CITY OF CROOKS
ORDINANCE #312

AN ORDINANCE OF THE CITY OF CROOKS, SOUTH DAKOTA, ADOPTING AND PROVIDING FOR DESIGN STANDARDS FOR PUBLIC IMPROVEMENTS AND STANDARD SPECIFICATIONS FOR PUBLIC IMPROVEMENTS WITHTIN THE CITY OF CROOKS.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CROOKS, SOUTH DAKOTA, THAT:

Section 1. Design Standards for Public Improvements and Standard Specifications for Public Improvements. The documents attached titled Design Standards for Public Improvements and Standard Specifications for Public Improvements are hereby adopted by reference and are hereby approved as the official design standard regulations and standard specifications for the City of Crooks, South Dakota.

Section 2. Ordinances repealed. All ordinances or parts thereof in conflict herewith are repealed. Ordinance #146 is specifically repealed.

Ayes: Harstad, Richardson, Beyer Nays: -- Abstain: --

Adopted this 12th day of December 2022.

F. Butch Oseby, Mayor

ATTEST:

Tobias Schantz,
Municipal Finance Officer

(MUNICIPAL SEAL)

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City of Crooks

Engineering

Design Standards

for

Public Improvements

Adopted: December 2022

City of Crooks
701 S. West Avenue
PO Box 785
Crooks, SD 57020

Table of Contents

Chapter 1 - General Provisions
Table of Contents

Section & Topic **Page**

Chapter 1

General Provisions

1.1 Short Title

These regulations, together with all future amendments, shall be known as the *City of Crooks Engineering Design Standards for Public Improvements* (hereinafter called Design Standards).

1.2 Jurisdiction

These Design Standards, along with the City of Crooks Standard Specifications for Public Improvements (hereinafter referred to as Standard Specifications), shall apply to all public improvements within the incorporated area of the City of Crooks except where superseded by Federal or State requirements.

1.3 Amendments and Revisions

These standards and criteria may be amended as new technology is developed or experience gained in the use of these Design Standards. The City of Crooks shall consider revisions and/or amendments to these Design Standards.

1.4 Enforcement Responsibility

It shall be the responsibility of the City of Crooks to enforce the provisions of these Design Standards.

1.5 Review Process

The City will review all submittals for compliance with the specific Design Standards. Acceptance by the City does not relieve the Owner, Design Professional, or Contractor from responsibility for ensuring that the calculations, plans, specifications, construction, and record drawings are in compliance with the Design Standards.

1.6 Prior Approval

These Design Standards shall not abrogate or annul: (a) any permits issued before the effective date of these Design Standards; (b) any construction plans approved before the effective date of these Design Standards; (c) any final plat documents that have been recommended for approval by the City of Crooks Planning Commission prior to the effective date of these standards; or (d) any easements or covenants already in effect.

1.7 Relationship to Other Standards

If special districts impose more stringent standards, this difference is not considered a conflict and the more stringent standard shall apply. If State or Federal Government imposes more stringent standards, criteria, or requirements, these shall be incorporated into these Design Standards in accordance with Section 1.3 of this Manual.

1.8 Variances

Variances from these Design Standards will be considered on a case-by-case basis by the City of Crooks.

1.9 Private Facilities

If an owner of private street or utility facilities wishes to dedicate these facilities for public use and maintenance, the facilities must meet the standards set forth herein prior to being accepted by the City of Crooks.

Chapter 2 - Submittal Procedures
Table of Contents

Section & Topic **Page**

Chapter 2

Submittal Procedures

2.1 General

2.1.1 All capital improvement plans, private subdivision plans, reports, and related documents shall conform to the following submittal requirements, unless waived by the city.

2.2 Submittal of Reports and Plans for Review

2.2.1 Submittal Format. Design Professionals or Owners seeking approval and/or acceptance of reports, plans, and related documents shall submit a copy to the City of Crooks. Submittal shall be in the form of one hard copy and one electronic copy in PDF format. Where the report and/or plans are returned for revisions, all revisions shall be made prior to resubmittal.

2.2.2 Conformance. Plans submitted shall be in conformance with the City of Crooks Subdivision Regulations. The plans shall include any special provisions. Reports submitted shall be in a typed, bound form in conformance with the requirements of the applicable chapters of these standards. If a report is required which is not provided for in these standards, the report shall include all data, references, and calculations as applicable.

2.3 Acceptance of Reports and Plans

2.3.1 Review Process. The City will attempt to complete the review of submitted plans in approximately ten (10) working days. This time will vary due to the complexity of the project and/or workload of the review staff. After review is completed, comments will be compiled and forwarded to the Design Professional/owner. If necessary a review conference will be scheduled. The report and/or plans will be accepted or returned for revisions as noted.

2.3.2 Acceptance. Upon acceptance of reports, plans and related documents, three (3) paper copies and an electronic copy (one DWG format and PDF format) shall be submitted to the City of Crooks. Submission shall also include design surface files where applicable. All final drawings, plans, specifications, reports, plats, or other architectural, engineering, or land surveying documents, papers, or diagrams involved in the practice of architecture, professional engineering, or land surveying shall be dated and bear the signature and stamp or seal of the architect, professional engineer, or land surveyor who was responsible for the preparation thereof.

2.4 Revisions to Accepted Plans

2.4.1 Initial Acceptance. Construction plans, specifications, and reports are accepted initially for eighteen (18) months. If not constructed during this time period, such reports automatically become void and must be updated to current criteria before any further permits can be issued. Upon written request, the City Council or a designee may grant a one-year extension to the construction plans, specifications, and/or drainage report, provided a) the development plans, construction plans, and specifications substantially conform to current standards and b) that other conditions affecting the development site have not substantially changed or do not require a modification to accepted plans or specifications.

2.4.2 Updates to Prior Submittals.

2.4.2.1 Whenever updates or revisions to previously accepted construction plans, specifications, or reports are necessary, the design professional will submit updates or revisions through the normal document submittal process. This submittal shall meet the requirements of Section 2.2 of these Design Standards.

2.4.2.2 Requests for updates and revisions will be considered only if there are NO revisions to the original development plan(s) or report(s). The City will review the original development plan(s) or report(s) for compliance with current standards under normal review procedures.

Chapter 3 - Permit Procedures and Requirements
Table of Contents

Section & Topic **Page**

Chapter 3

Permit Procedures and Requirements

3.1 Application Requirements and Procedures

3.1.1 Permit Application. A permit shall be required for any construction or installation within the public right-of-way or public easement for any substantial modification of existing construction or use. Application for such permits shall be made at the City Hall.

3.1.1.1 No permit will be required for contracts let by the City of Crooks except for water and sewer services. Permits for these will be required; however, they will be on a “no fee” basis. In subdivision work it will be the responsibility of the Owner’s Contractor to obtain the necessary permits from the City of Crooks.

3.1.1.2 Building permits, which are issued by the City, may include the Sidewalk and Driveway Permit and/or the Excavation and Grading Permit.

3.1.2 Types of Permits.

3.1.2.1 Sidewalk and Driveway Permit, which governs construction of new and repair or replacement of existing sidewalks and driveways within public right-of-way.

3.1.2.2 Private Utility Permit, which governs the installation, removal, repair, or maintenance of private utilities other than sanitary sewer, water and storm sewer services in public right-of-way or public easements.

3.1.2.3 Sewer and Water Service Permit, which governs the installation, removal, repair, or maintenance of sanitary sewer services, water services and storm sewer services.

3.1.2.4 Construction Permit, which governs the installation of public improvements within the public right-of-way and grading outside the street right-of-way in proposed subdivisions. This includes street grading, curb and gutter, roadway subbase, base and wearing surface, drainage and flood control facilities, water main and sanitary sewer installation, and grading outside the street right-of-way.

3.1.2.5 Excavation and Grading Permit, which governs grading in excess of 300 cubic yards outside the street right-of-way as defined by the Uniform Building Code (Chapter 7—Grading). An Excavation and Grading Permit is not required if a Construction Permit has been issued.

3.1.3 Letters of Responsibility. Those agencies set forth in Section 3.4.4 may obtain a permit under their Letter of Responsibility, Figure 3.1, or at their option, require the Contractor performing the work to obtain a permit in which event the Contractor would be required to furnish a performance bond as set forth in Section 3.4.1 thereby assuming full responsibility for the work performed. Except as set forth herein, the Contractor performing the work shall be the permittee.

3.1.4 Emergency Repairs. Permits shall apply to emergency repairs. However, a delay of 24 hours is granted, excluding weekends and holidays, following the beginning of such repair.

3.1.5 Issuance of Permits.

3.1.5.1 Sidewalk and Driveway Permits and Sewer and Water Service Permits will be issued only to those persons or corporations who, in the opinion of the City of Crooks, are qualified to perform the work. Exceptions to this requirement are Driveway and Sidewalk Permits issued for sidewalk installation where the property owner acquires the permit and does the construction.

3.1.6 Time Limits.

3.1.6.1 All permits requiring excavation within the paved portion of a city street will become void on November 1. Upon written request, extensions to existing permits may be made on a case-by-case basis by the City of Crooks. Permits requiring excavation within the paved portion of the street will be issued on an emergency basis only between October 15 and April 15 of the following year.

3.1.6.2 Unless otherwise provided for in the special provisions, the Sidewalk and driveway Permit shall be valid for an indefinite period from the date issued, unless revoked by mutual consent, for failure of the applicant to abide by the terms and conditions of the permit, or by operation of the law.

3.1.7 Cancellation.

3.1.7.1 Failure of the applicant to comply with any of the terms and conditions of the permit shall be sufficient cause for cancellation of the permit and may result in removal of the utilities, approaches or other facility by the City at the applicant’s expense.

3.1.7.2 The permit, the privileges granted herein, and the obligations of the applicant created thereby shall be binding upon the successors and assigns of the applicant.

3.2 Permit Standards and Conditions

This Section describes the requirements for plans and other information necessary for approval of a permit application.

3.2.1 Permit Approval. Permits are issued subject to the approval of City, County, State or other governmental agencies having either joint supervision over the section of road, or authority to regulate land use by means of zoning and/or building regulations. It shall be the applicant's responsibility to determine the necessity of and to obtain any such easements and approvals which may be required.

3.2.2 Street Restoration. Granting of a permit is based upon replacement or restoration of the street and right-of-way to its original condition or to a satisfactory condition by the applicant.

3.2.3 Landscaping. The permit holder shall be responsible for the restoration of landscaped areas between the property line and adjacent public roadways.

3.2.4 Relocating Utilities. The applicant shall be responsible for relocating or adjusting any utility facilities located on the street right-of-way as required to accommodate the approach or other facility applied for. Construction of the utility, road approach or other facility by the applicant, his agent or Contractor, will be permitted only after the applicant has furnished the City evidence that satisfactory arrangements for said relocation or adjustment has been made with the Owner of the affected utility facility.

3.2.5 Permit Release. Applicant must pay required fees and provide insurance and bonding, as required, prior to release of the permit.

3.3 Refunds

Refunds may be made on any permit fee at the discretion of the City Council.

3.4 Bonds and Insurance

3.4.1 Bonds. Bonds are required for work as listed in the Revised Ordinances of Crooks, South Dakota.

3.4.2 Inadequate Bond. Any permit determined to be without an adequate bond as required shall be subject to immediate revocation by the City.

3.4.3 Letters of Responsibility. Governmental agencies, other than the City of Crooks, special districts, cooperative utilities, and investor-owned electric, gas, and communications utilities, may provide a Letter of Responsibility in lieu of posting the required performance bond. Subject Letter of Responsibility shall be in the format of Figure 3.1.

3.4.4 Other Forms of Security. It shall be acceptable to the City to receive cash deposits, certified checks, or similar security in lieu of a performance bond. Bonds shall be filed at the City Hall.

3.4.5 Liability Insurance. The applicant shall obtain and carry, for the period of time required for the complete installation of facilities authorized by the permit, including the repair and restoration of the road facilities, and also during such future periods of time when operations are performed involving the repair, relocation, or removal of said facilities authorized by the permit, a liability and property damage insurance policy or policies. Coverage shall be provided against any claim, demand, suit, or action for property damage, personal injury, or death resulting from any activities of the applicant, his officers, employees, agents, or contractors in connection with the construction, installation, repair, or removal of the said facilities authorized by the permit. The said policy or policies shall include as named insured: the City of Crooks, its City Council, its officers, agents, employees, and consultants and their officers, employees and agents, except as to claims against the applicant, for personal injury to any members of the City Council or its officers, agents, and employees, or damage to any of its or their property. The said insurance shall provide coverage as set forth by City ordinance. The said insurance policy or policies shall be in any insurance company duly authorized and licensed to do business in the state of South Dakota. The applicant and/or its Contractor's insurer shall give the City thirty (30) days' written notice in advance of any cancellation of insurance required in the terms of these general provisions.

3.4.6 Certificate of Self-Insurance. Government agencies other than the City of Crooks, and public utilities, may provide a Certificate of Self-Insurance as shown in Figure 3.2 in lieu of any insurance policy or policies required under Section 3.4.6. Such Certificate shall be approved by the City Attorney and filed with the City of Crooks prior to the issuance of any permit.

3.5 Construction Specifications

3.5.1 Backfilling. All backfill material, compaction, and resurfacing of any excavation made in the City right-of-way will be done in accordance with the Standard Specifications and Standard Plates on file with or as directed by the City of Crooks.

3.6 Traffic Control

3.6.1 Street Closure. Traffic must be provided with a minimum lane width of ten (10) feet in the construction area. Any plan for traffic control during construction that indicates a complete closure of an arterial or collector street must show detour routes and must be approved by the City prior to issuance of a permit. Normally, only one side of the local street may be blocked at any given time. When a local street is closed to traffic, the Public Works Director or a designee must be notified 48 hours in advance.

3.6.2 Signing. Construction signing must be used and shall be maintained by the responsible Contractor. All traffic control devices must be in accordance with the *Manual on Uniform Traffic Control Devices*, latest edition.

3.7 Restoring Pavements

All persons, corporations, governmental agencies, special districts, utility companies who having obtained a permit and made a cut in a public right-of-way shall repair such pavements or surfacing to the original condition. If such pavements or surfacing are not restored and maintained as to the original condition, notice thereof in writing by first class mail shall be given the permittee, who shall put the same in good condition within a maximum of three (3) days. If the permittee fails after notice given to restore and maintain such pavements or the surface thereof, the City may make the necessary repairs and such permittee shall pay the costs thereof, and until paid no other permit shall be issued.

3.8 Utility Installations

3.8.1 Underground. All utility lines shall be installed at depths as specified in each section of these Design Standards or as directed by the City of Crooks. Exceptions may be granted where justified with prior written request by the Owner/Developer and approval by the City of Crooks.

3.8.2 Overhead. Minimum ground clearances shall conform to the National Electric Safety Code Standards, latest edition.

3.9 Fees

Fees shall be assessed for permits and inspection at the time of issuance of the permit in accordance with the fee schedule in force.

Figure 3.1

Letter of Responsibility

Office of City Administrator
City of Crooks
PO Box 785
Crooks SD 57020

THIS IS TO CERTIFY THAT _____
(Name of Agency)

Does agree that, in lieu of posting the required performance bond, the following practices will be adhered to:

1. That no street cuts, in any Crooks street, highway or other right-of-way, for any purposes, will be made without having secured the proper permit.

2. That any street cut made by the above will be backfilled and compacted in accordance with the current requirements of Crooks, and the surface restored to a condition equal to or better than that condition which existed prior to the making of the cut.

3. The responsibility for the maintenance of the restored cuts shall rest with the above for a period of one year after the cut has been filled and resurfaced.

4. That, in the event repairs are not made or maintained to the satisfaction of the City of Crooks or a designated representative, necessary repairs shall be made by the City at the expense of the above-named organization.

Subscribed to this _____ day of _____, _____.

_____

By: _____
Signature of Authorized Agent

_____
Title

NOTE: This document is to be filed with the City of Crooks.

Figure 3.2

Certificate of Self-Insurance

Office of City Administrator
City of Crooks
PO Box 785
Crooks SD 57020

THIS IS TO CERTIFY THAT _____, a _____, in lieu of providing the insurance policy required under Section 3.4.6 of the Engineering Design Standards for Public Improvements of the City of Crooks, South Dakota, is wholly self-insured or is self-insured to cover the deductible limit of _____ as expressed by Policy No. _____ issued by _____ for combined bodily injury and property damage liability. It is further certified that reserves in support of the self-insurance program are adequate to provide coverage at the levels required of insurance policies in Section 3.4.6.

Subscribed to this _____ day of _____, _____.

_____

By: _____
Signature of Authorized Agent

_____
Title

NOTE: This document is to be filed with the City of Crooks.

Chapter 4 - Utility Locations and City Utility Easements
Table of Contents

Section & Topic **Page**

Chapter 4

Utility Locations and City Utility Easements

4.1 Purpose of Standard Locations

4.1.1 Conflicts. It is necessary to provide adequate space for utilities in a manner that will minimize conflicts between using the public right-of-way for transportation purposes and utility purposes. When street grades, alignments, or widths are changed, utilities are usually required to relocate. Oftentimes standard locations are inapplicable and unobtainable in street areas where existing utilities are seriously crowded and where it would not be feasible to expect major or dramatic reorientation of the underground. The location criteria must be practical and applicable in new developments, in urban relocation work, and in cases where overhead facilities are being converted into underground structures and plans.

4.1.2 Relocations. Utilities are not expected to revise existing facilities as to location or depth solely or primarily for the purpose of creating uniformity. However, when new or relocation work is undertaken, uniformity should be sought. It is acknowledged that the present may be locked in because of the past, but there should be consideration for uniform utility locations for the future. When existing utilities are required to be relocated, the depth and location shall be approved by the City's authorized personnel.

4.2 Plans Required

4.2.1 Construction Approval. Any utility or other facility constructed in City right-of-way shall have construction plans submitted and approved in accordance with requirements in these Design Standards and ordinances for the City of Crooks. No construction permit shall be issued for the construction of new utilities or the extension of existing facilities (except service taps or laterals to individual properties) without prior construction plan approval by the City.

4.2.2 Conformance. The applicant's completed facility shall be in conformance with the drawings or sketches referred to above unless a special variance has been requested and approved by the City.

4.3 Location Requirements

All utilities located within the public right-of-way shall be approved by the City's authorized personnel.

(1) Utilities already existing may be replaced in the same location when permitted by the City of Crooks.

(2) Gravity lines shall take preference as to horizontal and vertical alignment over non-gravity systems and pressure systems.

(3) Consideration will be given to the use of utility easements adjacent to the public right-of-way and to the use of alleys and medians.

(4) In the event of a conflict, or if a particular utility requires more than one system be installed in the right-of-way, the alternate location may be used when permitted by the City of Crooks.

(5) Utilities shown are primarily for local distribution and collection. Large diameter lines may make it necessary to modify utility locations.

(6) Street trees placed between the curb and street side of sidewalk must not interfere with underground or overhead utilities.

(7) Normally street lights will be placed on the same side of the street as the electric utility.

(8) Street lights shall not be located closer than five (5) feet horizontally to fire hydrants.

4.4 Street Categories

The City of Crooks has developed a list of arterial and major collector streets where approval is required prior to any construction. All utility permits where work will be done in the street pavement or in the right-of-way and would require a lane closure, must be approved by the City of Crooks. All proposed permits shall be submitted a minimum of 48 hours prior to construction and be accompanied by a traffic control plan. The street category list shall be maintained and revised as needed by the City of Crooks.

4.5 City Utility Easements

Easements for sanitary sewer, storm sewer, drainage, water main, and power shall be obtained when the utilities are to be constructed outside of the typical street right-of-way (ROW) on private property. Sanitary sewer, storm sewer, drainage and water main easements shall have a minimum width of twenty (20) feet. Additional width may be required by the City to ensure proper access for City maintenance equipment. When City utilities are to be located adjacent to one another, the minimum separation distance between the utilities shall be ten (10) feet. Power shall have a minimum easement width of ten (10) feet.

Easements shall be labeled specifically for the utility in which it is describing, for example:

Sanitary Sewer Easement
Storm Sewer Easement
Drainage Easement
Water Main Easement
Power Easement

Chapter 5 - Street Access and Parking Lot Criteria
Table of Contents

Section & Topic **Page**

Chapter 5

Street Access and Parking Lot Criteria

5.1 Traffic Studies

5.1.1 If warranted by the City of Crooks, traffic impact reports may be required in order to adequately assess the impact of a proposal on the existing and/or planned street system. A written report will be required for a nonresidential development proposal when trip generation during the peak hour is expected to exceed 100 vehicles, or any multifamily residential development with 150 or more dwelling units.

5.1.2 Preparation of the report shall be the responsibility of the developer and must be prepared by a licensed design professional with experience in transportation planning. Information within the report shall contain, at a minimum, the following information: land use, site, and study area boundaries, existing and proposed site and vicinity uses, and existing and proposed roadways and intersections. All reports must be reviewed by the City before acceptance.

5.1.3 A traffic report will be required for all projects proposed for the construction of one or more traffic signals.

5.2 Access Control

5.2.1 General Access

5.2.1.1 Access in newly developing areas will follow these provisions. In areas being redeveloped, access will be determined as to the best fit based on traffic safety, existing conditions, future street improvements, and property development along with other considerations as appropriate.

5.2.1.2 A Sidewalk and Driveway Permit must be obtained from the City for any public or private access constructed to a public street. Access to streets or highways within the city limits under the jurisdiction of the South Dakota Department of Transportation (SDDOT) are also governed by requirements of the SDDOT. In addition to obtaining a permit from the City, a permit from the Area Engineer of the SDDOT must be obtained. Access shall be limited as dictated by the City of Crooks Design Standards. Any discrepancy between the SDDOT and the City of Crooks regarding precedence of access design standards, the City's standards shall prevail.

5.2.1.3 Fire department access to all buildings shall be provided and maintained during construction and upon completion of all improvements.

5.2.2 Definition of Terms for Access Control Several terms are used herein which have a somewhat distinct meaning. For the purpose of clarity, the definitions of some of these terms are listed below.

5.2.2.1 Width of Curb Opening (W)—The width of curb opening measured at the throat of the driveway from the edge of pavement to the edge of pavement.

5.2.2.2 Property Line (P)—The distance measured along the right-of-way from the nearest edge of the driveway to the property line.

5.2.2.3 Corner Clearance (C)—At an intersecting street the distance measured along the curb line from the end of the corner radius to the nearest edge of the curb opening.

5.2.2.4 Distance Between Double Drives (D)—The distance measured along the curb line between the radii or top of curb taper.

5.2.2.5 Frontage—The distance along the street right-of-way line of a single property or development within the property lines. Corner property at an intersection would have a separate frontage along each street.

5.2.2.6 Residential - Property used primarily for residential purposes such as single-family, two-family, and multifamily units.

5.2.2.6.1 Single-Family (SF) Residential - Single, detached family dwelling units or double bungalows or duplexes.

5.2.2.6.2 Multifamily (MF) Residential—Three or more attached dwelling units including townhouses, condominiums, and apartments.

5.2.3 Basic Principles for Curb Openings and Driveways

5.2.3.1 Arterial Street Access

5.2.3.1.1 Private residential access directly to arterial streets and any access to a principal arterial street shall be permitted only when the property in question has no other reasonable access to the general street system, or when denial of direct access to the arterial and alternative access to another roadway would cause traffic operation and safety problems as shown in a Traffic Report. Any access to arterials must adhere to City street standards as described in Chapter 8.

5.2.3.2 General Access

5.2.3.2.1 High Volume Access. In general, when trip generation served by the driveway exceeds 100 vehicles per hour during the peak hour or the driveway accesses an arterial street, returns using a standard street return radius as set forth in Table 5.1 and Figure 5.1 will be required.

5.2.3.2.2 Access Points. Access will not be approved for parking or loading areas that require backing maneuvers onto a public street right-of-way except for single-family or duplex residential uses on local and minor collector streets.

5.2.3.2.3 Standards. Every property that accesses the street shall have a driveway. Driveways shall be constructed in accordance with the Standard Plates on file with or as directed by the City of Crooks.

5.2.3.2.4 Existing and Future Demands. The opening or driveway width shall be adequate to handle properly the anticipated traffic volume and character of traffic, as well as being within the limits specified for the type of property development. The controls established for curb openings and driveways shall apply to existing streets as well as new streets that may be developed in the future.

5.2.3.2.5 Utility Conflicts. Any adjustments which must be made to utility poles, street light standards, fire hydrants, catch basins or inlets, traffic signs and signals, or other public improvements or installations which are necessary as the result of the curb openings or driveways shall be accomplished without any cost to the City.

5.2.3.2.6 Access Signs. Driveway approaches, whereby the driveway is to serve as an entrance only or as an exit only, shall be appropriately signed by, and at the expense of, the property owner subject to approval from the City of Crooks. Sign location, height, and legend must be in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD).

5.2.3.2.7 Abandoned Driveways. Any curb opening or driveway which has been abandoned shall be removed and the street restored by the property owner.

5.2.4 General Requirements

5.2.4.1 Number of Openings

5.2.4.1.1 Single-Family Residential—In general, each single-family residential property shall be limited to one access point. However, where houses are located on corner lots or have extra wide frontage, more than one access point may be permitted. Applicable zoning setback requirements must be followed.

5.2.4.1.2 Multi- Family Residential—In general, access shall be determined by information provided by the owner/developer in a Traffic Impact Report and/or by comments generated during the City's review and acceptance of that report.

5.2.4.1.3 Commercial/Industrial—In general, access to commercial and industrial property shall be limited to the requirements as set forth in Chapter 8 of the Engineering Design Standards and shall be based on the street classification described by the Crooks Comprehensive Plan. For commercial/industrial property located on a corner of an arterial street, access may also

be restricted if use of such access would be precluded by existing left turn lanes or other traffic control devices.

5.2.4.2 Access to Roadways with No Curb and Gutter. Private drive access to local, collector, or arterial streets that have no curb and/or gutter improvements shall be constructed to meet the following requirements:

5.2.4.2.1 The private drive shall extend from right-of-way line to the edge of the existing driving surface and shall be constructed of: (a) a eight- (8) inch-thick compacted aggregate base material, or if paved, (b) a minimum three - (3) inch-thick asphalt pavement over eight - (8) inch-thick aggregate base material; i.e., minimum acceptable roadway pavement design.

5.2.4.2.2 Access shall be governed by the driveway criteria.

5.2.4.2.3 A culvert properly sized for the ditch flow shall be installed at the established roadside ditch flowline beneath the private drive access. Minimum size for the culvert shall be 15 inches. Culverts shall have a sloped end section or cast in place concrete headwall. If a cast in place headwall is built, it shall have a maximum slope of 4:1 on any exposed face. No vertical headwalls will be allowed.

5.2.4.2.4 A sketch plan of the installation must be submitted with the access permit application. No construction permit will be issued until the access and its construction plan or sketch is approved by the City of Crooks.

5.2.4.3 Amount of Curb Opening Permitted. Driveway width shall comply with Table 5.1.

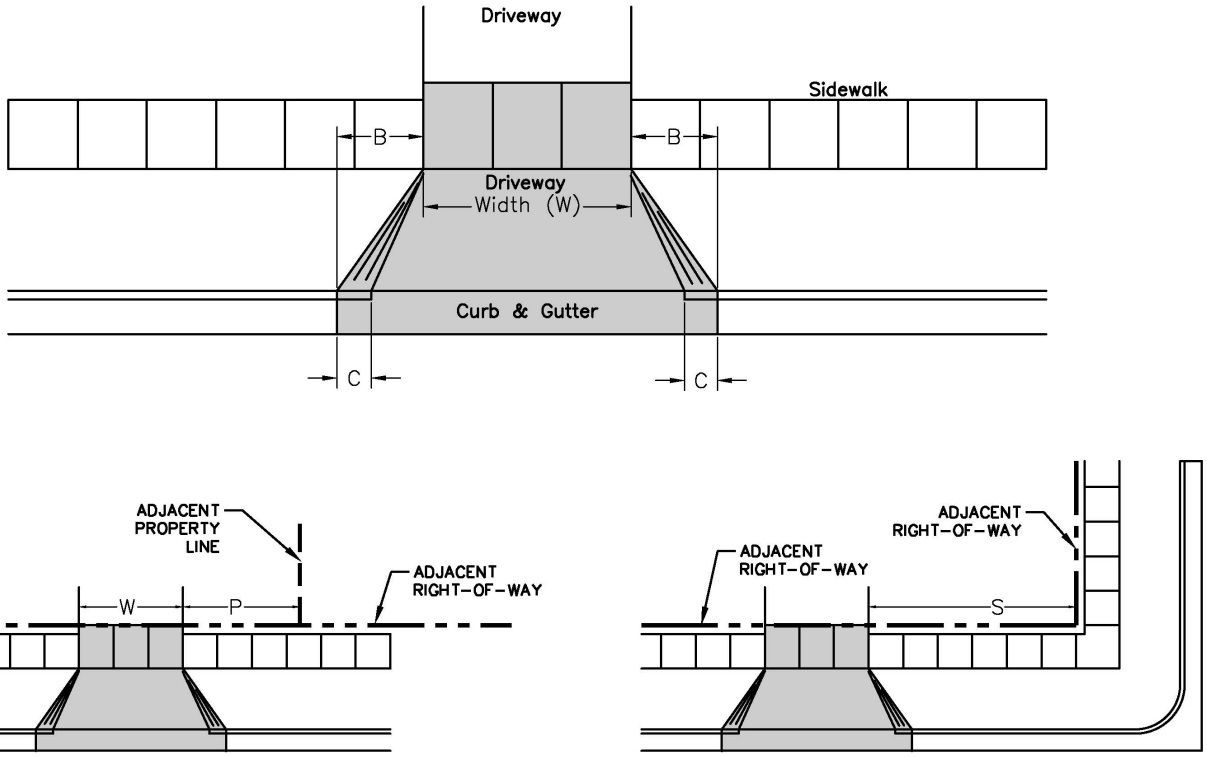
5.2.4.4 Mutual Access. On commercial, industrial, and multifamily developments, mutual use of access to streets is encouraged and may be necessary to meet driveway spacing requirements. Where used, mutual access will comply with City ordinance and will be shown on plans for approval prior to construction or change of use.

Table 5.1

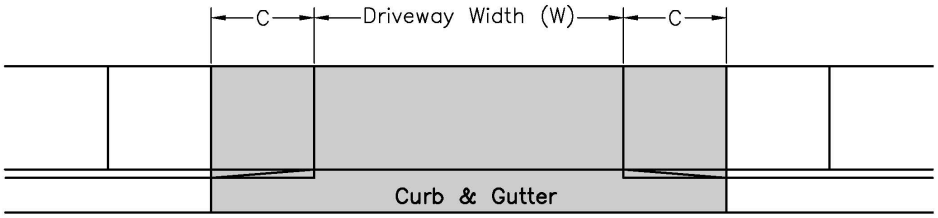
Driveway Dimensions
(All Dimensions in Feet)

	Zoning		
Dimension	Residential	Commercial	Industrial
Driveway Width (W)			
Minimum	12	15	20
Maximum	36*	36**	36**
Minimum Spacing			
From Property Line (P)	5	10	10
From Street Corner (S)	20	25	25
Between Driveways	10	20	20
Standard Approach			
Approach Taper (B) *			
Minimum	3	3	3
Maximum	5	5	5
Curb Transition (C) *			
Minimum	2	2	2
Maximum	3	3	3
Curbside Approach			
Curb Transition (C) *			
Minimum	6	6	6
Maximum	15	15	15
*Maximum width on a bulb of a cul-de-sac shall be 24 feet.			
**A maximum width of 40 feet may be permitted where tanker truck traffic is expected. Prior approval must be obtained from the City of Crooks.			
Driveways within the West Ave and 4th Street (470th Ave and 257th St) rights-of-way shall be subject to additional requirements and be coordinated with the City of Crooks			
Driveways shall be installed and measured perpendicular to the adjacent street and right-of-way. Angled driveways shall only be allowed with prior approval from the City of Crooks.			

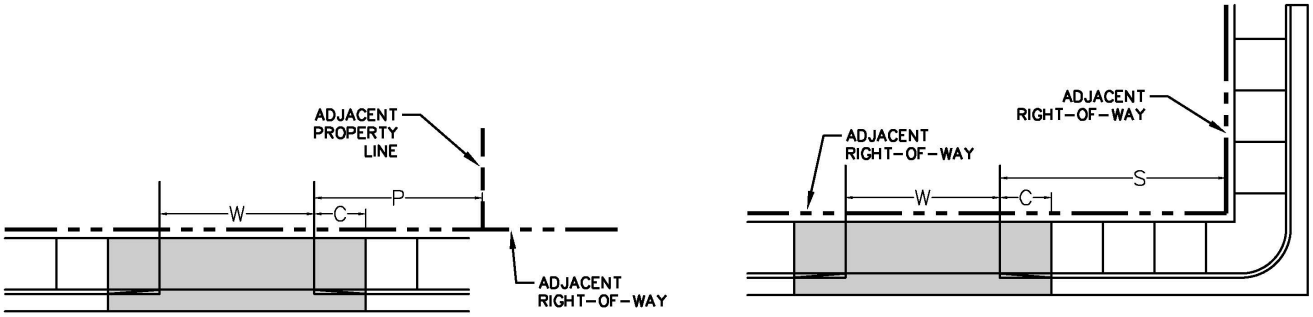
Figure 5.1: Driveway Dimensions



Standard Approach



The longitudinal slope of the approach pavement in these areas shall match the slope of the concrete curb transition. The slope is designed at 7.5% and shall not be steeper than 8.3%.



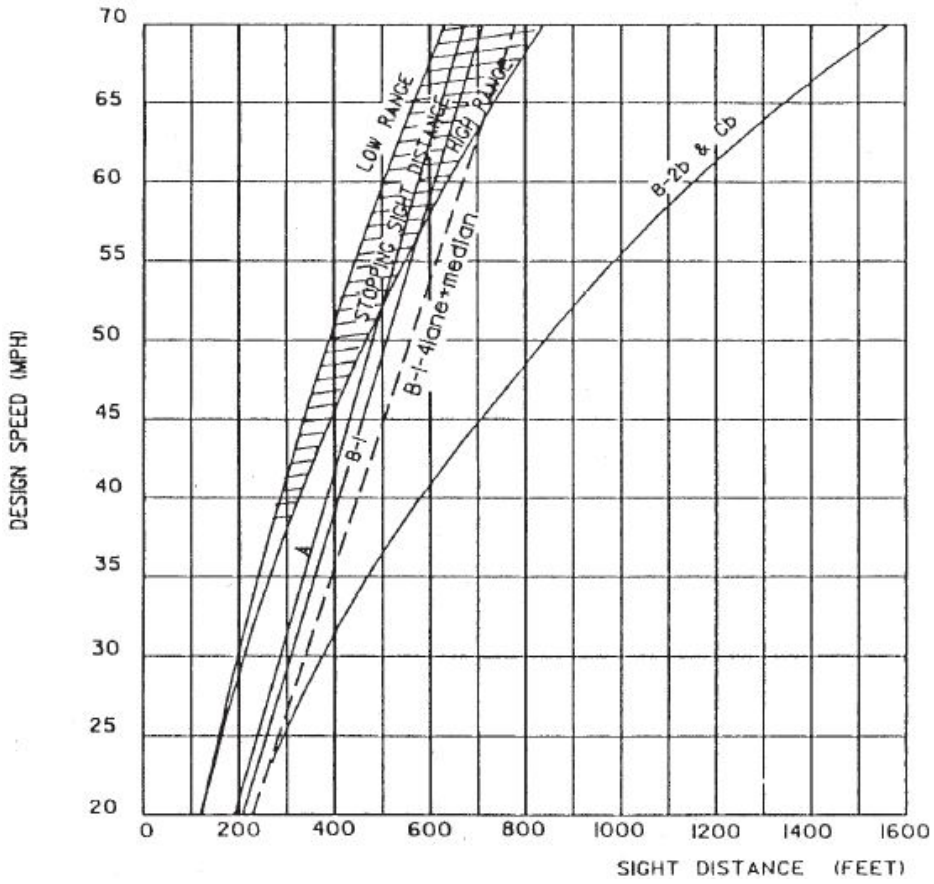
Curbside Approach

5.3 Access Design

5.3.1 Driveway Spacing

Where lots are large enough, the center of driveways not in alignment will normally be offset a minimum of 150' for all commercial/multifamily properties. Greater distances may be required if left-turn storage lanes require such on arterial streets. Minimum sight distance shall be provided at all access points as shown in Figure 5.2, which applies to both city street and driveway intersections.

Figure 5.2: Intersection Distance at At-Grade Intersection



A - SIGHT DISTANCE FOR P VEHICLE CROSSING TWO-LANE HIGHWAY FROM STOP (SEE DIAGRAM).

B-I- SIGHT DISTANCE FOR P VEHICLE TURNING LEFT INTO TWO-LANE HIGHWAY ACROSS P VEHICLE APPROACHING FROM LEFT (SEE DIAGRAM).

B-I-4 Lane+median SIGHT DISTANCE FOR P VEHICLE TURNING LEFT INTO FOUR-LANE HIGHWAY ACROSS P VEHICLE APPROACHING FROM LEFT (SEE DIAGRAM).

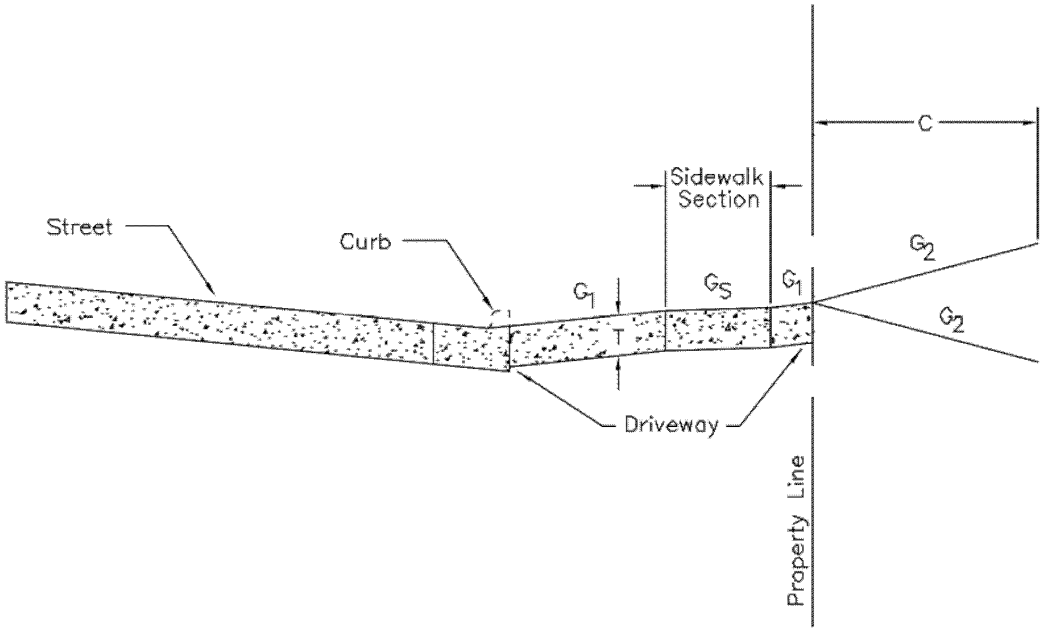
B-2b- SIGHT DISTANCE FOR P VEHICLE TO TURN LEFT INTO TWO-LANE HIGHWAY AND ATTAIN 85% OF DESIGN SPEED WITHOUT BEING OVERTAKEN BY A VEHICLE APPROACHING FROM THE RIGHT REDUCING SPEED FROM DESIGN SPEED TO 85% OF DESIGN SPEED (SEE DIAGRAM).

Cb- SIGHT DISTANCE FOR P VEHICLE TO TURN RIGHT INTO TWO-LANE HIGHWAY AND ATTAIN 85% OF DESIGN SPEED WITHOUT BEING OVERTAKEN BY A VEHICLE APPROACHING FROM THE LEFT AND REDUCING FROM DESIGN SPEED TO 85% OF DESIGN SPEED.

5.3.2 Driveway Design

Driveway sectional details are shown in Figure 5.3 with design requirements listed in Table 5.2.

Figure 5.3: Driveway Grades



*All sidewalk grades (Gs) shall be 2.0%.

Table 5.2

Type of Driveway	Minimum Thickness	Grade (G1)		Grade (G2)		Control Distance (C)
		Min.	Max.	Min.	Max.	
Low Volume Residential	6"	+5.0%	+8.0%	±0. 5%	±13%	20'
Low Volume Commercial/ Industrial	7"	±0.5%	±6%	±0. 5%	± 6%	40'
High Volume	7"	±0.5%	±3%	±0. 5%	± 3%	40'

The following sketches are the recommended minimum design for limited movement driveways. Acceleration and deceleration lanes may be required to be incorporated into the designs. The islands are raised with vertical curb. The ends of the islands should typically be provided with 2-foot radii.

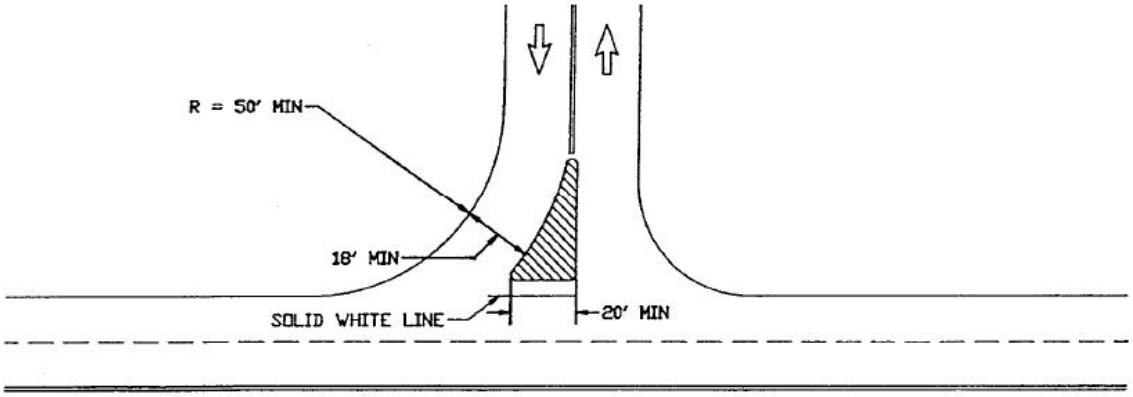


Figure 5.4: Right-In, Right-Out, Left-In Driveway Design

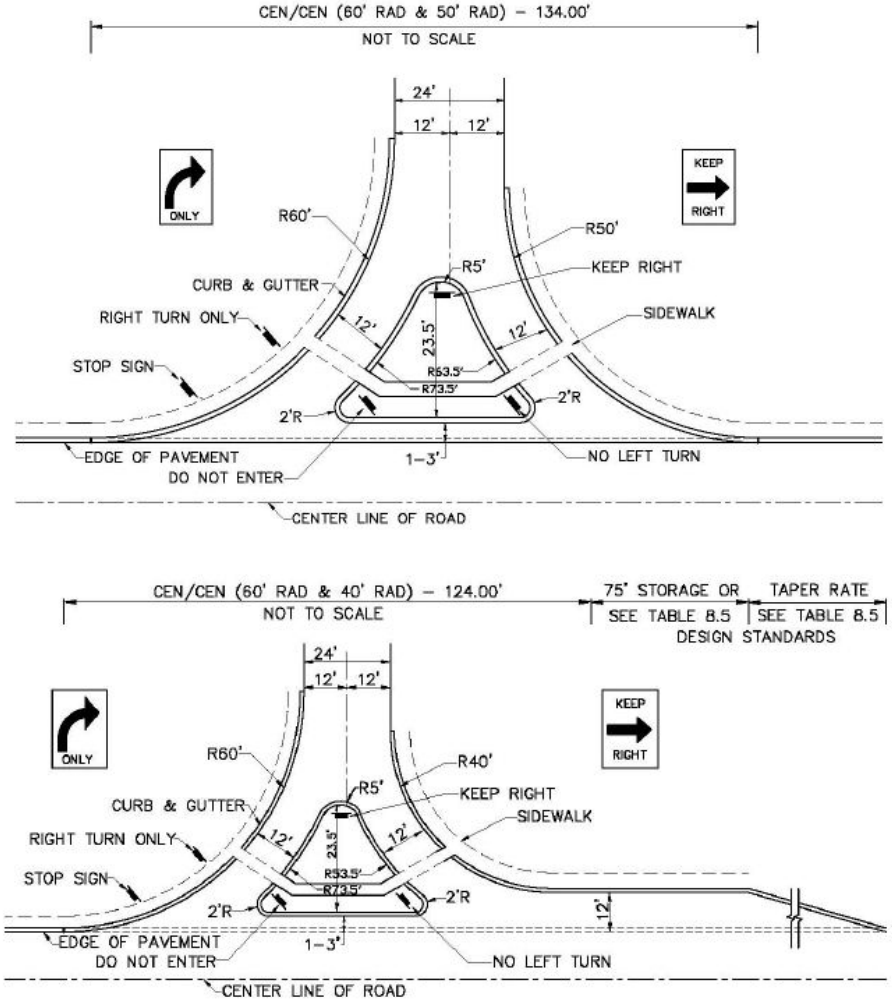


Figure 5.5: Right-In, Right-Out Driveway Designs

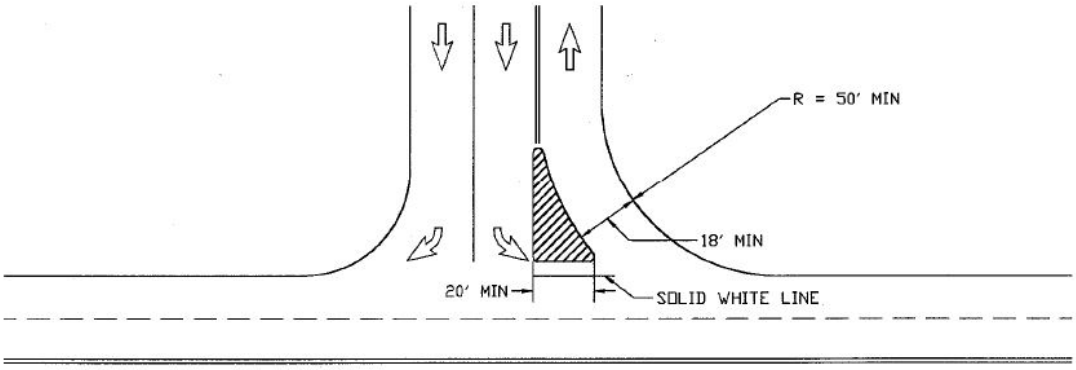


Figure 5.6: Right-In, Right-Out, Left-Out Driveway Design

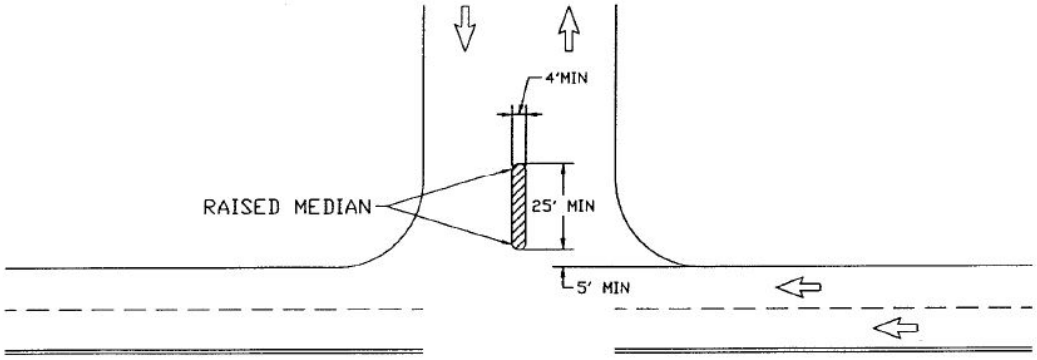


Figure 5.7: Driveway Design with Median Divider

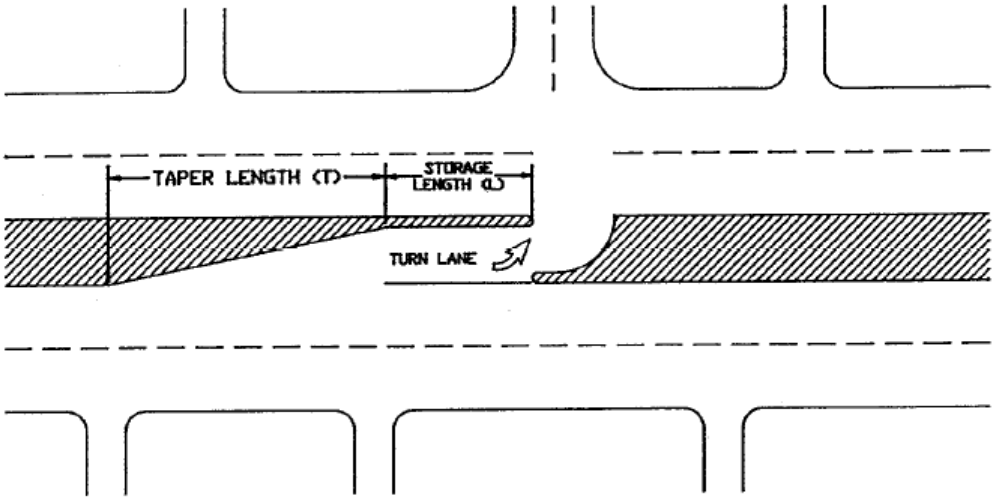


Figure 5.8: Median Design to Restrict Existing Left Turns

5.4 Off-Street Parking

5.4.1 General. The following guidelines regarding the design of off-street parking areas shall be followed.

5.4.2 Minimum Stall Width. The minimum stall width shall be eight and one-half feet (8½'), except compact vehicles. Compact vehicle minimum stall width shall be seven and one-half feet (7½').

5.4.3 Compact Vehicles. A maximum of 33 percent of total required parking stalls may be designated specifically for compact vehicles. When an area is designed for compact vehicles only, the area shall be adequately signed to inform drivers of the exclusion.

5.4.4 Parking Dimensions. Minimum module depths shall be as shown on Figure 5.9 and in Table 5.3.

5.4.5 Backing Into Street Not Allowed. The spaces shall be so arranged so that no vehicle will be required to be backed into the street in order to exit the lot except for single-family or duplex dwelling units.

5.4.6 Backing Over Sidewalk Not Allowed. The spaces shall be so arranged so that no vehicle will be required to be backed over a public sidewalk in order to exit the stall.

Figure 5.9: Parking Area Layout

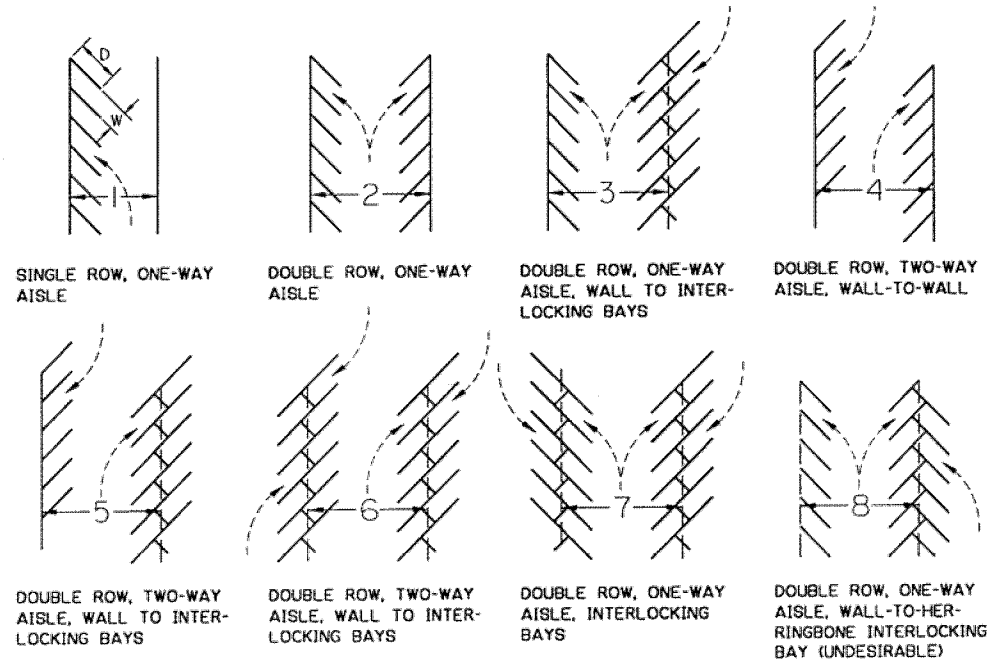


Table 5.3
Minimum Parking Lot Design Requirements
(All Dimensions in Feet)

PARKING ANGLE (DEGREES)	STALL DEPTH "D" (FEET)	STALL WIDTH "W" (FEET)	MODULE DEPTH (FEET)							
			1	2	3	4	5	6	7	8
45	16•	7.5•	26	41	40	52	50	50	39	39
45	18	8.50	30	48	45	58	54	51	42	42
45	18	9.00	30	48	45	58	54	51	42	42
45	18	9.50	30	48	45	58	54	51	42	42
45	18	10.00	30	48	45	58	54	51	42	42
60	17•	7.5•	29	46	45	57	55	53	43	43
60	20	8.50	37	57	55	60	58	56	53	53
60	20	9.00	36	56	54	60	58	56	52	52
60	20	9.50	34	54	52	60	58	56	50	50
60	20	10.00	33	53	51	60	58	56	50	50
75	17•	7.5•	33	49	49	50	49	49	49	49
75	20	8.50	41	61	60	61	60	59	59	59
75	20	9.00	40	60	59	60	59	58	58	58
75	20	9.50	39	59	58	59	58	57	57	57
75	20	10.00	38	58	57	58	57	57	57	57
90	16•	7.5•	35	50	49	50	50	50	50	50
90	19	8.50	45	64	64	64	64	64	64	64
90	19	9.00	43	62	62	62	62	62	62	62
90	19	9.50	42	61	61	61	61	61	61	61
90	19	10.00	41	60	60	60	60	60	60	60

• • COMPACT CARS ONLY

5.5 Accessible Parking Spaces and Signs

The following policy regarding the number, location, design, and signing requirements for accessible parking spaces shall be followed in accordance with the most current Americans with Disabilities Act (ADA) guidelines and these Standards.

Chapter 6 - Geotechnical Exploration and Report
Table of Contents

Section & Topic **Page**

Chapter 6
Geotechnical Exploration and Report

6.1 General

The geotechnical exploration and report shall determine any special geotechnical conditions and make recommendations regarding the special conditions, grading, foundations and pavement.

6.2 When Required

For public improvement projects, the determination as to when soils reports will be required will be determined on an individual, case-by-case basis by the City of Crooks.

6.3 Soil Exploration

6.2.1 General. When geotechnical explorations are required, all sampling and testing of the soil shall be performed in accordance with the appropriate AASHTO (American Association of State Highway and Transportation Officials) and ASTM (American Society for Testing and Materials) designations.

6.2.2 Sampling. Representative samples of the soils shall be obtained by drilling shallow penetration soil borings along the route of the existing or proposed public right-of-way.

6.2.2.1 Borings shall extend to a minimum depth of 5.0 feet below the proposed subgrade foundation, or 2.0 feet below the flow line elevation of any pipe or conduit. Every third boring, or a minimum of one boring, shall be of sufficient depth, or a minimum of ten (10) feet, for monitoring of the ground water elevation.

6.2.2.2 Borings will be performed at close enough intervals to determine the boundaries of each significant soil type present.

6.2.2.3 A random technique shall be used to select sampling locations.

6.2.2.4 Spacing of the borings will vary with the uniformity of the soil profile and the topography. The maximum interval between soil borings may not exceed 400 feet.

6.2.2.5 Where the original ground line is to be covered with fill material, five (5)-foot depth borings are necessary to determine the character of the support.

6.2.2.6 Where drainage areas are crossed or boggy areas are encountered, the spacing of the borings shall be at closer intervals in order to determine the boundaries of the "soft" area. At these "weak" areas, the depth of the borings may also have to be increased in order to determine if and to what depth improved subgrade material will be required to provide uniform support for the construction.

6.2.2.7 Representative samples from the borings shall be collected for submittal to a soils testing laboratory for evaluation.

6.2.2.8 A boring log shall be maintained for each soil boring performed. The boring log shall contain a complete record of the soil material observed.

6.2.3 Testing

6.2.3.1 The tests required are those for identification and classification purposes. These tests include a standard sieve and hydrometer analysis (ASTM D422 of AASHTO T-88) and Atterburg Limits (ASTM D423 and 424 or AASHTO T-89 and 90). The test results are used to give a soil a descriptive name and letter symbol (in accordance with the Unified Soils Classification System) indicating its principle characteristics. Based on the test results, similar soil types can be placed into several major groups.

6.2.3.2 These major groups shall be plotted on a profile sheet to determine their limits. The profile sheet is used with the laboratory data in selecting what soil types further testing should be performed on. Additional testing includes the moisture-density relationship (AASHTO T-99 or T-180) and California Bearing Ratio (MIL STD 621 Method 101 or ASTM D1883). The moisture-density relationship determines the maximum dry density and optimum moisture content for that particular soil. The CBR test is performed at 95 percent of the maximum dry density and at the optimum moisture content. The results of the CBR test determine the relative bearing value of the subgrade and is used in the pavement thickness design. A minimum of a three (3) point curve will be utilized for the CBR testing with a five (5) point curve preferred. If the various soil type areas are not large enough to justify separate pavement designs, a single design shall be made on the worst soil type.

6.4 Report

6.2.4 General. The report shall identify any geotechnical special conditions found in the exploration and recommendations to improve the special conditions along with grading, foundations, and subgrade and pavement requirements. The recommendations may be divided into three parts: geotechnical special conditions, grading and foundation, and subgrade and pavement.

6.2.5 Special Geotechnical Conditions. The special conditions portion of the report shall consider ground water, frost susceptibility, erosion potential, soils creep, landsliding, expansive soils, soil corrositivity, and any other special geotechnical conditions the Geotechnical Engineer becomes aware of.

6.2.6 Grading and Foundation. The grading and foundation portion shall include data regarding the distribution and engineering characteristics of the various soil materials, data about groundwater levels, recommendations about the need for mitigation measures for special geotechnical conditions, grading criteria, foundation design criteria, and any other information the Geotechnical Engineer considers pertinent.

6.2.7 Subgrade and Pavement. The subgrade and pavement portion shall include data regarding the distribution of various subgrade materials and design tests (such as CBR, R-value, and/or plate bearing) to be made. Where soils are susceptible to erosion, recommendations shall be made for preventing the undermining of pavements. The pavement design may be included in this report or prepared and submitted separately by the Engineer responsible for preparation of the construction plans and contract documents.

Chapter 7 – Grading
Table of Contents

Section & Topic **Page**

CHAPTER 7

Grading

7.1 General

7.1.1 All proposed developments shall be graded such that storm water runoff is conducted away from proposed building sites to swales constructed in drainage easements along lot lines, to public rights-of-way, or to another approved drainage course.

7.1.2 No filling will be allowed in any areas of land within a proposed subdivision or other type of development which lies either wholly or in part within the flood plain of a river, stream, creek, or lake unless under the terms of a permit granted by the U.S. Corps of Engineers and/or the City of Crooks where applicable.

7.2 Grading Requirements for Subdivisions

7.1.3 The longitudinal slope along a rear yard drainage easement shall be not less than 1.0 percent but not so great as to cause erosion.

7.1.4 All grade point elevations shall be shown on the plans for each lot at the property corners and at the low and high points along the property lines.

7.1.5 The general direction of overland drainage in the rear yard shall be indicated in the plans on each lot by an arrow.

7.1.6 High and low street grade points, slope direction (by arrow) and the location of all inlets and drainage ditches shall be shown on the grading plan.

7.1.7 A maximum slope of three (3) feet horizontal to one (1) foot vertical shall not be exceeded for all terracing. The toe of the slope shall be located outside of drainage easements and natural drainage ways unless adequate drainage is provided.

7.1.8 Grading plans shall be drawn to a scale of one inch = 100 feet (1” = 100’) or larger.

7.1.9 Grading plans shall include details of typical lot grading and drainage patterns intended to be used.

7.1.10 The grading plans shall show the contours with intervals of one (1) foot for land with a slope of one (1) percent or less, intervals of two (2) feet for a slope between one and one-tenth (1.1) and nine and nine-tenths (9.9) percent and contours of five (5) feet for land with a slope exceeding ten (10) percent.

7.1.11 All elevations shall be on the NAVD 1988 vertical control datum.

7.1.12 Drainage patterns other than those shown in standard details may be used and will be acceptable for review. Details of the typical lot drainage pattern shall be shown on the grading plan with all grade control points identified.

7.1.13 In general, for streets with ditches and no curbs, elevation of the front lot line shall be at least six (6) inches above the centerline of the road.

7.1.14 All nonconforming lots with drainage patterns other than those in standard details shall be noted on the grading plan.

7.1.15 Storm sewers and inlets shall be placed in rear yard swales at low (sump) points where front to rear grading is used.

7.1.16 Drainage swales shall be constructed entirely within the easements.

7.1.17 The grading plan shall show the minimum ground elevation adjacent to buildings for each lot.

Chapter 8 - Street Design and Pavement Thickness

Section & Topic **Page**

CHAPTER 8

Street Design and Pavement Thickness

8.1 General

8.1.1 This chapter sets forth the design and technical criteria to be used in the preparation of all roadway plans. Where design information is not provided herein, “A Policy on Geometric Design of Highways and Streets” (AASHTO Standards) as published by AASHTO’s most current edition (English units) shall be used.

8.2 Access Management

8.2.1 Access

8.2.1.1 Access Defined. Access is defined as any connection, driveway, street, turnout, or other means or providing for the movement of vehicles to or from the public roadway system. Access is further defined as any full movement access, right in right out movement, or partial movement access.

Access Management is defined by the Transportation Research Board National Access Management Manual as the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. It also involved the roadway design applications, such as median treatments and auxiliary lanes and the appropriate spacing of traffic signals. The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system. The contemporary practice of access management extends to concept of access design and location control to all roadways- not just limited access highways, streets, or interstates.

Access management principals and history can be reviewed in the Access Management Manual published by the Transportation Research Board. The City of Crooks implements access management principals. Using access management techniques can reduce the crash rate on a roadway section roughly in half while keeping the traffic flowing.

The City of Crooks may initiate an access management plan or corridor study that would supersede the design standards for access along an arterial or major collector street. Preparation of the study shall be the responsibility of the City of Crooks, South Dakota Department of Transportation, and/or private individuals, or jointly prepared. However, the study must be prepared by a licensed design professional engineer with experience in transportation planning. The access plan or corridor study shall be approved by the City of Crooks and/or South Dakota Department of Transportation.

Access planning that has not been identified in any type of study in existing development areas will be considered on a case by case basis. Retrofit

techniques will adhere to best access management practices as identified in the Transportation Research Board National Access Management Manual.

8.2.1.2 Access Permit. All access to arterial street public right-of-way (ROW) will be required to be approved by the City of Crooks. An Access Permit is defined as a permit issued by a governmental agency for the construction, maintenance, and use of a driveway or public street that connects to a roadway. Access locations shall all be measured from the center line of ROW to centerline of ROW or driveway.

The Development Access Permit is a non-standard access permit that will be completed by the property owner with a supporting map documenting the requested location of each direct or indirect access to arterial functional classification public ROW.

Access permits will be reviewed based on access category criteria, dimensions from centerline of the ROW from adjacent streets, traffic analysis, surrounding access points and any other information relevant to the operation of the access point. The Access Permit shall conform to the requirements listed in ordinance.

8.2.2 Spacing of Direct and Indirect Access, Angle of Intersection, and Offsets.

8.2.2.1 Spacing. For collectors and local streets in a subdivision, four-legged intersections will normally be spaced at least 300 feet apart.

8.2.2.2 Angle of Intersection. Proposed streets and driveways must intersect one another at 90° angles or as close to 90° as topography permits (no less than 80°).

8.2.2.3 Offsets. When “T” intersections are used, the center lines of the streets not in alignment must normally be offset a minimum of 150 feet on local streets, and 300 feet on nonresidential local, and collector streets.

8.2.3 Functional Street Classification.

8.2.3.1 Major Street Plan. The functional street classification of the City’s street network is shown on the Major Street Plan of the Comprehensive Plan kept in the City Office. The right-of-way requirements are noted in Subdivision Ordinances of the City of Crooks. The functional classification is a system used to group public roadways into classes according to their purpose in moving vehicles and providing access to the public.

8.3 Roadway Design and Technical Criteria

The City of Crooks designates streets as local, minor collector, major collector, minor arterial and principal arterial. The highway design speed shall be used to establish features such as superelevation rate, critical length of grade, vertical and horizontal curves, intersections, etc. See Table 8.1 for design standards for each of these street classifications.

8.3.1 Traffic Lane Widths

8.3.1.1 The minimum traffic lane width shall be 12 feet.

8.3.1.2 In the design of local streets, the number of lanes for moving traffic will be a secondary consideration.

8.3.2 Separate Turning Lanes

8.3.2.1 Separate turning lanes may be constructed on arterial and collector streets but will, as a rule, not be found on local streets.

8.3.2.2 Where separate turning lanes are constructed on the basis of a capacity analysis at the intersection, a lane width of 12 feet will be used for arterial streets where truck traffic is involved and 11 feet in width for other streets.

8.3.2.3 A directional median or ¾ turn or partial opening is allowed in a median section and allows for right in, right out, and left in and/or u turn movements. The left-out movement is prohibited. This directional median opening improves safety at intersections and has been proven to reduce crash rates.

8.3.3 Left-turn Lane Storage Lengths for New Facilities

8.3.3.1 Left-turn lane storage design at both signalized and unsignalized intersections for proposed street design plans shall be determined from the use of traffic analysis software or by the use of Figure 8.1. New street will use the desirable lengths. Minimum design lengths will only be permitted under constraints imposed by geometrics of existing streets. Lengths of dual left-turn lanes shall be independently designed.

8.3.4 Parking

8.3.4.1 Parking lanes will not be allowed on arterial or major collector streets.

8.3.4.2 No diagonal or perpendicular parking will be allowed on any City street with a right-of-way of 66’ or less.

8.3.4.3 Where on-street parking is provided, the parallel lane width shall be a minimum of eight (8) feet, which would include the gutter pan.

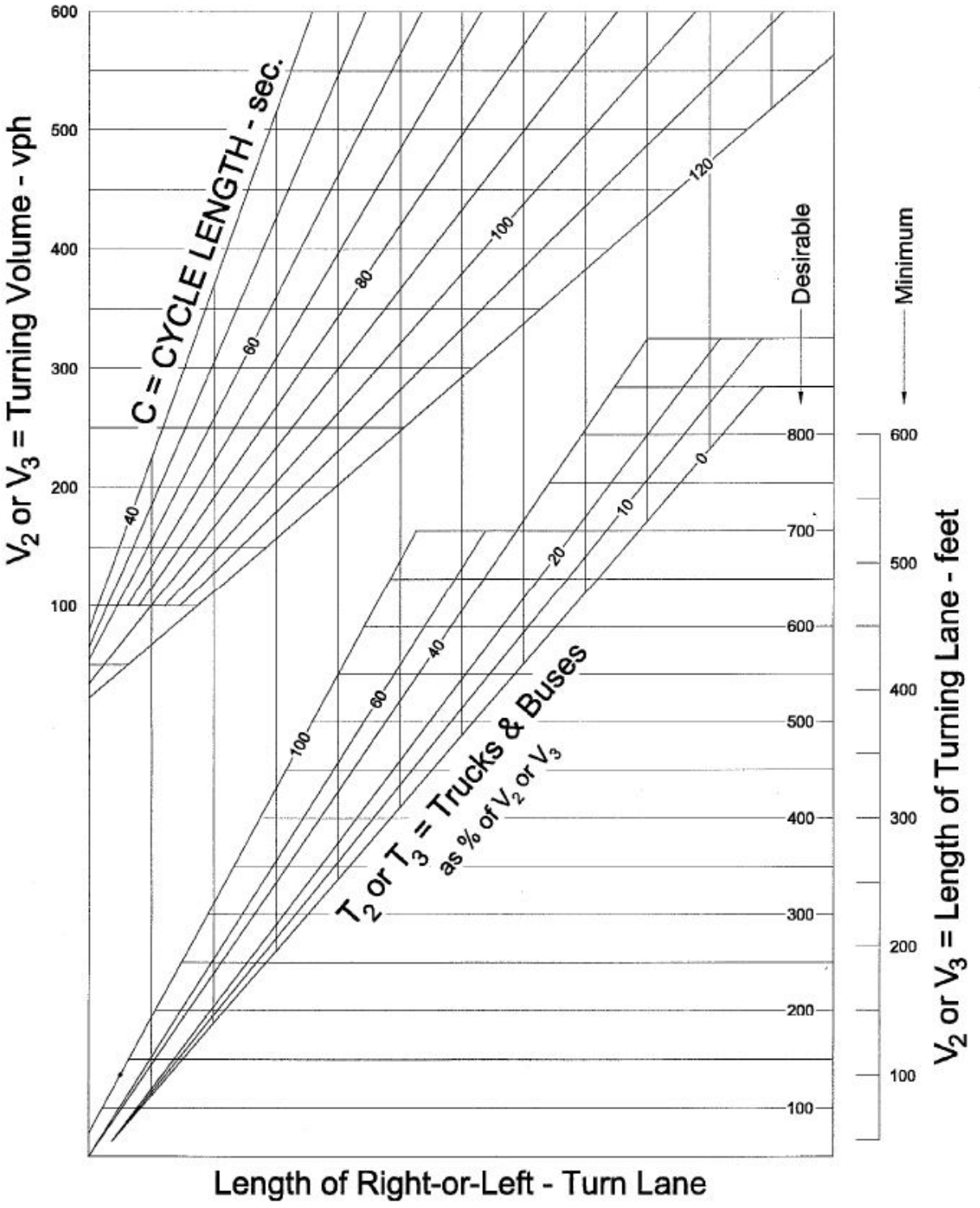
Table 8.1

Minimum Street Design Criteria

	Local		Collector		Arterial	
Design Elements	Residential cul-de-sac **	Single-Family	Minor	Major	Minor	Regional or Principal
Design Speed (mph)			35	40	45	50
Driving Lanes			2	2-4	4	4 or more
Right-of-Way (ft.)	60	66	66	80	100 +	120 +
Roadway Width* (ft.)	33	33	39	39	41-53	65 or more
Min.-Max.Grade (%)	0.6-8.0	0.6-8.0	0.6-7.0	0.6-7.0	0.6-6.0	0.6-6.0
Curb Return Radii (ft.)						
- intersect local	13.5	13.5	20	20		
- intersect collector	20	20	25	25	30	30
- intersect arterial			30	30	35	35
Horizontal Curve Radius (ft.)	150	150	- - - - - - - - -- - - - - - - - - - - AA SKTO Standards -			
Vertical Alignment	- AA SHTO Standards - - -- -					
Grade at Intersection*** (%)						
- intersect local	3	3	3	3		
- intersect collector	2	2	2	2		
- intersect arterial			2			

-
- * All dimensions are measured to back of curb. Traffic impact study may warrant additional width.
- ** Nonresidential cul-de-sac dimensions will differ.
- *** In addition to the intersection grade requirements listed on this table,intersection design must also comply with the pedestrian street crossing requirements outlined in the Accessible Sidewalk Requirements chapter of the Engineering Design Standards.

Figure 8.1: Design of Left-Turn Storage Length Volume-Based Nomograph For At-Grade signalized Intersections



8.4 Sidewalks

8.4.1 General Standards and Location. Sidewalks shall be constructed on both sides of all roadways unless specifically waived by the City of Crooks. Any sidewalk design standard listed in this section that is unable to be met is required to be waived by the City of Crooks. Generally, the sidewalks shall be located one-half foot from the property line within the street right-of-way.

8.4.2 Sidewalk Curb Ramps. State law requires that curb ramps be installed at all intersections and at certain mid-block locations for all new construction or reconstruction of curb and sidewalk. Curb ramps shall be constructed in accordance with the ADA and the standard plates of the South Dakota Department of Transportation (SDDOT). Curb ramps may be shown at all curb returns or called out by a general note on the development plans but must be shown (located) at all "T" intersections. When referencing a curb ramp, specify the SDDOT standard plate to be used to construct that ramp.

8.4.3 Sidewalk Curb Ramp Landing. The minimum dimensions for a landing shall be 60" by 60". A landing shall not have a grade exceeding 2% in any direction. If a landing is at a signalized intersection and has pedestrian push buttons, the horizontal distance between the edge of the landing and the push button location shall not exceed 10".

8.4.4 Sidewalk Width. Minimum sidewalk width shall be 5'. In areas where high pedestrian traffic is anticipated by the City it may be necessary to install wider sidewalks to allow for an adequate level of service.

8.4.5 Sidewalk Cross Slopes. The maximum cross slope for a sidewalk is 2%. This includes where sidewalks cross driveways. The minimum cross slope is 1%.

8.4.6 Sidewalk Grade. All grades on a sidewalk shall meet the current Americans with Disabilities Act standards.

8.4.7 Sidewalk Depth. Depth of sidewalk shall be 4" thick for detached sidewalk and 6" thick for sidewalk attached to the back of curb and sidewalk within an approach or driveway.

8.4.8 Sidewalk Surface. A sidewalk shall have an accessible vibration free route that is at least 48" wide. The number of surface variations such as junction boxes, grates, decorative pavers, etc. in the accessible vibration free route should be minimized. If grates are present, the openings should run perpendicular to the traveled way with less than a 1/2" opening with the traveled way.

8.4.9 Sidewalk Vertical Clearance. Sidewalks which go under a roadway or structure shall have a minimum clearance of 8' from the top of the sidewalk to the lowest part of the structure.

8.5 Bicycle Paths

8.5.1 General. The current AASHTO Guide for the Development of Bicycle Facilities shall be used as a design guide for the design of bicycle paths. A bicycle path, also referred to as a shared use path, is defined as a bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way. Bike paths may also be used by pedestrians, skaters, wheelchair users, runners, and other non-motorized users.

8.5.2 Bicycle Path Width. A bicycle path should have a preferred minimum of a 10'-wide unobstructed area of travel, which includes 2' wide shoulders. Under special circumstances the City Engineer may allow a narrower path.

8.5.3 Bicycle Path Shoulder. A bicycle path shall have shoulders on both sides, with a minimum of 24" wide.

8.5.4 Bicycle Path Cross Slopes. The maximum cross slope for a bicycle path is 2%. The minimum cross slope is 1%.

8.5.5 Bicycle Path Grade. All grades on a bicycle path shall meet the current Americans with Disabilities Act standards.

8.5.6 Bicycle Path Vertical Clearance. Bicycle paths which go under a roadway or structure shall have a minimum clearance of 8' from the top of the path to the lowest part of the structure.

8.5.7 Bicycle Path Horizontal Clearance. Bicycle paths which pass through tunnels shall have at least a 12' horizontal clearance from wall to wall. The entrances and exits to tunnel sections shall be as visually free of trees, shrubs, and other obstructions to facilitate a wide field of view when exiting tunnels.

8.5.8 Bicycle Path Tunnel Lighting. Tunnel sections shall be lit according to current AASHTO lighting guidelines. It is recommended that the ceilings in the tunnel are painted white.

8.5.9 Bicycle Path Surfacing. As directed by the City Engineer.

8.5.10 Paved Bicycle Path Surface. A paved bicycle path shall have an accessible vibration free route that is at least 48" wide. The number of surface variations such as junction boxes, grates, decorative pavers, etc. in the accessible vibration free route shall be minimized. If grates are present the openings should run perpendicular to the traveled way, with less than a 1/2" opening with the traveled way. In tunnel sections a non-slip surface shall be utilized such as brushed concrete or a rubberized surface.

8.6 Drainage

Drainage systems shall be designed in accordance with Chapter 11-Drainage Improvements. Development plans, including the drainage report, shall be considered as part of the street design and will be required for concurrent review with the street construction plans. Safe conveyance of traffic is the major function of streets; the storm drainage function of the street must therefore be designed to the limits set forth in Chapter 11-Drainage Improvements.

8.6.1 Curb and Gutter. Curb and gutter shall have a standard width of thirty inches with a twenty-four-inch gutter pan and six-inch depth from top of curb to the flow line of the gutter. Curb and gutter on roads under the jurisdiction of the SDDOT shall have thirty-two inches wide.

8.6.2 Polyethylene Drainage Tubing. In all areas in which connections to storm sewer infrastructure or existing drainage tubing are feasible and practical corrugated polyethylene drainage tubing shall be installed along the curb and gutter. Drainage tubing shall be installed at a depth of 42 inches when possible with positive drainage maintained at all locations. Tubing shall be backfilled with washed natural rock a minimum of 6” on each side and 12” above the of the outside of the tube. Drainage fabric shall be used to wrap porous backfill and overlapped a minimum of 12” at the seams. Porous backfill shall be monolithic with base course to promote drainage of the subbase.

8.6.3 Valley Gutters. Valley gutters shall be constructed in accordance with the Standard Plates on file with or as directed by the City of Crooks. Valley gutters are not permitted across arterial streets and are discouraged across collector streets. Valley gutters are not allowed on streets with storm sewer systems.

8.6.4 Inlets. Inlets shall be located to intercept the curb flow at the point curb flow capacity is exceeded by the storm runoff. Refer to Chapter 11—Drainage Improvements for curb capacity. Inlets shall also be installed to intercept cross pavement flows at points of transition in superelevation. Due to the presence of curb ramps, inlets are not allowed in the curb return, but will be located at the tangent points of the curb returns. In general, inlets shall be placed on the upstream side of the intersection so as to intercept the water before it reaches the pedestrian crosswalk.

8.6.5 Cross-slope. Except at intersections or where superelevation is required, streets, in general, shall be level from top of curb to top of curb (or flowline to flowline) and shall have a one and one-half (1.5) percent to three (3) percent crown as measured from centerline to lip of gutter, or lip of median gutter to lip of outside curb on roadways with medians. Where the crownpoint is not centered in the street, the crownpoint can be no further out than the quarter point of the street.

8.6.6 Temporary Erosion Control. Temporary erosion control is required at the ends of all roadways that are not completed due to project phasing, subdivision boundaries, etc., in accordance with Chapter 12—Erosion Control and with the Subdivision Regulations of the City of Crooks.

8.6.7 Sidewalk. Storm water from concentrated points of discharge shall not be allowed to flow over sidewalks but shall drain to the roadway by use of storm sewers. Sidewalk

chases will not be allowed unless specifically approved by the City of Crooks. If permitted, sidewalk chase sections shall not be located within the driveway.

8.7 Horizontal Alignment

8.7.1 Horizontal Curves. Any angular break in horizontal alignment of more than two (2) degrees shall require a horizontal curve. Refer to Table 8.1.

8.7.2 Curb Return Radius. Minimum curb return radius shall be as shown in Table 8.1. Where truck traffic is significant, curb return radii shall be provided in accordance with AASHTO standards.

8.7.3 Construction Signs and Barricades. Design and construction shall comply with the requirements of the *Manual on Uniform Traffic Control Devices*, latest edition. Details shall be shown on the construction drawings, and installation shall be provided by the contractor and/or owner.

8.7.4 Superelevation. The use of superelevation is discouraged for all streets. However, where superelevation is required for curves, horizontal curve radius and superelevation shall be in accordance with the recommendations of the AASHTO standards. Superelevation shall not be used on local roadways. All roadway designs utilizing superelevation are subject to review and acceptance by the City of Crooks.

8.7.5 Spiral Curves. Spiral curves shall not be used on streets within the City (State highways excluded) except upon written acceptance by the City of Crooks.

8.7.6 Cul-de-sacs. The following criteria shall be used for the horizontal geometry of cul-de-sac turnarounds.

(1)	Minimum property line radius:	Residential	62.5 feet
		Non-residential	65.0 feet
(2)	Minimum back of curb radius:	Residential	50 feet
		Non-residential	52.5 feet
(3)	Maximum length of cul-de-sac measured along centerline, between the radius point of the turnaround and the R.O.W. line of the abutting street		500.0 feet

8.7.7 Spacing of Direct and Indirect Access, Angle of Intersection, and Offsets

8.7.7.1 Spacing. Four-legged intersections will normally be spaced at least 300 feet apart.

8.7.7.2 Angle of Intersection. Proposed streets and driveways must intersect one another at 90° angles or as close to 90° as topography permits (no less than 80°).

8.7.7.3 Offsets. When “T” intersections are used, the center lines of the streets not in alignment must normally be offset a minimum of 150 feet on local streets, and 300 feet on nonresidential local, and collector streets.

8.7.8 Transition Length. If lanes are added, deleted, or adjusted, it will be necessary to construct a transition section for the safe conveyance of traffic. The following formula shall be applied to the taper or lane change necessary for this transition:

$$L=WS^2/60$$

where:

L = Length of transition in feet
W = Width of offset in feet
S = Speed limit or 85th percentile speed

8.8 Vertical Alignment

8.8.1 Changing Grades. The use of grade breaks, in lieu of vertical curves, is not encouraged. However, if a grade break is necessary and the algebraic difference in grade does not exceed one tenth (0.01 ft/ft) of a percent, the grade break will be permitted.

8.8.2 Vertical Curves. Design controls for vertical alignment must be in accordance with AASHTO standards. When the algebraic difference in grade (A) is at or exceeds one tenth (0.01 ft/ft) of a percent, a vertical curve is to be used. All vertical curves shall be labeled, in the profile, with length of curve (L) and K (defined as L/A).

8.8.3 Intersections. The following criteria shall apply at intersections.

8.8.3.1 The grade of the “through” street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the City of Crooks, shall have this precedence.

8.8.3.2 The elevation at the end of curb return on the through street is always set by the grade of the through street in conjunction with normal pavement cross-slope.

8.8.3.3 Carrying the crown of the side street into the through street is not permitted.

8.8.3.4 Dipping the flowline to the extent that the lip of the gutter is dipped is not permitted, except as specified by Standard Plates concerning curb opening inlets. Tipping an inlet for the benefit of drainage is not permitted.

8.8.3.5 A more detailed review shall be performed for arterial-arterial intersection to maximize drivability.

8.8.3.6 Flowline profiles and pavement cross-slopes shall be shown through an intersection until a normal cross-section is obtained. Elevations on a 15-foot grid shall be shown on a plan view drawing. This information shall be submitted using a scale of 1" = 20' horizontally and 1" = 2' vertically.

8.8.3.7 Parabolic or curved crowns are not allowed. In no case shall the pavement cross-slope at intersections exceed the grade of the through street.

8.8.3.8 The rate of change in pavement cross-slope, when warping side streets at intersections, shall not exceed one (1) percent every twenty-five (25) feet horizontally on a local roadway, one (1) percent every thirty-seven and one-half (37.5) feet horizontally on a collector roadway, or one (1) percent every fifty six and one-half (56.5) feet horizontally on arterial roadways.

8.8.4 Curb Returns. Minimum fall around curb returns shall be one-half of one (0.5) percent.

8.8.5 Connection with Existing Roadways

8.8.5.1 Existing grade(s) shall be shown for a sufficient distance to assure that horizontal and vertical curve requirements are being or can be met with field verified as-builts showing stations and elevations at twenty-five (25) foot intervals. In the case of connection with an existing intersection, these as-builts are to be shown within a one hundred (100) foot radius of the intersection. This information shall be included in the plan and profile that shows that proposed roadway. Limits and characteristics of the existing improvement are the primary concern in the plan view. Such characteristics include horizontal alignment, offset intersections, limits of the improvements, etc.

8.8.5.2 Previously approved designs for the existing improvement are not an acceptable means of establishing existing grades; however, they are to be referenced on the construction plan where they occur.

8.8.5.3 The basis of the as-built elevations shall be the same as the design elevations (both flowline or both top of curb, etc.) when possible.

8.9 Off-Site Design

The design grade, and existing ground at that design grade, of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued, in the same plan and profile as the proposed design, for at least three hundred (300) feet or to its intersection with another roadway. This limit shall be extended to six hundred (600) feet when arterial roadways are being designed.

8.10 Construction Traffic Control

8.10.1 Pedestrian Traffic

8.10.1.1 Every precaution shall be taken to ensure that construction work does not interfere with the movement of pedestrian traffic, which shall be maintained on the sidewalk at all times and flagmen provided for guidance as necessary.

8.10.1.2 Where an excavation interrupts the continuity of the sidewalk, the Contractor shall provide suitable bridge or deck facilities, to be supplemented by the use of such proper devices and measures as prescribed in the *Manual on*

Uniform Traffic Control Devices, latest edition, for the safe and uninterrupted movement of pedestrian traffic. The edges or ends of the pedestrian bridge or decking shall be beveled or chamfered to a thin edge to prevent tripping.

8.10.1.3 Temporary diversion walkways shall be hard surfaced and electric lighting shall be provided and kept continuously burning during hours of darkness, when required by the City of Crooks.

8.10.1.4 Unless otherwise authorized by the City of Crooks, pedestrians shall not be channeled to walk on the traveled portion of a roadway.

8.10.1.5 Under certain conditions, it may be necessary to divert pedestrians to the sidewalk on the opposite side of the street. Such crossings shall only be made at intersections or marked pedestrian crossovers.

8.10.1.6 Facilities satisfactory to the City of Crooks shall be provided for pedestrians crossing at corners, pedestrian crossovers, and public transportation stops.

8.10.2 Vehicular Traffic

8.10.2.1 Construction work zone traffic shall be controlled by signs, barricades, detours, etc., which are designed and installed in accordance with the *Manual on Uniform Traffic Control Devices*, latest edition. A traffic control plan shall be submitted to and approved by the City of Crooks, or designated agent, prior to start of any construction.

8.10.2.2 For construction of new facilities, traffic control should strive to keep the motorist from entering the facility. The primary means to accomplish this are by use of temporary barricades, located in advance of the construction area and with appropriate signing. New construction shall not be opened to traffic, and the construction traffic control removed, without the approval of the City of Crooks.

8.10.2.3 The details of the traffic control plan must be shown on a map. For minor projects or local roadways, a neat sketch of the roadways and the proposed control devices will suffice. For major projects or major roadways, the traffic control plan shall be superimposed on as-builts, construction plan drawings, or other detailed map.

8.10.2.4 The *Manual on Uniform Traffic Control Devices*, latest edition, shall be the basis upon which the traffic control plan is designed, in concert with proper, prudent, and safe engineering practice. All necessary signing, striping, coning, barricading, flagging, etc., shall be shown on the plan.

8.10.2.5 Any plan for traffic control during construction that indicates a complete closure of an arterial or collector street must show detour routes and must be approved by the City of Crooks. Requirements as to rerouting of traffic, signing, time of closure, and length of closure will be determined on a case-by-case basis. When a local street is to be closed to traffic, the City of Crooks must be notified, preferably 24 hours in advance.

8.10.2.6 Directional access on roadways may be restricted (minimum travel lane width in construction area is ten [10] feet), but proper controls including flagging must be indicated. Removal of on-street parking shall be considered, and noted where applicable.

8.11 Pavement Thickness

Design of pavement thickness for collector and arterial streets and local streets in industrial and commercial zoned areas shall be based on *AASHTO Guide for Design of Pavement Structures,* latest edition. Pavement design shall be based on an inherent reliability of 75 percent. For traffic conditions where the equivalent 18 kip/single axle loading is less than 1,000,000, the low-volume road design method may be used. Recommendations and subgrade properties developed by the Geotechnical Exploration Report shall be used in the design of the pavement structure.

8.11.1 Arterial Streets must be designed for pavement thickness on an individual street-by-street basis. Industrial Streets must be designed for pavement thickness on an individual street-by-street basis; however, in no event may the pavement thickness be less than that specified in Table 8.2. Local Residential Streets need not be designed on an individual basis, but must meet the minimum pavement thickness as set forth in Table 8.2.

8.11.2 Minimum compressive strength for Portland Cement concrete paving shall be 4000 psi at 28 days.

8.11.3 **Traffic Data.** Where traffic data is available, actual counts shall be used along with projections of traffic growth in determining the pavement design. If traffic data is not available, Table 8.3 may be used to provide data for the traffic design. Traffic data for all arterial streets will be determined by the City of Crooks.

Table 8.2
Minimum Pavement Thickness Requirements

	Local Residential Streets	Collector Streets	Truck Routes & Arterial Streets
Portland Cement Concrete (Requires Aggregate Cushion)	6"	9"	9”
Asphaltic Concrete with Aggregate Base	4" AC 8" Aggregate	5" AC 12" Aggregate	6" AC 12” Aggregate

Table 8.3
Traffic Volumes

Street Classification	ADT (2 way)	No. of Lots	18-kip ESAL Traffic	AASHTO Traffic Level
Cul-de-sacs and Local Residential	200	20-30	10,000-50,000	Low
Local, Local Multi-Family, Or Commercial	300-700	60-140	50,000-300,000	Low
Local Industrial	200-700		400,000-600,000	Med
Collector	7,000		400,000-1,000,000	High

8.12 Rural Urban Street Standards

Rural urban streets, including local, collector, and arterials, shall conform to the current edition of the AASHTO *Policy on Geometric Design of Highway and Streets*. Reference should be made to the current edition of the AASHTO *Roadside Design Guide* where high fills, right-of-way restrictions, watercourses, or other issues render a design where recoverable slopes are not practical.

Rural urban street sections shall be discouraged and only allowed when approved by the City of Crooks. Rural urban streets will only be considered when the location of the development fits with the City master planning.

Where bicycle facilities are included as part of the design, reference should be made to the current edition of the AASHTO *Guide for the Development of Bicycle Facilities*.

8.13 Rural Subdivision Road Standards

8.13.1 Subdivisions outside of the City limits and within the extraterritorial platting jurisdiction shall comply with these requirements.

8.13.2 Access shall be determined by street classification. Roadway serving the subdivision must be hard surfaced as approved by the City of Crooks.

8.13.3 Driveways shall be hard surfaced and comply with Figure 5.3 of the Engineering Design Standards.

8.13.4 Minimum width of the driving surface shall be 24 feet of and two-foot shoulders. Ditches and driveways shall have a maximum side slope of 4:1. Additional lanes may be required for higher traffic roadways as determined by the City of Crooks.

8.13.5 If access to the subdivision is not on a paved road, the subdivision roads may have a gravel driving surface. If access to the subdivision is paved surface or planned for paved surfacing, or if the size of development creates a significant traffic impact, the subdivision roads shall be paved.

8.13.6 Gravel roads shall have an initial 3-inch lift of gravel covering the road bed, and a second lift of 3 inches of gravel within one year following the completion of construction. Asphalt roads shall be constructed in accordance with Table 8.2.

8.13.7 A plan and profile for construction to existing trunk sanitary sewer and its extension upstream is required. Where trunk sewers cross roadways the ultimate roadway grade shall be called out.

8.13.8 An access road agreement or other arrangements for maintenance of detention ponds and/or BMP facilities shall be provided by association or other perpetual contract.

8.13.9 Culverts in the street right-of-way shall comply with county requirements. Flared end sections or slope concrete headwalls are required on all culverts within the road right-of-way.

8.13.10 The size of culverts shall be determined by a drainage study for the entire subdivision.

8.13.11 The City of Crooks will be responsible for accepting final street and drainage plans. The owner will be responsible for coordination of road access and approach permits with County, Township, and SDDOT officials.

8.13.12 Traffic control signs and street name signs shall be properly posted. Street names shall be approved by the City of Crooks.

Chapter 9 - Sanitary Sewers
Table of Contents

Section & Topic **Page**

Chapter 9

Sanitary Sewers

9.1 General Requirements

9.1.1 Design. The design for sanitary facilities shall be in conformance with the following.

1. "Recommended Standards for Wastewater Facilities Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers." 1997 Edition (Ten State Standards) or most current version.

2. Requirements and Standards of the South Dakota Department of Agriculture and Natural Resources.

3. City of Crooks Engineering Design Standards, Standard Specifications, and Standard Plates.

4. South Dakota State Plumbing Code.

5. Uniform Plumbing Code of International Association of Plumbing and Mechanical Officials.

6. Conflict—In case of a conflict between the above design standards, the most restrictive requirement shall apply.

9.1.2 Construction Standards. Construction standards shall conform to the most recent version of the Standard Specifications and Standard Plates together with the latest addenda or as directed by the City of Crooks.

9.2 Preliminary Submittals

A preliminary report and plan shall be reviewed and accepted by the City of Crooks prior to preparation of final construction drawings. Acceptance of these preliminary submittals shall constitute only a conceptual acceptance and shall not be construed as acceptance of specific design details.

The plan shall be in accordance with Article 3: Preliminary Plan of the Subdivision Ordinance of the most recent edition of the City of Crooks subdivision regulations.

9.3 Determination of Flow

9.3.1 Lateral Sewers

1. Discharge (Q_A) Average Daily Flow

   Equation 1: Area x Area Density x Unit Density x Rate = Average Daily Flow

   Equation 2: Number of Units x Unit Density x Rate = Average Daily Flow.

   Density for multiple dwelling units shall be not less than 2.5 persons/unit. Density for single family dwelling units shall be not less than 3.5 persons per unit.

2. Discharge (Q_P) Peak Lateral Sewer Flow

   Average Daily Flow x 400%—Peak Lateral Sewer Flow

3. Design Density and Rate—(See Paragraph 9.3.5)

9.3.2 Trunk Sewers

1. Discharge (Q_A) Average Daily Flow

   Equation 1: Area x Area Density x Unit Density x Rate = Average Daily Flow

   Equation 2: Number of Units x Unit Density x Rate = Average Daily Flow

2. Discharge (Q_P) Peak Trunk Flow

   Average Daily Flow x 250% = Peak Trunk Sewer Flow

3. Design Density and Rate—(See Paragraph 9.3.5)

9.3.3 Area. Gross area shall be used in determining design flows and shall include streets and alleys but exclude parks, school grounds, and similar dedicated open space.

9.3.4 Special Design Densities. Special design densities shall be subject to approval by the City of Crooks based on methodology provided by the design professional.

9.3.5 Density Design Table

Land Use	Area Density	Unity Density	Rate*
Low Density Residential	6 units/acre	3 people/unit	100 gpcd
Med. Density Residential	12 units/acre	2 people/unit	100 gpcd
High Density Residential	25 units/acre	2 people/unit	100 gpcd

Office & Institutional Special Design Density—dependent on water use

Commercial Special Design Density—dependent on water use

Industrial Special Design Density—dependent on water use

*gpcd—gallons per capita per day

9.4 Facility Design

9.4.1 Capacity of Pipe. The Manning Equation shall be used to determine pipe capacities. The design Manning's (n) for all Pipe Materials.

"n" = 0.013

9.4.2 Velocity within Pipe

Min. at peak flow = 2 feet per second (fps)

Max. at peak flow = 14 feet per second (fps)

The following are the minimum slopes that shall be provided unless the City Engineer allows an exception; however, slopes greater than these are desirable.

Pipe Size (in)	Slope (%)
8	0.400
10	0.280
12	0.220
14	0.170
15	0.150
16	0.140
18	0.120
21	0.100
24	0.080

Gravity sanitary sewer pipe slopes entering manholes shall not exceed 9%.

9.4.3 Approved Pipe Materials. Refer to Standard Specifications or as directed by the City of Crooks.

9.4.4 Force Main Minimum and Maximum Velocity. The minimum force main velocity shall be 2 feet per second.

Suction and discharging piping for lift stations shall be sized so that the maximum velocities do not exceed 5 feet per second and 8 feet per second, respectively.

Dual force mains will be required if the initial force main velocities cannot meet the minimum velocity standards or if odor problems are anticipated.

9.4.5 Size of Sewer Pipe. The minimum gravity sewer size for public or private sanitary sewer collection systems shall be 8-inch diameter.

9.4.6 Depth of Sewer. Gravity sewers shall have a minimum depth of 7 feet to top of pipe where practical. They shall be deep enough to serve all basements, designed with a 2 percent grade on building sewers (absolute minimum of 1 percent). They should be well below the frost line at all points and lower than any water lines placed in the same street. Insulation shall be required above the sanitary sewer where the dimension from the finished grade elevation to the top of the pipe is 5 feet or less. The maximum sanitary sewer depth to the invert at manholes shall be 15 feet.

9.4.7 Alignment of Sewers. Sewers shall be in a straight line between manholes. In subdivisions where street layouts are such that a straight alignment is not practical, sewers may be curved. All sanitary sewers on curved streets shall be located in the center of the street. Where it is possible to maintain the centerline location on a curved street (ex: road centerline radius of curvature less than 200 feet), the sanitary sewer shall be located as close to the centerline as possible and at a distance of at least 10 feet from the back of curb. The following table shows the minimum pipe radius.

Pipe Size (in)	Minimum Radius (ft)
8	200
10	250
12	300

The recommendation for 15-inch through 36-inch diameter sewer pipe is that the angular deflection at the joint is a maximum of 1.5 degrees. This will produce an offset in a 20-foot section of approximately 6.25 inches. The pipe manufacturer's recommended minimum curvature shall not be exceeded.

9.4.8 Physical Requirements

9.4.8.1 Minimum Manhole Diameter. 48 inches when the influent or effluent piping is less than 18 inches. Manholes are to have a minimum diameter of 60 inches when either the influent or effluent pipes are 18 inches and greater. In all cases, the manufacturer's recommended minimum spacing between pipes shall be followed.

9.4.8.2 Maximum Manhole Spacing. The maximum distance between manholes shall be 400'.

9.4.8.3 Manhole Locations. Manholes shall be installed at the following locations:

9.4.8.3.1 At the end of each sewer line. “Dead end” manholes on line segments shall be extended beyond the midpoint of the last serviced lot.

9.4.8.3.2 At all changes in pipe size, grade, or alignment.

9.4.8.3.3 At all sewer pipe intersections.

9.4.8.3.4 Manholes located within the pavement at the end of cul-de-sacs shall be located 5 to 10 feet from the back of curb and gutter.

9.4.8.3.5 All manholes located on trunk sewers or lines 10 inches and greater shall be constructed with a corrosion-resistant liner.

9.4.8.3.6 Sanitary sewer lines ending at development phase boundaries that do not terminate with a manhole shall be ended with a bell end section of pipe and watertight plug. A 1-foot or less section of pipe with a glued-on cap inserted into the bell end of the pipe will be allowable as a watertight plug. Couplings will not be allowed for this type of connection unless there is a change in pipe material. The sewer shall not be put in service until a manhole on the dead-end line is installed.

9.4.8.3.7 Shall be placed outside the 100-year floodplain. Exceptions will require approval from the City of Crooks and shall include placing the rim elevation a minimum of 1-foot above the 100-year base flood elevation.

9.4.8.4 Minimum Manhole Drop

9.4.8.4.1 Same pipe size—0.10 feet

9.4.8.4.2 Change in pipe size—match 0.8 depth point of all lines as a minimum, and match tops of pipes whenever possible.

9.4.8.5 Maximum Manhole Drop

9.4.8.5.1 The designer shall remove drop manholes of less than 4 feet by increasing the pipe slope as long as velocity requirements are not exceeded. When the drop is less than 1.5 feet, the manhole invert shall be constructed to form a uniform slope from the incoming pipes to the outgoing pipe.

9.4.8.6 Manhole Covers. For approved types of manhole covers, refer to Standard Specifications or as directed by the City of Crooks. If the possibility of surface runoff cannot be avoided, a solid manhole cover, having an integral self-sealing type gasket that can be bolted closed, must be used.

9.4.8.6.1 All manholes located outside dedicated street rights-of-way shall be designed and constructed with a bolt-down type cover, having an integral self-sealing type of gasket, and the manhole ring shall be bolted to the manhole cone unless otherwise directed by the City of Crooks. Bolt-down type covers may be required in other locations as directed by the City of Crooks. A note shall be added to the construction plans indicating where the bolt-down covers are required.

9.4.8.6.2 Plastic/fiberglass type manhole markers shall be used in areas outside of the dedicated street right-of-way, except for interstate areas, roadway right-of-way areas, and areas designated by the City of Crooks. Steel delineator posts and markers shall be used in interstate areas, roadway right-of-way areas, and areas designated by the City of Crooks (see the supplemental standard specifications and standard plates for types).

9.4.8.7 Access to Manholes. Manholes outside the street right-of-way shall be subject to the acceptance of the City of Crooks. Manholes located outside of the street rights-of-way must be located in areas which allow direct access by maintenance vehicles. In parking areas, there shall be no parking within 10 feet of a manhole rim.

9.4.8.8 Industrial Sewer Monitoring Facility. Any new building constructed or proposed to be constructed in an industrially zoned area with a floor space of greater than 5,000 square feet, and with a water meter size of greater than 3/4 inch and projected process wastewater flow greater than 5,000 gallons per day, or if otherwise required by the City of Crooks, shall install a sewer monitoring facility prior to final building inspection approval. The monitoring facility shall normally be situated outside of the building on the user's premises. If the industrial user's service line ties into an existing City manhole and such manhole allows for safe sampling and isolation of the industrial user's discharge, the City of Crooks may allow said manhole to serve as the industrial user's monitoring facility.

9.4.8.9 Crossings. Sanitary sewer crossings of storm sewers shall have no less than 6 inches of clearance. Special structural support and insulation will be required if there is less than 18 inches clearance (see the Standard Plates for insulation criteria or as directed by the City of Crooks). The minimum horizontal clearance shall be 2 feet. Clearance refers to the distance from the outside of the sewer pipe to the outside of the storm sewer pipe.

Sewer systems shall be designed to minimize the number of open channel drainage crossings. Sanitary sewer crossings of open channel drainage features shall be designed as nearly perpendicular as possible and shall be on a constant grade. Special structural support and insulation will be required if less than 3 feet of cover is provided within the stream bed.

Sanitary sewer crossings of other utilities shall be done in accordance with Ten States Standards, South Dakota Department of Environmental and Natural Resources, and City of Crooks Standard Specifications and Standard Plates.

9.4.8.10 Standard Plates. See Standard Specifications and Standard Plates for such details as manholes, drop connections, risers, and other appurtenances. If these are not available, details will be as directed by the City of Crooks.

9.4.9 Sewer Services

9.4.9.1 Connections to Manholes. Individual services may not be connected into manholes.

9.4.9.2 Regular Services

9.4.9.2.1 Each structure shall be served by a separate service line connected to a public or private sanitary lateral sewer. The service should be perpendicular to the lateral sewer line in the public right-of-way. Single-family attached housing (twin homes, duplexes, etc.) will be required to have separate services for each living unit. The service for each living unit shall not be located under the property of the adjacent living unit.

9.4.9.2.2 Sewer services must meet all the requirements of the Standard Specifications and Standard Plates or as directed by the City of Crooks.

9.4.9.2.3 All platted lots of a proposed subdivision are to front on and have a separate sewer service to a public sanitary sewer main without crossing any adjacent properties. Additional sewer services will be required for each additional principal structure on a given lot.

9.4.9.2.4 Sewer services across one lot to provide service to an adjacent lot in a proposed subdivision, may be approved, provided that all of the following conditions are met:

9.4.9.2.4.1 Proposed subdivision does not exceed two lots.

9.4.9.2.4.2 A private utility easement 20 feet in width is provided across the burdened lot (to be occupied by sewer service only).

9.4.9.2.4.3 The City of Crooks determines that a sewer main extension will not be necessary to perpetuate the system and, in all likelihood, no future development of abutting properties will benefit from a main extension.

9.4.9.2.5 Minimum size of building sanitary sewer stub outs shall be 4-inch diameter. All sanitary sewer services other than single-family residential units (example: commercial, industrial, office, multifamily, etc.) shall be a minimum of 6-inch diameter. No private lateral sewer shall be less than 6 inches in diameter; however, 8-inch diameter sewers are recommended.

9.4.9.2.6 Service lines shall be designed with a 2 percent grade (absolute minimum of 1 percent upon approval of the City Engineer).

9.4.9.2.7 Whenever possible, the building sewer shall be brought to the building at an elevation below the basement floor. In all buildings in which any building drain is too low to permit gravity flow to the public sewer, sanitary wastewater carried by the building drain shall be lifted by an approved means and discharged to the building sewer at the owner’s expense.

9.4.9.2.8 Risers on service stub outs shall be provided for sewers greater than 12 feet deep as measured at the main line sanitary sewer.

9.4.9.2.9 Private sewer service clean-outs will not be allowed in the public right-of-way. All clean-outs shall be protected with approved cover protection (see Standard Plates).

9.4.9.3 Lateral Extension

9.4.9.3.1 The sanitary sewer collection system shall be considered "public," if the following conditions exist:

9.4.9.3.1.1 The sanitary sewer serves upstream properties outside of the development.

9.4.9.3.1.2 Sanitary sewer services more than one lot.

9.4.9.3.2 The sanitary sewer collection system shall be considered "private" if the following condition exists:

9.4.9.3.2.1 The sanitary sewer is extended to a single private lot to serve a building(s) and/or dwelling unit(s), which are not platted separately and/or are not separated by a two-hour fire wall (identified by the International Building Code or City of Sioux Falls Ordinance). Appropriate private sanitary sewer easements shall be placed over the center line of the lateral or service extension meeting the width requirement for public sanitary sewer lines.

9.4.9.3.3 Shared public and private utility easements will not be allowed.

9.4.9.3.4 Private maintenance agreements—refer to subdivision ordinance for private maintenance agreements

9.4.10 Sewage Lift Stations. The Standard Specifications and Standard Details for sewage lift stations shall be used for all stations unless a separate design is determined necessary by the City of Crooks. Each pumping station shall be provided with a minimum of two pumps, each having a capacity sufficient to pump the peak design flow. Submersible pumps will not be allowed.

Temporary lift stations with reduced design requirements may be considered by the City of Crooks where future trunk sewers are planned to eliminate the need for the station within five years from the installation date of the lift station.

No sanitary sewage shall be allowed to be discharged into a newly constructed lift station wet well until final completion is made and notification is made by the City assuring operation responsibilities.

9.4.10.1 Specific Equipment Required. The sewage lift station shall be supplied with, but not be limited to, the following specific items:

- Flow Meter
- Auto Dialer for Alarm Conditions
- Secondary Power Supply – Engine Generator System
- Automatic Power Switch for the Secondary Power Supply

- Programmable Logic Controller to control and monitor the lift station remotely and locally
- Man Lift for All Dry Well Type Stations Greater Than 20 Feet in Depth (The depth shall be defined as the dimension from the top of the dry well entrance tube to the floor of the dry well.)
- Variable Frequency Drive (VFD) for All Motors Greater Than 30 Horsepower—The requirement for VFDs may be deleted if it is determined unnecessary by the City of Crooks.

9.4.10.2 Wet Well Design. The wet well design shall be coordinated with pump sizing in order to avoid frequent on/off cycling of the pumps. To prevent septicity, inflow into the wet well without pumping should not exceed approximately 30 minutes.

Cycle time is the total time between starts of an individual pump and can be determined by comparing the volume between the "on" and "off" levels in the wet well with the pump capacity. Cycle time is computed as follows:

Where:

CT = Cycle Time (minutes),

V = Wet Well Volume between On and Off Levels (gallons),

D = Rated Pump Capacity (gallons per minute), and

Q = Wet Well Inflow (gallons per minute),

$CT = V/(D-Q) + V/Q$

With a given wet well volume and pumps of uniform pumping rate, minimum cycle time will occur when the rate of inflow is equal to one-half of the discharge rate of the individual pump under consideration and the formula for cycle time simplifies to $CT = 2V/Q = 4V/D$. An effective wet well volume of at least 2.5 times the discharge rate of the pump is required.

The operating volume of the wet well shall be designed to provide the following maximum motor starting times at the design pumping rates.

Motor Size, hp	Maximum Motor Starting Times
0 - 25	6 starts per hour
26 - 35	5 starts per hour
36 - 60	4 starts per hour

9.4.10.3 Pump Design. The operating speed of the pumps shall not exceed 1,800 rpm. The test sphere minimum diameter shall be no less than 3 inches in diameter. The minimum suction and discharge diameter shall be no less than 4 inches in diameter.

9.4.10.4 Engine Generator Design. The engine generator shall be designed to operate each pump simultaneously but start each pump separately. If more than two pumps are used, the engine generator shall be designed to start the pumps necessary for the firm pumping capacity of the station simultaneously. It shall be

at the City of Crooks discretion to change the generator sizing requirements when the size of the lift station warrants it. The engine generator system shall be a four-cycle water-cooled type. The generator shall be supplied with an automatic transfer switch. An enclosure for the automatic transfer switch shall be supplied and sized large enough to contain the station on/off switches, compatible with the City's SCADA system, and other necessary controls. The generator shall be supplied with all accessories, which make it a complete operating system.

9.4.10.5 Power Supply. The power supply shall be 240 volt, 60 Hz, 3 phase unless 480 volt power supply is required and/or available.

9.4.10.6 Lift Station Site Fencing. A fence may be required and constructed around the lift station/generator sites. The City of Crooks shall determine if a fence is required. The fence shall be as detailed and specified in the Standard Plates.

9.4.10.7 Access Road to the Lift Station. An access into the lift station will be required and shall be shown on the construction drawings. The access road shall meet minimum thickness and materials standards for streets. The surfacing used shall be gravel or asphalt.

9.4.10.8 Site Landscaping. The Contractor shall maintain the grass areas by watering, fertilizing, reseeding, mulching, and mowing until the grass has established a 2-inch catch of grass. The Contractor shall immediately reseed and mulch areas which show bare spots at no additional cost.

9.4.10.9 Odor Control. Odor control shall be provided at the lift station and/or the force main discharge where it is determined to be a detectable problem or shown through a design analysis. The design engineer shall perform an analysis showing the modeled results of the odor control analysis. Odor control will be required at the lift station and force main discharge point if it is found to be a detectable problem in the analysis or in the field as determined by the City of Crooks within the two-year warranty period.

9.5 Sanitary Sewer Easements

Sanitary sewer easements shall be obtained for all sanitary sewers located on private and public property. Sanitary sewer easements shall have a minimum width of twenty (20) feet. In addition, temporary easements may be required for construction.

Sanitary sewer easements shall be accessible for City maintenance vehicles to drive on to maintain the sanitary sewer. All manholes shall be accessible to City maintenance vehicles. If determined necessary by the City of Crooks, the area over the sanitary sewer shall be benched to provide an access trail along the line and/or to the manholes.

The most current version of the sanitary sewer easement forms shall be used and obtained from the City of Crooks.

The following Table 9.5 lists the minimum easement widths for sanitary sewer with a pipe diameter of 30 inches or less. The minimum easement widths shall be used when preparing plans. The easement shall be shown on the development engineering plans and construction plans as dimensioned from the centerline of the pipe to the outside edge of the easement and

labeled “Sanitary Sewer Easement.” The easement widths may be required to be wider depending upon specific site conditions.

Table 9.5
Minimum Required Easement Width for Sanitary Sewer
(for 30-inch pipe and smaller)

Pipe Depth (feet)	Minimum Easement Width Required (feet)
8	20
9	20
10	20
11	22
12	24
13	28
14	30
15	34
16	36
17	40
18	42
19	46
20	48
21	52
22	54
23	58
24	60
25	64
26	66
27	70
28	72
29	76
30	78

Chapter 10 - Water Mains
Table of Contents

Section & Topic **Page**

Chapter 10

Water Mains

10.1 General

10.1.1 Design Standards. This chapter sets forth the design and technical criteria to be used in the preparation of all water main plans. Where design information is not provided herein, the most current edition of the following standards shall be used:

- *Recommended Standards for Water Works,* Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Manages (Ten State Standards).
- Requirements and Standards of the South Dakota Department of Agriculture and Natural Resources.
- City of Crooks Engineering Design Standards, Standard Specifications, and Standard Plates.
- American Water Works Association Standards.
- South Dakota Plumbing Code.
- Uniform Plumbing Code.
- International Fire Code and referenced NFPA Standards.

10.1.2 Material Specifications. Material specifications are as specified in the Standard Specifications or as directed by the City of Crooks. However, ductile iron pipe is required to be used in all sites known to have soil contaminated by volatile organic compounds such as fuel and petroleum products or as directed by the City of Crooks. Piping installed in sites known to have soil contaminated by volatile organic compounds shall be furnished with joint gaskets that are resistant to such contamination. All ductile iron pipe and fittings shall be encased in polyethylene regardless of soil conditions.

10.1.3 Construction Standards. Construction standards shall be the most recent revision of the Standard Specifications and Standard Plates together with the latest addenda or as directed by the City of Crooks. All details, materials, and water appurtenances shall conform to these standards.

10.1.4 Where a conflict occurs between the above standards, the most restrictive requirement shall apply.

10.1.5 An average daily water flow rate of 1,500 gallons per minute with a residual pressure of 20 psi at the at the most remote hydrant shall be maintained for all residential developments. Multifamily, commercial, and industrial developments shall be designed according to acceptable methods to determine their water flow

demands. The Insurance Services Office (ISO) fire flow guidelines may be used to determine demand.

10.2 Water Mains

10.2.1 Minimum size water main shall be six inches in diameter.

10.2.2 Minimum depth of cover, as measured from the top of the pipe to the finished surface elevation, shall be six (6) feet. Where an adjustment is required in order to pass under another utility, the length of the deeper main shall be kept to a minimum, and bends shall be used to achieve the desired offset. The existing main may be lowered in place, if this method is practical and acceptable to be City of Crooks.

10.2.3 Water mains shall be at least 20 feet away from buildings and under paved areas whenever possible. Water mains under enclosed walkways and tunnels shall be encased. Water mains will not be allowed under buildings.

10.2.4 Disinfection, bacteriological, and hydrostatic tests shall be required in accordance with the requirements of the Standard Specifications or as directed by the City of Crooks.

10.2.5 Water mains shall be located so as to best conform to the layout of the existing facilities. In streets where no pattern has been established, mains shall generally be located 10 feet to the north or west of the center line, or as noted in Chapter 4of the City of Crooks Engineering Design Standards for Public Improvements – Utility Location and City Utility Easements.

10.2.6 A minimum horizontal separation of 10 feet shall be provided when measured edge to edge between water mains and sanitary and storm sewers as required in the Ten States Standards.

Water mains crossing sanitary or storm sewers shall be laid to provide a minimum vertical distance of 18 inches when measured edge to edge. This shall be the case where the water main is either above or below the sewer with preference to the water main located above the sewer.

When it is impossible to obtain the minimum specified separation distances, the City of Crooks must specifically approve any deviations. Such deviations may allow for installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at which there is 18 inches above the top of the gravity sewer. In addition, the sewer pipe shall meet water main standards. The pipe shall be at least 20 feet in length, and the length of water pipe is located so both joints are as far as possible from the sewer main.

10.2.7 Water mains constructed under drainage structures or drainage mains shall be installed using the following guidelines:

- If a transmission main shall pass under culverts, drainage pipe, or closer than 10 feet from a drainage structure, water main shall be constructed with a steel encasement. Encasement shall end 10 feet from the outside edge of the drainage structure.

- If a transmission main is routed around a drainage structure, the water main system shall be installed 15 feet away (either upstream or downstream) from the outside edge of the structure.

- On all water mains, valves must be provided on each side of the drainage channel or creek to the maximum extent practicable; the means to provide for future access to water for development must be provided if the water main is taken off line.

- If a distribution or service main shall pass under drainage structures or drainage mains 24 inches and larger, with 2 feet or less in clearance, the water main shall be constructed with a steel encasement. Encasement shall end 10-feet from the outside edge of the drainage structure.

10.3 Valves

10.3.1 All valve operation on the existing water distribution system shall only be by a City of Crooks employee.

10.3.2 In general, valves on cross connecting mains shall be located so that no single break requires more than 1,000 feet to be out of service. Valves shall be arranged so that any section can be isolated by closing not more than four valves, with a maximum of 30 residential lots out of service.

10.3.3 Valves shall be located such that they will not be in the sidewalk line or in driveways.

10.3.4 All valves shall be installed with valve boxes.

10.3.5 Valves shall be placed on all dead-end mains for future extension, unless no services are planned and re-chlorination can be completed without interruption of water service.

10.3.6 All shut-off valves and curb stop valves shall be installed at least 20 feet away from structure(s). If the domestic service comes off of the fire line, both lines must have a shut off valve after they separate.

10.3.7 Valves, 12 inches in diameter and greater, shall be installed with two restrainer devises per valve.

10.3.8 Air Release valves shall be installed at the high points on water mains 12 inches or larger.

10.4 Fire Hydrants

10.4.1 Fire flow requirements for buildings or portions of buildings and facilities shall be determined by methods approved by the City of Crooks and Crooks Fire Department.

For arterial streets, fire hydrants shall be staggered on both sides of the street such that they are spaced at not more than 500 feet along the centerline of the street. Fire hydrants on each street side shall be spaced at not more than 1000 feet measured along the centerline of the street.

For collector and local streets, fire hydrants shall be spaced at not more than 500 feet along the centerline of the street.

Fire hydrants shall be spaced such that they will not be more than 300 feet from the farthest corner of any proposed building.

Private fire hydrants shall be provided to meet the fire code when distance to the nearest hydrant is greater than those prescribed by the fire code.

10.4.2 Spacing of hydrants around multiple family, commercial, or manufacturing establishments shall be considered as individual cases and shall be determined by consultation with the City of Crooks Fire Department and City.

10.4.2.1 Private fire hydrant systems—Where a portion of the facility or building hereafter constructed or moved into or with the jurisdiction is more than 400 feet from a hydrant on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building, on-site fire hydrants and mains shall be provided where required by the City of Crooks Fire Department and City.

10.4.3 Fire hydrants shall be located on the road right-of-way 3 feet from the back of curb for sidewalk adjacent to boulevards and on a lot line whenever possible. Fire hydrants installed within curbside sidewalk shall be located 2 feet behind the back of curb and on a lot line whenever possible.

10.4.4 A minimum of three (3)-foot clear space shall be maintained around the circumference (outside) of fire hydrants, except as otherwise required or approved by the fire code official. This requirement pertains to posts, fences, vehicles, vegetative growth, trash, storage, mailboxes, and other materials or things shall not be placed or kept near fire hydrants in a manner that would prevent such fire hydrants from being immediately discernible and/or usable.

A minimum of 15-foot clear space shall be maintained around the circumference (outside) of the fire hydrants as it pertains to light, electric, or traffic light poles.

10.4.5 Fire hydrants shall be installed on the end of all dead-end mains. If the main terminates in a cul-de-sac, the fire hydrant shall be installed to meet clear space requirements as outlined in this Engineering Design Standard.

10.4.6 When fire hydrants are located outside City ROW and are subject to impact by motor vehicles, guard posts, curb and gutter or other approved means shall be provided for hydrant protection.

10.4.7 Flushing hydrants installed for testing purposes shall be removed once testing has been completed. If the flushing hydrants will remain in place for the duration of a winter season, they shall be installed behind the proposed curb and gutter.

10.4.8 Fire hydrant(s) shall be installed not more than 100 feet from fire department connection(s) serving any buildings equipped with a standpipe system.

10.4.9 Finish grades for all hydrants shall be shown on the plans.

10.4.10 Fire hydrants shall be located not less than 40 feet from structures. Private fire hydrants on private water systems shall be located a minimum of 15 feet from structures.

10.4.11 For commercial construction, fire hydrants shall be located at least 25 feet from the exterior wall of any masonry building and at least 50 feet from any exterior wall of frame or equivalent construction, including brick and stone veneer.

10.5 Fire Service Lines

10.5.1 Fire service mains and appurtenances shall be installed in accordance with current edition of NFPA 24. Fire flow requirements for buildings or portions of buildings and facilities shall be determined by methods approved by the Crooks Fire Department or the City of Crooks.

Private fire hydrant systems shall be maintained in an operative condition at all times and shall be repaired where defective. Additions, repairs, alterations, and servicing shall comply with approved standards.

Private fire service mains and hydrants shall be periodically inspected, tested, and maintained in accordance with the current edition of NFPA 25 at the following intervals:

1. Private fire hydrants (all types): Inspection annually and after each operation; flow test and maintenance annually.

2. Fire service main piping: Inspection of exposed, annually; flow test every five years.

10.5.2 Fire lines shall be a minimum of six (6) inches in diameter. For mains that do not supply fire hydrants, sizes smaller than six inches shall be allowed subject to the following restrictions:

1. The main supplies only automatic sprinkler systems, open sprinkler systems, water spray fixed systems, foam systems, or Class II standpipe systems.

2. Hydraulic calculations show that the main will supply the total demand at the appropriate pressure.

10.5.3 Combination fire service line and domestic service line may be installed for apartment buildings with 6 units up to, and including, 15 units. Design calculations and documentation shall be submitted to the City of Crooks for usage and sizing approval.

10.5.4 Domestic service lines and fire service lines shall be separate lines from the property line to the structure. The only exception is combination fire service line and domestic service lines as outlined in 10.5.3.

10.5.5 An indicator valve is required on all dedicated fire service lines as dictated by the fire code. Post Indicator Valve (PIV) or Wall Indicator Valve (WIV) must be specified for approval.

10.5.6 Domestic service lines may be connected to the fire service main sized 6 inches or greater. Domestic service lines shall be tapped on the water main side of the PIV valve or at the property line if a WIV is proposed.

10.5.7 Shut-off valves for the domestic service shall be installed at the property line or as approved by the City of Crooks.

10.5.8 A minimum of 40-foot spacing is required of a PIV from structure(s), unless otherwise approved by the City of Crooks.

10.6 Domestic Services Lines

10.6.1 All platted lots are to front on and have a separate water service to a water main. No water service system shall be located in a lot other than the lot that is the site of the premise being served.

10.6.2 A minimum of 10-foot spacing is required of a service line from any structure(s).

10.6.3 Service lines shall be constructed to the property line as a part of the street construction project if the service line size is known. When the property develops, permanent service disconnection at the main will be required for services not utilized.

10.6.4 All service lines installed for future connection shall be marked by a steel fence post or an approved marker. The steel fence post should be painted blue on the top 1-foot portion of the marker. The marker should be placed near the curb stop or at the termination point of the service stub-in. The service line marker shall remain in place and be maintained by the property owner until the service line is extended into the property to serve a house, building, or other structure. The property owner will be responsible for replacing damaged markers.

10.6.5 Minimum size water service piping shall be 1 inch in diameter. Service sizes shall be detailed within the Construction Drawings.

10.6.6 The criteria for sizing service piping for single-family residential homes from the City main to the curb stop or shutoff valve shall be:

- Those dwellings that have a plumbing fixture load which requires a demand of 40 Fixture Units (FU) or less are allowed to be sized with a minimum 1-inch service.

- Those dwellings that have a plumbing fixture load which require a demand of greater than 40 FU shall be sized with a minimum 1 1/4-inch service.

  Reference Appendix A of the most current edition of the Uniform Plumbing Code for FU allocations to various fixture demands.

10.6.7 If newly developing separate platted properties are replatted to a single unit, any additional water services that were previously installed shall be removed to the corporation stop on the City main at the expense of the owner provided the final lift of asphalt or final surfacing has not been installed.

10.6.8 Perpendicular service line connections to existing mains shall be by means of a saddle and corporation valve.

10.7 Manufactured Home Parks

10.7.1 New manufactured home parks will be allowed to have individually metered services if the distribution system within the park is built to meet the City of Crooks Standards. Maintenance and access easements granted to the City of Crooks for the water main and the service lines to the curb stop are also required.

10.7.2 If individually metered homes are not desired, a metering structure is required for each water main entrance into the park. If a metering structure is used, the distribution system within the park will be considered private and will not be maintained by the City of Crooks.

10.8 Meters

10.8.1 Water meters will be furnished by the City of Crooks and shall be installed by the user under the supervision of the City of Crooks. The user will be required to pay a service charge on the meter equal to the cost of the meter to the department. Ownership of the meter will remain with the City of Crooks.

10.8.2 Master meters for main line metering of industrial and commercial complexes shall be subject to the approval of the City of Crooks. Authorization must be obtained from the City of Crooks to allow the use of a master meter in lieu of individual meters. Metering systems shall be reviewed on an individual basis and shall include such auxiliary equipment as deemed necessary by the City of Crooks. The meter shall be installed in an approved vault or an approved heated and ventilated above-grade enclosure. Below-ground vaults and enclosures for meters must be approved by the City of Crooks prior to installation.

10.9 Cross-Connection Control and Backflow Prevention

10.9.1 The City of Crooks potable water system shall be protected from all cross connections by a backflow prevention assembly in accordance with the South Dakota Plumbing Code and approved by the City of Crooks.

10.10 Lawn Irrigation Systems

10.10.1 Irrigation heads shall be located and maintained so as not to spray over or onto any impervious surface.

10.10.2 New lawn irrigation systems shall be installed with rain sensors that automatically shut off the system after one-quarter (1/4) inch of rainfall has occurred.

Chapter 11 - Drainage Improvements
Table of Contents

Section & Topic **Page**

CHAPTER 11

Drainage Improvements

11.1 Requirements for Storm Drainage Plans

11.1.1 General - The following criteria shall be utilized in the analysis of the drainage system.

Runoff analysis shall be based upon proposed land use and shall take into consideration all contributing runoff from areas outside of the study areas.

The analysis of storm runoff from existing developed areas lying outside of the study area shall be based upon present land use and topographic features.

All undeveloped land lying outside of the study area shall be considered as fully developed based upon the Crooks Comprehensive Plan. Whenever the future land use of a specific undeveloped area cannot be accurately predicted, the average runoff coefficient to be used in said area shall not be less than 0.50 for the Rational Method runoff coefficient or an approved equivalent value for any other method, Table 11.1 (Appendix).

The probable future flow pattern in undeveloped areas shall be based on existing natural topographic features (existing slopes, drainageways, etc.).

Average land slopes in both developed and undeveloped areas may be used in computing runoff. However, for areas in which drainage patterns and slopes are established, actual slopes and patterns shall be utilized.

Flows and velocities which may occur at a design point when the upstream area is fully developed shall be considered. Drainage facilities shall be designed to assure flows and velocities will not cause erosion damage.

The primary use of streets shall be for the conveyance of traffic. The computed amount of runoff in streets shall not exceed the requirements set forth in these Design Standards.

The use of on-site detention, detention within the development or detention in a drainage basin of which the development is part may be required. See the Subdivision Ordinances regarding drainageways and detention pond right-of-way dedication.

The changing of natural drainageway locations will not be approved unless such change is shown to protect against unreasonable hazard and liability, substantiated by thorough analysis.

The planning and design of drainage systems shall be such that problems are not transferred from one location to another. Outfall points shall be designed in such a manner that will not create flooding hazards.

Localized flooding information shall include the area inundated by the major storm runoff.

The flow routing for both the minor and major storm runoff shall be as directed by the City of Crooks. Drainage easements will be required and shall be designated on all drainage drawings and subdivision plats.

Approval will not be made for any proposed building or construction of any type of structure including retaining walls, fences, etc., or the placement of any type of fill material, which will encroach on any utility or drainage easement or which will impair surface or subsurface drainage from surrounding areas.

11.1.2 Minor and Major Design Storms

11.1.2.1 Urban areas generally have two separate and distinct drainage systems. One is the minor system corresponding to the minor (or ordinary) storm recurring at regular intervals. The other is the major system corresponding to the major (or extraordinary storm) which has a one percent probability of occurring in any one year, called the 100-year storm event. Since the effects and routing of storm waters for the major storm may not be the same for the minor storm, all storm drainage plans submitted for approval shall be submitted in detail identifying the effects of both the minor storm and the major storm.

11.1.2.2 Minor Storm Provisions. The minor storm drainage system shall be designed to provide protection against regularly recurring damage, to reduce street maintenance costs, to provide an orderly urban drainage system and to provide convenience to the urban residents. Storm sewer systems consisting of underground piping, natural drainageways, and other required appurtenances shall be considered as part of the minor storm drainage system.

11.1.2.3 Major Storm Provisions. The major storm drainage system shall be designed to prevent major property damage or loss of life. The effects of the major storm on the minor drainage system shall be noted. The route of the major storm shall be noted to assure an outlet to a designated major drainageway is available.

11.1.3 Design Storm Calculations

11.1.3.1 Introduction. Presented in this section are the criteria and methodology for determining the storm runoff design peaks and volumes to be used in the City of Crooks for the preparation of storm drainage studies, plans, and facility design.

11.1.3.2 Design Frequencies. The residential and commercial design storm return frequency shall not be less than 5 years for the minor storm and 100 years for the major storm. The industrial design return frequency shall not be less than 5 years for the minor storm and 100 years for the major storm. 2-year minor storm event design may be considered on a case by base basis with City of Crooks approval.

11.1.3.3 Design Rainfall. The design intensity-duration-frequency rainfall data to be used for the Crooks area was obtained from the National Weather Bureau. The intensity-duration-frequency chart in Figure 11.1A (Appendix) for storm durations of less than one hour and the intensity-duration-frequency chart in Figure 11.1B (Appendix) for storm durations of greater than one hour are presented for computations of rainfall intensities.

11.1.3.4 Rational Method. The Rational Method may be used in both the minor and major storm runoff computations for basins that are not complex and generally have less than 100 acres.

The Rational Method is based upon the following formula:

$$Q = CIA \qquad \text{(Equation 1)}$$

Where:

Q = Peak Discharge (cfs),
C = Runoff Coefficient (refer to Table 1.1),
I = Rainfall Intensity (inches/hour), and
A = Drainage Area (acres).

When using the Rational formula, an assumption is made that the maximum rate of flow is produced by a constant rainfall which is maintained for a time equal to the period of concentration of flow at the point under consideration. Theoretically, this is the time of concentration, which is the time required for the surface runoff from the most remote part of the drainage basin to reach the point being considered.

However, in practice, the concentration time, T_c, is an empirical value that results in acceptable peak flow estimates.

For basins that are larger than 100 acres, and for smaller basins that are complex, it is recommended that the design storm runoff be analyzed by other methods approved by the City.

11.1.3.4 Time of Concentration and Travel Time

As discussed in this Section, Tc, the time of concentration, is the time it requires for runoff to travel from the hydraulically most distant point of the watershed to the point of interest within the watershed.

Travel time is the time it takes water to travel from one location to another in a watershed.

In the application of the Rational Method, the time of concentration must be estimated so that the average rainfall rate of a corresponding duration can be determined from the intensity-duration-frequency chart in Figure 11.1A (Appendix) for storm durations of less than one hour and the intensity-duration-frequency curves shown in Figure 11.1B (Appendix) for storm durations greater than one hour.

Water travels across a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection. The minimum time of concentration shall be 15 minutes.

11.1.3.5 Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 11.2 (Appendix) provides Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\, s^{0.4}} \qquad \text{(Equation 2)}$$

Where:

T_t = travel time (hr),
n = Manning's roughness coefficient, Table 11.2 (Appendix),
L = flow length (ft),
P_2 = Two-year, 24-hour rainfall (in) = 2.7 inch for our area, and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time.

11.1.3.6 Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 2 was developed for use with the four standard rainfall intensity-duration relationships.

- South Dakota is a Type II intensity-duration relationship, as defined by the Soil Conservation Service (SCS).

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or no pressure flow.

- The minimum T_t used in Technical Release-55 (TR-55) Urban Hydrology for Small Watersheds is 0.1 hr (6 minutes).

11.1.3.7 Shallow Concentrated Flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from Figure 11.2

(Appendix) in which average velocity is a function of watercourse slope and type of channel. Tillage can affect the direction of shallow concentrated flow.

After determining average velocity from Figure 11.2 (Appendix), use the following equation to estimate travel time for the shallow concentrated flow segment:

$$T_t = \frac{L}{3600\ V} \qquad \text{(Equation 3)}$$

Where:

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft./sec.), and
3600 = conversion factor from seconds to hours.

11.1.3.8 Open Channel Flow

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Manning's equation is:

$$V = \frac{1.49\ r2/3\ s1/2}{n} \qquad \text{(Equation 4)}$$

Where:

V = average velocity (ft/s),
r = hydraulic radius (ft) and is equal to a/pw,
a = cross sectional flow area (ft2),
pw = wetted perimeter (ft),
s = slope of the hydraulic grade line (channel slope, ft/ft), and
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard hydraulic textbooks. After average velocity is computed using Equation 4, Tt for the channel segment can be estimated using Equation 3, page 11.6.

11.1.3.9 Rainfall Intensity (I)

The intensity (I), is the average rainfall rate in inches per hour for the period of maximum rainfall of a given frequency having a duration equal to the time of concentration. After the design storm frequency has been selected, the rainfall intensity shall be obtained from the intensity-duration-frequency chart in Figure 11.1A (Appendix) for storm durations less than one hour and the intensity-duration-frequency curves in Figure 11.1B (Appendix) for storm durations greater than one hour using the time of concentrations as calculated above.

11.1.3.10 Runoff Coefficient (C)

The runoff coefficient (C) represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception, all of which effect the time distribution and peak rate of runoff. Table 11.1 (Appendix) presents the recommended values of C for the various recurrence frequency storms. The values are presented for different surface characteristics as well as for different aggregate land uses. The coefficient for various surface areas can be used to develop a composite value for a different land use.

11.1.4 Concept Drainage Plan

The Concept Drainage Plan shall be submitted as part of the Development Sketch Plan.

The purpose of the Concept Drainage Plan is to identify any proposed drainage concerns regarding the development. Approximate flow paths and existing conditions will be provided. The Concept Drainage Plan will provide information as directed by the City of Crooks.

11.1.5 Developers Preliminary Drainage and Grading Plan

11.1.5.1 The developer shall submit a drainage plan for the drainage basin(s) of which the development is included. Scales as small as 1 inch equals 500 may be used to show the entire development.

11.1.5.2 The following information shall be included in the submittal:

11.1.5.2.1 A route outlet map will be required. This map shall show how the drainage from the proposed development will be transmitted to the nearest major drainageway. The map shall show any existing structure(s) which may limit the flow en route to the major drainageway. The route outlet map shall show the drainage area upstream of the proposed development and the estimate of flow under current conditions presently draining onto and through the development.

11.1.5.2.2 Data for minor and major storm flows within the proposed development for all drainage basins and sub-basins.

11.1.5.2.3 Identification of drainage problems with proposed solutions to deal with the problems within the development.

11.1.5.2.4 Identification of downstream and upstream facilities as shown on the route outlet map.

11.1.5.2.5 Locations and size of proposed detention ponds within the development shall be identified.

11.1.5.2.6 General locations and size of potential wetlands shall be identified. Include copies of all correspondence with the U.S. Army Corps of Engineers

requesting wetland determinations and any responses. All mitigated wetlands are to be noted.

11.1.5.2.7 Any and all existing 100-year floodplains must be identified, as shown by FEMA maps.

11.1.5.2.8 Existing contours.

11.1.5.2.9 Location and size of existing open channels, bridges, culverts, storm sewers and ponding areas, within the development.

11.1.5.2.10 Location of streets.

11.1.5.2.11 Identification of all drainage basins tributary to the development.

11.1.5.2.12 Drainage patterns within the proposed development.

11.1.5.2.13 Provide adequate information as to the effect of the drainage pattern on adjacent property. Provide survey data as required for adequate information. Identify the storm water path to the major drain way.

11.1.6 Development Engineering Final Drainage Plan

11.1.6.1 The Final Drainage Plan shall be a detailed plan of the proposed development phase, as defined per Subdivision Ordinance. It shall include detailed data for all runoff within the proposed development phase, and detailed data for the design of all drainage structures within the development phase.

11.1.6.2 Drawings and data (actual calculations may be required with submittal) comprising of the Final Drainage Plan shall comply with Chapter 2—Submittal Procedures, and shall include, but not be limited to the following information. Scale will be 1 inch equals 100 feet maximum.

11.1.6.2.1 Proposed contours, and arrows indicating drainage paths.

11.1.6.2.2 Location and elevations of Bench Marks.

11.1.6.2.3 Property lines.

11.1.6.2.4 Streets, names and grades.

11.1.6.2.5 Existing drainage facilities and structures, including existing roadside ditches, drainage ways, gutter flow directions, culverts, etc. All pertinent information such as size, shape, slope, location, etc., shall also be included to facilitate review and approval of drainage plans. Flow areas will be delineated.

11.1.6.2.6 Proposed storm sewers and open drainage ways, easement and right-of-way requirements, including proposed inlets, manholes, and culverts. General notes concerning erosion control and energy dissipation shall be provided.

11.1.6.2.7 Proposed outfall point for runoff from the development phase.

11.1.6.2.8 Routing and accumulative flows at various critical points for the minor and major storm runoff.

11.1.6.2.9 100-year flood level in all streets in which the curb is overtopped during the 100-year storm for sump condition or other critical points.

11.1.6.2.10 Identify 100-year flood elevations for major and lateral drainageways.

11.1.6.2.11 Inlet flow data.

11.1.6.2.12 Pipe flow data.

11.1.6.2.13 All flood plains, identified by FEMA maps, within the proposed development phase.

11.1.6.2.14 Location and size of potential wetlands.

11.1.6.2.14.1 Provide copies of all correspondence with state and federal agencies related to the potential impact to wetlands or other cultural resources. This includes:

11.1.6.2.14.1.1 Wetland determination for the US Army Corps of Engineers
11.1.6.2.14.1.2 Wetland mitigation plan – if required

11.1.6.2.15 Any restriction covenants that would prevent the City of Crooks from performing maintenance activities such as excavating within the wetlands.

11.1.6.2.16 Hydrological data for each drainage area.

11.1.6.2.16.1 Areas

11.1.6.2.16.2 Watershed lengths, elevations, time of concentration

11.1.6.2.16.3 Rainfall intensity

11.1.6.2.16.4 Runoff coefficients

11.1.6.2.16.5 Projected land uses and existing physical features of areas contributing runoff

11.1.6.2.16.6 Storm duration

11.1.6.2.16.7 Runoff (Q) (Note: This list of criteria assumes use of Rational Formula. If a different method is used, all relevant factors are to be enumerated.)

11.1.6.3 Major drainageways

11.1.6.3.1 Alignment

11.1.6.3.2 Existing and proposed profiles

11.1.6.3.3 “n” values (Manning)

11.1.6.3.4 Velocities

11.1.6.3.5 Soils analysis with a discussion of the proposed channel erosion potential

11.1.6.3.6 Shear stress.

11.1.6.4 Design recommendations

11.1.6.4.1 Dikes

11.1.6.4.2 Filling low areas

11.1.6.4.3 Provision of easements

11.1.6.4.4 Recommendations against building in certain areas

11.1.6.4.5 Provisions for onsite retention and detention

11.1.6.4.6 Other as appropriate for conditions

11.1.7 Existing Floodplain Map—Revisions

All submittals for floodplain revision must be reviewed and approved by FEMA or their authorized agent. The City of Crooks will not take responsibility for time, scheduling, or cost involved in floodplain map revisions or letters of map amendments.

The developer is responsible for collecting, developing and submitting all information to FEMA. Copies of all information sent to, and correspondence with FEMA must also be sent to the City of Crooks.

11.1.8 11.1.8 Review by Other Agencies

All open channel construction and existing drainageway modifications will be reviewed by the City and other appropriate county, state, or federal agencies.

11.2 Storm Sewers

11.2.1 Design Flow

For areas smaller than 100 acres, the Rational formula is acceptable to compute runoff. For areas larger than 100 acres, the Soil Conservation Service method or other acceptable computer applications shall be used. Computations for storm sewer design and storm inlet designs shall be submitted to the city for approval.

11.2.2 Material and Installation

All construction shall be in accordance with the approved Standard Specifications and Standard Plates or as directed by the City of Crooks for drainage improvements.

11.2.3 Location of Storm Sewers

11.2.3.1 All public storm sewers shall be installed in the public easement or right-of-way. If storm sewer pipe is placed on back lot lines or otherwise placed across private property, a drainage easement is required provided the pipe is utilized to drain public storm water. If the storm sewer pipe is to be used for private storm water runoff, no easement is required.

11.2.3.1.1 Placement

Storm sewer must be extended to the far edge of the platted subdivision to be serviced, regardless of where the inlets are placed.

11.2.3.1.2 Easements

All easements must be mutually exclusive for the City of Crooks. Easements shall be identified as public utility and drainage easements. Final Drainage Plans shall identify the type of easement. All drainage easements must be a minimum of 20 feet wide, additional width for access may be required. The pipe shall be placed only along the center of the easement, unless approved by the City of Crooks.

No landscaping except grass may be placed in the easement.

No permanent structure may be placed in the easement.

11.2.4 Size

No public storm sewer shall be less than 12 inches in diameter. Trunk storm sewers must be not less than 18 inches in diameter.

All changes in pipe size must occur at a manhole, inlet, or junction box.

11.2.5 Depth

The minimum allowable sewer depth of cover shall be 18 inches unless approved by the City of Crooks.

11.2.6 Pipe

Storm Sewer pipes shall be sized to carry a 5-year flow. Hydraulics of the sewer shall be analyzed. The hydraulic gradient shall remain below the gutter or ground surface elevation to prevent overflow.

Storm sewer pipe shall be reinforced concrete unless otherwise approved by the City of Crooks. In certain cases the designer may wish to specify one type of pipe for a certain purpose, in which case no alternate should be given. The “class” of reinforced concrete pipe shall be shown on the plans.

Storm sewer pipe made of other materials such as polyethylene may be approved by the City of Crooks for private development storm sewer or storm sewer to be installed outside the public right-of-way.

Coefficients of roughness, “n,” for use in the Manning formula as listed below shall normally be used:

Type of Pipe	“n”
Concrete	0.013
PVC	0.010
Polyethylene	0.010

11.2.7 Velocity

The minimum allowable velocity in a storm sewer shall be 3 feet per second (fps). The maximum velocity shall be 15 fps.

11.2.8 Pipe Strength

Pipe specified shall meet AASHTO HS-20 loadings.

11.2.9 Alignment

Sewer shall be installed with a straight alignment between structures with the following two exceptions: In locations where layouts are such that a straight alignment is not practical, sewers may be curved. The curvature must be concentric with the curvature of the street. The pipe manufacturer’s recommended maximum deflection angle shall not be exceeded. Storm sewer bends will be shown as required. The City of Crooks may require a structure instead of a bend.

11.2.10 Separation

Storm sewer crossings of the water main will be performed in accordance with the Standard Specifications or as directed by the City of Crooks. Water main will be installed at least ten (10) feet horizontally from any storm sewer.

Crossings of water main and storm sewer will have a minimum of 18 inches clearance between the outside surface of the pipes.

Storm sewer crossings of sanitary sewer shall be performed in accordance with the Standard Specifications or as directed by the City of Crooks.

Sanitary sewer shall be installed at least two (2) feet horizontally from any storm sewer.

Crossings of sanitary sewer and storm sewer will have a minimum of six (6) inches clearance between the outside surface of the pipe. Crossings that have less than 18 inches of clearance will be structurally supported.

11.2.11 Ground Water Barriers

When there exists a possibility that ground water may be diverted and follow the path of the new sewer, ground water barriers shall be constructed in adequate numbers to prevent ground water migration along sewer trenches.

11.3 Storm Sewer Appurtenances

11.3.1 Junction Boxes

Location

Trunk storm sewer is defined as any storm sewer 18 inches in diameter or larger that is used to convey storm water from two or more inlets.

Lateral storm sewer is defined as the storm sewer that connects to the trunk sewer system. Minimum lateral storm sewer pipe shall be 12 inches in diameter.

Structures shall be required when trunk line storm sewers intersect.

Pipe Tee-Sections may be used to connect a lateral storm sewer to the trunk storm sewer when the lateral length between the Tee-Section and a structure is 75 feet or less.

Field connections to connect a lateral system to the existing trunk storm sewer system, as described in the previous paragraph, will only be permitted if conditions prohibit the installation of a structure, as determined by the City of Crooks.

Bends may be used along the trunk system between structures when curvature alignment requires the bend and the maximum spacing between structures has not been exceeded. The City of Crooks may require a structure instead of a bend.

For 18-inch-diameter storm sewer, the maximum total bend or curvature allowed is 22.5 degrees. For 24-inch-diameter storm sewer and larger, the maximum single bend allowed is 45 degrees. If more than one bend is required due to alignment curvature, the maximum angle per bend is 7.5 degrees. Maximum total curvature is 90 degrees for 24-inch RCP and larger.

Structures shall be installed at the upper end of each line, at changes in grade, size, curvature or alignment, and at distances not greater than: 400 feet for sewers 15 inches in diameter or less; 450 feet for sewers 18 inches and 21 inches in diameter; and 500 feet for sewers 24 inches or larger.

Structures must be located in areas which allow direct access by maintenance vehicles.

11.3.2 Flow Channels

When there is an increase in sewer size of a smaller sewer connected with a larger one, the invert of the smaller sewer must be raised to maintain the same energy gradient. An approximate method of doing this is to place the 0.8 depth point of both sewers at the same elevation or to match the crown of the pipe. Structures that have a direction change of flow shall have a minimum 0.1-foot drop between the inverts.

Drop manholes shall be avoided whenever possible.

11.3.3 Outlets

Where a storm sewer discharges into a natural channel or irrigation ditch, an outlet structure shall be provided that will blend the storm sewer discharge into the natural channel flow in such a way as to prevent erosion of the bed or banks of the channel.

When the discharge velocity is low, or subcritical, the outlet structure may be one of the following:

a. Flared end section
b. Head wall
c. Wing walls

If the discharge velocity is high, or supercritical, prevention of erosion of the natural channel bed or banks in the vicinity of the outlet may require an energy dissipating structure.

All outlets shall have an apron consisting of one of the following:

a. Riprap with geotextile fabric base
b. Concrete slab
c. Other approved methods

11.3.4 Inlets

11.3.4.1 Introduction

A storm inlet is an opening into a storm sewer system for the entrance of surface storm runoff. There are three types of inlets: curb opening, grated and combination. In addition, inlets may be further classified as being on a continuous grade or in a sump. The term “continuous grade” refers to an inlet so located that the grade of the street has a continuous slope past the inlet and therefore ponding does not occur at the inlet. The sump condition exists whenever water is restricted to the inlet area because the inlet is located at a low point. A sump condition can occur at a change in grade of the street from positive to negative or due to the crown slope of a cross street when the inlet is located at an intersection.

11.3.4.2 Inlet Standards

Acceptable inlets for public streets shall be Type I curb opening or Type II combination. Curb opening inlets shall be used at true sumps or at sumps formed by crown slope of cross section at the intersection. Either curb opening type or combination inlets may be used on continuous grade. Grated inlets may be used for parking areas and open fields or other applications subject to approval by the City of Crooks.

Reduction factors shall be applied to the theoretical calculated capacity of inlets based upon their type and function. The reduction factors compensate for effects which decrease the capacity of the inlet such as debris plugging, pavement overlaying, and in variations of design assumptions.

The allowable capacity of an inlet shall be determined by applying the applicable reduction factor from Table 11.3 (Appendix) to the theoretical capacity as presented in the following sections.

The size of outlet pipes from storm water inlets shall be based upon the theoretical capacity of the inlet, but shall not be less than 12 inches in diameter.

11.3.4.3 Curb Opening Inlet Hydraulics

A curb opening inlet may operate under two different conditions of flow: (1) free flow conditions under which a free water surface is continuous into the inlet, or (2) submerged conditions, in which the inlet functions as an orifice. The continuous grade design procedures described herein assume that the inlets will be designed to operate under the free flow condition, since the gutter flow depth required to submerge the inlet is greater than the allowable street capacity.

The inlet dimensions evaluated herein are the standards used for Type I and II inlets.

11.3.4.4 Sump Condition

Presented in Figure 11.3 (Appendix) is a capacity nomograph for sump condition with a gutter depression at the inlet. This chart is an adaptation of a Bureau of Public Roads chart and is applicable to both the free flow and the submerged cases.

11.3.4.5 Continuous Grade

For the “continuous grade” condition, the capacity of the inlet is dependent upon many factors including gutter slope, depth of flow in the gutter, height and length of curb opening, street cross slope, and the amount of depression at the inlet. In addition, all of the gutter flow will not be intercepted and some flow will continue past the inlet area (“bypass”). The amount of bypass must be included in the

downstream drainage facility evaluation as well as in the design of the inlet.

Inlet size and spacing is dependent upon the allowable use of streets for handling storm runoff. Section 11.6, page 11.17, of this chapter will address pavement encroachment and provide criteria for the maximum width of spread (W) as addressed below.

When the allowable pavement encroachment has been determined, the theoretical gutter capacity for a particular encroachment can be determined by the use of Figure 11.4 (Appendix). To further simplify computations, Figure 11.5 (Appendix) is provided to enable direct determinations for various street sections. Figure 11.4 (Appendix) as well as the charts for inlet capacity provided in the Appendix of these standards will assist the designer in solving for the capacity of an inlet on a continuous grade. The procedure for properly sizing and determining inlet spacing is as follows:

After the design has determined a total runoff discharge (Q) flowing upstream of the inlet, enter Figure 11.5 (Appendix) for design Q and extend a vertical line down to intersect with the longitudinal gutter slope (S_o). Extend a horizontal line from the point to the cross slope (S_x) of the street being studied and extend a vertical line down from this point to the width of spread (W). The depth of flow (D) at the curb may also be determined if the vertical line intersecting the cross slope (S_x) on the lower portion of the graph is extended horizontally to intercept the depth at the curb.

Select the appropriate capacity chart from the Appendix for the type of inlet (Type I or II), street cross slope (S_x) and longitudinal gutter slope (S_o).

Type I inlets: Enter the chart for the inlet length selected. Extend a vertical line up to intersect the curve for the width of spread (W) determined in Step 1 and extend a horizontal line from this point to the inlet intercept ratio (Qi/Q).

Type II inlets: Enter the chart for the width of spread (W) determined in Step 1. Extend a horizontal line across to intersect the line for the longitudinal gutter slope (S_o) and extend a vertical line from this point to the inlet intercept ratios (Qi/Q).

Multiply the inlet intercept ratio (Qi/Q) determined in Step 3 times the total discharge (Q) carried by the gutter, yields the quantity of water being intercepted by the inlet (Qi). For Type I inlets, the designer may want to repeat Steps 3 and 4 for other lengths of inlets.

After the theoretical capacity has been determined as outlined above, capacity reduction factors must be applied as listed in Table 11.3 (Appendix). The designer will need to choose which type of inlet is most effective based upon both hydraulic and economic considerations.

11.3.4.6 Capacity of Grated Inlets in Sump

As previously noted, grated inlets may be used for parking areas and open fields or other areas subject to approval by the City of Crooks. The design procedure presented in the following section is based upon the assumption that the grated inlet is clear from debris and is operating at its maximum efficiency.

For a grated inlet operating under sump conditions, the reduction factors of Table 11.3 (Appendix) shall be applied.

Under sump conditions a grated inlet acts essentially as a series of orifices. Design charts indicate that the application of the orifice formula to the clear opening of the inlets gives satisfactory capacities for a clean inlet. Figure 11.6 (Appendix) shows the results of the tests. The head used shall be determined by the allowable depth of ponding for the installation at the design storm frequency.

11.4 Culverts

11.4.1 General

Culverts may be of any shape and construction as required by existing topographic features; provided, however, the size, location and type of construction of culverts shall be subject to acceptance by the City of Crooks.

Culverts within major drainageways that are under arterials or railroads shall have sufficient capacity to pass all of the runoff from the 100-year storm considering 20 percent of the inlet plugged, for pipes under 48" diameter.

For all other streets, culverts must be designed to convey a minimum of 10-year flow with no street overtopping and must be large enough so that the 100-year flow over the top of the road does not exceed 18 inches in depth above the invert of the gutter.

11.4.2 Design Criteria

11.4.2.1 The following design criteria shall be utilized for all culvert design:

The culvert including inlet and outlet structures shall properly take care of storm water flow, bed-load and debris at all stages of flow.

Inlets. Culvert inlets shall be designed to minimize entrance and friction losses. Inlets shall be provided with either flared-end sections or head walls with wing walls. Projecting ends will not be acceptable. For large structures provisions shall be made to resist possible structural failure due to hydrostatic uplift forces.

Outlets. Culvert outlets shall be designed to avoid sedimentation, undermining of the culvert, or erosion of the downstream channel. Outlets shall be provided with either flared-end sections or headwalls, with wingwalls. Projecting outlets will not be acceptable. Additional

outlet control in the form of rip rap, channel shaping, dissipation structure, etc., may be required where excessively high discharge velocities occur. All structural outlet velocity dissipaters shall be underlain with a suitable filter fabric to protect against scour.

Slopes. Culvert slopes shall be such that neither silting nor excessive velocities and scour occur. Generally, the minimum slope of culverts shall be limited to 0.50 percent.

Hydraulic Design. Culverts shall be analyzed to determine whether discharge is controlled by inlet or outlet conditions for both the initial storm discharge and the major storm discharge. The value of the roughness coefficient (n) used shall not be less than those specified by documentation of the culvert manufacturer. Computations for selected culvert sizes shall be submitted for review.

Minimum Allowable Size. The required size of the culvert shall be based upon adequate hydraulic design analysis. In no case, however, will approval be made for round culverts with less than 18 inches inside diameter, or for arched or oval shaped culverts with span-rise dimensions less than 24 inches x 18 inches nominal. Culverts 15 inches or greater in diameter may be used for single-family residential access drives.

The minimum height of a reinforced box culvert should be 3 feet to facilitate cleanout and allow removal of forms during construction.

Multiple Culvert Installation. Where physical conditions dictate, multiple culvert installations will be acceptable, provided the minimum size of any culvert to be used shall not be less than the requirements set forth above.

Structural Design. The structural design of culverts shall conform to those methods and criteria recommended by the manufacturer of a specific type of culvert dependent upon the type of bedding, the method of installation, and the load.

Trash and Debris Deflector. When, in the opinion of the City of Crooks, debris accumulation for a particular drainageway appears to pose a significant probability of culvert plugging, trash racks or debris deflectors will be required.

11.5 Open Channel Flow

11.5.1 General

Major drainageways and lateral drainageways will be classified by the City of Crooks.

See Figure 11.7A, 11.7B, 11.7C (Appendices) for design standards for channel construction.

All channels will be designed with the 5-year storm frequency and the 100-year storm frequency considered.

Channels shall be designed in such a manner that flows at the critical depth and supercritical flows are avoided.

If increased flows are proposed for any channel, protection as required shall be provided for a natural channel. Channel protection will be designed to withstand forces that attempt to overtop the channel banks, deteriorate the channel lining, erode soils beneath the channel lining and erode unlined areas of the channel.

Open channels conveying storm water shall be designed using the Tractive Force Procedure. The permissible shear stress, T_d, is the force required to initiate movement of channel lining material. Normal depths in the channel are calculated using Manning's equation. Manning's roughness coefficients for different ranges of depth are provided in Figure 11.7B. The coefficient of roughness generally decreases with increasing flow depth.

Shear stress, T, at normal depth, is computed for the lining by the following equation:

$$T = yds \qquad \text{(Equation 5a)}$$

Where:

T = shear stress in lb/ft^2
y = unit weight of water, 62.4 lbs/ft^3
d = flow depth in feet
s = channel gradient in ft/ft

If the permissible shear stress, T_d, given in Figure 11.7C, is greater than the computed shear stress, T, the chosen channel liner is considered acceptable. If the computed shear stress is too great, select a liner with a higher permissible shear stress and repeat the calculations for normal depth and shear stress. In some cases, it may be necessary to alter the channel dimensions to reduce the shear stress.

All channels shall be designed with proper and adequate erosion control features. When required, drops or check dams shall be installed to control water surface profile slope.

Grass-lined channels or side slopes of concrete-lined channels will be seeded with a mixture as set forth in these Design Standards.

Lateral drainageways without a low flow storm sewer will only be permitted with the acceptance by the City of Crooks.

For channels that cross a roadway and overflow the street section within design standards, it is acceptable to provide an easement for the 12-foot access strip along the backwater area. The remaining channel dedication will be per City Ordinance.

11.6 Street Flow Capacity

11.6.1 General

The criteria set forth herein will be used in analyzing and approving the adequacy of streets as a function of the drainage system. Both the minor and 100-year storm runoff must be considered and calculations showing such runoff at critical sections shall be submitted. Street, curb and gutter, valley gutters, and curb cuts shall conform to the Standard Specifications or as directed by the City of Crooks.

11.6.2 Street Capacity for Minor Storms

Pavement encroachment for the minor design storm shall not exceed the limitations set forth in the following table:

Allowable Pavement Encroachment and Depth of Flow for Minor Storm Runoff

Street Classification	Maximum Encroachment*
Local	No curb overtopping. Flow may spread to crown of street.
Collector	No curb overtopping. Flow spread must leave the equivalent of one 10-foot driving lane clear of water (one lane for two-lane street, two lanes for four-lane street).
Arterials	No curb overtopping. Flow spread must leave the equivalent of two 10-foot driving lanes clear of water; one lane in each direction.
Freeways	No encroachment is allowed on any traffic lane.

*Where no curbing exists, encroachment shall not extend past the property lines.

The storm sewer system shall commence at the point where the maximum allowable encroachment occurs. All storm sewer systems shall be designed for the 5-year storm event.

When the allowable pavement encroachment has been determined, the theoretical gutter carrying capacity for a particular encroachment shall be computed using the modified Manning's formula for flow in a triangular channel as shown in Figure 11.4 (Appendix). To simplify computations, graphs for particular street shapes may be used as shown on Figure 11.5 (Appendix). An "n" value of 0.015 shall be used unless special considerations exist.

11.6.3 Street Capacity for Major Storms

The allowable depth of flow and inundated area for the major design storm shall not exceed the limitations set forth in the following table:

Allowable Depth of Flow and Inundated Area for 100-Year Storm Runoff

Street Classification	Allowable Depth and Inundated Areas
Local and Collector	Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line. The depth of water over the gutter flow line shall not exceed 18 inches.
Arterial and Freeway	Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line. Depth of water at the street crown shall not exceed 6 inches to allow operation of emergency vehicles. The depth of water over the gutter flow line shall not exceed 18 inches.

11.6.4 Cross Street Flow

Cross street flow can occur by two separate means: (1) runoff which has been flowing in a gutter and then flows across the street to the opposite gutter or inlet; (2) water from some external source, such as a drainageway or conduit, will flow across the crown of the street when the conduit capacity beneath the street is exceeded. The maximum allowable cross street flow depth based on the worst condition shall not exceed the limitation stipulated in the following table.

Allowable Cross Street Flow

Street Classification	Minor Storm Runoff	100-Year Design Storm Runoff
Local	6-inch depth at crown or in the valley gutter	18 inches of depth above gutter flowline
Collector	Depth of flow shall not exceed 6 inches above gutter flow line	18 inches of depth above gutter flowline
Arterial	None	6 inches or less over crown
Freeway	None	6 inches or less over crown

11.6.5 Capacity Calculations

All theoretical flow capacities shall be reduced by the appropriate reduction factors as shown in Figure 11.8 (Appendix) to obtain allowable flow capacities.

11.6.6 Drainage Tract Requirements

All backward draining cul-de-sacs and sump streets are required to have a minimum 20-foot-wide drainage easement shown on the plat for the purpose of conveying drainage. The easement shall meet the applicable requirements for storm sewer easements.

11.6.7 Sump Pump Collection Systems

11.6.7.1 When required in accordance with Subdivision Ordinance, drainage systems can be designed with a sump pump system attached to the trunk drainage system.

11.6.7.1.1 It is acceptable for a sump pump collection system to be installed in the street right-of-way or within a backyard easement. If within a backyard easement, the collection pipe shall be installed 1.5 feet south or east of the back property line. If within a front yard easement, the collection pipe shall be installed eight (8) feet from the street right-of-way.

11.6.7.1.2 Services shall not cross the street section.

11.6.7.1.3 Storm sewer can serve as the sump pump collection pipe. RCP storm sewer pipe will be cored drilled for service connections. Polyethylene pipe or PVC pipe service connections will be installed in accordance with manufacturer specifications.

11.6.7.1.4 Service connections shall be installed and capped along the mainline pipe for each individual lot. For backyard installations, service stub-outs shall be centered on the back lot line.

11.6.7.1.5 A minimum 24-inch diameter structure shall be installed at a maximum distance of 600 feet. A 5-foot access easement from right-of-way to backyard easement is required for the backyard structures. Corner lots may not require a 5-foot access easement.

11.6.7.1.6 Structures will be installed at the farthest upstream and downstream end. For front yard installations, the structures shall be on the side lot line. For backyard installations, the structures shall be +/- 5 feet from the side lot line.

11.6.7.1.7 Minimum diameter of sump pump collection system pipe shall be 6 inches. Minimum velocity shall be 2 feet/sec.

11.6.7.1.8 Maximum number of homes connected to a sump pump collection system until connected to a trunk storm sewer system is 300 homes.

11.6.7.1.9 The connection of the sump pump collection pipe to the trunk storm sewer system shall be a minimum of 0.4 foot above the structure outfall storm sewer or flow line.

11.6.7.1.10 Depth of cover shall be a minimum of 4 feet. When the minimum cover cannot be established, the collection system shall be insulated per Standard Plates or as directed by the City of Crooks. For those systems that are insulated, a minimum cover of 18 inches in grassed /landscaped areas and 30 inches in asphalt/concrete areas shall be provided from finished grade to the top of the collection system pipe.

11.6.7.1.11 Bends will not be allowed. Minimum radius of curvature shall be 150 feet.

11.6.7.1.12 For backyard installations, if the swale along the back property line is less than 2 percent, the sump pump collection pipe may be a 6 inch min. perforated pipe with a filter fabric sock.

11.6.7.1.13 The minimum slope of collection pipes shall be 0.40 percent.

11.6.7.1.14 Animal guards shall be installed at the end of all collection pipes discharging directly into a public drainageway.

11.6.7.1.15 Sump pump collection pipe diameters less than 12 inches shall only convey groundwater.

11.6.7.2 A regional groundwater collection drain tile system can be installed instead of a sump pump collection system.

11.7 Detention Storage

11.7.1 General

Detention ponds shall be designed and constructed at those locations identified by the City of Crooks. The use of onsite detention is permitted at those locations where the onsite drainage system cannot be tied into an existing drainage system.

Onsite detention may be used if the development cannot provide adequate storm sewer systems to achieve the required storm sewer standards.

Parking lots which serve as detention storage ponds must not have a storage depth of more than 1 foot. It is recommended that notification signs be installed in parking lots which serve as detention ponds. The signs shall be permanent and high quality, meeting SDDOT Specifications for Traffic Signs.

11.7.2 Design Storm

Detention ponds along major drainageways shall be designed for a 100-year design flow.

Other detention ponds shall be designed such that the 5-year return storm is conveyed through the principal outlet assembly and the 100-year return storm is conveyed through the overflow assembly.

11.7.3 Release Methods

Intermittent ponds shall drain completely.

Careful consideration must be given to the discharge of the surface release as to the elimination of erosion potential, and the capacity of the downstream surface water course. The release structure shall be designed to withstand the forces caused by the structure being overtopped during a larger than design storm.

A stage (in feet) versus release rate (in CFS) curve must be provided for the release structure.

11.7.4 Maximum Release Rate

The detention pond volumes and release rate shall be designed to accommodate runoff generated by the development and post-developed upstream properties.

The release rate from the detention pond cannot exceed predevelopment rates for the 5-year and 100-year return storm when discharge is conveyed onto undeveloped property unless City-owned conveyance structures of adequate size are contiguous and downstream of the proposed discharge points.

11.7.5 Maintenance Requirements

Detention ponds and similar areas not required as a necessary part of the major drainage system, may be accepted by the City for maintenance only if such land provides another useful public service such as a public park or wildlife area.

All detention areas shall have a 30-foot-wide access to a public right-of-way if they are not located adjacent to a public right-of-way.

Detention ponds serving properties greater than two (2) acres in size where discharge is generated from publicly maintained infrastructure may be dedicated to the City. Property delineation markers shall be installed upon dedication of the property in locations specified by City. All other detention ponds shall be privately maintained.

11.7.6 Adjacent Property Elevations

The property corner elevation of properties abutting a detention pond shall be 1 foot above the 100-year design storm.

Recommended minimum ground elevations for homes abutting or affected by the detention pond shall be 2 feet above the overflow elevation. Recommended minimum ground elevation for homes abutting or affected by detention ponds will be a minimum of 4 feet above the 100-year pond high water elevation if an overflow system is not available or at an elevation that provides an additional 50 percent storage.

11.8 Best Management Practices

All projects, except those that are less than two acres and have less than one acre of new impervious area, shall meet the requirements of Section 11.8. The following process is recommended for selecting structural BMPs in newly developing and redeveloping urban areas:

11.8.1 Employ Runoff Reduction Practices

To reduce runoff peaks and volumes from urbanizing areas, employ a practice generally called “minimizing directly connected impervious areas” (MDCIA). The principal behind MDCIA is two-fold: to reduce impervious areas and to route runoff from impervious surfaces over grassy areas to slow down runoff, promote infiltration, and reduce costs. The benefits are less runoff, less storm water pollution, and less cost for drainage infrastructure. There are several approaches to reduce the effective imperviousness of a development site. Some examples include, but are not limited to: reduced pavement area, porous pavement, grass buffers, grass swales, and minimizing directly connected impervious areas.

11.8.2 Provide Water Quality Capture Volume

A fundamental requirement for any site addressing storm water quality is to provide water quality capture volume (WQCV). One or more of five types of water quality basins, each draining slowly to provide for long-term settling of sediment particles, may be selected to provide WQCV. These five BMPs include: Porous Landscape Detention, Extended Detention Basin, Sand Filter Extended Detention Basin, Constructed Wetland Basin, and Retention Pond.

The Constructed Wetland Channel BMP must be used with a BMP that meets the WQCV criteria. It does not provide WQCV by itself. It can however provide additional water quality treatment and aesthetic value.

The Water Quality Catch Basins and Water Quality Catch Basin Inserts BMP do not meet the WQCV criteria. They are only intended for use in highly urbanized areas, such as redevelopment conditions, where existing development precludes the ability to meet the WQCV criteria. These BMPs must be approved for use by the City. In determining BMP approval, preference will be given to structural BMPs providing WQCV as listed in this section.

CHAPTER 11 – DRAINAGE IMPROVEMENTS

APPENDIX

TABLES AND FIGURES

TABLES

Table 11.1 - Runoff Coefficients for Rational Method

Land Use or Surface Characteristics	Percent Impervious	Storm Frequency, years 5	10	100
Business:				
Commercial Areas	95	.88	.90	.93
Neighborhood Areas	65	.65	.70	.80
Residential:				
Single-Family	40	.45	.50	.70
Multi-Unit (detached)	50	.55	.60	.75
Multi-Unit (attached)	70	.70	.70	.80
1/2 Acre Lot or Larger	30	.40	.45	.65
Apartments	70	.70	.70	.80
Industrial:				
Light Areas	80	.80	.80	.85
Heavy Areas	90	.80	.85	.90
Parks, Cemeteries:	7	.25	.35	.60
Playgrounds:	13	.30	.40	.70
Schools:	50	.55	.60	.75
Railroad Yard Areas:	40	.45	.50	.70
Undeveloped Areas:				
Historic Flow Analysis Greenbelts, Agricultural	2	.20	.30	.60
Offsite Flow Analysis (when land use not defined)	45	.50	.55	.72
Streets:				
Paved	100	.88	.90	.93
Gravel	7	.25	.35	.65
Drives and Walks:	96	.87	.90	.92
Roofs:	90	.85	.90	.90
Lawns, Sandy Soil:	0	.10	.20	.50
Lawns, Clay Soil:	0	.20	.30	.60

NOTE: These Rational Formula coefficients do not apply for larger basins where the time-of-concentration exceeds 60 minutes.

REFERENCE: Urban Drainage and Flood Control District Rational Formula Procedure, Hydrology Research Program, August 1979.

Table 11.2

Roughness Coefficients (Manning's n) for Sheet Flow

Surface Description	**n**[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:[2]	
Short grass prairie	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).

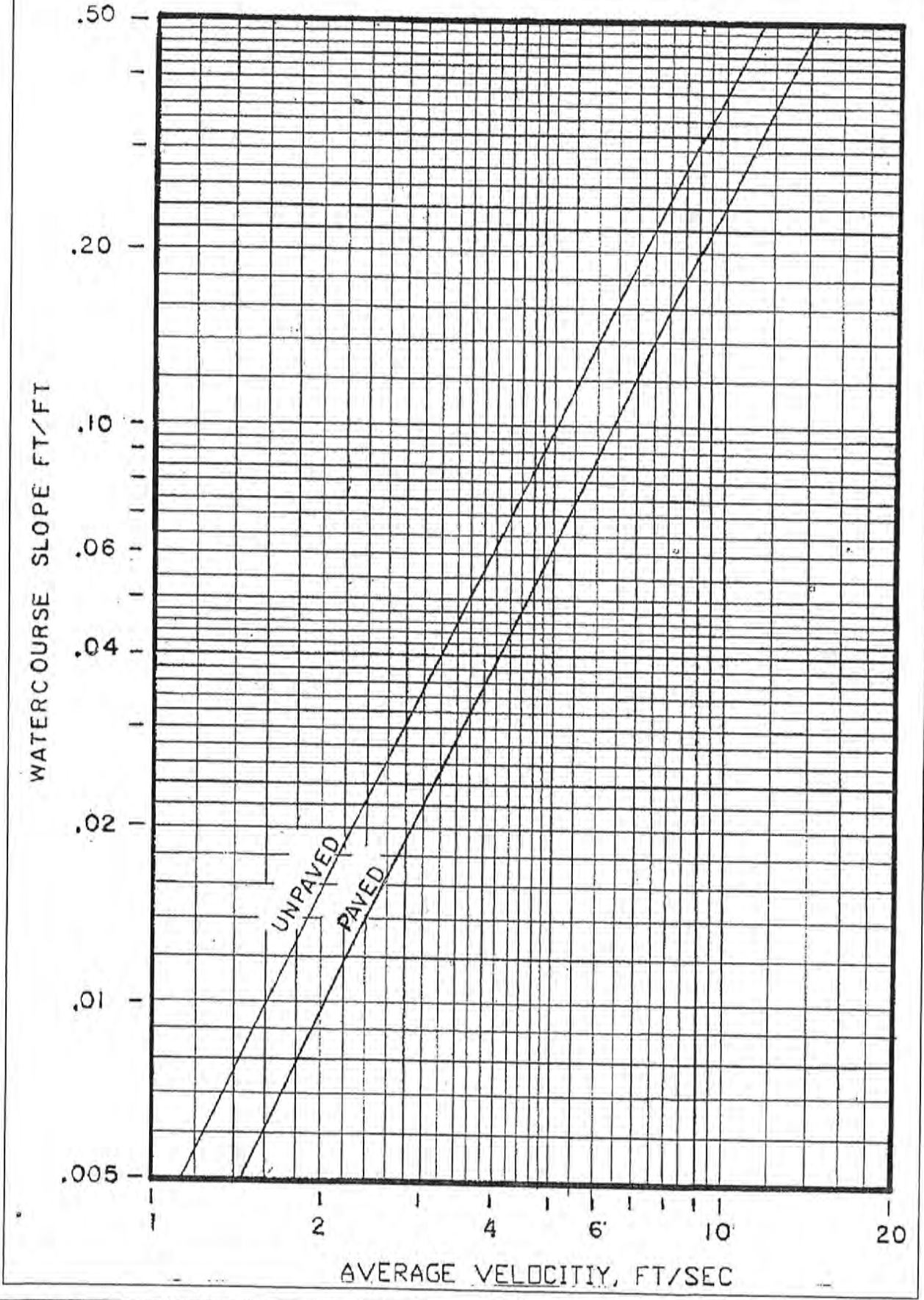
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Table 11.3
Reduction Factors to Apply to Inlets

Condition	Inlet Type	% of Theoretical Capacity Allowed
Sump	Grated	50%
Sump	Combination	65%
Continuous Grade	Deflector	75%
Continuous Grade	Longitudinal Bar Grate incorporating recessed transverse bars	60%
Continuous Grade	Combination	110% of that listed for type of grate utilized
Sump or Continuous Grade	Curb Opening	
	L = 3'	80%
	L = 6'	88%
	L = 8'	90%
	L = 10'	92%
	L = 15'	95%

FIGURES



AVERAGE VELOCITIES FOR ESTIMATING TRAVEL TIME FOR SHALLOW CONCENTRATED FLOW

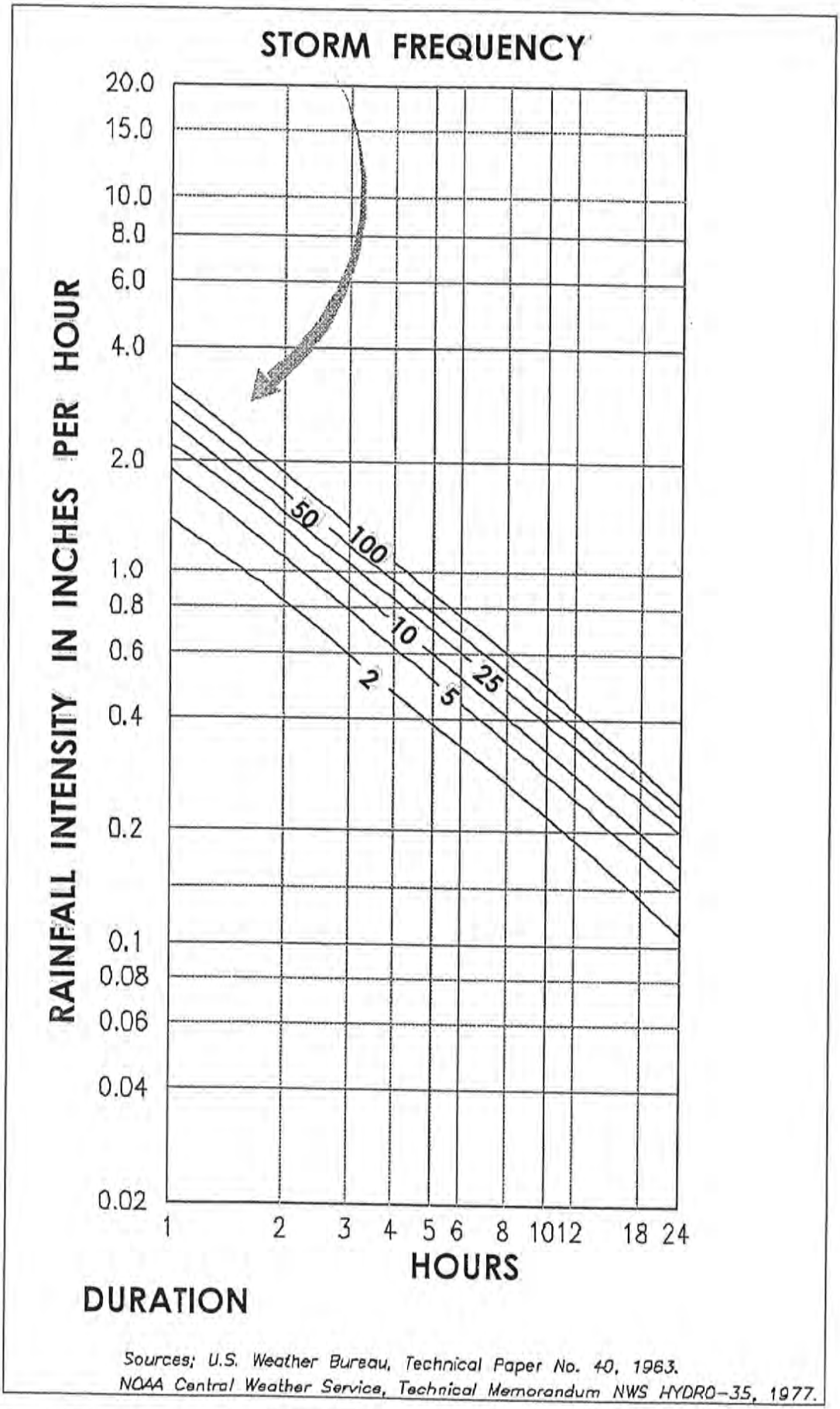
FIGURE NO.:
11.1

RAINFALL INTENSITY, in / hr

Tc	5 YEAR	100 YEAR	2 YEAR	10 YEAR	25 YEAR	50 YEAR
15	4.39	7.43	3.53	5.04	6.00	6.72
16	4.27	7.23	3.42	4.9	5.83	6.54
17	4.15	7.05	3.32	4.77	5.68	6.37
18	4.04	6.87	3.23	4.65	5.54	6.21
19	3.93	6.71	3.13	4.53	5.4	6.06
20	3.83	6.55	3.05	4.42	5.27	5.91
21	3.74	6.40	2.97	4.31	5.14	5.78
22	3.65	6.25	2.89	4.21	5.02	5.64
23	3.57	6.11	2.82	4.12	4.91	5.52
24	3.49	5.98	2.75	4.03	4.80	5.40
25	3.41	5.86	2.68	3.94	4.70	5.28
26	3.34	5.74	2.62	3.86	4.60	5.17
27	3.27	5.62	2.55	3.78	4.50	5.07
28	3.2	5.51	2.5	3.71	4.41	4.97
29	3.14	5.40	2.44	3.63	4.33	4.87
30	3.08	5.30	2.39	3.57	4.24	4.77
31	3.02	5.20	2.34	3.50	4.16	4.68
32	2.96	5.11	2.29	3.44	4.08	4.60
33	2.91	5.02	2.24	3.37	4.01	4.51
34	2.86	4.93	2.20	3.32	3.94	4.43
35	2.81	4.84	2.15	3.26	3.87	4.36
36	2.76	4.76	2.11	3.20	3.80	4.28
37	2.72	4.68	2.07	3.15	3.74	4.21
38	2.67	4.61	2.03	3.10	3.68	4.14
39	2.63	4.53	2.00	3.05	3.61	4.07
40	2.59	4.46	1.96	3.01	3.56	4.01
41	2.55	4.39	1.93	2.96	3.50	3.94
42	2.51	4.32	1.89	2.91	3.45	3.88
43	2.47	4.26	1.86	2.87	3.39	3.82
44	2.43	4.20	1.83	2.83	3.34	3.76
45	2.40	4.13	1.80	2.79	3.29	3.71
46	2.36	4.08	1.77	2.75	3.24	3.65
47	2.33	4.02	1.74	2.71	3.20	3.60
48	2.30	3.96	1.71	2.68	3.15	3.55
49	2.27	3.91	1.69	2.64	3.11	3.50
50	2.24	3.85	1.66	2.61	3.06	3.45
51	2.21	3.80	1.64	2.57	3.02	3.41
52	2.18	3.75	1.61	2.54	2.98	3.36
53	2.15	3.70	1.59	2.51	2.94	3.32
54	2.13	3.66	1.56	2.48	2.90	3.27
55	2.10	3.61	1.54	2.45	2.87	3.23
56	2.07	3.56	1.52	2.42	2.83	3.19
57	2.05	3.52	1.50	2.39	2.80	3.15
58	2.03	3.48	1.48	2.36	2.76	3.11
59	2.00	3.44	1.46	2.33	2.73	3.07
60	1.98	3.39	1.44	2.31	2.69	3.04

INTENSITY-DURATION-FREQUENCY CHART

FIGURE NO.:
11.1A

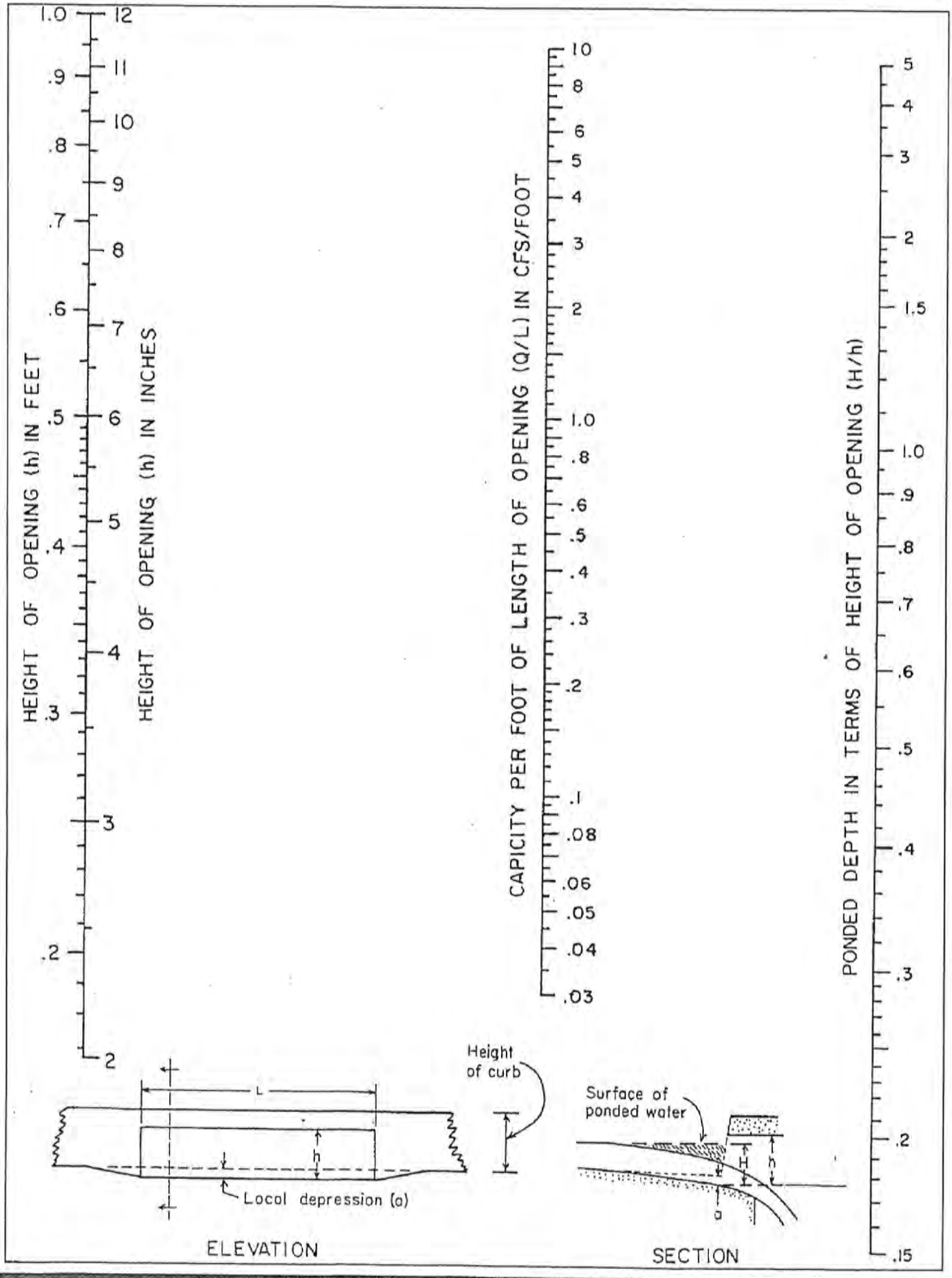


Sources; U.S. Weather Bureau, Technical Paper No. 40, 1963.
NOAA Central Weather Service, Technical Memorandum NWS HYDRO-35, 1977.

INTENSITY-DURATION-FREQUENCY

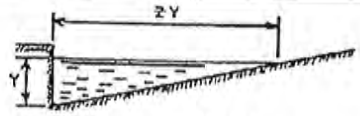
FIGURE NO.:
11.1B

S:\Files\CAD\Land Projects R2\Salem Details\dwg\Salem Details.dwg, 11.1B, 12/19/2006 12:06:32 PM, Kroth, 1:12



CAPACITY OF CURB OPENING
INLET AT LOW POINT IN GRADE

FIGURE NO.:
11.2



EQUATION: $Q = 0.56\left(\frac{Z}{n}\right) S^{\frac{1}{2}} Y^{\frac{8}{3}}$

n is roughness coefficient in manning formula appropriate to material in bottom of channel.

Z is reciprocal of cross slope

REFERENCE: H.R.B. Proceedings 1946 page 150, equation (14)

EXAMPLE: (see dashed lines)

GIVEN: S = 0.03
Z = 24
n = .02
Z/n = 1200
Y = 0.22

FIND: Q = 20 cfs

RATIO Z/n: 10000, 9000, 8000, 7000, 6000, 5000, 4000, 3000, 2000, 1000, 900, 800, 700, 600, 500, 400, 300, 200, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10

TURNING LINE

DISCHARGE (Q) IN CFS: 100, 70, 50, 30, 20, 10, 7, 5, 3, 2, 1, .7, .5, .3, .2, .1, .07, .05, .03, .02, .01

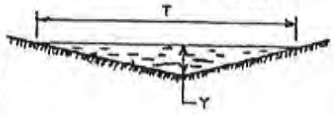
SLOPE OF CHANNEL (S) IN FT/FT.: .10, .08, .07, .06, .05, .04, .03, .02, .01, .008, .007, .006, .005, .004, .003, .002, .001

DEPTH AT CURB OR DEEPEST POINT (Y) IN FT.: 2.0, 1.0, .80, .70, .60, .50, .40, .30, .20, .10, .08, .07, .06, .05, .04, .03, .02, .01

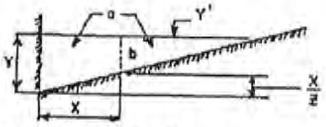
INSTRUCTIONS

1. Connect Z/n ratio with slope (S) and connect discharge (Q) with depth (Y). These two lines must intersect at turning line for complete solution.

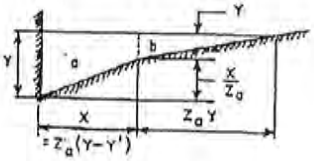
2. For shallow V-shaped channel as shown use nomograph with $Z = \frac{T}{Y}$



3. To determine discharge Q_X in portion of channel having width X: determine depth Y for total discharge in entire section a. Then use nomograph to determine Q_b in section b for depth $Y' = Y - \left(\frac{X}{Z}\right)$

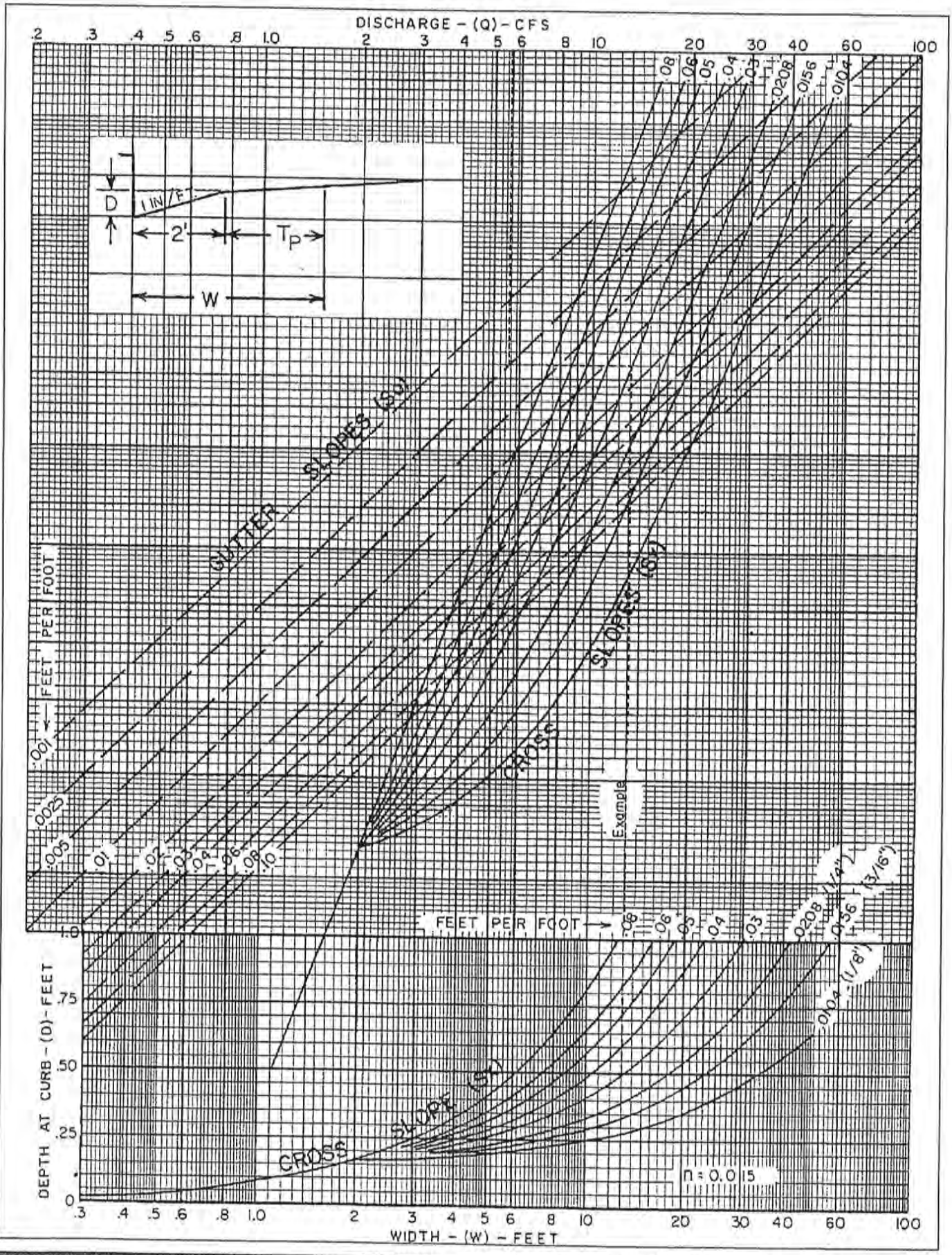


4. To determine discharge in composite section: - follow instruction 3 to obtain discharge in section a at assumed depth Y, obtain Q_b for slope ratio Z_b and depth Y then $Q_T = Q_a + Q_b$



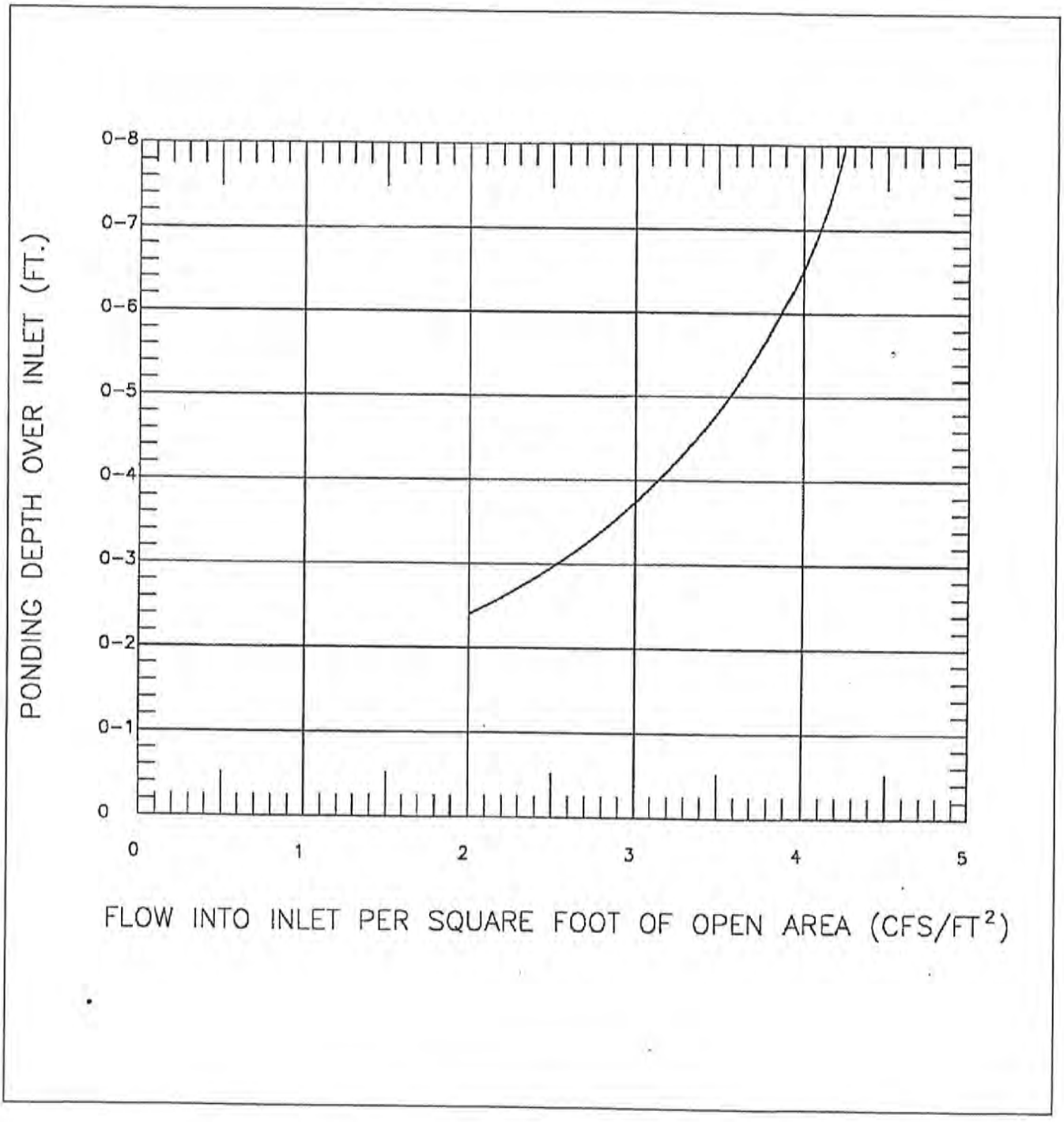
NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

FIGURE NO.: 11.3



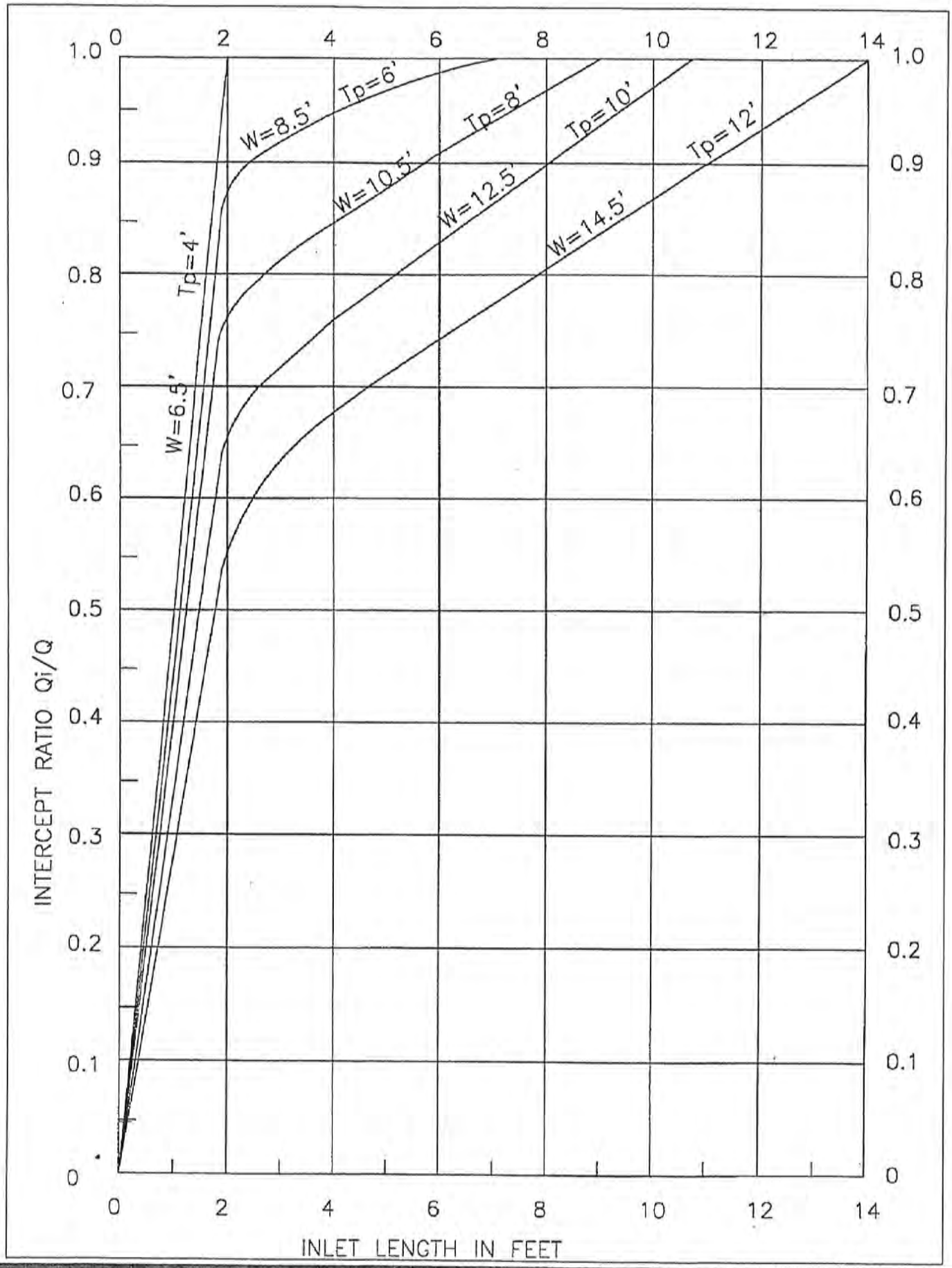
FLOW CHARACTERSTIC CURVES

FIGURE NO.:
11.4



CAPACITY OF A GRATED INLET IN SUMP

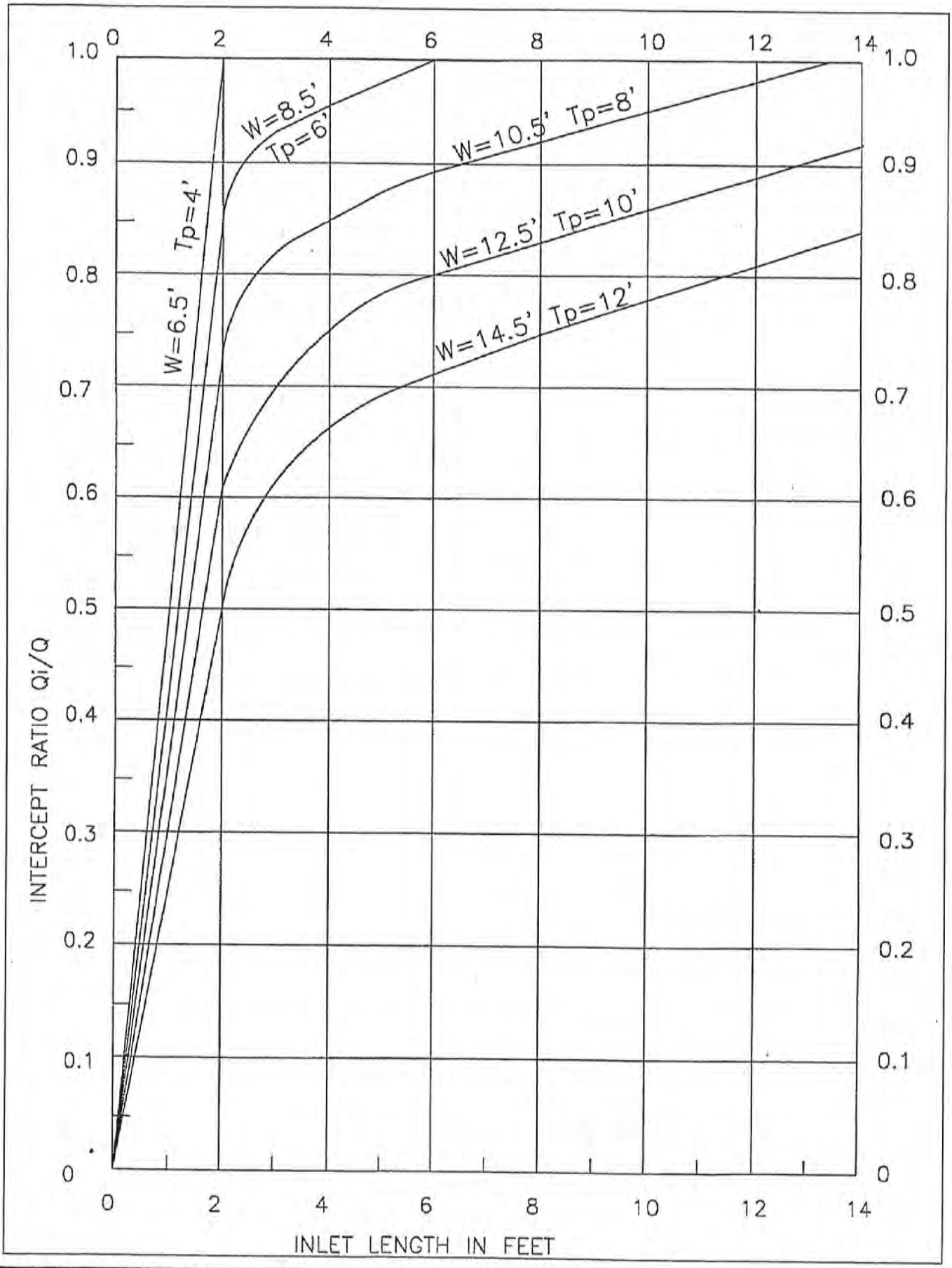
FIGURE NO.:
11.5



INLET CAPACITY TYPE I

So= 0.002, Sx=3/16"/ft

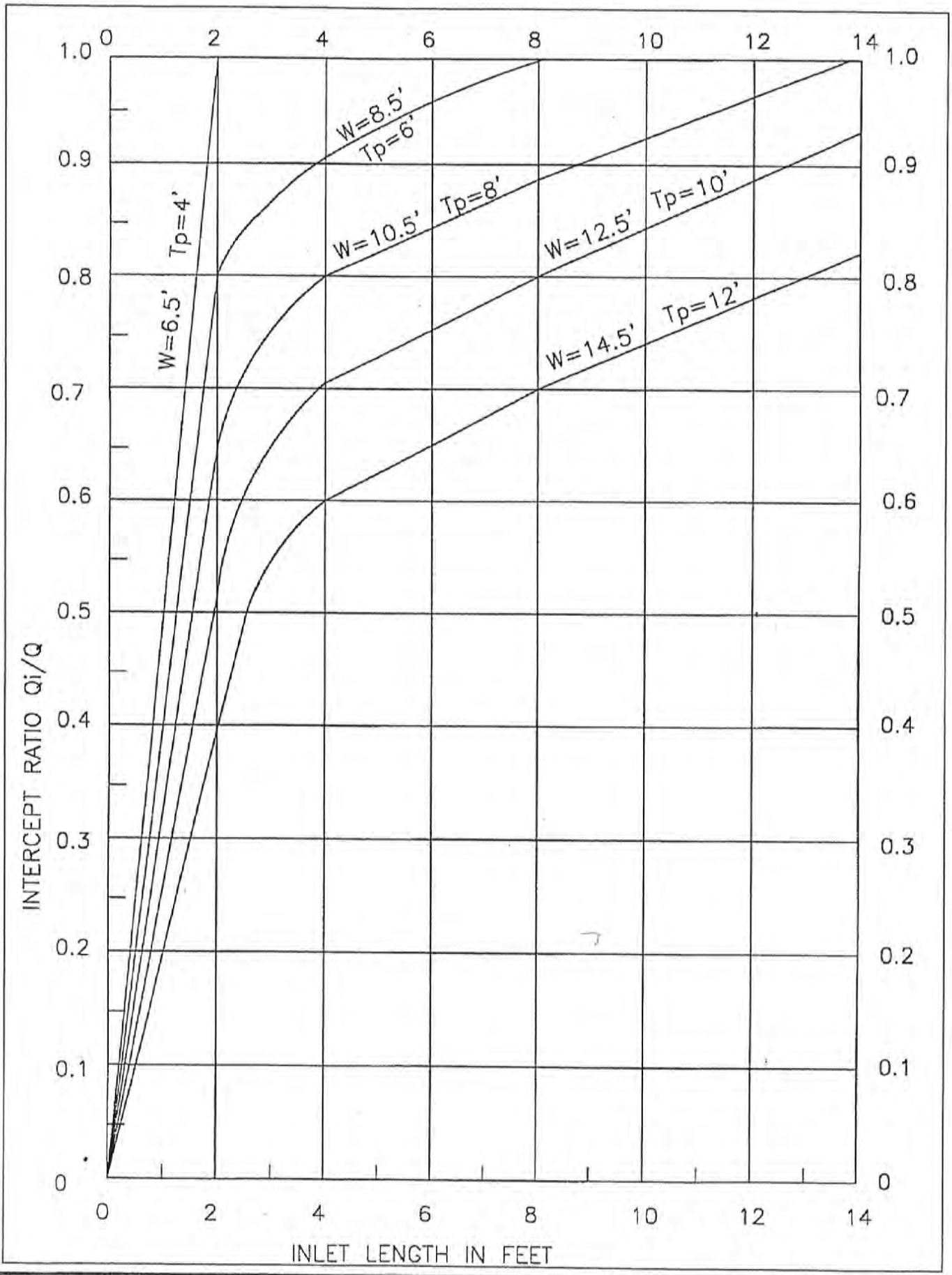
FIGURE NO.:
11.6



INLET CAPACITY TYPE I

So= 0.004, Sx=3/16"/ft

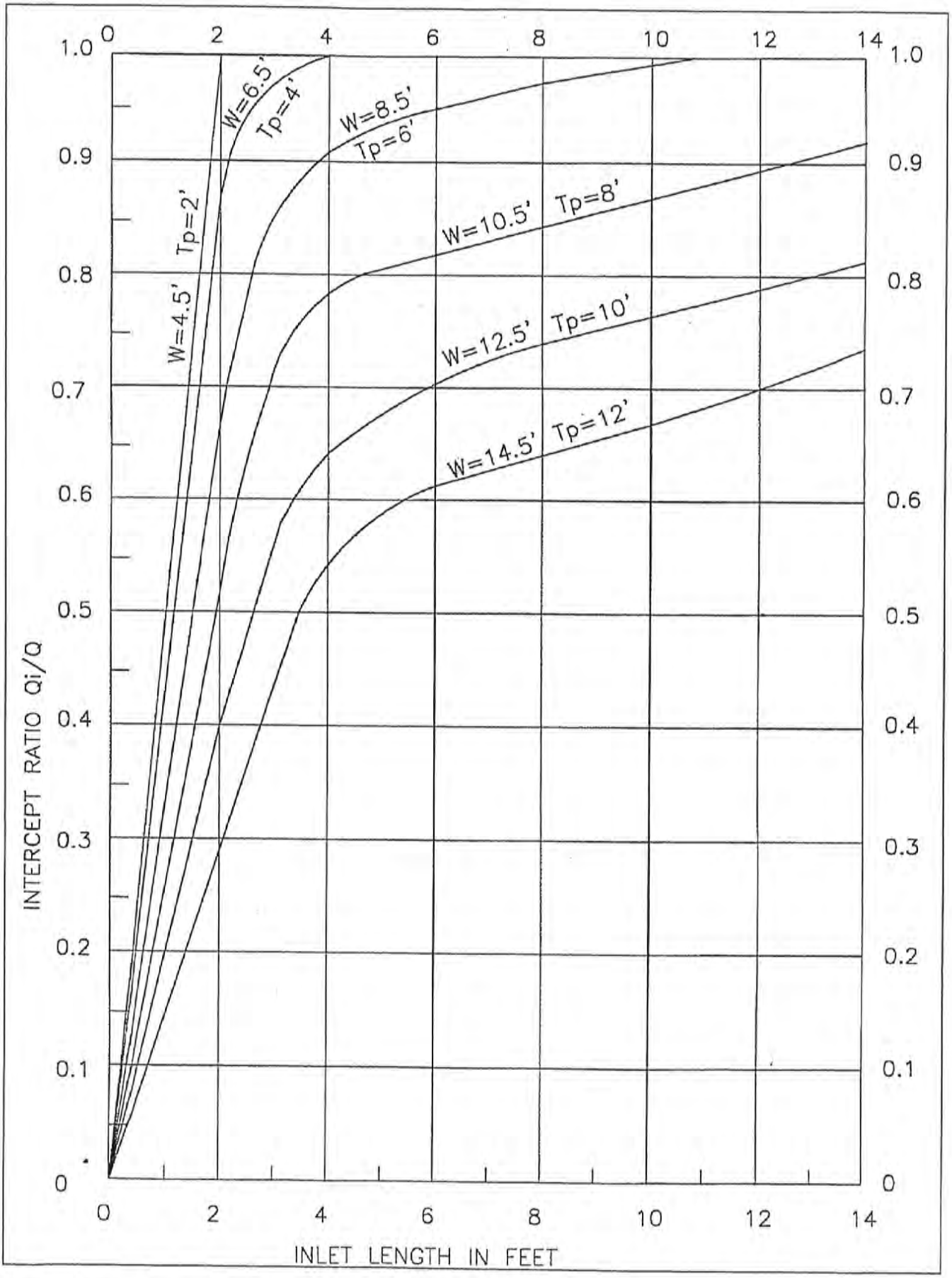
FIGURE NO.:
11.7



INLET CAPACITY TYPE I

So= 0.006, Sx=3/16"/ft

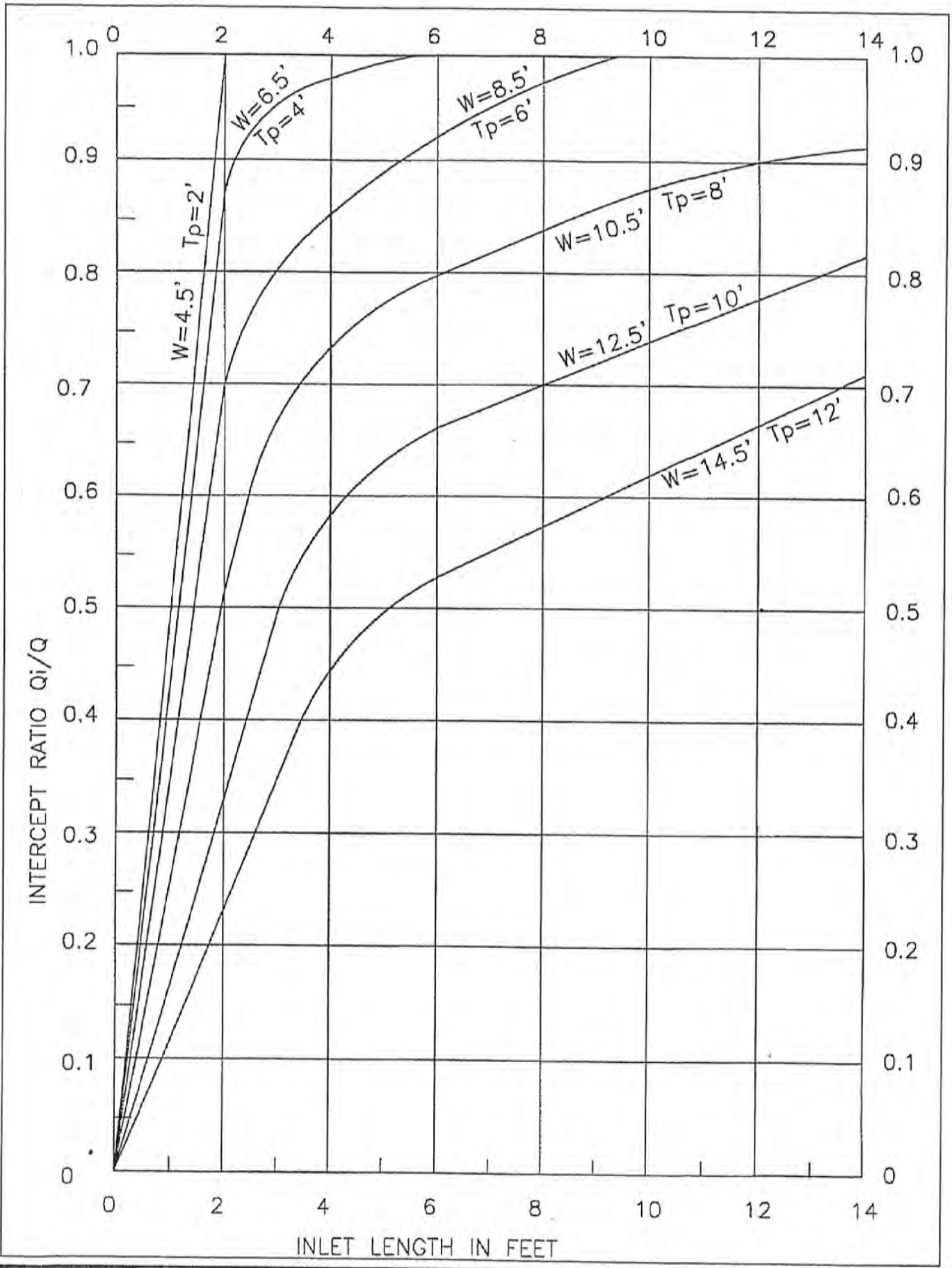
FIGURE NO.:
11.8



INLET CAPACITY TYPE I

So= 0.008, Sx=3/16"/ft

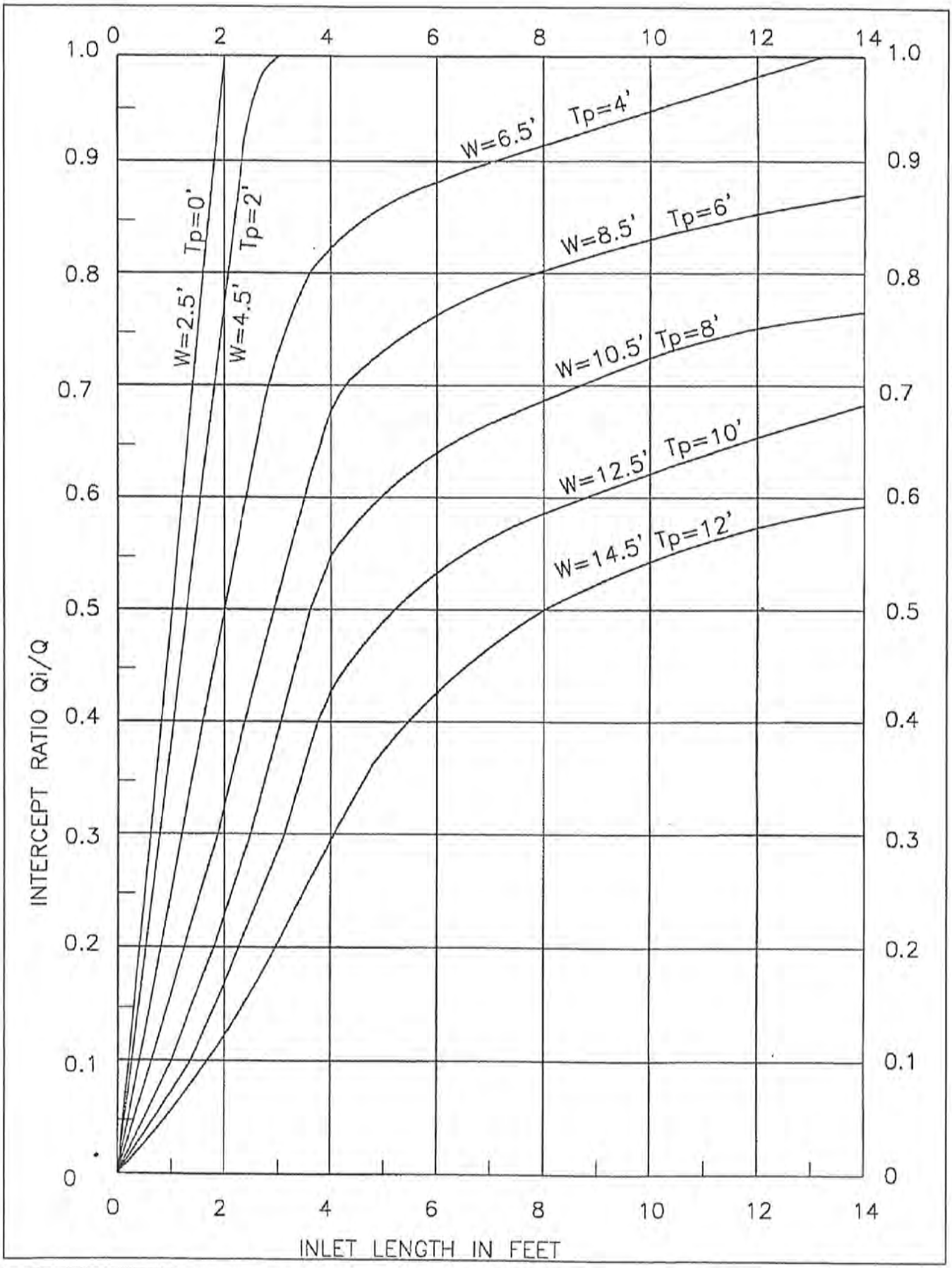
FIGURE NO.:
11.9



INLET CAPACITY TYPE I

So= 0.01, Sx=3/16"/ft

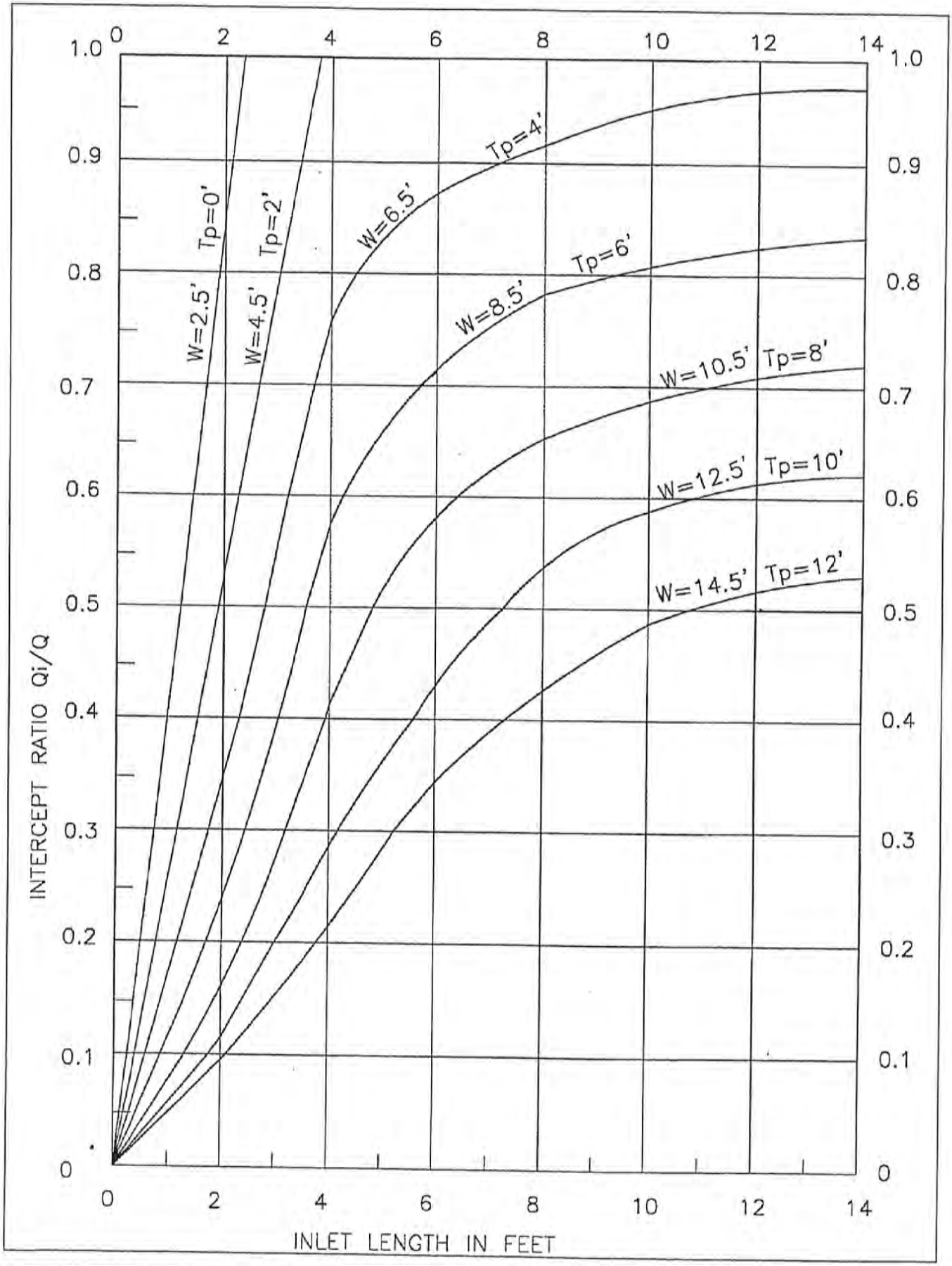
FIGURE NO.:
11.10



INLET CAPACITY TYPE I

So= 0.02, Sx=3/16"/ft

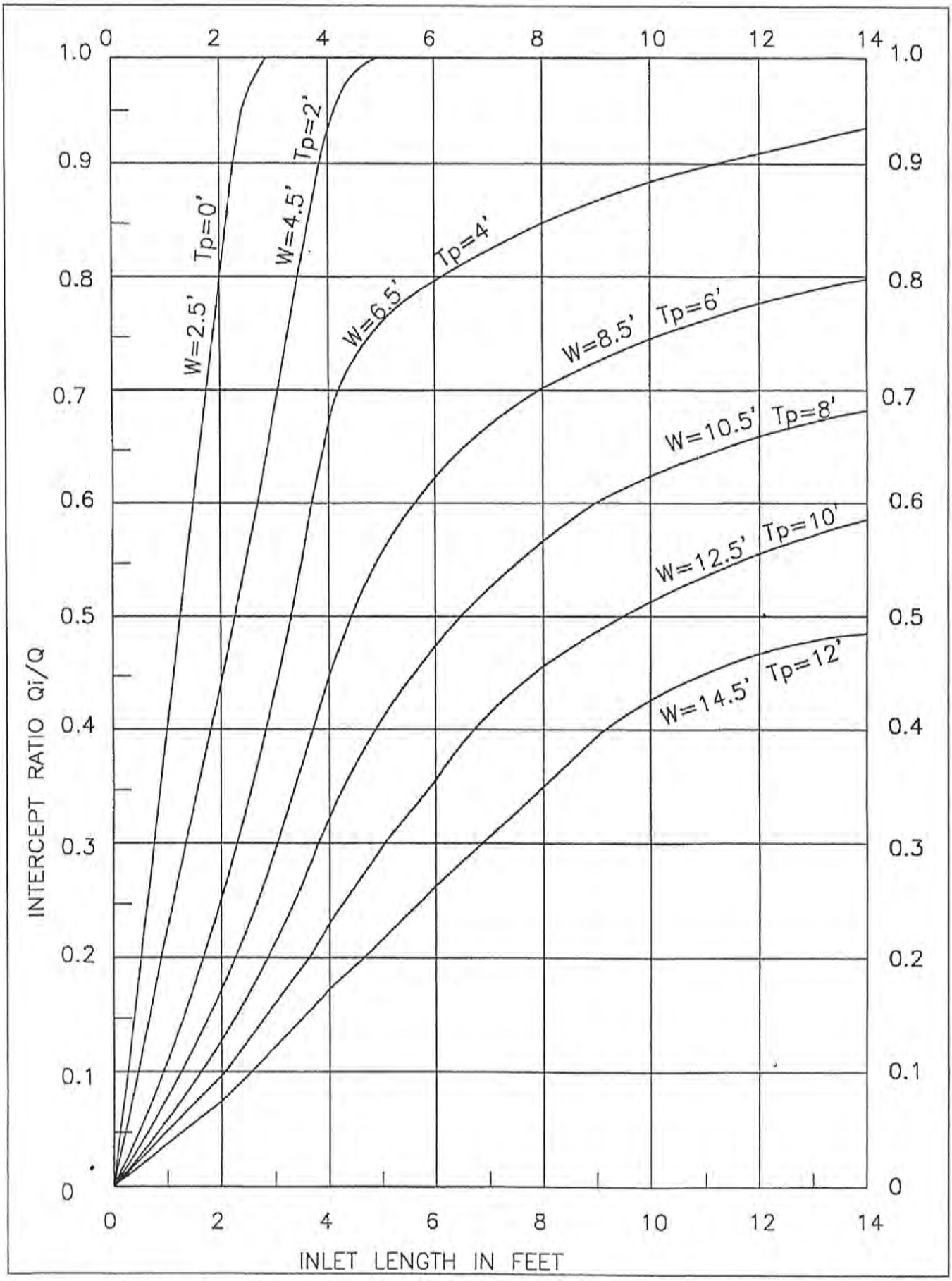
FIGURE NO.:
11.11



INLET CAPACITY TYPE I

So= 0.03, Sx=3/16"/ft

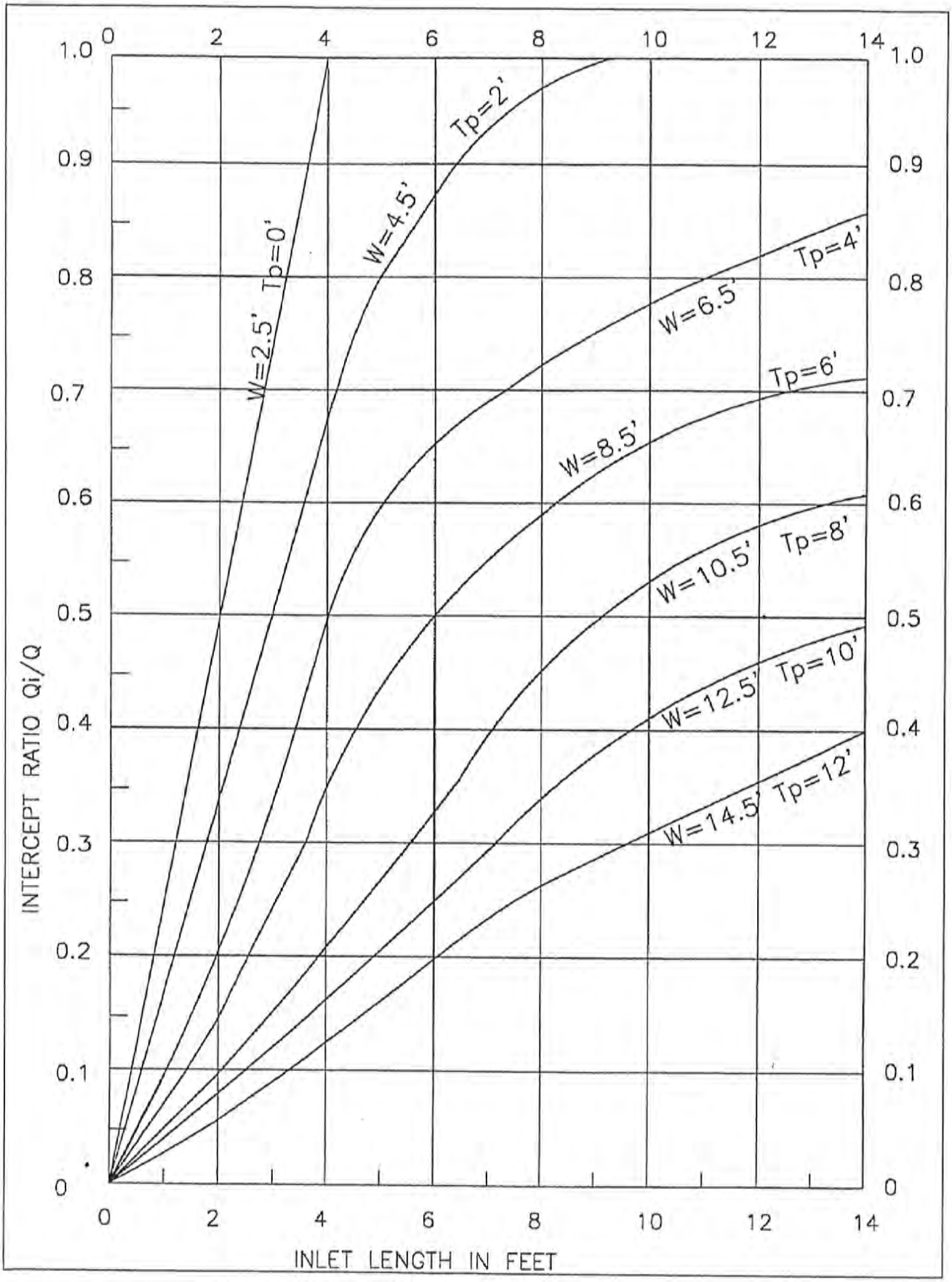
FIGURE NO.:
11.12



INLET CAPACITY TYPE I

So= 0.04, Sx=3/16"/ft

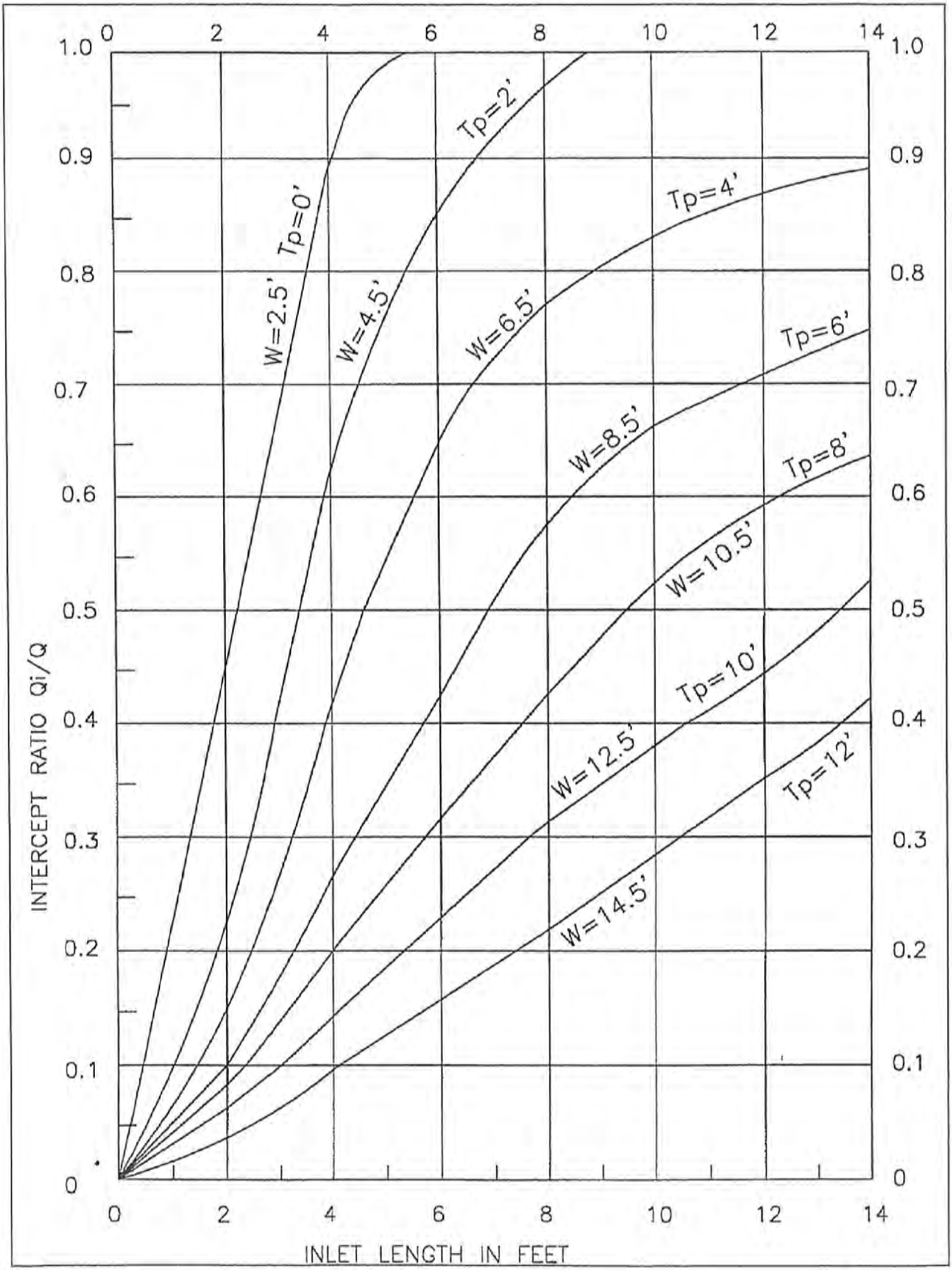
FIGURE NO.:
11.13



INLET CAPACITY TYPE I

So= 0.06, Sx=3/16"/ft

FIGURE NO.:
11.14



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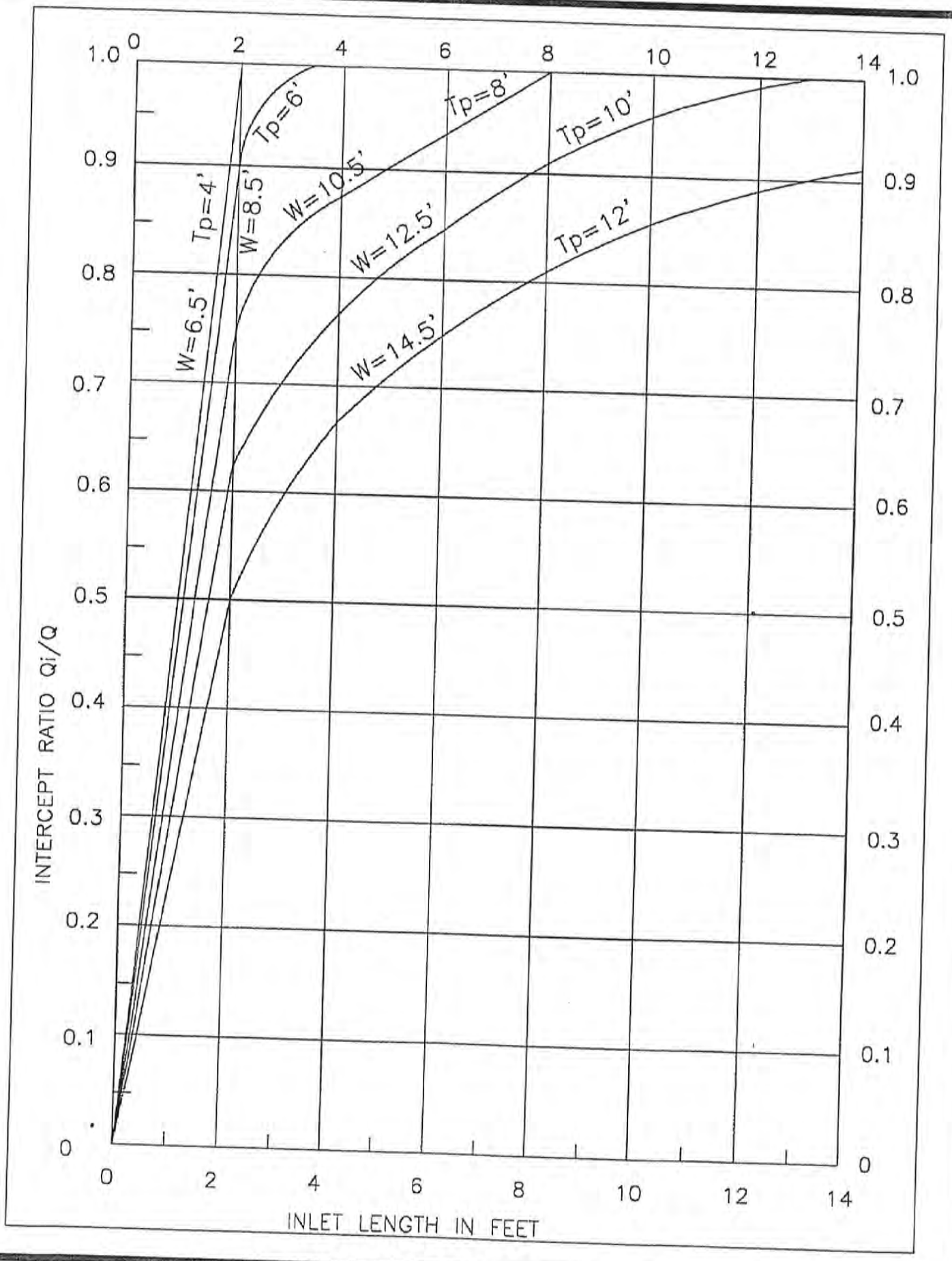

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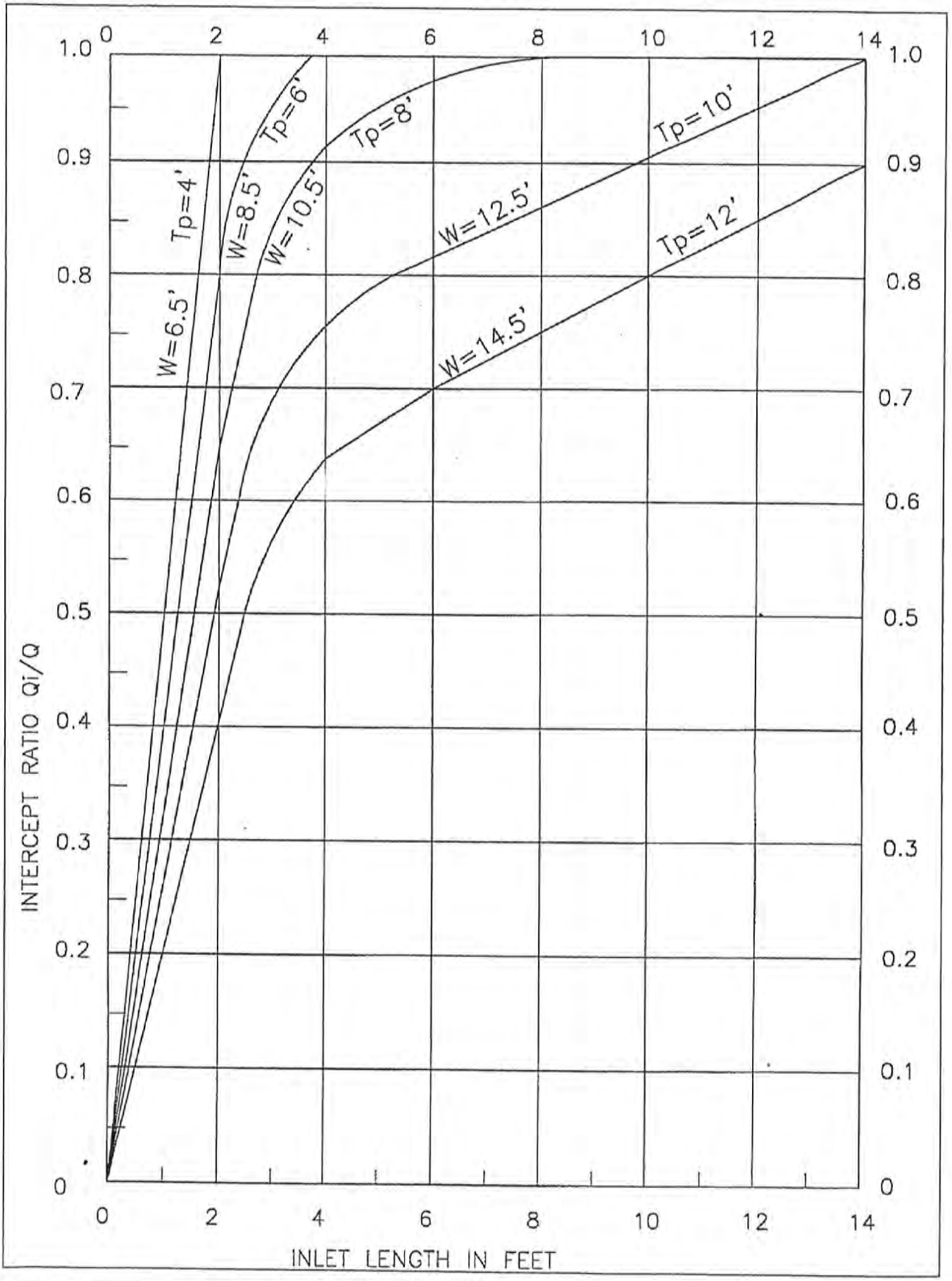

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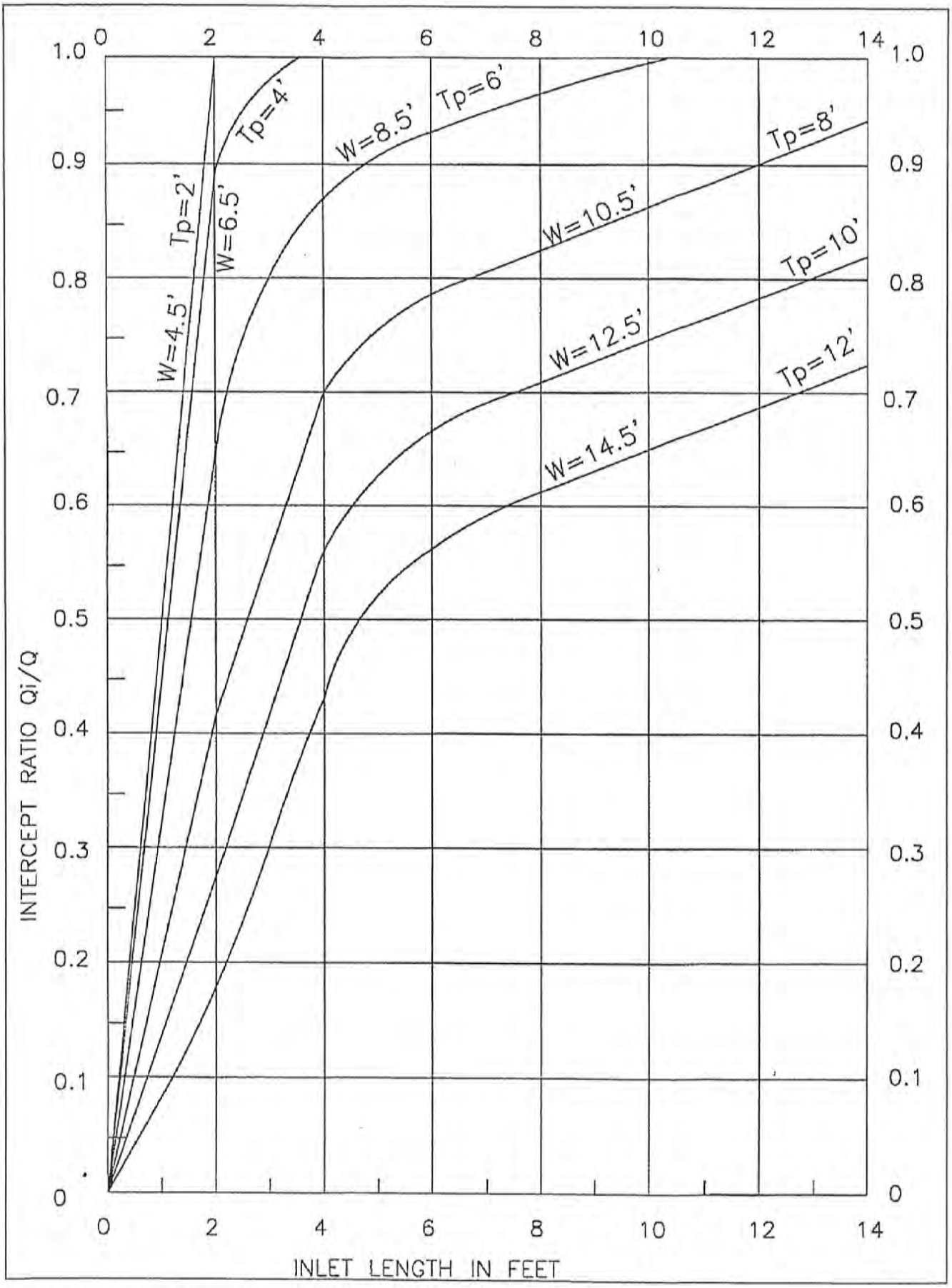

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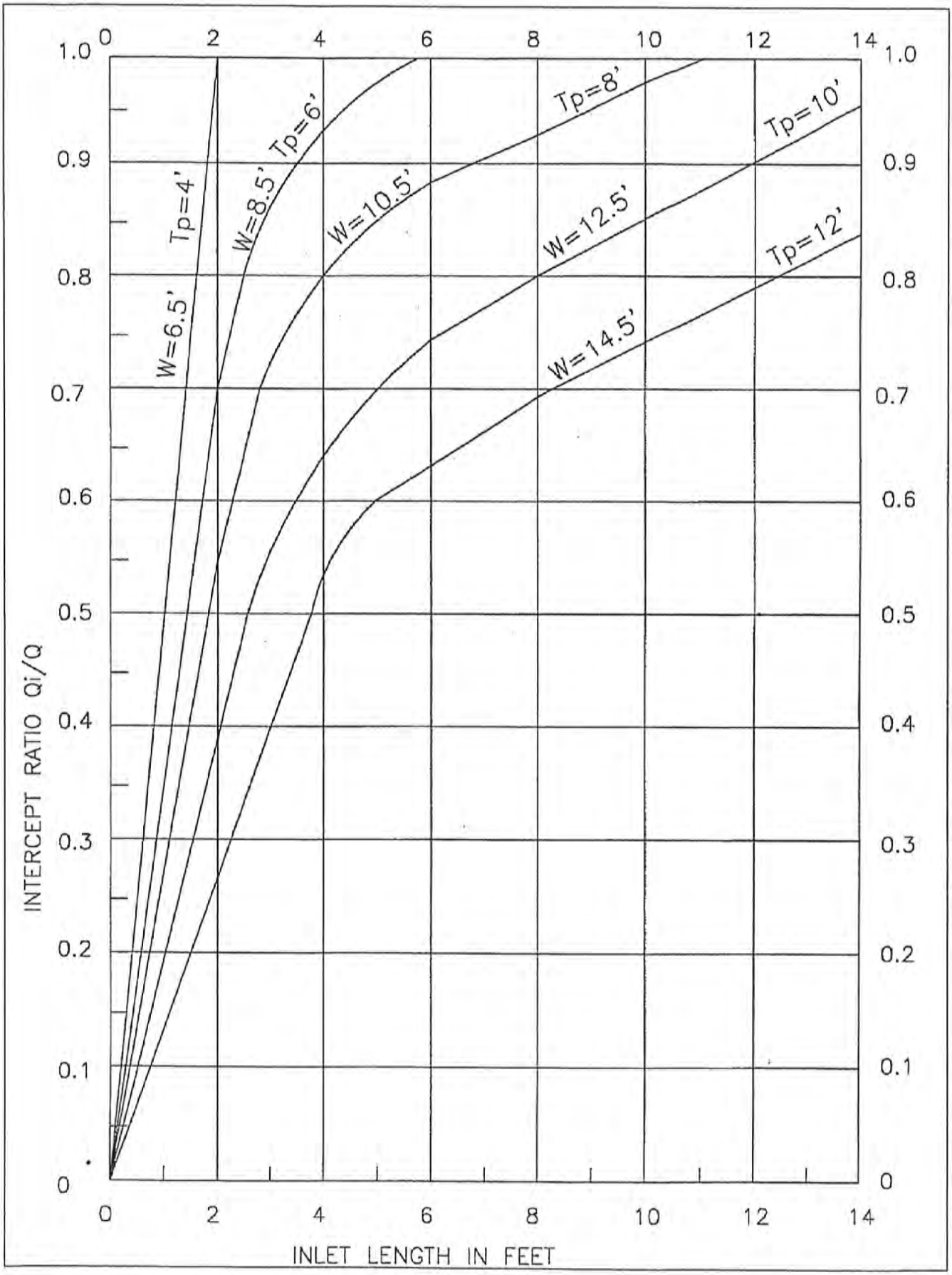

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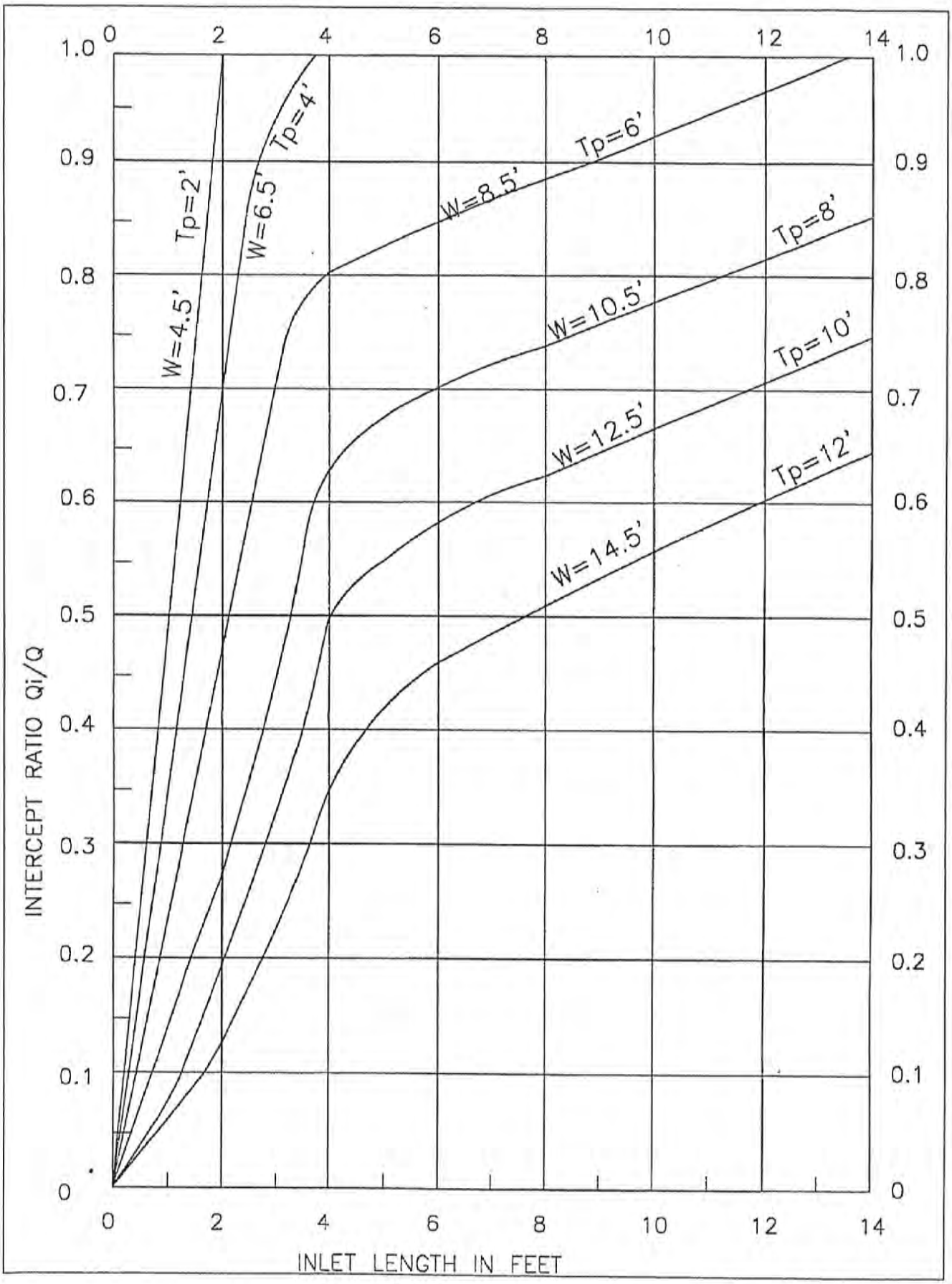

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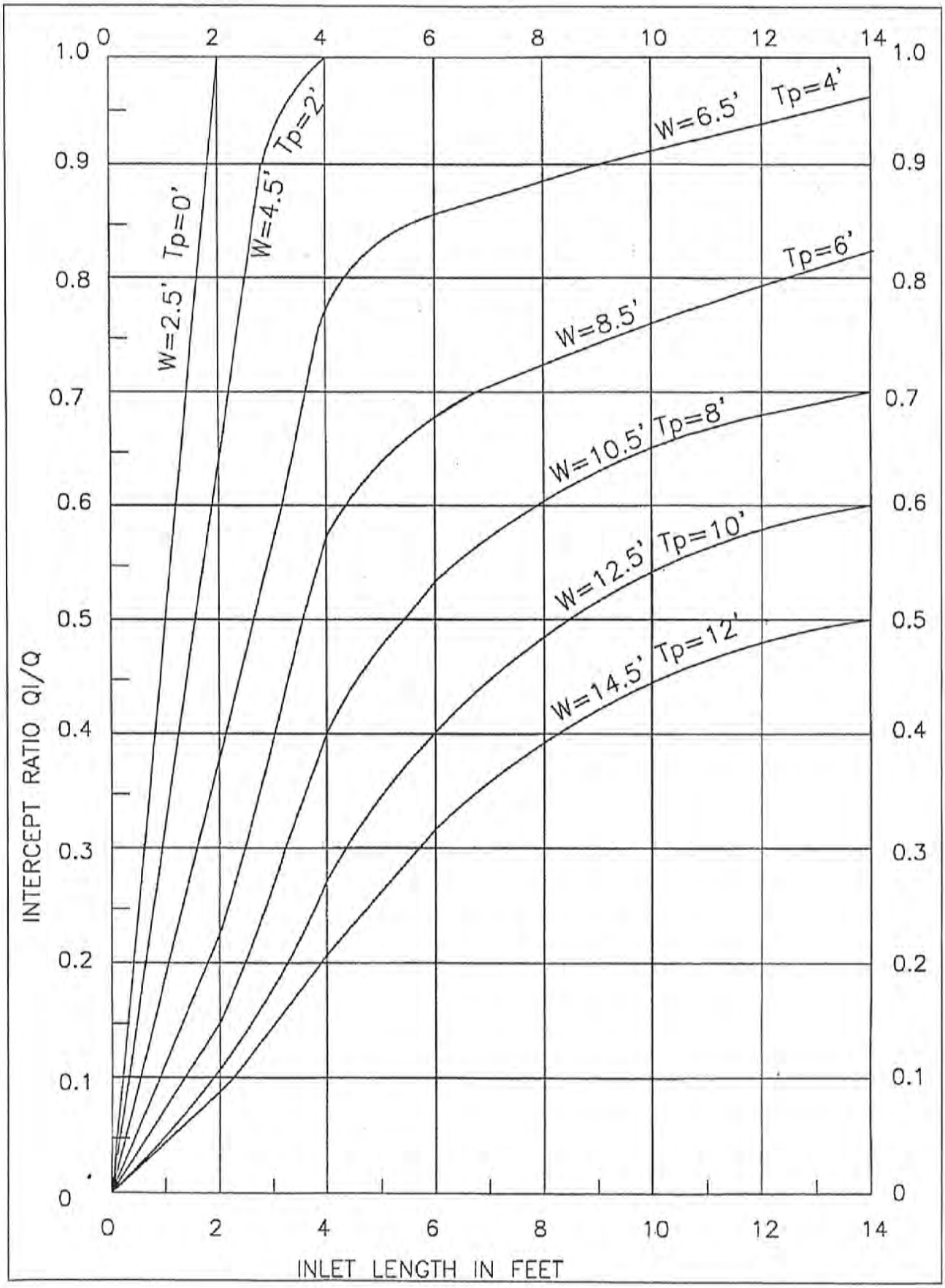

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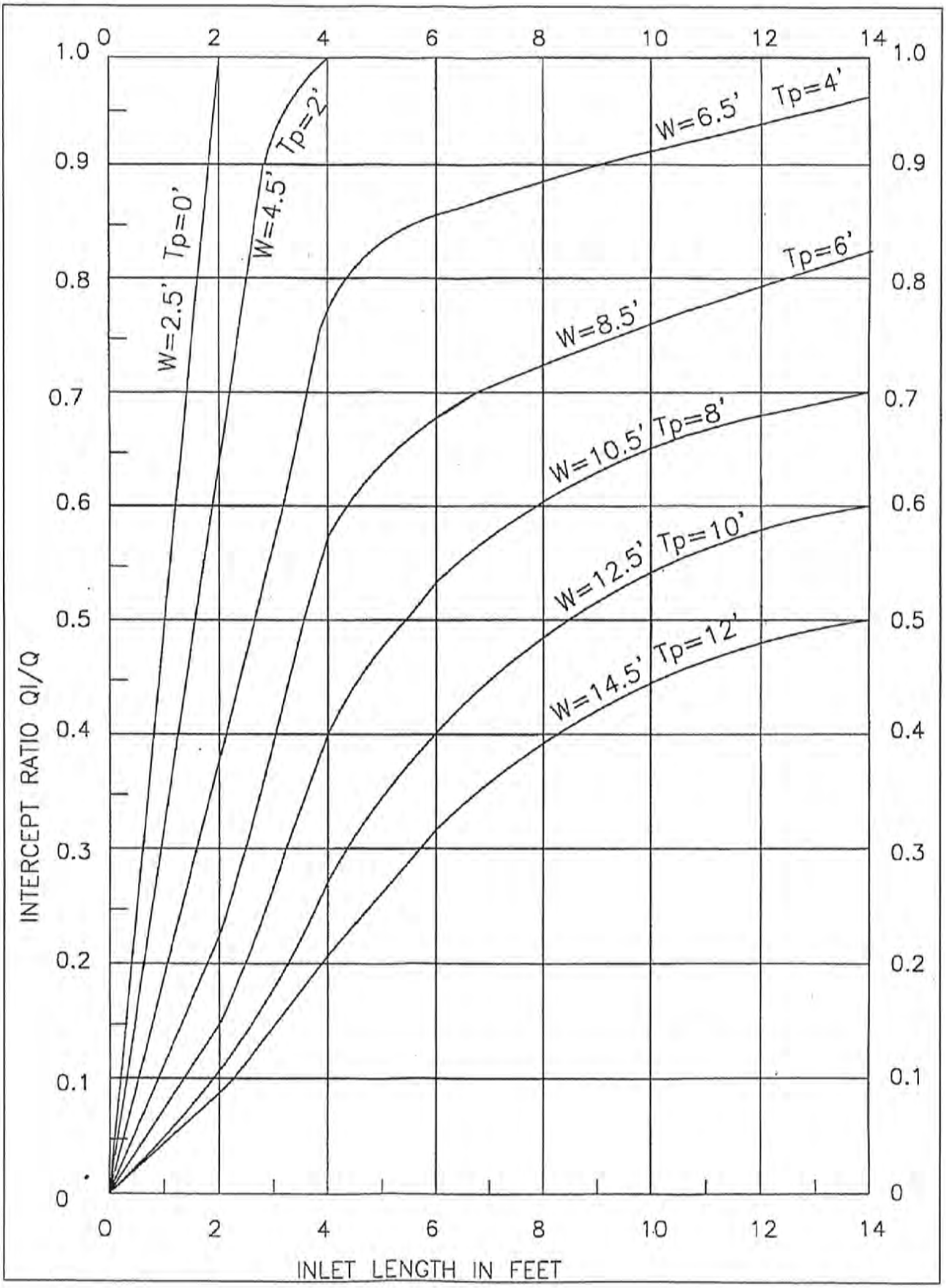

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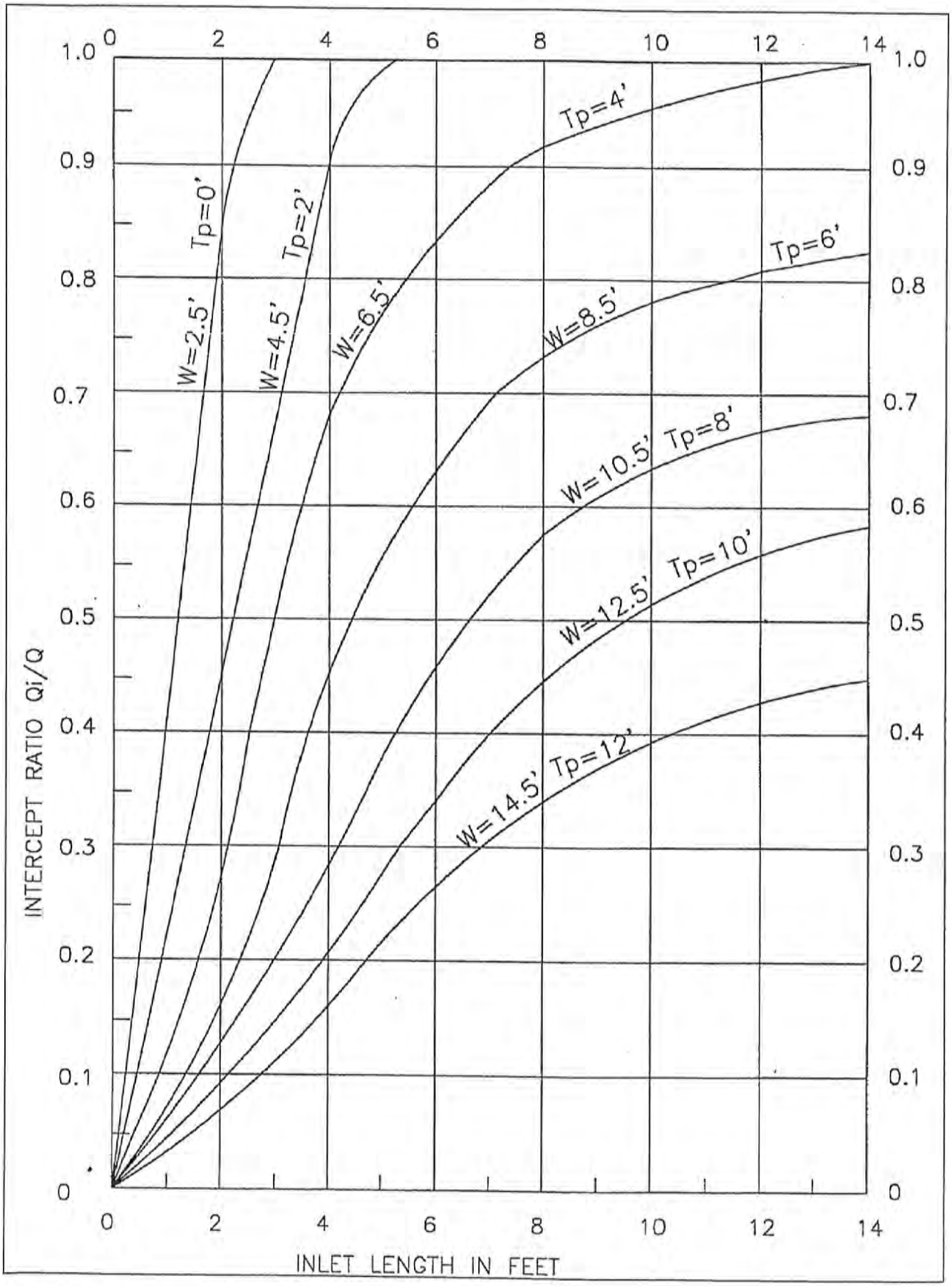

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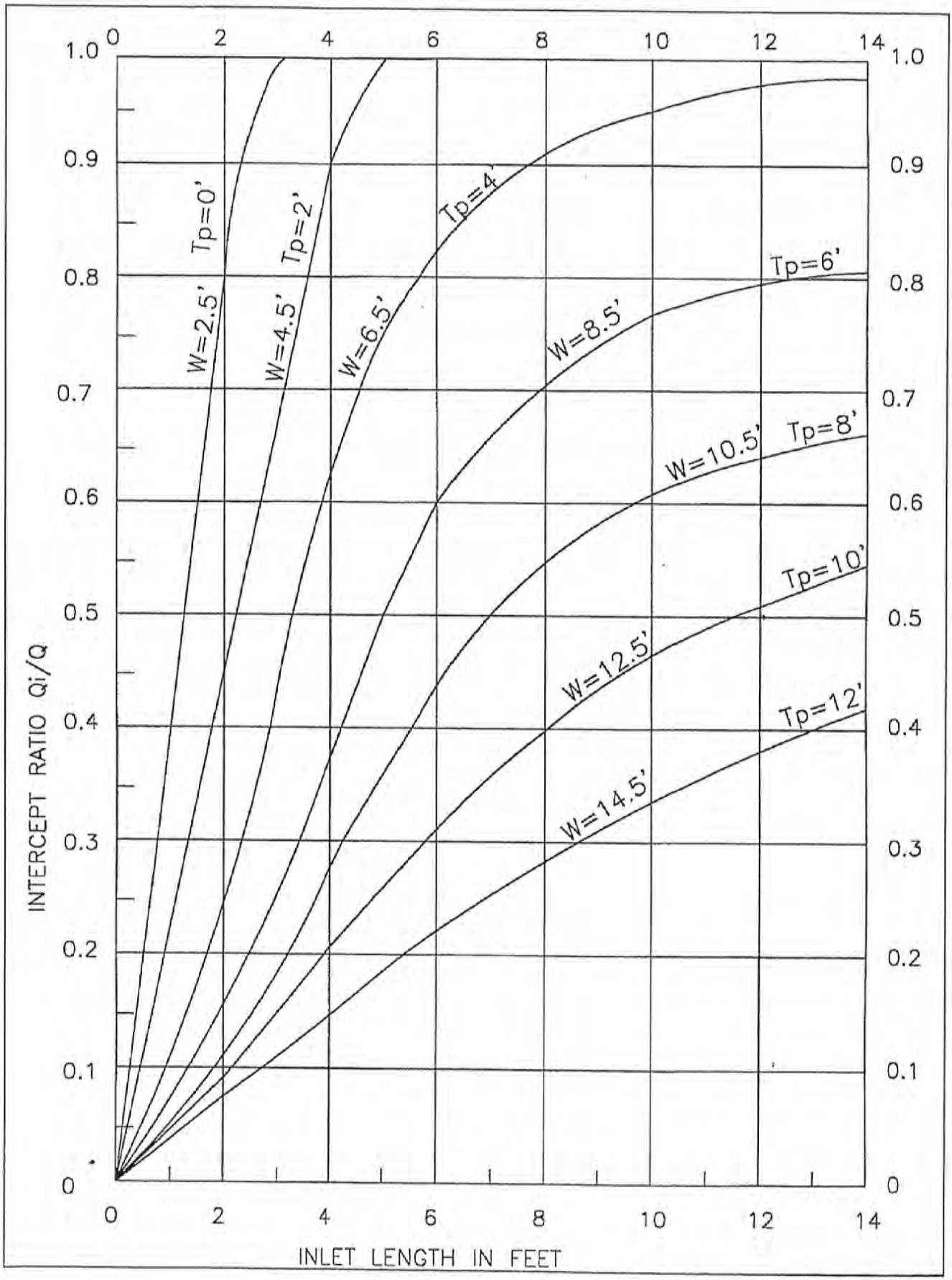

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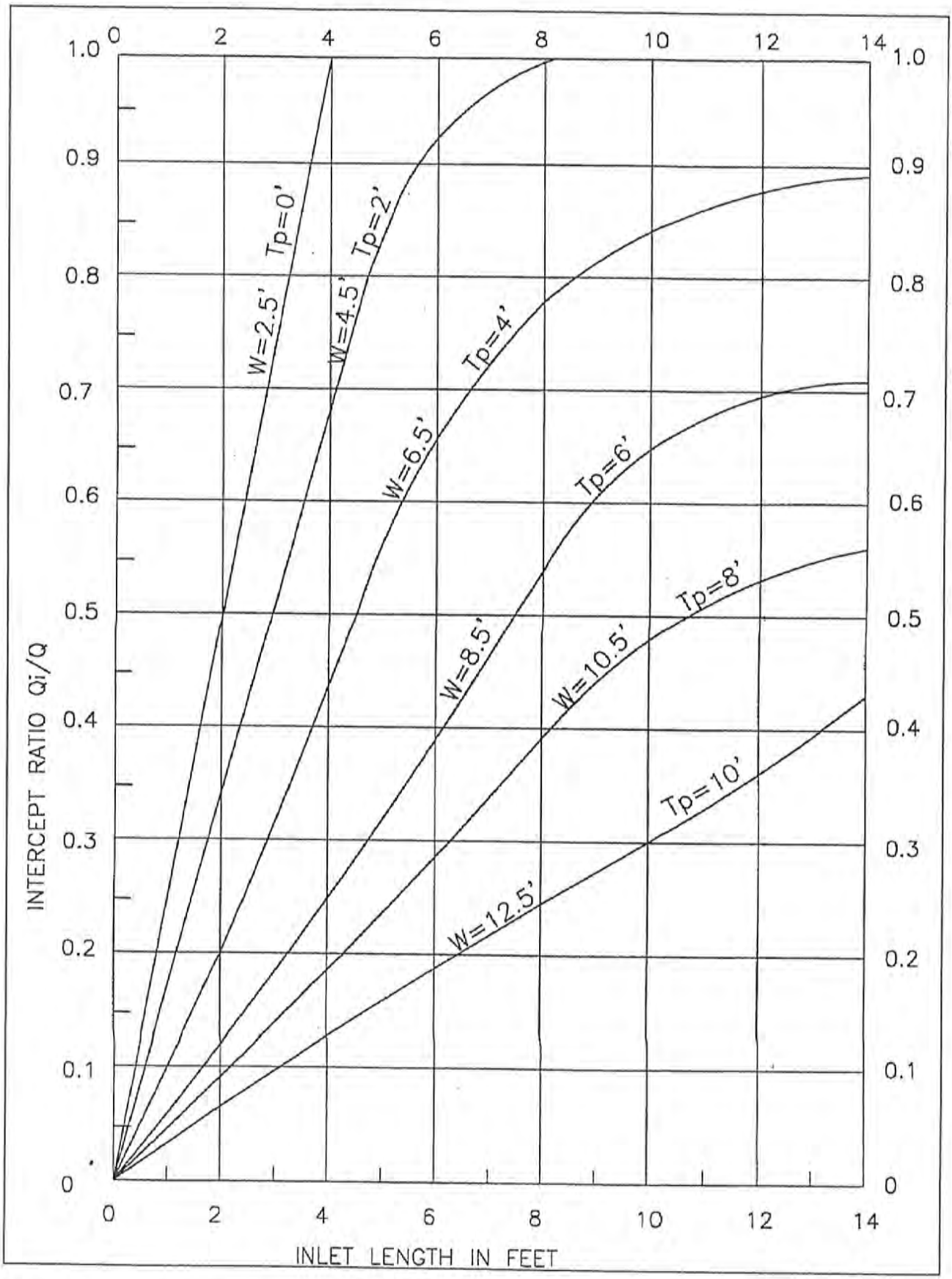

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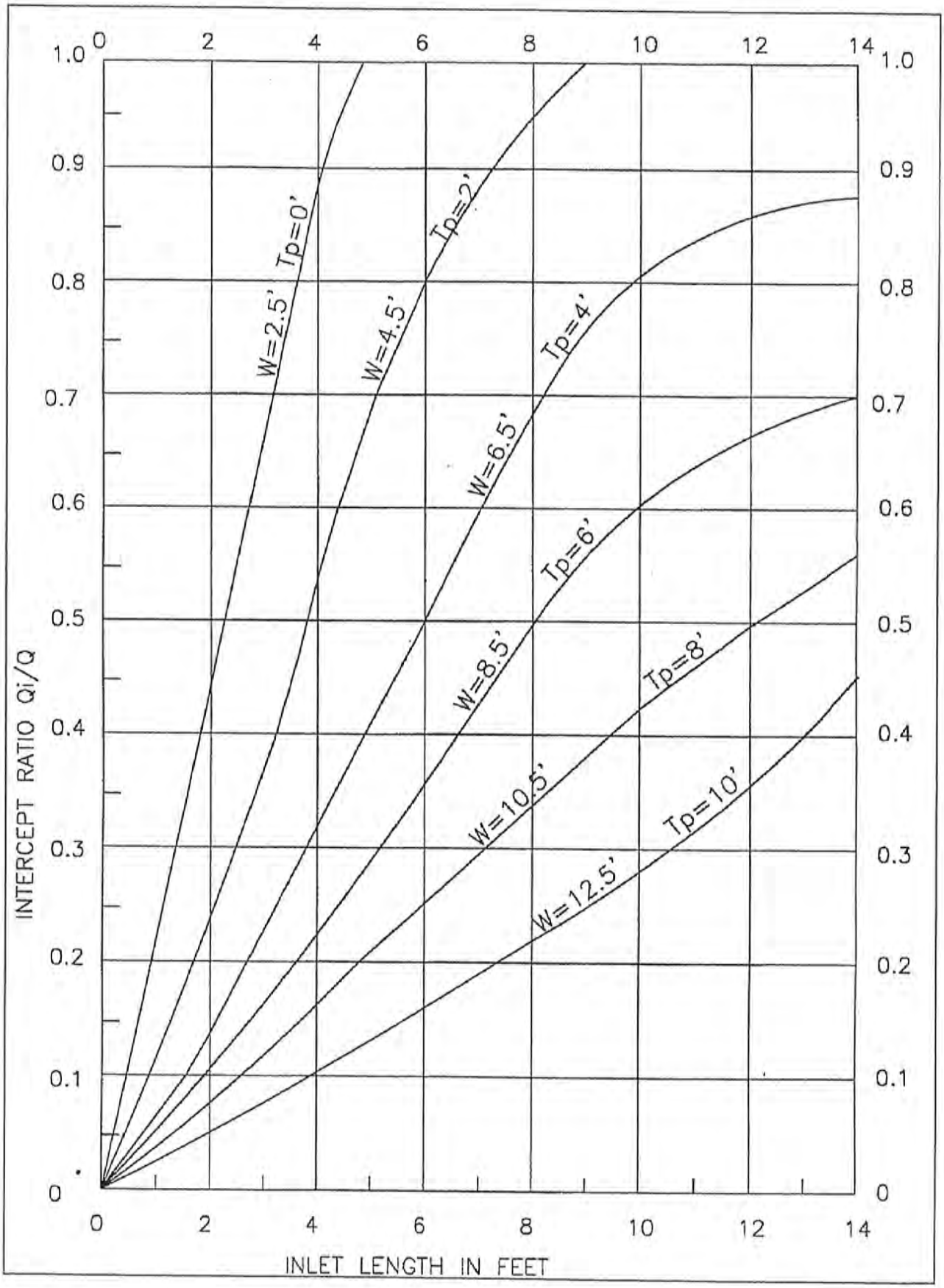

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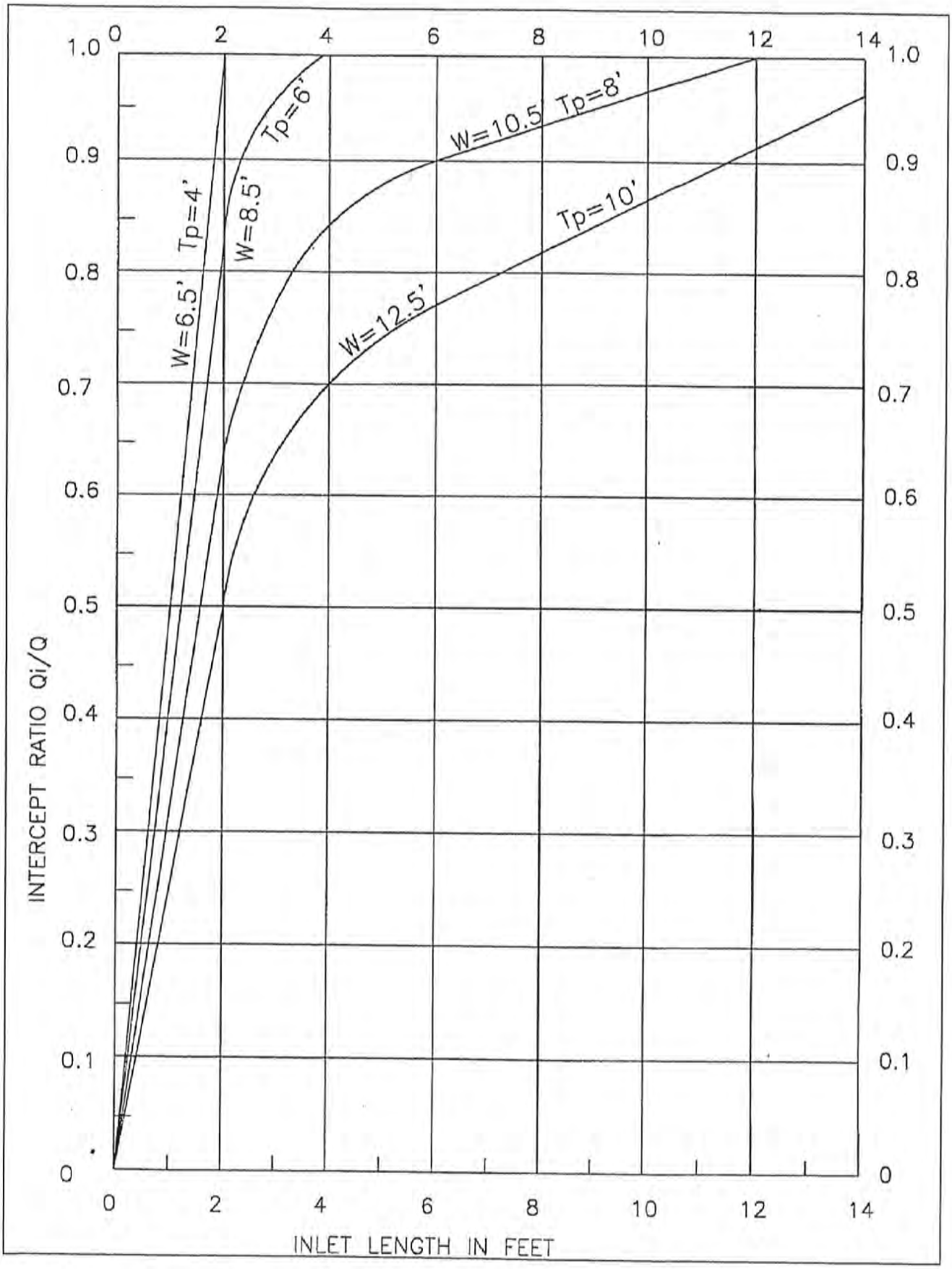

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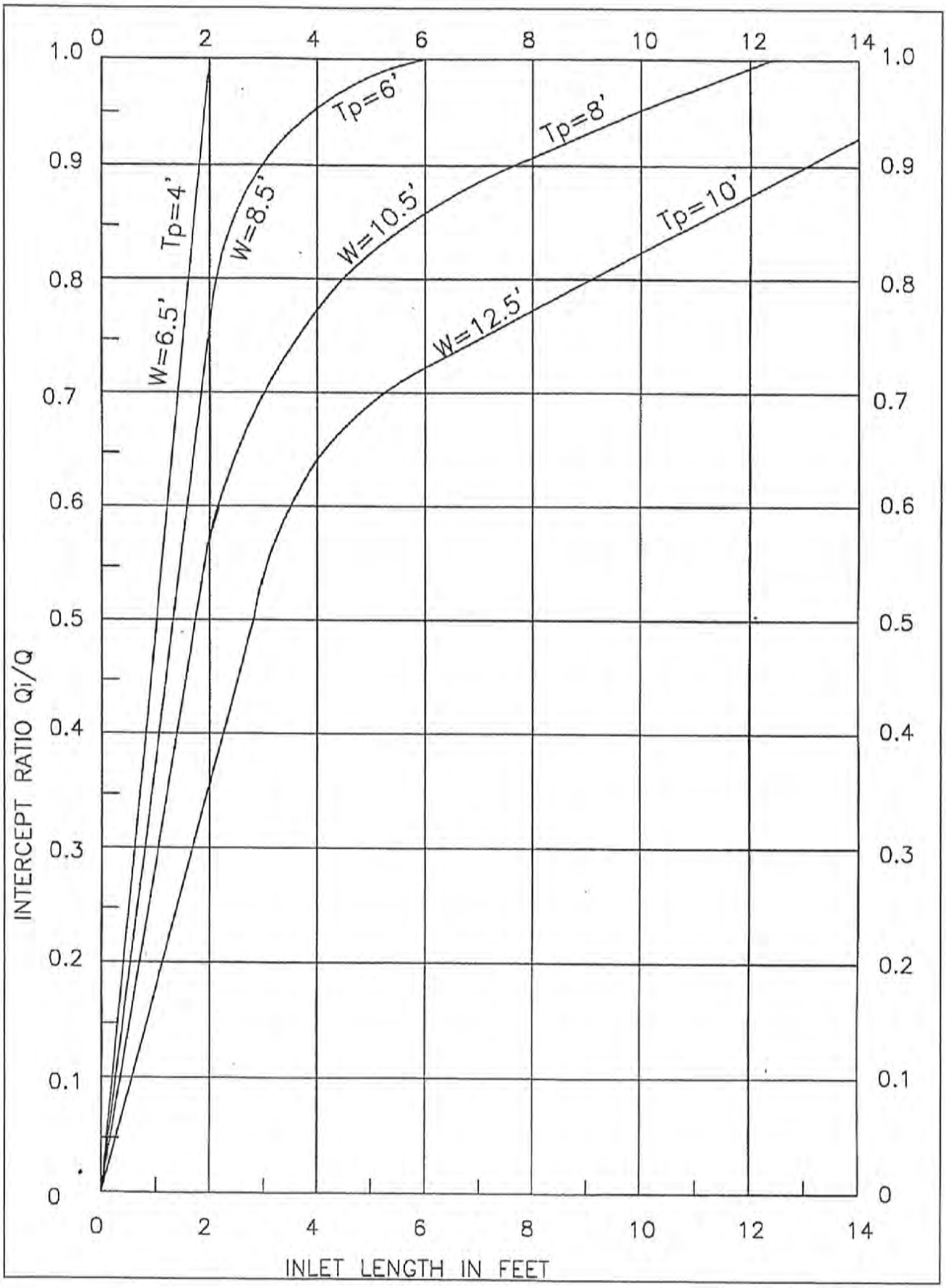

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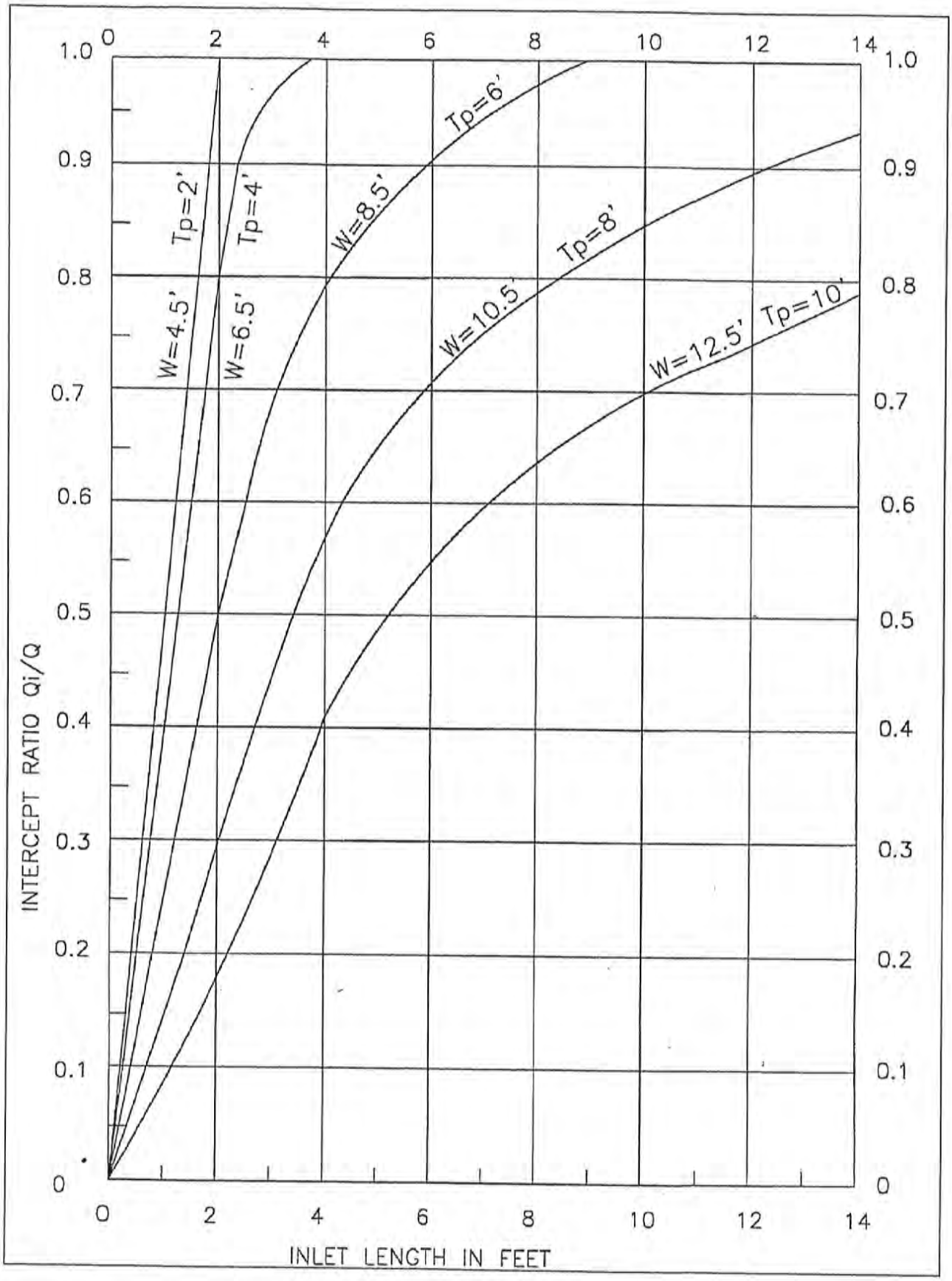

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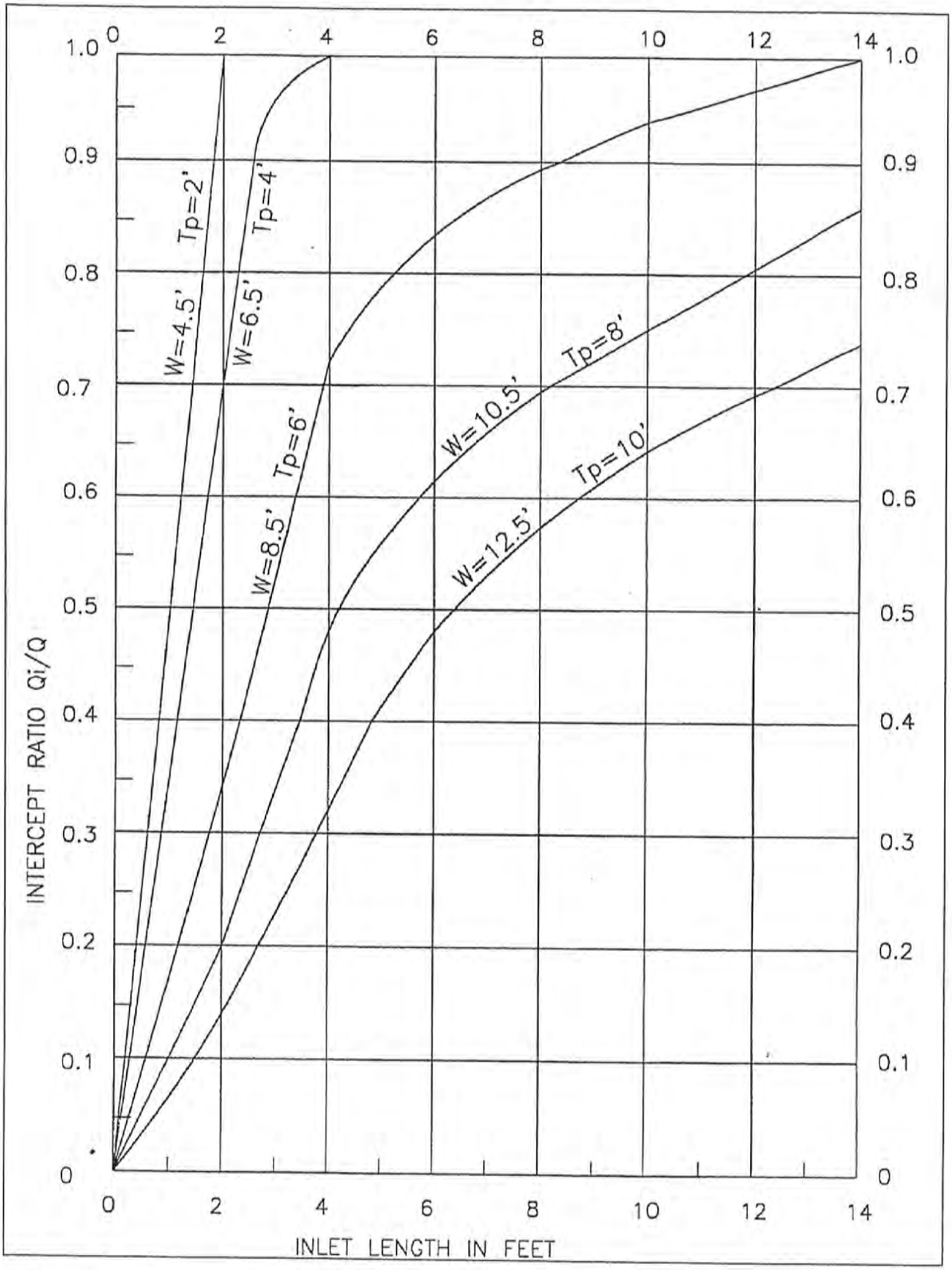

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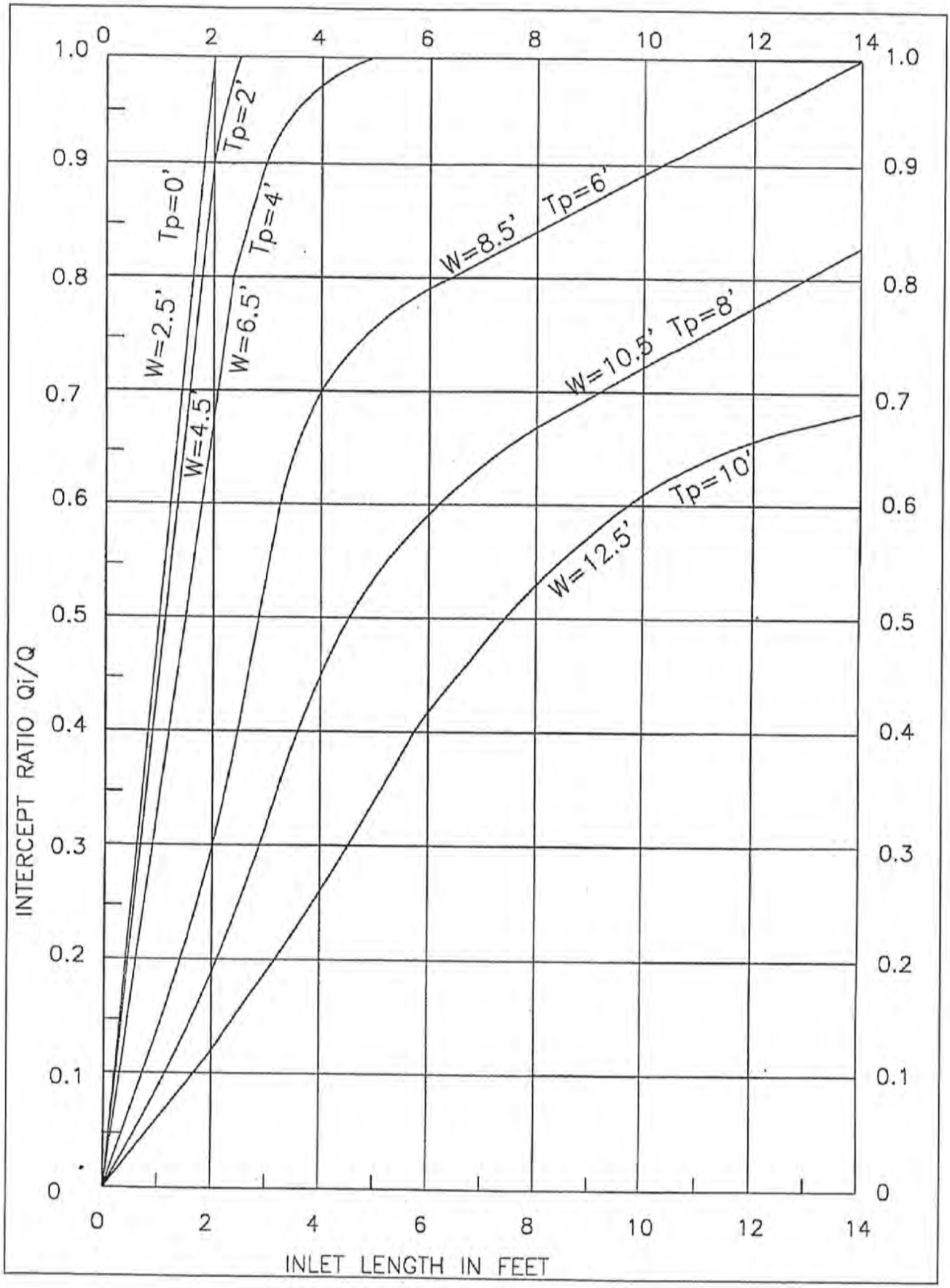

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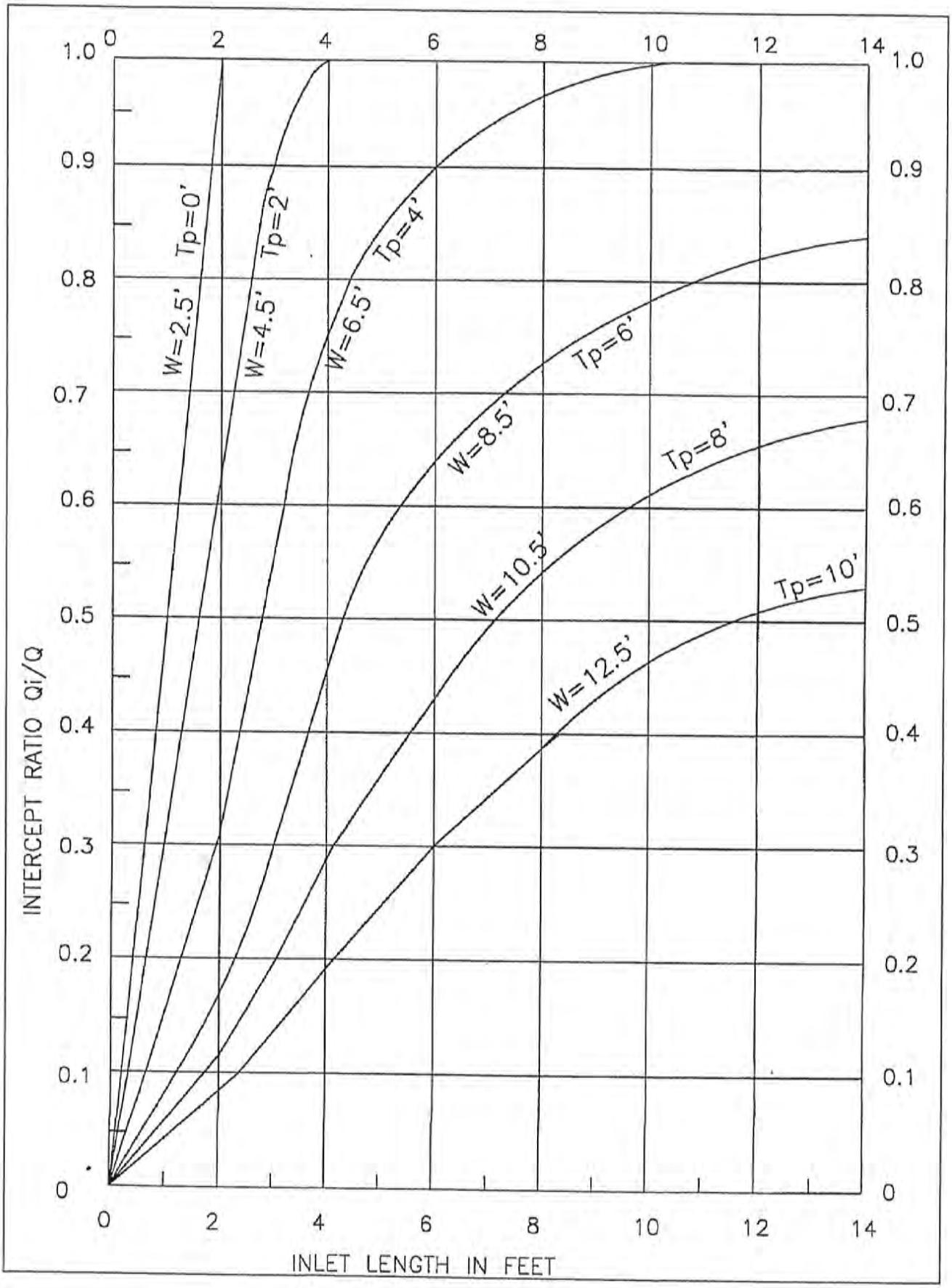

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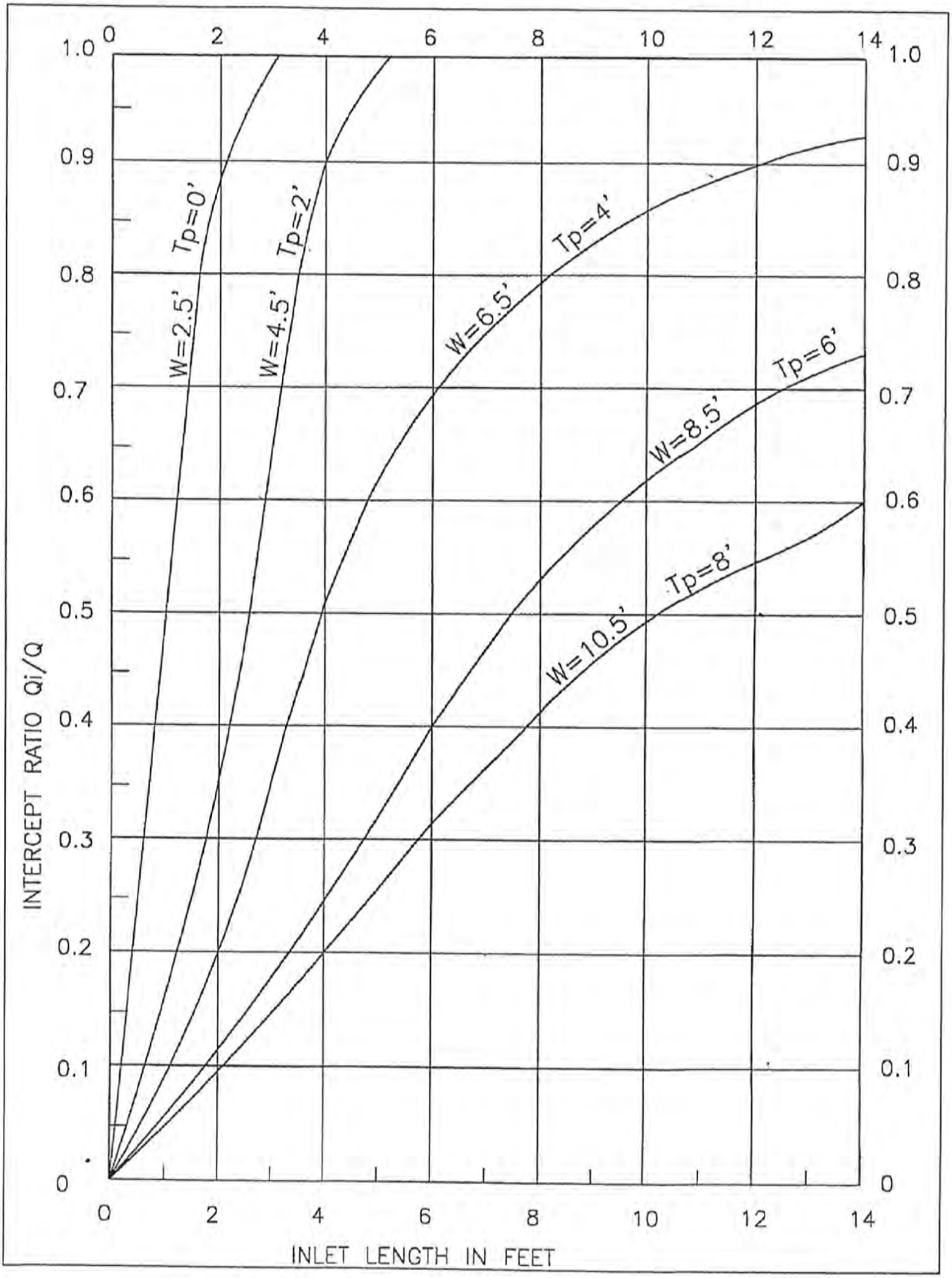

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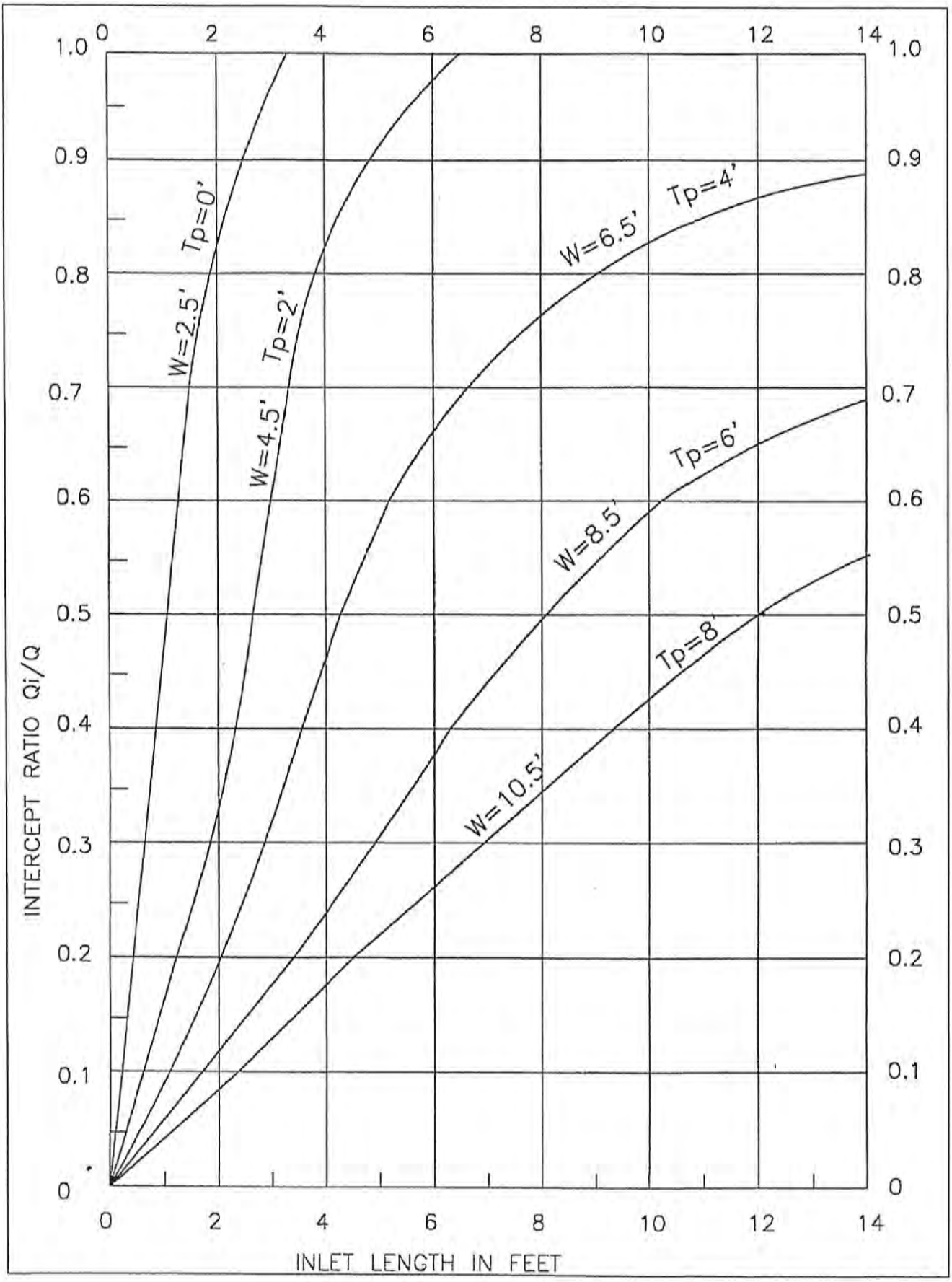
11.32



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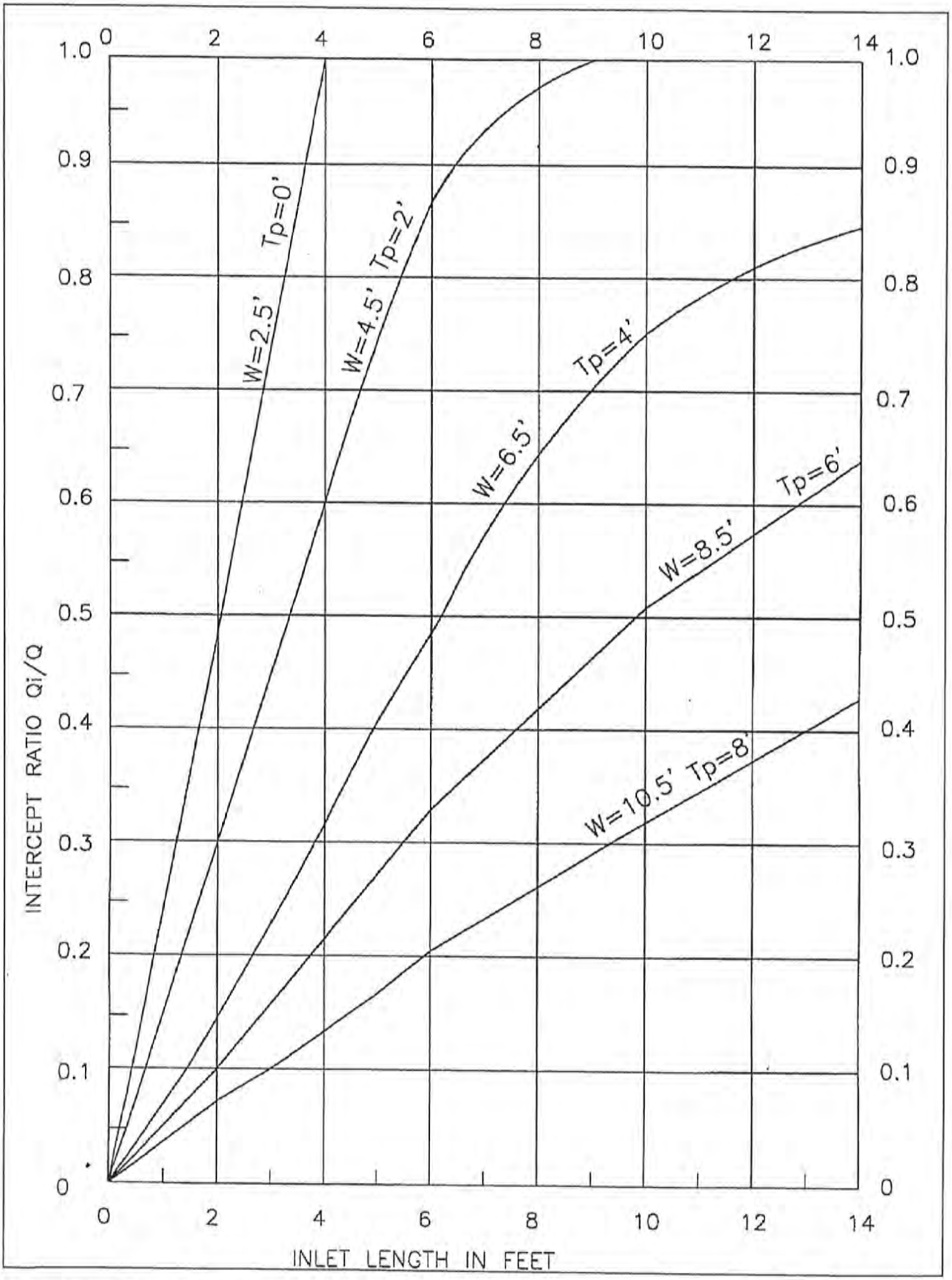

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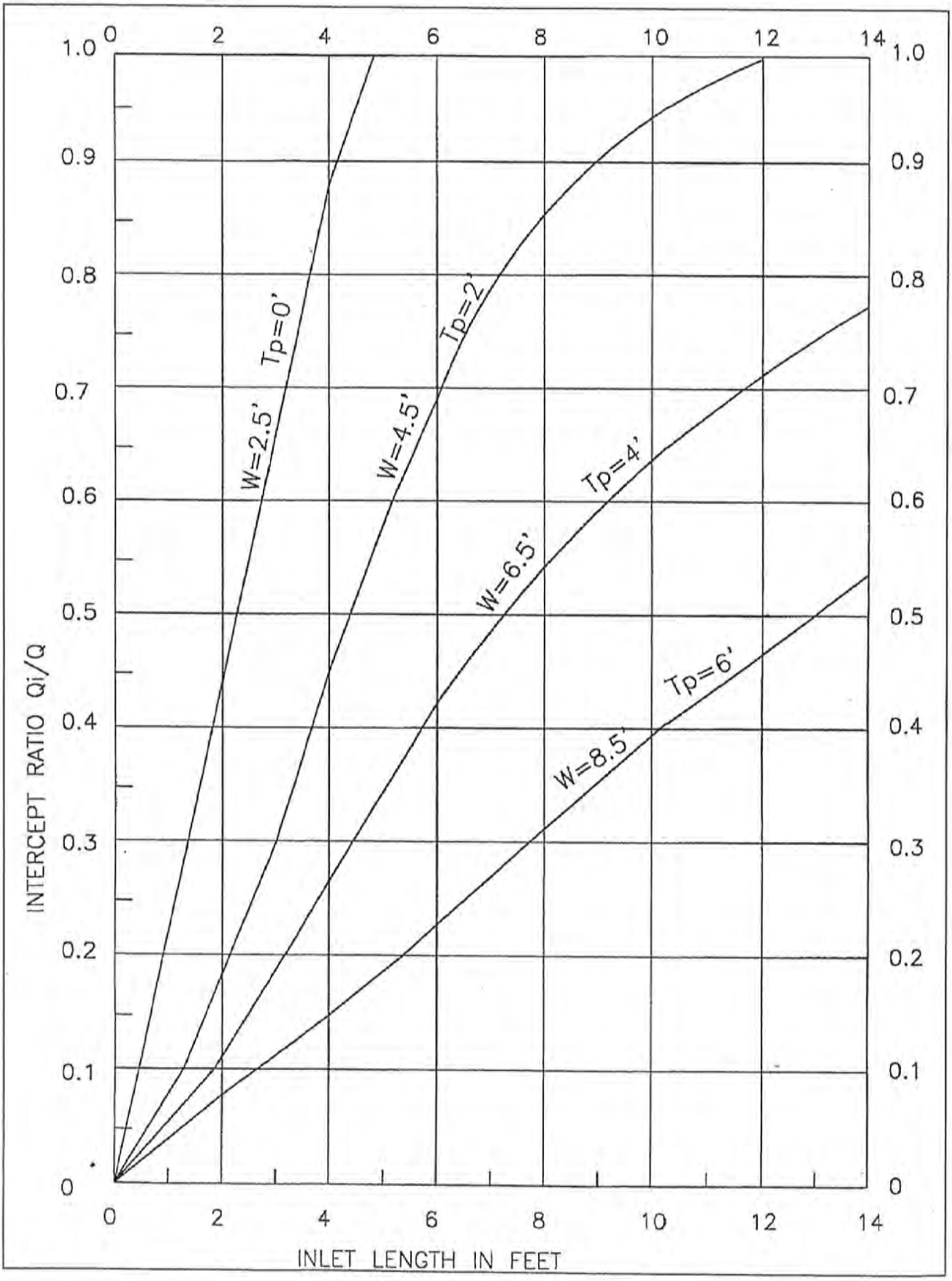

INLET CAPACITY TYPE I

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FIGURE NO.:
11.35

Chapter 12 - Erosion and Sediment Control
Table of Contents

Section & Topic **Page**

Chapter 12

Erosion and Sediment Control

12.1 Introduction

This *Erosion Control Standard* has been developed based on a model prepared by the Urban Drainage and Flood Control District of Denver, Colorado. It has been revised to reflect the needs of the City of Crooks and provides a set of criteria and technical guidance for erosion and sediment control at construction sites. In addition, it describes plan submittal requirements, planning considerations, and general exemptions followed by the City. The practices contained in this document shall be viewed as minimum requirements.

12.1.1 General

The Environmental Protection Agency (EPA) issued regulations on November 16, 1990, that require steps be taken to improve the quality of storm water from industrial activities, including certain construction activities. These criteria were developed to help mitigate the increased soil erosion and subsequent deposition of sediment offsite during the period of construction from start of earth disturbance until final landscaping and storm water quality measures are effectively in place. Compliance with these criteria will help meet the requirements of the EPA storm water regulations.

Submittal of an *Erosion and Sediment Control Plan* to the City does not supercede the requirement for the applicant to also obtain any required permits from the State of South Dakota, such as a South Dakota Storm Water Discharge Permit for Construction Activities. In most cases, the applicant will also have to submit a Notice of Intent to discharge storm water associated with construction activity to the South Dakota Department of the Environment and Natural Resources (SDDENR) as well as meet the requirements of the South Dakota Storm Water Discharge Permit for Construction Activities.

Implementation and maintenance of erosion control measures are ultimately the responsibility of the property owner. Because site conditions will affect the suitability and effectiveness of erosion control measures, a plan specific to each site is required. In addition, should the approved plan not function as intended, and it is determined by the City that additional measures are needed, the owner will have to provide additional measures needed to reduce soil erosion and sediment discharged from the construction site.

Nothing in these criteria limits the right of the City to impose additional or more stringent standards.

12.1.1.1 Exemptions

1. Exemptions from the erosion control planning process will be considered for any of the following; however, exempting the owner from preparing an *Erosion and Sediment Control Plan* and applying for an Excavation and Grading Permit does not exempt the owner from controlling erosion of soil at each construction site through the use of the techniques described in this manual:

    a. Agricultural use of land.

    b. Grading or an excavation below finished grade for basements, footings, retaining walls, or other structures on lots of less than one (1) acre in size in existing subdivisions unless required otherwise.

    c. A sidewalk or driveway.

    d. Land-disturbing activities involving less than one (1) acre of disturbed area. Individual lots involving less than one (1) acre of disturbed area in a larger subdivision project shall not be considered separate development projects, but rather as a part of the subdivision development as a whole. It will be the responsibility of the homeowner and homebuilder to conform to all requirements of the locally-approved *Erosion and Sediment Control Plan* for the subdivision. As part of any Building Permit for which a specific erosion control plan is not required, the following statement must be included: “We have reviewed the *Erosion and Sediment Control Plan* for (subdivision name) and agree to conform to all requirements contained therein and all erosion control requirements of the City of Crooks. We further agree to construct and maintain all erosion and sediment control measures required on the individual lot(s) subject to this Building Permit and/or in accordance with the provisions of the City of Crooks *Erosion and Sediment Control Standards*.”

    e. Underground utility construction, including the installation, maintenance, and repair of all utilities under hard-surfaced roads, streets, or sidewalks, provided such land-disturbing activity is confined to the hard-surfaced area and provided that runoff and erosion from soil stockpiles are confined and will not enter the drainage system.

    f. Gravel, sand, dirt, or topsoil removal as authorized pursuant to approval of the South Dakota Board of Minerals and Environment, provided said approval includes an *Erosion and Sediment Control Plan* that meets the minimums specified.

12.1.1.2 Variances

The City of Crooks may temporarily waive or modify the standards of this chapter for the entire city due to severe local conditions. Any such citywide waiver must be determined to be necessary to prevent loss of life, personal injury, or severe property damage.

Upon request, the City of Crooks may consider waiving or modifying any of the standards which are deemed inappropriate or too restrictive for site specific conditions by granting a variance. These site specific variances may be granted at the time of plan submission or formal request for plan revision. Request for variances shall include the following and must be submitted in a format that is deemed acceptable by the City of Crooks.

1. The standard from which the applicant seeks a variance.

2. The justification for not complying with the standard.

3. Alternate criteria or standard measures to be used in lieu of the standard. The standards specified with this Chapter relate to the application of specific erosion and sediment control practices. Other practices or modifications to these standards may be used if approved by the City of Crooks prior to installation. Such alternative practice must be thoroughly described and detailed to the satisfaction of the City of Crooks.

To expedite the review and decision on variance requests, the variance request should be submitted with, or submitted prior to the initial *Erosion and Sediment Control Plan* submittal.

12.1.2 Performance Objectives

The objectives for erosion and sediment control during construction include the following:

1. Conduct all land-disturbing activities to effectively reduce accelerated soil erosion and reduce sediment movement and deposition offsite.

2. Schedule construction activities to minimize the total amount of soil exposed at any given time to reduce the period of accelerated soil erosion.

3. Establish temporary or permanent cover on areas that have been disturbed as soon as possible after final grading is completed.

4. Design and construct all temporary or permanent facilities for the conveyance of water around, through, or from the disturbed area to limit the flow of water to non-erosive velocities.

5. Remove sediment caused by accelerated soil erosion from surface runoff water before it leaves the site.

5. Stabilize the areas of land disturbance with permanent vegetative cover or storm water quality control measures.

12.1.3 Erosion and Sediment Control Plan

An *Erosion and Sediment Control Plan* consisting of a written narrative report and a site plan map must be submitted to the City of Crooks for review and approval prior to any unauthorized soil disturbance activities.

A professional engineer must develop the site specific *Erosion and Sediment Control Plan* that is in full compliance with the erosion and sediment control standards established in this chapter.

The approved *Erosion and Sediment Control Plan* must be reviewed to ensure compliance with these standards anytime a site's planned development changes impact the soil disturbance activities. If this review determines that the *Erosion and Sediment Control Plan* needs revision, it must be resubmitted and approved by the City of Crooks prior to the soil disturbance activities caused by the planned development changes.

12.1.3.1 **Erosion and Sediment Control Plan Narrative Report.** The narrative report must contain, or refer to, the drainage report and shall contain the following:

1. **Name, mailing address, email address if available, and telephone number of the responsible parties.** The name, mailing address, email address and telephone number of the professional engineer preparing the *Erosion and Sediment Control Report* shall also be included if different from the applicant.

2. **Project description.** A brief description of the nature and purpose of the land disturbing activity, the total area of the site, the area of disturbance, and project location including township, range, section, and quarter-section, or the latitude and longitude of the approximate center of the project.

3. **Existing site conditions.** A description of the existing topography, vegetation, and drainage; and identify any drainage ways and water bodies (wetlands) on the site.

4. **Adjacent areas.** A description of neighboring areas such as streams, lakes, residential areas, roads, etc., that might be affected by the land disturbance.

5. **Soils.** A brief description of the soils on the site, including information on soil type and names, mapping unit, erodibility, permeability, hydrologic soil group, depth, texture, and soil structure. (This information may be obtained from the soil report for the site, or, if available, from soils reports from adjacent sites.)

6. **Areas.** An estimate of the surface area (in acres) of the proposed disturbance.

7. **Erosion and sediment control measures.** A description of the methods described in the *Erosion and Sediment Control* standard plates or as directed by the City of Crooks, which will be used to control erosion and sediment on the site. The erosion and sediment control narrative should be phased to reflect the major planned construction stages of the project.

a. Major site grading

b. Public infrastructure improvements

c. Individual lot development

Additional measures as necessary to control air emissions like dust from construction activities.

8. **Construction site nonstructural control measures.** A description of the methods described in the Crooks *Erosion and Sediment Control* chapter, which will be used to control storm water pollution, erosion, sediment, and spills on the site. During the construction process, the developer is responsible for maintaining all compliance documentation records.

9. **Time schedule.** A time schedule indicating the anticipated starting and completion time periods of the site grading and/or construction sequence, including workday, week, or date of completion. The schedule will include the installation and removal time periods of erosion and sediment control measures, and the time of exposure of each area prior to the completion of temporary erosion and sediment control measures.

10. **Permanent stabilization.** A brief description, including specifications, of how the site will be stabilized after construction is completed.

11. **Storm water management considerations.** Explain how storm water runoff from and through the site will be handled during construction. Provide a brief description of the post-construction storm water quality control measures to be included as a part of the site development.

12. **Maintenance.** A schedule of regular inspections during construction and repair of erosion and sediment control structures shall be described. A description of routine sediment basin maintenance shall also be included.

13. **Dewatering.** Provide detail on how any planned dewatering shall be managed on the site, or state that no groundwater or surface water dewatering shall occur on site during construction activity.

14. **Variances.** Professional engineer shall list any request for variance of these standards and justification as required in Section 12.1.1.2.

15. **Other information.** Other information or data as may be reasonably required by the City of Crooks. Information required by the SDDENR General Permit for Storm Water Discharges Associated with Construction Activities in addition to the information listed above shall also be included in the narrative report.

16. **The following note.** “This *Erosion and Sediment Control Plan* appears to fulfill the technical criteria and the criteria for erosion control and requirements of the City of Crooks. I understand that additional erosion and sediment control measures may be needed if unforeseen erosion problems occur or if the submitted plan does not function as intended. The requirements of this plan shall run with the land and be the obligation of the responsible party until such time as the plan is properly completed, modified, or voided.”

17. **Signature page and statement.** Signature page for owner/developer and may also include the general contractor acknowledging the review and acceptance of responsibility for erosion and sediment control, and a statement by the professional engineer acknowledging responsibility for the preparation of the *Erosion and Sediment Control Plan*.

12.1.3.2 Erosion and Sediment Control Plan Sheet. The *Erosion and Sediment Control Plan Sheet* shall be separate from the narrative report. The plan shall be prepared at a minimum scale of one (1) inch equals one hundred (100) feet and include the following:

1. **Property Line.** The property lines for the site where the work will be performed.

2. **Existing Topography.** Existing topography with one- (1-) or two-foot (2-) contour intervals, and encompass the area shown on the final drainage plan (drawn to scale). Additional information may be required.

3. **Proposed Topography.** Proposed topography with **one- (1-) or two-foot (2-)** contour intervals; the map shall show elevations, dimensions (drawn to scale), location, extent, and the slope of all proposed grading.

4. **Existing Facilities.** Location of any existing structures or hydrologic features on the site.

5. **Existing Conditions.** Location of all structures or natural features on the land adjacent to the site as required for the final drainage plan. The plan shall show the location of the street, street right-of-way, storm sewer, channel, or other waters receiving storm water runoff from the site. Any potential wetlands identified on inventory maps or observed shall be clearly shown.

6. **Proposed Facilities.** Show all proposed structures and development on the site.

7. **Proposed Conditions.** The plan shall indicate the proposed changes to the location of street, street right-of-way, storm sewer, channel, wetlands, water bodies or other waters receiving stormwater runoff.

8. **Limits of Construction**. Delineate allowable limits of disturbance for each phase of construction development.

9. **Location of Soil Stockpiles**. Areas designated for topsoil and subsoil storage.

10. **Location of Storage Areas**. Areas designated for equipment, fuel, lubricants, chemical, and waste storage.

11. **Location of Concrete Washout Facilities**. Areas designated for the washout of concrete equipment.

12. **Location of temporary roads.** Designated for use during the construction period.

13. **Plans of all drainage features.** Show all structural and nonstructural erosion controls, paved areas, retaining walls, cribbing, planting, temporary or permanent soil erosion control measures, or other features to be constructed in connection with, or as a part of, the proposed work, together with a map showing the drainage area of land tributary to the site and estimated two-year runoff of the area served by all drains.

14. **Detail drawings**. Design drawings of sediment controls, temporary diversions, and any practices used that are not referenced in these criteria.

15. **Other information.** Other information or data as may be reasonably required by the local jurisdiction.

16. **Detailed schedule.** Detailed schedule of events including dates (workday or week) of completion of the erosion control measures.

17. **Display Requirements.** Provide location for sign that complies with Section 12.8.5.3.

12.1.3.3 Erosion Sediment Control for Individual Lots of a Subdivision

Individual lots involving less than one (1) acre of disturbed area in an approved subdivision or larger common plan of development or sale shall not be considered a separate construction project, but rather as a part of the subdivision development as a whole. It will be the responsibility of the locally approved *Erosion and Sediment Control Plan* for the subdivision. Subdivision *Erosion and Sediment Control Plans* must incorporate a separate detail drawing and narrative describing minimum erosion control measures of individual lots within the approved subdivision or larger common place of development or sale. It is understood that the City of Crooks may require additional erosion control measures if unforeseen erosion problems occur or if the submitted *Erosion and Sediment Control Plan* does not function as intended.

12.1.3.4 Acceptance of Erosion and Sediment Control Plan

An *Erosion and Sediment Control Plan* must be accepted prior to issuance of an Excavation and Grading Permit by the City. Acceptance of the *Erosion and Sediment Control Plan* does not imply acceptance or approval of drainage plans, utility plans, street or road plans, design of retaining walls, or any other aspect of site development.

12.2 Erosion Control

Planning for the installation of permanent or temporary soil erosion controls is needed in advance of all major soil disturbance activities on the construction site. After construction begins, soil surface stabilization shall be applied within 14 days to all disturbed areas that may not be at final grade but will remain dormant (undisturbed) for periods longer than an additional 21 calendar days. Within 14 days after final grade is reached on any portion of the site, permanent or temporary soil surface stabilization shall be applied to disturbed areas and soil stockpiles. When the initiation of stabilization measures are stopped due to snow cover or arid conditions, stabilization measures shall be initiated as soon as possible.

Soil surface stabilization protects soil from the erosive forces of raindrop impact, flowing water, and wind. Erosion control practices include surface roughening, mulching, erosion control blankets, and, establishment of vegetative cover by seeding and mulching, and the early application of gravel base on areas to be paved. Stabilization measures to be used shall be appropriate for the time of year, site conditions, and estimated duration of use. The maximum time limits of land exposure for selection of erosion controls are summarized in Table 12.1 (page 12A.7).

12.2.1 Surface Roughening

Surface roughening provides temporary stabilization of disturbed areas from wind and water erosion. It is particularly useful where temporary revegetation cannot be immediately established due to seasonal planting limitations.

The soil surface is considered roughened if depressions are created two (2) to four (4) inches deep and are spaced approximately four (4) to six (6) inches apart. If slopes are sufficiently rough after final grading, no further treatment is required. The surface of exposed soil can be roughened by a number of techniques and equipment. A chisel or ripping implement can be used in most soil conditions. Roughening cannot be performed in very sandy or rocky soil.

Surface roughening, also referred to as scarification, shall be performed after final grading. Fill slopes can be constructed with a roughened surface. Cut slopes that have been smooth graded can be roughened as a subsequent operation. Roughening of ridges and depressions shall follow along the contours of the slope. On slopes steeper than 2:1, the tracks left by a dozer working perpendicular to the contour can leave acceptable horizontal depressions.

Care shall be taken not to drive vehicles or equipment over areas that have been scarified. Tire tracks will smooth the roughened surface and encourage runoff to collect into channels. As surface roughening is only a temporary control, additional treatments may be necessary to maintain the soil surface in a roughened condition.

12.2.2 Mulching

All disturbed areas shall be mulched, or seeded and mulched, within 14 days after final grade is reached on any portion of the site not otherwise permanently stabilized. Areas that will remain in an interim condition for more than one (1) year shall also be seeded. (See Section 12.2.3.2)

To protect newly seeded areas and to provide temporary cover on other disturbed areas that will not require temporary revegetation or cannot be seeded due to seeding date limitations, a mulch shall be applied consisting of:

1. Clean, weed- and seed-free, long-stemmed grass hay (preferred) or cereal grain straw. Hay is preferred as it is less susceptible to removal by wind. Mulch shall be applied evenly at a rate of two (2) tons per acre. At least 50 percent of the mulch, by weight, shall be ten (10) inches or more in length.

   Mulch shall be anchored. This can be accomplished mechanically by crimping or with the aid of tackifiers or nets. Anchoring with a crimping implement is preferred, and is the recommended method for all areas equal to or flatter than 3:1. Mechanical crimpers shall be capable of tucking the long mulch fibers into the soil four (4) inches deep without cutting them.

   On small areas sheltered from the wind and from heavy runoff, spraying a tackifier on the mulch is satisfactory for holding it in place. For steep slopes and other special situations, blankets, anchored with staples, may be required instead of mulch.

2. Hydraulic mulching shall be limited to those situations where it is too difficult to apply and anchor a mulch of long-stemmed grass hay or cereal straw; namely, slopes steeper than 3:1 or where access is limited. Wood cellulose fibers shall be mixed with water and a tackifying agent and applied at a rate of one thousand five hundred (1,500) pounds per acre with a hydraulic mulcher.

3. Mats, blankets, and nets are available to help stabilize steep slopes and drainage channels. Depending on the product, these may be used alone or in conjunction with grass or straw mulch. Normally, use of these products will be restricted to relatively small areas. Mats made of jute, coconut fiber, or various geosynthetic fibers can be used instead of mulch. Blankets are straw mulch that have been woven and oftentimes include a synthetic layer or net. Plastic netting may be used to anchor mulch.

4. Some synthetic tackifiers or binders may be used to anchor mulch. Caution shall be used to prevent the introduction of any potentially harmful material into the environment. Manufacturer’s recommendations shall be followed at all times.

12.2.3 Revegetation

A viable vegetative cover shall be established within one (1) year on all disturbed areas and soil stockpiles not otherwise permanently stabilized. Vegetation is not considered established until a uniform vegetative ground cover with a density of at least 70% is achieved, or which, in the opinion of the City, is sufficiently mature to control soil erosion and can survive severe weather conditions.

12.2.3.1 **Seedbed Preparation.** Areas to be revegetated shall have soil conditions capable of supporting vegetation. Overlot grading will oftentimes bring to the surface subsoils that have low nutrient value, little organic matter content, few soil microorganisms, and conditions less conducive to infiltration of precipitation. Under certain conditions, soil amendments and treatments may be necessary to provide an adequate growth medium to sustain vegetation.

Whenever possible, topsoil shall be salvaged for respreading on areas to be revegetated. The depth of soil stripping is determined by the depth of available topsoil.

The rooting zone of most semi-arid grasslands is six (6) to eighteen (18) inches. At a minimum, the upper six (6) inches of topsoil can be stripped and stockpiled, and respread to a thicker depth on surfaces not planned for buildings or impervious areas. If the surface is compacted, ripping of subsoils prior to topsoiling is recommended. Scarification will assist in placement of a stable topsoil layer on steeper slopes, and allow percolation and root penetration to greater depth.

Fertilizer can be added to improve nutrient levels necessary for plant growth. Other treatments, such as liming, can be used to adjust soil conditions as necessary with amendments. Soil testing is recommended to determine appropriate amendments required.

A suitable seedbed will enhance the success of revegetation efforts. The upper layer of soil shall be in a condition suitable for seeding at the proper depth and conducive to plant growth.

12.2.3.2 **Temporary Revegetation.** Temporary revegetation is required on all disturbed areas having a period of exposure prior to final stabilization of one (1) year or longer. All temporary seeding shall be protected with mulch.

To provide temporary vegetative cover on disturbed areas that will not be paved, built upon, or fully landscaped within 12 months but will be completed within 24 months, plant an appropriate annual grass and mulch the planted areas. The annual grasses generally suitable for this area are listed in Table 12.2. These are to be considered only as a general recommendation whenever specific design guidance for a particular site is not available.

12.2.3.3 Permanent Revegetation. To provide vegetative cover on disturbed areas not paved or built upon for two (2) years or longer, or for an indeterminate length of time, a perennial grass mix shall be planted. Each site will have different characteristics, and a landscape professional should be contacted to determine the most suitable seed mix for a specific site. In lieu of a specific mix and for planning purposes, one of the perennial grass mixes listed in Table 12.3 can be used. The Pure Live Seed (PLS) rates of application recommended in these tables are considered to be absolute minimum rates for seed applied using proper drill-seeding equipment. All permanent seeding shall be protected with mulch.

12.2.4 Roads and Soil Stockpiles

Road cuts, road fills, and parking lot areas shall be covered with the appropriate aggregate base course on the surfaces to be paved in lieu of mulching. Early application of road base is suitable where a layer of course aggregate is specified for final road or parking lot construction. This practice may not be desirable in all instances and is not needed when final pavement construction will take place within 30 days of grading to final contours. All non-paved portions of road cut, fill, and parking lot areas shall be seeded and mulched as soon as possible after final grading has occurred, but in no case later than 14 days after grading has been completed.

Soils planned to be stockpiled for more than 60 days shall be seeded with a temporary or permanent grass cover within 14 days after completion of stockpile construction. Mulching is recommended to assure vegetation establishment. If stockpiles are located within close proximity to a drainageway (i.e., one hundred [100] feet), additional sediment control measures, such as a temporary diversion dike or silt fence, shall be provided. (See Section 12.3)

12.2.5 Dust Mitigation

To avoid dust migration and deposition off site, appropriate application of water or other approved dust suppression techniques shall be required.

12.3 Sediment Control

Installation of Sediment Control Measures. All construction sites must install necessary perimeter sediment control measures in their approved *Erosion and Sediment Control* Plan prior to the issuance of an Excavation and Grading Permit by the City of Crooks. This only allows the minimum amount of soil disturbance necessary that is directly related to the installation of these sediment control measures. Construction sites may be required to be inspected to verify that these sediment control measures have been properly installed prior to the issuance of an Excavation and Grading Permit by the City of Crooks.

The installation of all other sediment entrapment and control facilities shall begin before major land disturbance activities begin on a construction site in accordance with their time schedule established in their *Erosion and Sediment Control Plan*.

Sediment control will be site specific (located on the site under construction unless designated and approved by the City of Crooks) and can include vehicle tracking controls; sod buffer strips

around the lower perimeter of the land disturbance; sediment barriers, filters, dikes, traps, or sediment basins; or a combination of any or all of these measures.

Sediment controls shall be constructed before land disturbance takes place. Earthen structures such as dams, dikes, and diversions shall be mulched within 14 days of installation. Earthen structures that are expected to remain in place for more than one (1) year shall be seeded and mulched.

12.3.1 Vehicle Tracking

Wherever construction vehicles enter onto paved public roads, provisions shall be made to prevent the transport of sediment (mud and dirt) by vehicles tracking onto the paved surface. It is recommended that coarse-aggregate rock surfacing be provided to keep most construction traffic from coming into contact with mud and dirt. In other words, stabilized access, parking, staging, and loading and unloading areas will reduce the likelihood that vehicles will come into contact with mud. Sites that have not voluntarily implemented these practices may be required to construct a stabilized vehicle tracking control device.

For sites greater than one (1) acre, a stabilized vehicle tracking control shall be constructed. Whenever deemed necessary by the City, wash racks shall be installed to remove mud and dirt from the vehicle and its tires before it enters onto public roads.

Whenever sediment is transported onto a public road, regardless of the size of the site, the road shall be cleaned at the end of each day. Sediment shall be removed from roads by shoveling or sweeping and be transported to a controlled sediment disposal area. Street washing shall not be allowed until after sediment is removed in this manner. Storm sewer inlet protective measures shall be in place at the time of street washing.

12.3.2 Slope—Length and Runoff Considerations

Cut-and-fill slopes shall be designed and constructed to minimize erosion. This requires consideration of the length and steepness of the slope, the soil type, upslope drainage area, groundwater conditions, and other applicable factors. Slopes that are found to be eroding excessively will require additional slope stabilization until the problem is corrected. The following guidelines shall assist site planners and plan reviewers in developing an adequate design:

1. Rough soil surfaces are preferred over smooth surfaces on slopes (see Section 12.2.1).

2. Temporary slope diversion dikes (as discussed in Section 12.3.2.1) can be constructed at the top of long or steep slopes, or hillslopes that have an upslope tributary drainage area over five (5) acres. Diversion dikes or terraces (Sections 12.3.2.1 and 12.3.2.3) may also be used to reduce slope length within the disturbed area.

   Temporary diversion dikes shall be provided whenever: $S^2L>2.5$ (Equation 1)

   Where: S = slope of the upstream tributary area (in feet/foot); and
   L = length of the upstream slope (in feet)

3. Concentrated storm water shall not be allowed to flow down cut or fill slopes unless contained within an adequately-sized temporary channel diversion, a permanent channel, or temporary slope drain (see Section 12.3.2.4).

4. Wherever a slope face crosses a water seepage plane that endangers the stability of the slope, adequate drainage shall be provided.

5. Provide sediment traps, basins, or barriers (silt fences or straw bale dikes) below slopes to reduce off-site sediment transport or to reduce slope lengths (see Section 12.3.3).

12.3.2.1 **Slope Diversion Dikes.** A temporary slope diversion dike is a horizontal ridge of soil placed perpendicular to the slope and angled slightly to provide drainage along the contour. Temporary diversion dikes can be constructed by excavation of a V-shaped trench or ditch and placement of the fill on the downslope side of the cut.

There are two types of temporary slope diversion dikes:

1. A diversion dike located at the top of a slope to divert upland runoff away from the disturbed area. The discharge from undisturbed or previously-developed upland areas collected by these diversion dikes may be directed to a permanent channel or temporary channel diversion. (See Section 12.4.2)

2. A diversion dike located at the base or midslope of a disturbed area to divert sediment-laden water to a sediment trap or basin. The discharge from these diversion dikes may be directed to a temporary slope drain or sediment basin.

12.3.2.2 **Roads and Roadside Swales.** The drainage system provided for roads will define to some extent the length and area of individual slope segments within the disturbed area. A number of smaller hillslope segments will be created by construction of roads. These areas shall require erosion control as described in Section 12.2.4, and sediment controls dependent on the size of upslope tributary area. (See Section 12.3.3)

For road areas that are not paved within 30 days of final grading, and have not received early application of roadbase (see Section 12.2.4), rough-cut street controls shall be used. These are runoff barriers that are constructed at intervals down the road. The barrier projects perpendicular to the longitudinal slope from the outer edge of the roadside swale to the crown of the road. The barriers are positioned alternately from the right and left side of the road to allow construction traffic to pass in the unbarricaded lane.

12.3.2.3 **Terracing.** Sediment can be controlled on slopes that are particularly steep by using terracing. During grading, relatively flat sections, or terraces, are created and separated at intervals by steep slope segments. The steep slope segments are prone to erosion, however, and must be stabilized in some manner. Retaining walls, gabions, cribbing, deadman anchors, rock-filled slope mattresses, and other types of soil retention systems are available for use. These shall be specified in the plan and installed according to manufacturer's instructions.

12.3.2.4 Slope Drains. There are certain instances when runoff must be directed down a slope within the disturbed area. A temporary slope drain can be used to protect these hillslope areas from scour and additional erosion. A number of alternative designs and materials can be used for a slope drain.

The sizing of temporary slope drains shall be defined but do not need rigorous hydraulic analysis. Slope drains shall be sized for a two-year storm event. The discharge from all slope drains shall be directed to a stabilized outlet. (See Section 12.4.3)

12.3.3 Sediment Entrapment Facilities

Sediment entrapment facilities are necessary to reduce sediment discharges to downstream properties and receiving waters. Sediment entrapment facilities include straw bale barriers, silt fences, sod filter strips, sediment traps, sediment basins, silt ditches, and wattles. The type of sediment entrapment facility to be used depends on the tributary area, basin slope, and slope length of the upstream area. Table 12.4 summarizes the recommended maximum tributary areas, slope lengths, and slopes for four types of sediment entrapment facilities.

All runoff leaving a disturbed area shall pass through a sediment entrapment facility before it exits the site and flows downstream.

An established green filter strip may be adequate for small sites, provided the limits for tributary slope are not exceeded and the flow is not concentrated. Straw bale barriers or silt fences may be used for somewhat larger areas, depending on the upslope drainage area. When the tributary area is less than five (5) acres but greater than that allowed for straw bale barriers or silt fences, runoff shall be collected in diversion swales and routed through temporary sediment traps.

12.3.3.1 Silt Fence. A silt fence is made of a woven synthetic material that filters runoff. Silt fence can be placed as a temporary barrier at the base of a disturbed area but is not recommended for use in a channel or swale. The material is durable and will last for more than one season if properly installed and maintained.

12.3.3.2 Filter Strips. Vegetated filter strips cause deposition of sediment within the area of vegetation. Buffer strips of natural vegetation can be left at the time of site grading, or can be created by using sod. A dense ground over is necessary or runoff will channelize within the area. A minimum width of 20 feet is recommended.

12.3.3.3 Sediment Traps. A sediment trap is a temporary structure that is designed to fill with sediment. A sediment trap can be constructed by either excavating below grade or building an embankment across a swale. Excavated traps are less prone to failure than embankments. No pipe is used at the outlet, as in a sediment basin, and an open-channel spillway shall be included in the design. A minimum of 3,600 cubic feet of storage volume shall be provided for each tributary acre.

If sediment traps are incorporated into the erosion control plan, provide the following guidance for the contractor:

- Sediment volume required and provided.
- Length, width, and depth of the trap.
- Provide the top elevation of the berm, and length, and elevation for the overflow assembly.

12.3.3.4 **Sediment Basins.** Areas draining more than ten (10) acres shall be routed through a sediment basin. Sediment basins shall be designed to a minimum 3,600 cubic feet of volume per tributary acre and be cleaned out prior to becoming half full.

Tributary acres shall be the total potential disturbed acres at one time drained to the sediment basin from a construction site or larger common plan of development or sale. This does not have to apply to storm water flows from acres that are:

- Undisturbed onsite areas with no erosion and sediment control issues.
- Previously disturbed onsite areas that have achieved final stabilization.
- Disturbed or undisturbed areas not within the construction site or larger common plan of development or sale.

Performance Standard: If the storm water flows from acreages that do not apply to this standard are sufficient to cause significant hydraulic overloads that impact the sediment basins designed performance, then alternative measures should be considered (e.g. divert flows from areas that do not apply around the disturbed areas and sediment basin or build sediment basin off-line of main drainageway and divert only disturbed areas to sediment basin).

If the site is to include a post construction storm water quality or flood control detention facility, the permanent detention facility may be used as the temporary sediment basin, provided the outlets are designed for construction activities and are later modified for post construction activities upon completion of construction and final stabilization of disturbed soils. Such permanent detention facilities or post construction water quality BMP's shall be restored to design grades, volumes, and configurations after site development is completed and the project is finalized. The outlet from a sediment basin shall be designed to empty its volume in no less than 16 hours; namely, to have an average outflow rate of 28.0 gallons/minute/tributary acre, or less. The basin length shall be no less than twice the basin width. The inflow structures at the entrance of the basin shall be designed to dissipate inflow energy and to spread the flow so as to achieve uniform flow throughout the basin's width. The gravel and rip rap horseshoe sediment basin should be utilized when drainage culverts are already in place prior to site construction activities since existing culverts and roadway fill sections readily afford sediment storage area.

If sediment basins are incorporated into the *Erosion and Sediment Control Plan*, provide the following information in the plan to provide necessary guidance for the contractor:

- Delineate the tributary drainage area to each sediment basin on the erosion control plan.

- Sediment volume required and provided.

- Length, width, and depth of the basin.

- For sediment basins, give the top elevation of the berm, and length, and elevation for the overflow assembly. The outlet structure size and invert elevations will also be provided.

For drainage locations serving less than ten (10) acres, a sediment basin or a combination of sediment basin(s) and sediment traps providing storage for three thousand six hundred (3,600) cubic feet of storage per acre drained may be required along with silt fences, silt ditches, or equivalent sediment controls on all sideslope and downslope boundaries of the construction area.

12.3.3.5 **Silt Ditch.** A silt ditch is constructed by excavating a small channel along and parallel to the existing contours of the land. Silt ditch can be placed as a temporary barrier at the base of a disturbed area but is not recommended for use in a channel or swale. Silt ditch shall be designed to a minimum 3,600 cubic feet of volume per tributary acre. The berm constructed on the downstream side of the excavated channel shall be seeded and mulched immediately after construction.

12.3.3.6 **Sediment Control Wattles.** A sediment control wattle is used to provide a flexible, lightweight, and porous sediment entrapment device. It is typically manufactured of a straw and coconut matrix, is 6-20 inches in diameter and is 10 feet long. The wattle is staked into the ground. Sediment control wattles are useful for control of sediment transport in ditch bottoms, swales, and waterways. The wattles may be used in lieu of, or in conjunction with silt fence, rock check dams, or silt ditch. Refer to Table 12.4 for wattle spacing criteria.

12.4 Drainageway Protection

At times, construction activities must occur adjacent to or within a drainageway. Whenever this occurs, bottom sediments will be disturbed and transported downstream to minimize the movement of sediments resulting from construction activities that take place within any drainageway. Temporary facilities can be installed to divert flowing water around such sediment-generating construction activities within drainageways.

12.4.1 Working Within or Crossing a Waterway

Whenever work occurs within a waterway, the following shall be considered as appropriate:

1. Construction vehicles shall be kept out of a waterway to the maximum extent practicable. Where in-channel work is necessary, steps, such as temporary channel diversions, shall be taken to stabilize the work area during construction to control erosion. The channel (including bed and banks) shall be restabilized immediately after in-channel work is completed.

2. Where an actively-flowing watercourse must be crossed regularly by construction vehicles, a temporary crossing shall be provided. Two primary methods are available: a culverted crossing and a stream ford.

   A culverted crossing shall be designed to pass the two-year design flow.

   A ford shall be lined with a minimum six- (6-) inch thick layer of one and a half-(1.5-) inch diameter rock.

   A permit is required for placement of fill in a waterway under Section 404 of the Clean Water Act. The Corps of Engineers office in Pierre, South Dakota, shall be contacted about the requirements for obtaining a 404 permit.

3. Whenever feasible, a temporary channel diversion (see Section 12.4.2) shall be used to bypass the work areas when work takes place within a channel.

4. Whenever possible, construction in a waterway shall be sequenced to begin at the most downstream point and work progressively upstream installing required channel and grade control facilities.

6. Complete work in small segments, exposing as little of the channel at a time as possible.

6. Where possible, perform all in-channel work between September 15 and April 15.

12.4.2 Temporary Channel Diversions

Limiting construction activities within actively-flowing water will significantly reduce sediment movement downstream from these activities. This can be done by using a temporary diversion facility that carries water around construction activities taking place within a waterway.

Permanent drainage channels shall be constructed at the earliest possible stage of development. Temporary channel diversions shall not remain in place for more than two years prior to removal or replacement by permanent facilities.

12.4.2.1 **Stability Considerations.** Temporary channels are not likely to be in service long enough to establish adequate vegetative lining. Temporary channel diversions must be designed to be stable for the design flow with the channel shear stress less than the critical tractive shear stress for the channel lining material. Unlined channels shall not be used unless it can be demonstrated that an unlined channel will not erode during the design flow. Design procedures for temporary channels are described in detail in the Hydraulic Engineering Circular No. 15 published by the Federal Highway Administration.

12.4.3 Outlet Protection

The outlets of slope drains, culverts, sediment traps, and sediment basins shall be protected from erosion and scour. Outlet protection shall be provided where the velocity of flow will exceed the maximum permissible velocity of the material where discharge occurs. This may require the use of a riprap apron at the outlet location.

Check dams can be used in ditches or swales and downstream of the outlets of temporary slope drains, culverts, sediment traps, and sediment basins. Check dams reduce the velocity of concentrated flows and trap sediment eroded from the upstream ditch or swale. They are not a primary sediment trapping facility and are a temporary flow-control structure.

Check dams may be used under the following conditions:

1. In temporary or permanent swales that need protection during the establishment of grasses;

2. In permanent swales that need protection prior to installation of a non-erodible lining;

3. In temporary ditches or swales that need protection where construction of a non-erodible lining is not practicable.

Check dams shall be constructed of four- (4-) to six- (6-) inch angular rock to a maximum height of two (2) feet. The center of the top of the dam shall be six (6) inches lower than the sides to concentrate the flow to the channel center. Where multiple check dams are used, the top of the lower dam shall be at the same topographical elevation as the toe of the upper dam.

Sediment that collects behind a check dam shall be removed when the sediment reaches the spillway level. Check dams constructed in permanent swales shall be removed when perennial grasses have become established, or immediately prior to installation of a non-erodible lining. All of the rock and accumulated sediment shall be removed, and the area seeded and mulched, or otherwise stabilized.

12.4.4 Inlet Protection

All storm sewer inlets that are made operable during construction shall be protected to prevent sediment-laden runoff from entering the conveyance system without first being filtered or otherwise treated to remove sediment.

Inlets may be temporarily blocked to prevent sediment-laden runoff from entering storm sewers. Inlet protection measures shall be removed after upstream disturbed areas are stabilized.

Caution must be used in temporarily blocking inlets to assure that localized flooding conditions do not develop.

Inlet protection shall be removed from storm sewer inlets within paved street sections or parking lots during the winter months between December 1 and February 15. The City may require removals earlier than December 1 or installations later than February. During the period when inlet protection has been removed, alternate erosion control methods for inlet protection must be employed if ground is not stabilized by frozen conditions.

12.5 Underground Utility Construction

The construction of underground utility lines that are not exempted (see Section 12.1.1.1.e) shall be subject to the following criteria:

1. No more than three hundred (300) feet of trench are to be opened at one time.

2. Where consistent with safety and space considerations, excavated material is to be placed on the uphill side of trenches.

3. Trench dewatering devices shall discharge in a manner that will not adversely affect flowing streams, wetlands, drainage systems, or offsite from the property. Site dewatering permit requirements shall be discussed with the South Dakota Department of Environment and Natural Resources.

4. Provide storm sewer inlet protection (see Section 12.4.4) whenever soil erosion from the excavated material has the potential for entering the storm drainage system.

12.6 Disposition of Temporary Measures

All temporary erosion and sediment control measures shall be removed and dispose within 30 days after final site stabilization is achieved, or after the temporary measure are no longer needed, whichever occurs earliest, or as authorized by the City of Crooks. For example, a site containing only one building shall have temporary erosion control measures removed after building construction is complete and final landscaping is in place. Temporary erosion control measures shall be removed from a commercial construction site or residential subdivision only after streets are paved and all areas have achieved final stabilization. Trapped sediment and disturbed soil areas resulting from the disposal of temporary measures shall be returned to final plan grades and permanently stabilized to prevent further soil erosion.

The professional engineer preparing the *Erosion and Sediment Control Plan* shall submit a schedule of removal dates for temporary control measures. The schedule shall be consistent with key construction items such as street paving, final stabilization of disturbed areas, or installation of structural storm water controls.

12.7 Maintenance

All temporary and permanent erosion and sediment control practices shall be maintained and repaired by the owner during the construction phase as needed to assure continued performance of their intended function. Silt fences and wattles may require periodic replacement and all sediment accumulated behind them shall be removed and disposed of properly. Sediment traps and basins will require periodic sediment removal when the design storage level is half full. All facilities shall be inspected in accordance with Section 12.9 by the responsible party or their representative.

12.8 Pollution Prevention Using Nonstructural BMPs

Nonstructural BMPs are to be a part of construction activities.

12.8.1 Objectives in the Use of Nonstructural BMPs

Nonstructural BMPs differ from the structural BMPs because they focus on activities to control water quality rather than physical structures. Because they rely on actions and not structures, nonstructural BMPs must be implemented constantly and repetitively over time. There are two main objectives of using nonstructural BMPs. These are:

1. Reduce or eliminate the pollutants that impact water quality at their source, thus reducing the need for structural control requirements. The use of nonstructural BMP practices may assist structural BMP efficiency and may eliminate the need for additional storm water treatment.

2. Address water quality concerns that are not considered cost-effective by structural controls such as implementing a spill prevention and containment program.

12.8.2 Good Housekeeping

12.8.2.1 **Application.** Good housekeeping practices are designed to maintain a clean and orderly work environment. The most effective first steps towards preventing pollution in storm water from work sites simply involves using good common sense to improve the facility's basic housekeeping methods. Some simple procedures a site can use to promote good housekeeping are improved operation and maintenance of machinery and processes, material storage practices, material inventory controls, routine and regular cleanup schedules, maintaining well organized work areas, signage, and educational programs for employees and the general public about all of these practices.

12.8.2.2 **Contact Information Display Requirement.** The permittee shall post a 24-hour, 7 days-a-week sign with the contractor contact name and contractor phone number readily visible at the development site entrance. A City of Crooks approved 24-hour contact number to register complaints must also be included on the sign. The contact information shall be clearly readable, securely anchored, and appropriately weatherproofed to assure its integrity throughout construction. The following or similar format shall be used:

1. To report an erosion, sediment, spill, or other problem at this construction site to the responsible contractor call:

   Contractor Name
   Contractor Phone

   To register a complaint about this construction site to the City of Crooks call:

   Approved City of Crooks Contact Number

12.9 Inspections

The permittee shall assure that qualified personnel inspect the site at least once every seven calendar days and within 24 hours of the end of a storm that is 0.5 inch or greater or snow melt event that cause surface erosion to confirm plan compliance. Where runoff is unlikely due to winter conditions, such inspections shall be conducted at least once per month. Based on the results of the inspection, the plan shall be revised and implemented, in no case later than seven calendar days following the inspection.

The inspection shall look for evidence of or the potential for pollutants entering the drainage system or leaving the site and shall include disturbed areas of the construction site that have not been finally stabilized, areas used for storage of materials, structural and nonstructural control measures, and locations where vehicles enter or exit the site.

A report summarizing the areas inspected, name(s) and title(s) of personnel making the inspection, the date(s) of the inspection, major observations, and corrective actions taken shall be made and retained as part of the plan for a least three years. Such reports shall identify any incidents of noncompliance. Where an inspection does not identify any incidents of noncompliance, the report shall contain a certification that the site is in compliance with the plan and permit. The report shall be dated and signed by the responsible party or their authorized representative.

Compliance documentation is the responsibility of the Owner/Developer/Contractor as identified in Section 12.1.3.1.

12.10 Construction Control Measures

12.10.1 Concrete Washout Area

Concrete washout areas shall be constructed during any period of planned development where concrete is being used and allowed to be disposed of on site. The use of a vehicle tracking control in conjunction with concrete washout area is required unless the concrete washout area is protected by the site’s vehicle tracking control.

12.10.2 Limits of Construction

Plan shall clearly delineate allowable limits of disturbance for each phase of construction. Limits of construction are designed to delineate construction site perimeters, protect and preserve stabilized areas, drainageways, regulated water bodies (wetlands), environmental sensitive areas, historical areas, erosion and sediment control measures and other resources.

12.11 Final Stabilization

All erosion and sediment control measures accepted in the *Erosion and Sediment Control Plan* must be maintained until final stabilization is reached which means that either:

1. All planned soil disturbing activities at the site have been completed and a uniform perennial vegetative cover with a density of 70 percent of the native cover or an equivalent permanent stabilization measure has been employed on any pervious areas of the site; or

2. A specific alternative to final stabilization as described in this chapter; or

3. A specific alternative approved by the S.D. DENR general permit for storm water discharges associated with construction activities.

Chapter 13 - Construction Plans
Table of Contents

Section & Topic **Page**

Chapter 13

Construction Plans

13.1 General

Detailed reproducible plans, prepared by or under the direct supervision with the signature, seal, and date of the licensed Professional Engineer in the State of South Dakota, shall be filed with the City Of Crooks or all work involved in public improvement contracts. Detailed plans shall conform to the City of Crooks Ordinances and to the following requirements.

13.2 Subdivision Plans – Refer to the City of Crooks Subdivision Regulations for plan requirements and submittals.

13.3 General Plan Sheet Requirements

13.3.1 Plan Sheet Size. Prepare plans on sheets 11 inches by 17 inches in size, except for special layout sheets when specifically accepted by the City of Crooks. Review plans may be submitted on sheets 22 inches by 34 inches. The maximum width of any sheet shall not be greater than 36 inches.

13.3.2 Names on Sheets. All persons designing, detailing, and checking plans shall legibly place their names on the plan sheets in a space provided for this purpose.

13.3.3 Title Block. A title block listing the name of the project, Owner, and Engineer along with sheet title, date, sheet number, and space to denote revisions. Title block shall go in lower right corner or right edge of each sheet except the title sheet so as to be read from the bottom or right side. Page numbers shall be in the lower right corner of each sheet.

13.3.4 Precision and Detail. Plans shall be prepared with such precision and in such detail as to be within the customary degree of accuracy for work of this kind and so permit the convenient layout in the field for construction and for other purposes. They shall also be of such character as to provide for the production of an accurate estimate of quantities for the several pertinent items of work to be performed in the construction of the improvement.

13.3.5 Special Provisions. Plans shall include special provisions for items of work included in the plans which are not covered by the Standard Specifications and accepted special provisions of the South Dakota Department of Transportation and the City of Crooks as may be required to properly cover the work contemplated by the plans. Special provisions may be prepared on 8 1/2-inch by 11-inch paper and bound with other bid documents.

13.4 Title Sheet

The following information shall be shown when applicable.

1. Project name and location.

2. Type of project.

3. Small scale map showing project location. Plan and profile sheet layout shall be shown on location map.

4. Index (a complete sheet index is to be shown).

5. File number (to be filed at the City Hall).

6. Engineer's firm name and address.

7. Estimate of quantities (may be placed on second sheet). Development plan shall contain utility quantities only.

8. Design Engineer's certification, registration number, and date certified.

9. General Notes (show all general notes pertaining to construction. Include a general note that project shall be constructed in accordance with the Standard Specifications or as directed by the City of Crooks).

10. Legend (define all symbols shown in the plans).

11. Legal Description, including section, township, and range.

13.5 General Information to be Shown on Detailed Plans

The following information shall be shown when applicable.

1. Construction limits.

2. Benchmarks.

3. Street names.

4. Right-of-way widths.

5. Removal of large trees, buildings, pavement, structures, or other features as required.

6. Horizontal and Vertical Control. Alignment notes and benchmark descriptions are to be located on the plan portion of the sheets. All vertical control shall be based on NAVD 1988 vertical datum.

7. Lot and block numbers and subdivision name in new subdivisions. Otherwise, show property addresses.

8. Lot dimensions (along rights-of-way or easements).

9. Show scale (usually 1" = 20' horizontal and 1" = 5' vertical reduced to 1" = 40’ horizontal and 1" = 10' vertical) using a bar type diagram and standard north arrow together. Show arrow on right-hand side pointing to top or left of sheet.

10. Existing and proposed utilities—type, size, and location. (Show existing features less prominently or dashed.)

11. Pavement widths.

12. Where stationing is continuous from one sheet to the next, the last station on one sheet is to be the first station shown on the next. If possible, locate on the sheet to avoid “breaking” the plan and profile.

13. Existing trees, fences, walks, drainage structures, ditches, pavements, buildings, and other obstacles or improvements that are in or near the work area. (Show existing features less prominently or dashed.)

14. Survey line or reference line shall be shown on plan view.

15. Temporary and permanent easements.

16. Special details and special notes when required.

17. Plan view and profile shall line up whenever possible.

18. Symbols and abbreviations used on plans if different from those shown in Standard Specifications.

19. Any soils information available. (Show test hole locations on plan and profile sheets.)

20. When it is required by the City of Crooks, a traffic control plan shall be shown on plans.

21. Other information deemed necessary by the Design Professional certifying the plans.

22. Revision block showing description, date, and by.

13.6 Street and Storm Sewer Plans

The following information shall be shown when applicable.

1. Show BEGIN STA. and END STA.

2. Storm sewer plans shall be shown on the same sheets as paving unless it is a major installation.

3. Match lines to other plan and profile sheets where they do not follow in order in the plans such as at an intersection.

4. Horizontal curve data near curve or code for clarity if several are to be shown or if the sheet is crowded. Show Point of Intersection (PI) Station, ∆angle, degree, radius, tangent, length, and superelevation, if any. Show Point of Curvature (PC), Point of Intersection (PI), and Point of Tangent (PT) station on the plan. For vertical curves show stationing, length, and elevations of Point of Vertical Curvature (PVC), Point of Vertical Intersection (PVI), and Point of Vertical Tangent (PVT). Also show "K" value as defined in *A Policy on Geometric Design of Highways and Streets* published by AASHTO, latest English edition.

5. Drainage arrows designating direction of runoff.

6. Stationing of paving projects will generally run from north to south or from west to east so that the north arrow will point to the top or lefthand side of the sheet.

7. New construction and information notes in accordance with standard "Typical Notes."

8. Show profile of existing ground or proposed street high enough to allow for storm sewer information and profile grades below. Show street profile grade elevations every 25 feet, typical. Label the existing ground line and show percent of grade on the new grade line (usually top of curb).

9. Show profile flow line elevations on all inlets, catch basins, pipes, and culverts. Show size, type, class (if necessary), and percent of grade on storm sewer pipes.

10. Show intersection details to the extent necessary to insure proper horizontal and vertical alignment. The following additional information is required:

a. Spot elevations along center lines and along curb lines extended through the intersection.

b. Drainage arrows showing direction of storm water flow.

Additional geometric information may be required including key distances, stations, angles, curve data, and elevations necessary for design and staking.

11. Show typical sections as required including information on the following:

a. Shoulder slopes, back slopes, side slopes
b. Paving widths, thicknesses, and types
c. Lane widths
d. Pavement cross slopes
e. Sidewalks and slopes
f. Subgrades and paving treatment
g. Typical right-of-way lines
h. Other typical details of paving or grading sections as appropriate not otherwise covered on the standard paving details.

Typical sections may be waived for private development plans if it is a standard section.

13.7 Sanitary Sewer Plans

The following information shall be shown when applicable.

1. Stationing, location, and type of all manholes, intakes, or other structures. Type of structures shall be in conformance with the Standard Specifications.

2. Details shall be shown for all structures that are not in accordance with City of Crooks standards.

3. Plan and profiles of all sewer lines (including existing ground profile and proposed finished grade profile).

4. Size, length, and grade of sewers.

5. Type of pipe materials and strengths (if necessary).

6. Invert elevations at all intakes, manholes, and other structures.

7. On reconstruction projects, location, size, and type of all sewer stubouts, wyes, or tees. Stubout locations shall be referenced to lot corners. When risers are to be installed, riser location and size shall be shown on reconstruction plans.

8. Estimates shall include stubout quantities when they are to be constructed by City contract.

9. Rim and invert elevations of existing and proposed manholes and structures.

10. Manholes shall be identified with numbering system on plan and profile.

11. Class of pipe bedding if necessary.

12. Existing underground utilities such as cables, water, sewer, or gas lines or any other underground features that cross or are near the proposed sewer. Show exact elevations, if possible, where there may be conflict with new construction.

13.8 Drainage Ditch and Drainageway Plans

The following information shall be shown when applicable.

1. Stationing and flow line elevation at beginning and end of ditch construction.

2. Size, type, length, and grade of ditch.

3. Typical sections showing ditch dimensions, backslopes, and invert and slope treatment.

4. Invert elevations at all structures.

5. All special structures shall be detailed on plans.

6. Drainage design data.

7. Cross-sections and topographic map showing existing ground and finished grade at intervals of 100'.

13.9 Water Main Plans

The following information shall be shown when applicable.

1. Stationing, location, and type of all water lines, manholes, valves, fire hydrants, or other appurtenances.

   a. Stationing and type of structure shall be shown on station bar.

   b. Location shall be shown on plan or on station bar if referenced to survey line or center line.

   c. Type of structures shall be in conformance with Standard Specifications, Standard Plates, or as directed by the City of Crooks.

2. Details shall be shown for all structures that are not in Standard Specifications, Standard Plates, or as directed by the City of Crooks.

3. Plan and profiles of all water lines where future changes in grade are possible.

4. Size and length of water lines.

5. Type of pipe materials and strengths if necessary.

6. Top of pipe grade to be six (6) feet below finished grade.

7. On reconstruction projects, location, size, and type of all water stubs, wyes, or tees. Stub locations shall be referenced to lot corners and stubbed to property line.

8. Estimates shall include stubout quantities when they are to be constructed by City contract.

9. Curb elevations at all hydrant locations.

10. All castings shall be City standard where maintained by the City.

11. Class of pipe bedding if necessary.

13.10 Erosion Control Plan

An erosion control plan shall be submitted as detailed in Chapter 12 of these Design Standards.

Chapter 14 - Acceptance Procedures and Requirements For Private Construction of Public Improvements Table of Contents

Section & Topic **Page**

Chapter 14

Acceptance Procedures and Requirements for Private Construction of Public Improvements

14.1 Application of Standards

The requirements contained herein shall apply to all new private development construction and site development construction within City dedicated right-of-way and easement areas that is planned for or subject to public use within the jurisdiction of the City of Crooks. This acceptance shall consist of all improvements included in the Owner submitted construction plans accepted by the City.

14.1.1 Acceptance Limitation. The acceptance of an improvement shall in no way constitute an assumption by the City of liability for defects in the improvement. By accepting the improvement, the City does not warrant or guarantee that the improvement has been properly designed or constructed. Any errors or omission of the Owner/ Developer/ Engineer shall not be the responsibility of the City.

14.2 Acceptance Procedure

The acceptance process will proceed in two phases. The first phase will consist of Utility Acceptance which includes the water main, sanitary sewer, and storm sewer facilities.

The second phase or Final Acceptance shall consist of all other public improvements including but not limited to grading, crushed base, curb and gutter, and surfacing. All items identified during the final inspection shall be complete before the final acceptance.

14.2.1 Utility Acceptance. A Utility Warranty Report shall be sent to the developer's representative when the water main, sanitary sewer, and storm sewer facilities are complete and accepted by the City of Crooks. Storm sewer facilities shall include storm sewer pipe, storm sewer inlets, and storm sewer junction boxes. The warranty start date shall be shown on the Utility Warranty Report.

The warranty start date shall be the date the two (2) -year warranty period commences for the water main, sanitary sewer, storm sewer pipe, storm sewer inlets, and storm sewer junction boxes.

14.2.2 Final Acceptance. The City of Crooks or an authorized representative shall notify the developer's representative when all public improvements are complete and accepted by the City. The date the improvements are accepted shall be included in this notification. This date shall be the date the two (2) -year warranty period commences for all improvements included in the final acceptance.

After the City grants final acceptance, the City will assume all maintenance responsibilities for the public improvements.

14.3 General Policy

The City shall provide snow removal service on streets where the lower lift of asphalt has been placed. The City shall not provide snow removal services on streets where manholes, valve boxes, and any other items protrude above the roadway surface.

Prior to the final acceptance, the Owner shall maintain the improvements and repair or correct any deficiencies that may occur before final acceptance is granted.

The City will accept responsibility for damage to curb and gutter caused by snow plow operations provided notification is given prior to the final lift of asphalt being placed.

The Owner shall be responsible for installation and maintenance of any barricades or warning signs required until final acceptance is granted.

Chapter 15 - Street Lighting

Section & Topic **Page**

Chapter 15

Street Lighting

15.1 Reserved for future use.

Chapter 16 - Inspection and Testing

Section & Topic **Page**

Chapter 16

Inspection and Testing

16.1 General

In order to ensure satisfactory completion and conformance with city standards, the City shall conduct inspections and require testing during construction. It is the responsibility of the contractor to abide by the proposed testing and inspection schedules set forth in this section and to notify the city when work is ready for inspection. In the event that the proposed schedules are not met, construction on the project shall cease until the items that are out of compliance are resolved.

All projects shall be constructed and tested in accordance with Engineering Design Standards, Standard Specifications, or as directed by the City of Crooks.

16.2 Submittals

The contractor shall submit shop drawings of all materials to be constructed to the City of Crooks for approval. Four (4) complete sets of original drawings plus any number the Contractor wishes to maintain shall be submitted. One complete set of shop drawings shall include all submittals for the project. Each set shall be bound into a single document with a cover page attached listing the following information.

1. Project Name

2. Submittal Date

3. Contact information for the Contractor

16.3 Testing Schedule

The following tests shall be scheduled by the contractor and performed by a certified testing agency. All results shall be forwarded to the City of Crooks. Tests shall be performed as detailed in the current version of the SDDOT Materials Manual or current ASTM Standards.

1. Asphalt Paving – Density tests shall be performed at the frequency of 1 per 900 lane feet per lift. Density tests shall be performed using the cut out (core) or nuclear gauge method. The nuclear gage method shall only be used for acceptance testing if it is calibrated with cores as detailed in the Materials Manual. A standard density (Rice) test shall be performed once per project and when there is a change in the mix. Testing may be waived by the engineer when the total project quantity for asphalt is less than 500 tons.

2. PCC Concrete Streets – An air content test shall be performed on the first truck before pouring is begun. An air test, slump test, and at least four concrete cylinders (1 for an early break, 2 for 28 day breaks, and one backup) shall be made for every 150 cubic yards of pouring.

3. Sidewalks, Curb & Gutter, Concrete Fillets, Valley Gutters, Inlets, and other Miscellaneous Concrete – An air test, slump test and a strength test shall be performed for every 100 cubic years of pouring. Additional strength tests should be run when needed to determine when concrete is ready to carry traffic.

4. Structural Concrete – Air tests, slump tests, and strength tests shall be run at the frequency specified by the current version of the SDDOT Materials Manual in the Minimum Sampling and Testing Requirements section.

5. Subgrade – Soil density and moisture content tests shall be performed on all pavement subgrade and roadway fills a minimum of one (1) per city block or every 600 feet, whichever is less, per four (4) feet of depth. A minimum of one (1) standard density and optimum moisture determination shall be made for the project and one (1) additional test for each change in the soil type.

6. Utility Trenches – Density tests on trench backfill shall be performed in accordance with the City's Standard Specifications for Construction. In general, a minimum of one density test and moisture content shall be made for every 500 lineal feet of trench per four (4) feet of depth. A minimum of one (1) standard density and optimum moisture determination shall be made for the project and one (1) additional test for each change in the backfill.

7. Base Course, Select Granular Backfill, Aggregates, and other Granular Materials – A minimum of one (1) gradation shall be run per project per type of material. Density tests shall be run on base course for roadways a minimum of one (1) per city block or every 600 feet, whichever is less. Testing may be waived by the engineer when the total project quantity for each type of material is less than 500 tons.

The engineer may at any time order additional testing above and beyond the minimum required. The contractor and supplier are encouraged to perform testing as needed to monitor their own quality control. This testing, however, will not be used in determining acceptance of the installed material. When testing will be destructive to the final product, such as coring asphalt pavement, approval must be obtained from the engineer prior to testing.

16.4 Inspection Schedule:

Listed below is a summary of inspections that shall require written documentation of approval by the City of Crooks. The Contractor shall schedule all inspections with the City of Crooks.

16.4.1 Streets:

1. Subgrade Stability: The contractor shall schedule an inspection with the City of Crooks to inspect the subgrade stability. The inspection shall be completed once the subgrade has been compacted into place and prior to placing the base course. The contractor will be required to proof roll the subgrade with equipment approved by the City of Crooks. Unstable areas shall be repaired by the contractor.

2. Base Course Stability: The contractor shall schedule an inspection with the City of Crooks to inspect the base course stability. The inspection shall be completed once the base course has been compacted into place and prior to placing surfacing. The

contractor will be required to proof roll the base course with equipment approved by the City of Crooks. Unstable areas shall be repaired by the contractor.

3. Bottom Lift Asphalt Stability: The contractor shall schedule an inspection with the City of Crooks to inspect the stability of the bottom lift of asphalt. The inspection shall be completed prior to placement of the second lift. The City of Crooks shall visually inspect the bottom lift for any failures or depressions. In areas of failure and excessive depression the existing asphalt shall be removed, the underlying grade stabilized and new asphalt patched back into place. In areas of moderate depression, a leveling course shall be installed prior to placement of the second lift.

16.4.2 Sanitary Sewer: Newly constructed sanitary sewer systems shall be tested as described in the City's Standard Specifications or as directed by the City of Crooks.

1. Pipe Inspection
2. Pipe Leakage
3. Manhole Leakage
4. Pipe Deflection Test
5. Television Inspection

16.4.3 Water: Newly constructed water main systems shall be tested as described in the City's Standard Specifications or as directed by the City of Crooks.

1. Pipe Inspection
2. Disinfection and Bacteriological Testing
3. Hydrostatic Pressure Testing

16.4.4 Drainage: Newly constructed storm sewer systems shall be tested as described in the City's Standard Specifications or as directed by the City of Crooks.

1. Pipe Inspection
2. Pipe Deflection Test
3. Television Inspection

16.4.5 Final Inspection: The City of Crooks shall conduct a final inspection once all improvements are complete. If all work appears substantially complete, an acceptance letter shall be forwarded to the contractor. If needed a punch list of items to be repaired or completed shall be attached to the acceptance letter.

16.4.6 Warranty Inspections: The City of Crooks shall conduct inspections as necessary throughout the warranty process. If needed a punch list of items to be repaired shall be generated and forwarded to the contractor. At the end of the warranty period, the City of Crooks shall forward a letter documenting the expiration of the warranty.

INFORMATION SOURCES

These Design Standards are a compilation of information taken from several different sources. The main sources used to develop these standards are as follows:

- City of Crooks Ordinances and Subdivision Regulations
- DGR Engineering Construction Specifications
- The City of Sioux Falls Design Standards for Public Improvements
- The South Dakota Department of Agriculture and Natural Resources
- South Dakota Department of Transportation

City of Crooks

Standard

Specifications

for

Public Improvements

Adopted: December 2022

City of Crooks
701 S. West Avenue
PO Box 785
Crooks, SD 57020

TABLE OF CONTENTS

SECTION 100

SUBSURFACE INVESTIGTATIONS AND EXISTING UTILITIES

1.0 SOIL INVESTIGATION

1.1 GENERAL

1.1.1 On any public improvements projects the determination for when soil investigations will be required will be determined on a case-by-case basis by the City of Crooks.

1.1.2 A geotechnical exploration shall determine any special conditions. A report shall be submitted and shall make recommendations regarding grading, foundations and pavement.

1.1.3 The OWNER will be responsible for performing soil investigations prior to construction and shall provide three copies of the soils report to the City for its review and files.

1.1.4 It shall be the Contractor's responsibility to determine to his own satisfaction the location and nature of all surface and sub-surface obstacles and the soils and water conditions which will be encountered during the construction.

1.1.5 All sampling and testing of the soils shall be performed in accordance with the appropriate AASHTO and ASTM designations and shall be completed by or under the direct supervision of a Registered Professional Engineer licensed in the State of South Dakota.

1.2 SAMPLING

1.2.1 Samples shall be obtained by drilling along the existing or proposed public rights-of-way.

1.2.2 The minimum depth of borings shall be 5 feet in fill areas, 5 feet below subgrade foundation, in cut areas and 2 feet below the flow line of pipes and conduits.

1.2.3 The maximum distance between borings shall not exceed 400 feet. Where drainage areas or soft areas are being crossed, the distance between borings shall be shortened to determine the edges of the soft area. The depth of the borings may also need to be increased to determine to what depth improved subgrade material may be required.

1.2.4 At least one boring shall be a minimum of 10 feet deep to establish the depth of the existing water table.

1.3 REPORT

1.3.1 The report shall identify any special conditions found including but not limited to water depth, potential for erosion, expansive soil, corrosion potential and any other special conditions found during the testing.

1.3.2 The report shall provide recommendations for foundations, grading, subgrade and paving. The pavement design may be included in the report or submitted by the design Engineer.

2.0 EXISTING UTILTIES

2.1 GENERAL

2.1.1 Existing utilities shall be shown on the drawings in accordance with available data. The exact locations shall be determined by each Contractor as the Work proceeds. All work shall be done carefully so as to avoid damaging the existing utilities and Work. The Contractor shall be responsible for locating, or having located, all utilities, whether shown or not on the plans or in the specifications.

2.1.2 Each Contractor shall provide for protection, temporary removal and replacement or relocation of obstructions as required for the performance of the Work.

2.1.3 Other obstructions not shown on the plans and requiring relocation shall be exposed by the Contractor without injury; or if injured, shall be repaired by Contractor at his expense. Removal of such obstruction or its relocation shall be made by the Contractor at no cost to the City.

2.2 UTILITY CONTACT

2.2.1 In accordance with South Dakota state law, no excavator may begin any excavation without first notifying the One-Call Notification Center at 1-800-781-7474 of any proposed excavation.

2.3 UTILITY REPAIR

2.3.1 When an existing utility is exposed or damaged, the Contractor shall comply with the repair requirements of the affected utility.

2.3.2 When an underground utility is exposed, the Contractor shall compact the backfill beneath the exposed utility before completion of the backfill operation.

3.0 SEWER AND WATER MAIN SEPARATION

3.1 Water mains shall be separated from gravity sanitary and storm sewer lines, manholes and inlets by a horizontal distance of at least 10 feet, measured edge to edge, unless the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer line and at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer line.

3.2 When it is impossible to obtain horizontal (10 feet) or vertical (18 inches above the sewer main) separation, the sewer line must be relaid and constructed with pipe equivalent to water main standards of construction and shall be pressure-tested to assure water tightness before backfilling.

3.3 Water mains shall be laid to provide a horizontal distance of at least 25 feet from any septic tank, seepage pit, absorption field, stabilization pond or lagoon.

3.4 When conditions prevent this separation, the water line must be encased in PVC, Ductile iron or cast iron for the 25 feet of separation. The encasement material be adequately sealed with a flexible end seal.

3.5 Water mains crossing above any sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer and one full length of water pipe must be located so both joints will be as far from the sewer as possible.

3.6 A non-perforated sewer main may cross above a water main if the minimum vertical separation of 18 inches is provided, the sewer main material is of acceptable water main pipe quality and is a continuous piece at least 20 feet in length, and the length of water pipe is located so both joints are as far as possible from the sewer main. Adequate structural support must be provided for the sewers to prevent excessive deflection of joints and settling on and breaking the water mains.

3.7 A water main may cross either above or below a non-perforated sewer line with a vertical separation of less than 18 inches if either the water or sewer line is encased (as per Paragraph 1.3.4) for at least 10 feet each side of the crossing. Adequate structural support must be provided for the sewers to prevent excessive deflection of joints and settling on and breaking the water mains.

3.8 Storm sewer lines may be installed closer than the required 18-inch vertical separation and the 10-foot horizontal separation provided the storm sewer line is constructed as follows:

3.8.1 In lieu of the encasement of the watermain as specified in Paragraph 1.3.4, each joint of the storm sewer within ten (10) feet of the watermain may be sealed using a butyl rubber sealant meeting federal specification #SS-S-21OA and AASHTO M-198, and each joint is encased with a two (2) foot wide by six (6) inch thick concrete collar centered on the joint. The band shall be reinforced with the equivalent steel area as that in the RCP.

3.8.2 Each joint of the storm sewer within ten (10) feet of the water main is sealed using a rubber "O"-ring gasketed joint capable of passing a low pressure (5 psi) air test.

3.9 There shall be at least a 10-foot horizontal separation between water mains and sanitary sewer force-mains. There shall be an 18-inch vertical separation at crossings as required in Paragraphs 1.3.5 and 1.3.6.

SECTION 200

SITE GRADING

1.0 GENERAL

1.1 New developments shall be graded such that storm water runoff is directed away from building sites to existing or proposed drainage ways, public rights-of- way or to other drainage routes approved by the City.

1.2 Storm water runoff shall not be allowed to drain to another property with higher volume or with greater velocity than what occurred in the natural condition of the pre-developed site.

1.3 The Owner and Contractor shall follow all federal, state and local laws concerning storm water runoff.

1.4 The Developer shall design for storm water runoff from adjacent properties that slope toward the site. The design shall be sized for the amount of runoff that would occur from the adjacent property in a fully developed state.

2.0 SUBDIVISION GRADING

2.1 All lots in the subdivision shall be generally graded for rear to front drainage unless otherwise approved by the City Street Superintendent.

2.2 Elevations shall be shown on the grading plans for all lot comers and each high or low point along the property lines and streets. Flow direction and location of inlets and ditches shall be indicated on the plans by arrows.

2.3 Elevations shall be on the datum established by the USGS.

2.4 A slope of four feet horizontal to one-foot vertical shall not be exceeded unless otherwise authorized by the City.

2.5 No filling will be allowed in any wetland or within the flood plain of any river, creek, lake or stream without a permit granted by the U.S. Corps of Engineers.

3.0 CLEARING AND GRUBBING

3.1 GRUBBING

3.1.1 On areas required for construction of embankments, all stumps, roots, etc., shall be removed to a depth of at least one foot below the existing ground surface.

3.1.2 On areas required for borrow sites and material sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used on construction.

3.1.3 On areas of excavation, all stumps, roots, etc., shall be removed to a depth of at least one foot below the top of the subgrade.

3.1.4 Stump holes and other holes from which obstructions have been removed shall be backfilled and compacted in accordance with the requirements of the applicable Design Standards dealing with the excavation, backfill, embankment and compaction in the areas affected.

3.2 CLEANING OF THE SITE

3.2.1 All materials cleared and grubbed shall be disposed of by the Contractor at a location acceptable to the street or utilities superintendent.

3.2.2 All trees, shrubs, brush, and other vegetation shall be removed and disposed of on a daily basis.

3.2.3 Before the work will be considered complete, the Contractor must remove all surplus materials, tools, equipment, weeds, brush, rubbish, stumps, or other objectionable materials, leaving the site of the work and all portions of the finished work clean, unobstructed and ready for use.

3.3 DISPOSAL

3.3.1 Materials and debris shall be removed from the project site and disposed of at locations acceptable to the city of Crooks. The Developer or Contractor shall be required to locate a disposal site and must obtain and file with the City permission in writing from the property owner or owners for the use of private property for disposal purposes. Any disposal shall be subject to final approval by the City, given in writing, prior to any work being done at the location under con sideration. The Contractor shall comply with all applicable federal, state, and local laws, ordinances, and regulations governing the disposal of solid wastes.

3.3.2 All perishable material shall be removed from the site. If burned, it shall be under the constant care of competent workmen and in such a manner that the surrounding vegetation and adjacent property is not jeopardized. The Contractor will be responsible for compliance with all federal, state, and local laws and regulations applicable to burning and controlling fires.

3.3.3 Prior to approval of project completion, the Contractor shall obtain and furnish to the City a lien waiver or a letter of satisfaction written by the property owner of the disposal area and addressed to the Contractor.

SECTION 300

BURIED UTILITY INSTALLATION

1.0 GENERAL

1.1 All material encountered shall be excavated to the lines and grades shown on the plans or as set by the Engineer.

1.2 Trenches for force main and water main shall be of a depth that will provide a minimum cover of 72" below the proposed finished grade or street subgrade if the finished ground will not be completed during the same construction season that it is started.

1.3 Where pipe elevation is determined by minimum depth only, the excavation shall be sufficient at all points to grade the pipes on the tangents and vertical curves as dictated by the minimum bending radius of the pipe and fittings as recommended by the manufacturers.

1.4 The trenches shall be sufficiently straight between designated angle points to permit the pipe to be laid true to line in the approximate center of the trench.

1.5 Intersections with and crossings of other underground utilities shall be in accordance with applicable state and local laws and regulations and the requirements set forth in Chapter 2 for Sewer and Water Main separation.

1.6 The areas immediately adjacent to the trench shall be graded as required to prevent surface water from entering the trenches.

2.0 ROADWAY CROSSINGS

2.1 At such roadway and all other crossings as may be designated by the street superintendent, the trenches are to be mechanically tamped and filled in such a manner as to prevent any serious interruption of traffic upon the roadway or crossing.

2.2 Not more than one street or road crossing may be obstructed by the same trench at any one time except by permission of the City.

3.0 ROCK EXCAVATION

3.1 When rock is encountered in a trench, excavation shall be completed to a minimum of eight (8) inches below and on each side of all pipes, valves, fittings and other appurtenances.

3.2 Excess excavation shall be backfilled with compacted material conforming to the bedding material required for the type of material being installed.

4.0 DEWATERING

4.1 Where water is encountered in a trench, water shall be removed by pumping to lower the water level to such elevation that the pipe may be laid dry at the grade shown on the plans.

4.2 All water pumped from the trench shall be disposed of in a manner so as not to cause any damage to adjacent property.

4.3 In the event the water from the dewatering procedures can reach the waters of the state, a general dewatering permit shall be required. To obtain information on the general dewatering permit the Contractor should contact the South Dakota Department of Agriculture and Natural Resources at (605) 773-5559.

5.0 TRENCH BOTTOM PREPARATION

5.1 The sides of all trenches shall be vertical from the bottom of the trench to a point one (1) foot above the top of the pipe.

5.2 The width of the trench shall be greater than six (6) inches but less than twelve (12) inches on each side of the pipe bell.

5.3 The bottom of all trenches for underground piping shall be carefully and accurately formed to the lines and grades as shown on the plans prepared by the Engineer or as specified herein.

5.4 Removal of rock, boulders, and large stones, or other manmade material shall be completed in accordance with Paragraph 6.3 "Rock Excavation".

5.5 If the trench bottom is inadvertently excavated deeper than necessary, it shall be backfilled to the proper grade with compacted bedding material.

5.6 Whenever wet, soft or unstable soils incapable of properly supporting the pipe, or other appurtenances are encountered in the trench, the Contractor shall be required to remove the unsuitable materials and backfill to the proper grade with concrete, granular material or other suitable approved material.

5.7 Backfill material installed to bring the trench bottom up to proper grade shall be compacted to a minimum density of 90% of maximum Standard Proctor Density (ASTM D698).

6.0 BACKFILLING AND COMPACTING

6.1 Any trenches improperly backfilled or showing excessive settlement shall be reopened to a depth required for proper compaction. Any additional settlement of the trench shall be brought back to grade with additional topsoil. The trench shall be left in a condition so as to present a neat appearance.

6.2 Backfill material shall be free of boulders, frozen clods, large roots, excessive sod or other vegetation, construction debris.

6.3 No backfilling shall take place in freezing weather without written permission from the City.

6.4 Bedding material for all sanitary sewer pipes shall be 1/4 inch to 3/4 inch clean angular, crushed rock with the following gradation requirements:

- 95% passing 3/4-inch sieve
- 95% retained in the No. 4 sieve and well graded

Bedding material for water main shall be pea rock or a clean, dry sand meeting the following gradation. Water main bedding material will be used for both PVC and ductile iron water main.

- Minus 1-inch with not more than 10 percent passing the No. 200 sieve.

Bedding material for Storm Sewer shall be Class I or Class II materials meeting the following gradation. Bedding material depth shall vary based on pipe material and shall follow manufacturer recommendations.

- Class I: Crushed rock or gravel, 100% passing 1 1/2" sieve, <5% passing #200 sieve
- Class II: Coarse grained soils includes sand, 100% passing 1 1/2" sieve, <5% passing #200 sieve

6.5 The embedment material above the bedding material shall be finely divided material free from debris, organic material, and clods, lumps or stones larger than 1-1/2 inches maximum diameter. The material shall be borrowed material or job site excavated material. Embedment material shall be placed in uniform layers not more than eight inches (8") thick and compacted to 95% maximum density as determined by ASTM D698 until the pipe has a cover of not less than one foot (1').

6.6 Trench stabilization material for all utility trenches where necessary shall be 3/4 inch to 4 inches crushed angular, well graded material. Larger material may be used if necessary and required to stabilize the bottom of the trench.

6.7 The remainder of the backfill above the embedment material shall consist of selected material from excavation or borrow, and shall be free from cinders, ashes, refuse, organic and frozen material, boulders or other materials that are unsuitable. This material shall be placed from 12 inches above the top of the pipe to 6 inches below the ground surface, unless otherwise specified, or to the subgrade elevation for streets or paved surfaces. Under no circumstances shall backfill material that is placed within two feet of the top of the pipe be allowed to contain stones, rocks or other solid debris that is greater than three (3) inches in size.

6.8 After completing the bedding and embedment of the pipe as specified, the remainder of the backfill material shall be placed in uniform layers not exceeding one foot (1') in thickness and tamped. It shall be the Contractor's responsibility to compact each layer throughout its entire depth to at least 95% of the maximum obtainable density at optimum moisture as determined by a Standard Proctor. The Contractor shall moisten or aerate the backfill material to obtain the required compaction. The upper 6-inch layer, forming the subgrade for surfacing shall be . compacted to at least 97% of the maximum density obtainable at optimum moisture content for flexible pavements and to at least 90% of the maximum density obtainable at optimum moisture content for rigid pavements and gravel. Density of backfill shall be determined based on Standard Proctor Test, ASTM Test Designation D698.

7.0 EXCESS EXCAVATION

7.1 The Contractor shall be responsible for securing and maintaining an adequate area where excess excavation can be stockpiled for future use or wasted.

7.2 The City's approval on the site selection will be required.

7.3 The Contractor shall be responsible for the final cleanup of the site chosen. The site shall be cleaned to the satisfaction of the property owner, and a lien waiver or a letter of satisfaction written by the property owner and addressed to the Contractor shall be obtained by the Contractor and furnished to the City.

8.0 TOPSOIL

8.1 All lawn and boulevards areas shall be left smooth with a minimum of 4" of compacted black dirt throughout the entire area disturbed by the trench.

8.2 All topsoiled areas and other non-paved areas disturbed by construction activities shall be reseeded to the full width and length of areas disturbed during construction.

8.3 Prior to topsoiling and finish grading, all rough grades shall be corrected, adjusted and brought to the required elevations.

8.4 The subgrade surface shall be prepared for topsoiling by cross-discing to a depth of two (2) inches or more to permit bonding of the topsoil to the subgrade.

8.5 All stones and other debris greater than two (2) inches in any dimension shall be removed from the surface of the subgrade prior to the placement of the topsoil.

8.6 Topsoil material shall not be placed when the topsoil or subgrade is frozen or wet enough to cause clodding.

8.7 Topsoiling operations shall be considered complete when the finished surface is smooth and true to required grades with a maximum allowable deviation of 0.1 foot and free of sticks, stones and other material one (1) inch or more in any dimension.

SECTION 400

ROAD CROSSINGS

1.0 GENERAL

1.1 All pipelines, conduit, and casing pipe installed within federal, state, or county highway right-of-way shall conform to the most recently adopted codes for the system involved, the State Accommodation of Utilities Policy, and all permits required by federal, state and local authorities.

1.2 Road crossings shall be located so as to cross tracks or highways approximately at right angles. In no case shall the crossing be less than 45 degrees to the centerline unless prior written authorization is obtained from the authority having jurisdiction over the area. The location shall be such so as to not restrict drainage, endanger existing structures or interfere with maintenance or reconstruction procedures.

1.3 All topsoil shall be saved and replaced upon completion of the crossing.

2.0 STEEL CASING

2.1 Steel casing pipe shall conform to ANSI Specification 836.10 and shall have a minimum yield strength of 35,000 psi. Minimum casing dimensions shall be in accordance with the following:

CARRIER PIPE DIAMETER (Inches)	CASING MINIMUM INSIDE DIAMETER (Inches)	CASING MINIMUM WALL THICKNESS (Inches)
2	6	0.188
4	10	0.188
6	12	0.188
8	16	0.188
10	18	0.188
12	20	0.188
14	22	0.282
15	24	0.282
16	24	0.282
18	26	0.313
20	28	0.344
21	30	0.375
22	30	0.375
24	32	0.407
26	34	0.438
28	36	0.469
30	38	0.469
32	40	0.501
34	42 .	0.532 . - ..,,

Need to verify sizes before submitting.

2.2 CASING SPACERS

2.2.1 Casing spacers shall be constructed of semi-circular stainless-steel bands which bolt together forming a collar around the carrier pipe. The spacers shall be designed with risers (when needed) and runners to support and center the carrier within the casing and maintain a minimum clearance of 0.50" between the casing 1.0. and the spacer 0 .0 . Each spacer shall have four riser and runner combinations -- two on each band. Type 304 stainless steel bolts and nuts shall be provided with the spacers.

2.2.2 The bands shall be manufactured of 8" wide, 14-gauge 304 stainless steel. The risers shall be constructed of 304 stainless steel having a minimum length of 6".

2.2.3 Abrasion resistant runners, having a minimum length of 7" and a minimum width of 1", shall be attached to each riser to minimize friction between the casing pipe and the carrier pipe as it is installed. Runners shall be made of ultra-high molecular weight polymer which has a low coefficient of friction. The ends of all runners shall be beveled to facilitate installation over rough weld beads or the welded ends of misaligned or deformed casing pipe.

2.2.4 Interior surfaces of the stainless-steel collar shall be lined with PVC or EPDM having a minimum thickness of 0.090" with a hardness of durometer "A" 85-90.

2.2.5 Recommended spacing of the spacers is one placed a maximum of one foot on each side of the bell joint and one placed every 8 to 12 feet apart thereafter.

3.0 BORED AND CASED ROAD CROSSING

3.1 Casing pipe shall be installed by boring or jacking with distance to the headers conforming to permit and/or code requirements. When pipes are installed by the boring method, the pipe must be jacked through the soil as the soil is removed by the auger. Installing pipe through pre-bored holes is not permitted. Removal of material from the bored hole by washing or sluicing is not permitted.

3.2 The casing pipe shall be uniform in alignment and grade.

3.3 The carrier pipe shall be protected within the casing pipe by casing spacers securely attached to the carrier pipe. The number of spacers per length of pipe shall be as per the manufacturer's recommendations.

3.4 Care and precautions are to be taken to prevent excessive belling or seating of the carrier pipe during installation.

4.0 BORED AND UNCASED ROAD CROSSING

4.1 Carrier pipe shall be installed by boring or jacking with distance to the headers conforming to permit and/or code requirements. The boring diameter shall be adequate to install the carrier pipe. Removal of material from the bored hole by washing or sluicing is not permitted.

4.2 The carrier pipe shall be uniform in alignment and grade.

4.3 Care and precautions are to be taken to prevent excessive belling or seating of the carrier pipe during installation.

4.4 Joints shall be allowed under the paved portions of the road only where the road width exceeds the nominal length of the carrier pipe being installed.

5.0 BACKFILL AND COMPACTION

5.1 The backfill and compaction of jacking and receiving pits shall be completed in accordance with the requirements of Chapter 6, "Buried Utilities".

SECTION 500

PAVING AND SURFACING

1.0 GENERAL

1.1 The following design criteria, technical criteria and specifications shall be used in the preparation of plans for streets in the City of Crooks.

1.2 Street lane widths shall be designed to conform with the City's Design Standards and subdivision regulations.

2.0 SIDEWALKS

2.1 Concrete sidewalk shall be installed at locations and with the dimensions and thickness as shown on the plans or as designated by the Engineer. Concrete sidewalks shall be at least four (4) inch thick concrete placed on a 3-inch compacted gravel cushion.

2.2 Handicapped ramps are required by state law at all intersections when sidewalk is being installed. Handicap ramps shall be installed to conform with current ADA regulations. Detectable warning panels shall be installed in all ramps.

2.3 Contraction joints shall be provided at intervals of not more than five (5) feet. Contraction joints shall consist of a groove with a depth of at least 25% of the thickness of the concrete section. The groove shall be at least 1¼ inch deep sawed in the green concrete or formed by inserting a removable metal template.

2.4 The surface of the concrete sidewalk shall be finished to a light broom finish.

2.5 The minimum width of a sidewalk shall be four (4) feet unless otherwise approved by the City street superintendent.

2.6 The Owner shall comply with the city ordinances regarding requirements of where and under what conditions sidewalk will be required to be installed.

3.0 CONCRETE CURB AND GUTTER

3.1 Curb and gutter shall be installed to a normal standard 6" top of curb 12" deep at the back of curb with an 30" wide pan which is 6" deep at the curb face, with non-reinforced concrete on a compacted gravel base.

3.2 In the event a joint is encountered within 5 feet of the new curb and gutter, the existing curb and gutter shall be removed to the joint.

3.3 Expansion joints shall be placed at changes in direction and at intervals not greater than 150 feet. Expansion joints shall be 1/2 inch wide, filled to within one inch of the surface with bituminous expansion joint material cut to the shape of the curb section. Smooth dowels shall be placed across expansion joints as shown on the drawings or as directed. One end of the dowels shall be smooth and greased or furnished with a plastic sleeve to allow lateral movement of the curb and gutter.

3.4 Contraction joints shall be provided at intervals of not more than 10 feet. Contraction joints shall consist of a groove at least 1-1/4 inches deep sawed in the green concrete or a plane of weakness formed by inserting a removable metal template.

3.5 All expansion joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

3.6 All exposed edges of curbs and gutter shall be rounded with a suitable edging tool. Exposed surfaces shall be finished smooth and even with a steel trowel, and then given a light broom finish.

4.0 CONCRETE FILLET SECTIONS

4.1 Concrete curb and fillet sections shall be installed at locations and with the dimensions as shown on the plans or as designated by the Engineer. The concrete fillet section shall be reinforced as shown on the plans and placed on a compacted gravel base.

4.2 The surface of the concrete fillet sections shall be finished to a light broom finish.

4.3 Dowels shall be placed across expansion joints as shown on the drawings or as directed. One end of the dowels shall be smooth and greased or furnished with a plastic sleeve to allow lateral movement of the curb and gutter.

5.0 CONCRETE VALLEY GUTTER

5.1 Concrete valley gutter sections shall be installed at locations and with the dimensions as shown on the plans or as designated by the Engineer. Concrete valley gutters shall be six (6) inch thick reinforced concrete placed on a compacted gravel base of not less than five (5) inches in depth. 5/8" smooth dowels shall be placed across expansion joints. One end of the dowels shall be smooth and greased or furnished with a plastic sleeve to allow lateral movement of the valley gutter.

5.2 Expansion joints shall be placed at ends of the valley gutter between the valley gutter and concrete fillet sections. Expansion joints shall be half inch wide, filled to within 5/8 inch of the surface with bituminous expansion joint material cut to the shape of the concrete section. Dowels shall be placed across expansion joints as shown in the plans or as directed by the engineer.

5.3 Contraction joints shall be provided at intervals of not more than ten (10) feet. Contraction joints shall consist of a groove with a depth of at least 25% of the thickness of the concrete section. The groove shall be sawed in green concrete or formed by inserting a removable metal template.

5.4 The surface of the concrete valley gutter shall be finished to a light broom finish.

6.0 DRAINAGE

6.1 Inlets. Inlets shall be installed whenever the city's storm sewer system is reasonably accessible. Inlets shall be installed in low points of the street and at the point where the curb flow capacity is exceeded. Because of handicap ramps, inlets will not be allowed in the curb return but may be placed at the tangent points to intercept runoff before it reaches the crosswalk.

6.2 Sidewalk Trench Drains. Concentrated points of discharge shall not be allowed to flow over the sidewalk. The Owner shall install trench drains (or chases) at all such locations or otherwise alter the route of the concentrated flow to the street or inlets.

7.0 TESTING RESPONSIBILITIES

7.1 The Owner shall secure the services of a qualified testing firm to conduct such tests as appropriate to determine general conformance and compliance with these specifications. The results of the tests shall be submitted to the city for review.

7.2 The testing firm shall conduct tests to determine in-place moisture and density of the roadway granular base course.

7.3 The testing firm shall conduct testing and process control in the production of the mineral aggregate materials.

7.4 The testing firm shall perform testing of the asphalt material.

7.5 The Contractor shall be responsible for the preparation of the asphalt concrete mix design for the material to be furnished. A new mix design shall be prepared when the mineral aggregate source or quality changes or when the asphalt material is changed.

7.6 The testing firm shall conduct in-place density tests of the asphaltic concrete mix after it has been placed and compacted using nuclear density testing machines.

7.7 Portland cement concrete tests shall be conducted by the testing firm to determine slump, entrained air and compressive strength.

7.8 A copy of each field test taken shall be submitted to the City.

8.0 GRANULAR MATERIAL FOR BASES AND SURFACING

8.1 The aggregate for granular bases and surfacing shall conform to Section 882 of the latest edition of the SD DOT Standard Specifications for Roads and Bridges unless otherwise authorized by the City of Crooks. See Table 1 Below

Table 1

	Sub-base	Base Course	Surfacing	Cushion
Processing Required	Crushed	Crushed		Crushed
	PASSING PERCENT BY WEIGHT			
2" Sieve	100	----		-----
1" Sieve	70-100	100	-----	-----
¾" Sieve	------	80-100	100	100
½" Sieve	------	68-91	-----	------
No. 4 Sieve	30-70	46-70	50-78	50-,75
No. 8 Sieve	22-62	34-58	37-67	38-64
No. 40 Sieve	10-35	13-35	13-35	15-35
No. 200 Sieve	0-15	3-12	4-15	3-12
Liquid Limit Max	------	25	-----	25
Plasticity Index	0-6	0-6	4-12	0-6
L.A. Abrasion Test Loss Maximum	50	40	40	40

8.2 The amount of crushed particles in the crushed rock shall consist of not less than 25% of the total weight. A crushed particle shall be defined to be a fragment of stone showing at least one freshly fractured face. The crushed rock produced for use in making the mineral aggregate shall contain at least 30% but not more than 50% by weight of air-dried material retained on a ¼ inch square opening sieve.

8.3 The sampling and testing of the materials shall be done in accordance with the following methods and procedures:

	Test Procedure
Sampling	SD 201
Gradation	SD 202
Liquid Limit and Plasticity Index	SD 207
L.A. Abrasion Test	ASSHTO T96
Crushed Particle Test	SD 211

9.0 ASPHALTIC CONCRETE

9.1 The physical characteristics and quality of the aggregate material shall conform to the specifications for Class G, Type 1 for the base course and Class G Type 2 for the surface course of asphalt thicknesses greater than 2 inches and Class G Type 1 for a 2-inch-thick mat placed in a single lift. The aggregate materials shall conform to those specified in Table 1, Section 880 - Aggregate for Asphalt Concrete in the latest edition of the South Dakota Department of Transportation Standard Specifications for Roads and Bridges and revisions thereto.

9.2 The aggregate retained on the No. 4 sieve shall contain at least fifty (50) percent by dry weight of crushed pieces having two (2) or more surfaces produced by fracture.

9.3 Asphalt used for prime coat of the base material shall be MC-70

9.4 conforming to AASHTO M-82 or RC-250 conforming to AASHTO M-81. Prime will not be required on street with curb and gutter on both sides of the roadway.

9.5 The asphaltic concrete bituminous material shall meet the requirements of AASHTO Specifications. Unless otherwise approved by the City the _asphalt cement shall be performance grade 64-22. The material shall meet the negative spot test as specified in AASHTO Methods.

9.6 The asphalt concrete shall be compacted on all areas until it has been compacted to not less than 95% of the maximum density as determined by the Marshall Method (Test Procedure SD 313).

10.0 PORTLAND CEMENT CONCRETE

10.1 The materials to be used for the Portland cement concrete shall conform to Section 750 through Section 821, Section 860, Section 870 and Section 1010 of the latest edition of the South Dakota Department of Transportation Standard Specifications for Roads and Bridges, and revisions thereto.

10.2 The 28-day compressive strength shall not be less than 4,000 psi.

11.0 PAVEMENT MARKING

11.1 Pavement marking paint shall be of standard quality typically used on state highway projects in the State of South Dakota.

11.2 Painting materials shall be furnished ready to use without thinning, diluting or other modifications required or allowed.

11.3 Paint shall dry to a consistency that will allow traffic to drive on it without damage to or pickup within 20 minutes of application.

11.4 Centerline and parking space striping shall be four (4) inches wide and cross walk and stop bar marking shall be twenty-four (24) inches wide unless otherwise approved by the street superintendent. In place width shall be as specified with a tolerance of +/- 1/8 inch on four-inch markings and +/- ¼ inch on twenty-four-inch markings.

11.5 Pavement marking and striping shall be applied by machine. On special areas and markings that are not adaptable to machine application, hand application will be permitted.

11.6 Paint shall be as furnished by the manufacturer. The paint shall be thoroughly mixed in the original container before it is transferred to the tank of the spraying equipment. Filling tanks, pouring paint or cleaning equipment shall not be allowed on the pavement.

11.7 Pavement marking shall be applied during daylight hours when the ambient air temperature is above 45 degrees F and the pavement surface is dry. The pavement shall be cleaned of dirt, loose stones and other foreign material before the paint is applied.

SECTION 600

WATER DISTRIBUTION

1.0 WATER MAINS

1.1 WATER MAIN PIPE

- Water main pipe 4-inches in diameter and greater shall be ductile iron or polyvinyl chloride (PVC) with a gasket joint. PVC pipe shall have a minimum sustained working pressure of 235-pounds per square inch (psi) (or project requirements, whichever is greater) with a minimum cover of 6-feet. Ductile Iron Pipe shall be designed for a minimum 150-psi (or project requirements, whichever is greater) rated working pressure. Pipe classes shall be as follows:

Pipe Size (inches)	Ductile Iron Pressure Class	PVC
4	350	C900 DR 18
6	350	C900 DR 18
8	350	C900 DR 18
12	350	C900 DR 18
16	250	C905 DR 18
20	250	C905 DR 18
24	200	C905 DR 18
30	150	C905 DR 18

- Gaskets for all ductile iron pipe shall meet the requirements of the pipe manufacturer. Sealing pipe joints for all AWWA C900 pipe shall use the Rieber joining system, which has the gasket formed into the pipe during the pipe manufacturing process. All gaskets shall meet NSF/ANSI Standard 61– Drinking Water System Components, Health Effects.

  Special gaskets will be required for all piping systems noted below:

  Soils contaminated with gasoline: use nitrile gaskets.

  Soils contaminated with volatile organic compounds, use fluorocarbon gaskets.

1.2 DUCTILE IRON PIPE

- All ductile iron pipe shall be manufactured in full conformance with the most current edition of ANSI/AWWA C150 and C151 standards. All ductile iron pipe shall meet NSF/ANSI Standard 61—Drinking Water System Components, Health Effects and, NSF/ANSI 372.

- Ductile iron pipe shall be lined with cement mortar (Portland cement) and shall be manufactured in full conformance with the most current edition of AWWA C104 standards. The thickness of linings shall be not less than the following: 1/16-inch for 6- to 12-inch pipe, 3/32-inch for 16- to 24-inch pipe and 1/8-inch for 30- to 60- inch pipe. A plus tolerance of 1/8-inch in thickness will be permitted. Linings shall be full thickness to the end of the spigot and to the seat of the bell, or shall be tapered for a length of not more than 2-inches.

- Ductile iron pipe shall be coated on the outside with bituminous coating at least one nominal mil in thickness

- The exterior of ductile iron pipe shall be coated with a layer of arc-sprayed zinc per ISO 8179-1. The mass of the zinc applied shall be 200 g/m2 of pipe surface area. A finishing layer topcoat shall be applied to the zinc. The coating system shall conform in every respect to ISO 8179-1 “Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer.” The bituminous coating shall then be applied as specified over the zinc coating. Pipe shall clearly be marked as zinc coated pipe meeting the specified requirements.

- The City or City’s engineering representative have the authority to reject any pipe they deem damaged or scratched. Zinc coating repair requirements shall meet the requirements of Section 4.3 and 4.5 of the ISO 8179-1. Approved zinc coating repair products are Tnemec Zinc Series 90-98, Sherwin Williams Corothane Galvapac 1k Zinc Primer or approved equal.

- Where direct buried ductile iron restrained joint pipe is shown on the plans, pipe shall be furnished with boltless, flexible, push-on restrained joints such as Fastite Pipe with Fast Grip Gaskets or Flex-Ring by American Ductile Iron Pipe, Tyton Joint Pipe with Field-Lok or Field-Lok 350 restrained joint gaskets by U.S. Pipe or prebid Engineer-approved equal. Field-adaptable restrained joints may be provided for pipe 24-inches in nominal diameter and smaller through the use of Fast-Grip Gaskets by American Ductile Iron Pipe, Sure Stop 350 Gaskets by McWane, or prebid Engineer-approved equal.

- Where ductile iron pipe is installed in trenchless, pipe bursting, directional drilling, or other applications where soil load and friction is limited or the pipe is subject to dynamic movement after the pipe systems are assembled, pipe shall be furnished with boltless, flexible, push-on restrained joints such as Flex-Ring by American Ductile Iron Pipe, TR Flex by U.S. Pipe, or prebid Engineer-approved equal.

1.3 POLYVINYL CHLORIDE PIPE

- All PVC shall be manufactured in full conformance with the most current edition of AWWA C900-16 Standards. All PVC pipe shall meet NSF/ANSI Standard 61–Drinking Water System Components, Health Effects and, NSF/ANSI 372.

- For identification purposes all pipe shall be marked with the following: Nominal pipe size, material code designation, SOR, pressure rating, manufacturer's name or trademark, NSF seal and ASTM numbers.

- Where PVC restrained joint pipe is shown on the plans, pipe shall be furnished with boltless, flexible, push-on restrained joints such as Diamond Lok, JM Eagle, Certa Lok, RieberLok or prebid Engineer-approved equal.

- Gasket joint couplings used for plain end pipe shall have a pressure rating equal to the pipe on which used. Centering of pipe within the coupling will be assured by means of an integral positive stop in the coupling. All couplings must be of the double gasket type. Couplings requiring welds will not be allowed.

- All gasketed joints shall have a seating depth equal to at least 50% of the nominal pipe diameter.

- The ends of the pipe to be inserted into couplings or joints shall be factory marked to allow field checking of the depth of setting of the pipe in the joint socket.

- Fittings for use on PVC pipe shall be ductile iron fittings conforming to the requirements of Paragraph 9.3 below.

2.0 TRACER WIRE

2.1 The components of the tracer wire system shall be suitable for direct bury applications. The conductor shall be 12 AWG, solid-strand, soft-drawn copper per ASTM B-3.

3.0 POLYETHYLENE ENCASEMENT

3.1 Polyethylene encasement shall meet all the requirements for ANSI/AWWA C105/A21.5 and ASTM A674. Polyethylene shall be V-bio polyethylene encasement which shall consist of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than 8-mils.

3.2 The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

4.0 DUCTILE IRON FITTINGS

4.1 Ductile iron fittings shall conform to the requirements of ANSI Specifications A29.

4.2 Ductile iron fittings to be installed underground shall be mechanical joint or push-on joint type conforming to the requirements of ANSI A21.11 unless shown otherwise. Mechanical joint nuts and bolts shall be corrosion resistant, high strength allow conforming to AWWA C111. Bolts and nuts shall be COR- BLUE T-bolts and nuts as manufactured by NSS Industries, 304 stainless steel, or approved equal.

4.3 Ductile iron fittings to be installed in "non-buried" locations shall be provided with flanged joints with rubber full face gaskets. Flanged faces shall be drilled to standard 125-pound template unless otherwise noted.

4.4 All ductile iron fittings shall be lined with cement mortar in accordance with ANSI A21.4. the exterior finishes shall be a coal tar varnish coating not less than 1 mil. thick.

5.0 COUPLINGS

5.1 Couplings shall be gasketed, sleeve type of a diameter to properly fit the pipes being joined. Each coupling shall consist of one (1) steel sleeve, two (2) end ring followers, two (2) rubber compound gaskets and sufficient bolts to properly compress the gaskets to make a watertight coupling.

5.2 The sleeve shall be ASTM A53, ASTM 512 or carbon steel or ASTM 536 ductile iron with a minimum yield of 30,000 psi. The steel sleeve shall have a minimum wall thickness of one quarter (1/4) inch and a minimum length of seven (7) inches. The carbon steel sleeves shall be furnished with a fusion bonded epoxy with a minimum dry thickness of 12 mils suitable for potable water service. Ductile iron sleeves may be furnished with the manufacturer's standard shop coating or coal tar varnish coating.

5.3 The end rings shall be Ductile Iron, ASTM A536 or steel, AISI C1018, and of such design to provide confinement of the gaskets. The end rings shall be furnished with shop coat enamel finish.

5.4 The coupling bolts and nuts shall be corrosion resistant, high strength low alloy steel conforming to the requirements of AWWA C111. The manufacturer shall furnish information as to recommended torque for the proper tightening of the bolts.

5.5 Gaskets shall be minimum grade 30 gaskets composed of new crude or synthetic rubber base compounded with other products to produce a material which will not deteriorate from age, from heat, or exposure to air under normal storage conditions. It shall also possess the quality of resilience and ability to resist cold flow of the material so that the joint will remain sealed and tight indefinitely when subjected to shock, vibration, pulsation and temperature or other adjustments of the pipeline.

5.6 The couplings shall be assembled on the job in a manner to insure permanently tight joints under all reasonable conditions of expansion, contraction, shifting and settlement, unavoidable variations in trench gradient, etc. The coupling shall be Dresser, Style 38, as manufactured by Dresser Manufacturing Division; Rockwell, Style 411, as manufactured by Rockwell International; Ford, Style FC3, as manufactured by Ford Meter Box Company; or JCM Style 201 as manufactured by JCM Industries.

6.0 BEDDING MATERIAL

6.1 Bedding material for water main shall be pea rock or a clean, dry sand meeting the following gradation. Water main bedding material will be used for both PVC and ductile iron water main.

- Minus 1-inch with not more than 10 percent passing the No. 200 sieve.

7.0 SERVICE LINES

7.1 PIPE. Water service pipe to be installed between the new watermain piping and the property shall be a minimum of one (1) inch diameter 200 PSI polyethylene tubing or soft copper tubing with fittings to be brass or PVC.

7.2 SERVICE SADDLES. Service saddles shall be sized for the size and type of pipe being installed, shall be cast from 85-5-5-5 brass shall be Ford S70, Clow Twin Seal or equal approved by the utility superintendent.

8.0 SERVICE LINE VALVES

8.1 CORPORATION STOPS. Corporation stop valves shall be ball type valves as manufactured by Ford Meter Box Company, Inc., A.Y. McDonald Manufacturing or approved equal approved by the utility superintendent. Corporation stop valves shall conform to the requirements of AWWA C800 (latest revision) Standard for Underground Service Line Valves and Fittings. Inlet threads of the corporation stop shall be AWWA Type CC. Outlet connection shall be furnished with pack-joint connections appropriate for the service line material size and type to be connected to the valve.

8.2 CURB STOPS. Curb Stops shall be ball type valves as manufactured by Ford Meter Box Company, Inc. and shall conform to the requirements of AWWA C800 (latest revisions) Standard for Underground Service line Valves and Fittings. Valves shall be furnished with pack-joint type connections on both inlet and outlet. Pack-joint connections shall be appropriate for the service line material size and type to be connected to the valve. The valves shall be Minneapolis pattern.

9.0 SERVICE LINE VALVE BOXES

9.1 Valve boxes for service line valves shall be furnished for Minneapolis pattern. Valve boxes shall be manufactured by the manufacturer of the service line valve

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9.2 Valve boxes shall be furnished with 1 1/4" steel pipe upper section and cast iron base and lid. Boxes shall be coated with asphalt base paint. Valve box lids shall be provided with a pentagon head plug.

9.3 Valve boxes shall be furnished with stationary rods. stationary rods shall be attached to the curb stop operator by means of a cotter pin. Stationary rods shall be of sufficient length to extend from the curb stop/service line valve operator to the top of the box.

10.0 MISCELLANEOUS COUPLINGS

10.1 Couplings for water service pipe and tubing shall be brass body with pack-joint connections on both ends. Pack-joint connections shall be appropriate for the service line materials size and type to be connected.

10.2 Couplings shall be as manufactured by Ford Meter Box Company, Inc.

11.0 BURIED PIPING INSTALLATION

11.1 All piping and fittings shall be laid true to line and grade. Each section of pipe shall be so laid and fitted together that when complete the piping will have a smooth uniform flow line. The inside of all pipe shall be cleaned before installation and kept thoroughly clean during and after laying the pipe. Pipe ends shall be cleaned inside and outside.

11.2 All pipe and fitting shall be examined for defects before being lowered into the trench. The interior and exterior protective coating shall be inspected, and field repaired, if required and possible. All field repairs shall be in accordance with applicable standards. If repair is not possible, the defective pipe section shall be removed.

11.3 The pipe shall be handled and installed in accordance with manufacturer's recommendations and the requirements of AWWA C600 for ductile iron pipe, and the appropriate AWWA Standards for the type of pipe being installed.

11.4 When pipelaying is not in progress, including the noon hours, the open ends of pipe shall be closed. No trench water, animals, or foreign material shall be permitted to enter the pipe.

11.5 Bedding material shall be used with all piping (See Paragraph 9.5). After each pipe has been graded, aligned, and placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe joining and embedment operations.

11.6 The pipe shall be laid upon properly placed bedding material so that the barrel of the pipe will have a bearing for its full length. Bell holes and depressions for joints shall be excavated after the trench bedding has been graded.

11.7 The Contractor shall provide and maintain all necessary means and devices at all times to remove and dispose of all water entering the trench during the process of

pipelaying. The trench shall be kept dry until the pipelaying and jointing are completed.

11.8 Thrust blocks may be used in conjunctions with mechanical joint thrust restraints to restrain pressurized piping at all abrupt changes in direction, tees, bends, dead ends and hydrants, and shall be in accordance with the pipe manufacturer's recommendations.

12.0 THRUST RESTRAINTS

12.1 GENERAL

- A combination of one or more thrust restraint devices such as thrust blocks, anchors and mechanical retainers shall be furnished at locations including , but not limited to, tees, elbows, hydrants, cleanouts, dead ends.

- DUCTILE IRON PIPE ANCHORS

  12.1.1 Ductile iron pipe anchors shall be ductile iron mechanical joint retainer glands: American Cast Iron Pipe Company, A-90857; Clow Corporation, F-1058 ; or approved equal.

  12.1.2 Restrained joint pipe may be used in lieu of the anchors described above. Pipe joints shall be Clow Corporation , F-128 Super- Lock joint, U.S. Pipe TR-FLEX restrained joint or approved equal.

- PVC PIPE ANCHORS

  12.1.1 Anchors for PVC pipe shall be designed for use on manufacturers' standard PVC Class 125, 160 and 200 pipe with outside diameters similar to steel pipe.

  12.1.2 Anchors for PVC pipe shall be Ford harness assemblies as manufactured by Ford Meter Box company, Wabash, Indiana; Uni-Flange Corporation, Northboro, Maine; or approved equal.

- THRUST BLOCK INSTALLATION

  12.1.1 The thrust blocks shall be constructed and/or placed so that the bearing surface is in direct line with the major force created by the pipe or fitting.

  12.1.2 The cast-in -place thrust blocks shall be constructed by pouring concrete between the fitting and the undisturbed trench shall be the bearing surface.

  12.1.3 If the character of the soil is such that adequate bearing may not be obtained, as proven by the calculations required in 1.03, mechanical thrust restraint and anchors shall be provided.

  12.1.4 The concrete shall not be allowed to cover the bolts of any fitting or anchor.

12.1.5 Precast concrete slabs will be allowed as thrust blocking when used in conjunction with mechanical thrust restraints.

13.0 ANCHORS

13.1 Where necessary, anchors shall be installed per the applicable AWWA standards and the manufacturer's recommendations.

14.0 MECHANICAL THRUST RESTRAINT

14.1 Mechanical thrust restraints shall be installed at all locations including, but not limited to those listed in Paragraph 10.1.1.

15.0 MECHANICAL JOINTS AND COUPLINGS

15.1 Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled or replaced. Overtightening bolts to compensate for poor installation practice will not be permitted.

15.2 The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top (or side for vertical piping) centerline. The top (or side) centerline shall be marked on each flange and mechanical joint piece at the foundry.

16.0 WATER MAIN VALVES

16.1 Gate valves shall be resilient wedge type manufactured to meet all applicable requirements of AWWA Standard for Resilient Seated Gate Valve C509. Gate valves shall be furnished with mechanical joint connections. Bolts and nuts shall be corrosion resistant, high strength alloy conforming to AWWA C111. Bolts shall be COR-BLUE T-bolts as manufactured by NSS Industries, 304 stainless steel, or approved equal.

16.2 All valves, unless otherwise specified shall have non-rising stems, opening by turning left and provided with 2 inch "square" nut with arrow cast in metal to indicate direction of opening.

16.3 Cast iron wedge shall have sealing surfaces of the wedge permanently bonded with resilient material to meet ASTM tests for rubber to metal bond ASTM 0 429-73. Each valve shall have a smooth unobstructed waterway free from any sediment pockets. Stuffing boxes shall be O Ring seal type with 2 rings located in stem above thrust collar. Low friction torque reduction thrust bearings shall be located both above and below the stem collar.

16.4 Body and cover bolts and nuts shall meet Specification ASTM A-307 and are suitably rustproofed. Exterior shall be asphalt varnish applied per Federal Specification TT-V-51-E. Interior shall be two-part thermo-setting, non-toxic epoxy which is safe for potable water. Interior coating shall conform to AWWA C550

(latest revision) Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

16.5 Non-rising stems shall be in full compliance with AWWA specification with cast integral stem collar and furnished of bronze conforming to ASTM 8584. Stem nuts shall be independent of wedge and shall be made of solid bronze conforming to ASTM B 62.

16.6 Valves shall have hydrostatic shell test of 400 psi and shut-off test of 200 psi. At the 200-psi shut-off test, valve must be bubble-tight with a zero (0) leakage allowance.

16.7 Resilient wedge gate valves shall be the product of a manufacturer having a minimum of five (5) years' experience in the manufacture of water works and distribution valves. Resilient wedge gate valves shall be as manufactured by American Darling Valve Co., Birmingham, Alabama; Mueller Company, Decatur, Illinois; Clow Valve Division, Oskaloosa, Iowa; Waterous Company, South St. Paul, Minnesota; or approved equal.

16.8 All valves shall be installed in accordance with the manufacturer's recommendations and in locations designated by the City Utility Superintendent.

17.0 VALVE BOXES

17.1 Valve boxes shall be cast iron, 5-1/4" inside diameter, adjustable valve boxes of the screw type with sufficient length for the pipe bury as shown. Where the valve box is shown or required on control manholes, the length shall be sufficient to penetrate the valve marker and the Type II reinforced manhole cover. The cast iron cover of the valve box shall have an arrow indicating the direction of opening.

17.2 Covers for water piping shall have the word "WATER" cast on the top.

17.3 Valve boxes and covers shall be as manufactured by Tyler Pipe Utilities Division, Tyler, Texas; Mueller Co., Decatur, Illinois; Clow Corporation, Oak Brook, Illinois; or approved equal.

17.4 Valve boxes shall be installed on the valve with the use of valve box adaptor manufactured from a rubber compound. The valve box adaptor shall be Valve Box Adaptor II as manufactured by Adaptor, Inc. or approved equal.

17.5 All foreign material and debris shall be removed from the top of the valve operator prior to setting the valve box and shall be centered and plumb over the operating nut of the valve and shall be set so that no shock or stress will be transmitted to the valve.

18.0 HYDRANTS

18.1 Hydrants shall manufactured by Waterous Pacer or Series 2700: American AVK. Hydrants shall be furnished with mechanical joint base elbow. Connecting bolts shall be corrosion resistant, high strength alloy conforming to AWWA C111. Bolts shall be COR- BLUE T-bolts as manufactured by NSS Industries, 304 stainless steel, or approved equal.

18.2 Hydrant shall be dry barrel types as manufactured in accordance with AWWA Standard C502. Hydrant shall be designed for 250 pounds working pressure and shop tested to 300 pounds hydrostatic pressure prior to shipment to the project site.

18.3 Hydrant body shall be constructed from cast or ductile iron. Hydrants shall be of the "break-away" design. Valves, when closed, shall remain reasonably tight when the upper portion of the barrel and operating mechanism is broken away. The barrel sections shall be bolted, not screwed, to the lower section. Hydrant body shall be of proper length to provide a minimum of 6 1/2' of bury or the specified depth of cover over the service main. The base elbow flange connection bolts shall be stainless steel.

18.4 The main valve seat ring and drain ring shall be bronze. The main valve shall be compression type. Hydrant shall be furnished with a stop nut to prevent over travel and compression of the main valve. The hydrant shall be constructed in a manner which permits removal of internal working parts without digging or destruction of barrel or casing.

18.5 Valve opening shall be at least 5¼" diameter. Valve opening shall have a net area of waterway at the smallest part, with valve wide open, not less than 120% of valve opening.

18.6 Each hydrant shall have one or more drain holes to drain the barrel. Construction shall be such that the drain holes will be closed when the main valve is open and open when the main valve is closed. Each hydrant shall be shop tested to hydrostatic pressure of 300 psi with valves in both open and closed positions.

18.7 The direction of the opening shall be to the left and markings shall be cast on the head thereof to so indicate.

18.8 Hydrant shall have one 4-1/2" steamer nozzle and two 2-1/2" hose nozzles. Nozzle threads shall conform to the pattern and type currently used by the Owner. Operating nuts and nozzle lugs shall conform to the size and pattern currently used by the City. The Contractor shall be responsible for verifying sizes, types and patterns prior to ordering material.

18.9 Hydrants shall be furnished with one shop coat of red epoxy paint and two finish coats of a color to be selected by the City. Interior coating shall conform to AWWA C550 (latest revision) Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

18.10 All hydrants shall be installed in locations as shown on the plans or as directed by the Owner. All hydrant locations shall be approved by the City utility superintendent.

18.11 All moving parts shall be examined and found to be in working order prior to setting.

18.12 Fire Hydrants shall be set truly vertical upon a flat slab of concrete with the minimum thickness of 4 inches and not less than 16 inches square.

18.13 Approximately ten (10) cubic feet of crushed rock which is free of cementing material shall be placed below the hydrant and above the hydrant drain holes.

18.14 Hydrants shall be set in all cases at such a location and grade that a minimum of 18" clearance is maintained between the groundline grade and the centerline of the lowest nozzle.

19.0 CLEANING AND DISINFECTING

19.1 CHLORINE

- Liquid chlorine shall conform to AWWA Specification B-301-99.
- Hypochlorite shall conform to AWWA Specification B-300-99.

19.2 FLUSHING

- All lines shall be thoroughly flushed at a minimum flow velocity of 2.5 ft/sec prior to acceptance. If flushing water source conditions are inadequate to allow the minimum flow velocity of 2.5 ft/sec to be reached, the Contractor shall be required to clean the water main with a cleaning pig to assure that all traces of construction materials, soil or other foreign matter have been removed.
- Flushing shall continue until the turbidity of the flushed water is equal to or less than 0.5 NTU or until the turbidity of the flushed water equals the turbidity of the source water.

19.3 PIPELINE DISINFECTION

- After a contact period of not less than 24 hours, the system shall be flushed with clean water until the residual chlorine content is equal to or less than the chlorine content of the flushing water supply but in no case shall the chlorine content of the flushed water be less than 1.0 parts per million. All valves in the lines being sterilized shall be opened and closed several times during the contact period.
- After disinfection, the water lines must be flushed and the disinfected line must be sampled. Two consecutive samples of water from the end of the disinfected line must be collected at least 24 hours apart. These samples must be submitted to the State Health Laboratory in Pierre, or other laboratory acceptable to the department and tested for coliform bacteria. The samples must be free of coliform bacteria before the system is placed into service. Should the sample collected indicate a positive test indicating the presence of coliform bacteria, the disinfection process shall be repeated until negative samples are obtained.

20.0 TESTING

20.1 TEST SECTIONS

- The pressure and leakage tests shall be applied to all sections of the line. The maximum length of any section being tested shall be 1,500 feet unless otherwise authorized by the Engineer.

20.2 FILLING AND VENTING OF WATER MAINS

- The section of line to be tested shall be slowly filled with water and all air expelled from the pipe. Care shall be taken that all valves and facilities for the venting of air from the pipeline are installed and open in the section being filled. Care is to be taken to ensure that the rate of filling does not exceed the venting capacity of the air venting devices.

20.3 TEST EQUIPMENT

- Test pressures shall be applied by means of a force pump of such design and capacity that the required pressure can be applied and maintained without interruption for the duration of each test.

- The water meter and the pressure gage shall be accurately calibrated and shall be subject to the approval of the Engineer.

20.4 PRESSURE TEST

- Test pressures shall be applied to each section of pipeline with all connections, valves and fittings along the length of the test section in place.

- The pressure test shall be initiated by bringing the hydrostatic pressure in the section being tested to a minimum of 120 psi, as measured at the highest point of the section being tested.

- After the section of the line to be tested has been filled with water and brought to the specified level, the test pressure shall be maintained for a period of not less than one hour, or for whatever longer period as may be necessary for the Engineer to complete the inspection of the line under test, or for the Contractor to locate any and all defective joints and pipeline materials.

- If repairs are needed, such repairs shall be made, the line refilled and the test pressure applied as before; this operation shall be repeated until the line and all parts thereof withstand the test pressure in a satisfactory manner.

20.5 LEAKAGE TEST

- After the specified pressure test has been completed, the line being tested shall be subjected to a leakage test under the same hydrostatic pressure specified. The pressure shall be maintained constant (within a maximum variation, plus or minus, of 5%) during the entire time that line leakage

measurements are being made so that the allowable leakage rate may be determined accurately from the leakage rate formula.

- Leakage testing shall not be started until a constant test pressure has been established. After the test pressure has been established and stabilized, the line leakage shall be measured by means of a water meter installed on the line side of the force pump.

- Line leakage is defined as the total amount of water introduced into the line as measured by the meter during the leakage test. The pipeline or tested section thereof will not be accepted if and while it has a leakage rate in excess of the rate as determined by the following formulas set forth in A\/1/WA Section C605-94 for PVC piping:

$$Q = \frac{ND\ (P)\ 0\ 5}{7{,}400}$$

in which: Q= Maximum permissible leakage rate, in gallons per hour, throughout the entire length of line being tested.
N= Number of joints in the length of pipeline being tested.
D= Nominal diameter (in inches) of the pipe in the line.
P= The average test pressure, in psig, in the tested portion of the line.

- Line leakage is defined as the total amount of water introduced into the line as measured by the meter during the leakage test. The pipeline or tested section thereof will not be accepted if and while it has a leakage rate in excess of the rate as determined by the following formulas set forth in AWWA Section C600-99 for DIP piping:

$$Q = \frac{SD\ (P)\ 0\ 5}{133{,}200}$$

in which: Q= Maximum permissible leakage rate, in gallons per hour, throughout the entire length of line being tested .
S= Length of pipeline being tested in feet.
D= Nominal diameter (in inches) of the pipe in the line.
P= The average test pressure, in psig, in the tested portion of the line.

- Where the leakage rate is in excess of the permissible maximum, the Contractor shall be responsible for the location and the repair of all leaks to the extent required to reduce the total leakage to an acceptable amount.

- All joints in piping in non-buried locations shall be watertight and free from visible leaks during the prescribed tests.

- Each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City of Crooks shall be located and repaired by and at the expense of the Owner regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

SECTION 700

SANITARY SEWER

1.0 GRAVITY PVC SEWER PIPE

1.1 Polyvinyl Chloride (PVC) gravity sewer pipe shall be Type I, Grade I, conforming to the requirements of ASTM Specification D 3034 for Rigid Poly (Vinyl Chloride) Sewer pipe. The pipe shall have the following minimum wall thicknesses:

Pipe Diameter (inches)	SDR Rating	Piping Wall Thickness (inches)
4	35	0.125
6	35	0.180
8	35	0.240
10	35	0.300
12	35	0.360
15	35	0.437

1.2 Solvent Cement for PVC pipe joints shall conform to ASTM Specification ASTM D 2564 and shall be applied in conformance with ASTM D 2855.

1.3 Gasketed type joints shall be made with rubber gaskets conforming to the requirements of ASTM F-477.

1.4 The pipe shall be capable of withstanding trench loads imposed on it.

2.0 GRAVITY PVC SEWER FITTINGS

2.1 Fittings for Polyvinyl Chloride (PVC) Gravity sewer fittings shall be of PVC with material and dimensions conforming to the requirements of ASTM Specification D 3034.

2.2 Wyes and service line bends installed at a depth greater than 14 feet shall be SDR26.

2.3 Gaskets for elastomeric joints shall conform to the requirements of ASTM F-477.

2.4 Solvent Cement for solvent weld joints shall conform to the requirements of ASTM Specification D 2564 and shall be applied in conformance with ASTM D 2855.

3.0 TRANSITION COUPLINGS FOR GRAVITY PIPING

3.1 Couplings used for transitions between piping of different materials shall be made from elastomeric polyvinyl chloride (PVC). Clamp bands, band screw and housing shall be made from stainless steel. Couplings shall provide an infiltration and exfiltration proof and root proof joint. Couplings shall be designed as a flexible coupling specifically for the sizes and types of materials being joined.

3.2 Transition couplings and adaptors for new and existing piping shall be "Strong-Back" as manufactured by Fernco, Inc.

4.0 BEDDING MATERIAL

4.1 Bedding material for all sanitary sewer pipes shall be 1/4 inch to 3/4 inch clean angular, crushed rock with the following gradation requirements:

- 95% passing 3/4-inch sieve
- 95% retained in the No. 4 sieve and well graded

5.0 BURIED PIPING INSTALLATION

5.1 All piping and fittings shall be laid true to line and grade. Each section of pipe shall be so laid and fitted together that when complete the piping will have a smooth uniform flow line. The inside of all pipe shall be cleaned before installation and kept thoroughly clean during and after laying the pipe. Pipe ends shall be cleaned inside and outside.

5.2 All pipe and fitting shall be examined for defects before being lowered into the trench. The interior and exterior protective coating shall be inspected, and field repaired, if required, and possible accordance with applicable standards.

5.3 The pipe shall be handled and installed in accordance with manufacturer's recommendations and the requirements of ASTM 2321 for PVC gravity sewer piping.

5.4 When pipelaying is not in progress, including the noon hours, the open ends of pipe shall be closed. No trench water, animals, or foreign material shall be permitted to enter the pipe.

5.5 Borrowed granular bedding material shall be used with all piping unless otherwise approved by the utility superintendent. (See Paragraph 4.1). The general requirements for placement shall be as shown on the plans or as directed by the engineer.

5.6 The bedding material under and around the pipe shall be deposited in layers not to exceed six inches (6) and carefully compacted to a degree of compaction at least equal to 90% maximum dry density as determined by Standard Proctor Test, ASTM Test Designation D698 throughout the entire depth of each layer. Where the pipe has a protective coating, care shall be taken not to damage the coating.

5.7 The pipe shall be laid upon properly placed bedding material so that the barrel of the pipe will have a bearing for its full length. Bell holes and depressions for joints shall be excavated after the trench bedding has been graded.

5.8 After each pipe has been graded, aligned, and placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe joining and embedment operations.

5.9 The Contractor shall provide and maintain all necessary means and devices at all times to remove and dispose of all water entering the trench during the process of pipelaying. The trench shall be kept dry until the pipelaying and jointing are completed.

SANITARY SEWER CLEANING AND TESTING

6.0 CLEANING AND FLUSHING

6.1 All lines shall be thoroughly flushed and cleaned before acceptance until all traces of construction materials, soil or other foreign matter have been removed.

6.2 The Contractor shall take all necessary measures to protect adjacent facilities and property. Damages caused by flushing water or water carried material shall be the responsibility of the Contractor.

6.3 All flushing and cleaning shall be completed prior to the initiation of the testing process described in herein.

7.0 TEST SECTIONS

7.1 The alignment tests of all gravity sewer lines shall be carried out on sections of sewer line located between manholes.

7.2 The pressure and leakage tests shall be applied to all sections of the line with a section being the shortest practical length between manholes for gravity sewer lines.

8.0 TEST EQUIPMENT AND FACILITIES

8.1 Test pressures shall be applied by means of a force pump of such design and capacity that the required pressure can be applied and maintained without interruption for the duration of each test.

8.2 The water meter and the pressure gage shall be accurately calibrated and shall be subject to the approval of the Engineer.

9.0 DISPLACEMENT AND DEFLECTION

9.1 All tests for alignment and displacement of the gravity sewer lines will be made not sooner than thirty (30) days after the pipe has been laid and the trench backfilled and compacted as specified in accordance with the South Dakota Department of Environment and Natural resources (SD DENR).

9.2 The test procedure for displaced or misaligned pipe shall consist of a light being shined between manholes by means of a flashlight or by reflecting sunlight with mirrors. This testing shall be done in the presence of the city utility superintendent.

9.3 If the illuminated interior of the gravity sewer line shows apparent displaced pipe or misalignment which prevents seeing less than 50% of the pipe opening at the other end of the section being tested, the Owner, unless otherwise approved by the City of Crooks, shall be required to remedy the defect at his own expense.

9.4 The Contractor shall conduct deflection testing to insure that the long term pipe deflection does not exceed 5%. Pipe deflections exceeding 5% will require corrective action by the Contractor at his own expense.

9.5 Acceptable methods for testing deflection are:

- Electronic deflectometer
- Rigid "Go - No Go" device of the size, dimensions and construction as recommended by the pipe manufacturer for the pipe size being tested.

9.6 The Contractor shall be required to conduct television inspections of all new gravity sanitary main line piping prior to final acceptance . The televising procedure shall be performed by a qualified firm specializing in sewer cleaning and televising sewer systems. The firm and individuals performing this work will be subject to the acceptance of the Engineer and Owner. Results of the television inspection shall be recorded on VHS and CD Rom with copies provided to the Engineer and Owner. The cost for the work herein described shall be considered incidental to the project.

10.0 INFILTRATION TEST

10.1 The gravity sewer line, sewer service lines, its connections and manholes shall be subjected to an infiltration test when the ground water levels are two (2) feet or more above the top of sewer pipe and the appurtenance being tested.

10.2 The maximum allowable rate of infiltration shall be 50 U.S. gallons per mile of sewer per inch of diameter for twenty-four (24) hours as measured by a flow measuring device acceptable to the City.

11.0 EXFILTRATION (WATER) TEST

11.1 An exfiltration test of the gravity sewer line will be performed when the ground water table is less than two feet below the top of the pipe or appurtenance being tested.

11.2 The maximum allowable rate of exfiltration shall be 50 U.S. gallons per mile of sewer per inch of diameter for twenty-four (24) hours.

11.3 During the exfiltration testing, the internal water head must be two (2) feet higher than the top of the pipe, or ground water level, whichever is higher at the highest point of the test section. At no time may the internal-external pressure differential exceed 25 feet (10.8 psi) at the lowest point on the system being tested.

11.4 The exfiltration test process shall be conducted for a period of not less than 2 hours on each section being tested.

12.0 EXFILTRATION (AIR) TEST

12.1 In lieu of an infiltration/exfiltration test, a low pressure air test may be used to evaluate the watertightness of the gravity sewer line. The low pressure air test shall conform to the requirements of the recommended practice for low pressure air testing of installed sewer pipe, Uni-Bell Plastic Pipe Assoc. specification UNI-8-6-90.

12.2 Maximum allowable air loss shall be Q = 0.0015 cubic feet per minute per square foot of internal surface area.

12.3 The minimum allowable time (T), in seconds, for the air pressure to drop 1.0 psig shall be based on the following:

$$T = \frac{[0.085\ DK]}{Q}$$

Where K = 0.000419 DL, but not less than 1.0
Q = 0.0015 cubic feet/min/sq.ft. of internal surface
D = Nominal pipe diameter in inches
L = Length of pipe being tested in feet

NOTE: If a 0.5 psig pressure drop is used, the appropriate required test times shall be exactly half as long as those using the above equation.

13.0 MANHOLE TESTING

13.1 Sanitary sewer manholes must be tested by the Contractor before final acceptance. The maximum allowable exfiltration will be 0.1 gallon per hour foot of diameter per foot of head in the manhole. Head shall be measured as the depth of the water from the top of the concrete manhole structure to the invert of the sewer in the manhole

13.2 In lieu of an exfiltration test for sanitary sewer manholes, a vacuum test may be used when performed in accordance with the following procedures.

1. The vacuum shall include testing to the top of the manhole, excluding the adjusting rings and the cast iron rings.
2. Plug all pipes entering the manhole at least eight inches (8") into the sewer pipe. The plug must be inflated at a location past the manhole/pipe gasket.
3. Brace all plugs to prevent the plug or pipe from being dislodged and drawn into the manhole.
4. A vacuum of at least ten and one-half inches (1O½") of mercury shall be drawn on the manhole. Shut the valve on the vacuum line to the manhole and disconnect the vacuum line. Open the vacuum line valve and adjust the vacuum to ten inches (1O") of mercury.
5. The pressure gauge shall be liquid filled having a 3.5-inch diameter face with a reading from zero to 30 inches of mercury.
6. The time for the vacuum to drop from ten inches of mercury to nine inches of mercury must be equal to or greater than the following values for the manhole to be considered as passing the vacuum test:

Minimum Test Times for Various Manhole Diameters in Seconds									
	Diameter, in.								
Depth (ft.)	30	33	36	42	48	54	60	66	72
	Time, in seconds								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

7. If a manhole fails the vacuum test, the manhole shall be uncovered and patched on the exterior of the manhole, retested prior to backfilling when the leak has been patched and retested after the backfill is completed.
8. Manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries Inc., P.A. Glazier Inc., or approved equal.
9. Pneumatic plugs shall be provided and installed in accordance with the manufacturer's recommendations.

SECTION 800

STORM DRAINAGE PIPING

1.0 CORRUGATED METAL PIPE (CMP)

1.1 Corrugated metal pipe shall conform to the requirements of AASHTO M36. The pipe shall be of the diameter and section as shown on the plans.

1.2 Bituminous coated corrugated metal pipe shall conform to the requirements of AASHTO M 190, except the pipe shall conform to Paragraph 1.1 before coating.

2.0 REINFORCED CONCRETE PIPE (RCP)

2.1 Reinforced concrete pipe shall conform to the requirements of ASTM C76, Class III. The pipe shall be of the diameter and size as shown on the plans.

2.2 The acceptability of the pipe will be determined on the basis of plant load bearing tests compressive strength of concrete, material tests and inspection of the complete product as delivered and installed.

2.3 The concrete in special sections shall have a minimum compressive strength of 4000 psi. The strength shall be determined by test cylinders or by cores. Tests with the Swiss Hammer may be used to supplement the tests.

3.0 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

3.1 Fittings and pipe for Polyvinyl Chloride (PVC) storm sewer shall be of PVC with material and dimensions conforming to the requirements of ASTM F 794 and ASTM F 949 and shall have a smooth interior.

3.2 Gaskets for elastomeric joints shall conform to the requirements of ASTM F 477.

3.3 Installation of PVC pipe shall be in accordance with ASTM D2321.

4.0 HIGH DENSITY POLYETHYLENS (HDPE) PIPE AND FITTINGS

4.1 High Density Polyethylene (HOPE) pipe shall have a smooth interior and all sizes shall conform to AASHTO classification Type D.

4.2 All pipe and fittings shall be made from virgin PE compounds conforming to the requirements of ASTM 03350.

4.3 Neoprene or rubber gaskets shall be supplied by the manufacturer. Only fittings and gaskets supplied or recommended by the manufacturer shall be used.

5.0 INSTALLATION METHODS

5.1 Reinforced Concrete Pipe shall be laid with the groove or bell end of the pipe upstream, and the tongue end shall be inserted into the groove. Except where watertight rubber gaskets are used, each joint shall be covered, over the top three-fourths (3/4) of the outside circumference of the pipe, with at least a six (6) inch strip of Type B drainage fabric conforming to the requirements of the latest edition of the SD DOT Standard Specifications for Roads and Bridges Section 831.1. This strip shall be centered over the joint and cemented with a plastic asphalt cement to hold it in place during embankment construction. Lift holes shall be covered or plugged to prevent backfill from entering the pipe. When the plans require the use of rubber gaskets at joints, they shall be installed according to the manufacturer's instructions.

5.2 Corrugated Metal Pipe shall be laid with outside laps of circumferential joints pointing upstream, and with the longitudinal laps on the sides. The ends of the pipe sections shall be approximately one (1) inch apart to enable corrugations of the bands to mesh with the corrugations of the pipe.

5.3 PVC storm sewer pipe shall be laid with the groove or bell end of the pipe upstream, and the tongue end shall be inserted into the groove. Watertight rubber gaskets shall be used with all PVC storm water pipe.

5.4 HOPE pipe shall be installed in accordance with ASTM D2321 and the r:nanufacturers recommendations for the type of jointing being used.

5.5 Multiple lines of pipe culverts shall be laid in truly parallel lines in all planes.

5.6 The amount of camber shall be varied to suit the height of fill and nature of supporting soil.

5.7 Proper facilities shall be provided by the Contractor for lowering the sections of pipe into place. Dropping the pipe into place will not be permitted.

5.8 Trenches shall be excavated to a width sufficient to allow for proper jointing of the pipe and thorough compaction of the bedding and backfill material under and around the pipe. Where feasible, trench walls shall be vertical. The completed trench bottom shall be firm for its full length and width.

5.9 The foundation for each type of bedding shall be adequate to furnish a uniform stable support.

6.0 PIPE BEDDING EMBEDMENT AND BACKFILL

6.1 Bedding material for Storm Sewer shall be Class I or Class II materials meeting the following gradation. Bedding material depth shall vary based on pipe material and shall follow manufacturer recommendations.

- Class I: Crushed rock or gravel, 100% passing 1 1/2" sieve, <5% passing #200 sieve
- Class II: Coarse grained soils includes sand, 100% passing 1 1/2" sieve, <5% passing #200 sieve

6.2 The pipe bedding shall consist of a gravel cradle of uniform density shaped to fit the lower part of the pipe with reasonable closeness for at least ten (10) percent of its overall height. The bedding shall conform to the following gradation:

SIEVE OPENING	BEDDING MATERIAL (Percent Passing)
No. 4	90-100
No. 16	45-85
No. 50	10-40
No. 100	2-10
No. 200	0-5

6.3 The embedment material for reinforced concrete pipe above the bedding material shall be finely divided material free from debris, organic material, and clods, lumps or stones larger than 1-1/2 inches maximum diameter. The material shall be borrowed material or job site excavated material. Embedment for all other pipes shall be granular material conforming to the requirements for bedding material as described above. Embedment material shall be placed in uniform layers not more than eight inches (8") thick and compacted to 95% maximum density as determined by ASTM D698 until the pipe has a cover of not less than one foot (1').

6.4 The remainder of the backfill above the embedment material shall consist of selected material from excavation or borrow, and shall be free from cinders, ashes, refuse, organic and frozen material, boulders or other materials that are unsuitable. This material shall be placed from 12 inches above the top of the pipe to 6 inches below the ground surface, unless otherwise specified, or to the subgrade elevation for streets or paved surfaces. Under no circumstances shall backfill material that is placed within two feet of the top of the pipe be allowed to contain stones, rocks or other solid debris that is greater than three (3) inches in size. The backfill material shall be placed in uniform layers not exceeding one foot (1') in thickness and tamped. It shall be the Contractor's responsibility to compact each layer throughout its entire depth to at least 95% of the maximum obtainable density at optimum moisture as determined by a Standard Proctor. The Contractor shall moisten or aerate the backfill material to obtain the required compaction. The upper 6-inch layer, forming the subgrade for surfacing shall be compacted to at least 97% of the maximum density obtainable at optimum moisture content for flexible pavements and to at least 90% of the maximum density obtainable at optimum moisture content for rigid pavements and gravel. Density of backfill shall be determined based on Standard Proctor Test, ASTM Test Designation D698.

SECTION 900

MANHOLES AND CASTINGS

1.0 GENERAL

1.1 Manholes shall be constructed of cast-in-place concrete or precast concrete with bases, rings, and covers as required.

1.2 The materials used shall conform to the following requirements:

A. Concrete shall conform to the requirements of ASTM C-478

B. Concrete reinforcing shall conform to ASTM A-615, Grade 60 except as otherwise indicated.

C. Steel wire shall be plain wire conforming to ASTM A-82.

D. Precast manhole sections shall have a minimum inside diameter of 48 inches and shall conform to ASTM C-478.

2.0 CASTINGS

2.1 Gratings and covers shall be of the standard design of the manufacturer. All castings shall be of uniform quality, free from blow holes, shrinkage, cracks, distortion, or other defects affecting strength and appearance. They shall be smooth and well cleaned.

2.2 Metal used in the manufacture of castings shall conform to ASTM A48- 76, Class 358 for gray iron or ASTM A536-80, Grade 65-45-12 for ductile iron.

2.3 All castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner . Round frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.

2.4 All cast dimensions may vary 1/2 the maximum shrinkage possessed by the metal or plus or minus 1/16 inch per foot.

2.5 All weights shall not exceed the manufacturer's published weights by plus or minus 5%.

2.6 The proof load test results shall be furnished upon request. The proof load test procedure shall be in accordance with Federal Specification RR-F- 621C.

2.7 Unless otherwise approved by the city Engineer, the manhole casting shall be Model R-1733 as manufactured by Neenah Foundry Company; or approved equal. Covers shall be solid with two concealed pick holes.

3.0 MANHOLE WALL JOINT SEALANT

3.1 Flexible gasket material for sealing manhole wall joints shall be RAM- NEK as manufactured by K.Y. Snyder Company, Inc., Houston Texas; ConSeal CS-202 as manufactured by Concrete Sealants, Inc., New Carlisle, Ohio; or approved equal.

4.0 MANHOLE WALL – CASTING SEALANT

4.1 Unless otherwise approved by the city Engineer, sealant material meeting the requirements above shall be used to make a watertight seal between the manhole wall and casting.

4.2 The manhole wall - casting joint shall be sealed with an internal or external flexible rubber seal which conforms to the following requirements:

- The rubber sleeve shall have a minimum thickness of 3/16 inches. The rubber sleeve shall be corrugated to allow up to 2 inches of vertical and horizontal movement without stretching the material. The rubber sleeve shall have a minimum unexpanded vertical height of 6 inches. The rubber seal for external mounting shall be designed such that the backfill material will not restrict repeated flexing. The rubber sleeve material shall have the physical properties as shown in Table I.

TABLE I
RUBBER SLEVE

PHYSICAL PROPERTIES

Tensile Strength	1200 psi
Elongation at Break	350% min.
Hardness (Durometer)	45 +/- 5
Accelerated Oven Aging	Max 15% decrease of tensile, 20% of elongation
Chemical Resistance	No weight loss in 1N of sulfuric or hydrochloric acid
Compression Set	25% maximum decrease
Water Absorption	Max 10% increase by weight
Ozone Resistance	Rating 0
Low Temperature	
Brittle Point	No fracture at -40° C.
Tear Resistance	200 lb. f/in.
Splice Strength	180° bend with no visible separation

- The expansion/compression bands shall be one piece, channeled 16-gauge stainless steel with a minimum width of 1 ¼ inches. The bands shall have a minimum 10-inch-long adjustments slot which shall provide a minimum of 2 ½ inches of diameter range. The bands shall be locked in place by the tightening of two self-locking stainless-steel studs.

5.0 PIPE OPENING GASKET

5.1 Unless otherwise approved by the city utility superintendent, the pipe opening in the manhole wall shall be made watertight with a rubber gasket assembly meeting the requirements of ASTM C-923 and the following:

GASKET	
	Minimum Thickness of Gasket Material
8" Holes thru 16" Hole Sizes	290" +\- .025
18" Holes and Larger Hole Sizes	300" +/-.025
Minimum Compound Tensile Strength of Rubber	1800 PSI
Elongation of Rubber	450%-550%
Shore A Durometer of Rubber	42 +/- 5
EXPANSION SLEEVE	
Material	Type 304 Stainless Steel
Tensile Strength of Steel	85,000 PSI
Yield Strength of Steel	35,000 PSI
8" thru 26" Hole Sizes	1.5" Wide 11 Gauge
28" Hole Sizes and Larger	1.5" Wide 10 Gauge
TAKE UP CLAMPS	
Materials	Stainless Steel
Band, Saddle and Housing	Type 302
Screw	Type 305

6.0 MANHOLE CONSTRUCTION

6.1 Manholes shall be constructed only when the temperature is above 32 degrees F. All Work shall be protected against freezing.

6.2 The bottom of the foundations shall be not lower than 12 inches below the lines of the invert of the sewer at that point and shall be included in the unit price bid for manholes.

6.3 Invert channels shall be smooth, accurately shaped, and in accordance with the plan elevations. Invert channels may be formed directly in the concrete of the manhole base; may be formed using a section of PVC of required size and length as form material and pouring concrete around same on top of the manhole foundation; may be built up of brick work and mortar; may consist of half tile laid in the concrete base; or may be constructed by laying full section sewer pipe straight through the manhole and cutting out the top half after the manhole floor is constructed and sufficiently set. The floor of the manhole shall be constructed in such a manner as to drain into the invert proper.

6.4 Manholes shall be built up so that the cover, when placed, will be at the grade required in the plans or as set by the Engineer.

7.0 PRECAST CONCRETE MANHOLES

7.1 Monolithic precast concrete manholes shall be constructed in accordance with the details shown on the plans approved by the Engineer, as required by ASTM specification C478 and as specified hereinafter.

7.2 Monolithic concrete and precast concrete manholes shall have offset cones; that is, one side shall be vertical when the depth is sufficient to accommodate a cone.

7.3 Precast base sections may be a base riser section and separate base slab or base section with integral floor. Cast in place bases shall be approved by the city Engineer.

7.4 Precast concrete manholes shall be placed using present acceptable construction methods.

7.5 The openings in monolithic precast sanitary sewer manhole sections shall be sealed using a rubber sleeve gasket to make a flexible watertight connection.

7.6 All lifting holes in the manhole walls shall be carefully grouted with non- shrink grout prior to backfilling.

8.0 BACKFILLING

8.1 After completion of footings, walls, and other construction below the elevation of the final grades and prior to backfilling, all forms shall be removed, and the excavation cleaned of all trash and debris.

8.2 The Contractor shall protect the manhole from all elements and from displacement during backfill operations. If any displacement of a manhole occurs, the Contractor shall repair all resulting damage and return the manhole to the original position required at his own expense.

8.3 The backfill material shall conform to the requirements of Section 300.

9.0 CASTING PLACEMENT

9.1 The manhole casting and cover shall be carefully centered and sealed in the opening manhole wall-casting. Sealant methods and material shall be as described in Paragraph 4.

10.0 SURFACE FINISH

10.1 The surface of the area shall be finished and smoothed to the lines and grades as shown on the plans and to the satisfaction of the City of Crooks.

10.2 The requirements for the surface finish of the surrounding area shall conform to the requirements of the standards relating to the surface to be replaced.

INFORMATION SOURCES

These Design Standards are a compilation of information taken from several different sources. The main sources used to develop these standards are as follows:

- City of Crooks Ordinances and Subdivision Regulations
- DGR Engineering Construction Specifications
- The City of Sioux Falls Supplemental Standard Specifications
- The South Dakota Department of Agriculture and Natural Resources
- South Dakota Department of Transportation