5	3#5	3#6	3#6	4#6	4#6	3#8	4#8	4#8
45°	L	2'0"	2'6"	3'0"	3'6"	4'0"	4'6"	6'0"	7'6"	8'6"	10'0"
	W	2'0"	2'6"	3'0"	3'6"	4'0"	4'6"	6'0"	7'6"	8'6"	10'0"
	D	1'6"	2'0"	2'0"	2'6"	2'9"	3'0"	3'6"	4'0"	4'6"	5'0"
	Reinf. Bars No & Size	3#5	3#5	3#5	3#6	4#6	4#6	4#8	4#8	4#8	4#9

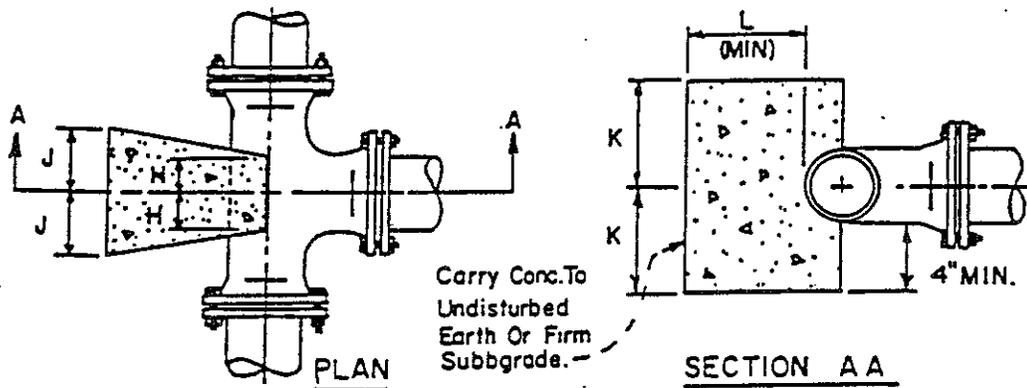
- NOTES: 1. $F_c = 3000$ PSI AT 28 DAYS.
 2. Carry All Bearing Surfaces To Undisturbed Earth Or Firm Subgrade.
 3. The Anchorage Dimension Are Based On The Water Pressure Of 150 PSI. Where The Pressure Is Different, The Volume Of Concrete (I.E., $L \times W \times D$) Shall Be Proportioned To Required Pressure.

ANCHORAGE FOR 11 1/4°, 22 1/2°, AND 45° UPPER VERTICAL BENDS



BUTTRESS FOR PLUGS & CAPS										
	SIZE									
	3"	4"	6"	8"	10"	12"	16"	20"	24"	30"
M	*	*	*	2'6"	2'8"	3'6"	4'8"	6'0"	6'8"	8'0"
N	*	*	*	1'6"	2'2"	2'6"	3'4"	4'0"	5'0"	6'8"
O	*	*	*	10"	1'0"	1'2"	1'4"	1'6"	1'8"	2'0"

REINFORCE WITH 66" EW



BUTTRESS FOR TEES										
	SIZE OF BRANCH									
	3"	4"	6"	8"	10"	12"	16"	20"	24"	30"
J	6"	6"	8"	9"	1'1"	1'3"	1'8"	2'0"	2'6"	3'4"
K	6"	8"	10"	1'3"	1'4"	1'9"	2'4"	3'0"	3'4"	4'0"
L	6"	6"	8"	9"	10"	12"	1'2"	1'6"	1'8"	2'0"
H	4"	4"	6"	6"	6"	6"	8"	1'0"	1'0"	1'0"

AREA OF BLOCK = 2J x 2K

NOTE: TAPPING ASSEMBLIES & SLEEVES TO BE CONCRETE BLOCKED AS COMPARABLE SIZED TEES

NOTES

1. $F_c = 3000$ PSI AT 28 DAYS.
2. THE BUTTRESS DIMENSIONS ARE BASED ON THE WATER PRESSURE OF 150 PSI WHERE THE PRESSURE IS DIFFERENT, THE AREA OF BLOCK SHALL BE PROPORTIONED TO REQUIRED PRESSURE
3. CARRY ALL BEARING SURFACES TO UNDISTURBED GROUND OR FIRM SUBGRADE

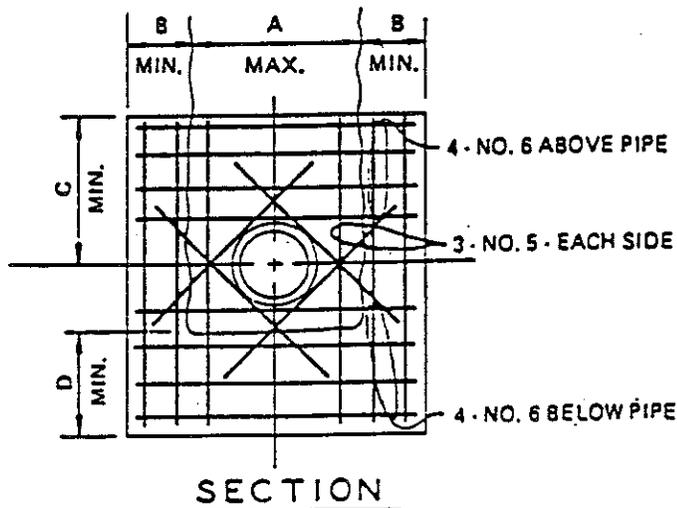
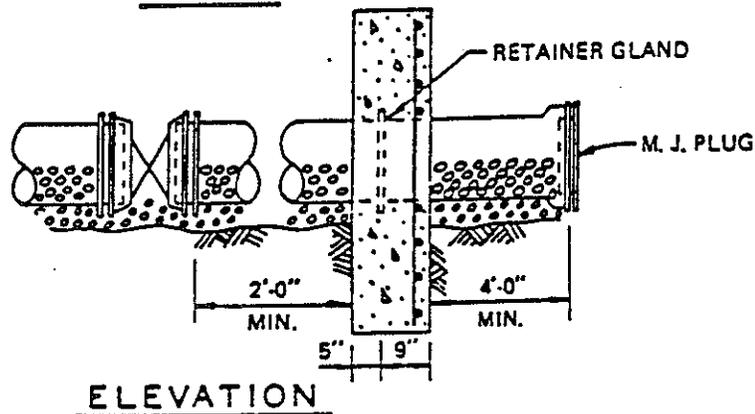
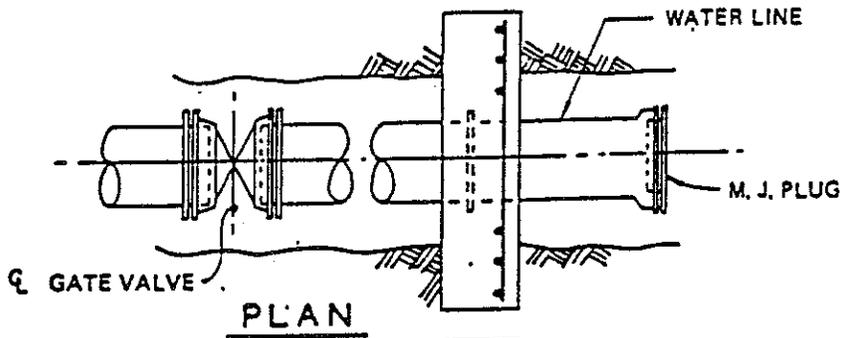
BUTTRESSES FOR TEES, PLUGS, AND CAPS

NOTE:

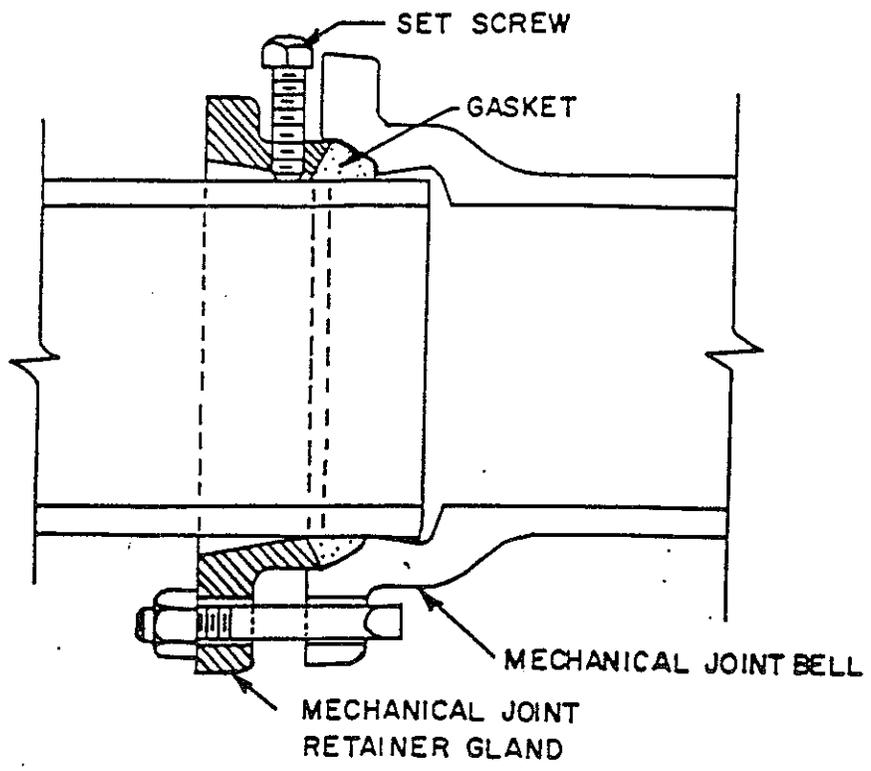
BEARING AREA IS BASED ON 200 PSI TEST PRESSURE AND A SOIL BEARING PRESSURE OF 2,000 POUNDS PER SQUARE FOOT. INCREASE BLOCK DIMENSIONS AS REQUIRED IN SOILS WITH LOWER BEARING VALVES.

DEAD END ANCHOR SCHEDULE

LINE SIZE	A	B	C	D
6"	2'-0"	1'-0"	1'-6"	1'-0"
8"	2'-0"	1'-3"	1'-6"	1'-0"
10"	2'-3"	1'-6"	1'-6"	1'-6"
12"	2'-6"	2'-0"	1'-6"	1'-6"



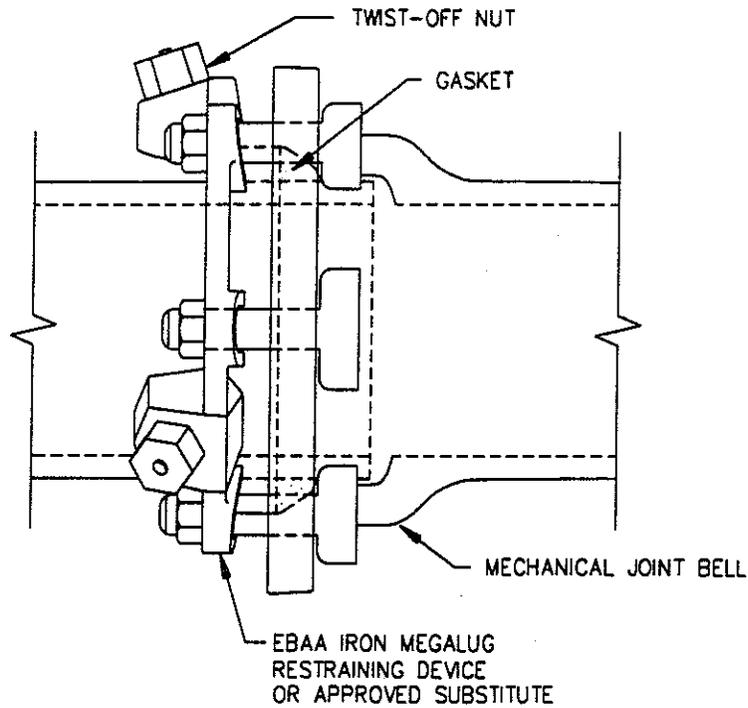
DEAD END ANCHOR



SIZE (INCHES)	NO. OF SET SCREWS	PRESSURE RATING IN PSI.
3	4	300 PSI.
4	4	300
6	6	300
8	9	200
10	16	200
12	16	200
16	24	200
20	28	200
24	32	150
30	40	150

- NOTES:**
1. All Set Screws Are 5/8" Size With Hardened Cupped Ends And 5/8" Square Heads.
 2. Sizes 16" Through 30" Are For Installation On Ductile Iron Pipe Only.
 3. Tighten Set Screws Evenly To 80 Ft. Pounds On 3"-12" Glands And 65 Ft. Pounds On 16"-30" Glands.

MECHANICAL JOINT RETAINER GLAND

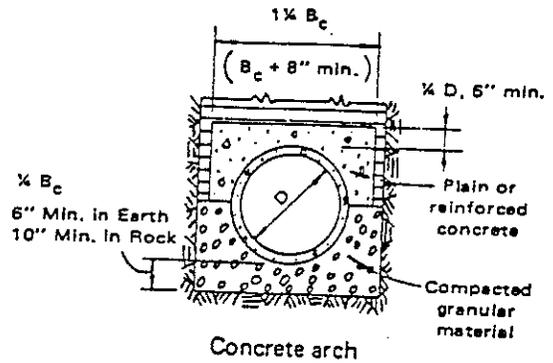
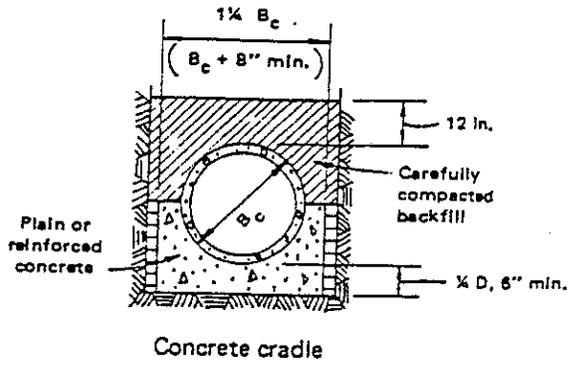


NOMINAL PIPE SIZE (INCHES)	NUMBER OF TWIST-OFF NUTS	NUMBER OF T-BOLTS	RATED PRESSURE
3	2	4	350 PSI
4	2	4	350 PSI
6	3	6	350 PSI
8	4	6	350 PSI
10	6	8	350 PSI
12	8	8	350 PSI
16	12	12	350 PSI
18	12	12	250 PSI
24	16	16	250 PSI
30	20	20	250 PSI
36	24	24	250 PSI
42	28	28	250 PSI

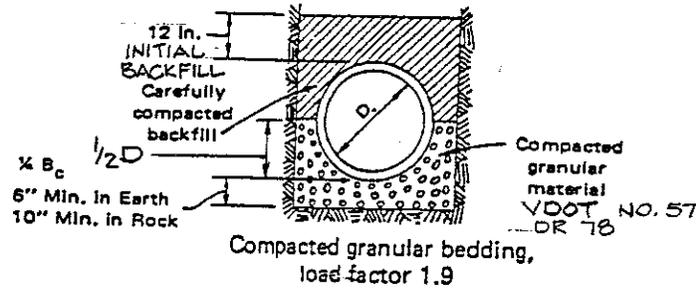
NOTES:

1. Make any joint deflection necessary before torquing the T-head bolts.
2. Tighten T-head bolts, bottom first, then top, sides and remainder.
3. Repeat Note 1. until all T-bolts are properly torqued.
4. Tighten twist-off nuts so that all wedges firmly contact pipe.
5. Tighten twist-off nuts in alternating manner, shearing off nuts.
6. MEGALUG may be reset or reused by assembly as described above and torquing wedge bolts to 90 ft-lbs.

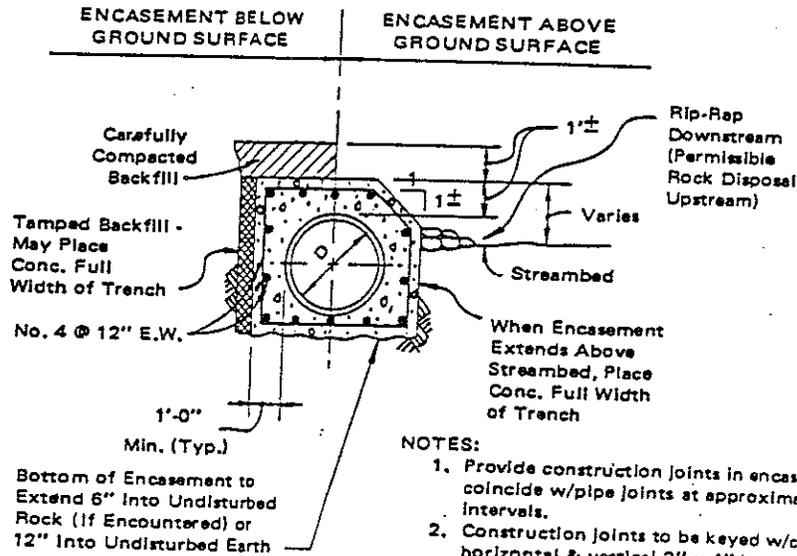
JOINT RESTRAINT DEVICE



CLASS A



CLASS B

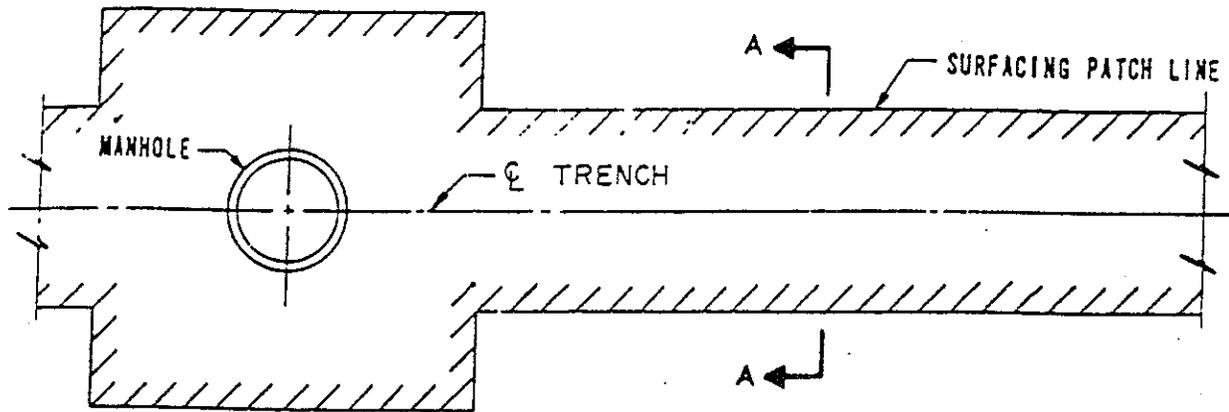


NOTES:

1. Provide construction joints in encasement to coincide w/pipe joints at approximately 32' intervals.
2. Construction joints to be keyed w/continuous horizontal & vertical 2" x 4" keys around conduit.
3. Construction joints shall have a separation area of at least 75% of total encasement cross section.
4. Discontinue longitudinal reinforcement at construction joints.
5. Begin & End Encasement at Pipe Joint.

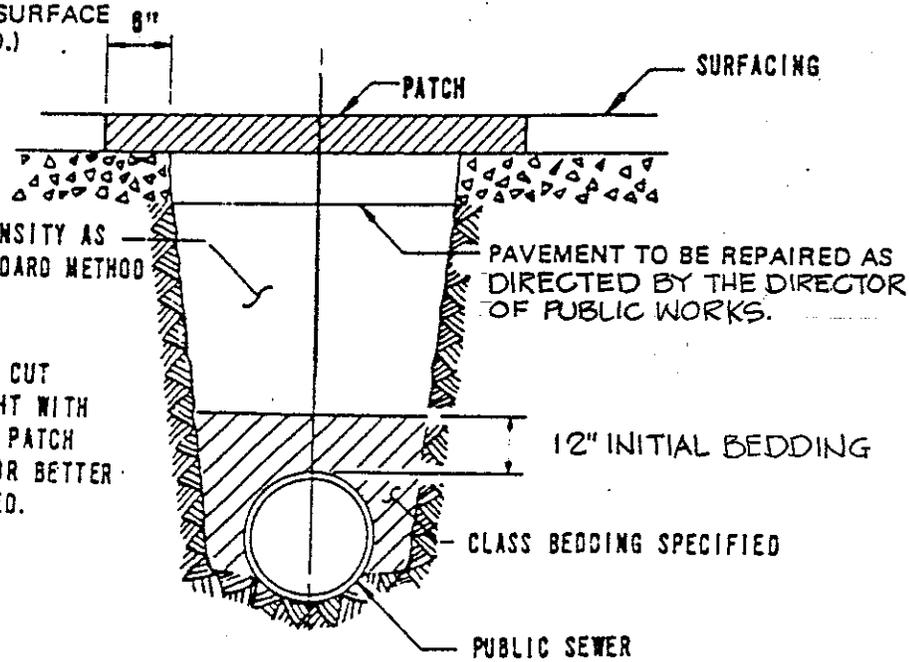
CLASS C - STREAM CROSSING

PIPE BEDDING AND ENCASEMENT AT STREAM CROSSINGS



PLAN

CUT SURFACING BACK MINIMUM OF 6" BEYOND EDGE OF TRENCH (OR 6" BEYOND LIMIT OF HEAVED OR OTHERWISE DAMAGED SURFACE WHEN BLASTING REQUIRED.)



COMPACTED TO 95% MAX. DENSITY AS DETERMINED BY AASHO STANDARD METHOD

PAVEMENT TO BE REPAIRED AS DIRECTED BY THE DIRECTOR OF PUBLIC WORKS.

NOTE: SURFACING TO BE CUT NEAT AND STRAIGHT WITH A CONCRETE SAW. PATCH SHALL BE EQUAL OR BETTER THAN THAT REMOVED.

SECTION A-A

PAVEMENT PATCHING DETAIL

ARTICLE III

SANITARY SEWER SYSTEMS

TABLE OF CONTENTS

	<u>Page</u>
SECTION 301.00 GENERAL REQUIREMENTS	III-1
301.01 Conformance and Interpretation	III-1
301.02 Lateral Connections to Trunk Lines	III-1
301.03 Easements	III-1
301.04 Pipe Material Changes Between Manholes	III-1
301.05 Service Connections Outside of Rights-of-Way or Easements	III-1
301.06 Connections Between Water and Sewer Lines	III-1
SECTION 302.00 DESIGN STANDARDS	III-1
302.01 Tributary Population Consideration	III-1
302.02 Design Quantities	III-2
302.03 Hydraulic Design Criteria	III-3
302.04 Location of Sewers and Appurtenances	III-4
302.05 Manholes	III-4
302.06 Service Connections	III-5
302.07 Minimum Depth of Cover	III-5
302.08 Anchors	III-5
302.09 Grease Traps, Volatile Liquid Separators	III-6
302.10 Sewers in Relation to Streams, Estuaries, Lakes, and Reservoirs	III-6
302.11 Relationship of Sanitary Sewers and a Public Water Supply	III-7
SECTION 303.00 MATERIALS AND EQUIPMENT	III-7
303.01 Pipe Materials	III-7
303.02 Service Connections	III-9
SECTION 304.00 CONSTRUCTION STANDARDS	III-9
304.01 General Requirements	III-9
304.02 Excavation	III-9
304.03 Bedding	III-10
304.04 Backfill	III-10
304.05 Pipe Installation	III-11
304.06 Service Connections	III-11
304.07 Manholes, Precast	III-12
304.08 Pipe Connections at Manholes	III-14
304.09 Acceptance Tests	III-14

SECTION 305.00	ON-SITE WASTEWATER DISPOSAL SYSTEMS	III-20
SECTION 306.00	PRESSURE SEWER SYSTEMS	III-21
306.01	Application	III-21
306.02	Design Criteria	III-21
SECTION 307.00	TYPICAL DETAILS	III-24

ARTICLE III

SANITARY SEWERS

301.00 GENERAL REQUIREMENTS

- 301.01 Conformance and Interpretation: Authority for discretionary provisions for sewer design shall rest with the Director of Public Works of the City of Manassas Park, who when necessary shall request and obtain the advice of the City Engineer.
- 301.02 Lateral Connections to Trunk Lines: Sewer laterals shall not be directly connected to a trunk line unless specifically approved by the Director of Public Works.
- 301.03 Easements: When deemed necessary by the Director of Public Works, and in order to assume maximum utilization of the sanitary sewer system, it will be required that appropriate easements shall be obtained for access to or extension of the sanitary sewer system.
- 301.04 Pipe Material Changes Between Manholes: There shall be no change in pipe materials from manhole to manhole, unless specifically approved in advance by the Director of Public Works.
- 301.05 Service Connections Outside of Rights-of-Way or Easements: All sewer service connections or portions of sewer service connections located outside of public road rights-of-way or sanitary sewer easements shall be privately owned and maintained.
- 301.06 Connections Between Water and Sewer Lines: There shall be no physical connection between a drinking water supply and a sewer, or appurtenance thereto.

302.00 DESIGN STANDARDS

- 302.01 Tributary Population Consideration: Sewer systems shall be designed for the estimated future population contributing at the point under consideration. Consideration shall be given to domestic, commercial, institutional, and industrial wastes plus ground water infiltration in determining the capacity of the sewer system. The design shall be based on estimates of anticipated population and tributary sewage flow for a period of fifty years hence, or the entire watershed shall be assumed to be completely developed according to present or proposed zoning categories, whichever required the

greater capacity. As a minimum and in the absence of any of the above, sewer systems shall be designed on a density of at least ten (10) persons per acre and a design analysis shall be submitted for all sewerage systems

302.02 Design Quantities: New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of not less than that set forth hereinafter (See Table 3-1). These figures are assumed to cover standard infiltration/inflow. When deviations from the foregoing per capita rates are proposed, a description of the procedure used for sewer design shall be included with the submission.

TABLE 3-1

<u>Design Unit</u>	<u>Discharge</u>	<u>Flow-gpd</u>
Dwellings	per person	100
Schools with showers & cafeteria	per person	16
Schools without showers & cafeteria	per person	10
Motels at 65 gals/person	per room	130
Restaurants	per seat	50
Service Stations	per vehicle served	10
Factories	per person per 8 hr. shift	15-35
Hospitals	per bed	300
Shopping Centers	per 1000 sq. ft. of ultimate floor space	200-300
Nursing Homes	per bed	200
Homes for the Aged	per bed	100
Doctors Office in Medical Center	per 1000 sq. ft.	500
Laundromats, 9 to 12 # loads	per machine	500
Swimming Pools	per swimmer	10
Theaters, Auditorium Type	per seat	5
Picnic Areas	per person	5
Camps, Day & Night/limited plumbing	per camp site	50
Luxury Camps/flush toilets	per camp site	100

TABLE 3-2

PEAK FLOW FACTORS

RELATIONSHIP BETWEEN AVERAGE DAILY SEWAGE FLOW & PEAK FLOW

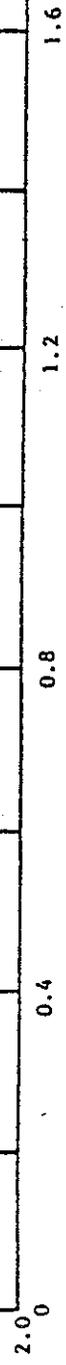
NOTE: AVERAGE DAILY FLOW OF DOMESTIC SEWAGE FOR DESIGN IS 100 GPCD FOR AVERAGE CONDITIONS ASSUME
 4.0 PERSONS PER SINGLE FAMILY HOUSE
 3.6 PERSONS PER TOWNHOUSE
 3.0 PERSONS PER APARTMENT

SANITARY SEWERS SHALL BE DESIGNATED TO HAVE A FULL FLOW CAPACITY OF NOT LESS THAN THE PEAK FLOW.
 PEAK FLOW = PEAK FLOW FACTOR X AVERAGE DAILY FLOW

INCLUDE SEPERATE ALLOWANCES FOR COMMERCIAL, INDUSTRIAL, INSTITUTION AREAS.
 NO SEPERATE ALLOWANCE FOR INFILTRATION IS REQUIRED.

NOTES CONTINUED:

THE MINIMUM SIZE FOR SEWERS IS 8 INCH I.D.
 THE MINIMUM SLOPE SHALL BE THAT REQUIRED TO PRODUCE A FLOWING FULL VELOCITY OF NOT LESS THAN 2.25 FPS.
 WHERE THE DEPTH OF AVG. FLOW IS LESS THAN 1/4 FULL, STEEPER SLOPES MAY BE REQUIRED.
 GRAVITY SEWERS SHALL NOT BE DESIGNED TO FLOW UNDER PRESSURE. THE HYDRAULIC GRADE SHALL NOT BE ABOVE THE CROWN OF THE PIPE AND HEAD LOSSES AT MANHOLES SHALL BE COMPENSATED FOR.
 THE MINIMUM DROP BETWEEN INVERT IN AND INVERT OUT ELEVATIONS IN MANHOLES SHALL BE 0.1 FT.



AVERAGE DAILY SANITARY SEWAGE FLOW (MGD)

302.03

Hydraulic Design Criteria: Sewers shall have a uniform slope and straight alignment between manholes. Sewers shall be designed to be free flowing with hydraulic grade below the crown of the pipe and with hydraulic slopes sufficient to provide an average velocity when running full of not less than 2.25 feet per second (fps). Velocity computations shall be based on a coefficient of roughness (n) of 0.013 as used in the Kutter or Manning formula. Due to low flows, upper or terminal manhole sections shall have a minimum slope of 0.80 percent unless there is a distinct possibility of the sewer being extended in the near future. Sewers shall be designed such that the maximum velocity is 15 fps. Where velocities must exceed 15 fps, the sewer shall be ductile iron pipe conforming to Section 303.01 of these specifications. Where smaller sewers discharge into larger sewers, the crown of the pipes shall be matched. Minimum size sewer main shall be eight inch (8) diameter.

In general, the following are minimum slopes to be provided for pipes flowing full to one-half (1/2) full:

TABLE 3-3

<u>Sewer Diameter in Inches</u>	<u>Minimum Slope Percent</u>
8	.47
10	.34
12	.26
15	.18
18	.14
21	.113

TABLE 3-4

<u>Depth of Flow</u>	<u>Multiplying Factor</u>
1/3	1.3
1/4	1.7
1.10	4.0

Hydraulic losses at manhole should be accounted for as follows:

- A. At manholes on straight runs, a head loss of 0.05 feet shall be allowed.
- B. At manholes which have a radius of turn less than two pipe diameters, a head loss of $(0.5 V^2)/2g$ shall be allowed.

At manholes where the radius of turn is greater than two pipe diameters, a head loss of $(0.25 V^2)/2g$ shall be allowed.

302.04 Location of Sewers and Appurtenances: In general, sewers shall be placed along the centerline of the street right-of-way. On curved streets, the sewer main shall not vary more than 10 feet on either side of the centerline, except at street intersections. Gas and water mains shall be a minimum horizontal distance of ten feet (10') horizontal separation, a minimum horizontal separation of six feet (6') may be allowed, providing the gas and water mains are at least eighteen inches (18") above the crown of the sewer main. All underground utility crossings of the sewer mains shall have a minimum vertical clearance of eighteen inches (18"). Sewer mains may be constructed on private property, with the approval of the Director, if a utility easement of a minimum of ten feet (10) is duly recorded. For trench depths greater than ten feet (10'), five feet (5') additional easement width shall be required for each five foot (5') additional depth. Increased easement widths may be required when determined necessary by the Director. All stream crossings shall be ductile iron pipe in conformance with Section 303.01 from manhole to manhole. Concrete encasement shall be required as determined by the Director, and shall extend a minimum of five feet (5') beyond each bank.

302.05 Manholes: Manholes shall be provided at all junctions with other sewers, at all points in change in alignment or grade and at the terminal point of the main. A manhole shall also be provided at the junction of a private sewer extension and the public sanitary system. The maximum distance between manholes shall be four hundred feet (400').

At all collector system manholes, the difference between influent and effluent inverts shall not be more than twelve inches (12"). Where this difference occurs, a smooth transition between the pipes, equal in height to 0.80 of the pipe, shall be provided. No

connections shall be made between twelve inches (12") and thirty inches (30") of separation. Where the difference is greater than a 2.5 foot drop, connections conforming to details shown in this Manual shall be constructed. On interceptor system manholes (for pipe larger than eighteen inches (18")), the difference may be twenty-four inches (24").

Four feet (4') inside diameter manholes shall be provided for sewers up to and including twenty-four inch (24") diameter pipes. Pipes larger than twenty-four inches (24") in diameter shall have specially designed manhole structures.

Manholes shall extend above the known level of flooding or, if this is not possible or practical, watertight manhole covers shall be used. As a minimum, watertight manhole covers are to be used to the elevation of the 25-year flood. Additional watertight manhole covers may be required as deemed necessary by the Director.

302.06 Service Connections: Service connections installed from the main to the property line or right-of-way shall be a minimum of four inches (4") inside diameter. A four inch (4") sewer cleanout shall be installed at the property line for all anticipated service connections at the time of construction of the sewer main. All service connections must be connected by means of a manhole connection or pre-manufactured tee or wye, or with an approved saddle type connection approved by the Director of Public Works. Service connections to terminal manholes shall not exceed 3 in number. Cleanouts shall be installed maximum distance of 50 feet on the service connection.

302.07 Minimum Depth Of Cover: Sewers which will be subjected to vehicular traffic shall generally be installed with six feet (6') cover below the finished street surface. Sewers at a more shallow depth shall be protected from superimposed loads or effects of traffic on the basis of H-20 highway loading. Special designs must be approved by the Director of Public Works. Minimum depth of cover for sewers in rights-of-way with no highway traffic shall be four feet (4'). The minimum depth of cover may be decreased to three feet (3') in rights of way with no highway traffic if ductile iron pipe is used.

302.08 Anchors: Concrete anchors shall be placed on sanitary sewer lines with grades of twenty (20) percent or greater. Minimum anchorage is as follows:

Not over 36 feet center to center on grades of 20% to 35%. Not over 21 feet center to center on grades of 35% to 50%. Not over 16 feet center to center on grades in excess of 50%.

302.09 Grease Traps, Volatile Liquid Separators: Grease traps, volatile liquid separators, or other devices shall be required for restaurants and may be required by the Director of Public Works on the facilities where, due to the nature of their operation, it is deemed necessary. The grease trap or volatile liquid separator is to be located externally in a manner so that all discharge from the kitchen plumbing pass through the grease trap or volatile liquid separator prior to entering the sanitary sewer; all other domestic waste water shall by-pass the grease trap. The grease trap or volatile liquid separator designs shall be reviewed on an individual basis during the plan review process. A minimum capacity of 500 gallons shall be provided per each grease trap. Adequate access for inspection and maintenance of the grease trap or volatile liquid separator is to be provided. The owner of the facility served by a grease trap or volatile liquid separator shall be responsible for its proper operation and maintenance.

302.10 Sewers In Relation To Streams, Estuaries, Lakes, And Reservoirs:

- A. 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. Reasons for requesting less cover shall be given in the application. In paved channels, the top of the sewer lines should be placed below the bottom of channel pavement. Sewers shall remain fully operational during 25-year flood/wave action. Sewers and their appurtenances located along streams shall be protected against the 100-year flood/wave action. Sewers located along streams shall be located outside of the stream bed wherever possible and sufficiently removed therefor to provide for future possible channel widening. Reasons for requesting sewer lines to be located within stream beds shall be given in the application.
- B. Sewers Crossing Streams, Estuaries, Lakes Reservoirs: Sewers entering or crossing the streams shall be constructed of watertight

pipe. The pipe and joints shall be tested in place, shall exhibit no 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 sewer will remain watertight and free from change in alignment or grade.

- 302.11 Relationship Of Sanitary Sewers and a Public Water Supply:
Sewers shall meet the requirements of the Virginia Waterworks Regulations with respect to minimum distances from water supply wells or potable water supply sources and structures. For all other potable water supply wells or potable water supply sources and structures, sewers should 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 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.

303.00 MATERIALS AND EQUIPMENT

303.01 Pipe Materials:

- A. Structural Requirements: Structural design of sewers shall conform with the methods given in the ASCE Manual Number 37 for the Design and Construction of Sanitary and Storm Sewers. In the use of this manual, backfill weight shall equal 130 pounds per cubic foot and K_u shall be 0.130. The live load for sewers subject to traffic effect shall be determined from a minimum wheel load equivalent to an H-20 loading (16,000 pound wheel load). An allowance of fifty percent (50%) of the design wheel load shall be added for impact. A minimum wheel load of 10,000 pounds per wheel shall be applied to all other sewers not subject to traffic load.

Ultimate lengths of rigid pipe shall be measured in terms of the ultimate three-edge bearing strength divided by a safety factor of 1.5. The allowable load shall be the working strength times a 2.5 load factor for concrete or arch bedding and times a 1.9 load factor for Class B gravel bedding condition.

B. Pipe Material Selections: The pipe materials listed hereunder have been generally approved for use in the City of Manassas Park. The type or types of pipe proposed for use on any specific project shall be shown on the construction plans and approved by the Director of Public Works.

1. Ductile Iron Pipe: Ductile iron pipe shall be centrifugally cast manufactured in accordance with ANSI Specification A21.51, latest revision, and shall be cement mortar lined in accordance with ANSI Specification A21.4.80.

Slip joint or mechanical joint pipe shall be used for gravity sewers. Slip joint pipe shall be designed in accordance with ANSI standard A21-50 and specified according to ANSI standard A21.11. Class 52 pipe shall be used in all sewer applications, unless otherwise approved by the Director of Public Works. Gaskets shall be furnished by the manufacturer and installed according to his recommendations. Ductile iron pipe may be used in general construction applications. Ductile iron shall be used in exposed pipe installations, across major stream crossings, and for excessive depth of fills where other pipe materials are subject to crushing.

2. Polyvinyl Chloride (PVC): PVC sewer pipe shall be manufactured in accordance with ASTM Designation D 1599 and AWWA C-900. Gravity sewer pipe shall be unplasticized polyvinyl chloride with integral rubber ring wall bell and spigot joints. Installation of PVC gravity sewer pipe and fittings shall be in accordance with ASTM Designation 3034 and manufacturer's recommendations. PVC sewer pipe shall be stored in accordance with manufacturer's recommendations on flat, even surfaces and shall remain racked on the pallets as delivered to the job site until such time as the trench is ready for placement of the pipe; i.e., PVC pipe shall not be strung out on the job site. Pipe stored for more than sixty (60) days prior to installation shall be covered with an opaque covering to prevent damage by the sun.

303.02 Service Connections: Polyvinyl chloride (PVC) sewer pipe conforming to ASTM Designation D 1599 and AWWA C-900; or schedule 40 PVC pipe conforming to ASTM Designation 178-76 shall be used between the sewer main and the building. The PVC joints shall be made with integral rubber ring wall with bonded-in-bell elastomeric seal. The schedule 40 PVC joints shall be made with a solvent weld bell and spigot joint using PVC pipe glue as supplied by the manufacturer. " No-hub" pipe shall not be permitted.

304.00 CONSTRUCTION STANDARDS

304.01 General Requirements: All construction of public and private sanitary sewer mains and appurtenances in the City of Manassas Park shall be in accordance with plans and specifications approved by the Director. Prior to the construction of the approved sanitary sewer, the developer's engineer or surveyor shall place adequate line and grade stakes in order that the sanitary sewer appurtenances may be constructed in accordance with the approved plans.

The engineer or surveyor shall then prepare legible cut sheets at fifty (50) foot stations indicating all pertinent construction data to include sewer service connection locations, concrete encasement or cradle, and finish grades of manhole rims. Five (5) sets of all cut sheets shall be submitted to the Director for review and approval.

If any deviation is contemplated in the location of line or grade of any sewer, structure or appurtenance from the approved plans, a revision to the plans showing the proposed deviation must be submitted to the Director for review and approval before the changes are constructed.

304.02 Excavation: Excavation shall conform to the lines and grades shown on the plans and cut sheets. Excavation shall not be carried below the established grades and any excavation below the required level shall be backfilled with granular material and thoroughly tamped, all at the contractor's expense. The contractor shall do all sheeting, bracing, and shoring, necessary to perform the work, to protect existing structures and to protect all excavations as required under Virginia OSHA Regulations.

Dewatering equipment shall be sized to maintain the trench in a satisfactory condition for pipe laying. Pipe laying will be permitted only where the depth of water is maintained below the surface of the pipe joint.

Not more than one hundred and fifty feet (150') of trench shall be opened in advance of the completed pipe laying. The trench walls shall be kept vertical whenever possible but the trench walls may be sloped above the top of the pipe for safety reasons. Excavation at manholes and similar structures shall be sufficient to have a minimum of twelve inches (12") clearance between their outer surface and the embankment or sheeting.

All blasting operations must be in accordance with existing ordinances and regulations. After blasting or other approved methods of removal, no projection of rock shall remain nearer than six inches (6") of any part of the sewer pipe when laid, nor shall project beyond the lines and grades of masonry structures. No blasting shall be done within twenty-five feet (25') of a tested or completed sewer. The ends of sewers adjacent to blasting shall be covered to avoid receiving debris.

Wherever the foundation material is unsuitable, it shall be excavated to a stable foundation and granular material with a maximum size of two inches (2") shall be placed in six-inch (6") layers until the trench bottom has been stabilized. Then, the standard granular bedding material shall be placed as specified in Section 304.03.

304.03 Bedding: All pipe up to and including eighteen inch (18") except ductile iron shall be bedded in compacted granular material placed on cradle or arch bedding. Pipe shall be placed on compacted granular bedding by having a minimum thickness of one-fourth (1/4) of the outside pipe diameter (4" minimum), and the granular bedding shall extend to a depth of four inches (4") over the crown of pipe, completely wrapping the pipe barrel. The granular material shall be well-graded crushed stone meeting the requirements of Virginia Department of Transportation (VDOT) Gradation 57 or 78. Ductile iron pipe shall have a minimum of four inches (4") of granular bedding. Bedding for pipe larger than eighteen inches (18") shall be designed on an individual basis and approved by the Director.

304.04 Backfill: Backfill in areas subjected to vehicular traffic shall begin at the top of the standard granular bedding and shall be placed in six-inch layers to a point at least twenty four inches above the top of pipe. It shall be thoroughly tamped to ninety-five percent (95%) compaction. Above this point, backfill shall be deposited in layers of a thickness which will facilitate 95% compaction. Backfill material shall be free of perishable material, frozen clods, sticky masses of clay, and other unsuitable material. Rock pieces larger

than four inches shall not be used in the backfill which is within 12 inches of the installed pipe in any direction. Backfill and replacement in existing or proposed roads to be accepted into the state highway system shall be executed in full accordance with the requirements of VDOT.

Backfill in areas not subjected to vehicular traffic shall be compacted to a (90%) ninety percent compaction. All surplus materials shall be disposed of in approved areas.

304.05 Pipe Installation: All pipe and fittings shall be carefully handled with slings or other devices to prevent damage to protective coatings or joints. Lifting equipment shall be satisfactorily rated to handle the pipe sizes used. Each section of pipe shall be thoroughly inspected for defects before being lowered into the trench. Pipe shall be laid true to line and grade with bells upstream and shall be jointed together such that the completed pipe will have a smooth invert. The standard bedding shall be shaped to the curvature of both the bell and barrel of the pipe. The trench shall be kept free of water while the work is in progress. The ends of the pipe shall be brushed so that proper joints can be made. As the work progresses, the interior of the pipe shall be cleared of dirt, cement, or other superfluous material. The exposed end of all pipe and fittings shall be fully closed to prevent earth, water or other substances from entering the pipe. During the winter season, or during periods of inclement weather, the trench shall be completely backfilled at the end of each work day.

304.06 Service Connections: C-900 PVC or Schedule 40 PVC, as approved by the Director, pipe connections to the sewer main shall be made by means of a commercially manufactured tee or wye branch, or approved saddle.

A four-inch (4") sewer clean-out shall be installed at the property line on all service lines. In addition, clean-outs shall be installed at 50-foot (50') intervals on long service lines and at bends in the service line greater than and including 45° (1/8) bends. Saddles used for making the sewer service connection to the sewer main shall be of the strap-on type with an "O" Ring seal and stainless steel strap. Saddles shall be specifically designed to adapt to the type of pipe used.

The saddle shall be secured to the pipe with a twenty-four (24) gauge stainless steel strap and two and three-eighth inch (2 3/8") by

three and one-eighth (3 1/8") by two and one eighth inch (2 1/8") Nickel-Bronze T Bolts. When a saddle is installed on an existing line, it shall be subjected to a ten-foot hydrostatic head (4.3 psi) prior to cutting the main with a tapping machine.

Sewer service connections shall be plugged with a pipe stopper manufactured for such service. The stopper shall be capable of sustaining ,without failure or leakage, an internal pressure head of ten feet (10') (4.3 psi).

Sewer service connections from the sewer main to the building shall be installed with the same care as the sewer main. Proper excavation, slope of pipe and standard granular bedding shall be provided throughout. All soil pipe joints shall be capable of resisting a hydrostatic pressure of fifteen (15) psi.

304.07 Manholes (Precast): Precast concrete manholes shall consist of precast reinforced concrete sections, an eccentric conical section and an expanded base section, extending a minimum of four inches (4") and a maximum of eight inches (8") beyond the outside vertical wall (riser section) of the manhole.

The precast base section shall be installed on a compacted stabilized foundation prepared similar to that required for the proper installation of the adjacent sewer as described elsewhere in this Manual.

The precast manhole sections shall be manufactured in accordance with ASTM Designation C-478, latest revision. Each section shall have lifting lugs or keyways. No lifting holes through the manhole wall are permitted. Joints shall be of the "O" Ring rubber gasket type and shall conform to the ASTM Designation C-361, latest revision. The joints shall be formed entirely of concrete employing a round rubber gasket and when assembled shall be self-centering and make a uniform water-tight joint. The gasket shall be the sole element utilized in sealing the joint from either internal or external hydrostatic pressure. In addition, a cold applied joint sealer may also be used in addition to the "O" Ring. No mortar joints are permitted.

The invert channels of the manhole 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. Changes in size and grade of the channels shall be made gradually. The invert channels shall be brought to grade and formed with brick and mortar.

The invert channel shall be at least 0.8 times the diameter of the pipe in depth for pipe 8" to 12" in diameter. The minimum difference in elevation of inverts of incoming and outgoing pipes shall be 0.10 feet.

Standard manhole drop connections shall be installed where indicated on the drawings. Drop connections shall conform to the details shown in this Manual. The drop pipe and fitting shall be the same type as the main sewer pipe and shall meet the same specifications as the sewer pipe. The entire drop connection shall be encased with Class A3 concrete as shown on the detail drawing in this Manual.

Manholes shall be constructed with manhole frames, covers and steps. The frames and covers shall be of the type and duty shown in this Manual. Where the frames and covers will be subjected to traffic loading, they shall be heavy-weight, 350 pounds. Where there will be no traffic loading, the frames and covers shall be light-loading, 290 pounds.

Casting shall be best quality tough, gray iron, free from cold shuts, blow holes, and other imperfections and shall meet the requirements of ASTM Designation A-48, Class 20. The castings shall be sound, true to form and thickness, cleaned by means of sand blast and neatly finished.

The material bearing surfaces shall be machine ground and finished to ensure satisfactory seating. Covers shall have the letter "S" cast into the top. Castings shall receive one coat of black asphaltum paint at the factory.

Covers shall be furnished with two (2) pick holes and two (2) center lifting holes. Covers shall be of the bolt-down type, if so required, for use in easements and remote locations. The plan sheet shall indicate manholes that require bolt-down, water-tight lids, and waterproof manhole inserts.

Steps for manholes shall be made of fiberglass construction, cast iron, or steel and shall have a plastic coating.

304.08 Pipe Connections At Manholes: All manholes for service with twenty-inch (20") diameter main line pipe or smaller shall be supplied with an approved flexible pipe connection suitable for specified pipe and manhole. Twenty-inch (20") and larger pipe connections shall have the first joint located four feet (4') from the inside face of the manhole. Plans shall indicate any and all bearings and/or angles of deflection of all mains connecting to manholes as to ensure proper location of boot connection to manhole.

Precast manholes shall be manufactured for the specified number of connections required. Manholes with more connections than needed can not be bricked or otherwise changed in configuration and are not acceptable. Connections to existing manholes, when approved by the Director of Public Works, shall be made by coring the manhole and installing a rubber boot.

304.09 Acceptance Tests: Sewers will be inspected to determine if any deviation from line and grade has occurred. The pipe alignment shall be checked with a GO-NO-GO Mandrel and incidental equipment. If the pipe shows poor alignment, displaced pipe, or any other defect, including a visible leak, the defect shall be corrected before acceptance.

An acceptance test shall be specified for all gravity sewer lines. The test may be either a water test or an air test. Where water testing is specified (exfiltration), the leakage toward shall not exceed one hundred (100) gallons per inch of nominal pipe diameter per mile per day (4,800 gpd/mi) maximum for any section of the system including manholes. Where the exfiltration test is employed, a minimum of four feet (4') of head at any point in the line and a maximum head of not more than ten feet (10') shall be required.

Where air testing is specified, test methods and acceptability criteria shall be in accordance with the appropriate ASTM Specifications. Air testing of gravity lines shall generally be acceptable for all types of pipe materials. If air testing is employed, the manholes shall be tested by exfiltration. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The stoppers shall be positioned in the lines far enough from the manhole to ensure testing to those portions of the lines not air tested. The manhole shall then be filled to the top with water. A twenty-four (24) soak shall be allowed. Leakage shall not exceed 1/4 gallon per hour for a four (4) hour test period.

The Contractors will furnish weirs, stand pipes, pipe plugs, water, pressure gauges, stop watches, air compressor, hose and such materials and assistance as required to perform these tests. All acceptance tests shall be conducted by the contractor in the presence of a City inspector.

Acceptance tests shall not be made until the sanitary sewer, manholes and required sewer service connections, as shown on the approved street plans, have been installed, and the sewer trenches have been backfilled and compacted to finished subgrade.

All sanitary sewers, including manholes, shall be inspected prior to acceptance testing, and any water leakage into the system sufficient to constitute any noticeable trickle or dribble, first shall be corrected and eliminated prior to undertaking the acceptance test.

Whenever it has been necessary to construct underdrains or place gravel under pipe lines in order to dewater the trench during construction of the sewers, the acceptance test will not be made until any pumps (which have been used in the dewatering process) have been disconnected. The contractor shall schedule all acceptance tests with the City inspector at least forty-eight (48) hours in advance. Each section of completed sewer shall be tested. Generally, the sewers will be tested from manhole to manhole. No sewers or sewer service connection are to be excluded from this testing procedure.

The test procedure shall be conducted in the following manner:

A. Low Pressure Air Testing Pressure:

1. The contractor shall thoroughly clean and remove all debris, silt, earth or other materials from the sewer prior to acceptance testing. The pipe may be flushed or sprayed with water. None of this water or debris shall be allowed to enter the existing sewer.
2. Test plugs shall be supplied and installed by the contractor within the pipe at each manhole. Each plug shall be securely braced.
3. If the pipe to be tested is expected to be below the ground water table, the contractor shall either: Install a small diameter perforated vertical pipe from the invert elevation of the sewer to the surface prior to backfilling;

or insert a pipe by boring or driving into the backfilling material adjacent to the invert elevation of the pipe, and determine the depth of the ground water level above the pipe invert immediately prior to acceptance testing the sewer.

All gauge pressures in the test shall be increased by the amount of this back pressure due to ground submergence over the end of the probe.

4. The contractor shall add air slowly to the portion of the pipe under test until the internal air pressure is raised to 1.0 psi gauge plus the ground water pressure.
5. As a safety precaution, no one shall be allowed in the manhole after the air pressure is increased in the sewer line. If the City inspector suspects that the test plug may be leaking, the pressure first shall be relieved before any adjustments are made to eliminate air leakage at the plug. The contractor may precoat the plug with a soap solution to check the plugs for leakage.
6. The contractor shall allow the air temperature to stabilize for at least two (2) minutes with the pipe subjected to an internal pressure of 4.0 psi by adding only the amount of air to maintain the pressure.
7. If the internal air pressure decreases, the time required for the pressure to drop from 3.5 to 2.5 psi gauge will be observed and recorded. The time interval shall be compared with the established standards in accordance with Table 3-6.
8. Pipe which fails to maintain the stipulated pressure for a period equal to or greater than the holding time shown in Table 3-6 shall be deemed not to have passed the low pressure air test and is unsatisfactory for acceptance by the City inspector. Any sewer or house connection that fails to pass this test shall be replaced by the contractor. A single repair clamp shall be allowed between manholes to facilitate the replacement of defective materials of workmanship.

TABLE 3-6

AIR TEST TABLES

Minimum holding time in seconds required for pressure to drop from 3-1/2 to 2 1/2 PSIG.

Pipe Diameter

	4"	6"	8"	10"	12"	15"	18"	21"	24"
25	4	10	18	28	40	62	89	121	158
50	9	20	35	55	79	124	178	243	317
75	13	30	53	83	119	186	267	364	475
100	18	40	70	110	158	248	356	485	634
125	22	50	88	138	198	309	446	595	680
150	26	59	106	165	238	371	510		
175	31	69	123	193	277	425			
200	35	79	141	220	317				
225	40	89	158	248	340				
250	44	99	176	275					
275	48	109	194	283					
300	53	119	211						
350	62	139	227						
400	70	158							
450	79	170							
500	88								
550	97								
600	106								
650	113	170	227	283	340	425	510	595	680

Note: To be used when testing one diameter only.

B. Exfiltration Testing:

1. All service laterals, stub and fittings into the sewer lines being tested should be properly capped or plugged, and carefully braced to resist the thrust actions developed by the internal water pressure. In preparing the blocking of plugs or end caps, it is extremely important to recognize that the 5 to 10 feet of head in the standpipe will exert considerable thrusts against the plugs or caps. For example, a 10' head will generate a total force of two hundred and fifteen (215) pounds against an eight inch (8") plug. Further consideration must be given to the fact that greater pressures will be developed in the downstream portion of the line, due to lower elevations, than in the upper reaches of the sewer line.
2. A tapped, plumber's type plug is inserted and tightened in the inlet pipe of the downstream manhole to which the water supply connection is made for filling the pipe. (See Figure 3-1).
3. The upper manhole is plugged and securely tightened for connection to the standpipe. The standpipe is then placed in this manhole and connected to the tapped plug. The standpipe must be capable of handling from five (5) to ten (10) feet of water head to determine the tightness and soundness of the sewer line, as specified and directed by the inspector (See Figure 3-1).
4. Water is introduced into the line at the downstream (lower) manhole until the standpipe in the upstream manhole has been completely filled. By filling the line from the lowest level, the air in the line is easily pushed ahead and, finally dispelled through the standpipe at the upper end of the test section.

Care should be taken to minimize entrapped air which will give distorted test results. The rate of drop in the standpipe may be quite rapid until the air has been expelled.
5. After filling with water, the line must be allowed to stand for at least several hours before beginning the test. During this time, some water absorption into the

manhole structures and asbestos cement sewer pipe will take place. After the water absorption has been stabilized, the water level in the standpipe is checked and water added if necessary.

6. The test is now ready to begin. The drop in the standpipe is measured and recorded over a ten (10) minute period. To verify the first results, a second ten (10) minute test is suggested. This will also verify whether a stable condition exists in the line.
 7. The measured drops in the standpipe are converted to leakage in terms of gallons per inch diameter per mile per day, the acceptable method of recording leakage. Caution should be taken about conducting exfiltration tests on sewer lines laid on steep grades. Consideration must be given to the downstream portion of the system to prevent excessive pressures in these lower lines. For these installations and where the upstream manholes are very deep, it is not advisable to fill the standpipe or manholes to the top when performing the test.
 8. Any sewer or house connection that fails to pass this test shall be replaced by the contractor. A single clamp shall be allowed between manholes to facilitate the replacement of defective materials or workmanship.
- C. Manholes will be tested by the air vacuum system as stipulated below:
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 specifications for which performance information has been provided by the manufacturer.
 5. A measured vacuum of 10 inches of mercury shall be

established in the manhole. The time for the vacuum to drop to nine inches of mercury shall be recorded.

6. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches of mercury shall be established in the manhole. The time for the vacuum to drop to nine inches of mercury shall be recorded.

Manhole Depth	Minimum Elapsed Time for a Pressure Change of 1 inch Hg
10 ft. or less	60 seconds
>10 ft. but <15 ft.	75 seconds
>15 ft. but <25 ft.	90 seconds

For manholes five feet in diameter, add an additional 15 seconds; for manholes six feet in diameter, add an additional 30 seconds to the time requirements for four-foot 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 and test repeated.

305.00 ON-SITE WASTEWATER DISPOSAL SYSTEMS

On-site wastewater disposal systems will be considered only in those cases where public sewer is not feasible. Each case will be considered on its own merit and is subject to approval by the Director and designed and constructed in accordance with VDH regulations.

306.00 PRESSURE SEWER SYSTEMS

306.01 Application: The pressure sewer system shall be considered as a supplemental tool for wastewater collection system and not as a replacement for the conventional gravity collection system. It is expected that pressure sewer systems would generally be used in small sub-systems or areas. This system may be approved for use under conditions such as the following:

- A. Where the topography makes it difficult for the potential users to be served by a gravity collection system.
- B. Where ground-water conditions make it difficult to construct and maintain a gravity collection system.
- C. Where excessive rock excavation makes the gravity collection system impractical.

306.02 Design Criteria: The following considerations shall be used for the design of a pressure sewer system including the grinder pump units:

- A. Collection System
 - 1. No pressure sewer less than 1 1/4 inches inside diameter shall be provided. The required size shall be determined to maintain low frictional losses in the system and a minimum scouring velocity of 2 feet per second at all points in the system.
 - 2. Special care shall be exercised in the hydraulic design of a pressure sewer system which is proposed to serve ultimately more units than those expected to be served initially.
 - 3. The determination of flow in the pressure sewer system shall be made on the basis of the maximum probable number of grinder pump units that would be expected to run simultaneously.
 - 4. The pressure sewer system shall be laid out in a branched or tree configuration to avoid flow-splitting at branches which cannot be accurately predicted.

5. The pressure sewer piping shall be installed in a depth sufficient to protect against freezing and damage from vehicular traffic.
6. Pipe shall be polyvinyl chloride pipe as per ASTM D2241 SDR-26 or approved equal. A value of C-130 to 150 is recommended for use in the Hazen-Williams formula.
7. Clean-out connections shall be provided at distances not to exceed capability of available cleaning equipment (approx. 400-600 ft.). Flushing clean-outs should be provided at the upstream end of every major branch.
8. Pressure and vacuum release valves shall be employed at appropriate locations. Pressure sewers should be constructed on a gradually ascending slope to minimize air binding.
9. All applicable provisions of sections 303.00 and 304.00 shall be utilized in the development of a pressure sewer system.
10. Pressure sewer system operating pressures in general shall not exceed a range of 40 to 50 psi for any appreciable period of time.
11. Thorough pressure testing of all lines, fittings, valves, etc. shall be made prior to start-up.

B. Grinder Pumps

1. The minimum net storage capacity of the grinder pump unit shall be approximately 50 gallons. The grinder pump tank should be able to accommodate normal peak flows and emergency storage for periods of 8 to 12 hours during a short power failure.
2. When a holding tank is provided for emergency purpose, during an extensive power failure or mechanical breakdown, the tank should be sized for at least 3 days' storage.

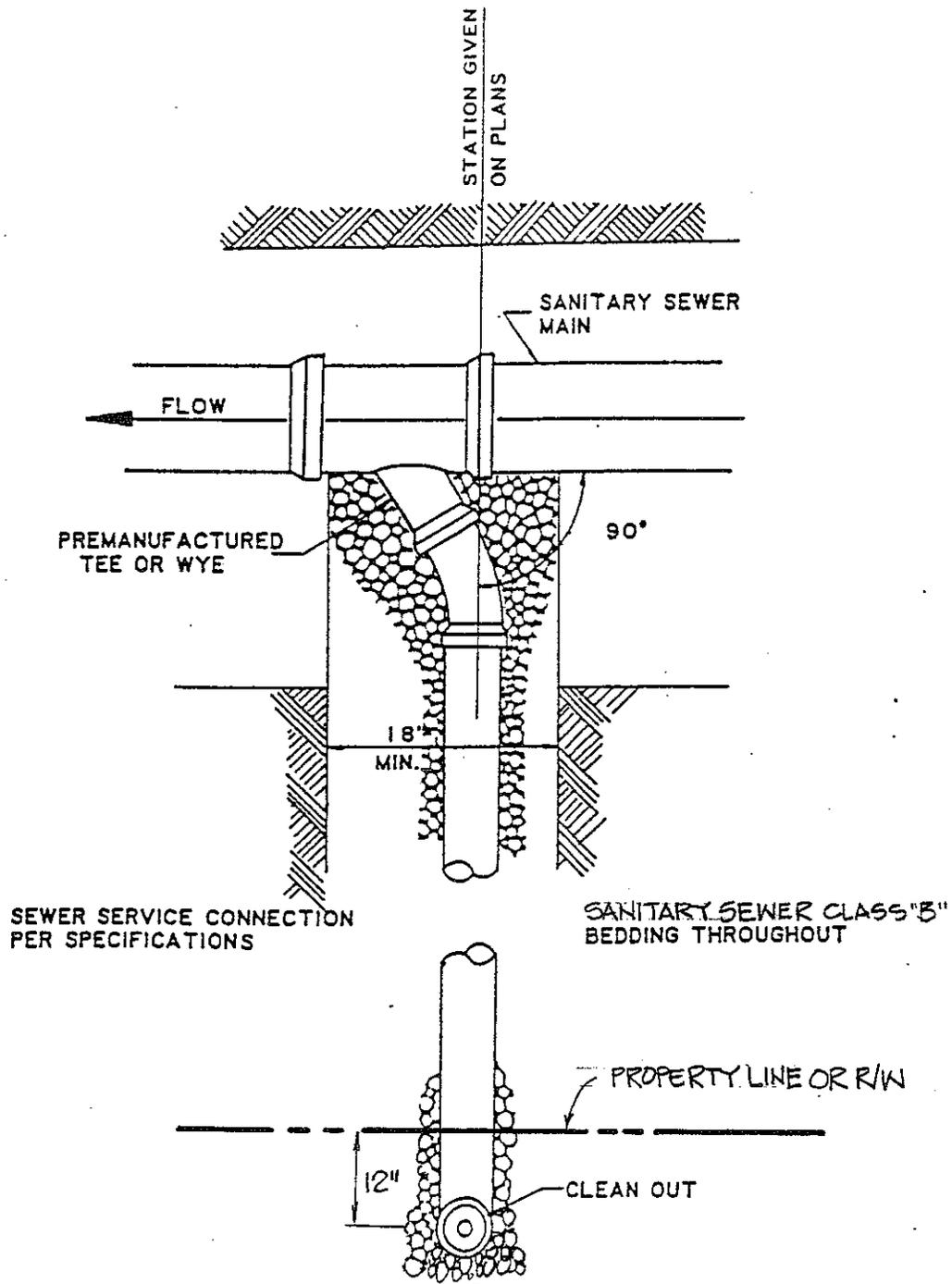
3. Adequate provisions should be made to empty the holding tank as and when necessary. The grinder shall have the characteristics which will continue to produce flows of at least 8 gpm even when conditions in the pressure system cause heads to rise temporarily to values as high as 50 psig.
4. Check and shut-off valves shall be employed to isolate the grinder pump unit from the unit service line and the pressure laterals.
5. Appropriate high water and overflow detection devices such as visual and/or audio alarm shall be provided.
6. Provisions shall be made to insure that grinder pump operates even under temporary loads above normal and contains integral protection against back siphonage and over pressure.
7. The grinder pump unit shall be capable of reducing any materials in the wastewater which enters the grinder unit to such size that the material will pass through the pump unit and pressure sewer without plugging or clogging. No screens or other devices requiring regular maintenance shall be used to prevent trashy material from entering the grinder pump.
8. At least one stand-by grinder pump unit for each 50 units or fraction thereof shall be provided for emergency replacement.
9. The grinder pump unit must be capable of being removed without dewatering the collection tank.
10. The pump chamber may be constructed of fiberglass except in areas subject to traffic flow. In the latter case the chamber will be constructed of concrete.

ARTICLE III

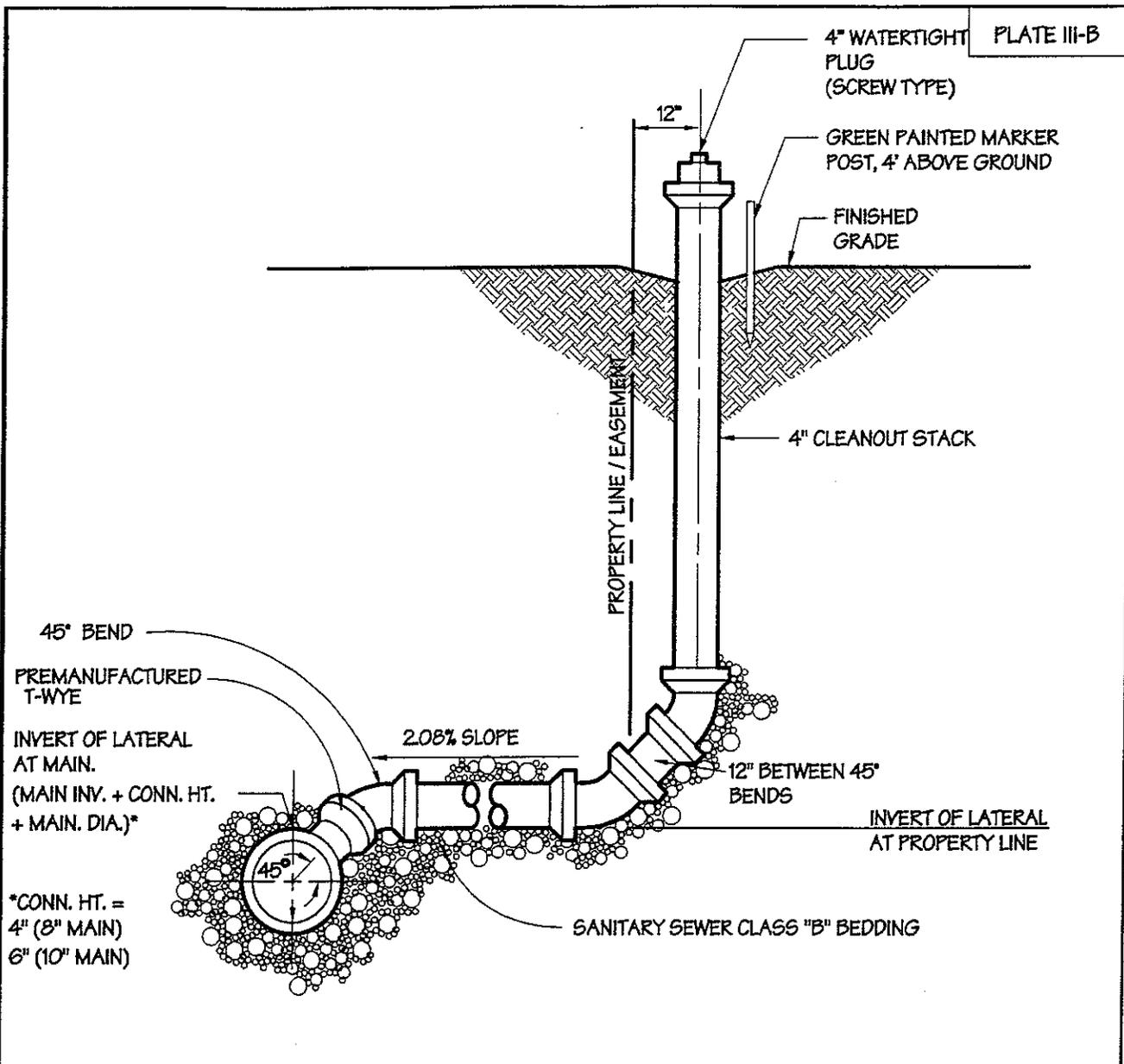
SANITARY SEWER SYSTEM

SECTION 307.00 - TYPICAL DETAILS

<u>Detail</u>	<u>Plate</u>
Sanitary Sewer Service Connection	III-A
Standard Lateral Detail	III-B
4' Diameter Precast Manhole	III-C
5' and 6' Diameter Precast Manholes with Riser Units	III-D
Precast Manhole Flat Top	III-E
Precast Manhole Reducer	III-F
Precast Manhole Conical Reducer	III-G
4' Diameter Precast "Dog-House" Manhole	III-H
Outside Drop Connection Detail	III-I
Inside Drop Connection Detail	III-IA
Waterproof Manhole Insert	III-IB
Pavement Patching Detail	III-J
Pipe Bedding and Encasement at Stream Crossings	III-K



SANITARY SEWER SERVICE CONNECTION



1. CONTRACTOR SHALL INSTALL A VERTICAL RISER TO FINISHED GRADE.

2. PLUMBER SHALL CUT THE VERTICAL RISER AT THE REQUIRED ELEVATION TO SERVICE THE BASEMENT AND INSTALL A WYE, A 45° FITTING AND TEST TEE. THE VERTICAL RISER SHALL THEN BE EXTENDED TO SURFACE GRADE AND PLUGGED TO SERVE AS A CLEANOUT.

3. THE LATERAL RISER PIPE AND FITTINGS SHALL BE OF THE SAME MATERIAL AS THE MAIN SEWER TO THE POINT WHERE THE PLUMBER CUTS THE VERTICAL RISER PIPE. GLUE JOINT PVC PIPE AND FITTINGS MAY THEN BE USED FOR THE HOUSE LATERAL.

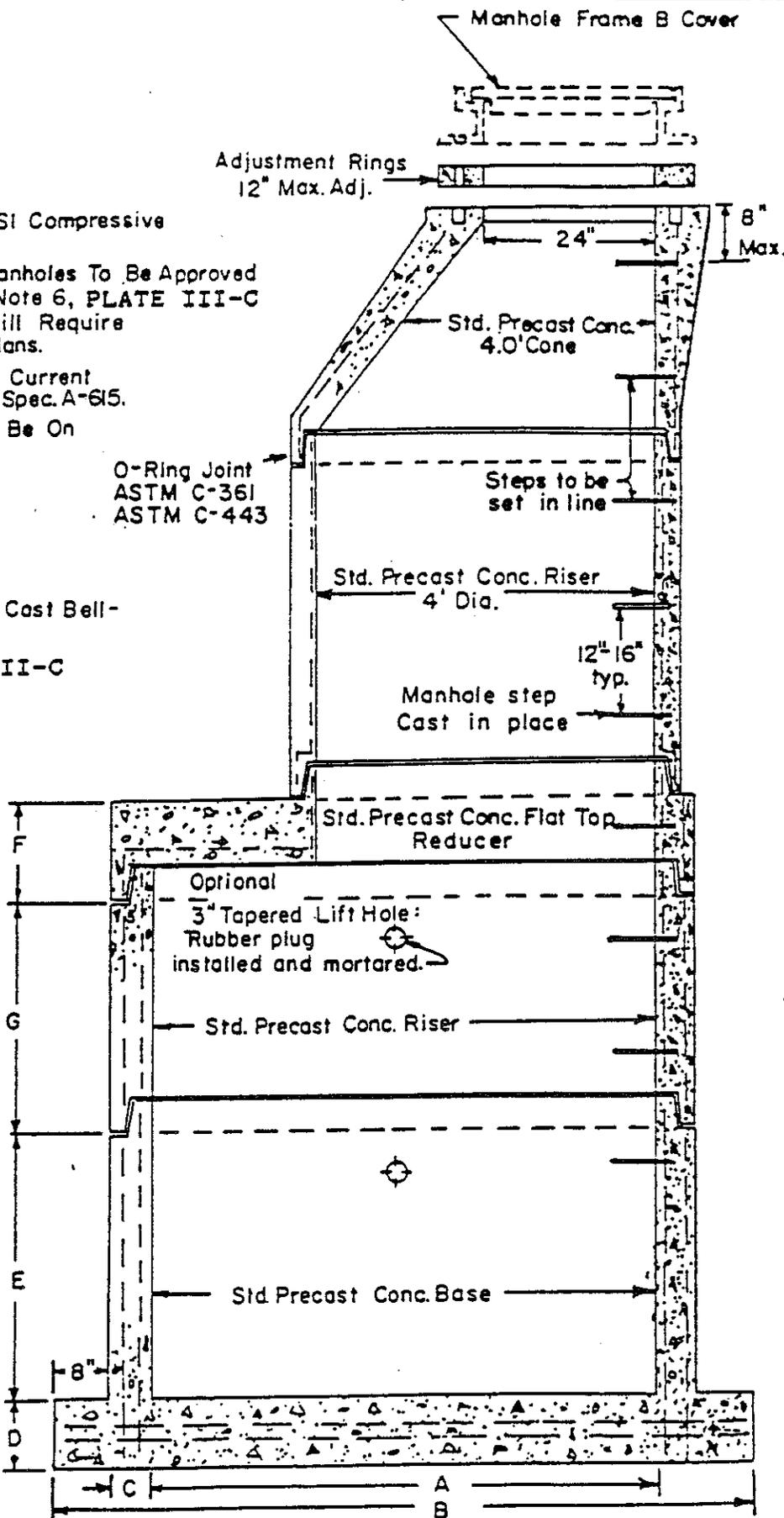
4. WITHIN FIVE FEET OF THE HOUSE, THE PLUMBER / CONTRACTOR SHALL INSTALL A SECOND CLEANOUT TO FINISH GRADE ELEVATION.

5. ALL SEWER MAINS, LATERALS AND FITTINGS SHALL BE PVC C-900 GASKETED, ASTM D1599 & F477.

STANDARD LATERAL DETAIL

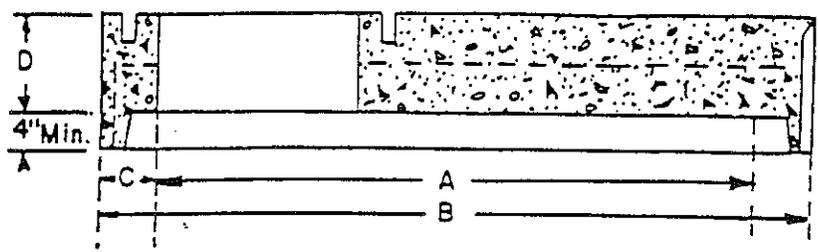
NOTES:

1. Concrete To Be 4000 PSI Compressive Strength, Minimum.
2. Pipe Connections To Manholes To Be Approved Flexible Sleeves. (See Note 6, PLATE III-C)
3. Manholes Over 6' Dia. Will Require Detailed Drawings On Plans.
4. All Reinforcing To Meet Current Requirements Of ASTM Spec. A-615.
5. Manufacturer's Name To Be On Inside Face Of Cone.
6. Manhole To Meet Current Requirements Of ASTM Spec. C-478
7. Compacted Gravel Under Base Sections.
8. Joint Configuration May Cast Bell-Up Or Spigot Up.
9. See Note 5, PLATE III-C



		Manhole Diameter In Feet	
		5'	6'
Dimensions	A	60"	72"
	B	84"	98"
	C	6"	7"
	D	8"	8"
	E	Varies	
	F	13" min. 13" min.	
	G	Varies	

5' & 6' DIAMETER PRECAST MANHOLES WITH RISER UNITS



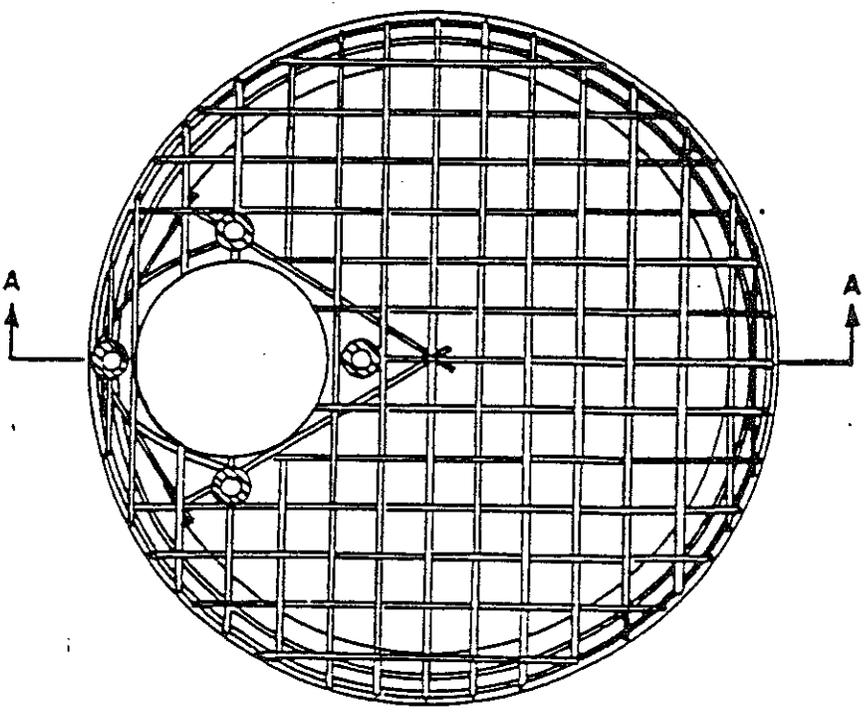
SECTION AA

NOTES

1. Concrete To Be 4000 PSI Compressive Strength, Min.
2. All Reinforcing Steel To Meet Current Requirements Of ASTM Spec. A-615.
3. Manhole Sections To Meet Current Requirements Of ASTM Spec. C-478.
4. Flat Top Shall Be Used Only When Specifically Required By The Plans Or Where There Is Height Or Invert Conflict As Determined By The Contractor And Approved By The Inspector.
5. Joint Configuration May Be Cast Bell-Up Or Spigot-Up
6. See note 5, PLATE III-C

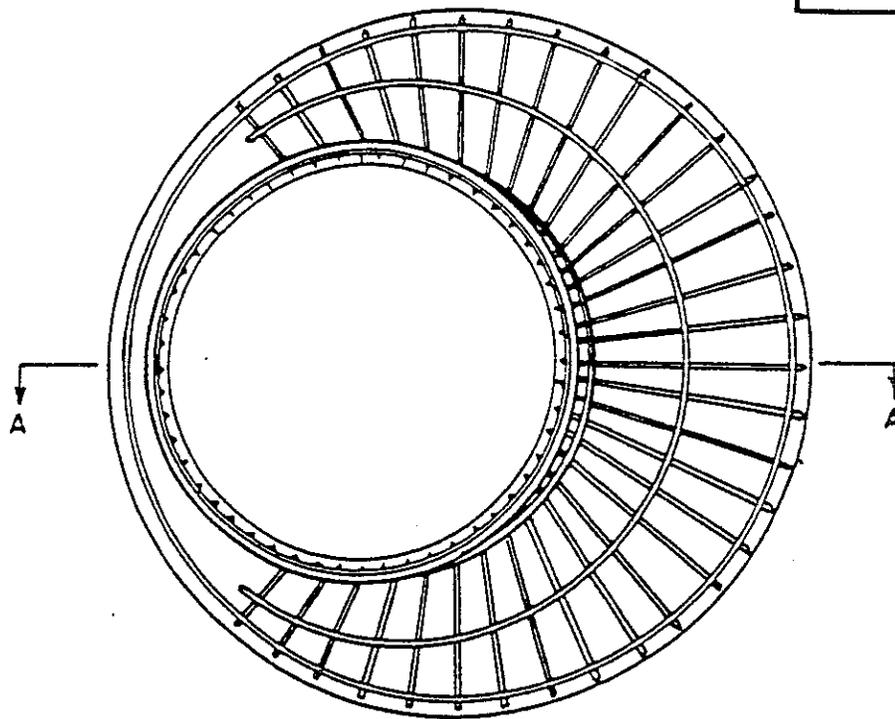
MANHOLE SIZE

	4'	5'	6'
A	48"	60"	72"
B	58"	72"	86"
C	5"	6"	7"
D	6"	8"	8"



TOP VIEW

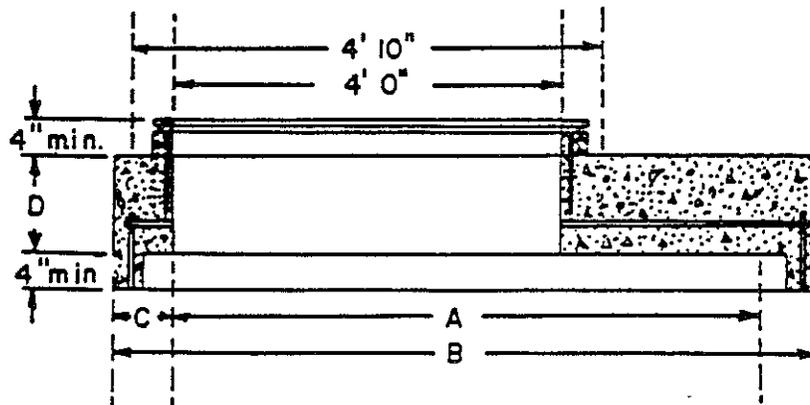
PRECAST MANHOLE FLAT TOP



TOP VIEW

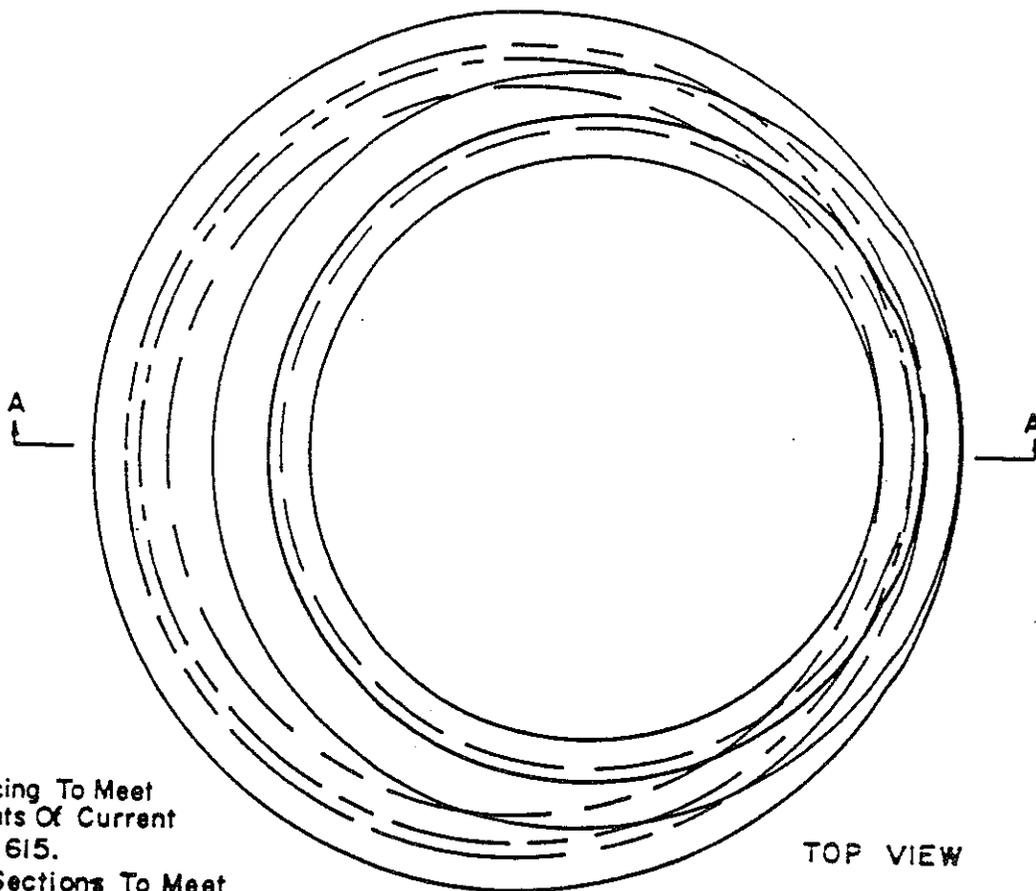
- NOTES:**
1. Concrete To Be 4000 PSI. Compressive Strength, Min.
 2. All Reinforcing Steel To Meet Current Requirements Of ASTM. Spec. A-615.
 3. Manhole Section To Meet Current Requirements Of ASTM Spec. C-478.
 4. Joint Configuration May Be Cast Bell-Up And Spigot-Up.
 5. See Note 5, PLATE III-C

DIMENSIONS		
	5'4"	6'4"
A	60"	72"
B	72"	86"
C	6"	7"
D	8"	8"

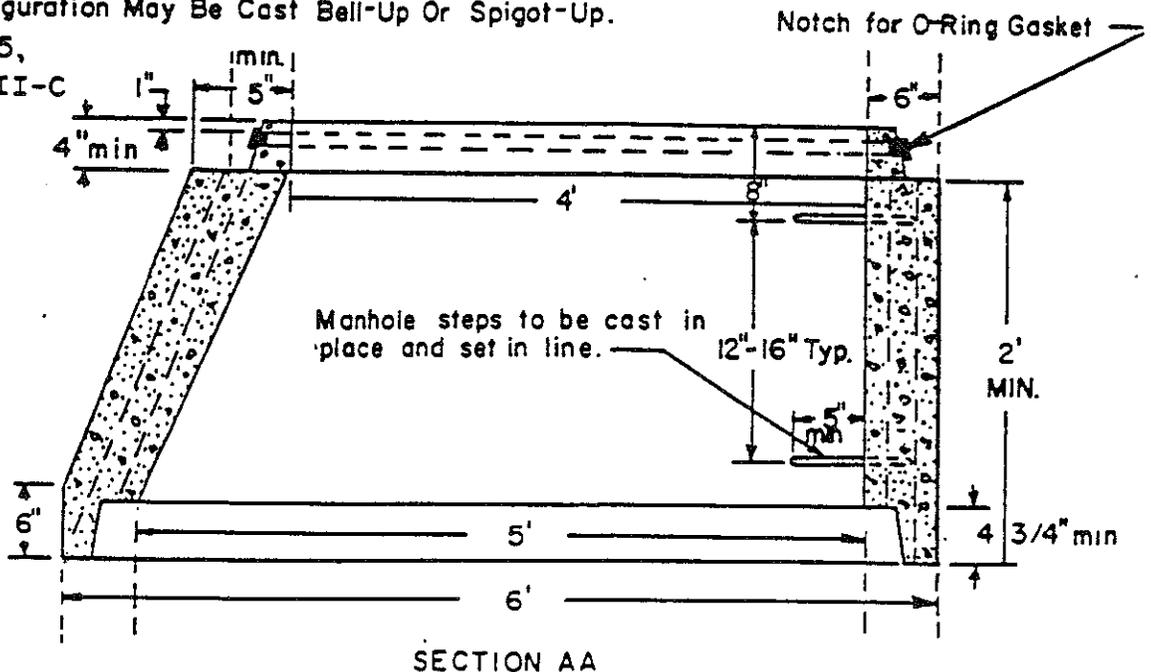


SECTION AA

PRECAST MANHOLE REDUCER

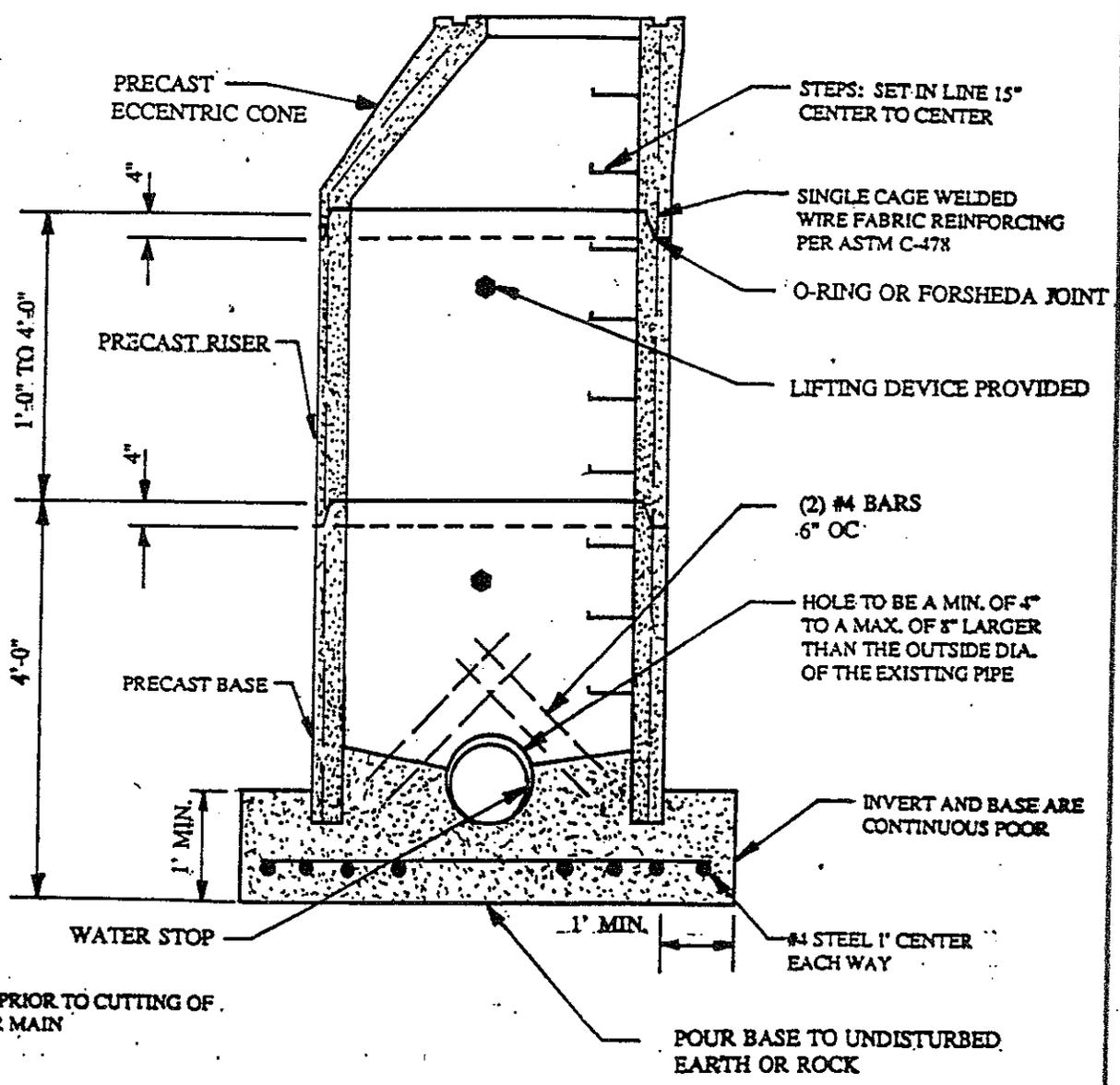
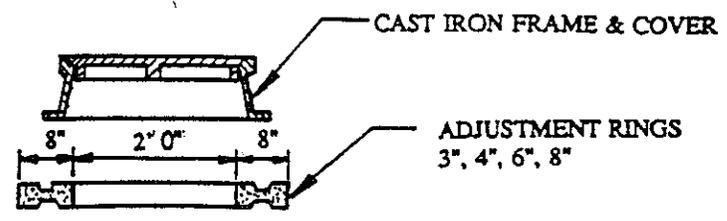


- NOTES**
1. All Reinforcing To Meet Requirements Of Current ASTM A-615.
 2. Manhole Sections To Meet Current Requirements Of ASTM Spec. C-478.
 3. Tapered Joint With O Ring Gasket To Meet Current Requirements Of ASTM Spec. C-361
 4. Joint Configuration May Be Cast Bell-Up Or Spigot-Up.
 5. See Note 5, PLATE III-C



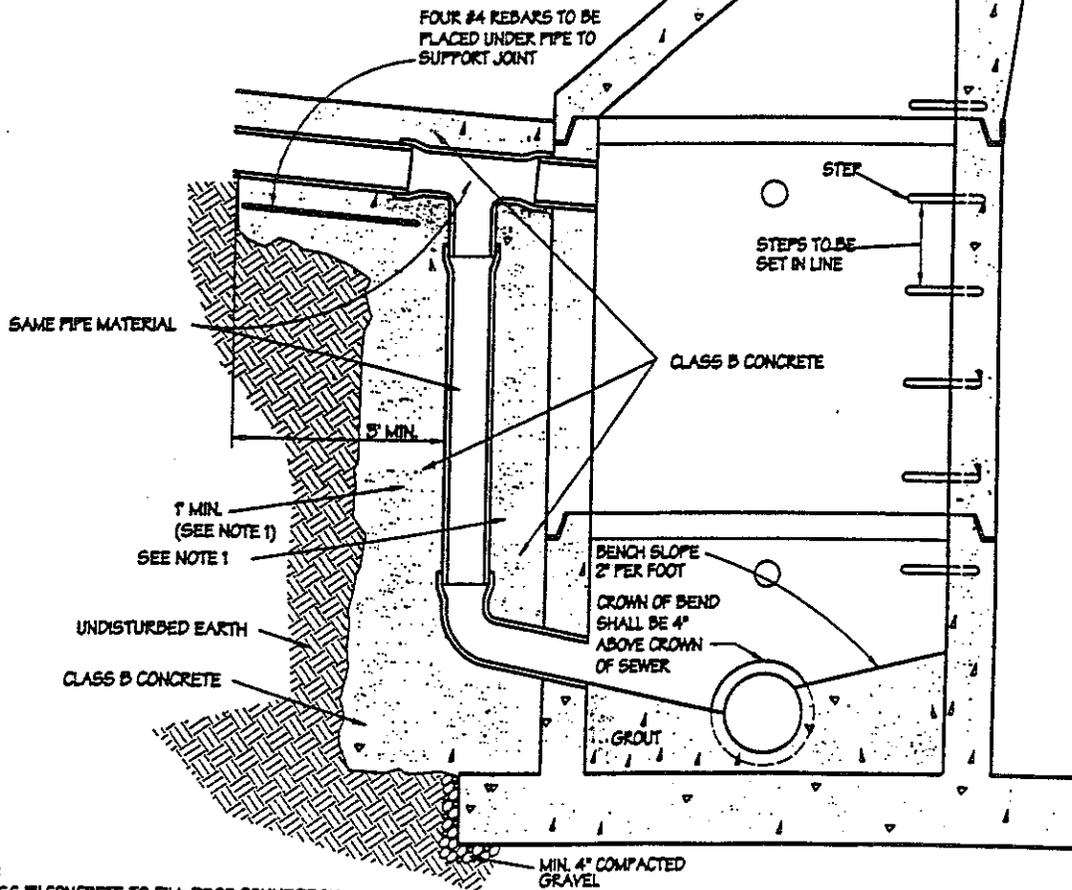
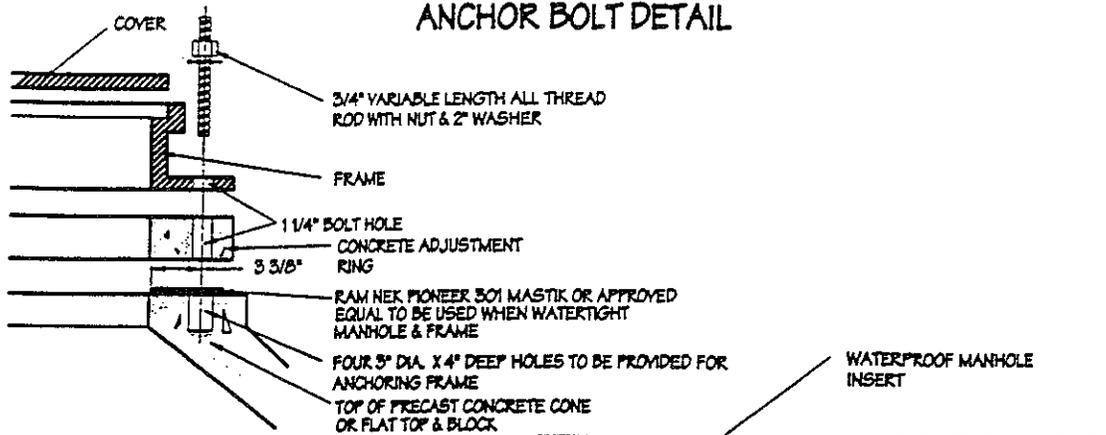
PRECAST MANHOLE CONICAL REDUCER

MAXIMUM FRAME ADJUSTMENT
6" IN EASEMENT, 12" IN PAVEMENT.



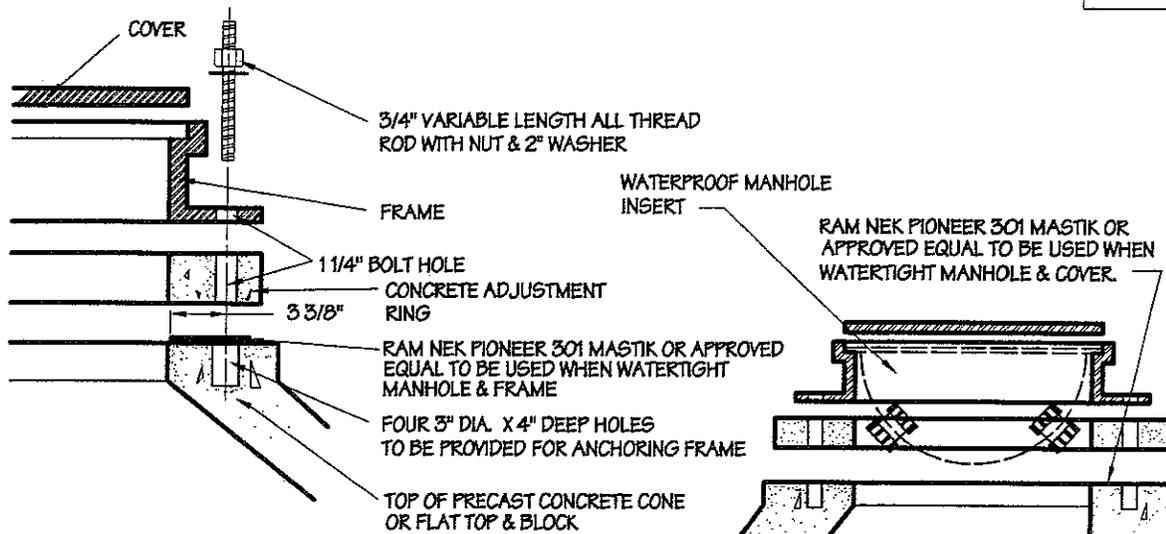
4' DIAMETER PRECAST "DOGHOUSE" MANHOLE

ANCHOR BOLT DETAIL

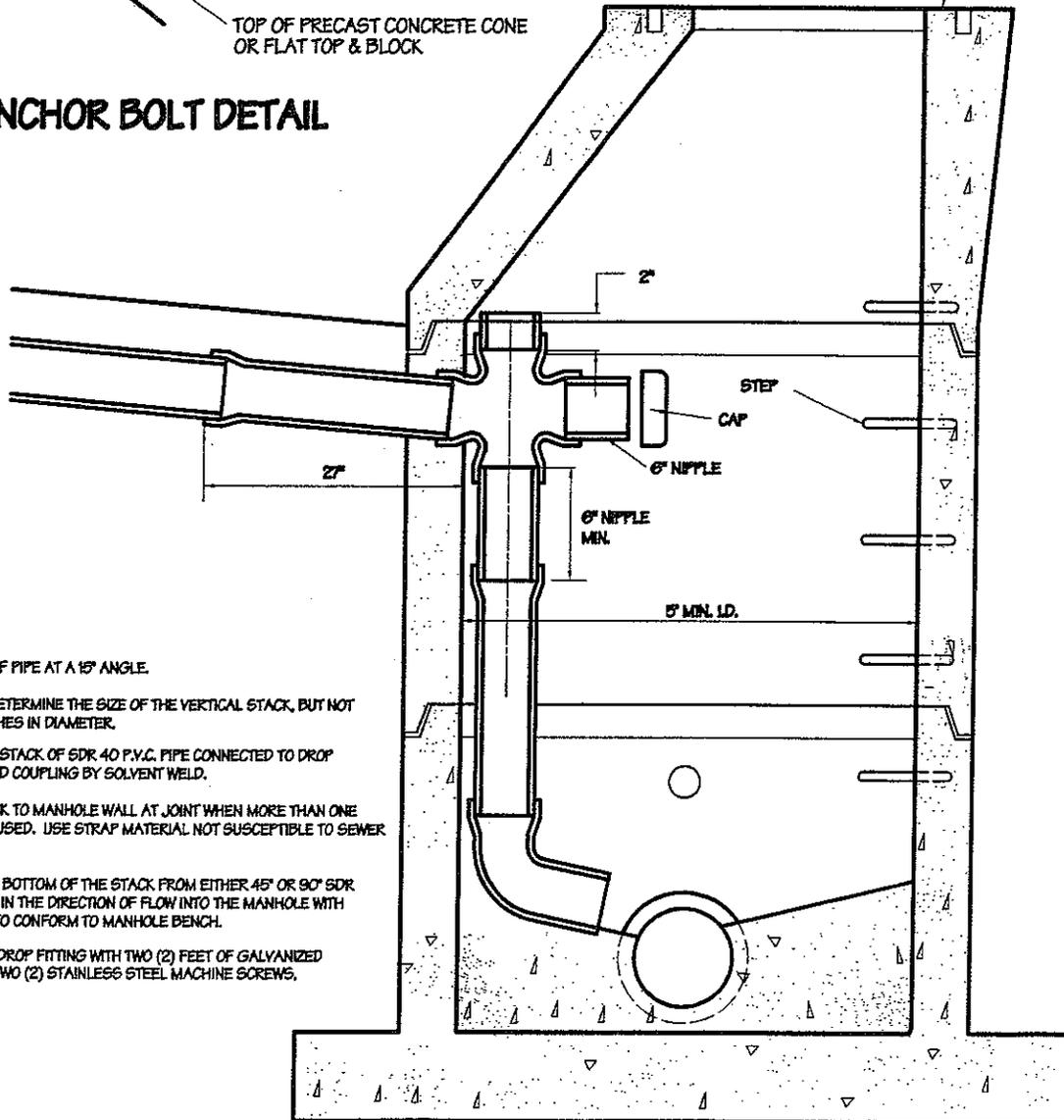


NOTE
1. CLASS B CONCRETE TO FILL DROP CONNECTION TRENCH. DROP CONNECTION TRENCH WIDTH TO BE SAME AS APPROACH TRENCH

OUTSIDE DROP CONNECTION DETAIL
MANHOLE FRAME & COVER DETAIL



ANCHOR BOLT DETAIL



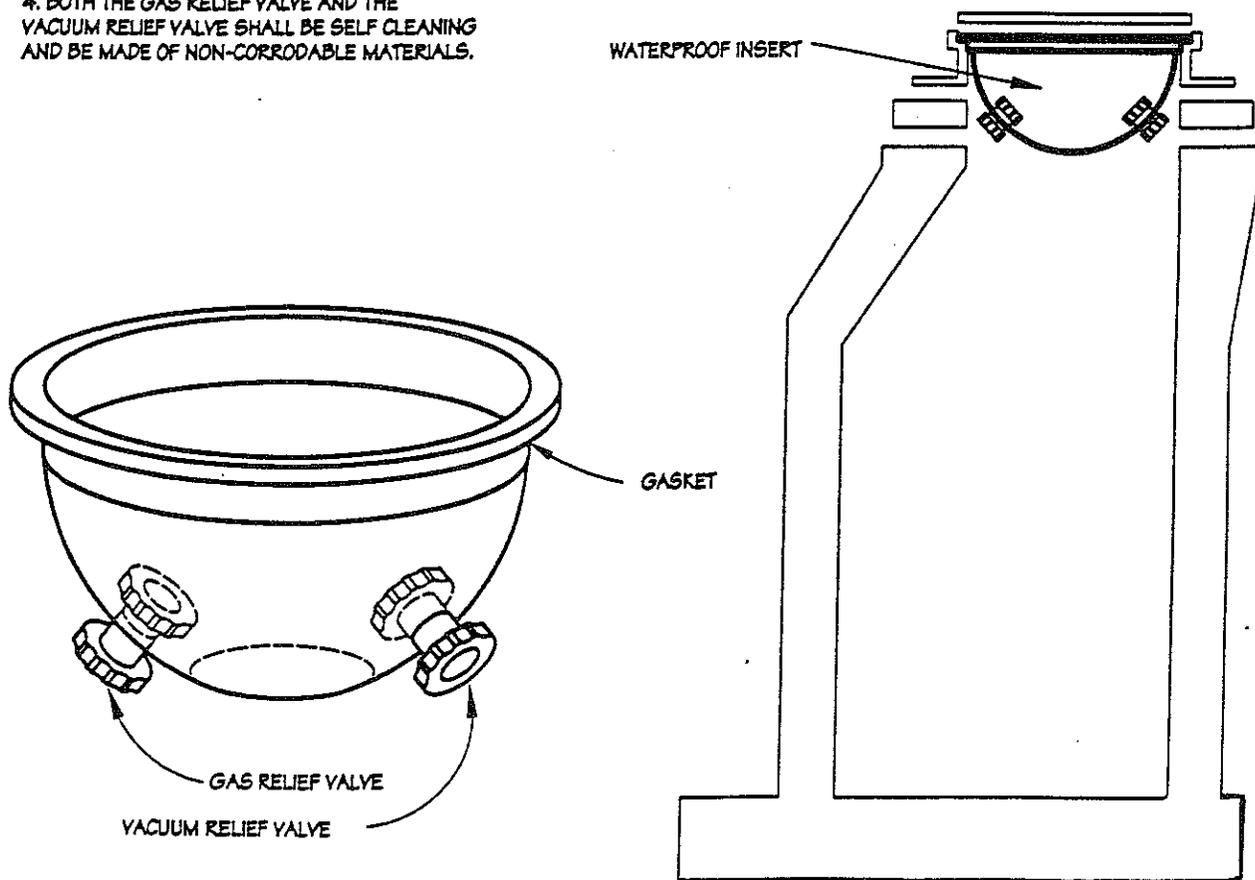
NOTES:

- 1) CHAMFER ALL SIZES OF PIPE AT A 15° ANGLE.
- 2) THE ENGINEER WILL DETERMINE THE SIZE OF THE VERTICAL STACK, BUT NOT LESS THAN 6X (6) INCHES IN DIAMETER.
- 3) CONSTRUCT VERTICAL STACK OF SDR 40 P.V.C. PIPE CONNECTED TO DROP FITTING WITH STANDARD COUPLING BY SOLVENT WELD.
- 4) STRAP VERTICAL STACK TO MANHOLE WALL AT JOINT WHEN MORE THAN ONE (1) SECTION OF PIPE IS USED. USE STRAP MATERIAL NOT SUSCEPTIBLE TO SEWER GAS CORROSION.
- 5) CONSTRUCT ELBOW AT BOTTOM OF THE STACK FROM EITHER 45° OR 90° SDR 40 P.V.C. BEND PLACED IN THE DIRECTION OF FLOW INTO THE MANHOLE WITH BENCH CONSTRUCTED TO CONFORM TO MANHOLE BENCH.
- 6) SECURE ALL CAPS TO DROP FITTING WITH TWO (2) FEET OF GALVANIZED CHAIN SECURED WITH TWO (2) STAINLESS STEEL MACHINE SCREWS, NUTS AND WASHERS.

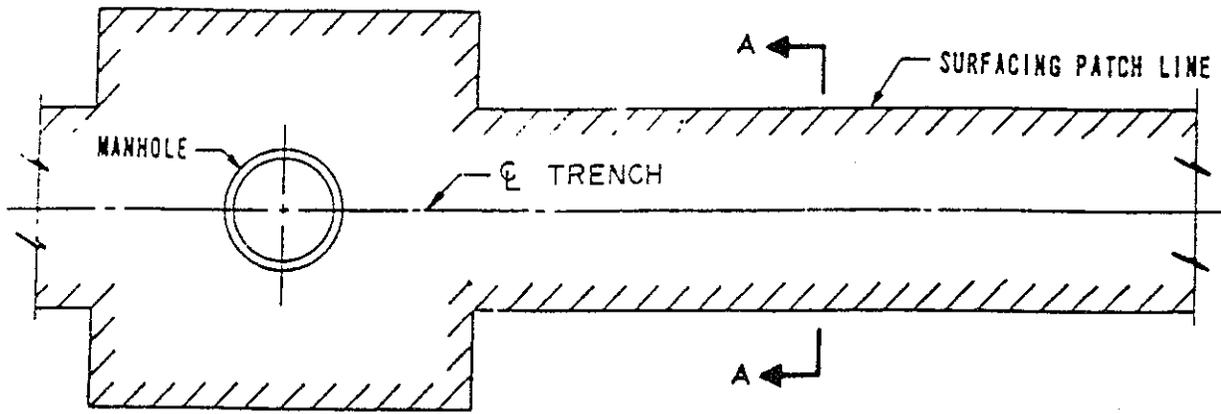
**INSIDE DROP CONNECTION DETAIL
MANHOLE FRAME & COVER DETAIL**

NOTES

1. THE INSERT SHALL BE DEEP ENOUGH TO PREVENT THE MANHOLE COVER FROM COMING IN CONTACT WITH THE VALVES WHEN THE MANHOLE COVER IS REMOVED OR INSTALLED.
2. THE INSERT WILL RESTRICT FLOW TO NO MORE THAN 1 GALLON IN 24 HOURS.
3. THE MANHOLE INSERT WILL BE MADE OF NON-CORRODABLE MATERIALS AND WILL NOT BE DAMAGED BY SEWER GASES OR ROAD OIL.
4. BOTH THE GAS RELIEF VALVE AND THE VACUUM RELIEF VALVE SHALL BE SELF CLEANING AND BE MADE OF NON-CORRODABLE MATERIALS.
5. THE GAS RELIEF VALVE WILL BE AUTOMATICALLY ACTIVATED AT A PRESSURE DIFFERENTIAL OF APPROX. 2.25 PSI.
6. THE VACUUM RELIEF VALVE WILL BE AUTOMATICALLY ACTIVATED AT A PRESSURE DIFFERENTIAL OF APPROX. 2.25 PSI.
7. A GASKET WILL BE INSTALLED UNDER THE LIP OF THE INSERT TO INSURE A TIGHT SEAL BETWEEN THE INSERT AND THE MANHOLE FRAME.

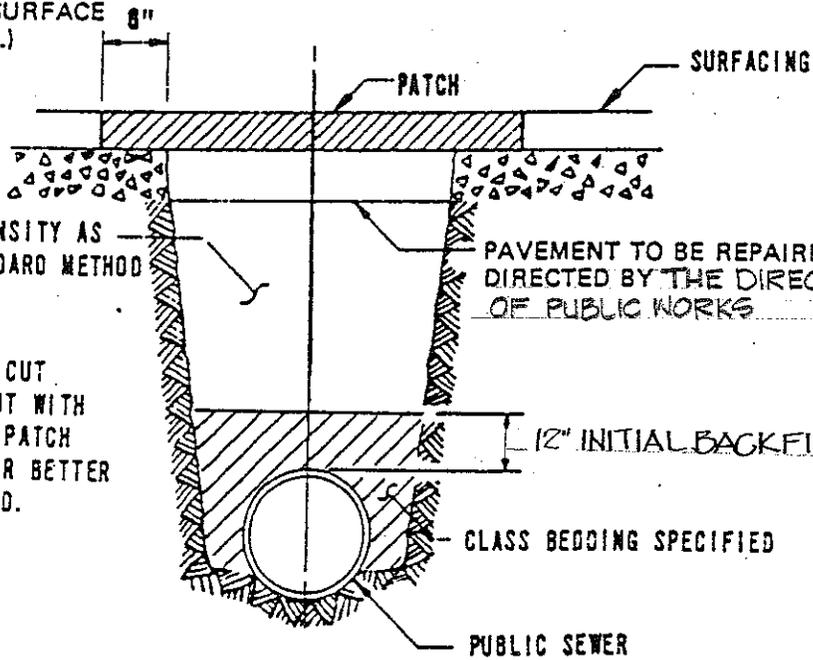


WATERPROOF MANHOLE INSERT



PLAN

CUT SURFACING BACK MINIMUM OF 6" BEYOND EDGE OF TRENCH (OR 6" BEYOND LIMIT OF HEAVED OR OTHERWISE DAMAGED SURFACE WHEN BLASTING REQUIRED.)

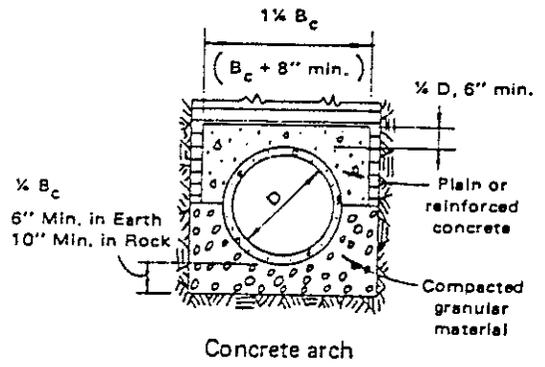
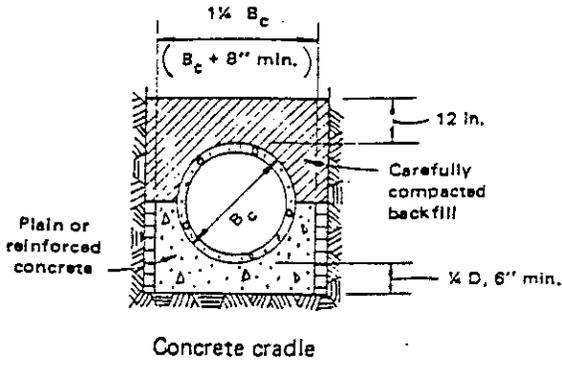


COMPACTED TO 95% MAX. DENSITY AS DETERMINED BY AASHO STANDARD METHOD

NOTE: SURFACING TO BE CUT NEAT AND STRAIGHT WITH A CONCRETE SAW. PATCH SHALL BE EQUAL OR BETTER THAN THAT REMOVED.

SECTION A-A

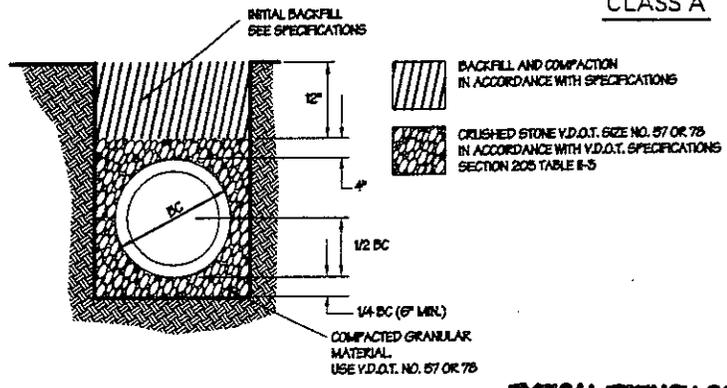
PAVEMENT PATCHING DETAIL



Concrete cradle

Concrete arch

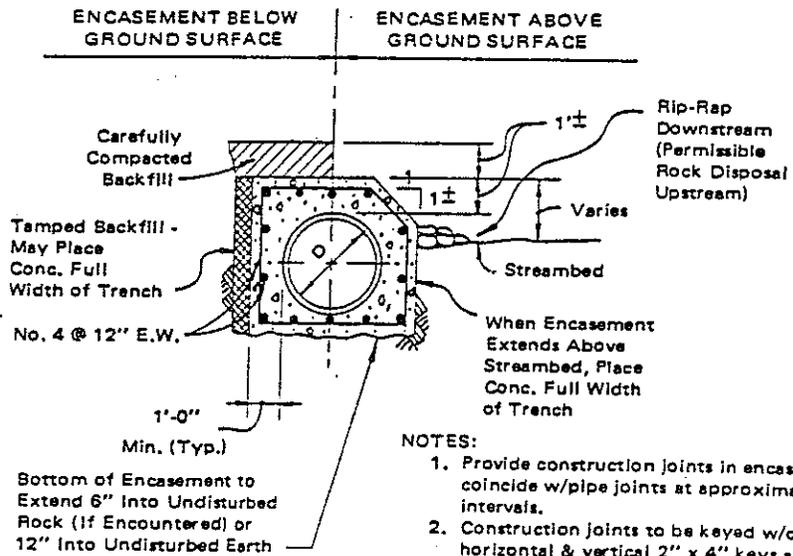
CLASS A



NOTE 1:
THE WIDTH OF THE TRENCH IS TO BE AS SPECIFIED BY THE ENGINEER ON THE PLANS OR AS SET FORTH IN THE SPECIFICATIONS.

NOTE 2:
THE PIPE SHALL BE BEDDED IN CAREFULLY COMPACTED GRANULAR MATERIAL PLACED ON A FLAT TRENCH BOTTOM. THE GRANULAR MATERIAL SHALL BE CRUSHED STONE V.D.O.T. SIZE 57 OR 78, IN ACCORDANCE WITH V.D.O.T. SPECIFICATIONS, SECTION 205, TABLE 8-5. THE GRANULAR BEDDING SHALL HAVE A MINIMUM THICKNESS OF ONE-FOURTH THE OUTSIDE PIPE DIAMETER (6" MIN.) AND SHALL EXTEND VERTICALLY IN ACCORDANCE WITH ALTERNATES A OR B. IF THE MAXIMUM WIDTH OF THE TRENCH AT THE TOP OF THE PIPE EXCEEDS THOSE SPECIFIED, GRANULAR BEDDING MATERIAL WILL BE BROUGHT TO THE TOP OF THE PIPE FOR THE FULL WIDTH OF THE TRENCH. THE REMAINDER OF THE SIDE FILLS AND A MINIMUM DEPTH OF 12" OVER THE TOP OF THE PIPE SHALL BE FILLED WITH CAREFULLY COMPACTED MATERIAL. SHOULD THE CONTRACTOR ELECT TO USE LARGER STONE TO CARRY THE WATER, THE LARGER STONE IS TO BE PLACED BENEATH THE SPECIFIED AMOUNT OF GRANULAR MATERIAL. THE LARGER STONE IS NOT IN ANY WAY TO EFFECT THE AMOUNT OF GRANULAR MATERIAL USED.

**TYPICAL TRENCH CONSTRUCTION
SANITARY SEWER CLASS "B" BEDDING**



- NOTES:**
1. Provide construction joints in encasement to coincide w/pipe joints at approximately 32' intervals.
 2. Construction joints to be keyed w/continuous horizontal & vertical 2" x 4" keys around conduit.
 3. Construction joints shall have a separation area of at least 75% of total encasement cross section.
 4. Discontinue longitudinal reinforcement at construction joints.
 5. Begin & End Encasement at Pipe Joint.

CLASS C - STREAM CROSSING

PIPE BEDDING AND ENCASEMENT AT STREAM CROSSINGS

ARTICLE IV

STREETS

TABLE OF CONTENTS

	<u>Page</u>
SECTION 401.00 STREET REQUIREMENTS	IV-1
401.01 Single Family Dwellings	IV-1
401.02 Direct Access to Arterial Roads	IV-1
401.03 Townhouses, Apartments, and Condominiums	IV-1
401.04 Construction of Streets to Property Line	IV-2
401.05 Access to Adjoining Property	IV-2
401.06 Subdivision Blocks	IV-2
401.07 Construction in Accordance with Standards	IV-2
401.08 Frontage Improvements	IV-2
401.09 Frontage on Major Arterials	IV-3
401.10 Connections to Divided Highways	IV-3
401.11 Reverse Frontage	IV-3
401.12 Curb, Gutter, and Sidewalk Requirements	IV-3
401.13 Standard Landings at Intersections	IV-4
401.14 Emergency Access Island	IV-4
401.15 Service and Emergency Vehicle Traffic	IV-4
401.16 Street Intersection Spacing	IV-4
401.17 Conformance with Comprehensive Plan	IV-4
401.18 Street Lighting	IV-4
SECTION 402.00 INFORMATION TO BE PROVIDED ON CONSTRUCTION PLANS	IV-5
402.01 Curb-Cut Ramps	IV-5
402.02 Guard Rail and Paved Ditch Requirements	IV-6
402.03 Entrance Requirements	IV-6
402.04 Proposed Street Construction	IV-6
402.05 Design Requirements	IV-9
402.06 Other Information to be Shown on Plans	IV-11
SECTION 403.00 PRELIMINARY STREET PLANNING	IV-12
403.01 General Requirements	IV-12
403.02 Trip Generation	IV-13
403.03 Traffic Flow Characteristics	IV-14
403.04 Street Cross Section Determination	IV-14
SECTION 404.00 ROAD DESIGN STANDARDS AND SPECIFICATIONS	IV-16



ARTICLE IV

STREETS

401.00 STREET REQUIREMENTS

- 401.01 Single Family Dwellings: All single-family detached dwelling unit sites shall have frontage on existing city or state maintained public streets or streets approved and bonded to be constructed to a standard acceptable for addition to the city or state system. The amount of frontage shall be established in accordance with the appropriate regulations for the zoning district as set out in the Zoning Ordinance.
- 401.02 Direct Access to Arterial Roads: Residential, commercial, institution and industrial building sites or lots are to be designed so that the sites or lots will not have direct access to any arterial road unless deemed necessary by the Director, by reason of an unusual natural topographical or pre-existing condition, or unless the shape or size of the tract would preclude other methods of providing access.
- 401.03 Townhouses, Apartments, and Condominiums: Townhouses, apartments, and condominium developments must have access to the city or state maintained roads. This access may be via private streets provided that:
- A. All lot owners are assured perpetual right of access to the city or state-maintained road;
 - B. An automatic homeowners association is established and given the responsibility of ownership and perpetual maintenance of the private roadways. The homeowner's association documents shall be established and reviewed prior to Final Plan approval;
 - C. No private roadways carry in excess of seven hundred (700) vehicles per day;
 - D. Public agencies including police and fire departments are assured a suitable access easement to allow them to carry out their duties;
 - E. All permitted private roadways and parking areas in commercial, multi-family, townhouse, apartment, and condominium developments are designed and constructed in accordance with the appropriate

standards in this manual,

- F. No perpendicular parking shall be permitted on private streets carrying in excess of four hundred and twenty (420) vehicles per day.

- 401.04 Construction of Streets to Property Line: All streets shall be constructed to the property line if eligible to be accepted into the city or state system. If the developer is unable to obtain off-site easements necessary to construct streets to the property line, it is permissible to stop the street construction a distance from the boundary line, dedicate the undeveloped street and provide an escrow agreement for future completion of the street to the boundary line. In these cases it may also necessary to obtain off-site grading easements for future completion of the street when the off-site area is developed. All construction of the private streets, parking bays, common sidewalks and associated drainage facilities shall be included in the completion bond for the project.
- 401.05 Access to Adjoining Property: Streets shall be provided to give access to adjoining acreage to the satisfaction of the Director. Also, streets shall be provided to connect with appropriate highways and with appropriate streets in adjoining subdivisions. All right-of-way shall conform to the standards as set forth in this manual.
- 401.06 Subdivision Blocks: Subdivision blocks should be spaced so as to provide traffic circulation within and between existing or anticipated subdivisions.
- 401.07 Construction in Accordance with Standards: All streets shall be constructed and surfaced in accordance with the standards set forth in this Manual as well as the requirements of the latest edition of VDOT subdivision street requirements. Where conflicts might exist, the more stringent case shall apply.
- 401.08 Frontage Improvements: When a subdivision abuts one side of any street which has been included in the city or state system of highways and will add substantial traffic to this facility, the subdivider shall, to the extent commensurate with the additional traffic generated, be required to dedicate one-half of the proposed right-of-way or more if necessary to improve the horizontal alignment or meet the minimum design standards for that street. Also, the subdivider may be required to be responsible for such

grading, widening or surfacing, curbing, drainage and provision of sidewalk along such street as may be deemed necessary by the City or Virginia Department of Transportation (VDOT) to meet minimum safety and/or design standards.

401.09 Frontage on Major Arterials: Whenever a subdivision abuts a road which is included in the state system of primary highways, a service drive extending for the full length of the subdivision along such road, and providing limited access thereto, shall be provided except when both of the following conditions are met:

- A. A reverse frontage concept is utilized such that no lot has direct ingress or egress to the arterial or primary highway;
- B. Sufficient setback is provided to permit the ultimate section of the arterial to be constructed; Service drive construction shall conform to the standards as set forth in this Manual.

401.10 Connections to Divided Highways: Subdivision street connections made to existing or future divided highways shall whenever possible be located at existing crossovers or approved locations that meet all design criteria for crossover locations.

401.11 Reverse Frontage: It is the intent of this Manual to provide access to individual residential lots only from local and collector classifications of streets. The Director shall require a reverse frontage or service drive concept for streets which (1) carry in excess of five thousand, five hundred (5,500) vehicles per day and are categorized as thoroughfare or arterial highways; or (2) for streets which the comprehensive plan or existing zoning regulations indicate will carry in excess of five thousand, five hundred (5,500) vehicles per day.

In the event that the Director finds that there will be in excess of three thousand (3,000) vehicles per day, he may require a traffic study and, where projections exceed 5,500 require a reverse frontage or service drive concept.

401.12 Curb, Gutter, and Sidewalk Requirements: Urban section streets including curb, gutter must be provided in all subdivisions. Sidewalks on each side of the street are required in residential areas. Sidewalks in non-residential areas are based on need as recommended by staff.

- 401.13 Standard Landings at Intersections: Wherever a minor street intersects a major street, construction of a standard landing will be required on the minor street.
- 401.14 Emergency Access Island: In any occupancy or use group that has vehicle parking in an area adjacent to the structure without separation from that structure by means of a fire lane, an emergency access space shall be installed at the main entrance to each structure or at locations as directed by the Fire Marshall to provide reasonable access to the facility.
- 401.15 Service and Emergency Vehicle Traffic: All through subdivision streets and cul-de-sacs shall be designed in such a manner to incorporate good traffic design providing ease of access for domestic service and emergency vehicular traffic. Excessively long blocks or cul-de-sacs are discouraged.
- 401.16 Street Intersection Spacing: Subdivision streets intersecting an existing or future street, not directly opposite another existing or future street, must have a minimum spacing of 200 feet between their centerlines.
- 401.17 Conformance with Comprehensive Plan: The arrangement, character, extent, grade and location of all streets shall conform to the Comprehensive Plan of the City.
- 401.18 Street Lighting:
- A. Street lighting, including related wiring and easements shall be provided in all new developments. Street lighting easements (may be included in Common Service Easements) shall be provided along the frontage of all lots in a residential development.
 - B. In residential developments, minimum requirements for street light locations include street intersections, permanent cul-de-sacs and all entrances to the development. Other lighting locations shall be coordinated with the City Engineer.
 - C. Street lights shall be provided at the entrances of commercial and industrial development where the entrance carries more than 400 vehicles per day.
 - D. All street lighting shall be installed, owned and maintained by the supplying utility company.

- E. The developer shall pay for the cost of installation.
- F. Bonding for the cost of installation shall be required.
- G. The street light plan shall be shown on the site plan or construction plans and coordinated with the City Engineer.
- H. Street light installation shall be in conformance with VDOT specifications. The style shall be approved by the City Engineer.

402.00 INFORMATION TO BE PROVIDED ON CONSTRUCTION PLANS

402.01 Curb-Cut Ramps:

- A. Policy on Ramps for the Handicapped.
 - 1. All residential developments shall provide standard curb-cut ramps located to conform to VDOT Standards or this Manual.
 - 2. In parking lots for commercial and industrial site plans, standard curb-cut ramps shall be located at the major crosswalks. Where site plan sidewalks are constructed at various vertical elevations, a curb cut ramp shall be installed at each entrance elevation.
 - 3. Churches, schools, and appropriate public facilities site plans shall provide standard curb-cut ramps as required by the Director.
 - 4. All ramps shall be designed in accordance with and Sections 315.00 and 615.00 of the Virginia Uniform Statewide Basic Building Code. VDOT Road and Bridge Specifications.
- B. Location of Ramps for the Handicapped.
 - 1. Indicate locations of curb-cut ramps for handicapped persons as specified by the VDOT standards.
 - 2. At entrances utilizing a CG-10A entrance, the sidewalk may be ramped down to the travelled way.
 - 3. A CG-9D commercial entrance may be utilized in lieu of the CG-10A entrance. This standard raises the entrance to the level of the sidewalk, and allows the passage of pedestrians

across the entrance without the need of a step down.

402.02 Guard Rail and Paved Ditch Requirements: The following note must be added to the plan:

"A joint inspection will be held with the developer and City representatives to determine if and where guard rail and/or paved ditches will be needed. Further, the developer will be responsible for providing guard rail and paved ditches as determined by this joint inspection." Refer to VDOT guard rail and paved ditch specifications.

402.03 Entrance Requirements:

- A. Indicate all driveway entrances and the size, length and type of driveway entrance culvert where applicable on subdivision plans or lot grading plans.
- B. CG-11 entrances shall be used for subdivision street connections.
- C. CG-10A entrances shall be used for all commercial entrances of parking bays, parking courts, townhouses, etc.
- D. CG-9D entrances may be used for commercial entrances where a ramp for handicapped persons is required.
- E. Reference to nearest intersections in both directions.
- F. Site distance must be labeled and proof of such shall be verified through a profile.

402.04 Proposed Street Construction: The plan shall include either a typical section or a reference to a specific standard and pavement design. Final pavement design shall be determined after CBR testing is completed to determine bearing capacity of the roadbed. The following items must be shown on the construction plan.

- A. Indicate stations every one hundred feet (100') on centerlines at points of curvature, points of intersections, at subdivision or section limits and at turn around radius points.
- B. Show profile of building restriction lines on the plan. Where there is no building restriction line show profile 25' from the right-of-way

line. Any profile greater than 25 feet shall require approval by the Director.

- C. Show existing centerline profiles for two hundred feet (200') minimum distance to insure proper grade tie when proposed street is an extension of or connects with an existing street.
- D. Show centerline profile of existing street for three hundred and fifty (350') feet or longer if necessary to insure that appropriate sight distance is achieved; to right and left of proposed connection when a proposed street intersects with an existing street.
- E. Show centerline and building restriction line profiles extended three hundred feet (300') beyond property line or boundary on all streets providing for access to adjoining property.
- F. Grade line of proposed street construction to include:
 - 1. Percent of grade. Minimum grade for curb and gutter shall be 0.5%. Maximum grade of street construction shall be as specified in standards for each typical section. Minimum grade for streets without curb and gutter is 1%.
 - 2. Elevations at beginning and end of all vertical curves.
 - 3. Length of vertical curves with elevation, sight distances and stations of points of vertical intersection (P.V.I.).
 - 4. Elevations computed every 25'.
 - 5. Elevations at all centerline intersections of streets and at all street centerline intersections with boundaries of subdivision.
 - 6. Point of finished grade on typical section (i.e., centerline, top of curb, etc.).
 - 7. Finish elevations of all sanitary sewer and water manholes that are in the paved area of a street.
- G. Indicate all roadside ditches in plan view and profile view where depth of cut is not in conformance with typical sections. Indicate all paved roadside ditches in plan view.
- H. Show proposed and existing culverts, storm sewer crossings, sanitary

sewer crossings, and utility crossings on street profiles at proper location and grade.

- I. When a proposed street parallels or is located near an existing stream or open drainage way, furnish profiles of top of bank of stream, computed water elevations and invert (or flow line) of stream or open drainage way. Show relation of proposed street grade to existing profiles of stream or open drainage way. Whenever street construction is proposed within the 100-year flood plain the requirements of Section 507 must be met.
- J. Grade profiles of proposed curb and gutter construction in cul-de-sacs to be computed along face of curb starting at the beginning of the curb return, following the face of curb around the cul-de-sac and then to the end of the return opposite the point of beginning. Grade ties of the proposed street, before entering the cul-de-sac grade shall be shown on each end of the cul-de-sac grade profile to insure proper grade connection. Other approved methods may be used subject to approval of the Director.
- K. Building restriction line profiles for cul-de-sacs shall be radial to the existing profile at face of curb and proposed curb grade.
- L. If a cul-de-sac is to be used as a turnaround at the temporary end of a street the proposed grade and existing profiles shall be carried through to provide for the future extension of the proposed street a distance of three hundred feet (300') beyond the property line. Final lot grading of the proposed extension shall be shown on the grading plan.
- M. Street construction shall be for the full frontage of all lots.
- N. All street construction, including sidewalks, must be within the dedicated street right-of-way. Grading or filling may be done in adjoining easements.
- O. Maximum centerline grade of a permanent cul-de-sac shall not exceed five percent (5%). The cross slope of the street for cul-de-sac will be a minimum of 1/4":1'.
- P. If a difference exists in elevations on proposed curb grades, identify curb elevations as: top of right curb and top of left curb.
- Q. Provide standard street landings on plans to provide adequate sight

distance. Standard landings are required for the minor (less VPD) street at all intersections.

- R. Lot grading plans must provide for adequate vehicular clearances.
- S. Indicate profiles of centerline of street and spot elevations for both left and right curb returns at intersections of streets to assure proper transition from one street to the other.
- T. Show connection to proposed VDOT construction when necessary.
 - 1. VDOT approval is required on all plans and revisions within VDOT right-of-way, and all plans and revisions that are to be accepted into the state system.
 - 2. Indicate state route numbers of existing streets. Show symmetrical transition of pavement at intersection with existing street. Transitions shall be a minimum of fifty feet (50') from the end of the curb return to the existing edge of pavement. This is a minimum requirement. A longer transition turn lane may be required.
- U. A VDOT permit will be required prior to any construction within the right of way or new access being connected to state system.

402.05 Design Requirements: The following procedures and use of tables 4-1 and 4-2 should be followed in the design of all streets and street connections, including commercial entrances.

- A. Determine the speed of the street in question. On new streets the design speed for sight distance consideration is based on the projected A.D.T. as shown in the following chart:

Projected A.D.T.	0-400	401-1000	1001-4000	4001-7000	7001-15,000
Design Speed(MPH)	20	25	30	40	45

- B. Design each new street so that all horizontal and vertical curves meet the minimum stopping sight distance outlined in Table 4-1, and the minimum passing sight distance outlined in Table 4-2. The alignment of all new streets has to meet these minimums with the exception that sag vertical curves are required to provide not less than the sight distance given in Table 4-1. Sight distances shall be calculated for all ranges of algebraic difference in grade based on a headlight height of two

feet (2') and a one degree (1°) upward divergence of the headlight beams. Standard VDOT "K" values will be used.

- C. After each street has been designed to meet the criteria in Tables 4-1 and 4-2 below, then each intersection needs to be checked to see that the criteria in Table 4-3 is achieved as well as other intersectional items such as standard landings, channelization, etc. It is also necessary that each connection to existing streets is checked to ensure these distances are achieved. The verification of this sight distance should be done graphically checking both the horizontal and vertical alignments. Sight distance will be shown along the line of sight.

TABLE 4-1

STOPPING SIGHT DISTANCE

Height of Eye:	3.50		Height of Object: 0.5'					
Design Speed	20	25	30	35	40	45	50	55
Minimum Sight Distance	125	150	200	240	275	325	400	450
Desirable Sight Distance	125	150	200	250	325	400	475	550

Use desirable values as the minimum values on all roads which carry in excess of 5500 VPD.

TABLE 4-2

SIGHT DISTANCES ALONG MAJOR STREETS AT INTERSECTION WITH
MINOR STREETS, CROSSOVERS, AND COMMERCIAL ENTRANCES

Height of Eye:	3.50'	Height of Object:	4.25'
----------------	-------	-------------------	-------

Design Speed (MPH)	20	25	30	35	40	45	50	55
	200	250	300	350	400	450	500	550
2,3&4 lane major street								

The term "Major Street" refers to the highest V.P.D. of the two (2) intersecting streets.

For median widths greater than sixty feet (60') each street can be considered separately.

The sight distances should be noted on the profile sheet on all vertical curves and on the plan sheets for all horizontal curves and for all the intersections. Profiles of existing streets must be shown a minimum of three hundred fifty feet (350') or the applicable sight distance in each direction along the main street.

Minimum crossover spacing for arterial roadways shall be 500 feet.

402.06 Other information to be shown on the plans:

- A. Show turnarounds where required and location of City required utilities.
- B. Indicate paved ditches when required at edge of street and at toe of fill; show easements where necessary. Include computations for determining the need for paved ditches.
- C. Indicate 3:1 maximum slope at end of street construction with necessary easement shown on the Plan.
- D. Show and provide slope and maintenance easement where required by VDOT.
- E. Indicate the erosion control protection to be provided at the end of construction of curb and gutter.
- F. Indicate the typical cross section for public and private streets, access aisles and parking areas. Where a typical section is approved, provide details on plans.
 1. Typical sections and geometric design criteria for streets shall conform to this Manual.
- G. Indicate cul-de-sacs at the ends of all dead-end streets. The minimum

pavement radius in the cul-de-sacs shall be forty-five feet (45') to the face of curb on edge of pavement.

- H. Show sidewalks where required in accordance with this Manual.
- I. Show traffic barricade signs where required.
- J. The following typical notes should be shown on all plans:
 - 1. Subbase depth is based on CBR value of 5. Soil tests of subgrade will be performed for actual determination of required subbase thickness prior to the placement of subbase.
 - 2. A smooth grade shall be maintained from centerline of existing road to proposed curb and gutter to preclude the forming of false gutters and/or the ponding of any water on the roadway.

403.00 PRELIMINARY STREET PLANNING

403.01 General Requirements: All streets on preliminary subdivision plats and also any streets in apartment, commercial and industrial developments, which are to be dedicated for public use, shall be designed to comply with the geometric standards of this Manual and current VDOT geometric standards. These standards require that design be based on traffic usage.

- A. In order to determine the proper street cross-section to use and to facilitate review and approval of preliminary plats, the following information shall be provided for each street intersection:
 - 1. The number of vehicles per day entering and leaving the intersection shall be noted on each leg of each street in each direction.
 - 2. The proposed street right-of-way, together with the proposed width of street (face of curb to face of curb or edge of pavement to edge of pavement) for each block on every street in the subdivision, is to be shown.
 - 3. All street construction shall be within the dedicated street right-of-way. Easements shall not be accepted to make up the minimum required right-of-way if any construction is proposed thereon. Slope construction easements shall be provided where required.
- B. The following information shall be shown for all streets which intersect the exterior boundary of the subdivision and which will provide access

to adjoining undeveloped property:

1. Number of acres expected to contribute vehicles to this street;
 2. An indication of how the adjoining property is shown on the adopted comprehensive plan together with the number of units per acre residential density proposed;
 3. The total number of units expected to be contributing to the subject street; and
 4. The total vehicles per day expected to be using the street.
- C. For streets which intersect the exterior boundary of the subdivision and connect with existing, dedicated or proposed streets in adjoining subdivisions, the following shall be required:
1. The number of lots from the adjoining subdivision from which vehicles will be expected to use the subject street; and
 2. The number of vehicles expected to enter the subdivision over the subject street from said lots.

403.02 Trip Generation:

- A. The following 24 hour volume trip generation for the various zoning districts shall be used:

1. Development Type	Trip Gen. per Dwell. Unit
Single-family residential	10
Townhouse residential	8
Apartment residential	5

Trip generation per use

Schools:

Parochial	960 VPD
Elementary	750 VPD
Intermediate	950 VPD
High School	3,900 VPD
Industrial	90 - 160 VPD/Acre
Shopping Center	400 -1000 VPS/Acre

- B. The above figures for trip generation shall be used for determining

vehicle contribution on-site and from adjoining undeveloped acreage based on the number of units allowed or expected per gross acre. Traffic volume calculations must appear on each Preliminary Plat.

403.03 Traffic Flow Characteristics:

- A. In the determination of traffic flow calculations, all preliminary plats shall show traffic divides, in a manner similar to the way in which drainage divides are currently shown, for the traffic which will be generated by the subject subdivision and from the adjoining subdivision passing through it or from adjoining undeveloped property which will ultimately be subdivided with traffic passing through the subject subdivision.
- B. The following items shall be considered in the calculation of traffic volumes where appropriate:
 - 1. Will any of the proposed streets serve as principal or secondary access to any school, either existing or proposed?
 - 2. Will any of the streets provide access to existing or proposed parks?
 - 3. Will any of the streets provide access to a neighborhood or other shopping area?
 - 4. Will any of the streets provide access to a public or semi-public facility or institutional use, such as church, nursing home, lodge hall, community swimming pool, private school, fire station, library, etc.?
 - 5. Could any street in the subdivision serve as a bypass or shortcut for traffic with both origin and destination outside of the subject subdivision or the adjacent subdivision or undeveloped property?
- C. An allowance for additional traffic volume shall be included when any of the above traffic generators could affect the proposed subdivision streets or which reasonably may be expected to at some future date.

403.04 Street Cross Section Determination:

- A. When traffic volume falls off to indicate a reduced cross section in the middle of the block, no reduction shall be permitted in mid-block.
- B. Typical street cross section shall be determined using Plate IV-E, based on design traffic volume.

- C. Cross sections may be reduced at intersections and at entrances contributing high volumes of traffic, such as shopping centers and apartments.
- D. If a through street has a wide cross section on both ends and traffic volumes would indicate a reduction for only several hundred feet in the middle of the subdivision, the full width street section shall be continued for its entire length.
- E. Averaging of traffic volumes (e.g. averaging 6,000 VPD on one end of the street with 2,000 VPD on the other end to produce a 4,000 VPD volume and thus a lower cross section) shall not be allowed for the purpose of reducing cross sections.
- F. All calculations which indicate the number of vehicles per day for each portion of each street in the subdivision shall be shown to expedite the review for conformance of proposed typical sections with the VDOT standards. Lacking this information it shall be assumed that no estimates have been made and the plan shall be returned for inclusion of traffic data.

ARTICLE IV

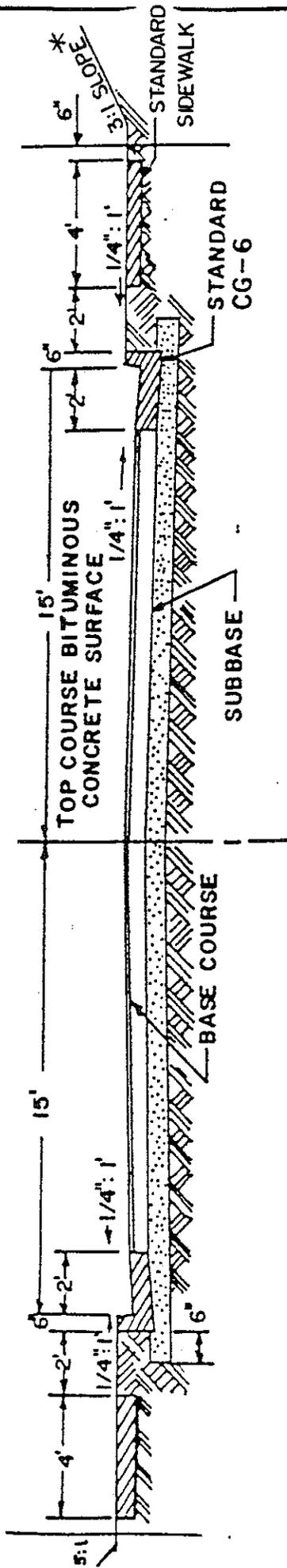
STREETS

SECTION 404.00 - ROAD DESIGN STANDARDS AND SPECIFICATIONS

<u>Detail</u>	<u>Plate</u>
Typical Section - Private Townhouse, Condominium, or Apartment Street with no Residential Frontage	IV-A
Intersection Landing Requirements for Grades between 2% and 7%	IV-B
Intersection Landing Requirements for Grades between 7% and 9%	IV-C
Private Driveway Entrance - Ditch Section	IV-D
Typical Street Sections	IV-E
Standard Entrance/Pipestem Lots/Curb & Gutter Section	IV-F
Standard Driveway Entrance DE-1	IV-G

ϕ PVMT.

PLATE IV-A



1. No Residential Frontage Permitted.

2. No Parking Permitted.

3. A Barrier Or Barricade Must Be Installed Between Adjoining Parking Bays And The Dedicated Right of way To Prevent Parked Vehicles From Overhanging The Right-of-way.

4. Distinct Cul-de-sacs Must Be Constructed Where Streets End And Parking Bays Begin.

★ 5. 2:1 Slopes Will Be Allowed Where Special Stabilization Is Provided In Accordance With The Erosion Control Ordinance.

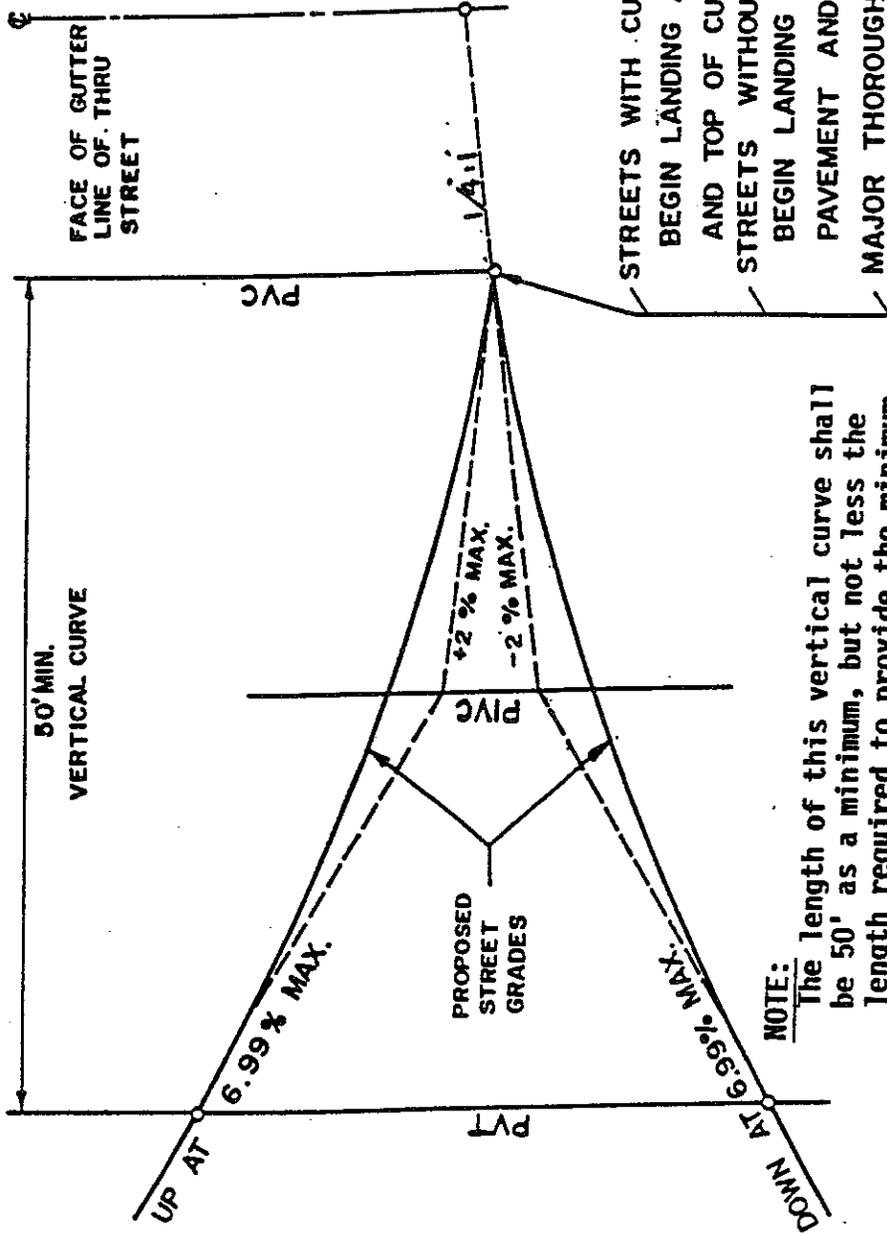
6. Standard Landing Required For Intersections With Public Streets.

7. Ingress/Egress Easements To Be Dedicated To The City Of Manassas Park.

8. Maximum Of 700 Vehicles Per Day For Private Streets.

9. Typical Section - Street Category II (See Plate IV-E).

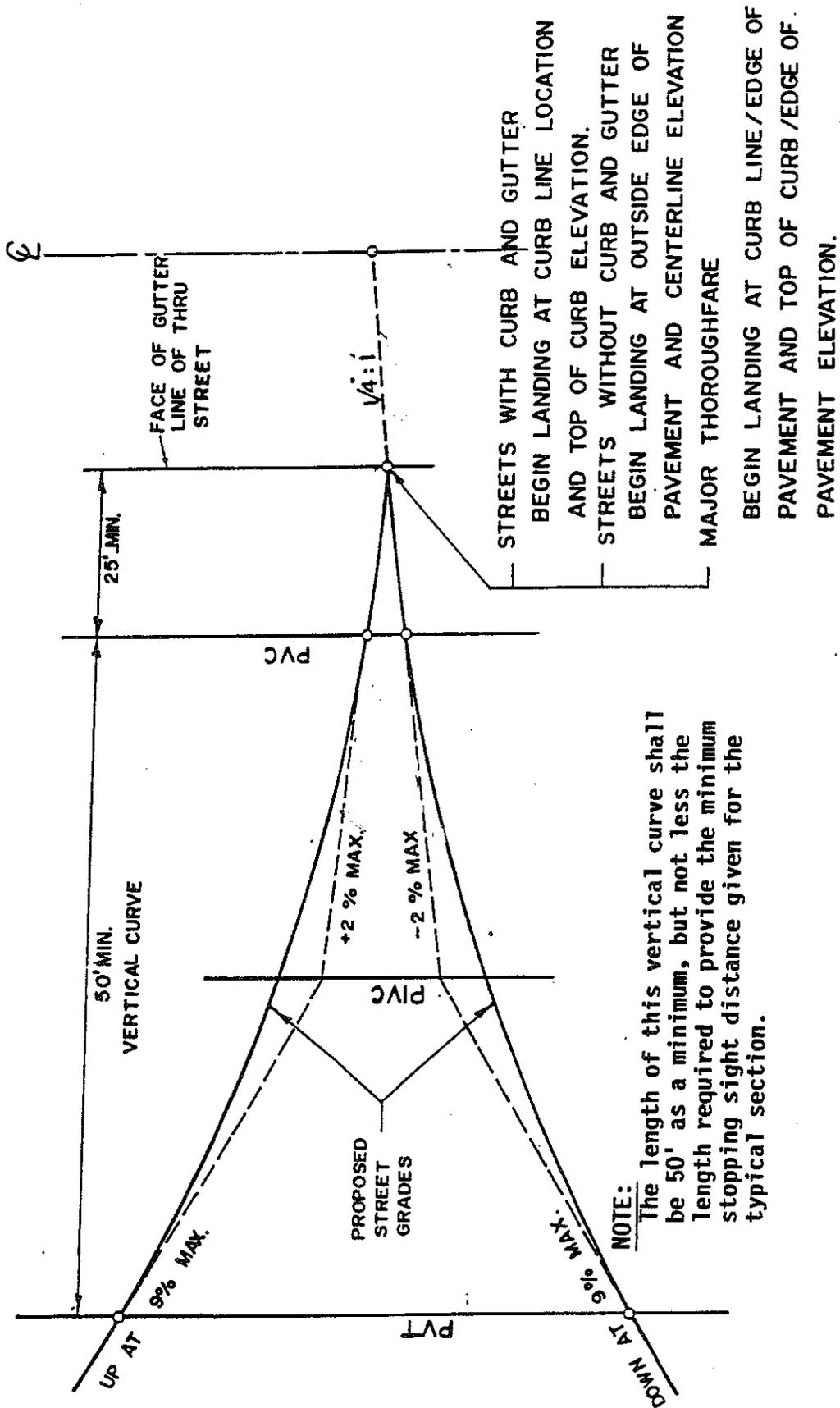
TYPICAL SECTION - TOWNHOUSE, CONDOMINIUM, OR APARTMENT STREET WITH NO RESIDENTIAL FRONTAGE



STREETS WITH CURB AND GUTTER
 BEGIN LANDING AT CURB LINE LOCATION
 AND TOP OF CURB ELEVATION.
 STREETS WITHOUT CURB AND GUTTER
 BEGIN LANDING AT OUTSIDE EDGE OF
 PAVEMENT AND CENTERLINE ELEVATION
 MAJOR THOROUGHFARE
 BEGIN LANDING AT CURB LINE/EDGE OF
 PAVEMENT AND TOP OF CURB/EDGE OF
 PAVEMENT ELEVATION.

NOTE:
 The length of this vertical curve shall
 be 50' as a minimum, but not less the
 length required to provide the minimum
 stopping sight distance given for the
 typical section.

INTERSECTION LANDING REQUIREMENTS FOR GRADES
BETWEEN 28 AND 78

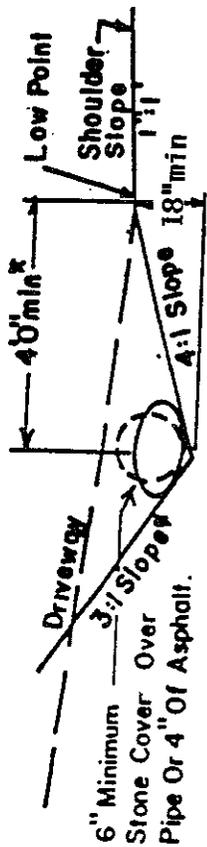


INTERSECTION LANDING REQUIREMENTS FOR GRADES

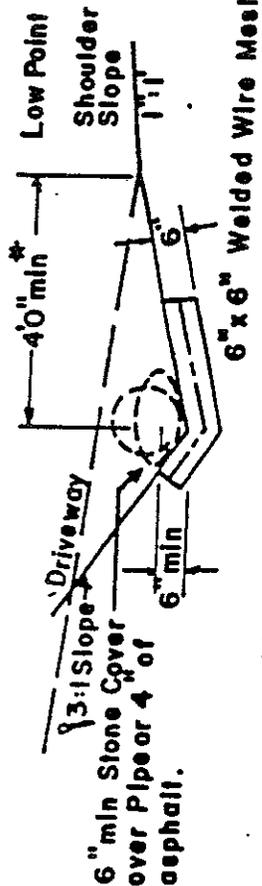
BETWEEN 7% AND 9%

DRIVEWAY CULVERT PIPE INSTALLATION

PLATE IV-D



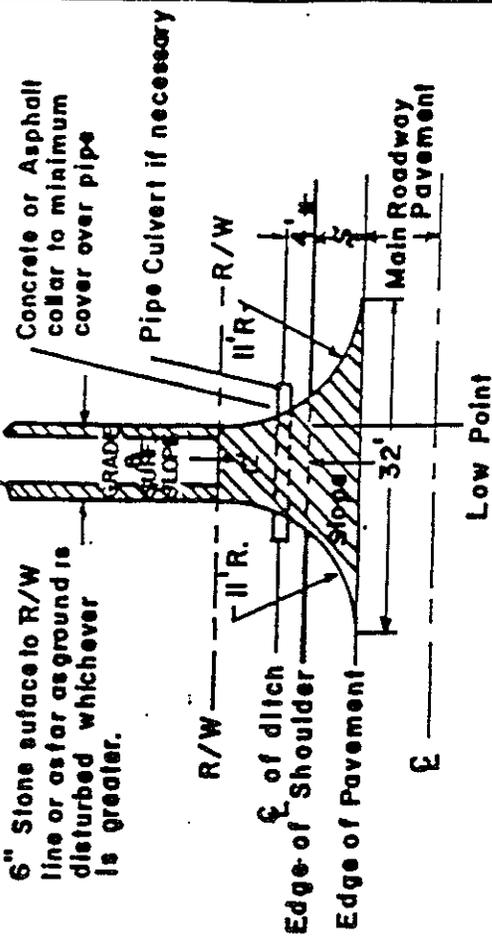
WITH UNPAVED ROADSIDE DITCH



WITH PAVED ROADSIDE DITCH

a paved ditch is required where soil conditions and runoff velocities will cause erosion.

* 2:1 Slopes will be allowed where special stabilization is provided in accordance with erosion and sedimentation control ordinance.

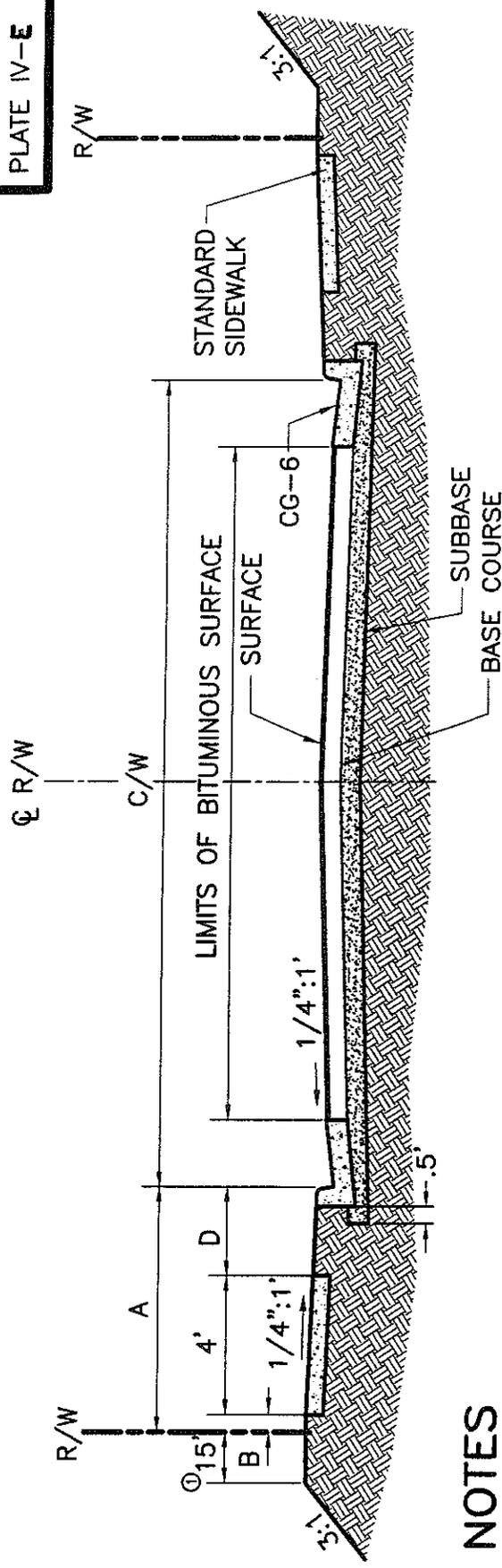


All construction and materials shall conform, where applicable, to the current Virginia Department of Transportation Road and Bridge Specifications.
 Concrete pipe or corrugated metal pipe may be used. Indicate type and size on plans.
 Driveways shall be surfaced from edge of pavement to property line with the same type of surfacing as used on street.
 All driveway grades shall start back of the shoulder line.
 In cut sections, sides of driveway shall be graded to a maximum 3:1 slope.
 Lengths of culverts if not shown on plans shall be a minimum of 20'.

* Ditch line may be moved back to provide required cover. The transition of the ditch line shall be smooth with a minimum length of 10 feet.

Grading Plans must provide for adequate vehicular clearance for driveway approach, departure and breakover transitions. Driveway profiles are required where steep grades prevail.

Driveways Shall Be Graded To Insure Positive Drainage Away From House.



NOTES

1. 15' C.S.E. REQUIRED WHERE APPLICABLE
2. MAXIMUM GRADE MAY BE INCREASED TO 15% UPON APPROVAL OF THE DIRECTOR OF PUBLIC WORKS.
3. NO SUPERELEVATION REQUIRED.
4. PAVEMENT DESIGNS BASED ON ASSUMED C.B.R. OF 5.
5. ADJUSTMENTS MAY BE MADE WITH SUBMISSION OF HIGHER TEST RESULTS.

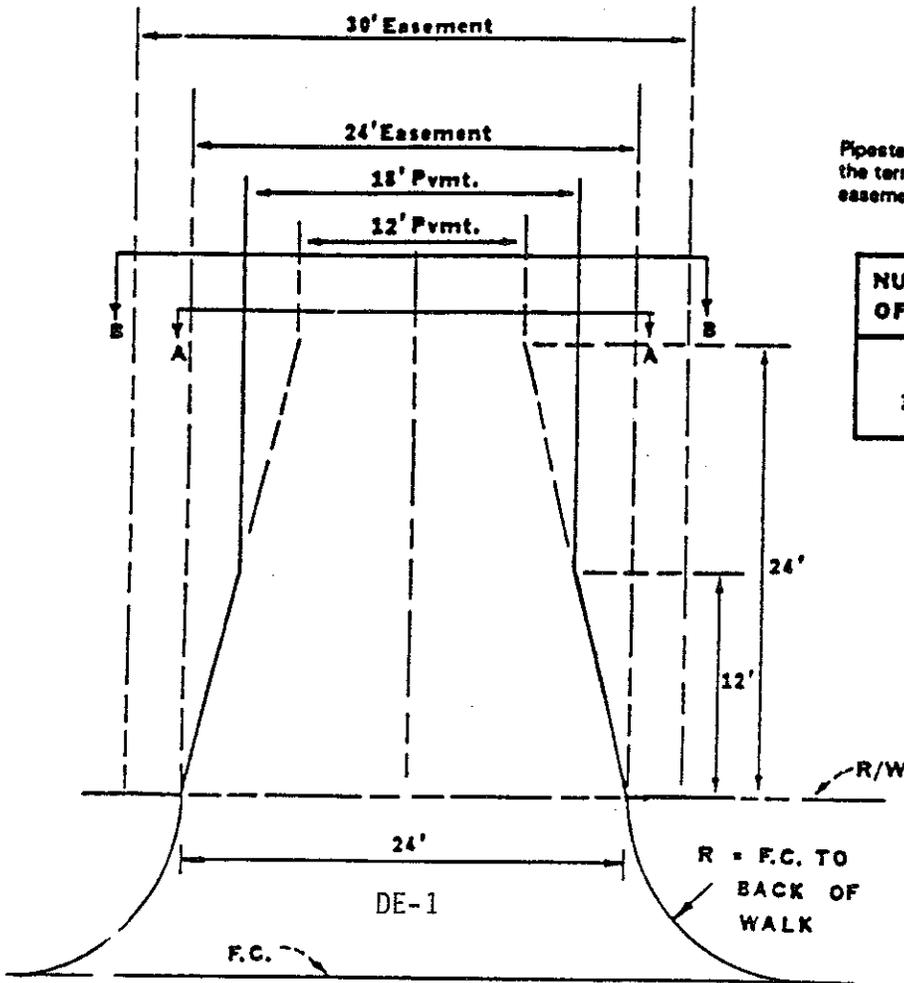
STREET CATEGORY	VPD	R/W	MAX. GRADE	MIN. RADIUS	C/W	A	B	D	SUBBASE 21-A	BASE BM-2	SURFACE SM-2A
I	0-400	50'	10%	120'	30'	10'	3.5'	2.5'	6"	3"	1.5"
II	401-1000	50'	10%	180'	36'	7'	0.5'	2.5'	6"	3"	2"
III	1001-2000	50'	10%	300'	36'	7'	0.5'	2.5'	6"	3"	2"
IV	2001-4000	52'	10%	300'	38'	7'	0.5'	2.5'	8"	6"	2"
V	OVER 4000	60'	9%	637'	44'	8'	1.5'	2.5'	8"	8"	2"

TYPICAL PUBLIC STREET SECTIONS

Driveway Clearances

PLATE IV-F

Grading Plans must provide for adequate vehicle clearance for driveway approach, departure and breakover transitions. Driveway profiles are required where steep grades prevail.

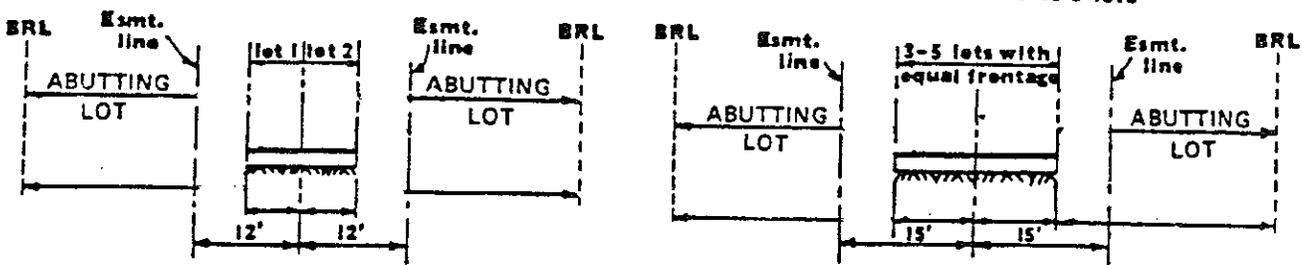


Pipestem driveways shall be paved to the terminal point of the driveway easement

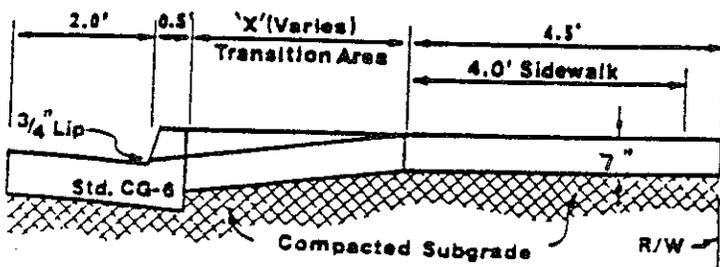
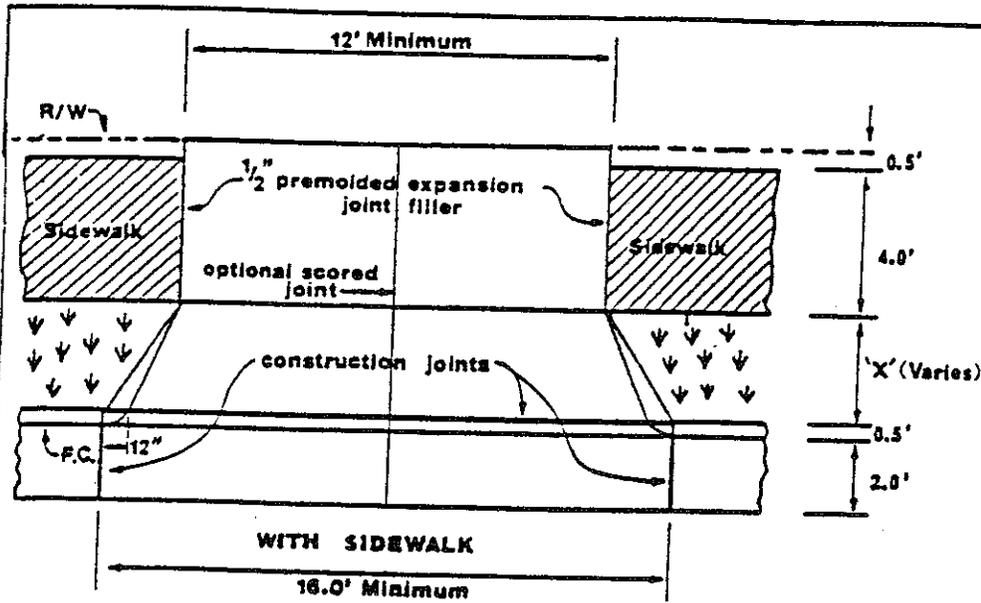
NUMBER OF LOTS	WIDTH OF EASEMENT	WIDTH OF PAVEMENT
2	24'	12'
3-5	30'	18'

SECTION A-A: 2 lots

SECTION B-B: 3 to 5 lots



STANDARD ENTRANCE
PIPE STEM LOTS
CURB & GUTTER SECTIONS



Driveway Clearances-

Lot grading plans must provide for adequate vehicular clearance for driveway approach, departure and breakover transitions. Driveway profiles are required where steep grades prevail.

All materials and construction of this design in a right of way to be maintained by COMP shall conform to the current VDOT Road and Bridge Specifications and VDOT Road and Bridge Standards.

**STANDARD DRIVEWAY
ENTRANCE**

REVISION NO.	DATE	STD. NO.
		DE-1
		PAGE NO

ARTICLE V

STORM DRAINAGE SYSTEMS

TABLE OF CONTENTS

	<u>Page</u>
SECTION 501.00 SPECIAL DEFINITION OF ADEQUATE STORM DRAINAGE SYSTEMS	V-1
SECTION 502.00 GLOSSARY FOR HYDRAULICS AND DRAINAGE	V-1
SECTION 503.00 CRITERIA FOR DESIGN OF STORM DRAINAGE SYSTEMS	V-6
503.01 Rational Formula	V-6
503.02 Schematic Drainage Plan	V-7
503.03 Runoff Coefficients	V-7
503.04 Rainfall Intensity vs. Duration	V-7
503.05 Time of Concentration	V-8
503.06 Pressure Flows at Junctions	V-8
503.07 Criteria for Acceptability of Storm Sewer Systems	V-9
503.08 Hydraulic Grade Line	V-9
503.09 Measures for Lowering the Hydraulic Grade Line	V-9
SECTION 504.00 GENERAL REQUIREMENTS FOR STORM SEWERS AND CULVERTS	V-11
504.01 Deviation from Standards	V-11
504.02 Plan and Profile Sheets	V-11
504.03 Pipe Materials	V-11
504.04 Pipe Culvert Sizes	V-12
504.05 Structure Locations	V-12
504.06 Maximum Distance Between Structures	V-12
504.07 Reduction of Pipe Size	V-12
504.08 Minimum Cover Requirements	V-13
504.09 Endwalls and Endsections	V-14
504.10 Erosion Control at Outlets	V-14
504.11 Placement of Erosion Control Measures	V-15
504.12 Erosion Control Guidelines	V-15
504.13 Flow Velocities Exceeding 20 Ft/Second	V-16
504.14 Manning's Formula	V-16
504.15 Spread on Streets	V-16
504.16 Drainage Across Intersections of Streets with Curb and Gutter	V-16
504.17 Drainage Across Intersections of Streets without Curb and Gutter	V-16
504.18 Headwater and Tailwater Computations	V-16
504.19 Easement Widths for Storm Sewer Systems	V-16

504.20	Easement Widths for Open Drainageways	V-16
504.21	Flood Plain Studies	V-17
504.22	Drainage Computation Sheets	V-17
504.23	Overland Relief	V-17
504.24	Drainage/Flow Arrows	V-17
504.25	Minimum Allowable Clearance	V-18
504.26	Erosion Protection at End of Curb and Gutter	V-18
504.27	Paved Ditches	V-18
504.28	Construction to Property Line	V-18
504.29	Curb Inlets in Sag Points	V-18
504.30	Major Culvert Design	V-18
504.31	Ditch Linings	V-18
504.32	Storm Sewer Construction on Steep Grades	V-18
504.33	Standard Details - Drainage Structures	V-19

SECTION 505.00 GENERAL REQUIREMENTS FOR INSTALLATION
OF DRAINAGE APPURTENANCES

		V-19
505.01	Construction Stakeout	V-19
505.02	Trenches	V-19
505.03	Bedding	V-19
505.04	Backfilling	V-19
505.05	Pipe Materials	V-19
505.06	Jointing - Rubber Gasket	V-20
505.07	Jointing - Corrugated Metal Pipe	V-20
505.08	Jointing Specifications	V-20
505.09	Ditch Construction	V-20
505.10	Curb and Gutter Construction	V-20
505.11	Expansion Joints	V-20

SECTION 506.00 STORMWATER MANAGEMENT

		V-20
506.01	General Requirements	V-20
506.02	Runoff Coefficients, Rainfall Intensities	V-21
506.03	Off-Site Drainage	V-21
506.04	Design Criteria	V-21
506.05	Stormwater Management Easements	V-22
506.06	Fencing Requirements	V-22
506.07	Stormwater Runoff Quality Control	V-22

SECTION 507.00 FLOOD PLAIN REQUIREMENTS

		V-23
507.01	General Off-Site Information Required	V-24
507.02	Flood Plain Study Requirements through Site	V-24
507.03	Basis for Determining Flood Limits	V-25
507.04	Minimum Lot Area Requirements	V-26

SECTION 508.00 EXHIBITS

V-27

ARTICLE V
STORM DRAINAGE SYSTEMS

501.00 SPECIAL DEFINITION OF ADEQUATE STORM DRAINAGE SYSTEMS

Adequate drainage systems are those which have the hydraulic characteristics to accommodate the maximum expected flow of storm waters for a given watershed or portion thereof for a specified duration and intensity of rainfall. Said systems (1) should be designed to account for both off-site and on-site storm waters, including storm waters coming onto a given tract of land from upstream, (2) should discharge said water into the natural drainageway, and (3) should carry said water to a point where it will flow by gravity downstream into a stream, channel, or drainageway, or where it can be connected into existing facilities of sufficient capacity as determined by the Director to receive the same. In general, drainage facilities should not be terminated short of the property line unless an adequate outfall exists there. Drainage structures should be constructed in such a manner that they can be maintained at reasonable cost. To facilitate design, construction, and maintenance, said systems should meet or conform to this Manual and Virginia Department of Transportation Standards.

Determination of the size and capacity of a drainage structure should take into account the ultimate planned development in the watershed or the affected portions thereof. The design should not adversely affect adjacent or neighboring properties.

502.00 GLOSSARY FOR HYDRAULICS AND DRAINAGE

(From Virginia Department of Transportation: the following were extracted from various publications or texts, having a more extensive glossary for the subjects of hydrology, and drainage)

ACRE-FOOT - Quantity of water that would cover 1 acre, 1 ft. deep. An acre-foot contains 43,560 cu. ft.

APPROACH CHANNEL - The reach of channel upstream from a dam, bridge, construction, culvert, or other structure.

APPROACH SECTION - A cross section of a stream channel, normal to thread of current, located in the approach channel.

APRON - A floor or lining of concrete to protect a surface from erosion, such as the pavement at the outlet of culverts or storm sewers.

BACKWATER - (A) In a general sense, a flow retarding influence due to a dam, other constriction such as a bridge or culvert, or another stream; (B) the

increase in water surface elevation due to a bridge constriction above the normal unstricted elevation, at an approach section located one bridge length upstream from the bridge constriction.

BACKWATER CURVE - A particular form of the surface curve of a stream of water which is concave upward. It is caused by an obstruction in the channel such as an overflow dam: the depth is greater at all points than Belanger's critical and the normal depths; and the velocities diminish downstream. The term is used in a generic sense to denote all water surface curves.

BERM - The space left between the upper edge of a cut and toe of an embankment to break the continuity of an otherwise long slope.

BRIDGE - A structure erected over a watercourse, depression, or obstacle (Webster's Collegiate Dictionary). As distinguished from a culvert it is a large structure spanning a watercourse, the bed of which is left comparatively undisturbed. The opening width is generally large compared to length (in the direction of flow). The structure generally consists of a deck or super-structure supported on two, or more, abutments, or piers.

CATCHMENT AREA OR BASIN - Watershed; drainage basin; also, the area of such a basin.

CHANNEL - An elongated open depression in which water may, or does, flow. An elongated depression, either naturally or artificially created and of appreciable size, which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It must have a definite bed and bank which serve to confine the water.

CHANNEL COEFFICIENT - A roughness factor in the Kutter, Manning, Bazin, and other formulas expressing the character of a channel as affecting the friction slope of water flowing therein. More specifically, the roughness factor (n) in the Manning formula.

COEFFICIENT OF ROUGHNESS - See CHANNEL COEFFICIENT.

CONDUIT - A general term for any channel intended for the conveyance of water, whether open or closed., any container for flowing water.

CONTROL - A section or a reach of a conduit where conditions exist that make the water level about it a fairly stable index of discharge. A control may be partial or complete. A complete control is independent of downstream conditions and is effective at all stages. An overflow dam, a ledge of rock crossing a channel, a boulder-covered reach, an indurated bed, are examples.

Controls may be either natural or artificial.

CRADLE - A footing structure shaped to fit the conduit it supports.

CREST - (A) The top of a dam, dike, spillway, or weir; frequently restricted to the overflow portion; (B) the summit of a wave; peak of a flood.

CRITICAL DEPTH - A given quantity of water in an open conduit may flow at two depths having the same energy head. When these depths coincide, the energy head is a minimum and the corresponding depth is Belanger's critical depth. It is the depth at which, for a given energy content of the water in a channel, maximum discharge occurs; or the depth at which in a given channel a given quantity of water flows with minimum content of energy.

CULVERT - A culvert is a closed conduit of waterway carrying water through a highway or railroad embankment. Although there are border-line cases, a culvert is distinguished from a bridge by certain characteristics, such as (a) a culvert generally has the same material all around its perimeter, and has a regular, symmetrical shape, where a bridge opening has not - in other words, a culvert is a large pipe; (b) a culvert usually has a large ratio of length to width.

CUT-OFF - A wall, collar, or other structure intended to reduce percolation of water along otherwise smooth surfaces, or through porous strata.

DEBRIS - Any material, including floating trash, suspended sediment, or bed load, moved by a flowing stream; detritus.

DIKE - An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of low lands; a levee.

DISCHARGE - (A) The quantity of water, silt, or other mobile substances passing along a conduit per unit of time; rate of flow; cubic feet per second; liters per second, millions of gallons per day, etc. (B) The act involved in water or other liquid passing through an opening or along a conduit or channel. (C) The water or other liquid which emerges from an opening or passes along a conduit or channel.

DITCH - An artificial channel, usually distinguished from a canal by its smaller size.

DRAINAGE AREA - The drainage area of a stream at a specified location, measured in a horizontal plane, which is enclosed by a topographic divide such that direct surface runoff from precipitation normally would drain by gravity into the river basin above the specified point.

DROP - (A) A structure for dropping the water in a conduit to a lower level and dissipating its surplus energy. A drop may be vertical or inclined; the latter is called a chute; (B) a fall. Also the drop or fall (h) in water surface elevation between the upstream and downstream (between headwater and tailwater) sides of a bridge construction or submerged culvert. or between two sections of a slope reach.

ENERGY - The capacity to perform work; kinetic energy is that due to motion; and potential energy is that due to position. In a stream the total energy at any section is represented by the sum of its potential and kinetic energies.

ENERGY GRADIENT - The slope of the energy line with reference to any plane.

ENERGY HEAD - The elevation of the hydraulic grade line at any section plus the velocity head of the mean velocity of the flow in that section. The energy head may be referred to any datum, or to an inclined plane, such as the bed of a conduit. Total head above datum at any cross section.

ENERGY LINE - A line joining the elevations of the energy heads of a stream. The energy line is above the hydraulic grade line a distance equivalent to the velocity heads at all sections along the stream. A line representing the energy in flowing water. It is plotted a distance equal to depth plus velocity head above a profile of the flow line of a conduit. The slope of this line represents the rate of loss of head and it must always slope downward in the direction of flow.

ENTRANCE LOSS - The head lost in eddies and friction at the inlet to a conduit or structure.

FLOOD PEAK - The maximum discharge of a particular flood at a given point along a stream.

FLOOD PLAIN - Any plain which borders a stream and is covered by its water in time of flood; stream bed areas subject to recurrent overflow, or inundation.

FLOOD ROUTING - (RESERVOIR ROUTING) - Determination of the hydrograph for a particular site in a surface channel on the basis of hydrograph data for another site some distance up or downstream. NOTE: Flood routing is generally used to determine changes made in flood hydrograph by the floods passing through a stream reach or reservoir.

FLOODWAY - The channel of a river, stream or other watercourse and the adjacent land area that must be reserved to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot at any

point.

FREQUENCY CURVE - A graphical representation of the frequency of occurrence of specific events. In flood studies, frequency is expressed as recurrence interval which is the average number of years within which a given peak discharge or rainfall intensity will be equalled or exceeded.

FRICITION LOSS (OR HEAD) - The head or energy loss as the result of disturbances set up by the contact between a moving stream of water and its containing conduit. For convenience friction losses are best distinguished from losses due to bends, expansions, obstruction, impacts, etc., but there is no recognized line of demarcation between them, and all such losses are often included in the term "friction loss".

HEAD - The height of water above any point or plane of reference. Used also in various compounds, such as energy head, entrance head, friction head, static head, pressure head, lost head, etc.

HEAD-WATER - (A) The water upstream from a structure; (B) the source of a stream.

HYDRAULIC GRADE LINE- In a closed conduit a line joining the elevation to which water could stand in risers. In an open conduit, the hydraulic grade line is the water surface; piezometric head line.

HYDRAULIC GRADIENT - The slope of the hydraulic grade line; the slope of the water surface in uniform, open-channel flow.

HYDRAULIC JUMP - The sudden and usually turbulent passage of water from a stage below critical depth to a stage above critical depth during which the velocity passed from supercritical to subcritical. It represents the limiting conditions of the surface curve wherein it tends to become perpendicular to the stream bed.

HYDROLOGY - The science dealing with the waters of the earth in their various forms; precipitation, evaporation, run-off, and ground water.

IMPERVIOUSNESS - That quality or condition of a material that minimizes percolation.

INVERT - The floor, bottom, or lowest part of the internal cross-section of a conduit.

KINETIC ENERGY - Energy due to motion. The kinetic energy of a given

discharge is generally taken as proportional to the product of its weight per unit of time and the velocity head of its mean velocity. For a constant discharge, kinetic energy may be represented by a line at a distance above a flowing water surface proportional to the velocity head of its mean velocity. The elevation of such a line above any datum represents the total energy (potential plus kinetic) of the given discharge above that datum. Strictly, the kinetic energy of a given discharge is the integral of the kinetic energies of its particles.

OPEN-CHANNEL FLOW - Flow in any open or closed conduit where the water surface is free; that is, where the water surface is at atmospheric pressure.

PRECIPITATION - The total measurable supply of water received directly from the clouds, as rain, snow, and hail; usually expressed as depth in a day, month, or year, and designated as daily, monthly, or annual precipitation.

REACH - A comparatively short length of a stream or channel.

RUN-OFF COEFFICIENT - The rate of run-off to precipitation.

SECOND-FOOT - A cubic foot per second; optional usage, cu. ft. per sec.; cfs.

SPECIFIC ENERGY - The energy of a stream referred to its bed; namely, depth plus velocity head of mean velocity.

STORM SEWER - A sewer that carries only storm water, drainage and other water from the surface of the street, but not domestic sewage or industrial wastes; is commonly known as a storm sewer. NOTE: A storm sewer system consists of underground conduits, inlets, manholes, open channels, swales, and special appurtenances.

TAIL-WATER - The water just downstream from a structure.

TIME OF CONCENTRATION- The estimated time required for run-off to flow from the most remote section of the drainage area to the point at which the discharge is to be determined.

VELOCITY HEAD - The distance a body must fall freely under the force of gravity to acquire the velocity it possesses; the kinetic energy, in feet of head, possessed by a given velocity.

503.00 CRITERIA FOR DESIGN OF STORM DRAINAGE SYSTEMS

503.01 Rational Formula: The rational method shall be used for all stormwater drainage design (for drainage areas less than 200 acres)

in which $Q=ACI$. In drainage areas larger than 200 acres another proven method shall be used, e.g., Anderson method.

Q = Quantity of stormwater runoff in cubic feet per second

A = Drainage area in acres, contributing to the point of

concentration

C = Coefficient of runoff

I = Average rainfall intensity in inches per hour for the period of concentration to the point under consideration.

503.02 Schematic Drainage Plan: The on-site drainage area (A) shall be outlined on a schematic drawing which shall include contours at a two foot interval. Each differential area shall be shown with respect to the point of concentration and the acreage shown thereon. The minimum acceptable scale shall be 1" = 100' unless approved by the Director. Off-site drainage areas contributing water to the system being designed may be shown on USGS quad sheets or City topographic maps. A schematic drainage plan showing probable areas for detention, major drainage systems being proposed, and all existing drainage divides and any major changes in divides proposed must be submitted with the preliminary plan and all rezonings.

503.03 Runoff Coefficients: Coefficients of runoff shall be employed with respect to development as shown in Table 5-1.

503.04 Rainfall Intensity vs. Duration: Rainfall intensities for the following drainage designs can be derived by use of Plate V-A entitled "Rainfall Intensity vs. Duration".

- A. For all storm sewer systems where the drainage area does not exceed 500 acres, the 10 year rainfall frequency curve shall be used.
- B. For the design of all open, permanent channelization outfall systems where the quantity of water exceeds the equivalent capacity of a 72" concrete storm sewer, with 0.5% slope, the 25 year rainfall frequency curve shall be used.
- C. For waterways under major bridges or through culverts in the secondary roads system where the contributing drainage area is 600 acres or less, the 10 year rainfall frequency curve shall be used but calculations for the 25 year storm must be included and the corresponding water elevation shown on the plan and contained in an easement. If the contributing area is greater than 600 acres, then the 50 year rainfall frequency curve shall be used for secondary road bridges, culverts, etc. except when conditions upstream warrant additional consideration as determined by the Director or Virginia Department of Transportation (VDOT).
- D. Whenever a bridge or culvert is designed or considered for use on

the primary road system, then the 50 year rainfall frequency curve shall be used for all contributing drainage areas, and at least one foot (1') of freeboard shall be added to the waterway to avoid inundation of the roadway shoulder. See also 504.19.

- E. For determining the width of the flood plain where the watershed is one square mile or less, the 100 year rainfall frequency curve shall be used and 2 feet of freeboard shall be added to the easement line. For watersheds greater than one square mile contributing to the flood plain, the 100 year rainfall frequency curve shall be used and no freeboard shall be required.

- F. Standard curb inlets shall be designed in accordance with the latest edition of the VDOT Drainage Manual. Yard inlets and similar structures shall be designed using the 10-year storm event, unless otherwise specified by the Director.

503.05 Time of Concentration: The recommended time of concentration for various types of development are shown in Table 5-1. Plate V-B, entitled "Overland Flow Time", or any other acceptable engineering method may be used if the time of concentration is to be calculated.

503.06 Pressure Flows at Junctions: Storm sewer systems shall not be designed based on head-water pressure in junctions such as curb inlets, manholes, etc. The location of the hydraulic grade line shall be calculated and submitted on all systems where it appears possible that the water surface elevation in junction structures may approach the elevation of inlet throats or manhole covers during passage of the design storm flow. Without limiting the generality of the foregoing, the following system characteristics act to increase the possibility that interior water surface elevations will approach the level of inlet throats or manhole covers. The following characteristics should either be avoided or their effects compensated for:

- A. Numerous bends
- B. Shallow systems
- C. Junctions with directly opposed laterals
- D. Systems which rely on pipes flowing full at high velocities
- E. Systems with ineffective channelization

- F. Systems with numerous junction structures - extensive systems.

503.07 Criteria for Acceptability of System: Systems shall be acceptable where the hydraulic grade line for the 10 year storm flow is below the elevation of inlet throats or manhole covers and where, as provided for in the body of this policy, the capacity of pipes flowing full by Manning's Formula equals or exceeds the 10 year storm flow. Systems not meeting these criteria are unacceptable.

503.08 Hydraulic Grade Line: Calculation of the hydraulic grade line shall include adequate consideration of head losses at all junction structures (see Plate V-H). The hydraulic grade line shall be completed as recommended by the latest edition of the VDOT Drainage Manual. Other methods of computation must be approved by the Director.

503.09 Measures for Lowering the Hydraulic Grade Line: Measures for lowering the hydraulic grade line include the following:

- A. Increase pipe sizes thus reducing necessary velocities.
- B. Eliminate bends (but do not, for instance, replace one 90° bend with two 45° bends).
- C. Lower the system to provide deeper structures.
- D. Eliminate opposing laterals by off setting their centerlines a distance equal to the sum of the diameters.
- E. Limit the extent of individual systems.
- F. Provide effective channelization.
- G. Provide inlet shaping per VDOT IS-1 standard.

TABLE 5-1
 COEFFICIENTS OF RUNOFF (C) TO BE
 USED WITH THE RATIONAL FORMULA

	<u>C</u>	<u>Tc (MIN)</u>
Residential (Average lot size)		
a. 10,000 sq. ft. to 20,000 sq. ft.	0.35 - 0.45	10 - 15
b. 20,000 sq. ft. to 5 Ac	0.30 - 0.40	10 - 15
Parks and Agriculture (over 5 acres)	0.25 - 0.35	to be computed
Cemeteries	0.25 - 0.35	to be computed
Townhouses	0.65 - 0.75	5 - 10
Schools	0.50 - 0.60	10 - 15
Apartments	0.65 - 0.75	5 - 10
Industrial	0.80 - 0.90	5
Business, Commercial or Office	0.80 - 0.90	5
Residential Planned Community		
a. High Density	0.80 - 0.90	5
b. Medium Density	0.65 - 0.75	5 - 10
c. Low Density	0.35 - 0.45	10 - 15
d. Commercial and Industrial	0.80 - 0.90	5
e. Schools	0.50 - 0.60	5 - 10
f. Open Space	0.25 - 0.35	10 - 15
g. Gravel Lots	0.65 - 0.75	5 - 10
h. Asphalt Parking Lots Roofs	0.90 - 0.95	5
i. Grass Areas	0.50 - 0.60	10 - 15

- NOTES:
1. When calculating flow to a structure if all run-off to the structure is from impervious areas (i.e. pavement & roofs) the C to be used is 0.90.
 2. The lowest range of run-off coefficients may be used for flat areas (areas where the majority of the grades and slopes are 2% and less).
 3. The average range of run-off coefficients should be used for Intermediate areas (areas where the majority of the grades and slopes are from 2% to 5%).
 4. The highest range of run-off coefficients shall be used for steep areas (areas where the majority of the grades are greater than 5%), for cluster areas, and for development in clay soil areas.

504.00 GENERAL REQUIREMENTS FOR STORM SEWERS AND CULVERTS

- 504.01 Deviation from Standards: This Manual shall be followed unless specific deviation therefrom is authorized, in writing, by the Director.
- 504.02 Plan and Profile Sheets: The storm sewer and culvert systems are to be shown in plan and profile on 24" x 36" sheets.
- A. All construction information, including invert elevations (in and out), size, type of pipe, gauge, length and percent of slope shall be shown on plan and/or profile.
 - B. All storm sewer appurtenances shall be identified by type and number (i.e., DI-3B, Y1-1), including number of throats and locations on both plan and profile.
- 504.03 Pipe Materials: All pipe used for the construction of storm drainage systems shall be concrete. Corrugated metal pipe can be used for culverts where permitted.
- A. 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 reinforced concrete pipe; latest revision. Culvert pipe classed as "seconds" by the manufacturer of 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.

- B. Corrugated metal pipe culverts, where permitted by the Director and the Virginia Department of Transportation, shall meet the requirements of current Virginia Department of Transportation Designs and Standards.
- 504.04 Pipe Culvert Sizes: The minimum size for pipe culverts for storm drainage shall be fifteen (15) inches, except when used under driveway entrances without curb and gutter where 12 inch culverts may be permitted. Larger sizes may be required if deemed necessary by the Director and smaller sizes might be allowed if approved by the Director as being of adequate hydraulic design.
- 504.05 Structure Locations: A manhole or inlet shall be constructed at every change in line and grade or change in pipe culvert size. All storm sewers shall be straight between manholes, catch basins, or other appurtenances. At every structure there is required a minimum of 0.10 drop in inverts for pipes having the same diameter. Pipes 18 inches in diameter or larger may be constructed on horizontal curves. Radius and deflections shall not exceed 1/4 of the spigot length or as recommended by the pipe manufacturer. shop drawings shall be submitted to and approved by the Director prior to installation.
- 504.06 Maximum Distance Between Structures: The maximum distance uninterrupted by appurtenances shall be five hundred (500) feet if the pipe diameter is 42" or larger and shall otherwise be three hundred (300) feet.
- 504.07 Reduction of Pipe Size: There may not be a reduction in pipe size along the direction of flow except for stormwater management purposes.
- 504.08 Minimum Cover Requirements: The minimum cover for all drainage culverts within the street right of way shall be 2 feet. When the storm sewer pipe is laid outside the street right-of-way, a minimum of 1' cover shall be required unless subjected to loading conditions, where 2' of cover shall be required. If the minimum cover requirements as set forth in this section, cannot be met, then structural modifications may be submitted for approval by the Director .
- 504.09 Endwalls and Endsections: The ends, entry or exit, of any storm sewer or culvert shall be provided with a standard endwall,

headwall, curb inlet, yard inlet, flared end section or other appurtenance suitable for the intended use of the storm sewer, with the following exception: Twelve (12) and fifteen (15) inch diameter pipe culverts under driveways from streets using open drainage ditches in lieu of an underground system with curb and gutter may not be required to have endwalls. All such structures shall be shown on the plan and profile drawings. The following guidelines will be used to determine whether an end section or endwall will be used:

- A. On culverts or storm sewer inlets and outlets from 12" in diameter to 24" in diameter flared end sections will be used unless the height of fill and side slopes exceeds 20 feet or 2:1 respectively in which case a standard headwall should be used. If the headwater exceeds HW/D ratio greater than 1.5, then a headwall or approved end treatment will generally be required provided it can be installed safely and won't create a potential traffic hazard in the opinion of VDOT or the Director.
- B. On culverts or storm sewer inlets and outlets between 24" and 36" in diameter either standard flared end-sections or headwalls will be required depending upon the height of the fill, the quantity of water, and its velocity for the designed year storm. Generally speaking, a flared end-section can be used if the fills are 20' or less, HW/D is less than 1.5, there is less than 50 cfs inflow, or if the installation of a headwall would constitute a safety hazard in the opinion of the Virginia Department of Transportation and the Director.
- C. If the culvert or storm sewer inlet and outlet exceeds 36" in diameter a standard headwall will be provided unless this headwall would constitute a safety hazard to the traveling public in the opinion of VDOT and the Director, in which case a flared end-section should be considered. It should also be noted that for oval or elliptical shaped pipes the comparative size for round pipes will be used in determining what type of end treatment will be provided.

504.10 Erosion Control at Outlets: Provide erosion protection at the outlets of storm sewer lines and culverts based on outlet velocity in accordance with the following:

- A. 2 fps to 5 fps velocity: sod protection at the outlet (Kentucky Blue Grass or equally erosion resistant sod or other material).
- B. 5 fps to 8 fps velocity: VDOT Class I, dry rip-rap (VDOT Spec 414.03) or current equivalent.

- C. 8 fps to 11 fps velocity: VDOT Class II, dry rip-rap (VDH&T VDOT Spec 414.03) or current equivalent.
- D. 11 fps to 18 fps velocity: VDOT grouted rip-rap (VDOT Spec 414.03) or current equivalent.
- E. Velocities in excess of 18 fps shall require special design energy dissipators or impact basins. These structures may be designed in accordance with the following publications: Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Nomograph #25, U.S.Department of the Interior, Bureau of Reclamation; Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation, or similar text. Appropriate rip-rap protection should be provided in conjunction with these devices to prevent erosion and scour below the structure.

504.11 Placement of Erosion Control Measures: Placement of the above erosion control measures shall be performed in accordance with VDOT Standard 114.01, EC-1 with the following exceptions:

- A. The length of the apron of erosion control shall be calculated by the following formula:

$$L_a = 0.37V_o D$$
 Where L_a = apron length required, in feet V_o = outlet velocity, feet per second
 D = diameter of pipe, in feet
- B. The minimum depth of Class II rip-rap (414.03) shall be 24" (2 feet). If necessary, appropriate notes and/or details for construction of these erosion control measures shall be included on the plans.

504.12 Erosion Control Guidelines: In an effort to eliminate the numerous erosion problems and subsequent construction failures which have occurred at the outlets of storm sewer systems, the Director recommends the following guidance for laying out and designing storm sewer systems:

- A. The outlet end of the storm sewer system should, without exception, discharge directly into a stabilized existing drainageway.
- B. The outlet end of the storm sewer system should be as

compatible as possible with the grade, horizontal and vertical alignment and location of the existing drainageway into which it will discharge.

- C. Placing outlet structures or storm sewer systems on fill material should be avoided. If the outlet is on fill extra erosion protection is required.
- D. Placing erosion protection at outlets on fill material should be avoided. Should it be necessary for some reason to deviate from items (a) and (b) above, the preferred alternative would be a stabilized ditch of adequate capacity to convey the design storm flow from the outlet structure to the existing drainageway. However, any such deviation from the above stated policy will be subject to the review and approval of the Director.

504.13 Flow Velocities Exceeding 20 Ft/Second: For velocities in storm pipes greater than 20 fps based on 10 year frequency storms, pipe manufactured with 6000 psi concrete and meeting the strength requirements of ASTM C76 Class III and Class IV latest revision, as required for the intended use and location shall be required. Where velocities exceed 20 fps special designs will be required for consideration by the Director.

504.14 Manning's Formula: Storm sewer pipe sizes are to be determined by using Manning's Formula:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

with a minimum coefficient of roughness for the following types of pipes:

concrete pipe	0.013
corrugated metal pipe culverts with paved invert	0.021
plain corrugated metal pipe	0.024
field bolted arch pipe	0.030

- 504.15 Spread on Streets: Storm sewer systems must be designed and constructed in accordance with the VDOT Drainage Manual.
- 504.16 Drainage Across Intersections of Streets with Curb and Gutter: Whenever curb and gutter construction is proposed, storm water shall not be allowed to cross the surface of street intersections except in unusual circumstances where subsurface conveyance of storm water is deemed impractical (due to the distance to the nearest structure) by the Director and provided that the surface storm water flow does not exceed 2 cubic feet per second. In such cases the means of surface conveyance shall be approved by the Director and the Resident Engineer of the Virginia Department of Transportation.
- 504.17 Drainage Across Intersections of Streets without Curb and Gutter: Whenever streets without curb and gutter are proposed, no water shall be allowed to cross a street intersection. The water must be handled by a storm sewer pipe or system.
- 504.18 Headwater and Tailwater Computations: Headwater and tailwater computations must be submitted on standard forms approved by the Director (See Plate V-G). The maximum allowable headwater depth is that depth where the water does not exceed a height greater than 18 inches below the edge of the roadway shoulder, or where the depth of the ponded area exceeds 15 feet.
- 504.19 Easement Widths for Storm Sewer Systems: The widths of drainage easements shall not be less than as prescribed in the following table and shall be shown on plan and profile sheets and record plats:

15" to 18" pipe	15' easement
21" to 33" pipe	20' easement
36" to 48" pipe	25' easement
54" to 72" pipe	30' easement

For trench depths greater than six feet (6'), five feet of additional easement width shall be required for each five feet increment of additional depth.

All storm sewers shall be placed within the middle third of the easement.

- 504.20 Easement Widths for Open Drainageways: All open drainageways (areas of concentrated flow) will be in a minimum drainage easement of fifteen (15) feet. For open drainageways (areas of

concentrated flow) an easement is required of sufficient width for proper construction and maintenance based on the drainageways slope and typical cross-section. Drainage ditches shall be designed and constructed in accordance with the current Virginia Department of Highways Transportation Drainage Manual. The computations shall be submitted to the Director and the ditch shall be shown on the plan and profile with a typical section. Stabilization will be required based on velocity. Easements shall be shown on the record plat.

- 504.21 Flood Plain Studies: Flood plain studies, when requested by the Director shall be based upon the 100 year frequency rainfall curve. Two copies of the study shall be submitted which shall include plan and profile, topography contour intervals, flood level line, freeboard line and all lots adjacent to flood plain limits. Flood plain studies will be required whenever the drainage area is greater than 100 acres.

Flood plain studies may be required with a drainage area greater than 40 acres if there are lots proposed adjacent to the stream, it is a high density area and if the upstream development (actual or proposed) is not controlled, or planned to be controlled, by storm water management devices. In addition to determining the 100 year flood plain, the Director may require calculation of a floodway.

Flood plain studies may be required for drainage areas less than 40 acres. If there are lots proposed adjacent to the stream on which the proposed building site is less than 10 feet above the flow line of the stream. In such cases where the flood plain study is not required, a building restriction line shall be shown on the plat which conforms, as a minimum, to the contour which is 10 feet above the flow line of the stream. An easement shall be required for the flood area as established above.

- 504.22 Drainage Computation Sheets: Drainage computations sheets shall be submitted on forms approved by the Director. This shall include consideration of on-site and off-site drainage.
- 504.23 Overland Relief: All storm drainage systems must be designed to, as a minimum, provide overland relief for the 100 year storm without damaging or endangering nearby buildings.
- 504.24 Drainage/Flow Arrows: Drainage arrows are to be shown on curb and gutter, storm sewers, ditches, on-site pavement and drainage

areas.

- 504.25 Minimum Allowable Clearance: Minimum allowable clearance between storm sewer and any other underground piping shall be 18 inches.
- 504.26 Erosion Protection at End of Curb and Gutter: Erosion protection shall be placed where curb and gutter ends on fill sections or any soil which has eroding characteristics as determined by the Director.
- 504.27 Paved Ditches: In addition to other situations that require paved ditches, paved ditches shall be required in accordance with VDOT specifications. All paved ditches shall be shown in plan and profile by stationing and grade. A typical section of proposed ditch shall be shown on plans. Transitioning of paved ditches to other appurtenances shall be shown.
- 504.28 Construction to Property Line: 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 sewer 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.
- 504.29 Curb Inlets in Sag Points: For curb inlets occurring in sag points of the roadway, a minimum length of throat of six feet (6') shall be required and shall be calculated based on a 0.1% grade.
- 504.30 Major Culvert Design: All major culvert designs will be in accordance with the Virginia Department of Transportation drainage policy.
- 504.31 Ditch Linings: In storm drainage systems, permanent ditch liners of part-circle sections of bituminous or asbestos fiber pipe, or plastic or similar materials of light weight with non-rigid properties, are not acceptable. Ditch liners of part-circle sections of heavy weight, rigid pipe, such as cement concrete may or may not be acceptable depending on conditions, means of jointing and anchoring provided, bedding indicated, etc. Ditch linings of poured concrete are generally acceptable for most situations.
- 504.32 Storm Sewer Construction on Steep Grades: The need for anchors must be investigated when concrete storm sewers are laid on steep grades. Give careful attention to providing effectual anchors to

prevent sliding when the slope exceeds 16%, and erosion control at the outlet to prevent undermining of the endwall. Generally, slopes over 20% are not acceptable unless specifically approved by the Director.

504.33 Standard Details - Drainage Structures: Structures and appurtenances for inlets, curb and gutter, endwalls, junctions, etc., shall conform to the current edition of the Road Designs and Standards of the Virginia Department of Highways and Transportation unless approved otherwise in writing and on the plans by the Director. The use of precast structures from an approved manufacturer as per VDOT will be allowed.

505.00 GENERAL REQUIREMENTS FOR INSTALLATION OF DRAINAGE APPURTENANCES

505.01 Construction Stakeout: Prior to the construction of any storm drainage system, the owners' or developers' engineer or surveyor shall place adequate line and grade stakes and shall also set stakes and furnish grades so that all manhole tops can be set to finish grade, all in accordance with approved plans.

505.02 Trenches: The provisions of Section 204.02 of this manual shall apply to the construction of trenches to contain storm drainage systems.

505.03 Bedding: The provisions of the current sections of the VDH&T VDOT Specifications shall apply for the bedding requirements of storm drainage systems.

505.04 Backfilling: In addition to the provisions of Section 204.02 of this manual, all storm drainage pipe culverts shall be backfilled to a minimum depth of cover of two (2) feet above the top of the pipe.

If necessary when the storm drain occurs under curb and gutter, a minimum of nine inches (9") clearance from the bottom of the gutter may be permitted by the Director.

505.05 Pipe Materials: Unless otherwise approved in writing by the Director, or unless specifically indicated on plans having his approval, all pipe used for construction of storm drainage systems shall be concrete culvert pipe, meeting the current and appropriate specifications of the American Society for Testing Materials. The laying length shall not be less than three (3) feet.

- 505.06 Jointing-Rubber Gasket: The use of rubber gaskets when joining pipes will be permitted provided that installation is in strict accordance with manufacturer's specifications and the recommended lubricant is used. The type of rubber gasket, lubricant, and pipe therefor will be subject to approval by the Director or his designated agent.
- 505.07 Jointing-Corrugated Metal Pipe Culvert: When corrugated metal pipe culvert is used, jointing shall be in strict accordance with the pipe manufacturer's specifications.
- 505.08 Jointing Specifications: All jointing must comply with the current criteria, standards, and specifications of the VDOT if roads and streets are to be taken into the State Highway System.
- 505.09 Ditch Construction: Ditches shall be constructed true to the approved cross-section and shall be constructed on a uniform grade and straight line with the longitudinal axis of the drain pipe unless otherwise approved by the Director. The sideslopes shall be free from rocks and stumps and wild vegetation. After dressing the slopes to proper cross-section, they shall be seeded with a grass type seed or sodded to prevent erosion in accordance with the Virginia Erosion and Sediment Control Handbook, latest edition.
- 505.10 Curb and Gutter Construction: Curb and gutter construction shall be in sections of uniform length, approximately ten (10) feet, and no section shall be less than six (6) feet in length.
- 505.11 Expansion Joints: Expansion joints shall be placed in header curb, combination curb and gutter, and sidewalk every forty (40) feet. Where stationary structures such as drop inlets, manholes, etc. are within the limits of the curb and gutter, and sidewalk, an expansion joint shall be placed between the structure and the curb and gutter and sidewalk.

506.00 STORMWATER MANAGEMENT

- 506.01 General Requirements: The general goal of the City of Manassas Park's policy on stormwater run-off control is, "the amount (rate) of run-off will not exceed that which exists before development occurs." The location, area, and a general description of the storm water management plan must be submitted at the time of preliminary plan submission.

At the time of final plan submission, a final storm water management plan must be included. Design and calculations signed and sealed by a duly registered professional engineer, or a land surveyor (3-B) licensed to practice in the Commonwealth of Virginia, must be submitted.

The Director reserves the right to disapprove certain types of stormwater management systems for certain types of development. (i.e. the exclusive use of stormwater retention trenches in a large lot subdivision). Systems designed in VDOT right-of-way will only be approved if there is a well defined method of maintenance approved by VDOT.

- 506.02 Runoff Coefficients, Rainfall Intensities: Run-off coefficients and rainfall intensities shall be in accordance with this section. Coefficients of run-off shall reflect current zoning and/or planned use whichever is greater. On sites larger than 10 acres, the methodologies outlined in the Virginia Erosion and Sediment Control Handbook may be used in developing run-off volume and peak discharge.
- 506.03 Off-Site Drainage: Off-site topography clearly defining all contributing drainage areas must be submitted as part of the calculations.
- 506.04 Design Criteria: The basic criteria used in designing a facility are as follows:
- A. The 10 year frequency - 2 hour duration storm will be used in determining undeveloped flow.
 - B. A 10 year frequency, 2 hour duration storm will be used in determining the developed run-off. Increments of this storm (5 or 10 minutes) are computed and compared to the undeveloped storm to determine the amount of storage required.
 - C. Emergency spillways and ponds will be designed to pass the 100 year, two hour storm assuming that the principal spillway is inoperative. The effect of the 100 year two hour storm must be considered in the design of all stormwater management facilities. The weir formula ($Q=CLH^{3/2}$) shall be used in the design of the emergency spillway.

- D. The calculations submitted will have to include but not be limited to the following:
1. Hydrograph showing the 10 year and 100 year inflow and discharge.
 2. Depth versus volume of storage curve.
 3. Emergency spillway design calculations.
 4. Embankment design calculations.
 5. Percolation test and calculations for gravel trenches or pits proposed. The City Engineer reserves the right to require any additional calculations or information which may be necessary to evaluate the design of the facility.

506.05 Stormwater Management Easements: Due to the fact that all stormwater management plans are designed to be permanent systems, the City will require an easement around the system and an access easement to it. Access to the stormwater management facility shall not exceed a grade of 10%. Although the system is in an easement, the City will require the following note:

The owner of any property on which there is located an easement for stormwater drainage or control shall be responsible for the following items of maintenance, where applicable: Grass mowing with reasonable frequency, and the removal of debris and other matter to the best of the owner's ability where such debris or matter has impeded, or threatens to impede, the free flow of storm water through any drainage structure.

506.06 Fencing Requirements: The Director shall require temporary fencing around any silt pond. The Director may require permanent fencing, 6' in height around a stormwater management facility if the facility is over 2 feet deep, takes over two hours to drain, and the slope to the facility is in excess of 3:1; or, is in a congested area. If the facility is required to be fenced according to the above criteria, fencing may be waived if all homeowners within 500 feet of the facility sign a petition requesting the fence not to be erected.

506.07 Stormwater Runoff Quality Control: Preventing or reducing the amount of water pollution generated by non-point sources to a level compatible with water quality goals as set by the Federal Pollution

Control Act is a goal of primary importance to the City of Manassas Park.

The State Water Control Board has developed manuals for Best Management Practices which set forth an economically feasible program to control non-point 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.

Structural measures that store stormwater and rely upon solid settling processes to remove pollutants should be implemented, since minor modifications could practically convert a stormwater detention facility to a multipurpose facility satisfying both water quality and quantity needs.

Volume control best management practices like porous pavement, modular pavement and infiltration pits or trenches (when the soil permeability allows it) are also encouraged to be used.

507.00 FLOOD PLAIN REQUIREMENTS

It is recognized that whenever the balance established by nature between a watershed and its naturally stabilized drainageways is disturbed that some corrective measures must be taken to restore the balance and to avoid downstream flooding and damage.

Therefore, it is recognized that some improvements must be made within flood plains, streams and/or drainageways in such manner that the increased run-off from changes or improvements within the watershed may be accommodated without unacceptably elevating flood plain or stream levels particularly within improved or developed areas. This may take the form of stream bed clearing, removal of obstructions, reduction of constrictions, stabilization of stream bottom and/or banks or areas to eliminate or reduce erosion, widening, deepening or realigning of streams to provide the necessary hydraulic characteristics to accommodate the anticipated stormwater flow without damaging adjacent properties. These improvements should include the removal of silt and debris which may clog or damage downstream drainage structures or property, the filling of drainage ponding areas and stagnant pools which are potential vermin shelters and mosquito breeding areas. Recognizing the right of a land owner to the full lawful use of his land and the City's responsibility for the protection of the health, safety and welfare of all of its citizens, backwater areas may be filled when they are not required as safety valves or temporary retention reservoirs to control downstream run-off intensity

so long as the necessary drainageway is preserved and filled or excavated areas are adequately stabilized against erosion. The method outlined herein will provide a general guide as to the criteria and procedures used by the Director in the processing and approval of flood plain studies and their related flood plain easements.

507.01 General Off-Site Information Required:

- A. Drainage divides of off-site contributing areas and their relation to the site in question at a maximum scale of 1" equals 2,000 ft. (U.S.G.S. Quadrangle Sheets).
- B. Present zoning and planned zoning of the off-site contributing areas, and coefficient of imperviousness .
- C. Time of concentration will be estimated by generally accepted engineering procedures.
- D. With the establishment of the total off-site drainage area, the required rainfall curve to be used is as follows:
 - 1. If the off-site drainage area is less than one square mile, the 100-year rainfall curve shall be used. The freeboard easement shall be two feet (2') above the approved computed water level.
 - 2. If the off-site drainage area is more than one square mile, the 100-year rainfall curve shall be used without any freeboard.
- E. Friction coefficient - "N" factor both on-site and off-site shall be approved by the Director.
- F. The discharge (Q) shall be determined by the rational formula $Q = CIA$ for drainage areas less than 200 acres. For (drainage areas greater than 200 acres, another proven method shall be used, e.g. Anderson method.

507.02 Flood Plain Study Requirements Through Site:

- A. Field run topography of the stream through the site and extending three hundred (300') feet up and downstream from the property lines or to major construction, if deemed necessary.

- B. Field run topography shall extend to cover the limits of the flood plain freeboard except in cases of abrupt change in the characteristics of the terrain additional topography may be required.
- C. Base line shall be located as closely as possible to the centerline of the flooded area and the field run cross-sections shall be perpendicular to the stream channel and flood plain and taken at all constrictions and other areas of change in the channel and flood plain.
- D. A mathematical tie between the base line, flood plain easement line, and the lot property lines shall be required on the contour plan view of the flood plain at a scale of one inch equals fifty feet (1" = 50') horizontally.
- E. Cross-sections shall be plotted at a scale of one inch equals ten feet (1" = 10') vertically and horizontally. In cases of extremely flat terrain, a scale of one inch equals five feet (1" = 5') vertically and one inch equals fifty feet (1" = 50') horizontally shall be used.
- F. A profile of the stream bed indicating the elevation of water surface and invert of the stream entry fifty feet (50') for the full length of the flood plain will be submitted with the cross-sections. The scale of the profile shall be one inch equals five feet (1" = 5') vertically and one inch equals fifty feet (1" = 50') horizontally.
- G. Flood Plain Studies must be certified by a Virginia registered professional engineer.

507.03 Basis for Determining Flood Limits:

The procedure described herein is the method that shall be used for establishing water level elevations and balance of energy of flowing streams and/or flood plains.

- A. The examination of the topography of the flood plain area for the location of major constrictions, sharp changes of slope, or where the cross-section becomes narrow relative to the width of the channel.

- B. Review of the plotted cross-sections of the stream.
- C. Flood plain limits shall be determined using the Corps of Engineers HEC-12 computer model. Other modeling must be approved by the City Engineer.

507.04 Minimum Lot Area Requirements: In all zones with minimum lot area requirements, lots may be platted within the 100-year flood plain as long as the minimum lot area required by the particular zone is located outside the limits of the 100-year flood plain.

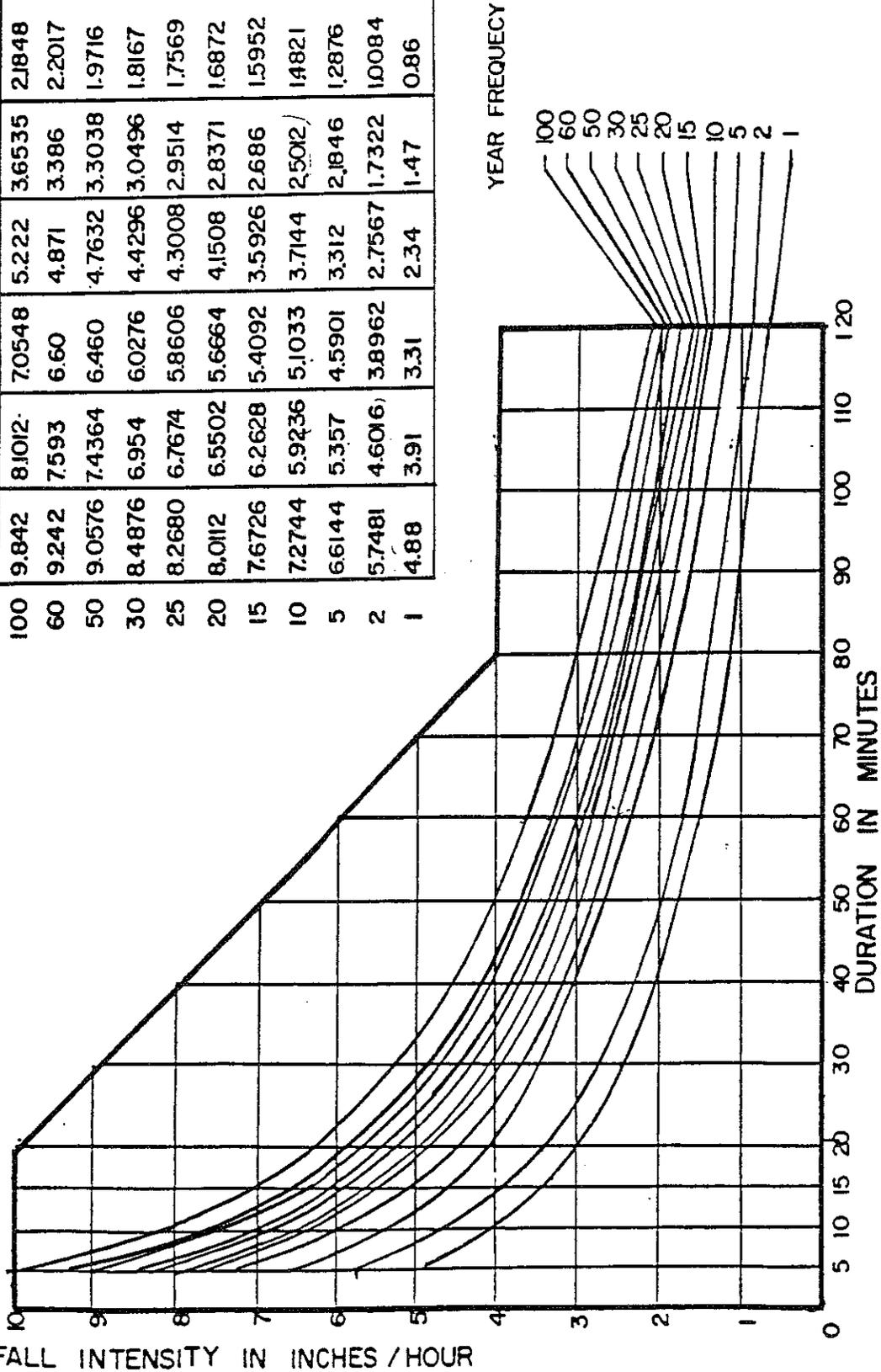
ARTICLE V
STORM DRAINAGE

SECTION 508.00 - EXHIBITS

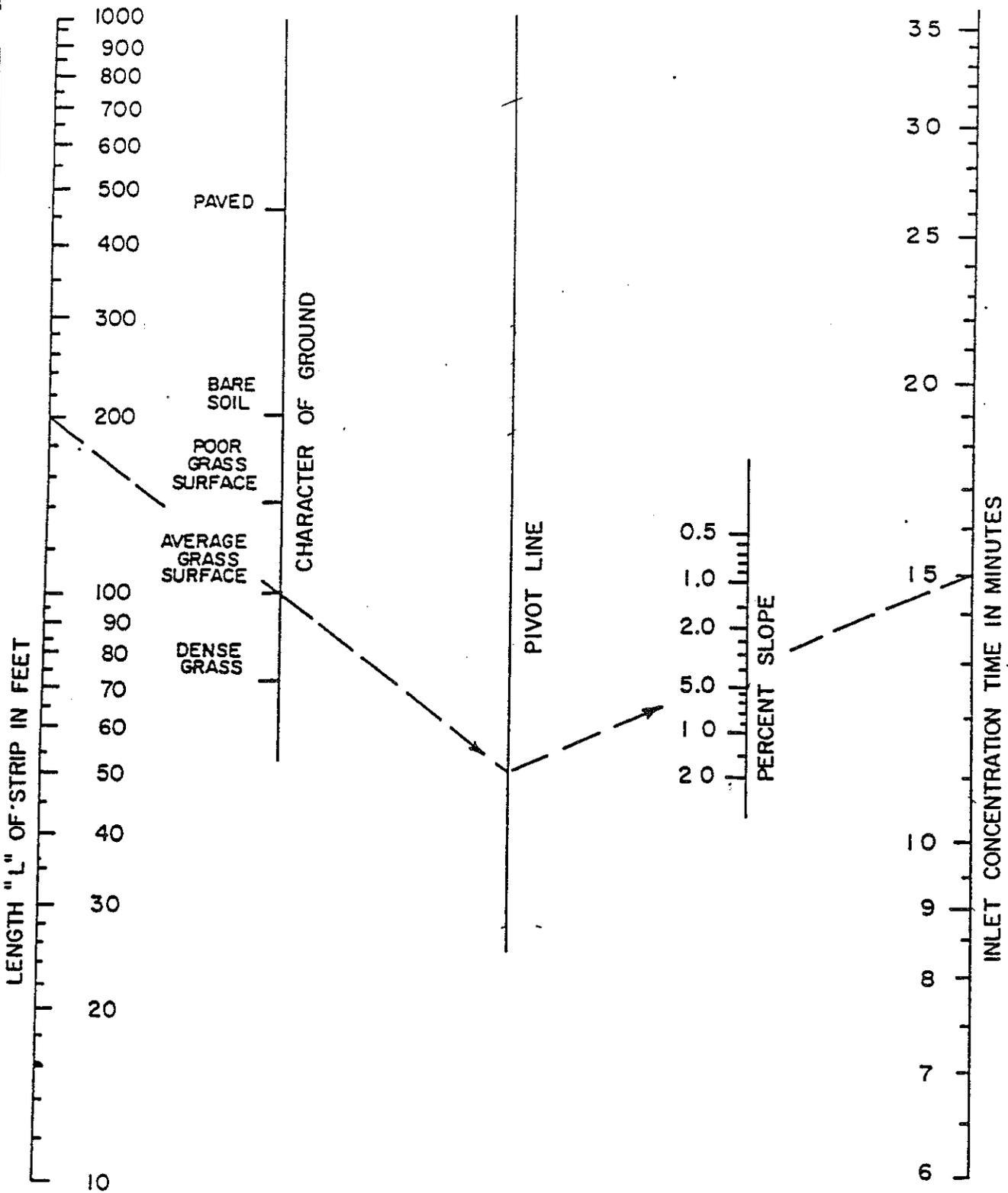
<u>EXHIBITS</u>	<u>PLATE</u>
Rainfall Intensity vs. Duration	V-A
Overland Flow Time	V-B
Pipe Capacities Flowing Full by Manning's Formula	V-C
Head Losses at Bends Other Than 90°	V-D
Storm Water Inlet Computation Sheet	V-E
Storm Sewer Design Computation Sheet	V-F
Culvert Headwater Computation Sheet	V-J
Hydraulic Grade Line Computation Sheet	V-H
Unit Inflow Hydrographs - 10 Year, 2 Hour Storm	
Tc = 5 Minutes	V-I
Tc = 10 Minutes	V-J
Tc = 15 Minutes	V-K
Tc = 20 Minutes	V-L
Tc = 25 and 30 Minutes	V-M
Unit Inflow Hydrographs - 100 Year, 2 Hour Storm	
Tc = 5 Minutes	V-N
Tc = 10 Minutes	V-O
Tc = 15 Minutes	V-P
Tc = 20 Minutes	V-Q
Tc = 25 Minutes	V-R
Tc = 30 Minutes	V-S
Incremental Unit Hydrograph Values	V-T

(Used with the Rational Formula)

	5 Min.	10 Min.	15 Min.	30 Min.	60 Min.	120 Min.
100	9.842	8.102	7.0548	5.222	3.6535	2.1848
60	9.242	7.593	6.60	4.871	3.386	2.2017
50	9.0576	7.4364	6.460	4.7632	3.3038	1.9716
30	8.4876	6.954	6.0276	4.4296	3.0496	1.8167
25	8.2680	6.7674	5.8606	4.3008	2.9514	1.7569
20	8.0112	6.5502	5.6664	4.1508	2.8371	1.6872
15	7.6726	6.2628	5.4092	3.5926	2.686	1.5952
10	7.2744	5.9236	5.1033	3.7144	2.5012	1.4821
5	6.6144	5.357	4.5901	3.312	2.1846	1.2876
2	5.7481	4.6016	3.8962	2.7567	1.7322	1.0084
1	4.88	3.91	3.31	2.34	1.47	0.86



RAINFALL INTENSITY VS. DURATION



OVERLAND FLOW TIME

with n = 0.013 for concrete pipe

$$Q = a \times \frac{1.486}{0.013} \times \left(\frac{a}{p}\right)^{2/3} \times s^{1/2}$$

$$F = a \times \frac{1.486}{0.013} \times \frac{a}{p}^{2/3}$$

$$Q = F \times (s)^{1/2}$$

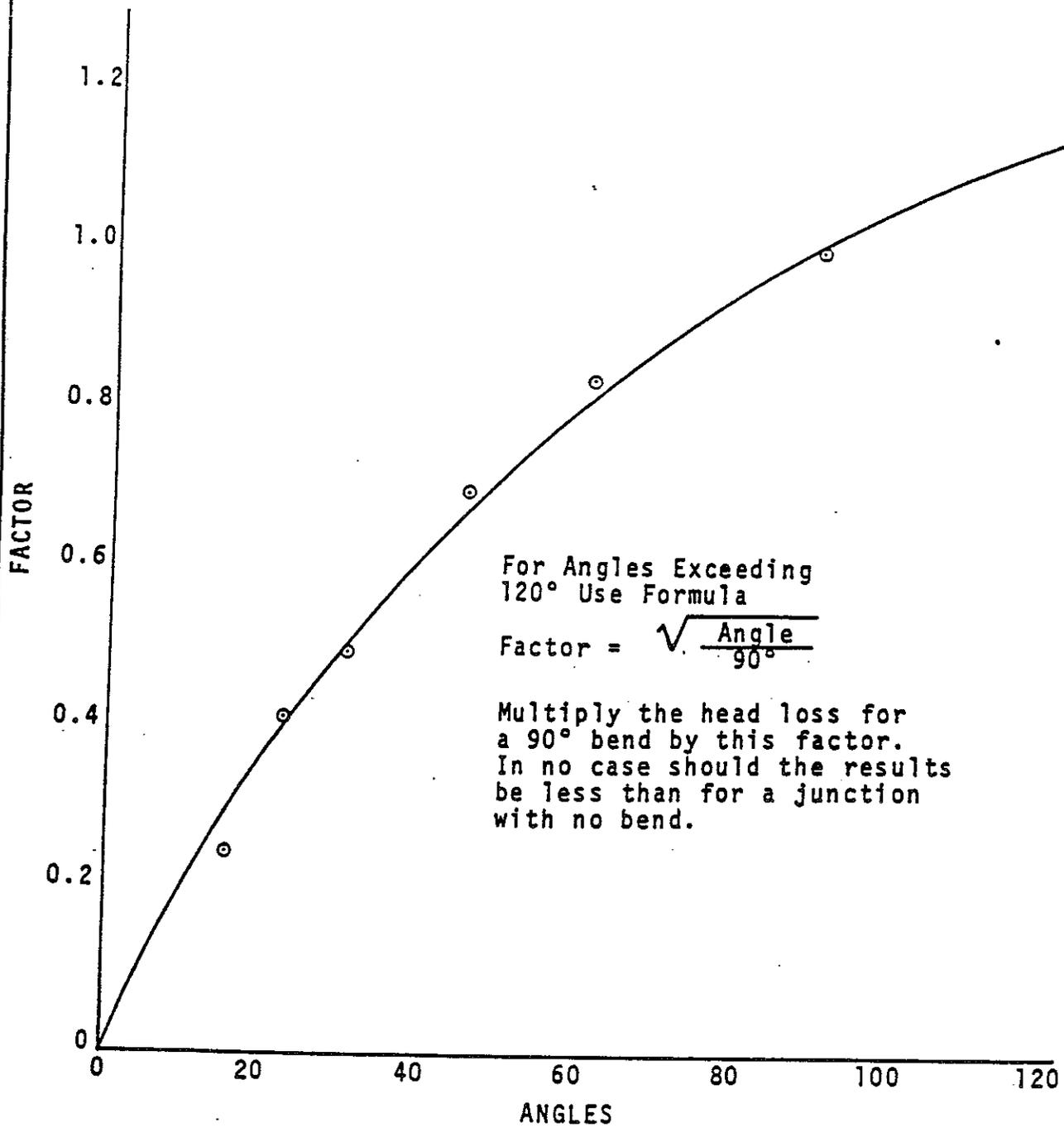
(s)^{1/2} values

PIPE DIAMETER, inches	F	Number	.....0	.....1	.....2	.....3	.....4	.....5	.....6	.....7	.....8	.....9
12"	35.64	.00001	.003162	.013317	.003464	.003606	.003742	.003873	.004000	.004123	.004243	.004359
15"	64.59	.00002	.004472	.004583	.004690	.004796	.004899	.005000	.005099	.005196	.005292	.005385
18"	105.04	.00003	.005477	.005568	.005657	.005745	.005831	.005916	.006000	.006083	.006164	.006243
21"	158.32	.00004	.006325	.006403	.006481	.006557	.006633	.006708	.006782	.006856	.006928	.007000
24"	226.20	.00005	.007071	.007141	.007211	.007280	.007348	.007416	.007483	.007550	.007616	.007681
27"	309.50	.00006	.007746	.007810	.007874	.007937	.008000	.008062	.008124	.008185	.008246	.008307
30"	410.20	.00007	.008367	.008426	.008485	.008544	.008602	.008660	.008718	.008775	.008832	.008888
33"	528.90	.00008	.008944	.009000	.009055	.009110	.009165	.009220	.009274	.009327	.009381	.009434
36"	666.60	.00009	.009487	.009539	.009592	.009644	.009695	.009747	.009798	.009849	.009899	.009950
42"	1006.10	.00010	.010000	.010050	.010100	.010149	.010198	.010247	.010296	.010344	.010392	.010440
48"	1436.00	.0001	.01000	.01049	.01095	.01140	.01183	.01225	.01265	.01304	.01342	.01378
54"	1965.00	.0002	.01414	.01449	.01483	.01517	.01549	.01581	.01612	.01643	.01673	.01703
60"	2604.00	.0003	.01732	.01761	.01789	.01817	.01844	.01871	.01897	.01924	.01949	.01975
66"	3357.00	.0004	.02000	.02025	.02049	.02074	.02098	.02121	.02145	.02168	.02191	.02214
72"	4234.00	.0005	.02236	.02258	.02280	.02302	.02324	.02345	.02366	.02387	.02408	.02429
78"	5242.00	.0006	.02449	.02470	.02490	.02510	.02530	.02550	.02569	.02588	.02608	.02627
84"	6387.00	.0007	.02646	.02665	.02683	.02702	.02720	.02739	.02757	.02775	.02793	.02811
90"	7679.00	.0008	.02828	.02846	.02864	.02881	.02898	.02915	.02933	.02950	.02968	.02985
96"	9119.00	.0009	.03000	.03017	.03033	.03050	.03066	.03082	.03098	.03114	.03130	.03146
		.0010	.03162	.03178	.03194	.03209	.03225	.03240	.03256	.03271	.03286	.03302
		.001	.03162	.03317	.03464	.03606	.03742	.03873	.04000	.04123	.04243	.04359
		.002	.04472	.04583	.04690	.04796	.04899	.05000	.05099	.05196	.05292	.05385
		.003	.05477	.05568	.05657	.05745	.05831	.05916	.06000	.06083	.06164	.06243
		.004	.06325	.06403	.06481	.06557	.06633	.06708	.06782	.06856	.06928	.07000
		.005	.07071	.07141	.07211	.07280	.07348	.07416	.07483	.07550	.07616	.07681
		.006	.07746	.07810	.07874	.07937	.08000	.08062	.08124	.08185	.08246	.08307
		.007	.08367	.08426	.08485	.08544	.08602	.08660	.08718	.08775	.08832	.08888
		.008	.08944	.09000	.09055	.09110	.09165	.09220	.09274	.09327	.09381	.09434
		.009	.09487	.09539	.09592	.09644	.09695	.09747	.09798	.09849	.09899	.09950
		.010	.10000	.10050	.10100	.10149	.10198	.10247	.10296	.10344	.10392	.10440
		.01	.1000	.1049	.1095	.1140	.1183	.1225	.1265	.1304	.1342	.1378
		.02	.1414	.1449	.1483	.1517	.1549	.1581	.1612	.1643	.1673	.1703
		.03	.1732	.1761	.1789	.1817	.1844	.1871	.1897	.1924	.1949	.1975
		.04	.2000	.2025	.2049	.2074	.2098	.2121	.2145	.2168	.2191	.2214
		.05	.2236	.2258	.2280	.2302	.2324	.2345	.2366	.2387	.2408	.2429
		.06	.2449	.2470	.2490	.2510	.2530	.2550	.2569	.2588	.2608	.2627
		.07	.2646	.2665	.2683	.2702	.2720	.2739	.2757	.2775	.2793	.2811
		.08	.2828	.2846	.2864	.2881	.2898	.2915	.2933	.2950	.2968	.2985
		.09	.3000	.3017	.3033	.3050	.3066	.3082	.3098	.3114	.3130	.3146
		.10	.3162	.3178	.3194	.3209	.3225	.3240	.3256	.3271	.3286	.3302

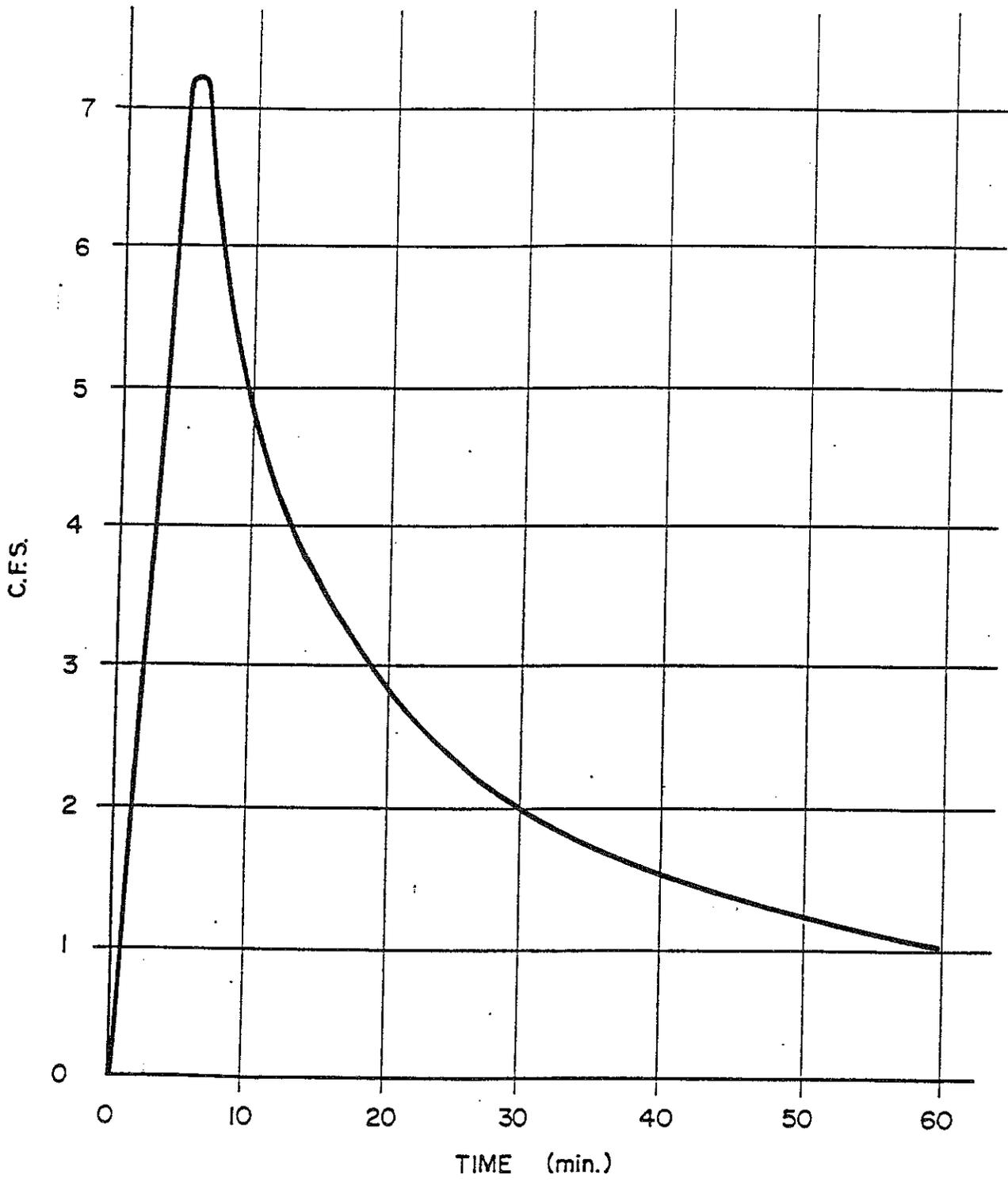
To obtain Q, multiply F by the square root of the slope, S, in ft. per ft.

To utilize this table for values of n* other than 0.013, first obtain Q based on 0.013, then multiply this Q by the ratio: other value of n divided into .013.

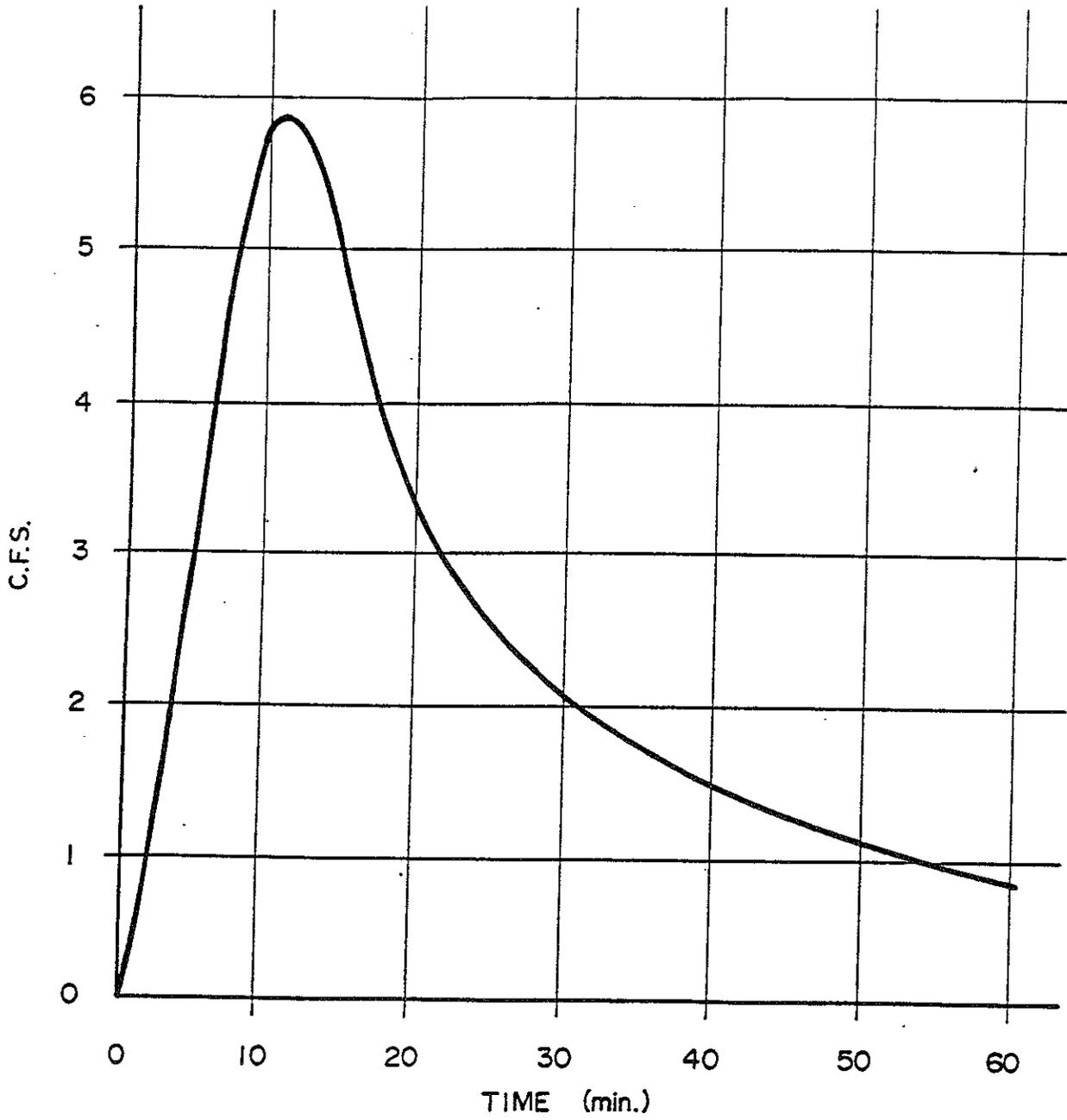
PIPE CAPACITIES FLOWING FULL BY MANNING'S FORMULA



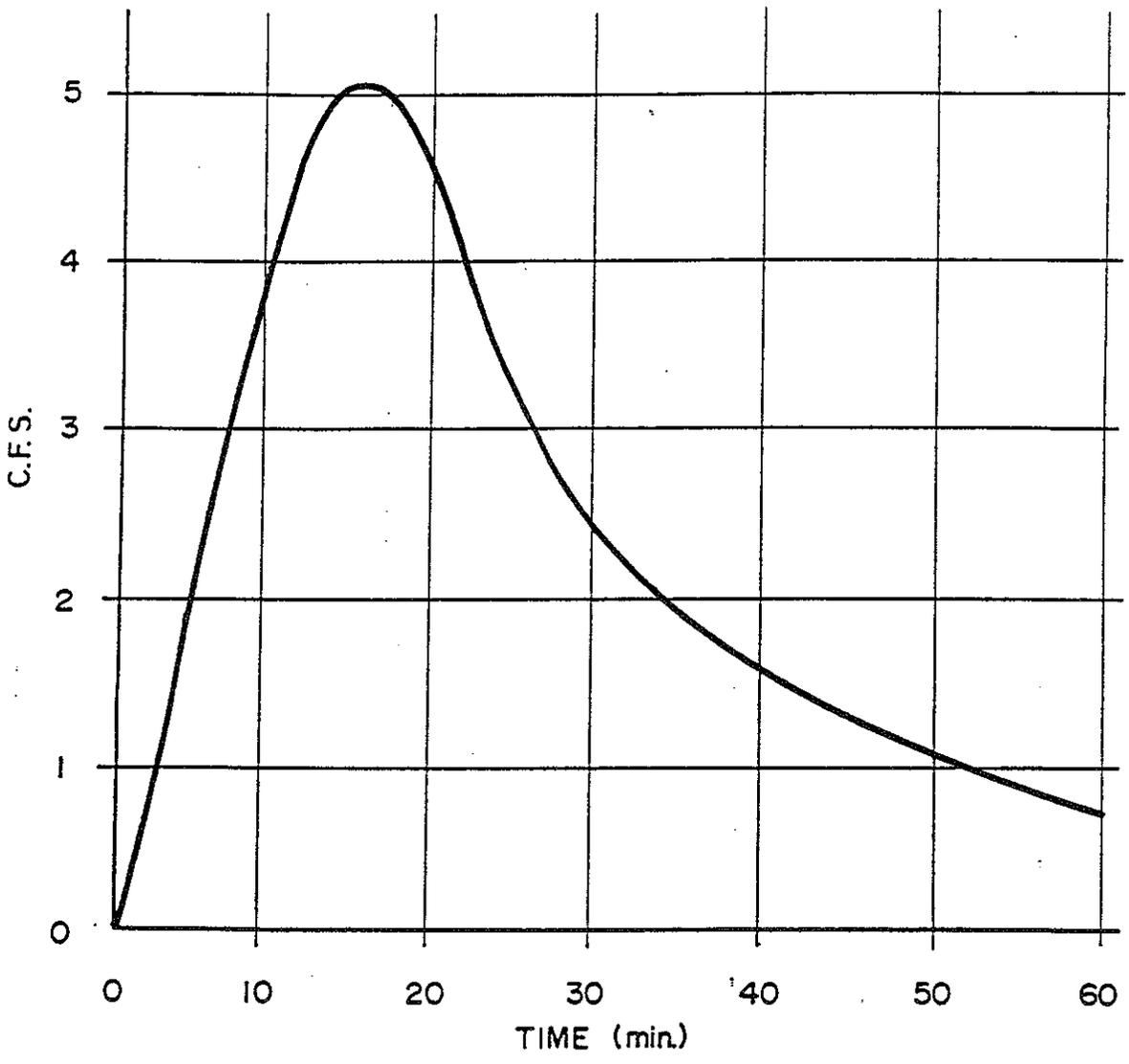
HEAD LOSSES AT BENDS OTHER THAN 90°



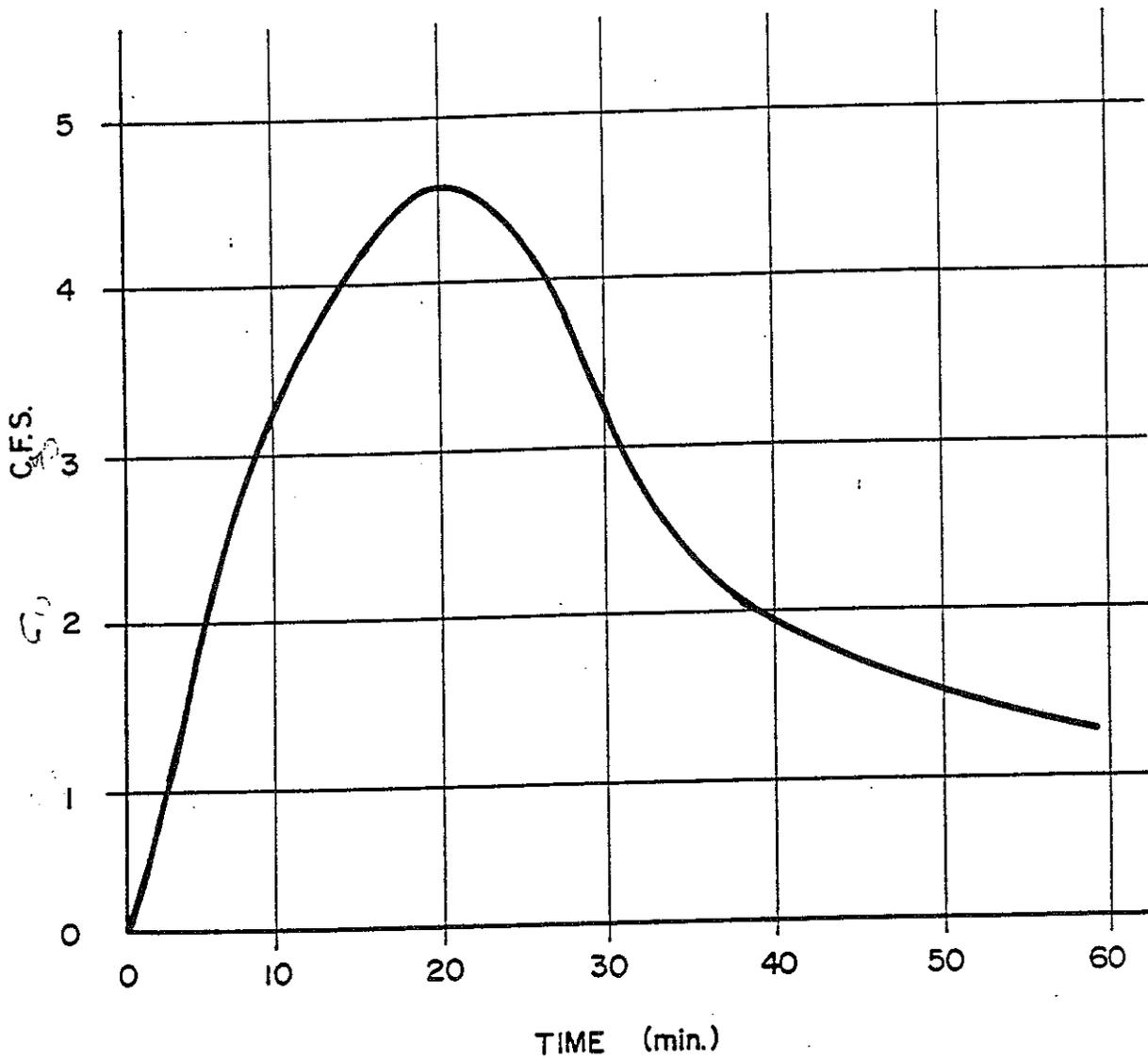
UNIT INFLOW HYDROGRAPH
10 YEAR, 2 HOUR STORM
 $T_c = 5$ MINUTES



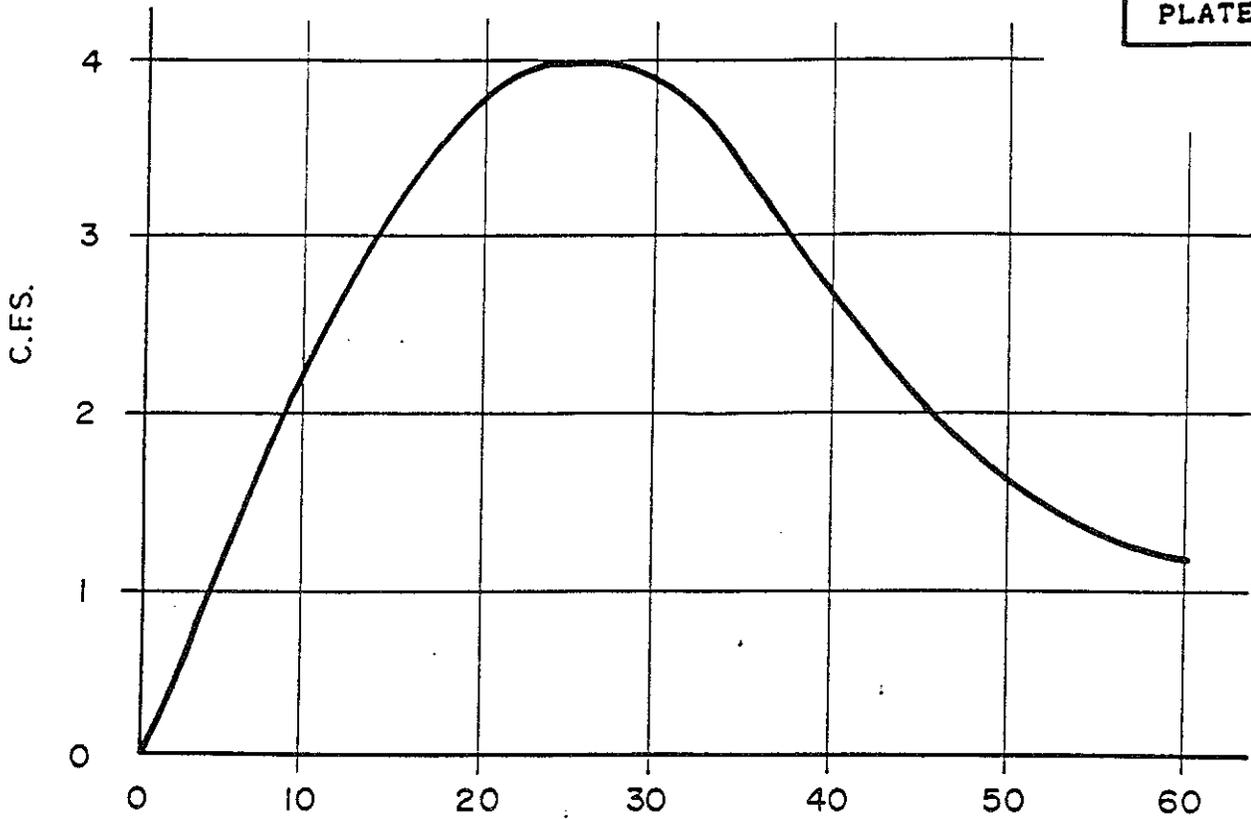
UNIT INFLOW HYDROGRAPH
10 YEAR, 2 HOUR STORM
Tc = 10 MINUTES



UNIT INFLOW HYDROGRAPH
10 YEAR, 2 HOUR STORM
Tc = 15 MINUTES

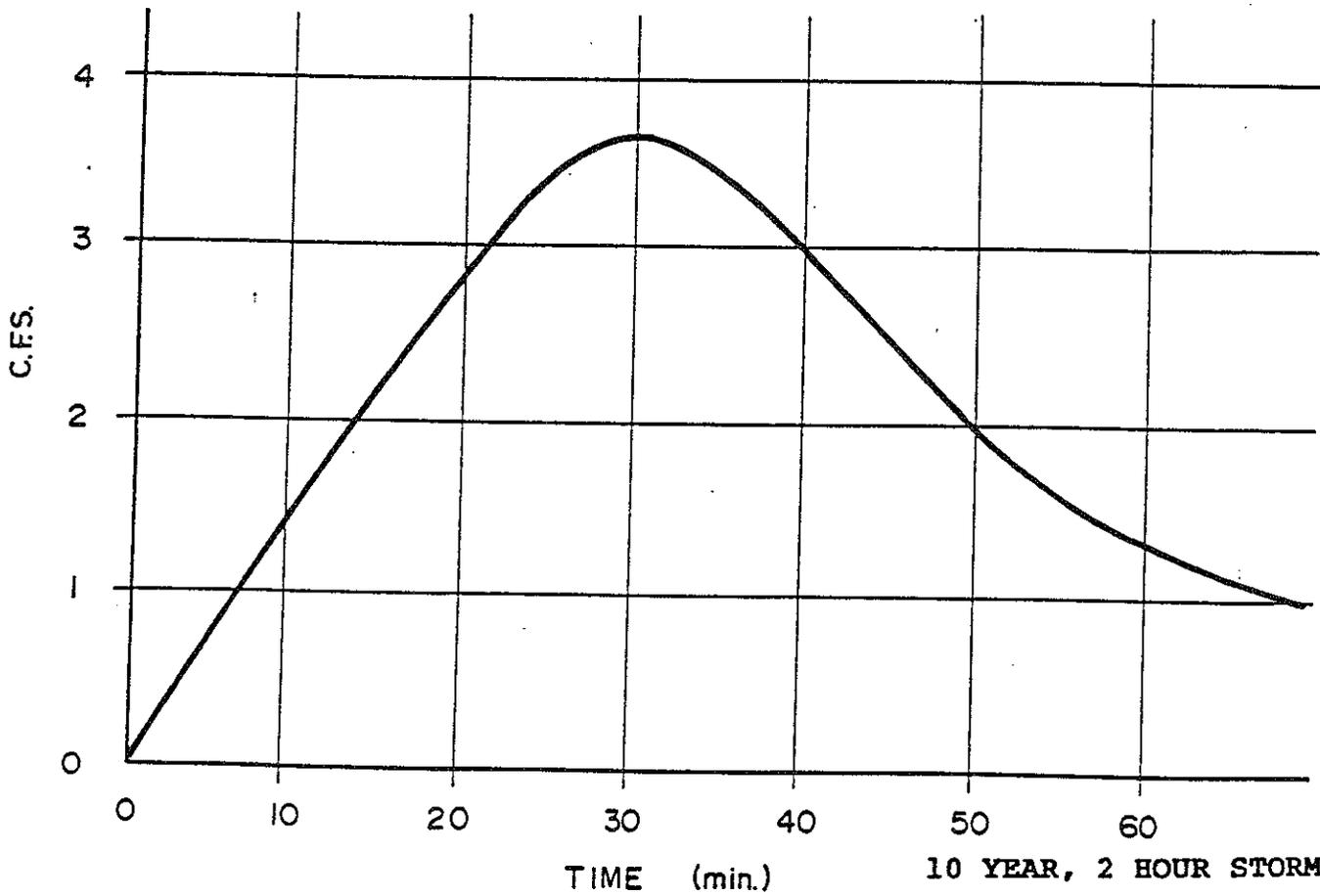


UNIT INFLOW HYDROGRAPH
10 YEAR, 2 HOUR STORM
Tc = 20 MINUTES



10 YEAR, 2 HOUR STORM

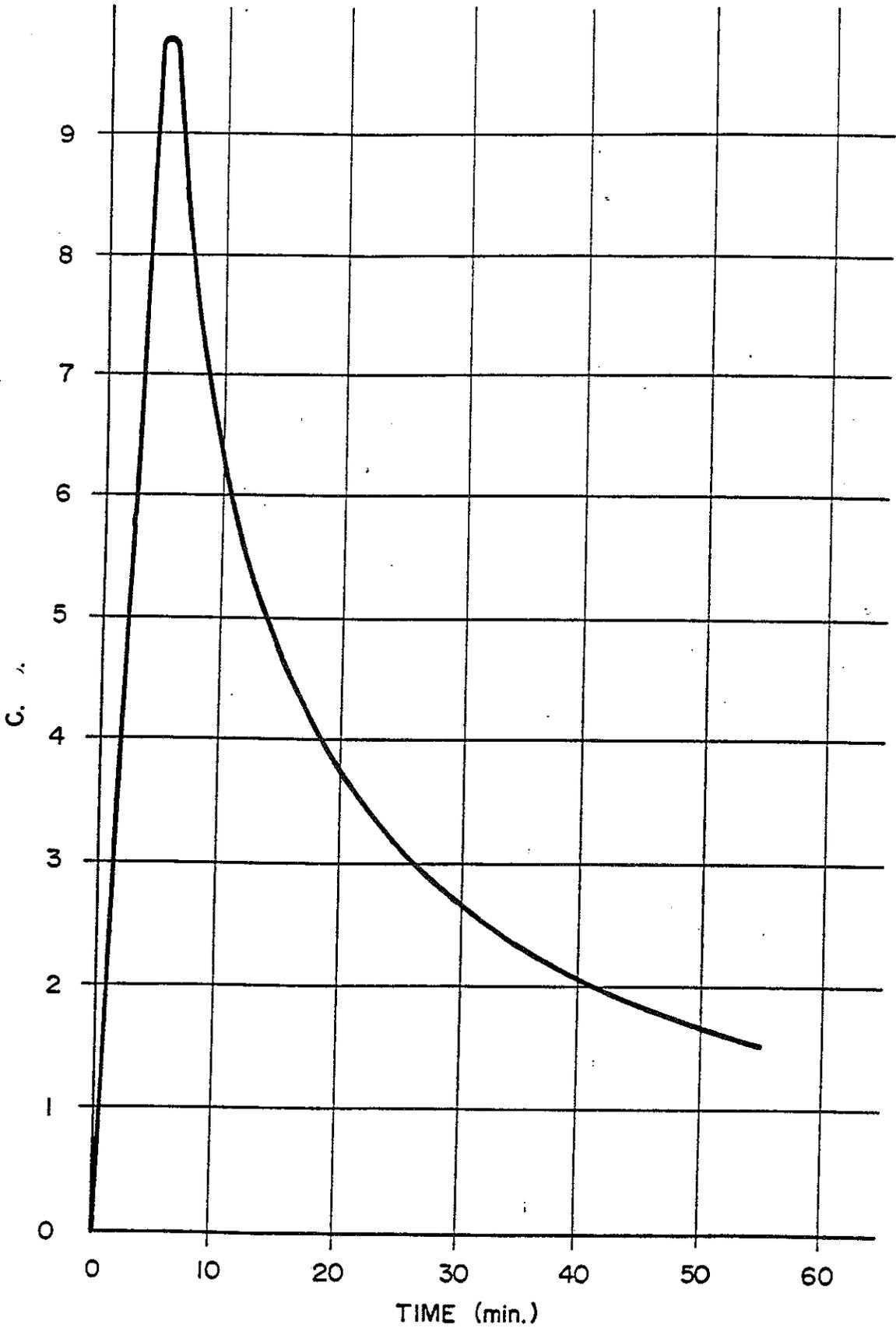
Tc = 25 MINUTES



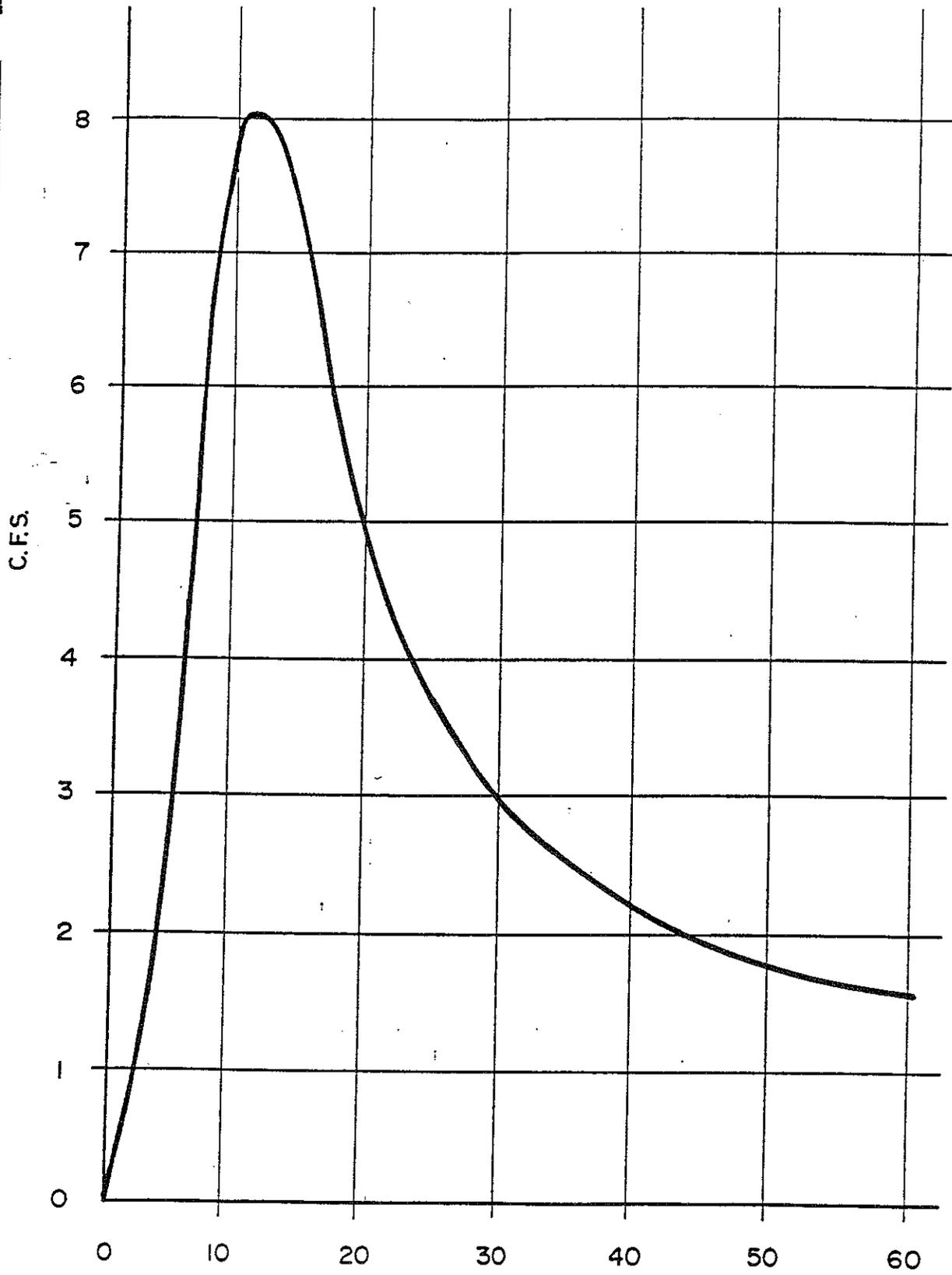
10 YEAR, 2 HOUR STORM

Tc = 30 MINUTES

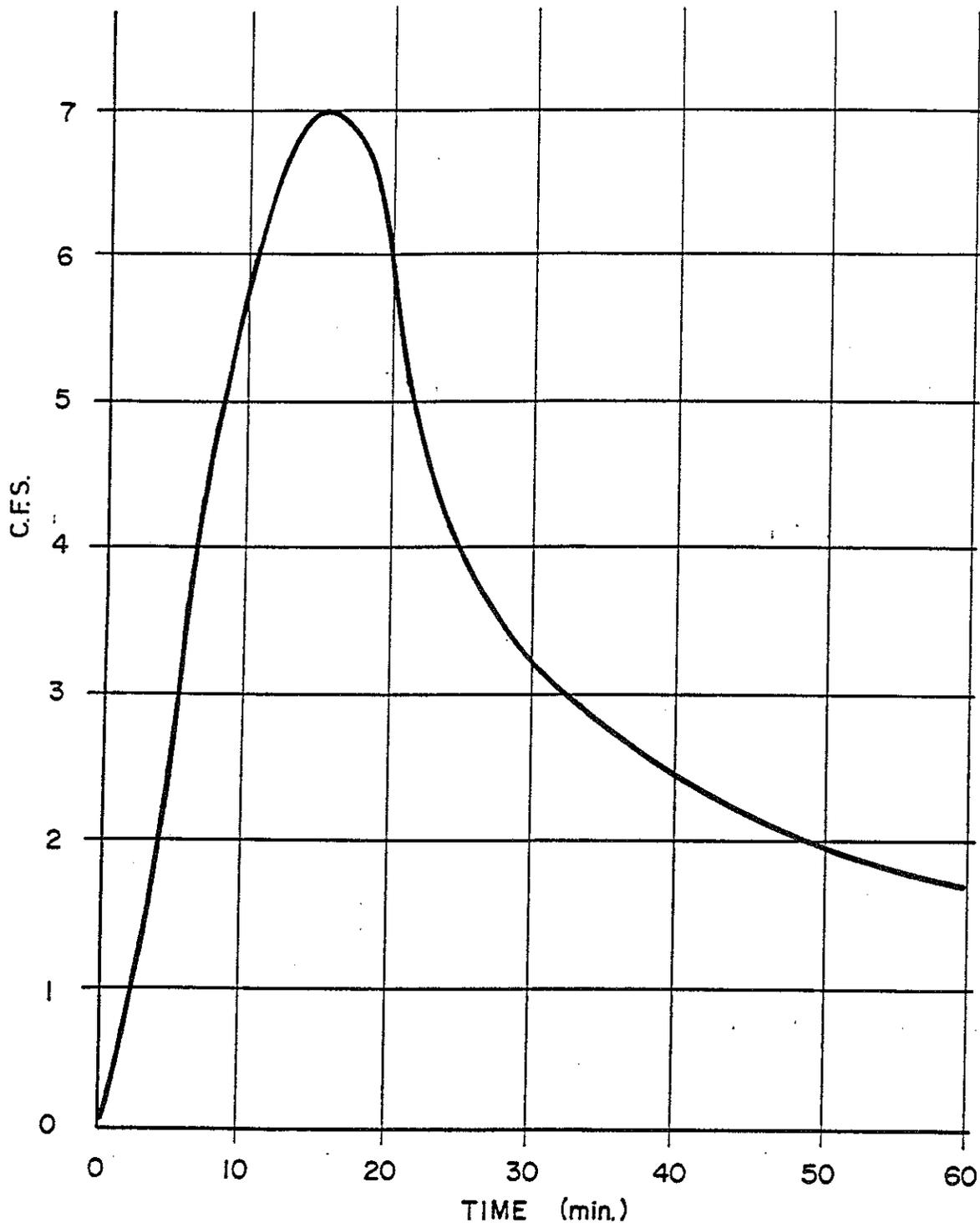
UNIT INFLOW HYDROGRAPH



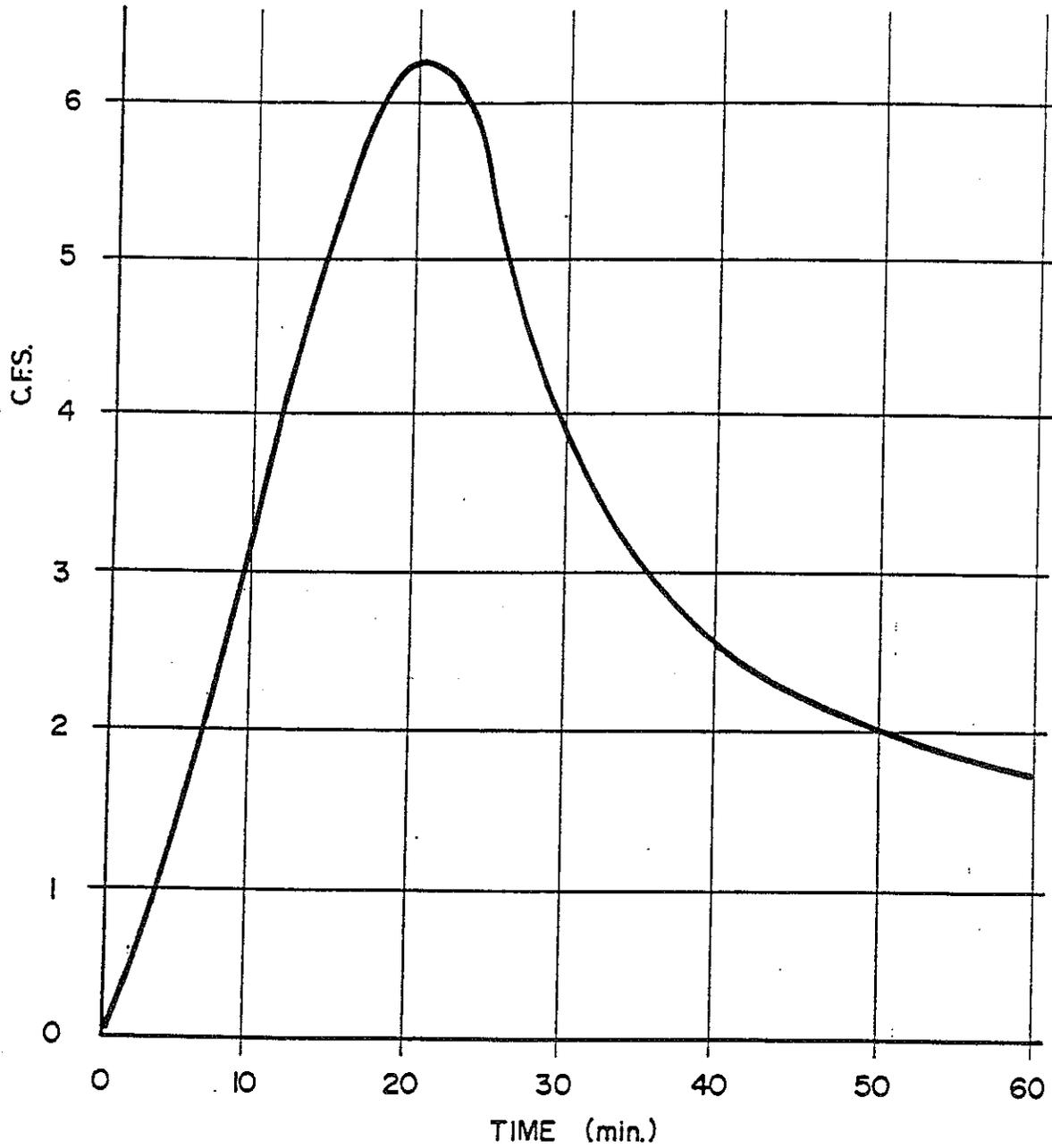
UNIT INFLOW HYDROGRAPH
100 YEAR, 2 HOUR STORM
T_c = 5 MINUTES



UNIT INFLOW HYDROGRAPH
100 YEAR, 2 HOUR STORM
Tc = 10 MINUTES



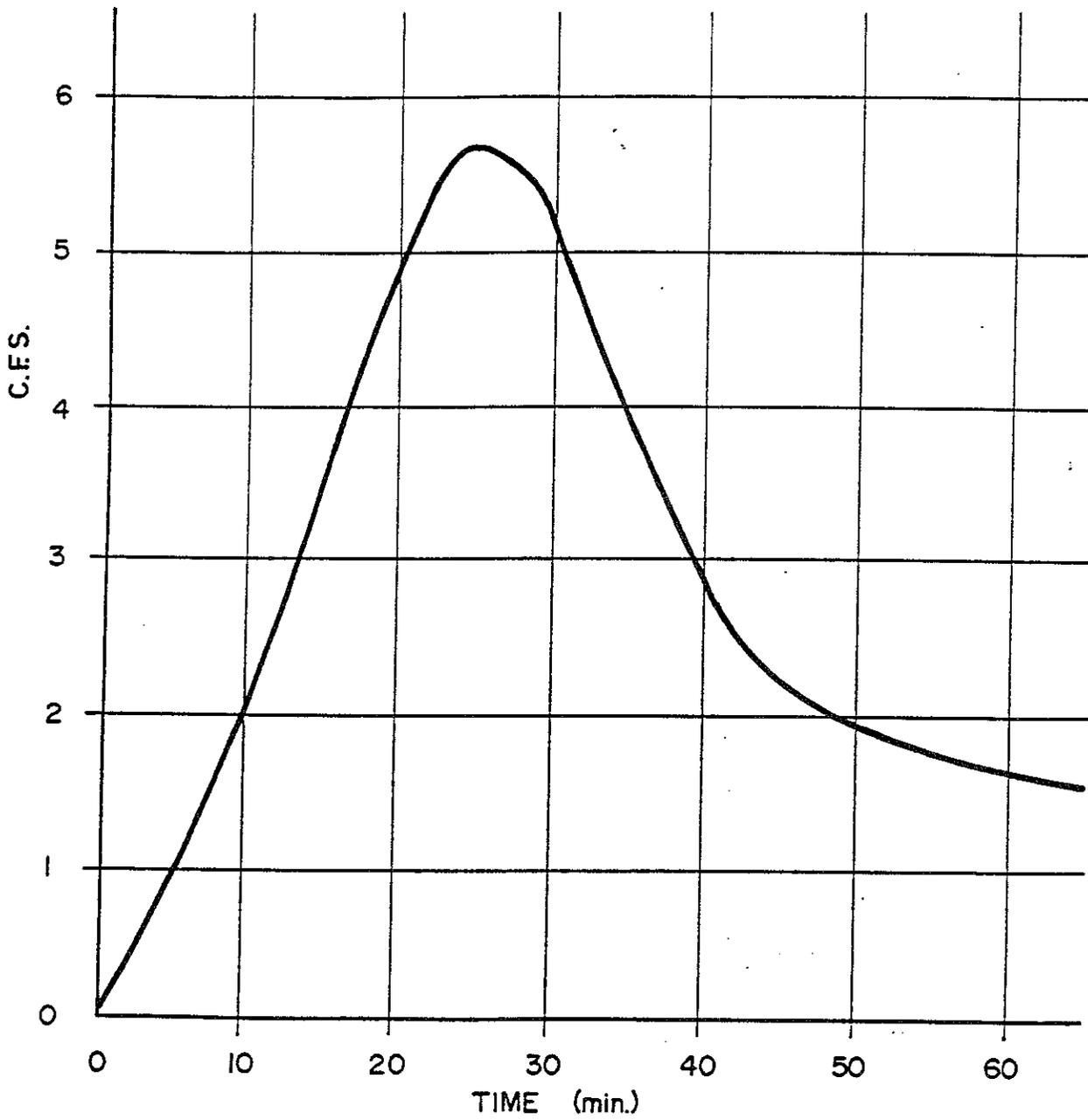
UNIT INFLOW HYDROGRAPH
100 YEAR, 2 HOUR STORM
Tc = 15 MINUTES



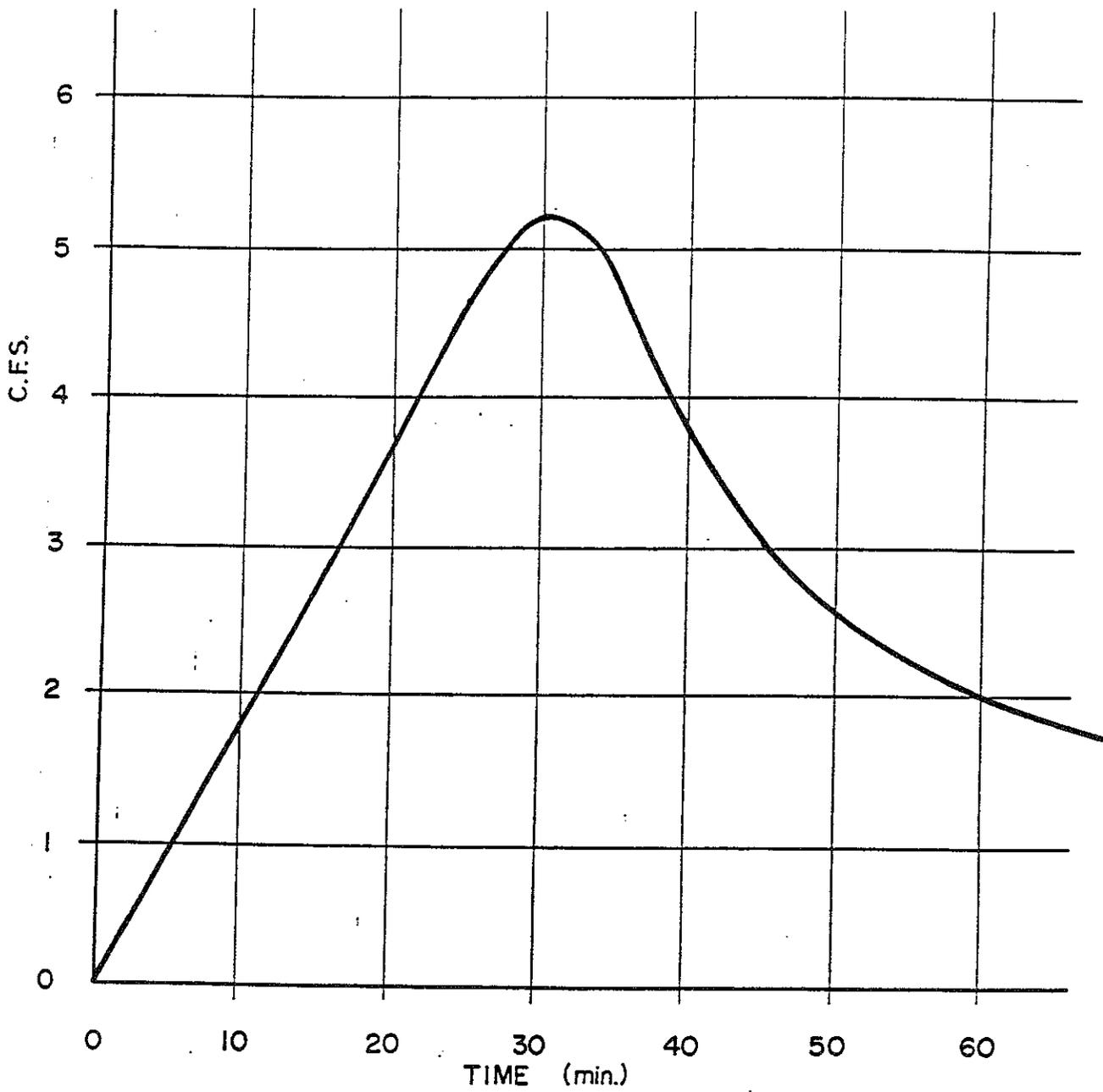
UNIT INFLOW HYDROGRAPH

100 YEAR, 2 HOUR STORM

$T_c = 20$ MINUTES



UNIT INFLOW HYDROGRAPH
100 YEAR, 2 HOUR STORM
 $T_c = 25$ MINUTES



UNIT INFLOW HYDROGRAPH
100 YEAR, 2 HOUR STORM
 $T_c = 30$ MINUTES

INCREMENTAL UNIT HYDROGRAPH VALUES

Tc Time	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
5 min.	7.27	4.68	3.46	2.77	2.29	1.94	1.68	1.47	1.31	1.18	1.08	0.99							
10 min.	3.25	5.92	4.53	3.14	2.43	1.99	1.67	1.41	1.21	1.04	0.92	0.80							
15 min.	2.20	4.24	5.10	4.36	3.08	2.34	1.89	1.56	1.29	1.07	0.89	0.73							
20 min.	1.98	3.37	4.20	4.56	4.16	3.02	2.22	1.83	1.58	1.41	1.27	1.17							
25 min.	1.28	2.40	3.25	3.83	4.03	3.89	3.35	2.68	2.05	1.58	1.29	1.12							
30 min.	0.80	1.57	2.32	3.00	3.52	3.71	3.48	3.03	2.49	1.97	1.58	1.32	1.11	0.97					
5 min.	9.84	6.37	4.73	3.74	3.13	2.65	2.33	2.07	1.88	1.69	1.55								
10 min.	3.68	8.10	6.47	4.44	3.50	2.86	2.43	2.17	1.93	1.78	1.67	1.58							
15 min.	2.81	5.99	7.05	5.69	3.89	3.17	2.73	2.40	2.16	1.98	1.83	1.68							
20 min.	1.43	3.36	5.33	6.52	5.15	3.78	3.03	2.55	2.23	2.00	1.87	1.75							
25 min.	0.98	2.26	3.79	5.05	5.75	5.17	3.99	2.90	2.28	1.96	1.77	1.65	1.53	1.43	1.39				
30 min.	0.97	1.88	2.80	3.79	4.73	5.22	4.78	3.92	3.04	2.52	2.20	1.97	1.81	1.65	1.55	1.51	1.49		1.45

10-Year

100-Year

INCREMENTAL UNIT HYDROGRAPH VALUES

ARTICLE VI

MISCELLANEOUS DESIGN STANDARDS

TABLE OF CONTENTS

	<u>Page</u>
SECTION 601.00 GENERAL REQUIREMENTS FOR LOT GRADING	VI-1
601.01 Grading Plan Requirements	VI-1
601.02 Grading Plan Submission	VI-2
601.03 Grading in Subdivisions	VI-3
601.04 Flooding	VI-3
SECTION 602.00 EROSION AND SEDIMENT CONTROL	VI-4
602.01 General Goal	VI-4
602.02 General Requirements	VI-4

ARTICLE VI

MISCELLANEOUS DESIGN STANDARDS

601.00 GENERAL REQUIREMENTS FOR LOT GRADING

- 601.01 Grading Plan Requirements: The following items are to be included on all grading plans:
- A. Spot elevations are required to be shown at all house entrances, at the driveway entrance and at all changes in grade of the driveway. Spot elevations should be shown at each corner of the house. Walkout basements should be indicated on the plans, showing the entrance and the appropriate spot elevations.
 - B. The minimum size allowed for a driveway culvert is 12 inches and the inverts for the pipe must be shown. In any case, where a driveway culvert must be larger than 12 inches based on the flow, culvert computations must be submitted.
 - C. A parking pad at least 360 square feet in area shall be allotted on driveways for parking. This parking pad should be at no greater than 5% grade and no less than 1%. A 180 square foot parking pad will be allowed for houses that include a single car garage or carport. No parking pad is required for houses that include a garage or a carport for two or more vehicles. The portion of the driveway from the street to the parking pad should be on grade of no more than 15% and no less than 1%. A waiver request shall accompany any plans which do not conform to these driveway standards.
 - D. The lead walk and all risers must be shown on the plan and the elevations at all landings must be specified.
 - E. In subdivisions where yard lights are required, their locations must be shown on each individual lot.
 - F. The grading of the front of the lot along with whatever cuts and fills are proposed should be shown inasmuch as they define the ditch line and the location of the driveway culvert.
 - G. Erosion controls are required for all areas on the lot where the ground will be disturbed. The original erosion controls for the subdivision are satisfactory for areas that they will cover as long as the erosion controls won't be removed (or the escrow

release requested) until all the construction on the lot is completed and the ground stabilized.

- H. Lot grading plans shall be to a scale of one (1) inch as equal to 30 feet, or less on lots with areas of less than one (1) acre. A scale of one (1) inch as equal to 50 feet is the maximum that will be allowed for lots of areas of one (1) acre or greater. All plans will have two foot contours defining lot grading and all proposed changes at the time the plan is submitted.
- I. All existing (platted) storm drainage and sanitary sewer easements will be shown with deed book and page number.
- J. Easements must be provided for all areas of concentrated flow on lot grading plans and subdivision plans. These areas include natural drainage ways (swales) concentrating flow from several lots, swales leading into culverts, and those stabilized existing drainageways handling the outfall of the culverts. These easements are not required inside State right-of-way.
- K. All slopes greater than 3:1 must be provided with special stabilization. Slopes greater than 3:1 shall be permitted by the Director under critical conditions. The type of special stabilization must be specified on the plan. Slopes greater than 2:1 are not permitted.
- L. The minimum lot grade should be 2%. Any swales on a lot must be at a minimum 2% slope but should preferably be at 3%. Any swale with steep longitudinal slope must be properly stabilized in accordance with the Virginia Erosion and Sediment Control Handbook.
- M. All retaining walls over four (4) feet in height shown on lot grading plans must be accompanied by structural plans and calculations certified by a Virginia registered engineer . The grading plan should also note where handrails will be required on any retaining wall as specified in the Virginia Uniform Statewide Building Code.

601.02

Grading Plan Submission: Lot grading plans must be submitted and approved prior to the issuance of a building permit. It is noted that the lot grading plans are used to check the final grading prior to the issuance of the occupancy permit. The permit will be refused if the plan and the on-site grading

do not agree unless such deviation has been approved by the Director or his agent as being substantially in accordance with the intent of this plan. Preferably, lot grading plans are incorporated in the final plans when submitted. Otherwise, they can be submitted after approval and release of the final plans. Minor revisions to an approved lot grading plan may be approved by submitting a description of the proposed revisions in letter form. Once approved these revisions become part of the lot grading plan for this lot.

601.03

Grading in Subdivisions: Overlot 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. This should not be construed to mean that surface swales discharging water toward the street between adjacent pairs of houses will automatically be approved so long as the watershed of each does not exceed 1.0 acre. Individual circumstances such as street slope exceeding 5% potential sidewalk erosion problems etc. may lead to further requirements such as yard inlets.

601.04

Flooding:

- A. The storm drainage system plans for pipes, inlets, etc. are based upon a storm drainage map showing the areas contributing to flow at various inlets. Overlot grading plans should delineate the drainage divide lines to insure the originally approved drainage map is followed, or notation should be made on the plan that it conforms to the approved overall drainage plan.
- B. Designs for overlot grading, and the siting and elevation of houses, should provide for protection of the house against flooding from storms exceeding the capacity of the normal design storm for which the pipe system is sized. Consideration of this factor will also provide protection against occasional blockage of pipes. Houses should not be sited in areas of depressed grading where overland flow out of the depressed area could only take place when ponded water reached an elevation higher than that of the house. Provision of a yard inlet in any such depression is necessary, but not sufficient by itself since it can be blocked or its capacity exceeded by a storm exceeding the 10-year design storm.

Consideration should similarly be given to houses located adjacent to street sags where, in the event of a storm greater than the design 10-year storm water would tend to flood out of the street and flow overland. Paths of overland flow (including a 100-year storm) shall, in conjunction with the pipe system, provide for discharge of similar flows through internal areas of a development without flooding of homes. Where overlot grading and house location plans do not appear to meet this requirement, the Director will request that hydraulic calculations be submitted proving the adequacy of the proposed plan to thus dispose of the design flood.

- C. In developments where the FHA is not the insuring agency, and where FHA overlot criteria are not mandatory, be advised that the City considers FHA Criteria to provide reliable guidance. In such matters as protective swales and slopes, and maximum driveway grades, the City strongly recommends designs to similar standards.
- D. Where design flood elevations have been established for larger streams adjacent to lots by flood plain studies, lot grading shall provide for siting of lot areas above such a flood elevation. Further, such flood plain studies are based upon certain cross sectional areas of flow in the flood waterway. Filling, in conjunction with overlot grading, of any part of this waterway restricts the flow and raises the floodwater surface. Therefore, if any such filling not accounted for in the flood plain study is proposed, it shall be accompanied by submittal of a suitably revised flood plain study to show the effect of the reduction in waterway area.

602.00

EROSION AND SEDIMENT CONTROL

602.01

General Goal: The general goal of the City of Manassas Park's erosion and sediment control policy is to protect its soil and water resources by limiting soil erosion and sediment deposition caused by land disturbing activities.

602.02

General Requirements: The City must comply with all current erosion and sediment control requirements as set forth in the Virginia Erosion & Sediment Control Handbook. Additional erosion and sediment control measures may be required by the City, when deemed necessary by the Director of Public Works.

END OF SECTION

SUPPLEMENT A
PUBLIC FACILITIES MANUAL
FEE SCHEDULE

Preliminary Subdivision Plats

Sketch Plan	\$100.00
Preliminary Plat, up to 10 lots, Per Plat plus per lot	\$500.00 \$10.00
Preliminary Plat, over 10 lots, Per Plat plus per lot	\$500.00 \$10.00
Preliminary Plat Revision, Per Revision (after approval)	\$25.00

Final Subdivision Plats

Final Plat, w/preliminary plat, per plat Plus per lot	\$600.00 \$10.00
Final plat w/o preliminary plat, per plat Plus per lot	\$850.00 \$10.00
Final Plat Revision, per revision after approval	\$100.00

Fee Schedule - Site Plans

Sketch Plan	\$150.00
Site Plans plus	\$600.00
a. Institutional, per 1000 S.F. floor area (gross)	\$50.00
b. Industrial, per 1000 S.F. floor area (gross)	\$50.00
c. Commercial, per 1000 S.F. floor area (gross)	\$50.00
d. All residential, per unit	\$10.00
e. Residential revisions, resites per submission	\$100.00

Erosion and Siltation Control Plans

Erosion and Siltation Control Plan plus per acre	\$100.00 \$10.00
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Bonds and Agreements

Approval	No Fee
Bond extension	\$200.00
Bond reduction	\$200.00

