CITY OF BOX ELDER, SD

PUBLIC WORKS DEPARTMENT

INFRASTRUCTURE DESIGN STANDARDS

2024 EDITION

List of 2024 Revised Sections

Contents

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I. GENERAL REQUIREMENTS

A. INTENT

1. The following summarizes and outlines policy, methods, practice, procedures, and design standards utilized by the City of Box Elder (City). The Criteria are adopted to obtain consistency in the design and development of infrastructure, for both public improvements and private developments, in the City.

2. These criteria, in conjunction with the City's standard specifications for public works construction, are intended to protect the public health, safety, and welfare, in the provision for and maintenance of public improvements within the City. The criteria apply to the comprehensive design and construction of all public improvements associated with developing, redeveloping, and subdividing lands and provides necessary criteria for all drainage, right-of-way, transportation, and utility services design within the City.

3. The intent of these requirements is to publish design criteria that follow all applicable laws. Where the criteria are found to be out of compliance with any applicable statute or law, the City will revise the criteria, as necessary.

4. The design criteria provide design guidance, and the specifications provide construction practices.

B. SCOPE

1. The City will review, approve, and monitor the design and construction of all public improvements within existing or proposed public right-of-way or public easements to ensure compliance with the criteria and specifications. The City has the sole authority for approving and accepting any public improvement.

C. JURISDICTION

1. These criteria, along with the specifications, shall apply to all public improvements within the incorporated area of the City and the 3-mile jurisdiction limit, except where the criteria are suspended by Federal or State requirements.

2. The most recent version of the document will be available on the City website.

D. SECTIONS

1. General Requirements - Section I: These criteria apply to all the sections contained in the design requirements.

2. Streets and Right-of-Way - Section II: The street and right-of-way criteria prescribed in Section II provide the study, design, and construction of the site accesses, streets, sidewalks, bicycle facilities, trails, etc.

3. Water and Wastewater - Section III: The utility criteria prescribed in Section III provide for the study, design, and construction of water and wastewater service facilities. These criteria detail required forecasting for the sizing water distribution and wastewater collection mains, and requirements for ensuring public health standards are met, and requirements for installing domestic water and sewer service lines.

4. Stormwater - Section IV: The storm water criteria prescribed in Section IV provides for study, design and construction of storm water drainage and flood control improvements. Detention ponds, storm sewer and drainage way systems, water quality, and erosion control measures may be required as part of construction approval to mitigate the impact of increased runoff resulting from land development or change in land use.

5. Grading - Section V: Grading Criteria are provided in Section V.

6. Right-of-Way Management: The Criteria for the management of City Right-of-Ways are provided as part of Section II.

7. Landscaping and Parking Lots: These Criteria are covered in City Ordinances.

E. MINIMUM CRITERIA

1. These criteria prescribe the minimum requirement to be met or exceeded when designing all public improvements. Whenever the criteria are found to be inconsistent with any other adopted standards, regulations, or codes, the more restrictive standards, regulations, or codes shall control. Reference to any code, regulation, standards, criterion, or manual of any technical society, organization, or association, or to any law or regulation of any governmental authority, whether such reference be specific or by implication, shall mean the most recently adopted or current law, code, regulation, standard, criterion, or manual in effect at the time of the City approval of the design documents for any project.

2. The design of all public improvements shall be prepared under direct supervision of a professional engineer and duly registered and licensed by the State of South Dakota.

F. USING THESE CRITERIA

1. These criteria are to be used when designing all public improvements and infrastructure within the City. For this document, public improvements and infrastructure include, with limitation, all improvements intended for public

purposes or for the benefit of the community, located within dedicated public right-of-way and public easements. Construction and material requirements for infrastructure are provided in the specifications.

G. PUBLIC IMPROVEMENTS DESIGN

1. These criteria prescribe minimum requirements for designing adequate and functional improvements. However, the design of public improvements also depends on the land use zoning and comprehensive planning requirements for the City, as well as the specific site geography of the land to be improved or developed. The City review for acceptance of submitted design plans for public improvements occurs as part of the development review process that distributes design applications to staff in multiple departments, divisions, and agencies. The Planning and Public Works Departments development review staff shall have primary responsibility to coordinate the review and approval of construction plans for the public improvements in developments.

H. CONSTRUCTION APPROVALS

1. An applicant seeking approval to construct public improvements in the City shall develop engineering designs and construction plans that comply with City design and construction criteria and any other applicable State or Federal regulations. In addition to complying with these criteria, an applicant shall file the necessary applications and meet the requirements of the City's land use regulations, permit standards, and fee assessments. All necessary permits and approvals shall be obtained prior to beginning construction.

2. An applicant seeking construction approval shall consult all relevant local master plans and determine the location of existing public infrastructure while developing specific project designs.

I. REVISIONS TO THIS MANUAL

1. Criteria may be amended from time to time, as determined by the City.

2. Revisions to this manual shall be issued in writing and can be made only by the City.

3. Changes or modifications shall be summarized on the “Revision Page” of the document. The revisions to the document will be made available on the City website.

4. Users requesting changes to the criteria in this manual shall provide detailed comparative engineering data supporting the reasons and justifications for the change.

J. EXCEPTIONS

1. Exceptions to these design standards will be considered on a case-by-case basis. Exception requests must be submitted in writing to the City for consideration.

K. RELATED DOCUMENTS

1. Information regarding design of public improvements is also contained in the following related documents. The designer shall become familiar with these and other documents:

    a. City of Box Elder Municipal Code

    b. City of Box Elder Standard Construction Specifications and Details

2. Conflicts between the specifications and these criteria, relating to the design requirements shall be resolved in favor of these criteria. Materials or construction requirements shall be resolved in favor of the specifications. Questions regarding conflicts shall be referred to the City Public Works Director, City Engineer, or the Planning Director, as appropriate.

L. TERMINOLOGY

1. Terms, words, abbreviations used in these criteria are defined in the Glossary.

M. SUBMITTAL REGULATIONS FOR CONSTRUCTION APPROVAL

1. Submittal requirements outlined in this section are focused on the submittal of applications to meet development requirements for the City managed, funded, maintained, or sponsored projects that are contractually specified in the design agreements between the City and the design engineering firm or developer. The City/engineering firm/developer contractual requirements shall, at a minimum, meet the submittal standards outlined herein.

N. DOCUMENTATION

1. An applicant for construction approval shall submit required engineering reports, right-of-way and easement dedications, ancillary permits and agreements, and construction plans in compliance with these criteria, construction approvals are subject to the City's review and acceptance.

    a. Prior to approving construction plans, the City shall require an applicant to submit the following documentation as appropriate:

i. Engineering reports

ii. Rights-of-way and easements as proposed or as existing

iii. Permits and agreements as proposed

iv. Government agencies approvals, SDDANR, Corp of Engineers, FEMA, etc.

b. Prior to the final acceptance of public improvements, the City will require an applicant to submit the following documentation:

i. As-built drawings

ii. Testing results

iii. Inspection approvals

iv. Financial guarantees and warranties

v. All closeout documentation must be submitted electronically.

O. ENGINEERING REPORTS

1. Engineering reports required for construction approval shall be prepared:

   a. in compliance with these criteria.

   b. under the direct supervision of a SD licensed professional engineer.

   c. such that each report shall contain adequate information to evaluate the submitted findings and designs, including calculations, details, and references; and

   d. with engineering reports required for construction approval of project which includes, but is not all inclusive, the following:

      i. Geotechnical soils report, which provides geotechnical conditions and design requirements based on the soils investigation and testing and geological site conditions in compliance with standard engineering practices for soil mechanics and groundwater analysis.

      ii. Pavement Design Report, which provides geotechnical soils conditions and adequate pavement design requirements and structural cross-sections of roadway construction.

iii. Storm Water Report, which address storm water conditions, impacts, and design requirements in compliance with Section IV.

iv. Utility Report, which addresses water and wastewater utilities service impacts, demands, and design requirements in compliance with Section III.

v. Traffic Study, which identifies traffic impacts from proposed developments or roadway modifications and proposes transportation design requirements and mitigation measures in compliance with Section II.

vi. Corp of Engineers 404 permit, where applicable.

vii. FEMA “No Rise” Certification Report, where applicable.

viii. Any applicable FEMA LOMR, CLOMR, etc.

2. The City's acceptance of a technical report is not a certification of the accuracy of data or calculations in the report.

3. An applicant for construction approval shall submit two hard copies along with an electronic version of same in a format which is commonly in use by office workers (e.g., *.pdf) of all required engineering documents to the City for review and acceptance. If found to be acceptable, City acceptance stamps (Public Works and Planning & Zoning), signed and dated by the City, will be placed on both hard copies of the report. The City will retain one copy and the remaining copy will be returned to the applicants engineer.

4. Engineering report approval automatically expires two years following the date of acceptance, unless substantial construction of improvements under the report has been initiated.

P. RIGHTS-OF-WAY AND EASEMENT DEDICATIONS, PERMITS, AND AGREEMENTS

1. Rights-of-way and easements required for construction approval shall be described and sealed by a land surveyor registered by the State of South Dakota and dedicated by subdivision platting or by a separate legal instrument that describes a specific legal description of dedication.

2. Agreements required for construction approval shall be executed and may include without limitation:

   a. Development agreement,

   b. Public improvements agreement,

c. Public Improvements extension agreement,

d. Subdivision agreement, and/or

e. Utility over sizing reimbursement agreement.

3. The applicant is responsible for identifying and securing all permits for construction. Permits required for construction acceptance shall be of "approved and issued" status and may include without limitation:

a. City of Box Elder Flood Plain Development Plan

b. City of Box Elder Flood Plain No Rise Certification

c. City of Box Elder Right to Work Permit

d. City of Box Elder Grading Permit

e. City of Box Elder On-Site Wastewater Permit

f. City of Box Elder Approach Permit

g. South Dakota Department of Transportation Access Permit

h. South Dakota Department of Transportation Utility Permit

i. South Dakota SDDANR Utility (water & sewer) Approval Letter

j. South Dakota SDDANR Storm Water Discharge Permit

k. Railroad Right-of-way License

l. United States Corps of Engineers 404 Permit

m. Applicable FEMA Approvals and Permits

n. Other permits as may be applicable

Q. CONSTRUCTION PLANS

1. All construction plans shall be submitted in an industry standard size, conforming to the City’s GIS requirements; to ensure legibility and consistency; to facilitate review, construction, and public inspection; and to provide a clear public record.

R. SUBMITTAL AND ACCEPTANCE OF CONSTRUCTION PLANS AND DRAWINGS

1. Submittal: An applicant who wishes to obtain City acceptance and begin construction shall submit two hard copies along with an electronic version of same in a format which is commonly in use by office workers (e.g., *.pdf) of any required construction plans to the City for review including:

    a. A drawing set prepared by a professional engineer and signed, sealed, and dated by the professional engineer. The plan sets submitted for review may contain a statement that the plans are for review only or not for construction.

    b. The City will review the submittal and provide comments.

2. All submittals (drawings and specifications) believed by the professional engineer to be final shall contain the licensure seal and signature of the South Dakota Licensed Professional Engineer responsible for the design of the plans and specifications for the referenced project. The seal and signature shall be affixed to the cover page of project plans, the cover of the specifications book and on the cover page of all submittal documentation. All closeout documentation such as testing reports shall contain the same certification from the licensed professional engineer responsible for the testing.

    In addition, the As-Constructed Plans shall contain a Statement of Conformance with City Standards, which shall read, "I (insert professional engineers name) certify that I have read and understand the provisions contained in the City of Box Elder Standard Construction Specifications and Details, current edition, and the City of Box Elder Infrastructure Design Standards, current edition. The drawings and specifications contained here within, to the best of my knowledge, were prepared in accordance with these documents." This statement shall appear on the cover sheet of the drawing set and on the first page of specifications after the cover sheet.

3. Acceptance: The City shall review construction plans for compliance with these criteria. If acceptable:

    a. The applicant shall submit a complete drawing set of accepted drawings prepared by, signed, sealed, and dated by a professional engineer. In addition, an electronic copy of the drawing set shall be submitted.

    b. The applicant shall address all City comments from previous submittal review and identify all modifications not shown on the previous submittals.

    c. City acceptance stamps (Public Works and Planning & Zoning) signed and dated by the City will be placed on the cover page of the each drawing set of the accepted construction plans.

d. The original accepted drawing set then will be returned to the applicant from which copies can be made for construction.

e. Drawing sets will be maintained on the file with the City as the record set of the construction plan approval documents and for use by the City.

f. Applicant must receive all necessary approvals from the SDDANR prior to beginning construction and prior to the City issuing a grading permit.

g. Submitted designs must be completed to the proper completion level or they will be returned without review. As an example, if the submittal is intended to be as a review of the final design, but the submitted plans are only partially complete, they will be returned without review.

h. Submittals that are not in substantial compliance with the criteria and specifications established by the City may be rejected for revision without detailed review and comment.

i. The City's review is for general compliance with the City criteria and specifications. The City, through acceptance of the plans or reports, assumes no responsibility for the completeness and/or accuracy of the plan or report.

4. Effective Period: Construction plan acceptance expires two years following the date of acceptance unless substantial construction has been initiated. An applicant for construction acceptance may resubmit the construction plan from reacceptance, subject to the review for compliance with standards in effect at the time of resubmittal.

5. Errors and Omissions: The professional engineer shall be responsible for the completeness and accuracy of the construction plans and drawings.

6. As-Built Drawings:

   a. Requirements: As-built drawings reflect the actual in-place construction of public improvements. The applicant shall submit as-built drawings for final construction acceptance prior to the City acceptance of any public improvements.

   b. Preparation: As-built drawings shall be prepared by the professional engineer. Drawings shall:

      i. follow the requirements of common drawing standards.

      ii. be based on completed filed inspections, accurate measurements, survey data, and testing results, materials, and equipment records; and

iii. reflect any variations from the accepted construction plans in the public improvements constructed.

S. TRANSFER OR RESPONSIBILITY

1. If the professional engineer responsible for the preparation of the original construction plans is replaced prior to the preparing as-built drawings, the replacement professional engineer shall agree in writing to accept the responsibility for the design certified by the original professional engineer, prior to the City acceptance of the constructed public improvements. See SDCL 36-18A-46.1

T. AS-BUILT DRAWINGS

1. Submittal

    a. An applicant for construction acceptance shall submit as-built drawings to the City. As-built drawing sets shall contain the following at a minimum:

        i. One hard copy as-built drawing set prepared by and signed, sealed, and dated by a professional engineer. In addition, an electronic copy of the drawing set shall be provided.

        ii. All test reports, material certifications, material and equipment submittals, operation and maintenance manuals, and other items required by ordinance(s) and specification(s) for acceptance shall be submitted with the as-built drawings.

        iii. When the responsible professional engineer has been responsible for completed construction phase services on the project, he shall then state on the drawing set cover sheet "I hereby affirm that the public improvements for (name of subdivision or project) have been constructed in substantial compliance with the construction plans and specifications accepted by the City of Box Elder.

        iv. If a third party has been responsible for construction phase services, a statement certifying the improvements were installed per the “As-Built” plans and specifications signed by the third party must be included.

2. Acceptance

    a. A *.pdf file containing the record (as-built) drawing set will be submitted along with the *.dwg or *.dxf file(s) utilized to generate the record drawings shall be submitted to the City for approval. The City will review the as-built drawings for general compliance with the City submittal and drawing standards. The

submitting party shall be notified by City staff of any concerns associated with the submittal. This requirement shall be for all projects submitted to the City for approval and acceptance.

b. The City will not accept any construction, place in service, release of financial guarantees, or issue utility connections for any public improvements for which acceptable as-built drawings have not been submitted.

U. MODIFICATIONS

1. Public improvements shall be constructed in accordance with accepted plans. Modification of accepted plans will not be made without prior authorization by the City.

V. VARIATIONS AND DISCREPANCIES

1. If any substantial variations or discrepancies exist, particularly with respect to location, design, slopes, grades, dimensions, and clearances, the professional engineer shall recommend a solution or alternative solutions to the City for review and acceptance. If no proposed alternative will satisfy the requirements of these criteria, the applicant shall reconstruct the deficient public improvements to comply with the accepted construction plans.

W. ALTERNATIVE MATERIALS AND METHODS OF CONSTRUCTION

1. These criteria not intended to prevent the consideration of any material or method of construction not specifically prescribed in these criteria, provided that the alternative material or method of construction have been approved in writing and their use authorized by the City. The City may approve an alternative material or method of construction on a case by case basis, provided the proposed design is at least the equivalent in the suitability, strength, effectiveness, durability, safety, and sanitation to the standard set in these criteria.

X. REFERENCES

1. Glossary: Whenever used in this manual, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

   a. Applicant: Entity submitting application for development.

   b. Bonds: Bidding, performance and maintenance bonds, and other instruments of securing furnished by the applicant and is surety.

c. Building Code: Code as adopted by the City of Box Elder and the State of South Dakota.

d. Building Official: The designated authority charged with the administration and enforcement of the building code as adopted by the City of Box Elder.

e. Chief: The Fire Chief and/or Police Chief or his/her designee.

f. City: The City of Box Elder.

g. City Engineer: The designated professional engineer employed by the City of Box Elder and/or the Public Works Director or their designee, for the purposes of this manual.

h. Director: The Director of Public Works or his/her designee.

i. Drawings: The part of the submittal documents, which shows the characteristics and scope of the work to be performed and which have been prepared or approved by a professional engineer.

j. Engineer of Record: Engineer providing design and/or construction management services. Engineer whose stamp is on the design drawings and specifications and is responsible for the content of the design drawing and specifications.

k. Fire Code: The International Fire Code (IFC) adopted by the City of Box Elder.

l. Laboratory: A testing facility, designated to investigate, test, report, and assure the quality of materials and equipment being incorporated in the work conforms to that specified in the criteria and specifications.

m. Land Surveyor: A person registered as a land surveyor by the State of South Dakota.

n. Mobile Home Development: Any area or tract of land where space is occupied for three or more mobile homes.

o. On-Site Wastewater Treatment Facility: A sewage treatment system, or part thereof, serving a dwelling, or other establishment, or group thereof, and using sewage tanks followed by soul treatment and disposal or using advance treatment devices that discharge, below final grade. Onsite wastewater systems include holding tanks, subsurface sand chambers, "no-dak systems", and vault privies.

p. Ordinance: The City of Box Elder Municipal Code.

q. Owner: The person or entity that holds ownership of the components of a project. For City managed, funded, or sponsored projects, the Owner is the City of Box Elder.

r. Plumbing Code: Code as adopted by the City of Box Elder and the State of South Dakota.

s. Private Fire Protection System: Hydrants, valves, water lines and appurtenances, sprinkler systems, house connections, and other equipment constructed for the purpose of providing fire protection for particularly building or group of buildings and supplied with water from a public water supply system. Private Fire Protection Systems are located in the public R.O.W. and are owned, operated, and maintained by the owner(s) of the property being served.

t. Private Sewer System: Manholes, sewer piping, and appurtenances constructed for the purpose of collecting wastewater from multiple buildings. Private sewer collection systems are located on private property, although some components may be in Public Right-of-way, and are owned, operated, and maintained by the owner(s) of the property being serviced.

u. Private Storm Water System: Piping and appurtenances constructed for the purpose of collecting, conveying, or storing storm water. Private storm water systems are located on private property, although some components may be in the public R.O.W., and are owned, operated, and maintained by the owner(s) of the property being served.

v. Private Street System: Street and access approaches constructed for the purpose of conveying traffic. Private Street System are located on private property, although some components may be in public R.O.W., and are owned, operated, and maintained by the owner(s) of the property being served.

w. Private Water Distribution System: Water piping and appurtenances constructed for the purpose of supplying water to multiple buildings. Private water distribution systems are located on private property, although some components may be in the public R.O.W., and are owned, operated, and maintained by the owner(s) of the property being served.

x. Professional Engineer, P.E., or PE: A person registered as a professional engineer by the State of South Dakota. Engineer providing design and/or construction management services.

y. Public Improvement: Means any public facility, system or infrastructure within the City of Box Elder jurisdictional area including, but not limited to: earthwork or landscaping; streets; sidewalks; bike paths; trails; parking and traffic control devices; water supply, treatment, storage and distribution systems; wastewater collection and treatment systems; and storm water and flood control collection and conveyance systems in proposed or existing public easements or right-of-way.

z. ROW: Public Right-of-Way.

i. Standard Specifications: City of Box Elder Standard Construction Specifications and Details, current edition.

ii. State: The State of South Dakota.

iii. Ten States Standards: Recommend standards for water works when cited in reference to water distributions systems and recommend standards for wastewater facilities when cited in reference to sewer collection systems, both by Great Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental mangers, as amended by the SDDENR.

2. Abbreviations: Whenever the following abbreviations are used in these criteria, they are to be construed the same as the respective expression represented:

a. AASHTO American Association of State Highway & Transportation Officials

b. ACI American Concrete Institute

c. ACPA American Concrete Pipe Association

d. AGC American General Contractors of America

e. AIA American Institute of Architects

f. AIEE American Institute of Electrical Engineers

g. AISC American Institute of Steel Construction

h. ANSI American National Standards Institute

i. APA American Plywood Association

j. APHA American Public Health Association

k. APWA American Public Works Association

l. ASCE American Society of Civil Engineers

m. ASTM American Society for Testing Materials

n. AWSC American Welding Society Code

o. AWWA American Water Works Association

p. IEEE Institute of Electrical and Electric Engineers

q. MUTCD Manual of Uniform Traffic Control Devices

r. NACE National Association of Corrosion Engineers

s. NBS National Bureau of Standards

t. NEC National Electrical Code

u. NEMA National Electrical Manufacturer's Association

v. NFPA National Fire Protection Association

w. SDDANR South Dakota Dept. of Agriculture & Natural Resources

x. SDDOT South Dakota Department of Transportation

y. UL Underwriters Laboratories, Inc.

z. USGS United States Geological Survey

ab. WEF Water Environment Federation

II. STREETS AND RIGHT-OF-WAY

A. STREET CLASSIFICATIONS

1. These standards shall govern the planning, design, and construction of all streets within the City of Box Elder and in all areas that are subject to its extra-territorial jurisdiction.

B. DEFINITIONS

1. Streets and roads shall be designed, based on the following definitions, and anticipated functional classifications:

    a. Alley: A public way providing a secondary means of access to abutting properties. Alleys shall not provide the only means of access.

    b. Arterial Street: A street serving the highest traffic volume corridors and major centers of activity. Traffic studies and AASHTO standards shall be used to determine the final design criteria for all arterial streets. These streets are designed with limited access to preserve capacity and enhance safety. Locations for arterial streets are as described on the adopted Master Transportation Plan.

    c. Collector Street: A street which collects traffic from other minor streets and channels it into the arterial street system. Collectors provide land access and traffic circulation within and between residential neighborhoods and commercial and industrial areas. They distribute traffic movements from these areas to the arterial streets. The cross section of a collector street may vary widely depending on the scale and density of adjacent land uses and desired character of the local area. Left turn lanes should be considered on collector streets adjacent to nonresidential development.

    d. Commercial Street: A street intended primarily to facilitate the movement of automobiles and other goods carriers into and within a commercial development.

    e. Cul-de-sac: A street having one end connecting to the street system and having one closed end terminated by a turnaround.

    f. Expressway: A street that is like a freeway but can include some at-grade intersections at cross-streets. Access may be either fully or partially controlled with small amounts of direct land access. Expressways are intended to provide high levels of mobility, rather than to provide local property access.

g. Freeway: A divided, limited access facility with no direct land access and no at-grade crossing or intersections. Freeways are intended to provide the highest degree of mobility serving higher traffic volumes and longer-length trips.

h. Industrial Street: A street intended primarily to facilitate movement of large trucks or other goods carriers into and within an industrial or development site.

i. Lane/place: A street serving a residential site of not more than four dwellings, whose purpose is to provide primary access to abutting properties and to move traffic generated from abutting properties to nearby streets.

j. Local (Residential) Street: A street serving a residential site of more than ten dwellings, whose purpose is to provide direct access to abutting property and to move traffic to collector and other major streets.

k. Rural Road: A street providing a means of direct or indirect access to abutting property but having no curb and gutters at the edges of the traveled roads. Rural Roads generally require parallel roadside drainage ditches to transmit surface drainage. Driveway approaches, generally, require cross culverts to maintain ditch flow. Rural roads shall be classified and built according to City street standards.

C. MINIMUM RIGHT-OF-WAY / PAVEMENT WIDTHS

1. Right-of-way and street pavement widths shall be based on street classifications and parking requirements as provided in Figure II.9.

D. MODERATE / HIGH / EXTREME FIRE HAZARD AREAS

1. In moderate / high / extreme fire hazard areas, as declared by the City, Lane / Place streets shall provide minimum right-of-way and pavement widths equal to local street requirements. The City shall make the necessary determination of Fire Hazard area when the project is submitted for layout plat approval.

E. GENERAL DESIGN CONSIDERATIONS

1. Streets and public rights-of-way shall be designed in a manner to connect to existing and proposed streets, taking into consideration, the topographical conditions, public convenience, and safety; in appropriate relation to the proposed uses of land to be served by the streets.

2. The street layout shall be with a plan for the most advantageous development of the entire neighboring area. Sufficient proposed streets shall extend to the boundary lines of the tract to be subdivided to ensure normal circulation of traffic

within the vicinity. Land abutting a proposed subdivision may not be left land-locked by subdivision of land. Designated local or residential streets shall be designed to discourage the utilization of through traffic, in any residential area, when possible

3. Where there exists a dedicated or platted half-street right-of-way adjacent to the tract to be subdivided, the other half shall be platted.

4. Where there exists an unpaved dedicated or platted street adjacent to the tract to be subdivided, the developer shall be required to provide concrete curb and gutter, sidewalks, and asphalt mat for existing streets. All streets shall conform to the master transportation plan and the city infrastructure design standards manual.

5. There shall be no private streets platted within a subdivision, and there shall be no reserve strips in a subdivision except where the control is vested in the city.

F. PRIVATE STREETS

1. Private streets shall be built to the same design standards as public streets, except that private streets shall be in an access easement. The access easement must clearly state ownership, maintenance responsibilities, provide access for all necessary City services, and must define who the allowed users of the private street are. Private streets shall not provide the principal access to more than four tracts, parcels, or lots of any size.

G. MINIMUM ACCESS

1. A street with a single access shall not be used for more than twenty dwelling units accessed from the street. A second access means shall be a natural extension of the street system. The second access shall be configured such that emergency responders and the public have a second route to the property or exit from the property if one route is blocked. The number of dwelling units shall be determined as being the combination of all development(s) gaining access from the street. This requirement shall apply to all developments, including phased projects. No additional development shall be allowed on any street currently exceeding ten dwelling units, unless second street access is provided, or the Box Elder City Council has approved an exception.

H. HORIZONTAL / VERTICAL ALIGNMENT

1. Street alignment should closely fit the existing topography to minimize the need for cuts or fills sacrificing pedestrian and vehicle safety.

2. Additional consideration shall be given to providing adequate driveway access to properties adjacent to the street, either through vertical alignment lot grading, or similar design considerations.

3. All designs shall be accomplished in accordance with the AASHTO standards for Low-Speed Urban Streets.

I. DESIGN SPEED

1. Design speed is selected based on the functional classification of the road. Design speeds shall be in accordance with Table H-1. Posted speeds for all streets may be at or below the design speeds at the discretion of the City.

TABLE H-1 MINIMUM DESIGN SPEED FOR STREETS AND ROAD	
Design speeds may be reduced, at the discretion of the designer, if the terrain is such that the cut/fill section at the top or bottom of the vertical curves exceeds 12 feet.	
Lane / Place	25 MPH
Local Street	25 MPH
Collector Street	35 MPH
Arterial Street	50 MPH
Expressway	55 MPH
Freeway	As determined by SDDOT

J. STREET GRADE

1. Street profile grades shall be as flat as is consistently possible with the surrounding terrain while allowing for good drainage.

    a. Local & Lane / Place Streets: For Local and Lane/Place Streets, the maximum normal design street grade shall be 10%. The minimum street grade is 1/2 percent.

    b. Collector Streets: For Collector Streets, the maximum design street grade shall be 10% percent and the minimum street grade is 1/2 percent.

    c. Arterial Streets: For Arterial Streets, the maximum design grade and minimum grade shall be as dictated by the AASHTO design standards and shall be based on street design speed.

    d. Expressway & Freeways: Grades shall be dictated by the SDDOT and AASHTO.

e. Cross - Slope: Adequate pavement cross-slope is required to provide drainage off the traveled portion of the roadway and into the gutter or ditch. Care should be taken when using vertical curves, combined with variable profile and cross-slope grades, to provide adequate drainage to prevent ponding or icing conditions. Maintaining drainage is especially critical where super-elevated sections are utilized. Minimum cross-slope shall be 2%. Maximum cross-slope shall be 4%. In varying and hilly terrain, the final design may dictate deviations from the cross-slope criteria. However, maintaining adequate drainage is of critical importance.

K. VERTICAL AND HORIZONTAL CURVES

1. Geometric design features shall be consistent with the specified design speed. Horizontal and vertical alignment must complement each other and be considered in combination. Adequate stopping sight distances and passing sight distances (when applicable) must be provided. Minimum horizontal and vertical curve radii shall be provided in accordance with the latest edition of the American Association of State Highway and Transportation Officials' *A Policy on Geometric Design of Highways and Streets* (ASSHTO Guidelines). The guidelines for Low-Speed Urban Streets shall be used.

L. INTERSECTIONS

1. The alignment, grade and geometrics of intersecting streets shall provide both drivers and pedestrians with a complete and unobstructed view of approaching traffic and shall enable each of them to make necessary maneuvers to transverse the intersection safely.

    a. Intersecting Angles: Streets should be designed to intersect at 90-degree angles. The intersecting angle of streets centerlines shall never be less than 60 degrees.

    b. Intersecting on Curves: Intersections should be designed to intersect at 90 degrees angles. The intersecting angle of the streets maneuvers to transverse the intersection safely.

    c. Street Grade at Intersections: The intersection and approach areas of lesser streets, where they intersect with higher order streets and where vehicles storage while waiting to enter an intersection, shall not exceed 5% profile grade for a minimum distance of 50 feet from the near right-of-way line.

    d. Curb Radii: Intersection curb radii shall comply with Table K-1. Fillet and pan, curb, and handicapped access ramp construction shall comply with the current edition of the City of Box Elder Standard Construction Specifications and Details.

TABLE K-1 MINIMUM INTERSECTION CURB RADII	
Intersection Type	Minimum Radii from Back of Curb
Local / Local	**25 Feet**
Local / Collector	**25 Feet**
Collector / Collector	**25 Feet**
Commercial any street	**30 Feet**
Industrial any street*	**40 Feet**
Arterial	**40 Feet**

* Compound curves may be used for Industrial Intersection

e. Distance Between Intersections: The distance between intersections shall not be less than 125 feet, unless minimum approach spacing required in Figure II-1 dictates a greater distance.

f. Distance Between Intersection and Access Approaches: See Section IIP for access approach spacing standards.

M. SIGHT TRIANGLES

1. The Criteria for sight triangles presented in this section are based on the recommendations contained within the AASHTO Guidelines. The figures are present as general representations of the required sight triangles; it is the responsibility of the designer to verify the applicability of each figure to the facility being designed.

   a. Definitions

      i. Sight Triangle: A specified area at an intersection that is free of any obstructions which may block a driver's view of potentially conflicting traffic. Intersection facilities may include streets, alleys, driveways, rail lines, sidewalks, and bicycle paths and shall meet AASHTO and MUTCD requirements.

      ii. Stop Controlled Intersection: An intersection with traffic control stop signs. Alley, private street, and driveway intersections are considered stop-controlled intersections for the purpose of sight triangle requirements.

      iii. Yield Controlled intersection: An intersection with traffic control "yield signs."

      iv. Signalized intersection: An intersection with traffic controlled by a traffic signal.

v. Pedestrian sight triangle: A specified area at an intersection of sidewalks or bicycle paths that is free of any obstructions, which may block a user's view of potentially conflicting traffic.

vi. Uncontrolled intersection: An intersection with no traffic control.

vii. Railroad Crossing: The area formed by the intersection of a railroad track with any street, highway, private street, driveway, sidewalk, bike path and alley.

b. Restrictions

i. Obstructions: No obstructions to vision shall be allowed within the applicable sight triangle(s), except as permitted by ordinance. An object shall be deemed an obstruction if it creates a hazard as defined by the AASHTO guidelines.

ii. Multiple Sight Triangles: When more than one sight triangle applies to the same corner, all applicable sight triangle requirements must be satisfied.

c. Point of Measurement: All distances shall be measured from the edge of travel lane.

d. Stop-Controlled Intersections: Each stop-controlled intersection shall have a sight triangle based on the speed limits of the intersecting streets, except that the intersection of two alleys shall have a sight triangle of 25 feet on each leg. See Figure II-2 for sight triangles at stop-controlled intersections.

e. Yield-Controlled Intersections: See Figure II-3 and Figure II-4 for sight triangles at yield-controlled intersections.

f. Uncontrolled Intersections: See Figure II-4, Figure II-5, and Figure II-6 for sight triangles at uncontrolled intersections.

g. Signalized Intersections: Signalized intersections should be considered to be stop-controlled for the purpose of sight triangle requirements. See Figure II-2.

h. Pedestrian Sight Triangle: At intersecting sidewalks or bicycle paths, and at any intersection of a sidewalk or bicycle path with a street, alley, or driveway, a pedestrian sight triangle shall be maintained. These distances are shown on Figure II-6.

i. Railroad Crossing: Sight triangle for railroad crossing shall be in accordance with the AASHTO guidelines.

N. CUL-DE-SAC DESIGN

1. Local or Lane/Place streets may be designed to have one end permanently closed. Permanent cul-de-sacs in commercial or industrial areas shall be allowed when they meet all permanent cul-de-sac criteria.

   a. Length: Cul-de-sacs in residential areas shall not exceed 800 feet in length and shall not serve more than 20 housing units. Cul-de-sac length shall be measured from the edge of traveled way of the intersecting street that provides two means of egress to the center of the cul-de-sac turnaround. Cul-de-sacs in commercial or industrial areas shall not exceed 500 feet, measured in the same manner as above.

   b. Turn Around Requirements: Cul-de-sacs shall be provided with a turnaround at the closed end and intermediate turnarounds at intervals not to exceed 400 feet. Turnarounds shall meet the following minimum dimensions.

TABLE M-1 MINIMUM TURNAROUND DIMENSIONS					
AREA CLASSIFICATION	PARKING	R-O-W DIAMETER	PAVEMENT DIAMETER	REVERSE RADIUS R-O-W	REVERSE RADIUS CURB
RESIDENTIAL	NO	120'	96'*	30'	40'
COMMERCIAL	NO	120'	96'*	30'	40'

   * Includes two (2) feet on each side for curb and gutter.

   Circular turnarounds with center islands, and "T", and "Y" shaped turnarounds may be permitted when approved by Public Works. See Figures II-7 & II-8 for acceptable dimensions.

   c. Moderate / High / Extreme Fire Hazard Area: Cul-de-sacs in residential moderate / high / extreme fire hazard areas shall not exceed 400 feet. Project covenants shall be placed on any development requiring residential fire sprinkler systems in all buildings accessing from the Cul-de-sac roadway. The City will make the determination of Moderate / High / extreme fire hazard areas.

   d. Grades in Turn Around's: Grades in Cul-de-sac bulbs or turn arounds shall not exceed 6%.

   e. Temporary Cul-de-sacs: Temporary cul-de-sacs where specifically permitted by phased or separate construction, shall be provided at the ends of streets slated for future extension and connection to the street system. Temporary cul-de-sacs shall conform to all the dimensional criteria of permanent cul-de-sacs. Curb and gutter, sidewalk, and pavement are not required. However, gravel or another approved all-weather surface must be placed on the cul-de-

sac such that temporary surface can support wheeled equipment weighing up to 75,000 lbs.

O. PAVEMENT DESIGN CRITERIA

1. Street pavement design shall be based on the volume and characteristics of the traffic expected to use the street over a minimum period of 20 years. Street pavement design shall also account for the sub grade soil's supporting the strength characteristics, the type and strengths of the paving materials, and their combined behavior under load, in all probable climatic conditions.

    a. Guidance Document: The design of street pavement shall follow AASHTO guidelines and any further requirements herein.

    b. Geotechnical Investigation: A geotechnical investigation shall be conducted by a qualified individual prior to design of any City Street, except for lane / place or local streets. The geotechnical investigation shall be used to obtain the soil characteristics and design data necessary to prepare an AASHTO pavement design.

    c. Design Criteria: All pavement designs shall be conducted by a South Dakota licensed professional engineer and shall bear the engineer's stamp and signature upon delivery to the City.

        i. Pavement structures shall be designed for the predicted traffic loading over a minimum 20-year performance period. Traffic can be represented by the number of 18-kip equivalent single axle load (ESAL's). The ESAL's for the performance period represents the cumulative number of loadings from the time the roadway pavement is placed to the time when the serviceability is reduced to a terminal value.

        ii. The minimum design traffic levels for Lane/Place and Local Streets in residential areas, with fewer than 40 dwelling units, shall be 20,000 18-kip ESAL applications. Design traffic levels for all other residential Lane/Place and Local streets shall be 45,000 18-kip ESAL applications. The ESAL applications for all other street use and classifications, including Local Streets in industrial and commercial areas, shall be determined by the City based on traffic counts or existing streets within the City that have a similar end use.

        iii. Other Minimum Street Pavement Design Criteria:

	Local Street (Residential Only)	All Other Classifications
Design Deviation	**.45**	**.45**

Soil Modules	**CBR x 1500**	**CBR x 1500**
Initial Serviceability	**4.2**	**4.2**
Terminal Serviceability	**2.0**	**2.5**

- The Drainage Coefficient for all street designs shall be 1.0 with edge drains and 0.75 without edge drains.

- Soil Resilience Modules must be expressed in terms of the results of a California Bearing Ratio (CBR).

- The maximum AASHTO Design Reliability input shall be 75 for local streets in residential areas. The maximum AASHTO Design Reliability input shall be 80 for streets in industrial or commercial areas. The AASHTO Design Reliability shall be 90 for all other areas.

- Roadbed soils that are susceptible to swell, frost heave, or loss of structural support from viable or high moister content shall be given special design consideration to ensure threat the long-term pavement performance is not compromised. This includes clay / shale type soils typical to the Box Elder region.

d. Asphalt Cement Concrete (ACC) Pavement

i. The minimum ACC pavement section for local streets in residential areas shall be from 5 inches of PCC pavement on 8 inches of crushed gravel, or ledge rock base course on 12 inches of reconditioned subgrade. Reconditioning shall consist of scarification, watering to optimum moisture, and re-compaction. Use of lesser pavement sections for local streets in residential areas shall require a geotechnical investigation and pavement design.

ii. All other street classification and uses shall require a geotechnical investigation and pavement design.

iii. The City reserves the right to require a formal pavement design by a qualified geotechnical engineer if there are concerns about the subsurface soil conditions or a history of unsuccessful pavement sections around the new street.

e. Portland Cement Concrete (PCC) Pavement

i. The minimum PCC pavement section for Local Streets in residential areas shall be 6 inches of PCC pavement on 4 inches of crushed gravel, or ledge rock base course on 12 inches of reconditioned subgrade. Reconditioning shall consist of scarification, watering to optimum moisture, and re-compaction. Use of lesser pavement sections for local streets in

residential areas shall require a geotechnical investigation and pavement design.

ii. All other street classification and uses shall require a geotechnical investigation and pavement design.

iii. The City reserves the right to require a formal pavement design by a qualified geotechnical engineer if there are concerns about the subsurface soil conditions or a history of unsuccessful pavement sections around the new street.

f. Synthetics and Non-Standard Materials and Construction Practice: The use of synthetics for sub-grade stabilization, or non-standard materials or practices such as cement or lime stabilization is beyond the scope of these regulations and may need to be considered on an individual basis.

P. ALLEYS

1. Alleys shall not be allowed in residential development unless specifically approved by the City.

2. Alleys may be required in commercial and industrial districts. The planning commission or City Council may waive this requirement where other provisions are made for service access. Such access may include off-street loading, unloading, or parking consistent with ordinance requirements.

3. Minimum right-of-way and paved width for alleys is shown in Figure II-9.

4. Alleys shall be constructed of concrete or asphalt. In no case shall alleys be surfaced with gravel or millings.

Q. PARKING, CURB AND GUTTER, BOULEVARDS AND SIDEWALKS

1. Parking Requirements

   a. Off street parking shall be provided in accordance with the parking requirements of the applicable City of Box Elder Ordinances.

   b. Common use, visitor parking for Single-family / Duplex / Townhouse and residential use properties shall be provided at the rate of no less than one paved parking space per unit, located within 150 feet of the residence. The distance shall be measured from the nearest point in the parking stall to the closest edge or corner of the dwelling unit. For street classifications below the Collector designation, on-street parking may be parallel parking constructed to serve the visitor parking requirement. Where on-street parallel parking is

used to meet this requirement the public right-of-way and street width shall conform to the requirements identified in Figure II.9 for on-street parking. If on-street parking is not provided, approved no-parking signs shall be installed prohibiting on-street parking.

2. Curb and Gutter: Standard, “Type B”, curb and gutter shall be provided in accordance with the City's standard specifications.

3. Rural Road Section (No Curb and Gutter): A Lane / Place Street may be constructed as a rural road section in the City's extraterritorial jurisdiction if an exception to the subdivision regulations is approved for the elimination of curb & gutter and sidewalk. Minimum Lane/Place right-of-way and pavement widths as contained in Figure II-9 shall be maintained. A minimum of 2-foot-wide gravel or paved shoulders shall be provided. Ditches and driveways shall have a maximum side slope of 4:1 (H:V). Access approaches shall be constructed in accordance with the City's standard specifications. Roadway ditches and culverts shall be provided for drainage. The sizing of ditches and culverts shall be in accordance with the City's Storm Water Design Criteria. Maintenance of ditches and culverts on Lane / Place streets will be the responsibility of the landowners abutting the streets.

4. Boulevards
   a. Boulevards shall be required on all street classifications unless otherwise approved by the City.
   b. Minimum boulevard width requirements are shown on Figure II-9.
   c. The top four inches of boulevards shall be backfilled with topsoil free of rocks, debris, and weeds.
   d. Boulevards shall be hydroseeded with native, drought tolerant grass mix as approved by the City.

5. Sidewalks
   a. Sidewalks shall be provided at all locations along both sides of all roadways and streets. Sidewalks shall be provided in accordance with the City standard specifications. Sidewalks along one side of the lane/place or local streets may be allowed with exception approval of the Planning Commission and City Council collectively. A single sidewalk shall be a minimum of 6 feet in width.

   b. All sidewalks, except for lanes/place and local streets and cul-de-sacs, shall be property line sidewalks per Figure II-9.

   c. No curbside sidewalks will be allowed unless special approval is granted by the City.

   d. Minimum sidewalk width requirements shall be as shown on Figure II-9. Under no circumstances shall the sidewalk width be less than five feet.

e. Sidewalks shall be formed of concrete no less than four inches thick with four inches of aggregate base course.

f. Longitudinal sidewalk grades shall, where possible, match the profile grade of the adjacent street. Sidewalks for steep streets shall, where possible, be designed with ADA requirements. If ADA requirements cannot be met, an exception to these standards may be granted allowing the deletion of sidewalks. Steps on the sidewalk will not be permitted. Transverse grades shall slope toward the street and not exceed 2%.

g. Handicapped Accessibility: Walkways (sidewalks, crosswalks, ramps, etc.) shall follow the Americans with Disability Act (ADA) accessibility guidelines except when the unique characteristics of terrain prevent the full incorporation of accessibility features. The determination of a non-conforming location will be at the discretion of the City Engineer. Handicapped access ramps shall be constructed at all intersections where sidewalks are required and shall conform to the City's standard specifications.

6. Bike Paths and Special Sidewalks: Sidewalks designated as bike paths on designated bike routes shall be a minimum of 10 feet in width.

R. ACCESS APPROACHES

1. The design and location of access approaches onto streets is directly related to the specific use of the approach and the functional classification of the street approach it is fronting. Also, where work is being done in areas previously developed, expectations to access requirements may need to be considered to allow sensible re-development.

2. All access approaches shall be constructed in accordance with the City's standard specifications unless exceptions are granted by the City Council.

3. General Requirements

   a. No access approach shall be so located as to interfere with a utility facility.

   b. Any necessary adjustment to a private or public utility facility or public structure must be approved by the City. Proposed adjustments will not be approved until an agreement, signed by all parties involved, has been submitted detailing how the cost of the adjustment will be paid for.

   c. No access approach shall be located to create a hazard to pedestrians or motorists or to invite or compel illegal or unsafe vehicular movements.

d. City street and highway rights-of-way shall not be used for private or commercial purposes. Parking shall not be allowed within the boulevard area. An approach access permit shall not be issued unless all vehicles to be serviced can maneuver and park entirely within the private property lines. However, backing from the property into the street may be permitted only in residential areas.

e. If a property borders or fronts on more than one Lane / Place or Local Street, approach access may be granted on either street, at the request of the property owner, but not to both streets.

f. Lots with street frontage of 150 feet or less shall be limited to one access approach.

g. The setback distance in Section P shall be measured from the property line, unless otherwise permitted.

h. Access approach driveway aprons and / or curbs shall not encroach past the extended adjacent property line. The driveway opening shall be located at a minimum of 5 feet from the extended adjacent property line.

i. Access approach spacing shall be in accordance with Section IIP8.

j. Where several properties exist along a collector or higher classification of street, each having limited frontage, or where there is a probability of such development, consideration shall be given to shared access points, and frontage or rear lot road to reduce the number or accesses to the street. Frontage or rear lot road access to the street shall be at the extremities of the frontage or rear lot from the street intersection or at well-spaced intervals along it. Intervals shall be at least distance of normal intersection spacing.

4. Residential Area: In addition to the requirements of Section IIP3 the following items shall also apply to access approaches.

   a. Number of Openings:

      i. Not more than one access approach will be permitted to a single residence except as otherwise permitted.

      ii. Two access approaches are permitted if no traffic operation or safety problems result for:

         - lots with 300 feet or more of combined frontage on two local streets in a residential area. A second access approach shall not be permitted onto collector or arterial streets, or

- mid-block lots with 200 feet or more of street frontage, to accommodate circular driveways, which meet the standards listed in Section IIP6, or mid-block lots that have severe terrain prohibiting a standard two or three stall side-by-side garage.

5. Width of Access and Driveway in Right-of-Way

   a. A 20-foot maximum access approach and driveway in the ROW plus 5-foot tapers is allowed in the following situations:

      i. One and two stall (side-by-side) garage at all setback distances.

      ii. Three stall (side-by-side) garage with a setback distance of 30 or more feet.

      iii. On the bulb of a cul-de-sac, for one and two stall (side-by-side) garages.

   b. A 24-foot maximum access approach and driveway in the ROW plus 5- foot tapers are allowed where two family units or larger are built or where a shared approach is used.

   c. A 30-foot maximum access approach and driveway in the ROW plus 5-foot tapers is allowed for the following situations:

      i. Three stall (side-by-side) garage with a garage setback distance or less than 30 feet, or

      ii. A shared driveway for townhouses and duplexes with adjoining two or three stall (side-by-side) garages with a setback distance of 30 or more feet, or

      iii. On the bulb of cul-de-sacs for a three or more stall (side-by-side) garage, or

   d. A 40-foot maximum access approach and driveway in the ROW plus 5-foot tapers is allowed where a shared driveway for townhouses and duplexes with adjoining two or three stall (side-by-side) garages with a setback distance of less than 30 feet.

6. Circular Driveways

   a. Circular Driveways are permitted if all the following conditions are met:

      i. The lot has 200 feet or more of street frontage.

      ii. The inside radius of the driveway is not less than 20 feet.

iii. The radius point is located at or inside the property line.

iv. The minimum acute angle, measured from the edge of pavement, is 80 degrees; and

v. The maximum width of the access approach and driveway in the ROW is 16 feet plus 5-foot taper returns.

7. Commercial and Industrial Areas

   a. In addition to the requirements of Section IIP3, the following items shall also apply to access approaches in commercial and industrial areas.

      i. The number of access approaches allowed to a commercial or industrial establishment will be dependent on the size and design of the establishment or development. The developer or owner shall be responsible for showing the need for the proposed number of access points.

      ii. In the commercial and industrial zoned areas, the access approach openings shall be not less than 16 feet in width for one way traffic, not less than 24 feet in width for two-way traffic, and no more than 40 feet in width, exclusive of the curb tapers and radii.

      iii. Access approaches for commercial and industrial sites shall be designed as radius approaches, like an intersection. Radii shall be specified elsewhere in these standards.

8. Access Approach Spacing

   a. The distance between adjacent access approaches must be sufficient to allow vehicles to safely queue, accelerate, decelerate, and cross-conflicting traffic streams without excessive interference with through traffic using adjacent access approaches.

   b. Where access approaches are to be signalized, a minimum spacing of 1,200 feet of signalized intersection is required. Access approach signals shall be interconnected with any other signals within 2,500 feet of the signalized approach.

   c. Access approach signalization shall be in accordance with City and/or State of South Dakota standards in effect at the time the permit is acquired. The access approach signalization shall be at no cost to the City or State. The City will assume maintenance and utility costs upon completion and acceptance of the installation.

9. Approach Corner Clearance: Minimum access approach clearances for street intersections shall be as indicated on Figure II-1. All distances in Figure II-1 shall be measured from the back of curb or, where there is no curb, from the edge of the pavement or gravel surface.

10. Location Coordination: Commercial and industrial access approaches on opposite sides of a street, where possible and reasonable, will be located so opposing lanes lineup to provide the best possible vision of drivers entering the street. Adequate sight distance shall be provided for vehicles exiting and entering an approach. Approach locations will be evaluated to determine whether sight obstructions such as buildings, signs, vegetation, parked vehicles, highway alignments, etc. exist.

11. Joint or Shared Access Easement: When one access approach is to be used or shared by adjacent properties under different ownership, each property owner must provide the necessary legal documents to establish an access easement agreement. Joint access is encouraged whenever practical.

12. Driveway Grades: Driveway grades shall be compatible with their intended use and in compliance with the City's Standard Specifications.

S. TRAFFIC STUDIES

1. Responsibilities for Traffic Report

    a. Traffic impact reports shall be required by the City, on projects as specified below, to adequately assess the impact of a proposal on the existing or planned street system. The primary responsibility for assessing the traffic impacts associated with the proposed development/business improvement will rest with the developer/business owner with the City serving in a review capacity.

    b. Unless waived by the Public Works Director and Planning Director, a written report meeting the guidelines will be required for any nonresidential development proposals when trip generation during the peak hour into the development is expected to exceed 100 vehicles as determined by section IIQ2ii, or any multi-family residential development with 150 or more dwelling units.

    c. Preparation of the report shall be responsibility of the developer and must be prepared by South Dakota licensed professional engineer with experience in traffic engineering. Upon submission of a draft traffic report, the City will review the study data sources, methods, and findings. Comments will be provided in a written form. The developer and his/her engineer preparing the report will than have an opportunity to incorporate necessary revisions prior to

submitting a final report. All reports shall be reviewed and accepted by the City.

d. When a new phase of development is submitted for review, all previous traffic reports relating to the development that are more than 2 years old must be updated, unless it is determined by the Public Works Director, that conditions have not changed to warrant an update.

e. Traffic reports will be required if the trip generation or dwelling unit criteria as noted in Section IIQ1b are exceeded for the following:

   i. For a rezoning application or conditional use permit.

   ii. For a final or final development plan if the property has already been rezoned for the proposed use and no traffic report was required for rezoning.

   iii. Prior to issuance of a building permit, if the property has already been zoned/plated and no previous report less than 2 years old exists.

   iv. Additional access off an arterial street to an existing use is being requested.

   v. The developer shall be required to submit a new traffic report if, after submitting the original traffic report, the land use intensity and traffic generation area increase by more than 15%.

   vi. Where access points are not defined or a site plan is not available at the time the traffic report is prepared, additional traffic analysis may be required when a site plan becomes available, or the access points are defined.

   vii. The developer will be notified at the planning stage if a traffic report will be required, provided sufficient information is available for the City to determine whether the trip generation / dwelling unit criteria have been met. If insufficient information is available but the property appears to involve a sufficiently intense land use, a traffic report may be required.

2. Traffic Report Format

   a. Traffic consultants are encouraged to discuss projects with the applicable City Department prior to starting the study. Topics for possible discussion at such meetings may include directional distribution of traffic, definition of the study area, intersections requiring critical lane analysis, and methods for projecting build-out volume. A firm base of cooperation and communication between the City, the owner and/or developer, and the consultant in creating traffic

characteristics that are in the best interest of the total community desired, specific requirements will vary depending on the site location; however, all traffic reports shall contain, as a minimum, the following information:

i. Introduction: A brief description of the size of the land parcel, general terrain features, the location within the jurisdiction, and the region should be included in this section. In addition, the roadways that afford access to the site, and are included in the study area, must be identified. The exact limits of the study area are to be based on the engineering judgment, and an understanding of existing traffic conditions at the site. In all instances the study area limits shall be mutually agreed upon by the developer, his/her design professional, and the City. A vicinity map shows the site, in relation to the surrounding transportation system, must be included. The introduction shall also include:

ii. Existing and Proposed Site Uses: The existing and proposed uses of the site must be identified in terms of the various zoning categories of the City. In addition, the specific use for which the request is made must be identified, if known, since several uses may be permitted under the existing ordinances.

iii. Existing and Proposed Uses in Vicinity of the Site: A complete description of the existing land uses in the vicinity of the site, as well as their current zoning and use, must be included. The developer must also state the proposed uses for vacant adjacent land in order that any proposed transition in uses is identified. This latter item is especially important where large tracts of undeveloped and/or underdeveloped land are in the vicinity of the site, and within the prescribed study area. It should be noted that generally much of this information can be obtained from the meetings with the City's Planning Staff.

iv. Existing and Proposed Roadways and Intersections: Within the study area, the developer must describe existing roadways and intersections (geometrics and traffic signal control) as well as improvements contemplated by government agencies. This would include the nature of the improvement project, its extent, implementation schedule, and the agency or funding source responsible.

1. Trip Generation and Design Hour Volumes

- A summary table listing each type of land use, the size involved, the average trip generation rates used (total daily traffic and a.m. and p.m. peaks), and the result total trips generated shall be provided.

- Trip generation will be calculated from the latest data contained within the "Institute of Transportation Engineers, Trip Generation

Guide (latest edition)" or "NCHRP report No. 187". If data is not available for the proposed land use, the City must approve the estimated rates prior to acceptance.

- The peak hour volume used to determine public improvements will be estimated by one of the following methods which are listed in:
    - Traffic volume counts for existing areas.
    - Peak hour trip generation rates as published in the ITE Trip Generation Guide (latest edition).
    - NCHRP Report No. 187, where justified.

v. Trip Distribution: The direction of approach for site-generated traffic will be presented in this section. The technical analysis steps, basic methods, and assumptions used in this work must be clearly stated.

vi. Trip Assignment: This section shall describe the utilization of study area roadways by site-generated Traffic. The anticipated site traffic volumes must be combined with existing and projected area traffic volumes in Section IIQ2ii to describe the mainline and turning movement volumes for future conditions with the site developed as proposed. Internal trips more than 10% will require analytical support to demonstrate how the higher figures were delivered. Non-generated passerby traffic reductions in generation volumes may be considered if applicable. All estimates of trip distribution, assignment, and modal split are subject to review and approval by the City.

vii. Existing and Projected Traffic Volumes

- Graphics must show:
    - AM peak hour site traffic (in and out) including turning movements.
    - PM peak hour site traffic (in and out) including turning movements.
    - AM peak hour total including site (in and out) and through traffic including turning movements for current conditions and 20-year projections or build-out.
    - PM peak hour total including site (in and out) and through traffic including turning movements for current conditions and 20-year projections of build-out.

b. All raw traffic count data (including hourly ADT and peak hour turning movements) and analysis worksheets shall be provided. Computer techniques and the associated printouts can be used as part of the report.

c. Build-out projections shall include major vacant properties around the proposed development as defined by the City. Volume projections for background traffic growth will be provided by the City, or a method for determining their volume will be recommended by the City.

d. All total daily traffic counts should be actual machine counts and not based on factored peak hour sampling. The latest available machine counts from the South Dakota Department of Transportation (SDDOT), the City, and other agencies may be acceptable if not more than 2 years old.

e. All traffic will be assigned to existing and planned facilities in a manner consistent with existing traffic patterns and approved by the City.

    i. Capacity Analysis: A capacity analysis will be conducted for the street intersections at driveways for the proposed development. Within the limits of the previously defined study area, capacity analyses will also be conducted for street intersections. The a.m., p.m., and any other possible peak period will be tested to determine which will be analyzed. Pedestrian movements should also be considered in the evaluation. Capacity calculations should also include an analysis for 20-year projections or build-out conditions. Capacity analysis will be calculated in accordance with the procedures outlined in "The Highway Capacity Manual, TRB Special Report No. 209.

    ii. Traffic Signals

        - The need for new traffic signals shall be checked using the warrants in "The Manual of Uniform Traffic Control Devices (latest edition). Traffic progression is of paramount importance. Generally spacing of one-half (1/2) mile for all signal-controlled intersections should be maintained. This spacing is usually desirable to achieve good speed, capacity, and optimum signal progression.

        - To provide flexibility for existing conditions and ensure optimum two-way signal progression, an approved traffic engineering analysis will be made to properly locate all proposed connecting access approaches that may require signalization. An optimum two-way progression pattern will be established between two public intersections that bracket the proposed approach as chosen by the City. These bracketing intersections should be about 1 mile apart, and be existing, or possible future signal locations.

- The progression pattern calculation must use a cycle length of between 50 and 120 seconds, and a travel speed of 40 mph, unless existing signal systems and speed limits govern usable cycle lengths and travel speeds. A desirable bandwidth of 50% must be used where existing conditions allow. Where intersections have no signals presently, but are expected to have signals, a 60% mainline, and 40% cross street cycle split should be assumed. The green time allowed to the cross street will be considered no less than the time which is required for a pedestrian to cross the mainline at 4 feet per second. Those intersections which would reduce the optimum bandwidth if a traffic signal were installed will remain un-signalized and have turning movements limited by driveway design or median islands.

iii. Level of Service: Level of Service "C" during the peak hour will be the design objective. The design year will be approximately 20 years following construction or at build-out of the area. Levels of service are defined in "The Highway Capacity Manual."

iv. Traffic Crashes: Traffic crash data for affected street corridors shall be required for the study.

v. Recommendations: If analysis indicates unsatisfactory levels of service on study area roadways, a description of proposed improvements to remedy deficiencies shall be included. These proposals would not include committed projects by the City or the SDDOT, in general, the recommendation section should include:

- Proposed Recommended Improvements: This section shall describe the location, nature, and extent of proposed improvements to assure sufficient roadway capacity.

- Volume / Capacity Analysis at Critical Points: Another iteration of the volume / capacity analysis will be described, which demonstrates the anticipated results of making these improvements.

- Levels of Service at Critical Points: As a result of the revised volume / capacity analysis presented in the previous section, levels of service for the highway system with improvements will be presented.

vi. Conclusion: The last chapter of the report must be a clear, concise description of the study findings. It is anticipated that this concluding chapter will serve as an executive summary.

vii. Revision to Traffic Report: Revisions to the traffic report must be provided as required by the City. The need to require revisions will be

based on the completeness of the traffic report, the thoroughness of the impact evaluation, and the compatibility of the study with the proposed access and development plan.

T. TRAFFIC CONTROL

1. Traffic Control Plans, Traffic Control Devices, Traffic Signals, and Pavement Markings and Signage shall be designed in accordance with the "Manual on Uniform Traffic Control Devices (MUTCD), the City Standard Specifications, and ADA requirements.

U. ROADWAY LIGHTING

1. Required Roadway Lighting is intended to provide minimum lighting levels in the roadway for vehicular and pedestrian safety. All electrical work shall comply with the National Electrical Code and the requirements and standards of the SDDOT for Roadway Lighting.

    a. Conduit and wiring: All wiring under roadways and driveways shall be in PVC conduit. Conduit shall have a minimum of 24-inch bury and shall be 1.5 inches minimum size. Other wiring may be direct buried cable. Wiring shall be run, by the local power provider, from the nearest transformer to the light location and property metering shall be provided at the transformer location. The installation shall be coordinated with and done by local power provider.

    b. Street light Locations and Spacing

        i. Streetlights shall, whenever possible, be installed on the property line, which runs perpendicular to the street. Generally, fixtures shall be placed in the ROW and shall be a minimum 2 feet behind the curb, unless curbside sidewalks are provided, then the light fixtures shall be place at the back side of the sidewalk. If no curb is installed, special locations proposed must be submitted for approval. If roadway lighting cannot be installed with the ROW, a utility easement will be required.

        ii. On residential streets including Lane / Place, Local, and Collector streets, lights shall be placed at all intersections and shall be located between intersections, essentially at curves, with non-staggered pattern and not more than 400 feet in separation.

        iii. On Commercial, Industrial, Expressway, and Arterial streets, spacing shall be not more than 250 feet apart, and the lights shall be staggered on opposite sides of the street, where possible.

iv. Where special fixtures are proposed, light fixture locations shall be as stated above or as determined by the specific fixture and lighting design. Optometric and lighting level result shall be submitted as part of the design submittal.

c. Light Fixtures and Poles

i. Generally, within the City, light fixtures and poles are furnished and installed by the local power provider as part of a street lighting agreement with the City. If the local power provider does not offer lighting poles and fixtures approved by the City, the developer is still required to install City approved poles and fixtures as described in this section. Wooden poles are not allowed.

ii. Poles: City street light poles shall be a Nova Pole, NPT8050D31DB6-VD-NPSM. This pole mounts at a 31' height with a 4-foot rise for the light bracket. It shall have a 0.250-inch wall thickness, 8-inch diameter pole base, a hand hole height of 18-inches, a spun aluminum Top Cap with set screw, an ID Tag located 6-inches above Hand Hole, and have a Rotary Polished finish. The pole shall have a 72-inch direct bury and shall be installed in accordance with the manufacturer's installation recommendations. The pole shall come with a fixture arm with 10-foot horizontal and 4-foot vertical extension.

iii. Residential Street Lighting: Street Lighting for Residential area service shall be Cooper Verdeon C-Series lighting. The product shall have a model number of Verd-CO18-D-U-T2-4N7-AP. This relates to a model CO18 Light Engine with a 0-10 V Dimming Driver for use with Universal 120-277 Voltage, Type II Light Distribution having a NEMA 7-Pin Photocontrol Receptacle and 10kV MOV Surge Protection Device in a Standard Grey finished color. All fixtures and components shall be installed per manufacturer's installation standards and tested for operation before acceptance by the City.

iv. Commercial/Arterial Street Lighting: Street Lighting for Commercial or Higher Volume Streets shall be Cooper XNV2 lighting. The product shall have a model number of XNV2-AF-02-D-U-T3R-10K-4-AP. This relates to a model with a Version AF Light Engine with 2 Light Squares, a 0-10 V Dimming Driver for Universal 120-277 voltage, Type III Roadway lighting distribution, a Cooper 10kV Surge Module and a NEMA Twistlock Photocontrol Receptacle in Standard Grey finished color. All fixtures and components shall be installed per manufacturer's installation standards and tested for operation before acceptance by the City.

v. If a developer desires special roadway lighting for a project the City will consider such a request when the following data is submitted:

- Catalog cuts and specifications of the proposed fixtures. Care shall be used when selecting proposed fixtures to minimize light pollution, spill light and the creation of bright spots in the roadway.

- A proposed fixture layout with lighting intensity calculation for the area proposed. In residential areas, lighting calculations are intended to show only luminance, and luminance ratio in the immediate vicinity of the fixture.

- An approved fused disconnecting means shall be provided near the transformer which furnishes power to the light fixture.

- A properly executed power use and maintenance agreement with the City. A copy of such an agreement can be obtained from the Public Works Department.

d. New Technology: As new technologies are developed for roadway lighting (e.g., LED lighting, solar powered lighting, etc.), developers are encouraged to consider these options when presenting their lighting plans.

V. TRAFFIC CALMING

1. Traffic calming is the purpose by which vehicular speeds are reduced to acceptable levels on local streets, providing a safer environment for both motorists and pedestrians. The calming may be accomplished through the installation of approved devices such as "roundabouts", flares, and center islands. Traffic calming devices must be designed to accommodate emergency and maintenance vehicles. Traffic calming features require approval by the City upon submission of engineering backed justification data.

2. Calming Devices

   a. Roundabouts: Roundabouts may be accepted, when planned on Lane / Place, Local or Collector streets as a traffic stilling device. Their use should be in keeping with the character of the development and the location in the street system. If a center landscaped island is proposed within the roundabout, the minimum radius of the island shall be no less than 33 feet.

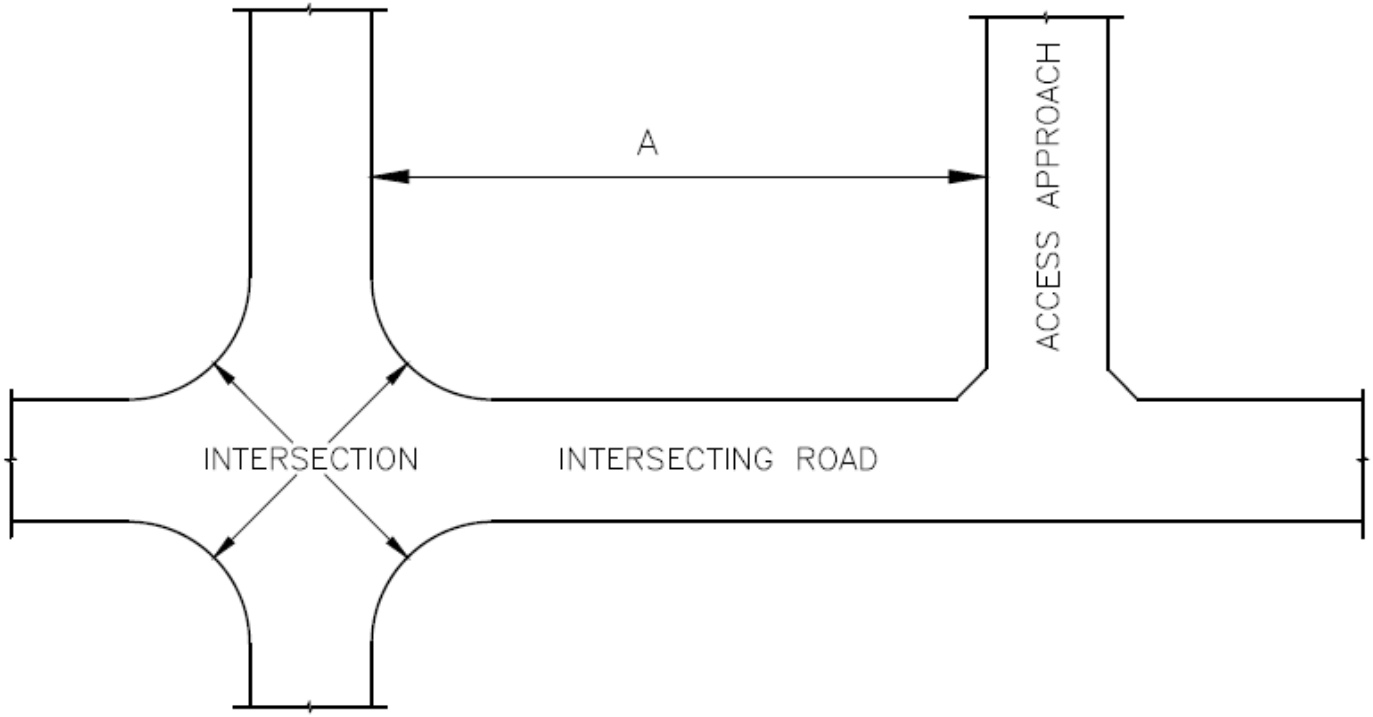
   b. Street Islands and Boulevards: Center of street islands and boulevards may be acceptable, when planned Lane / Place, Local or Collector streets for speed control, when they encourage pedestrian safety, and when they are designed to enhance the character and beauty of a development. Center islands may be located at intersections, or mid-block, but shall not be longer

than 200 feet. Street pavement width on each side of the island shall be 20 feet minimum.

c. Curb Line Flairs: On Collector streets, where on street parallel parking is planned; the designer is encouraged to consider the use of curb line flares. Flares may also be used to increase pedestrian safety when used in conjunction with pedestrian generators such as schools, parks, etc.

3. Landscaping: All planting areas within traffic calming devices must have planting designed such that site triangles are not compromised. Agreements with adjacent property owners must be in place for the continued maintenance of vegetation within the devices.

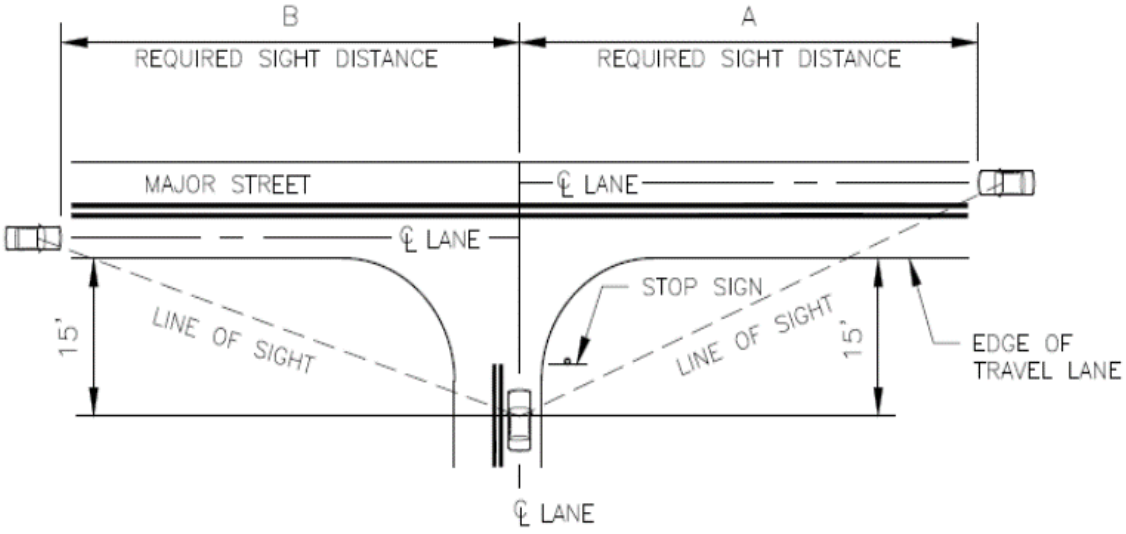
FIGURE II-1: MINIMUM APPROACH CLEARANCES



	CLASSIFICATION OF INTERSECTING ROAD							
INTERSECTION	ARTERIAL		MINOR ARTERIAL		COLLECTOR		LOCAL & LANE/PLACE	
CONTROL	SIGNALIZED	UNSIGNALIZED	SIGNALIZED	UNSIGNALIZED	SIGNALIZED	UNSIGNALIZED	SIGNALIZED	UNSIGNALIZED
MINIMUM CORNER CLEARANCE A (FEET)	**250**	**150**	**200**	**125**	**175**	**90**	**100**	**50**

FIGURE II-2: SIGHT DISTANCE AT STOP-CONTROLLED INTERSECTION

POSTED SPEED LIMIT OF MAJOR STREET	CAR-PASSENGER	TRUCK-COMMERCIAL	CAR-PASSENGER	TRUCK-COMMERCIAL
50	**480**	**775**	**555**	**850**
45	**430**	**700**	**500**	**765**
40	**385**	**620**	**445**	**680**
35	**335**	**540**	**390**	**600**
30	**290**	**465**	**335**	**510**
25	**240**	**390**	**280**	**425**
	DISTANCE B (FT)		DISTANCE A (FT)	



Notes:

1. The values cited assume turns ono a two-lane street with no median and grades of 3% or less.

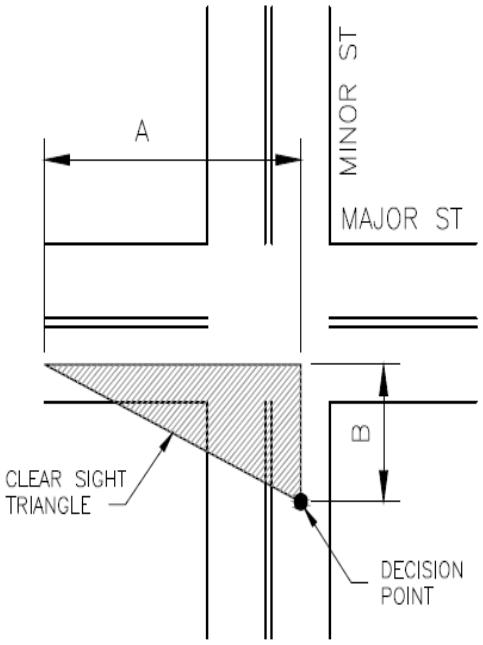
2. For conditions different than those stated in Note 1, the sight distance must be adjusted per ASHTO guidelines.

3. The values shown for trucks shall be applied in commercial and industrial zones.

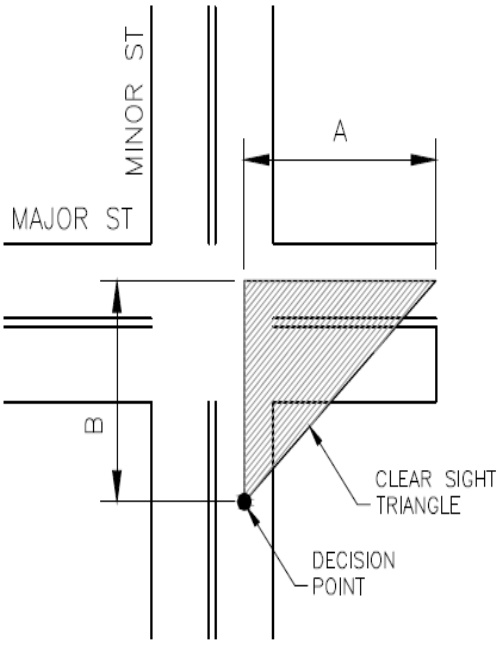
FIGURE II-3: SIGHT DISTANCE AT YIELD-CONTROLLED INTERSECTION WITH 4 LEGS

POSTED SPEED LIMIT OF MAJOR STREET	CAR-PASSENGER
50	**480**
45	**430**
40	**385**
35	**335**
30	**290**
25	**240**
	DISTANCE A (FT)

CAR-PASSENGER	POSTED SPEED LIMIT OF MINOR STREET
320	**50**
275	**45**
235	**40**
195	**35**
160	**30**
130	**25**
DISTANCE B (FT)	



CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE LEFT

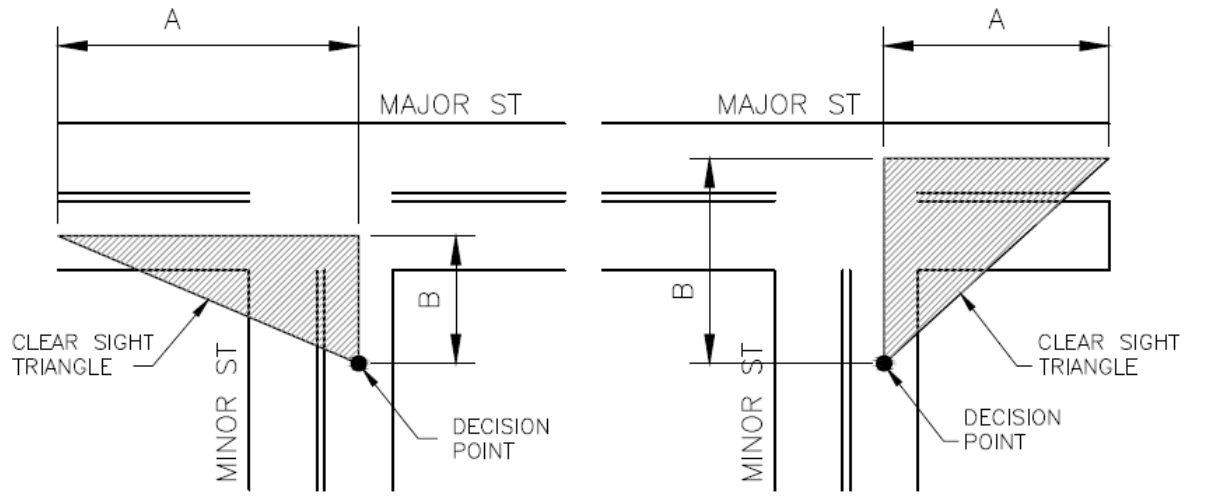


CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE RIGHT

Notes:
1. The values cited assume a two-lane major street with no median and grades of 3% or less.
2. For conditions different than those stated in Note 1, the sight distance must be adjusted per AASHTO guidelines.

FIGURE II-4: SIGHT DISTANCE AT YIELD-CONTROLLED & UNCONTROLLED INTERSECTIONS WITH 3 LEGS

POSTED SPEED LIMIT OF MAJOR STREET	CAR-PASSENGER	CAR-PASSENGER	POSTED SPEED LIMIT OF MINOR STREET
50	**590**	**85**	**50**
45	**530**	**85**	**45**
40	**475**	**85**	**40**
35	**415**	**85**	**35**
30	**355**	**85**	**30**
25	**295**	**85**	**25**
	DISTANCE A (FT)	DISTANCE B (FT)	



CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE LEFT

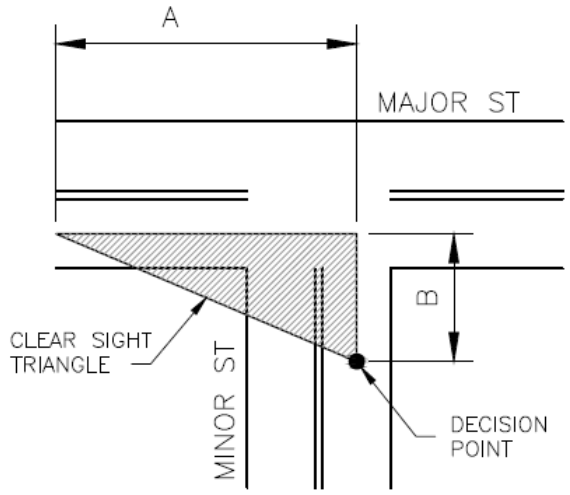
CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE RIGHT

Notes:
1. The values cited assume a two-lane major street with no median and grades of 3% or less.
2. For conditions different than those stated in Note 1, the sight distance must be adjusted per AASHTO guidelines.

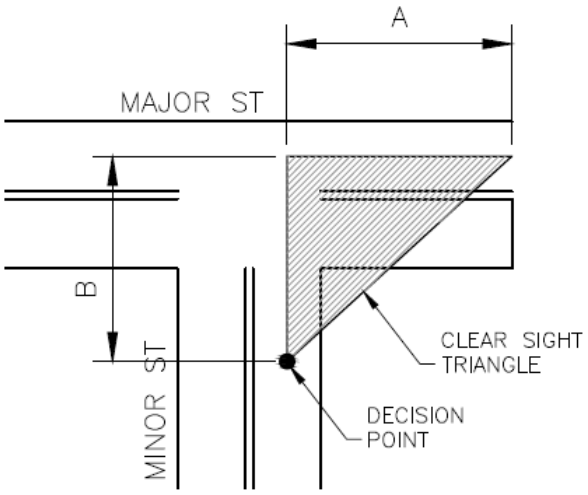
FIGURE II-5: SIGHT DISTANCE AT UNCONTROLLED INTERSECTION WITH 4 LEGS

POSTED SPEED LIMIT OF MAJOR STREET	CAR-PASSENGER
50	**245**
45	**220**
40	**195**
35	**165**
30	**140**
25	**115**
	DISTANCE A (FT)

CAR-PASSENGER	POSTED SPEED LIMIT OF MINOR STREET
245	**50**
220	**45**
195	**40**
165	**35**
140	**30**
115	**25**
DISTANCE B (FT)	



CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE LEFT



CLEAR SIGHT TRIANGLE FOR VIEWING TRAFFIC APPROACHING FROM THE RIGHT

Notes:
1. The values cited assume a two-lane major street with no median and grades of 3% or less.
2. For conditions different than those stated in Note 1, the sight distance must be adjusted per AASHTO guidelines.

FIGURE II-6: SIGHT DISTANCE AT PEDESTRIAN INTERSECTION

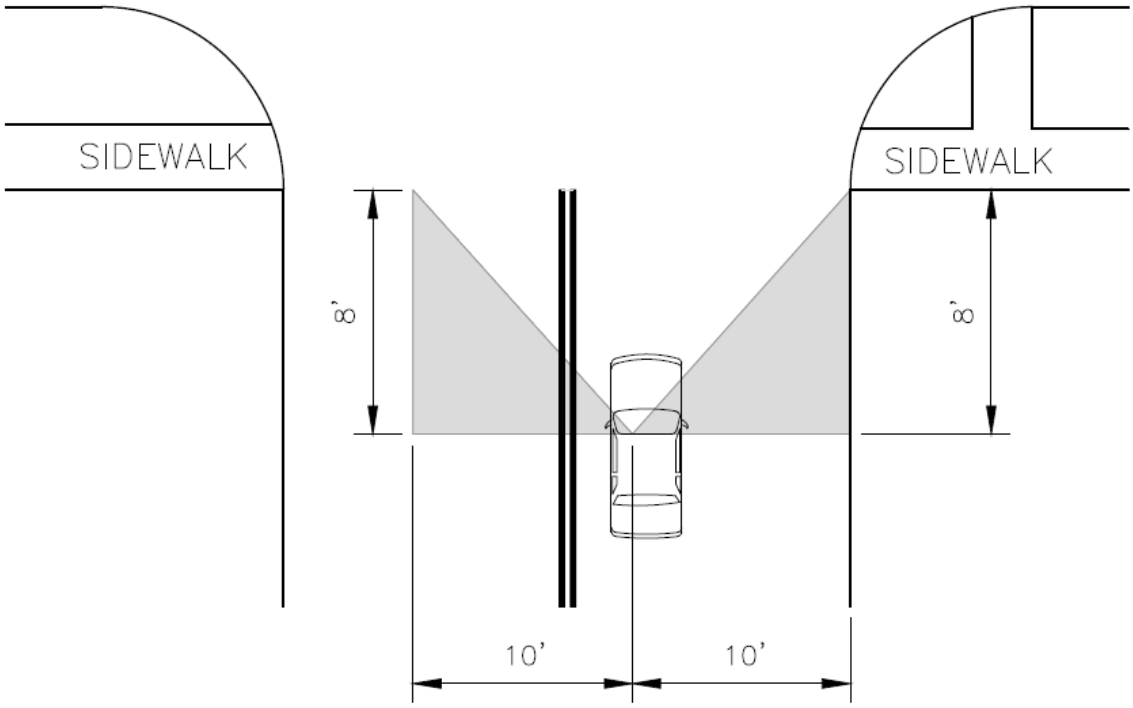
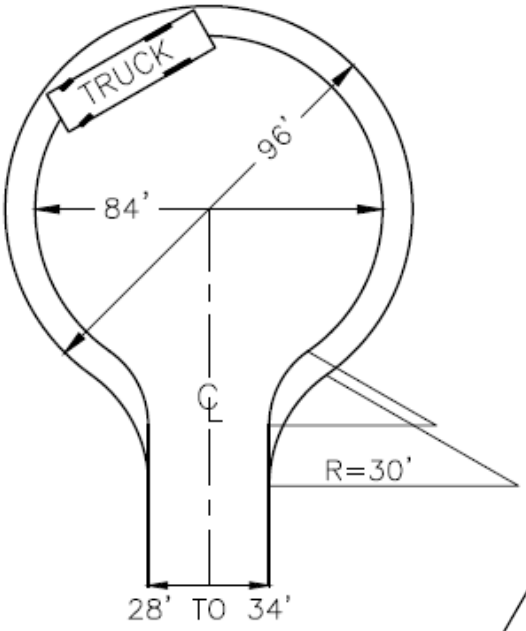


FIGURE II-7: CUL-DE-SAC TURNAROUND DIMENSIONS



NOTES:
1. FOR CUL-DE-SACS UNDER 500' IN LENGTH AS MEASURED FROM THE BEGINNING CURB OF THE DEAD-END ROADWAY TO THE CENTER OF THE CUL-DE-SAC, AN 84-FOOT DIAMETER BULB MAY BE USED. FOR ANY DEAD-END EXCEEDING 500 FEET, A 96-FOOT DIAMETER BULB SHALL BE USED.

2. AS AN ALTERNATE TO NOTE 1 ABOVE, THE CUL-DE-SAC BELOW MAY BE USED REGARDLESS OF THE DEAD-END LENGTH FROM THE CURB.

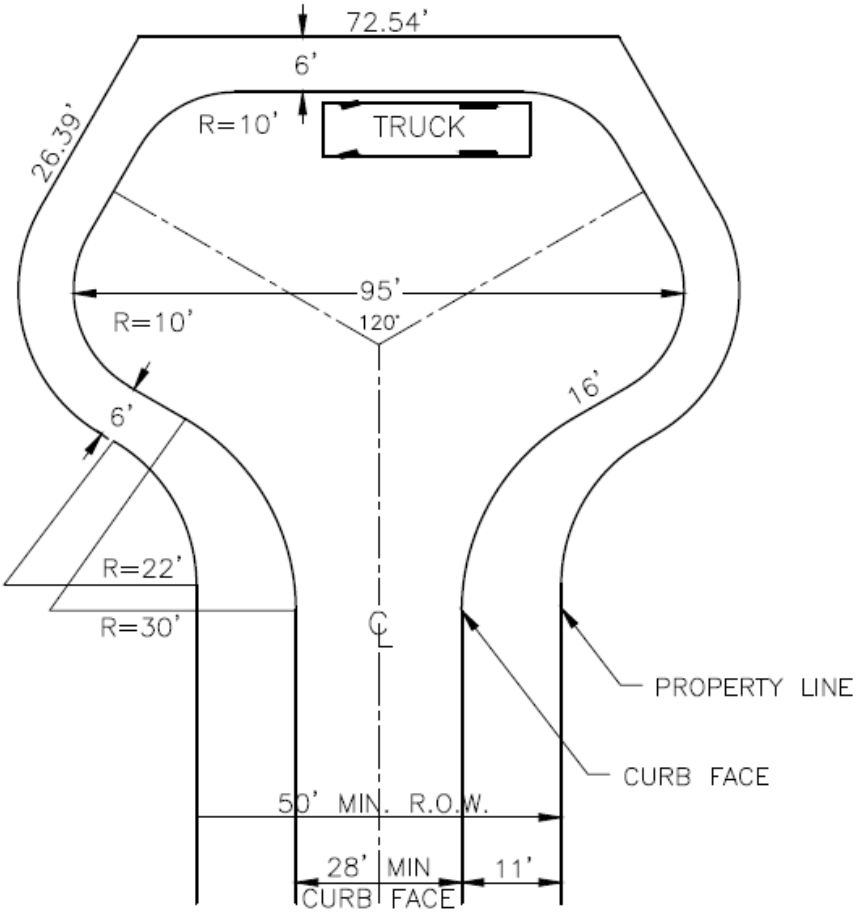
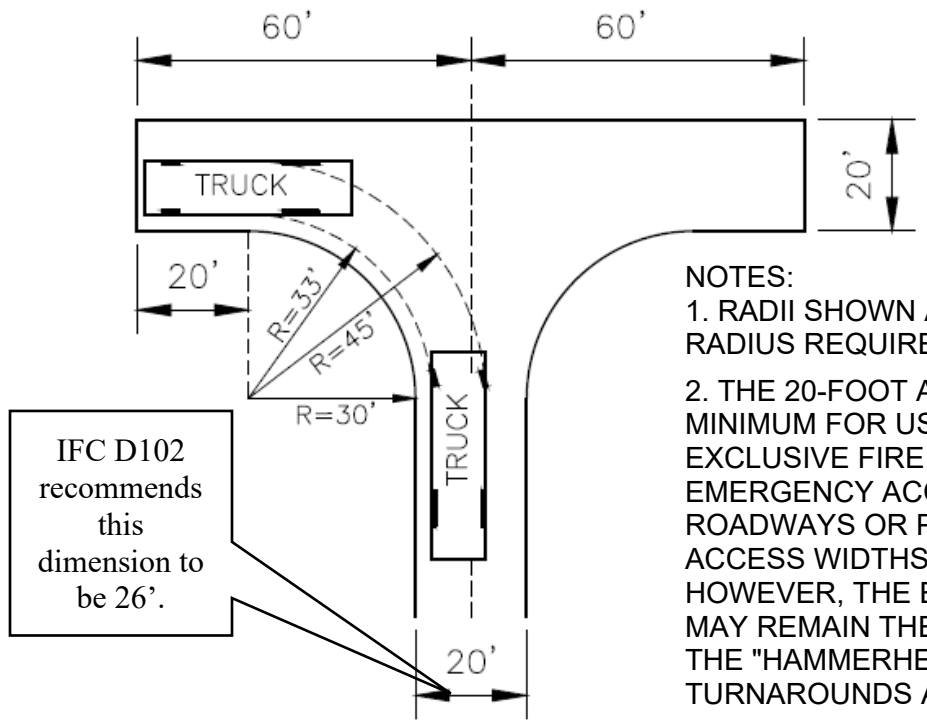


FIGURE II-8: T- AND Y-SHAPED TURNAROUND DIMENSIONS

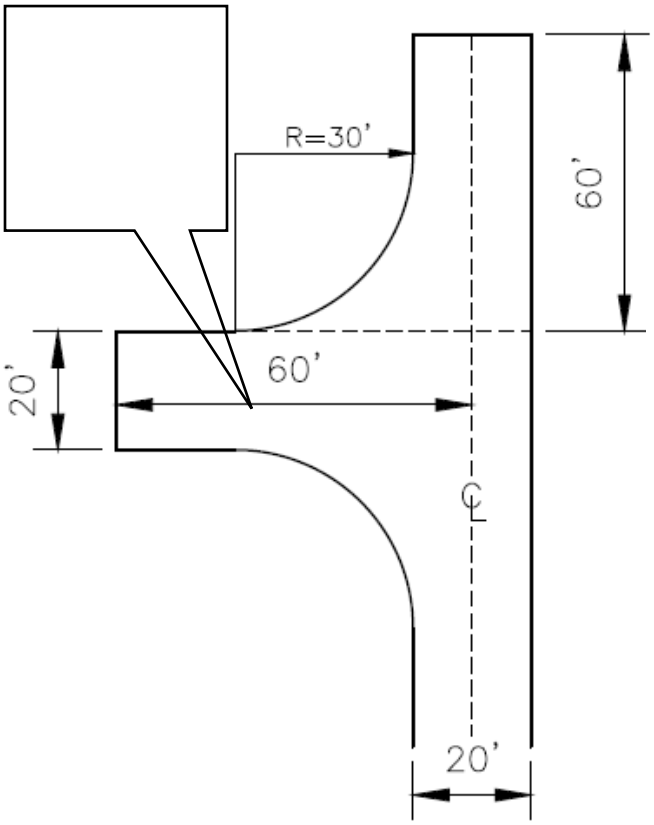


NOTES:

1. RADII SHOWN ARE MINIMUM TURNING RADIUS REQUIRED FOR FIRE APPARATUS.

2. THE 20-FOOT ACCESS WIDTH IS A MINIMUM FOR USE ONLY WITH AN EXCLUSIVE FIRE DEPARTMENT EMERGENCY ACCESS WAY. FOR ROADWAYS OR PUBLIC STREETS, THESE ACCESS WIDTHS MUST BE INCREASED. HOWEVER, THE END LENGTH OF 60 FEET MAY REMAIN THE SAME. VARIATIONS OF THE "HAMMERHEAD" T- AND Y-SHAPED TURNAROUNDS ARE SHOWN.

3. ANY ANGLE FROM 90° TO 180° IS ACCEPTABLE FOR A Y-SHAPED TURNAROUND PROVIDED THE SPECIFIED LENGTHS AND RADII ARE MAINTAINED.



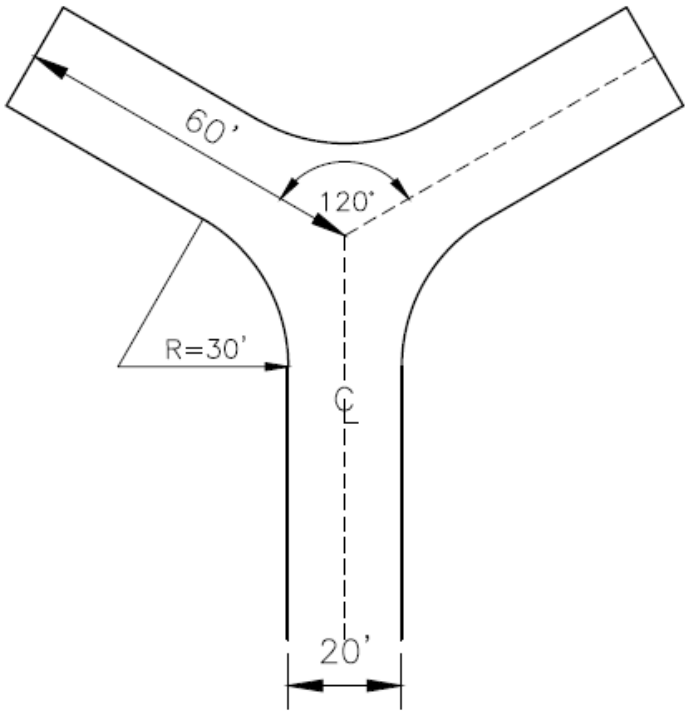
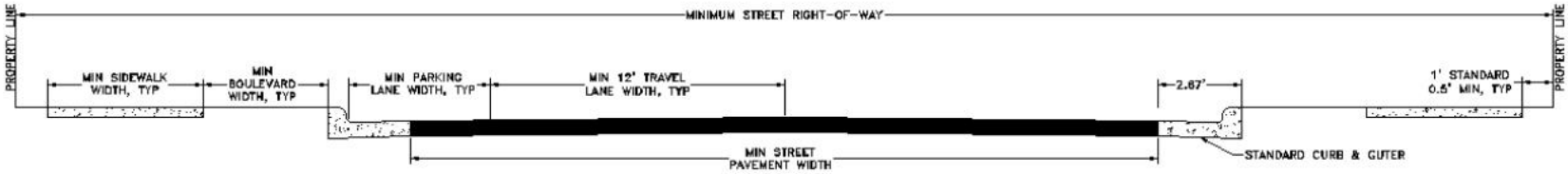


FIGURE 11-9: STREET AND RIGHT-OF-WAY CRITERIA



Street Classification	Minimum Street Pavement Width with No Parking[4] (Feet)	Minimum Street Pavement Width with One-Side Parking[4] (Feet)	Minimum Street Pavement Width with Two-Side Parking (Feet)	Minimum Parking Lane Width[6] (Feet)	Minimum Boulevard Width (Feet)	Minimum Sidewalk Width (Feet)	Minimum Right-of-Way Width[3] (Feet)
Alley[5]	16	NA	NA	NA	NA	5	20
Lane/Place[7]	24 [1]	29.5	35	7.5	4	5	60[2]
Local/Collector	24 [1]	29.5	35	7.5	6	5	66[2]
Arterial	26 [1]	NA	40	10	6	6	80
Industrial	26 [1]	NA	NA	NA	8	6	60[2]
Commercial	26 [1]	NA	40	10	10	10	90[2]

[1] Where a turn lane is required, pavement width increases by 10 feet and additional right-of-way may be required.

[2] Right-of-way width increases by 10 feet at a point that is 200 linear feet from an intersection with an arterial street.

[3] Increase in right-of-way may be required to accommodate special pavement widths such as additional travel lanes, turn lanes, parking, etc.

[4] Special approval required by the City.

[5] Alleys may be required in commercial zones to provide private property access. Alleys shall not be incorporated into new development unless special approval is granted by the City.

[6] Total parking lane width may include width of gutter pan.

[7] Special approval must be granted by the City to incorporate Lane/Place streets into new development.

Notes:

1. The minimum street placement widths shown are the responsibility of the "Developer". If added width is required by the City beyond those shown, the cot shall be negotiated with the City as a potential "oversize cost".
2. The minimum travel lane width for any road classification shall be 12-feet

III. WATER AND WASTEWATER FACILITIES

A. APPLICABILITY

1. This section applies to water and sewer utilities, including mains, pumping systems, pressure reducing stations, meter pits, domestic and fire service lines, and on-site systems; it does not cover irrigation systems. Construction and material requirements for infrastructure are specified in the City of Box Elder Standard Construction Specifications and Details, current edition.

B. AUTHORITY

1. This section is intended to comply with the Administrative Rules of South Dakota, which establishes standards for public water and sanitary sewer systems.

C. RELATED DOCUMENTS

1. State of South Dakota Standards.

2. Ten States Standards: as adopted and supplemented by SDDENR are incorporated into this manual of reference.

3. Administrative Rules of South Dakota, for individual and small on-site wastewater systems and as supplemented by any applicable City Ordinances governs the design and construction of on-site wastewater systems.

4. The following documents or references may be utilized as additional or supplemental additional or supplemental sources of design criteria or standards:

    i. Alternative Wastewater Systems, MOP FD-12, WEF, latest edition,

    ii. AWWA Standards, various,

    iii. Design or Gravity Sewers, MOP FD-5, ASCE/WEF, latest edition,

    iv. Design of Wastewater and Storm Sewer Pumping Systems, MOP FD-4, WEF, latest edition,

    v. Gravity Sanitary Sewer Design and Construction, ASCE Manual and Report on Engineering Practices No. 60,

    vi. Design Manual, on-site Wastewater Treatment and Disposal Systems, USEPA, latest edition,

    vii. Handbook of PVC Design, Third Edition, latest edition, and

viii. Pumping Station Design, current edition, published Elsevier Butterworth-Heinemann and distributed by AWWA.

D. GENERAL REQUIREMENTS

1. The design of private fire protection systems, water distribution systems, and on-site wastewater systems shall be accomplished by or under the direct supervision of a professional engineer registered by the State of South Dakota and in accordance with all applicable, City, State, and National codes and laws.

2. Private fire service mains shall be installed in accordance with NFPA 24 and shall be maintained in accordance with NFPA 25.

E. REQUIRED LOCATIONS OF UTILITY SYSTEMS

1. Location of Utilities within public right-of-way shall confirm to the requirements of Figure III-1.

2. Mains shall be constructed only in ROW, except as approved by the Public Works Director his/her designee. Consideration for construction of mains within easements may be considered under the following conditions:

    a. Topography is such that no street alignment, which allows mains to serve adjacent properties from a location in the ROW, can be provided.

    b. Water mains need to complete a looped system.

    c. For sewer mains, no more than one manhole is in the easement and the manhole is a standard manhole, not a drop manhole.

    d. Special circumstances: such as, offsite utilities must pass through un-platted property to provide service for proposed development.

    e. An easement is granted to the City and recorded with the County Register of Deeds, which easement shall include the following:

        i. Minimum easement width of 20 feet centered on the main.

        ii. For utilities buried deeper than 10 feet the easement width shall be two times the depth, centered on the utility.

        iii. If the utilities must pass between adjacent properties, the easement shall be located on one property.

iv. Combined water and sewer easement shall be a minimum of 30 feet wide with 10 feet separation between utilities and 10 feet between the utility and the edge of the easement.

v. Easement documents shall indicate that the property owner shall maintain easements free of all obstructions including but not limited to buildings, walls, hedges, trees, and shrubs. These easements grant, to all public authorities, the right to construct, operate, maintain, inspect, and repair such improvements and structures as the authority deems necessary to facilitate operation and maintenance of the public infrastructure.

vi. Easement documents shall identify entities responsible for repair or maintenance of any surfacing.

f. The finished surface profile of utility easements, parallel to the utility, shall not exceed 20 percent grade.

g. The finished cross slope or transverse slope of the utility easement, transverse to the utility shall not exceed 5 percent.

h. For public water mains, all high points in the profile shall be located within public right-of-way, or if located in an easement, all weather surfacing shall be provided to the high point for maintenance access.

i. For pubic sewer mains, all-weather surfacing shall be installed to provide access to all manholes, except under Section IIIE2d, a single manhole may be located in a location without all-weather surfacing provided that the manhole is not a terminus manhole and all other provisions for installation in an easement are met. Refer to Figure III.2.

j. Easements longer than 1,000 feet shall provide turnarounds for maintenance vehicles at 600 feet on center. Refer to Figure III-3 for turn-around dimensions.

k. Minimum vertical clearance above grade over easements shall be 13.5 feet.

l. Minimum surfacing width must be 12 feet. Surfacing shall be an "all weather" material, such as gravel or crushed rock.

3. Supplemental requirements for fire hydrants that cannot be located within the right-of-way.

a. A separate easement specifically for the City shall be provided for the fire hydrant.

b. The easement shall provide an area from the ROW defined as 8 feet each side of the fire hydrant lead and extending 6 feet minimum past the rear of the fire hydrant.

c. The fire hydrant shall be located so that there are no obstacles, barriers, or topographical constraints, within fifteen (15) feet of hydrant, which limit the City and/or Fire Department's ability to use the hydrant.

d. A note shall be placed on the easement document stating that the property owner cannot cover, block, or otherwise inhibit the use of the fire hydrant by installing any landscaping structural features, bushes, fences, retaining walls, etc. and the fire hydrant shall, always remain visible from the street ROW.

e. Fire hydrant placement outside of the ROW requires authorization of the Public Works Director, except for private fire protection systems.

4. Water mains shall be extended across the full frontage of each parcel to be served, except as modified for cul-de-sacs.

5. Sewer mains shall be extended across the full frontage of each parcel to be served, except may be terminated at a point just upstream of where service lines enter the ROW and when the City determines that no possibility exists that the main will need to be extended to serve adjacent property. Refer to Figure III-4.

6. Service lines shall be laid approximately perpendicular to the mains and shall connect directly into mains without crossing side or rear lot lines or adjacent parcels, and without running parallel to ROW centerline. Refer to Figure III-5.

7. Special Circumstances, Cul-de-sacs. Refer to Figure III-6.

8. Special circumstances, development, and utility service outside the City limits.

9. Separate and individual service lines shall be provided for each building or in the case of townhomes or condominiums, for each unit. Refer to Figures III-7A, III-7B and III-8.

F. CONSTRUCTION PHASING

1. Sewer systems shall terminate at the nearest upstream manhole located in adjacent and subsequent phases; if the sewer has the potential to be extended, a 2-foot stub shall be provided on the upstream side of the last manhole.

2. Water distribution systems shall extend across all proposed street intersections located in adjacent and subsequent phases.

3. Construction phasing which terminates mains in mid-block will be required to meet Section III.G.

G. PROVISIONS FOR FUTURE EXTENSION

1. Water Distribution Systems: Mains shall be terminated with a valve and plug immediately beyond a hydrant set on a tee and not at the end of the pipe to permit future extension of the main without opening or shutting off the main. Fire hydrants located at the terminus of a cul-de-sac may be terminated in accordance with Figure III-6.

2. Sewage Collection Systems:

    a. Manholes shall be fitted with inlet hole, boot, and a 2-foot sewer pipe extension with cap to permit future extension without additional modification to the manhole. Termination manholes will be permitted where the City determines that no future extension of sewer main is possible.

    b. Sewer main clean-outs will not be permitted.

H. REQUIREMENTS FOR MANUFACTURED HOME PARKS AND ONE OWNER, MULTI-RESIDENTIAL COMPLEXES, EXCLUDING APARTMENT BUILDINGS

1. Manufactured home parks and one-owner multi-residential complexes shall have mains located within the internal street system of the park or complex.

2. Each park or multi-residential complex shall have a single “master” meter for water billing. The park or multi-residential complex Owner may choose to install individual meters for each unit, but they will not be used for billing by the City.

3. Service lines in manufactured home parks and one-owner multi-residential complexes shall meet the requirements of Section III.N and all other applicable City and State standard specifications.

4. The requirements of this Section shall apply to proposed manufactured home parks when replacement or major improvements are made to existing utility systems.

5. Nothing in this section shall prohibit the water and sewer mains within the park or one-owner development from becoming public infrastructure, subject to approval by the City Council, provided the utilities meet all applicable standards and criteria and are placed within the public right-of-way or applicable utility easement.

I. WATER SYSTEMS

1. Design Life: All proposed water distribution systems shall be designed to achieve a minimum hardware design life goal of 75 years.

2. Design Criteria

   a. Water use criteria for various areas of the City shall be as stated in the current utility system master plan document. If values are not available in the master plan document, the following values shall be used:

      i. Domestic Water Use Criteria

WATER USE CRITERIA			
Land Use	**Average Day**	**Peak Day**	**Peak Hour**
Residential-Single	0.4 gpm/du	1.8 gpm/du	4.0 gpm/du
Residential-Multi-Family	0.3 gpm/du	1.3 gpm/du	3.0 gpm/du
Commercial-Office/Retail	0.8 gpm/ac	3.2 gpm/ac	6.4 gpm/ac
Industrial	0.8 gpm/ac	3.2 gpm/ac	25.6

gpm = gallons per minute
du = dwelling unit (house, apartment, hotel/motel room, campsite, etc.)
ac = acre

* Duplexes for the purpose of determining water use shall be considered as two residential single-family units.

** Recommended value to be utilized in the absence of site-specific engineering criteria/analysis.

      ii. Residential Fire Flow Requirements: Fire flow shall be as detailed in the currently adopted version of the IFC by the City of Box Elder.

      iii. Allowable Pipe Velocities: The following table shows the maximum allowable pipe design velocities:

MAXIMUM WATER PIPE VELOCITY	
Conditions	Maximum Allowable Pipe Velocity
Average Day Demand	**6 feet per second**
Peak Day Demand with Fire Flow	**12 feet per second**
Peak Hour Demand	**10 feet per second**

      iv. Water Pipe Friction Factor Criteria: The designer shall evaluate the distribution system they are analyzing for friction factors and minor losses. The designer shall summarize the assumptions made and supporting

rational. In the absence of a more refined evaluation for small distribution systems a Hazen-Williams "C" factor of 120 shall be used for the piping material.

v. Water Storage Requirements: The following methodology shall be used for sizing water storage facilities:

SSR = OS + (the larger FR or ER)

Where:

SSR = Supply Storage Required

FR = Fire Reserve (fire flow X duration)

OS = Operating Storage (water demand in excess inflow capabilities from water supply sources, which demand must be provided by outflow from the reservoir)

ER = Emergency Reserve (stored water needed to meet demand during a period when some or all supply sources are out of service)

- Notes:
    - The design engineer shall determine an OS value based on design conditions but shall not use an OS value less than 25 percent of the Total Peak Day Demand.
    - The design engineer shall determine an ER value based on the design conditions but shall not use an ER value less than 1 day of Average Day Demand.
    - The above formula assumes that a supply emergency (ER) and major fir event are not likely to occur simultaneously and therefore FR and ER are not additive, but rather than larger of the two values shall be used in the equation for determining Supply Storage Required (SSR).

3. Water Main Materials

a. Water main materials: shall conform to the requirements of the City of Box Elder Standard Construction Specifications and Details, most recent edition.

b. Standard main sizes for the City will be 6-inch to 16-inch in 2-inch increments. Refer to criteria for applicable uses of 6" main.

4. Pressure

    a. Static Pressure Requirements for systems are 40 psi minimum, and 135 psi maximum. Pressures are to be designed and measured at the highest surface elevation of the main for minimum pressure and lowest surface elevation of the main for maximum pressure.

    b. Peak 1-hour Flow Residual Pressure shall be 35 psi minimum. Pressures are to be designed and measured at the highest surface elevation of the main.

    c. Minimum Static and Residual Pressures delivered the finished ground floor elevation of any building site after the backflow preventer shall be 30 psi static and 25 psi residual.

    d. Individual booster pumps shall not be allowed for individual service from the public supply main to the meter/back-flow assembly, except in special approved circumstances and with the written permission of the Public Works Director or his/her designee. Meter/back-flow assemblies shall be located within the structure being served or remote enclosures / meter pits.

    e. When evaluating the distribution system pressure, the designer shall evaluate the system under two reservoir conditions. The system shall be evaluated with the reservoir at 50 percent full and at 100 percent full. The pressure criteria shall be satisfied for both the reservoir conditions.

    f. When evaluating the distribution system pressure, the designer shall also evaluate the system under the assumption that ancillary pumping systems are not running, and that 100 percent of the water used for evaluation purposes is from reservoir storage. The pressure criteria shall be satisfied for this condition.

5. Diameter

    a. Minimum diameter of system mains shall be 8 inches unless both of the following conditions are met:

        i. A minimum 6-inch diameter main may be permitted in a permanent cul-de-sac, assuming there is:

            - no potential of the line being looped,

            - no more than one fire hydrant connected,

            - a maximum length no greater than 450 feet, and

- a network analysis demonstrates a 6-inch diameter main satisfies fire flow and pressure requirements.

ii. Diameter shall be sized as necessary to meet the greater of "Peak Hour Demand" or "Peak Day Demand with Fire Flow" conditions.

b. Design shall limit the head loss to comply with the pressure requirements listed previously in this section.

c. Design shall limit pipe velocities to comply with the maximum velocity criteria listed previously in this section.

d. When evaluating the distribution system for purposes of determining pipe diameters the designer shall evaluate the total system as stated in this section.

6. Fire Flows

a. All water distribution systems shall be designed to provide levels of fire protection consistent with the zoning of property served.

b. Public system fire flow requirements shall be as determined by the currently adopted IFC by the City of Box Elder.

c. When evaluated the distribution system for purpose of evaluating fire flows the designer shall evaluate the system as described in this section.

d. Private fire protection systems shall be designed in accordance with the currently adopted IFC by the City of Box Elder.

7. Dead-Ends

a. Dead-end mains shall be minimized by looping.

b. Dead-end mains up to 600 feet will be permitted in permanent cul-de-sacs or to promote phased construction.

c. Dead-end mains greater than 600 feet and less than 1,200 feet shall only be permitted in special circumstances and require the written approval of the Public Works Director and/or his/her designee prior to the preparation of engineering drawings and submittal for City and State review. Additional cost does not constitute a special circumstance.

d. Dead-end mains longer than 1,200 feet are expressly prohibited.

e. All dead-end mains shall be terminated with a standard fire hydrant.

8. Valves

    a. Valve types shall be according to the following table:

Main Size	Type of Valve
6" thru 16"	Gate Valves
> 16"	Butterfly Valves

    b. Required Locations:

        i. At intersection for valve clusters.

        ii. On all branches of tees and crosses.

        iii. On the up-gradient side of all hydrant tees.

        iv. At pressure zone separation boundaries - a fire hydrant shall be installed at all pressure zone separation boundaries and two valves shall be installed, one on each side of the fire hydrant tee.

        v. At any other location directed by the Public Works Director or his/her designee deemed necessary for more efficient operation and maintenance of the system.

    c. Maximum spacing in compliance with above criteria but not more than:

        i. Distribution mains: 450 feet maximum to coincide with hydrant spacing.

        ii. Transmission mains: 900 feet maximum.

    d. The location, size, and type of all valves shall be shown on the plan and profile drawings.

    e. No valve or valve box shall be installed within concrete curbs, gutters, ramps, fillets, or within 10 feet (clear) of sewer facilities that require easement.

    f. Valve boxes may be placed in sidewalks and are required to be encased in a 16-inch x 16-inch minimum square concrete collar at the top of the valve box.

9. Fire Hydrants

    a. Spacing shall be as required by the IFC, but no greater than 450 feet for distribution mains or 900 feet for transmission mains.

b. Required Locations:

   i. Street intersections, within mainline valve cluster.

   ii. High point in the pipe profile.

   iii. Side lot line when spacing requires a hydrant to be in mid-block.

   iv. Setback from back of curb shall be at a minimum 4 feet and a maximum of 15 feet.

   v. Fire hydrants shall be located a minimum of 1-foot clear from edge of sidewalks.

   vi. Pumper steamer nozzle shall be oriented perpendicular to the least travel street at intersections and perpendicular to the street at mid-block.

c. Flushing hydrants are permitted only upon special approval by the City.

d. The location of all fire hydrants and valves shall be shown on the plan and profile drawings.

e. No fire hydrant or valve or valve box shall be installed within concrete curbs, gutters, ramps, fillets, or 10 feet of sewer facilities that required encasement.

f. Fire hydrant bollards shall be provided whenever a fire hydrant is located within a travel way such as a parking lot or when required by the Public Works Director.

10. Water Main Profile

a. Bury depth shall be measured from the finished grade to the top of the pipe per the following table:

Pipe Diameter (D), Inches	**Minimum Bury*, Feet**	**Maximum Bury*, Feet**
D ≤ 12"	6.0	15
12" < D < 20"	6.0	15
20" ≤ D	6.0	15

*If grading occurs such that the bury depth no longer meets the required minimum or maximum depths, the water main shall be reconstructed with a new main. Insulating the existing main may not be permitted except as described below in "Use of Insulation."

b. Use of Insulation: shall not be allowed to correct deficiencies in depth or to protect water mains from freezing due to the proximity to storm sewers. The Engineer of Record may request the exception to allow use of insulation. The request shall be in writing to the Public Works Director and shall detail the reasons why the main cannot be lowered and describe the alternatives. The request shall be made prior to the preparation of drawings and any submittal for City review. The use of insulation will not be permitted without the written approval of the Public Works Director or his/her designee. The use of insulation as a cost savings vs. lowering the main to the proper depth will not be considered a valid justification.

c. High points in profile shall be minimized by utilizing profile grades to establish the high point. Where high points occur, fire hydrants shall be located at the high point. If in the opinion of the Public Works Director and/or City Engineer, a hydrant would not be satisfactory, an air release valve may be required.

11. Joint Restraints and Thrust Blocks

a. Thrust restraint shall be provided for each dead end, valve, bend, tee, fire hydrant, reducer, fitting otherwise unrestrained, and where changes in the pipe diameters or flow direction occur.

b. The design engineer shall specify the size and shape of concrete thrust blocks, if specified.

c. The length of restrained joint piping and details of joint restraint glands, clamps, friction slabs, or other anchors shall be as specified by the design engineer.

d. The design engineer shall refer to the City of Box Elder Standard Construction Specifications and Details, current edition, for the requirements and use of joint restraints and thrust blocks and shall prepare their design to comply with the requirements of the specifications.

e. The designer shall be responsible for evaluating the soil type, bearing capabilities, and corrosion potential.

f. The designer shall employ a design safety factor commensurate with the site conditions and risk potential but in no case shall a safety factor of less than one-and-one-half (1.5:1) be applied.

g. The project drawings shall contain information for each fitting, tee, cross, etc., criteria for "Minimum Concrete Thrust Block Bearing Area" and "Minimum Concrete Volume per Thrust Block".

h. The designer shall include a plan note indicating if a fitting installation is to be restrained or thrust blocked and, if restrained, the beginning and the end of the restraint.

12. Water Mains in Relation to Sewers: Separation of water and sewer mains shall be as required by SDDANR criteria and the City of Box Elder Standard Construction Specifications and Details, current edition.

13. Stream Crossing

    a. For this manual, stream shall meet the Corps of Engineer designation, be any stream requiring a 404 permit, or as defined by the Public Works Director and/or City Engineer.

    b. A stream crossing shall start and end within a minimum of 20 feet horizontally into the stream bank or where scour and erosion will not occur.

    c. Pipe and installation shall comply with Ten States Standards, SDDANR criteria, and the City of Box Elder Standard Construction Specifications and Details, current edition.

    d. At a minimum, water main pipe shall be installed within a casing pipe or have a concrete pipe cap installed.

    e. If a concrete pipe cap is proposed, the designer shall provide a detailed design for the pipe cap that in general meets the following minimums:

        i. Cap at a minimum shall have a width three times the diameter of the pipe.

        ii. Shall extend the entire length of the stream crossing.

        iii. Concrete shall be reinforced concrete with a minimum thickness of 6 inches.

        iv. The cap shall extend vertically from the spring line of the pipe to a minimum of 6 inches above the pipe crown.

14. Water Mains in Casing Pipes

    a. Water mains in casing pipe shall have restrained joints.

    b. If the pipe jacking method of installation is used the casing pipe shall be reinforce concrete pipe, or steel with minimum yield strength of 35,000 psi and minimum wall thickness as follows:

Diameter of Casing, Inches	Minimum Wall Thickness*, Inches
Under 14	0.188
14 & 16	0.282
18	0.312
20	0.344
22	0.375
24	0.406
26	0.436
28 & 30	0.469
32	0.500
34 & 36	0.531
38, 40 & 42	0.563

* Additional wall thickness may be required based on the design, especially in the case of long bores or poor soil conditions.

c. If the directional boring method is used the casing pipe shall be a minimum 250 class PVC restrained joint pipe or minimum 250 class HDPE fused pipe.

d. Casing pipe shall have an inside diameter at least 6 inches greater than maximum outside bell diameter of the carrier main.

e. Water mains with bell and spigot joints placed in casing pipe shall be supported with the centering restraining casing chocks specifically designed for this purpose. Casing chocks shall be fabricated from non-corrosive materials.

f. Chocks shall be installed at each side of pipe joint at the midpoint of the carrier pipe joints. Maximum spacing shall not exceed 10 feet between chocks. Casing chock details shall be included on the drawings.

g. Casing pipe shall be sealed with prefabricated non-corrosive end seals and bands manufactured specifically for the purpose of preventing movement of ground water or backfill through the casing pipe.

h. Grout seals of the annular shall not be permitted.

i. Casing pipes shall be designed with a life expectancy equivalent to that of the carrier pipe.

15. Design Calculations Submittal Requirements for Water Mains: The Engineer of Record shall submit their design assumptions and criteria used to establish the pipe sizing and pressure rating. In addition to this information, the designer shall submit the calculated Peak Hour Demand, Peak Day Demand with Fire Flow, and Average Day Demand conditions.

J. REGIONAL WATER FACILITIES

1. Administrative Requirements Pertaining to Ancillary Water Facilities

    b. Water facility consisting of pressure reducing stations, water booster stations (constant pressure and standard), water storage reservoirs, water supply and treatment facilities (wells and well houses, galleries, and surface water collection systems) shall comply with current City Master Plans.

    c. These types of facilities shall be designed and constructed as regional facilities, whenever possible.

    d. All proposed regional facilities except for on-site systems within the City shall be designed, bid, and constructed under the supervision of the Public Works Department.

2. If a private developer wishes to propose a regional facility within the City, then the developer shall prepare a "feasibility study analysis" for review by the Public Works Department staff and/or City Engineer.

    a. Public Works staff shall prepare a proposal and recommendation for City Council consideration.

    b. If the council agrees with the proposal, they shall authorize staff to allocate resources to prepare a "Development Agreement".

    c. The Development Agreement shall be prepared and executed between the City and the Developer identifying the probable costs of the facility, the financial responsibilities for the facility, and schedules for design and construction.

    d. The Development Agreement shall be approved by City Council prior to submitting Preliminary Plats for review by the City staff.

    e. In cases where the City is the entity initiating the project, then council approval of a Request to Solicit Proposal for Engineering Services shall be acceptable for the purpose of initiating the project and Development Agreement will not be required.

    f. Regional facilities within the jurisdictional area of the City, but outside the City limits, shall comply with current City Master Plans.

    g. If facilities outside the City Limits but within the jurisdictional area of the City are proposed to be operated by entities other than the City, then authorization of the Box Elder City Council to allow facilities to be private shall be obtained

prior to Preliminary Plats are approved by the City Planning Commission and Council.

h. All proposed regional facilities except for on-site systems not authorized by the Council to be private shall be designed, bid, and construction under the supervision of the Public Works Department.

i. Facilities to be designed and constructed under supervision of the Public Works Department shall meet the provisions above.

3. General Requirements

a. Regional water facilities will only be employed when the extension of off-site water mains for the appropriate pressure zone is not feasible or is not in accordance with the recognized city master plans, documents, or comprehensive plans.

b. Appendix A contains the City review/summary form for evaluation of proposed systems.

c. Consideration for regional water facilities will be evaluated by the City Public works Department for City initiated projects.

d. For City initiated projects this will be accomplished through the RFP process.

e. The feasibility study and analysis shall be submitted to the Public Works Department and shall include the following:

ii. Description of the project and purpose.

iii. Provide justification for the facility and analysis of alternatives.

iv. Address the facility's roles as a regional facility and projected integration into the City's identified service zones and systems.

v. The Public Works Department will review the "feasibility study and analysis" and provide written comments back to the developer, the developer may provide written response to the comments which will be incorporated into the presentation of the "feasibility study and analysis" to the Council.

vi. The Public Works Department will submit the "feasibility study and analysis" along with developer comments and staff recommendations to the City Council.

vii. The City shall retain an Engineering Consultant in accordance with the City's adopted consultant selection policy.

viii. The Engineering Consultant shall provide a detail design report. Following review by the Public Works Department, the detailed design report shall be submitted to the Council for approval. The detailed design report shall include the following, both for present and future design conditions:

- Design period.
- Population densities per acre and total population.
- Areas served in acres.
- Per capita contribution - average and maximum.
- Land use.
- Commercial and industrial contributions.
- Design flow rates - average and peak.
- Fire flow requirements.
- Standby power requirements.
- Physical address.
- Required building permits.
- Listing of supplemental Design Criteria.

4. Criteria for Water Booster Stations

a. Design life goal of non-mechanical components shall be 75 years. Mechanical components shall have a design life goal of 25 years.

b. The design report for water booster stations shall include the following for both initial and future conditions:

i. Number, type, capacity, motor horsepower and net positive suction head (NPSH) requirements of proposed pumping units.

ii. System head curve (including head computations) for the pumping system.

iii. System head calculations and assured C (friction) factor.

iv. Water hammer and surge analysis.

v. Detailed design criteria for each specific Water Booster Station shall be developed by the Engineer of Record and approved by the Public Works Department.

vi. Operation and maintenance considerations shall include those items discussed and agreed upon between the Consultant and the Public Works Department for the specific facility.

vii. Engineering Economic Analyses, when necessary.

viii. Funding options.

c. The final design and construction documents for the water booster station facility shall incorporate specific Design Criteria determined and agreed upon between the Consulting Engineer and the Public Works Director.

5. Criteria for Water Storage Reservoirs

a. Design life goal of the storage reservoir facility shall be 100 years. Mechanical components shall have a design life goal of 25 years.

b. The design report for water storage reservoir shall include the following for both the initial and future conditions:

i. Type of facility, elevated, ground level, buried, etc.

ii. Reservoir materials and structure.

iii. Site and facility aesthetics.

iv. Geotechnical engineering site evaluation and considerations.

v. Site evaluations, alternatives, availability.

vi. Details design criteria for each specific water storage reservoir shall be developed by the Engineer of Record and approved the Public Works Department.

vii. Operation and maintenance considerations to include provisions for accessibility, facility and site operation and maintenance considerations, provisions for equipment replacement and maintenance and upgrades,

availability of replacement parts, reservoir coatings, maintenance considerations, and security considerations.

viii. Engineering economic analysis, including funding options.

c. The final design and construction documents for the facility shall incorporate the design criteria developed and agreed upon between the consulting Engineer and the Public Works Director.

6. Criteria for Source Water Facilities Consisting of Wells and Well Houses and Infiltration Galleries

a. Design life goal of the source water facility shall be seventy-five (75) years. Mechanical components shall have a design life goal of twenty-five (25) years.

b. The design report shall include the following for both the initial and future conditions:

i. Description of the proposed water source including geology, hydrology, reliability, aquifer characteristics (draw downs, sediment transport, water quality and quantity), applicable regulations, etc.

ii. Number, type (line shaft and submersible), capacity, motor horsepower and requirements of proposed pumping units.

iii. System head curve (including head computations) for the pumping system.

iv. System head calculations and assured C (friction) factor.

v. Treatment methods (disinfections, filtration, etc.) utilizing best available technology treatment practices. Includes addressing chemical availability and solids, and residuals handling.

vi. "CT" analysis for disinfection.

vii. Water hammer and surge analysis.

viii. Detailed design criteria for each specific facility shall be developed by the Engineer of Record and approved by the Public Works Department.

ix. Well borehole size recommendations, casing material, screens recommendations.

x. Probability of flowing wells or artesian conditions, address design challenges associated with these types of facilities.

xi. Test pumping and well development recommendations.

xii. Water rights / acquisition shall be addressed at the time the report is submitted for review.

xiii. Facility plan preparation; and

xiv. Funding sources.

c. Operation and maintenance considerations to include provision for accessibility, building and site operation and maintenance considerations, provisions for equipment replacement and maintenance, upgrade, and availability of replacement parts. Power costs and overall facility efficiency, flow metering provisions. Need for visible or audible screening of facilities, including items not inside buildings, shall be identified and discussed in the report.

d. The final design and construction documents for the facility shall incorporate the following design criteria:

i. Site Design.

ii. Facility design; and

iii. Operations and maintenance manuals and as-constructed drawings.

7. Criteria for Surface Water Treatment Facilities: Specific criteria will be developed by the Public Works Department after the City authorizes design work for the facility.

8. Criteria for Pressure Reducing Facilities

a. Design life of the pressure reducing facility shall be designed to achieve a design life goal of 75 years. Mechanical components (not buried) shall be designed to achieve a design life goal of 25 years.

b. Prior to design, pressure reducing stations must be approved by the Public Works Director and/or City Engineer.

c. Pressure reducing stations shall not be permitted on water mains or lines having a normal working pressure of less than 100 psi.

d. Pressure reduction in mains having working pressures less than 100 psi shall be accomplished by using individual pressure reducing valves on individual service lines.

e. Approved reducing stations shall meet the following criteria:

i. Contain a minimum of two pressure reducing valves operating in parallel.

ii. The smaller valve shall be sized for full open operations at 1/3 of the design flow.

iii. The larger valve is sized for full open operations at 2/3 of the design flow.

iv. Design flow shall be the Peak Day with Fire Flow.

v. Internal by-pass piping and valving around each pressure reducing valve shall be provided.

vi. External by-pass piping and valving around each pressure reducing valve shall be provided.

vii. Prefabricated, below-grade steel structures shall be protected in approved manner, exterior insulated, ventilated, heated, dehumidified, and provided with sump and sump pump when necessary.

f. The site shall be provided with the following:

i. Parking space for at least one maintenance vehicle adjacent to the station.

ii. A paved surface of approximately 100 square feet at and around the station entrance hatch; and

iii. Guard-post with spacing and location as necessary to protect the access hatch, electrical equipment, and accessory equipment.

9. The design report shall include the following for both initial and future conditions:

a. Description of proposed facility including the system hydraulics.

b. Number, type of pressure reducing valves.

c. System head curve including loss computations for pressure reducing station.

d. System head calculations and assumed C (friction) factor.

e. Detailed design criteria for each specific facility shall be developed by the Engineer of Record and approved by the Public Works Director and/or City Engineer.

K. WASTEWATER COLLECTION SYSTEMS

1. Design Life: All proposed sewer collection systems shall be designed with a minimum design life goal for hardware components of 75 years.

2. Design Flow

   a. Average flow determinations shall be in accordance with current Utility System Master Plan Documents and/or reports.

   b. In the absence of current Master Planning Documents or reports, per capita flows shall be used for residential and multi-family land uses and standard flow generation criteria from the SDDENR shall be used for commercial, industrial, and public land uses.

      Average Residential Flow*: Q_{Ravg} (gpm) = ((Q_{pcpd} x PPH x DU x A) / 24) / 60

      * Equation to be used for residential and multi-family land uses.

      Where:

      Q_{Ravg} = Average calculated residential wastewater flow in gallons per minute (gpm).

      Q_{pcpd} = Design flow in gallons per capita per day (gpcpd). In the absence of better information use 100 gpcpd.

      PPH = Population per household (PPH). In the absence of better information use 2.65 PPH.

      DU = Dwelling units per acre. Use future land use plans. In the absence of future land use plans request recommended land use projections from the City.

      A = Area in acres. The designer may apply a reduction factor to the area if topography will not allow for the property to be fully developed in accordance with future land use plans. The use and magnitude of a reduction factor requires authorization from the Public Works Director and/or the City Engineer.

Average Commercial Flow**: Q_{Cavg} (gpm) = QA x A

Average Industrial Flow**: Q_{Iavg} (gpm) = QA x A

Average Public Land Flow**: Q_{Pavg} (gpm) = QA x A

** Same equation to be used for commercial, industrial, and public land uses.

Where:

Q_{Cavg} = Average calculated commercial wastewater flow in gallons per minute (gpm).

Q_{Iavg} = Average calculated industrial wastewater flow in gallons per minute (gpm).

Q_{Pavg} = Average calculated public land wastewater flow in gallons per minute (gpm).

Q_{Cavg} = Average calculated commercial wastewater flow in gallons per minute (gpm).

QA = Design flow in gallons per acre (gpm/acre). In the absence of better information use 3 gpm/acre for commercial and industrial flow estimates and 2 gpm/acre for public land flow estimates.

A = Area in acres. The designer may apply a reduction factor to the area if topography will not allow for the property to be fully developed in accordance with future land use plans. The use and magnitude of a reduction factor requires authorization from the Public Works Director and/or the City Engineer.

Note: For areas with mixed land uses, the designer shall calculate the Q_{avg} for each land use and sum them to establish the total Q_{Tavg}:

Q_{Tavg} = $Q_{Ravg} + Q_{Cavg} + Q_{Iavg} + Q_{Pavg}$

c. Peak flow determinations shall be in accordance with current Utility System Master Plan Documents and/or reports.

d. In the absence of current Master Planning Documents or reports, the following criteria shall be used.

Peak Flows: Q_{peak} (gpm) = Q_{avg} x PF x RF

Where:

Q_{peak} = Peak calculated wastewater flow in gallons per minute (gpm).

Q_{avg} = Average calculated wastewater flow in gallons per minute (gpm).

PF = Peaking factor, use:

4.2 for residential and multi-family

2.7 for commercial and industrial

1.2 for public land

RF = Reduction factor, use:

Residential Reduction Factors*

POPULATION SERVED	RF
< 500	1.000
501 - 1,000	0.955
1,001 - 2,000	0.905
2,001 - 5,000	0.860
5,001 - 10,000	0.775
> 10,000	0.720

* Derived from SDDENR Design Criteria Manual.

Commercial/Industrial Reduction Factors**

AREA (ACRES)	RF
< 1,000	1.00
1,001 - 2,000	0.95
2,001 - 5,000	0.85
> 5,000	0.71

**Derived from ASCE Manual of Practices, No. 60, 1982.

Note: For areas consisting of multiple land uses, the designer shall calculate Q_{avg} and Q_{peak} for each land use. When applying a reduction factor (RF) for sizing the sewer main, the designer shall apply the RF incrementally based on the above tables from the farthest downstream location up to the point where an RF will not be applied. This methodology may require the use of multiple RF's.

3. Sewer Main Layout

    a. The position of new sewer main within the ROW shall be in accordance with these criteria.

    b. Relationship to other (private) utilities:

        i. Other (private) utilities (parallel to sewer mains) shall maintain a minimum 5-foot horizontal separation from the water main.

        ii. Other (private) utilities shall attempt to cross water mains at right angles to obtain the 5-foot separation as soon as practical.

        iii. Sewer and water main separation shall meet the requirements as established elsewhere in this section.

4. Minimum Size

    a. No gravity sewer main shall be less than 8 inches in diameter.

    b. The sewer main shall be sized so that the peak flow does not exceed the following:

        Q_{peak} d/D ratio < 0.70

        Where:

        d = depth of Q_{peak} flow in sewer main

        D = diameter of the sewer main

    c. Upstream sewer mains shall not be larger in diameter than the downstream sewer. The Engineer of Record may request an exception to this requirement. The request shall be in writing, to the Public Works Director, and shall be made prior to the preparation of drawings and any submittal for City review.

5. Depth

    a. Interceptor sewers (no services) shall have a minimum depth of 4 feet over the top of pipe, or when not possible, berms or insulation may be used.

    b. Collector sewers shall have a minimum depth as follows:

        i. 5 feet over the top of the pipe.

        ii. As necessary for top of main 1 foot below service line invert at the main.

6. Slope

    c. Minimum slope shall be established to provide flow velocities greater than 2.0 feet per second (fps) for design peak flows, but not less than recommended in Ten States Standards and SDDANR recommended design criteria.

    d. Deviations from the minimum slope may be permitted, down to average daily flow velocities of 1.8 (fps), with written approval of the Public Works Director and/or City Engineer.

    e. Maximum slopes on mains shall not exceed a slope creating a velocity of 10 fps at half pipe depth. Greater velocities may be permitted with written approval from the Public Works Director or City Engineer. Deviations from the maximum slope on all mains may be considered if manholes with energy dissipating structures of the vortex type are utilized. Mains with slopes greater than 20% or with velocities greater than 10 fps at half pipe depth shall be anchored according to the requirements of the Ten State Standards and SDDENR Recommended Design Criteria.

    f. Because of the nature of the material being conveyed in a sewer, an "n" value less than 0.013 is not recommended, therefore friction factor (“n") values less than 0.013 are not permitted.

    g. Manholes shall be located at all changes in slope. Refer to Figure III-11 for sewer mains 24 inches and larger in diameter. It is desirable to maintain a constant slope on sewer mains of the same diameter over long segments containing multiple manholes. It is also desirable to minimize having steeper slopes segments upstream from segments with flatter slopes. Additional burial depth of sewer main is not sufficient justification to disregard these recommendations.

    h. All changes in pipe diameter shall be made in manholes. Changes in pipe diameter, at a minimum shall be accomplished by matching the crown of the outlet pipe with the crown of the lowest inlet pipe crown.

    i. The pipe slope shall be calculated from the inside edge of manhole to inside edge of manhole using the design invert elevations, (rise / run). The run shall be calculated from inside edge of manhole to inside edge of the next manhole.

7. Alignment

    a. All changes in direction shall be made at manholes. Refer to Figure III-11 for sewer mains 24 inches and larger in diameter.

b. Deflecting the pipe at joints to change alignment or slope shall not be permitted.

c. Branches or sewer laterals extending from sewer mains shall begin at manholes.

8. Sewer Main Material

   a. Sewer mains shall be the following material, meeting the requirements of the standard specifications.

   b. The design engineer shall address coating or other corrosion protection measures from the pipe to achieve the design life goals.

9. Sewer Manholes

   a. Position in ROW shall generally be as shown in figures in these standards.

   b. Maximum spacing shall be 400 feet for sewers 15 inches or less. Distances up to 450 feet may be allowed if justification is provided by the designer and approval is granted by the Public Works Director and/or City Engineer. Maximum spacing for sewers 18 inches and larger shall be 500 feet.

   c. Minimum manhole diameter shall be 48 inches. For sewer mains 24 inches and larger in diameter, manholes shall be pre-cast tees with a minimum of 48-inch vertical riser.

   d. Manholes 5.5 feet and greater in depth, measured from invert to rim, shall have eccentric cone top sections per the Standard Details.

   e. Manholes less than 5.5 feet in depth shall have flat concrete covers designed for AASHTO H-20-wheel loading as shown in the Standard Details.

   f. Invert channel slope or drop shall be greater of the following:

      i. Minimum slope through a manhole shall not be less than the average slope of "the slope in" and "the slop out", but in no case shall be less than what is required below.

      ii. Manholes placed at changes in horizontal alignment less than 45 degrees shall not have a drop less than 0.10 feet across the manhole.

      iii. Manholes placed at changes in horizontal alignment greater than 45 degrees shall not have a drop less than 0.15 feet across the manhole.

   g. The designer shall select the type of frame and cover in accordance with the Standard Specifications. The opening of the eccentric cone section shall be

centered over the inlet sewer main. In cases where there is more than one inlet, the opening of the eccentric cone section shall be centered between the inlet mains.

h. Steps shall not be provided for sanitary sewer manholes.

i. Sewer mains shall terminate with a manhole. Cleanouts shall are permitted.

j. Services less than 8 inches in diameter shall not be connected to manholes, except as approved in writing in advance by the Public Works Director.

k. Manholes located outside of paved surfaces shall be designed such that a positive drainage will be maintained away from the manhole.

10. Drop Manholes: Drop manholes should be avoided whenever reasonably possible, to avoid excessive depth and will only be allowed with written permission from the Public Works Director and/or City Engineer. Internal drop manholes will not be allowed under any circumstances.

11. Sewer Mains in Casing Pipes

a. Sewer mains in casing pipe shall have restrained joints.

b. Casing pipe shall be reinforced concrete pipe, or steel with minimum yield strength of 35,000 psi and minimum wall thickness as follows:

Diameter of Casing, inches	Minimum Wall Thickness*, inches
Under 14	0.188
14 & 16	0.282
18	0.312
20	0.344
22	0.375
24	0.406
26	0.436
28 & 30	0.500
32	0.500
34 & 36	0.531
38, 40 & 42	0.563

* Additional wall thickness may be required based on the design especially in the case of long bores or poor soil conditions.

c. Casing pipe shall have an inside diameter at least 6 inches greater than the maximum outside bell diameter or the carrier main.

d. Sewer main in casing pipe shall be supported with centering and restraining casing chocks, specifically designed for the purpose. Casing chocks shall be fabricated from on-corrosive materials. Chocks shall be installed at each side of pipe joint, at the point of the carrier pipe between pipe joints, and maximum spacing shall be 10 feet between chocks. Casing chock details shall be included on the design drawings.

e. Casing pipe shall be sealed with prefabricated, non-corrosive, end seals and bands manufactured specifically for the purpose of preventing movement of ground water or backfill through the casing pipe. Grout seals of the annular space shall not be permitted.

f. Corrosion shall be component of the design of casing installations.

12. Stream Crossings

a. For purposes of these standards, steam shall mean all Corps of Engineer designated streams, any stream requiring a 404 Permit, or as required by the City Engineer. A stream crossing is defined to start and end within 20 feet of the stream bank or where scour and erosion will not occur.

b. Pipe and installation shall comply with Ten States Standards, SDDANR design criteria, and the City of Box Elder Standard Construction Specifications and Details, current edition.

c. The sewer main pipe shall be installed within casing pipe or have a concrete pipe cap installed. When utilizing a pipe cap, the designer shall provide a detailed design for the pipe cap meeting the following:

i. Cap shall have a width of three times the diameter of the pipe.

ii. Cap shall extend the entire length of the stream crossing.

iii. Concrete shall be reinforced concrete with a minimum thickness 6 inches.

iv. Cap shall extend vertically from the spring line of the pipe to a minimum of 6 inches above the pipe crown.

13. Sewers in Relation to Water Mains

a. Separation of water and sewer mains shall be as required by SDDANR criteria and the City of Box Elder Standard Construction Specifications and Details, current edition.

b. When the separation requirements of Ten State Standards cannot be satisfied at crossings of water and sewer mains, one of the mains shall be encased in low strength concrete.

14. Hydrogen Sulfide Generation Analysis for Sanitary Sewer Mains

a. Sanitary sewer mains shall be analyzed from hydrogen sulfide (H2S) generation. The designer shall evaluate H2S generation in accordance with "ASCE - Manuals and Reports on Engineering Practice - No. 60 Titled Gravity Sanitary Sewer Design and Construction." For gravity sanitary sewer mains 24 inches in diameter and smaller the following "Z" formula shall be used:

Z = (EBOD / (S1/2 X Q 1/3) X (P/B)

Where:

Z = Defined Function Value for H2S generation

S = Hydraulic Slope (ft/ft)

Q = Discharge Volume (cfs)

P = Wetted Perimeter (ft)

B = Surface Width (ft)

EBOD = Effective BOD (mg/l)

Hydrogen Sulfide Condition Values

Z Value	Condition Description
Z< 8,000	Rare H2S generation potential
5,000 < Z < 10,000	Marginal H2S generation potential
Z > 10,000	Common H2S generation potential

b. The design engineer shall analyze the sanitary sewer collection system for H2S generation. For gravity sanitary sewer mains 24 inches in diameter and smaller, the above equation and the following variable values shall be used:

S = The designer shall use the flattest slope in the system being analyzed.

Q = The designer shall analyze H2S generation at 1%, 5%, 25%, 75%, 95%, 100%, and 105% of peak flow Q_{peak}.

c. As a minimum the designer shall analyze H2S generation at the following sewage characteristics:

   EBOD = 300 mg/l (residential, multi-family, & public land uses)

   EBOD = 500 mg/l (commercial & industrial land uses)

   *For commercial and industrial applications, the designer may be required to use a larger more specific EBOD, as identified by the industrial waste survey.

d. For systems classified as "Marginal H2S generation potential" or "Common H2S generation potential," the design engineer shall incorporate and supplement the Standard Specifications to provide additional system protection against H2S attack. The design engineer shall establish recommendations that meet the intent of achieving the established design life goals. The uses of coatings, the installation of venting devices, chemical addition, or mechanical aeration are examples of additional protection measures.

e. The designer shall evaluate H2S generation for gravity sewers larger than twenty-four (24") inches in diameter in accordance with "ASCE - Manual and Reports on Engineering Practice - No. 60 title Gravity Sanitary Sewer Design and Construction.

f. The Engineer of Record shall submit their design assumptions, criteria used, and reference their design resources as a condition of plans approval. In addition to this information, the designer shall submit the design information referenced above for all proposed piping.

L. REGIONAL WASTEWATER FACILITIES

1. General

a. Ancillary Wastewater Facilities consisting of Lift Stations, Wastewater Treatment Facilities including but not limited to mechanical plants and lagoons, on-site systems, and Alternative Wastewater Collection Systems shall comply with current City Master Plans and Public Works general philosophy of system integration. These types of facilities shall be designed and constructed as regional facilities whenever feasible.

b. All proposed regional facilities except for on-site systems and alternative wastewater collection systems within the City shall be designed, bid, and constructed by the Publics Works Department.

c. If a private developer wishes to propose a regional facility including on-site systems and alternative wastewater collection in the City, then the developer shall prepare a "feasibility study and analysis" for review by Public Works Department staff. Public Works staff shall prepare a proposal and recommendation for City Council consideration. If the Council agrees with the proposal, they shall authorize staff to allocate resources to prepare a Development Agreement. The Development Agreement shall be prepared and executed between the City and the Developer identifying the probable costs of the facility, the financial responsibilities for the facility, and schedules for design and construction. The Development Agreement shall be approved prior to submitting Preliminary Plans for review by the City staff. In cases where the City is the entity initiating the project, Council approval of a Request to Solicit Proposal for Engineering Services shall be acceptable for the purpose of initiating the project and a Development Agreement will not be required.

d. Regional Facilities within the jurisdictional area of the City, but outside of the City limits shall comply with current Master Plans and Public Works Department general philosophy of system integration. If Facilities outside the City limits but within the jurisdictional area of the City are proposed to be operated by entities other than the City then authorization by the Box Elder City Council to allow the facilities to be private shall be obtained prior to Preliminary Plat Approval by the City Council. All proposed regional facilities except for on-site systems and Alternative Wastewater Collection Systems not authorized by Council to be private shall be designed, bid, and constructed Public Works Department. Facilities to be designed, bid, and constructed by the Public Works Department shall meet the provisions above.

2. Regional Wastewater Facilities

a. Regional Wastewater Facilities will only be employed when the extension of offsite gravity sanitary sewer mains for the appropriate drainage basins is not feasible or is not in accordance with recognized City Master Plans, documents, or comprehensive plan; otherwise pump stations will not afford consideration.

b. Consideration for regional wastewater facilities will be evaluated by the City Public Works Department from a "feasibility study and analysis" prepared by the developer for subdivisions, or the Public Works Department for the City initiated projects. For City initiated projects this will be accomplished through the Proposal Process. The feasibility study and analysis shall be submitted to the Public Works Department and shall at a minimum include the following:

i. Description of the project and propose.

ii. Provide justification for the facility and analysis of alternatives.

iii. Address the facility's role as a regional facility and projected integration into the City's identified service basins and systems.

iv. The Public Works Department will review the "feasibility study and analysis" and provide written comments back to the developer.

v. The developer may provide written response to the comments, which will be incorporated into the presentation of the "feasibility study and analysis" to the Council; and

vi. The Public Works Department will submit the "feasibility study and analysis" along with developer comments and staff recommendations to the Council.

c. After a Development Agreement has been executed the City shall procure an engineering consultant in accordance with the City's adopted Consultant Selection Policy.

d. The engineering consultant shall provide a detailed design report. Following review by the Public Works Department the detailed design report shall be submitted to Council for approval. The detailed design report shall elaborate on the following for both present and future conditions.

i. Design period.

ii. Population densities per acre and total population.

iii. Areas served in acres.

iv. Per capita contribution - average and maximum.

v. Land use.

vi. Residential, commercial, and industrial contributions.

vii. Design flow rates - average and peak.

viii. Standby power.

ix. Infiltration.

x. Annual project operation and maintenance costs for the proposed facility; and

xi. Supplemental Criteria as described below.

3. Criteria for Wastewater Lift Stations

a. Design life of non-mechanical components shall be designed to achieve a design life goal of 75 years. Mechanical components shall be designed to achieve a design life goal of 25 years.

b. Design report shall include the following for both initial and future conditions:

i. Number, type, capacity, motor horsepower and net positive suction head (NPSH) requirements of proposed pumping units.

ii. System head curve (including head computations) for the pumping system.

iii. System head calculations shall include the size and length of force main and assumed "C" (friction) factor.

iv. Sewage detention time in the wet wells and force main.

v. Odor control potential shall be evaluated and addressed.

vi. Detailed design criteria for each specific lift station shall be developed by the Engineer of Record and approved by the Public Works Department.

vii. Operation and maintenance considerations to include provisions for.

- Accessibility.

- Building and site operation and maintenance considerations.

- Provisions for equipment replacement and maintenance upgrades.

- Availability of replacement parts.

- Power costs and overall facility efficiency.

- Flow metering provisions; and

- Need for visible or audible screening of facilities including items not inside building's shall be identified and discussed in the report.

viii. Engineering Economic Analysis; and

ix. Funding Options.

x. The final design and construction documents for lift station facilities shall incorporate all elements determined in the report phase.

4. Criteria for Individual On-Site Wastewater Facilities

   a. On-site wastewater facilities as defined by the City of Box Elder Municipal Code shall be designed and constructed in accordance with provisions of the SDDANR.

   b. The standards in this section are not intended to modify or eliminate subdivision improvements as required in the Municipal Code.

5. Criteria for Wastewater Mechanical Treatment Plants and Lagoons: These facilities are very specialized and are very site specific. Design criteria will be developed by the Public Works Department and the design engineer after the project has been identified and after the City authorizes design work for the facility.

M. ALTERNATIVE COLLECTION SYSTEMS

1. Criteria for Subdivisions with Pressure Sewer Systems

   a. System identified under these provisions require City Council authorization prior to consideration of review by staff.

   b. When the subdivision plat is recorded, a miscellaneous document shall be recorded at the Register of Deeds office for each property to be connected to a common force main. The miscellaneous document shall identify the design parameters including the anticipated flows, pumping rates, pipe line sizing calculations for pressure main, head loss calculations for friction and other minor losses (valves, fittings, etc.), maximum static and total dynamic head at each lot, minimum elevation (relative to the finished floor) each grinder pump can be set for each lot, and recommended grinder pump model and manufacture. Other grinder pumps may be proposed which meet the requirements of the design parameters.

   c. Pressure sewer systems shall meet the SDDANR's requirements set forth in their Recommended Design Criteria Manual - Wastewater Collection and Treatment Facilities and shall be submitted to SDDANR for their approval. SDDENR criteria shall be supplemented as needed or required.

   d. The designer shall incorporate the applicable following criteria subject to special considerations noted under Section IIIE7 as it applies for individual pumping stations.

i. No pressure sewer main shall be less than 1 ¼ inches inside diameter and shall be sized to maintain a minimum scouring velocity of 2 ½ feet per second at all points in the system.

ii. In the pressure sewer mains, clean-out connections shall be provided at distances not to exceed 500 feet.

iii. Operating pressures in general shall not exceed a range of 40 to 50 psig for any appreciable period. Additionally, grinder pumps shall have the characteristics which will continue to produce flows of at least 8 gpm if heads rise temporarily to 50 psig.

iv. The minimum net storage capacity of the grinder pump unit shall not be less than 50 gallons.

v. An Engineer's report shall be submitted to the City and SDDANR per SDDANR's criteria, including but not limited to service area, anticipated flows, pumping rates, pipe line sizing calculations for pressure main, head loss calculations for friction and other minor losses (valves, fittings, etc.) maximum static and total dynamic head at each lot, and minimum elevation grinder pump can be set for each lot;

vi. Pressure sewer mains (within the City Limits) will become part of the City's sanitary sewer system and are to be located within the street right-of-way at least 10' feet from property lines. The pressure service line from the pumping unit to the point of connection to the pressure sewer main will remain private and the obligation of the property owner.

vii. Pressure sewer pipe, fittings, and valve materials shall meet the City of Box Elder Standard Construction Specifications and Details, current edition, for water mains, with appropriate pressure rating for design heads for given site. The Engineer of Record shall identify appropriate alternate pipe materials for pressure sewer mains less than 4 inches in diameter. These materials at a minimum shall meet the requirements of the plumbing code currently adopted by the City of Box Elder.

viii. The pressure sewer main shall be buried not less than 6 feet deep to the top of the pipe, including service line beginning at the pump unit discharge port, and installed such that at least 6 feet of earth cover over the top of the pipe will be provided upon completion of all grading and construction.

ix. Each service line shall have a full-diameter one-quarter-turn plug valve and curb box to be in the public right-of-way from 1 to 7 feet from the property line. The cover of the curb box shall be clearly marked with the letter "S”.

x. A system of grinder pumps connected to a common pressure sewer main shall be supplied by a single manufacture.

xi. Each lot shall have an individual package pumping unit with a duplex pumping system. The pumping units shall be manufactured as a complete unit including grinder pumps (two), dual check valves, tank, alarms, and all necessary controls packaged into a single unit. The control panel for the packaged pump unit shall be mounted in the interior of the building being served by the sanitary sewer. Each unit shall include an exterior visual alarm and an audible alarm within the building being served. The alarms shall have multiple "trip" settings including but not limited to high level (prior to overflow), high level in the overflow tank, pump failure, and pump electrical overload. Pumps shall be equipped with automatic reset after electrical overload.

xii. Each packaged grinder pump unit shall be an exterior unit and shall be located on the lot such that the top of the access hatch is located vertically a minimum of 1 foot below the lowest floor elevation requiring sanitary sewer service.

xiii. Each system shall have an emergency overflow tank with a minimum capacity of 500 gallons. Adequate provisions should be made to empty the overflow tank when necessary.

xiv. The structure being served shall have an accessible backwater valve on the gravity discharge prior to the grinder pump; and

xv. Start-up, testing, and certification that each pumping unit has met the design plans and specifications shall be the responsibility of the Coordinating or Prime professional engineer, and such testing and certification shall be performed and submitted to the City before a Certificate of Occupancy will be issued for the building being served.

N. WATER AND SEWER SERVICES

1. General

a. Separate service lines shall be provided for each dwelling unit. Refer to figures contained in this section of the standards.

b. All water and sewer lines, including private systems, must run at right angles to the street and may not run in the ROW parallel to the street.

c. Service lines shall not cross adjoining property lines and shall connect to mains fronting the property.

d. Private service lines should not, if possible, cross adjoining properties even if they are in private easements.

e. Where service lines are being replaced to bring property into compliance, the new service line shall be installed in accordance with City requirements and connect to a main at the front of the property even if this requires a main extension.

f. Water and sewer service line connections may be installed as follows:

   i. If these guidelines cannot be met, the service lines must be placed in separate trenches that have 10-foot separation.

   ii. If separate trenches with 10-foot separation is not possible, the sewer service must be located 18 inches minimum below the water service and must have a 12-inch minimum horizontal separation and water service must a single continuous pipe with no fittings between meter pit and building connection.

   iii. Reconnecting existing service lines is not allowed unless they meet the separation requirements of a new installation.

g. Existing service lines may be used for a new building only if they are examined by camera and found by the Public Works Department to comply in all respects with section. Sewer service shall also be tested per City standards.

2. Water Services: Service lines shall be designed in accordance with currently adopted plumbing code of the State of South Dakota.

3. Meter Vaults

   a. Meter vaults will be installed for all water service connections within the City.

   b. For water service to property such as parks, cemeteries, and athletic fields which have no structures meter pits will be required as well.

   c. Meter vaults shall not be in ROW. The property owner shall provide the City with an access easement to the vault. Meter vaults will be maintained by the landowners. The property owner/developer must provide access to City for Meters placed inside of buildings or place meter on outside of building in a meter pit where it can be clearly monitored. If a meter vault falls into a state of disrepair such that the City's meter is in danger of damage the landowner will repair the vault to the City's satisfaction.

d. Meter vaults for 1-inch and smaller meters shall be Ford Coil Pitsetter 15” X 72” PFCBHH-288-15-72-NL, Closed Cell Insulating Disc CCID-15-4 (15”) and Cast-Iron Flat Lid with recessed locking electronic read (PPSC-15-L-REC-T), or approved equal. The prefabricated and pre-assembled, 18-inch diameter, PVC, therma-coil meter vault shall be equipped with setter pre-mounted on a movable platform, cast iron lid, insulating pad, and provision for remote reader cable. Field constructed or assembled meter vaults are not permitted.

4. Backflow and Cross Connection Prevention: Backflow and cross connection prevention shall be governed by the requirements of the currently adopted South Dakota Plumbing Code.

5. Fire Service Line: Fire services shall meet the requirements of the IFC adopted by the City of Box Elder.

6. Sewer Services

    a. Service lines shall be designed in accordance with the currently adopted Plumbing Code.

    b. Taps on sewer mains shall not exceed 6 inches in diameter. Service lines greater than 6 inches in diameter shall be connected to the main with a manhole.

    c. Services 4 inches and 6 inches in diameter shall be tapped directly to the main and not connected to manholes.

    d. Foundation drains, roof drains, area drains, storm drains, sump pumps, and other sources of surface or ground water shall not be connected to sanitary sewers, unless otherwise approved by the Public Works Director.

7. Individual Pumping Stations

    a. The designer shall incorporate the applicable standards found elsewhere within these standards as they apply to individual pumping stations.

    b. A privately owned pumping station may serve no more than one parcel of property.

    c. Individual pumping stations, except those serving a single-family residence duplex, shall be designed by a professional engineer.

    d. Plans and specifications for individual pumping stations shall be submitted to the Public Works Department for review and acceptance.

e. Individual pumping stations shall be of the grinder pump type. Septic tank effluent pumps (STEP) shall not be permitted due to the anaerobic quality of the septic tank effluent, and solids handling service line diameters to provide velocities equal to or greater than 3.0 fps.

f. Individual pumping stations shall be designed to provide pump cycle times no greater than 3 hours at average daily flow rates based on 100 gal per capita per day.

8. Pressure Service Lines

a. The designer shall incorporate the applicable criteria found within these standards as they apply to pumping stations.

b. Material: PVC, ASTM 2241, Pressure Class 200, gasketed ends.

c. Minimum diameter: 1 ¼ inches.

d. Minimum velocity shall not be less than 3.0 feet per second (fps) when the pump is operating at the midpoint of its normal operating range. Maximum velocity shall not be more than 10 feet per second (fps).

e. Minimum depth of burial shall be 6 feet.

f. Isolation Valve: For pressure services connecting to a pressure main an isolation valve with valve box shall be installed in the ROW between 1 foot and 7 feet of the property line. Isolation valve shall be resilient-seated gate valve. Pressure services connecting to a gravity main are not required to have an isolation valve; and

g. Testing shall be performed in accordance with water main pressure testing provisions of the City of Box Elder Standard Construction Specifications and Details, current edition.

9. Abandoning Services

a. Water or sewer services shall be abandoned if they meet one or more of the following conditions:

i. They are replaced or reconstructed.

ii. They serve structures which are removed from their foundations, vacated, or demolished except as permitted in the Box Elder Municipal Code.

iii. They are a service stub-out to an undevelopable lot or on which a structure was constructed and served by another service line; and

iv. They are extra service line(s) resulting from re-platting two (2) or more lots into a developmental lot.

b. Sewer Services shall be abandoned by disconnecting them from the main and completely removing the connection from main and installing an approved patch on the are affected by the removal.

c. Water Services:

i. Water service lines permanently removed from service smaller than 1 inch in diameter or constructed of materials not complying with the City of Box Elder Standard Construction Specifications and Details, current edition, shall be abandoned at the water main by closing the corporation stop and disconnecting the service line from the corporation and capping the corporation.

ii. Curb boxes shall be removed when the service line is abandoned at the main.

iii. Water service lines 1 inch and larger which are constructed of materials complying with the City of Box Elder Standard Construction Specifications and Detail, current edition, which will be reactivated within 1 year of abandonment, and which will provide sufficient volume and pressure for their intended use shall be abandoned by closing the curb stop and cutting and plugging the service line on the property side of the curb stop. If, at the end of 1 year following abandonment, the service line is not reactivated, then the Public Works Director may either grant a time extension not to exceed 1 year or require immediate abandonment at the main.

10. Sewer Services

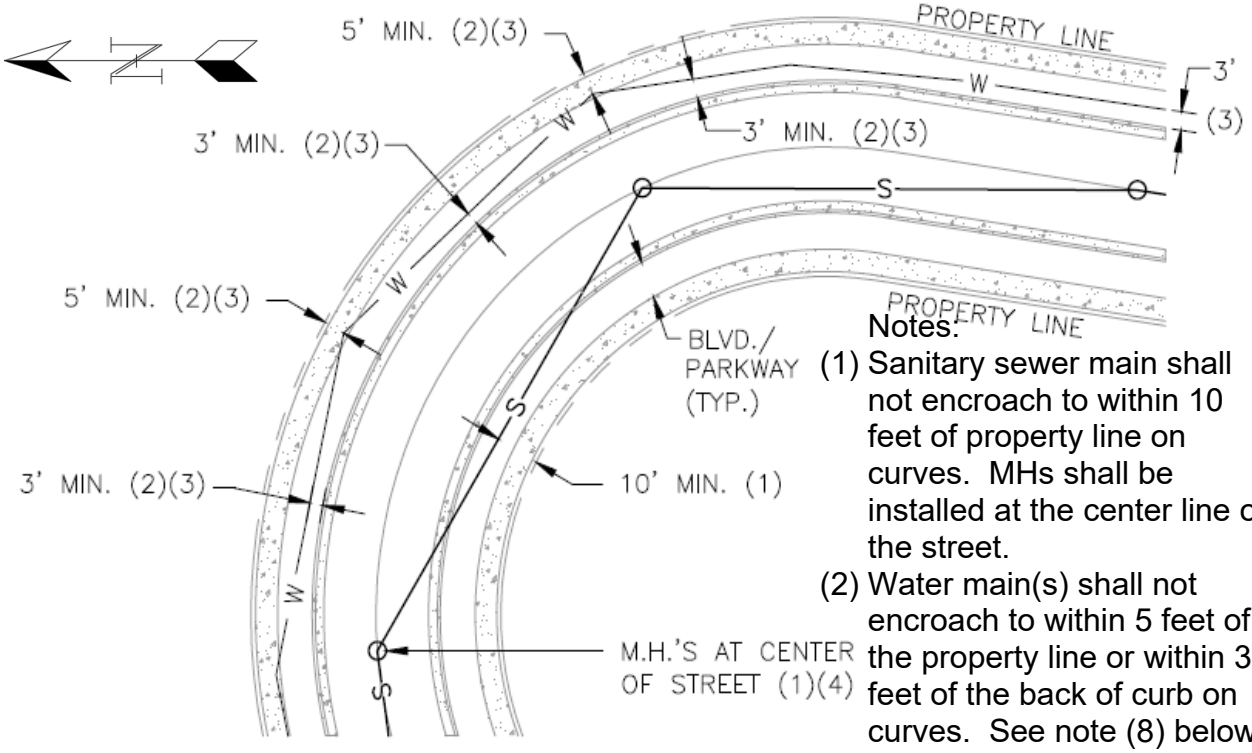
a. Abandoned sewer service lines permanently removed from service, or less than 4 inches diameter, or constructed of materials not complying with the City of Box Elder Standard Construction Specifications and Details, current edition, shall be abandoned at the sewer main by disconnecting the service line from the main by removing the service pipe from the tap and plugging the tap.

b. Abandoned sewer service lines 4 inches in diameter and larger which are constructed of materials complying with the City of Box Elder Standard Construction Specifications and Details, current edition, which will be reactivated within 1 year of abandonment, and will have sufficient capacity for their intended use shall be abandoned by cutting and plugging the service line at the property. If, at the end of 1 year following abandonment, the service

line is not reactivated, then the Public Works Director may either grant a time extension not to exceed 1 year or require abandonment at the main.

11. Private Fire Protection Systems: Private Fire Protection systems are beyond the scope of these standards. Consult the current IFC for guidance.

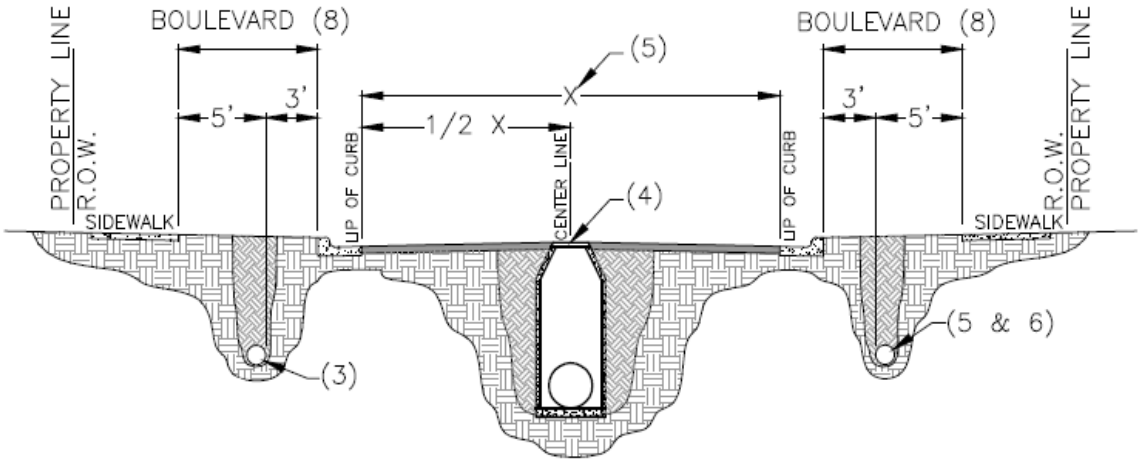
FIGURE III- 1: STANDARD UTILITY PLACEMENT IN R.O.W.



Notes:

(1) Sanitary sewer main shall not encroach to within 10 feet of property line on curves. MHs shall be installed at the center line of the street.

(2) Water main(s) shall not encroach to within 5 feet of the property line or within 3 feet of the back of curb on curves. See note (8) below.



(3) Standard location for water mains shall be the north or east boulevard within ROW.

(4) Standard location for sanitary sewer main(s) shall be the center line of the street section within the ROW. All MHs shall be installed at the center line.

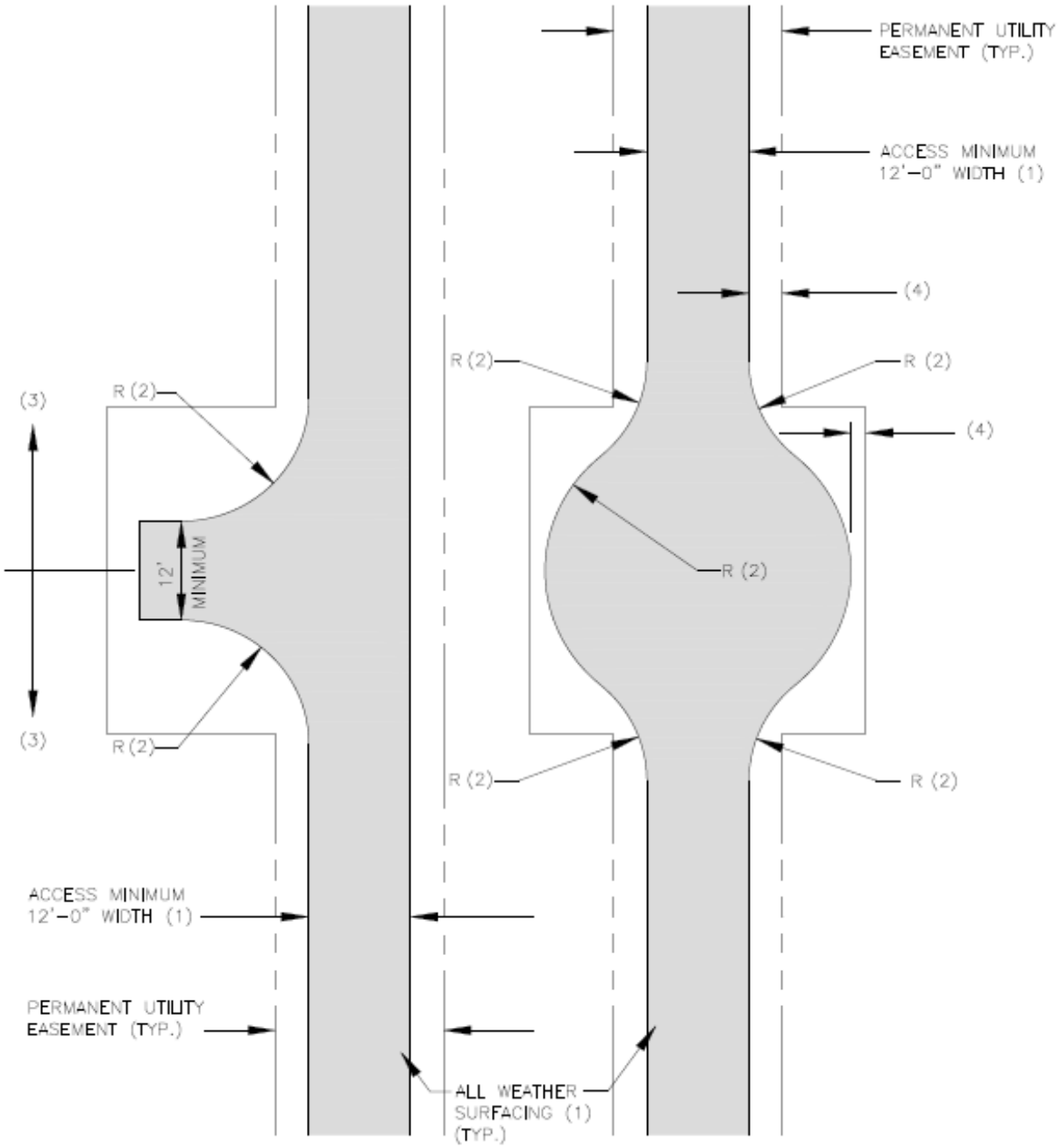
(5) If "X" is greater than 42 feet, then a second parallel water main may be constructed in the opposite boulevard within the ROW.

(6) A second parallel water main shall be constructed in the opposite boulevard for all streets designated as an arterial or future arterial regardless of the street width.

(7) Changes in direction for sanitary sewers shall be accomplished at MHs.

(8) For boulevards less than 8 feet in width the 5 feet from sidewalk requirement may be reduced. Maintain minimum 3 feet from the back of curb.

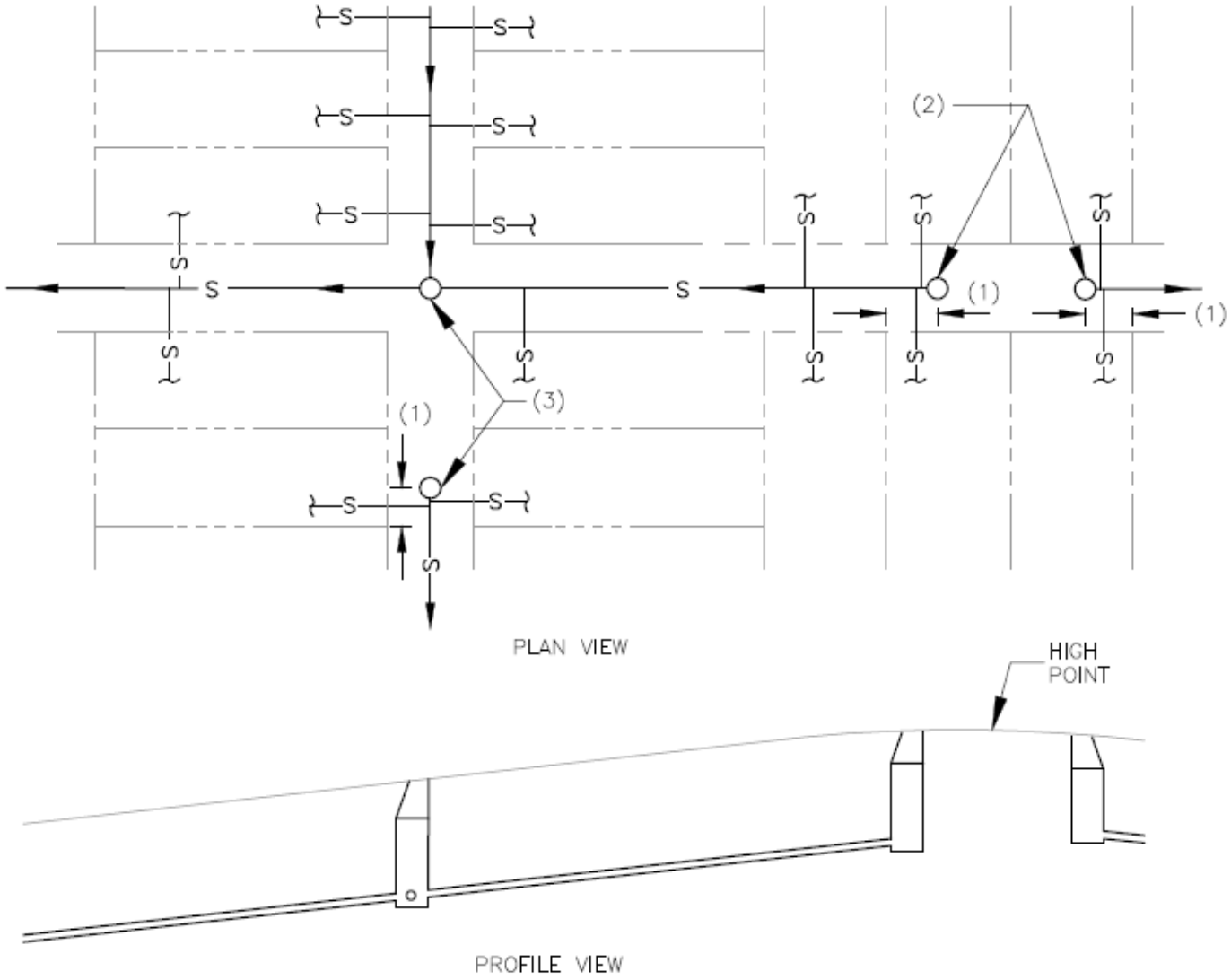
FIGURE III- 2: PERMANENT UTILITY EASEMENT TURN AROUND CRITERIA



Notes:

(1) All-weather surfacing required for access within permanent utility easements.
(2) "R" shall be a minimum of 40 feet.
(3) 500-foot maximum distance between turn arounds.
(4) Minimum 2-foot clearance between edges of all-weather surfacing and easement.
(5) Written pre-authorization by Public Works Director required for sewer main(s) to be in easements.

FIGURE III- 3: EXCEPTION FOR THE EXTENSION OF SANITARY SEWER MAINS ACROSS THE FULL FRONTAGE OF PARCELS



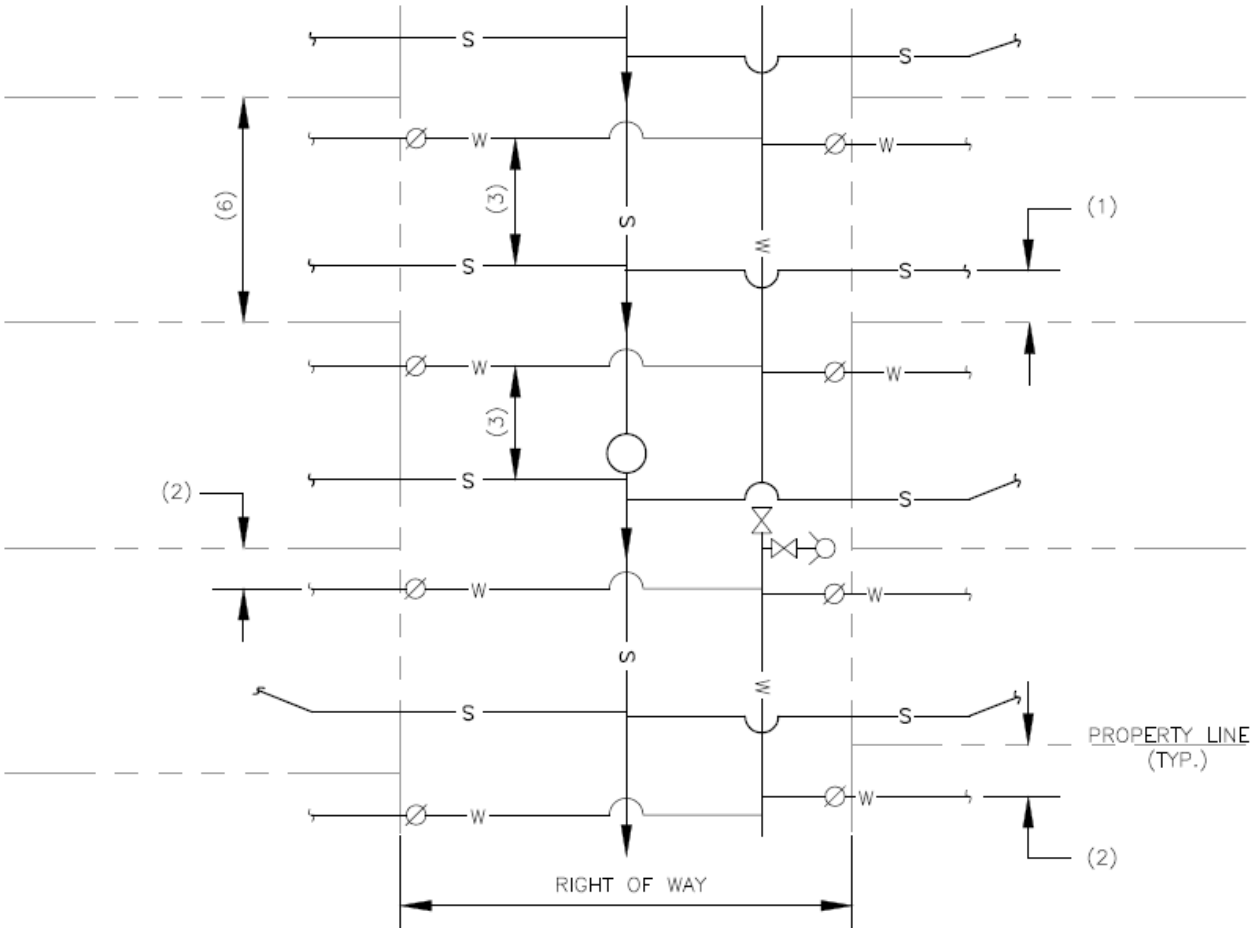
Notes:

(1) Sewer to be extended a minimum of 15 feet from center of manhole past downstream property line projection but may be extended more to facilitate service line requirements.

(2) Sewer main does not have to front 100 percent of parcels at high points provided all parcels have ability to connect to a sewer main that fronts a minimum of 15 feet of the parcel.

(3) Sewer main does not have to front both frontages of a corner parcel provided all parcels have a sewer fronting one side.

FIGURE III- 4: TYPICAL WATER AND SANITARY SEWER SERVICE LAYOUT



Notes:

(1) Sanitary sewer service shall be installed on the down-gradient side of the parcel being served. The service shall be at least 10 feet from the side lot line and shall be extended perpendicular from the main to the parcel.

(2) Water service shall be installed on the up-gradient side of the parcel being served. The service shall be at least 10 feet from the side lot line and shall be extended perpendicular from the main to the parcel.

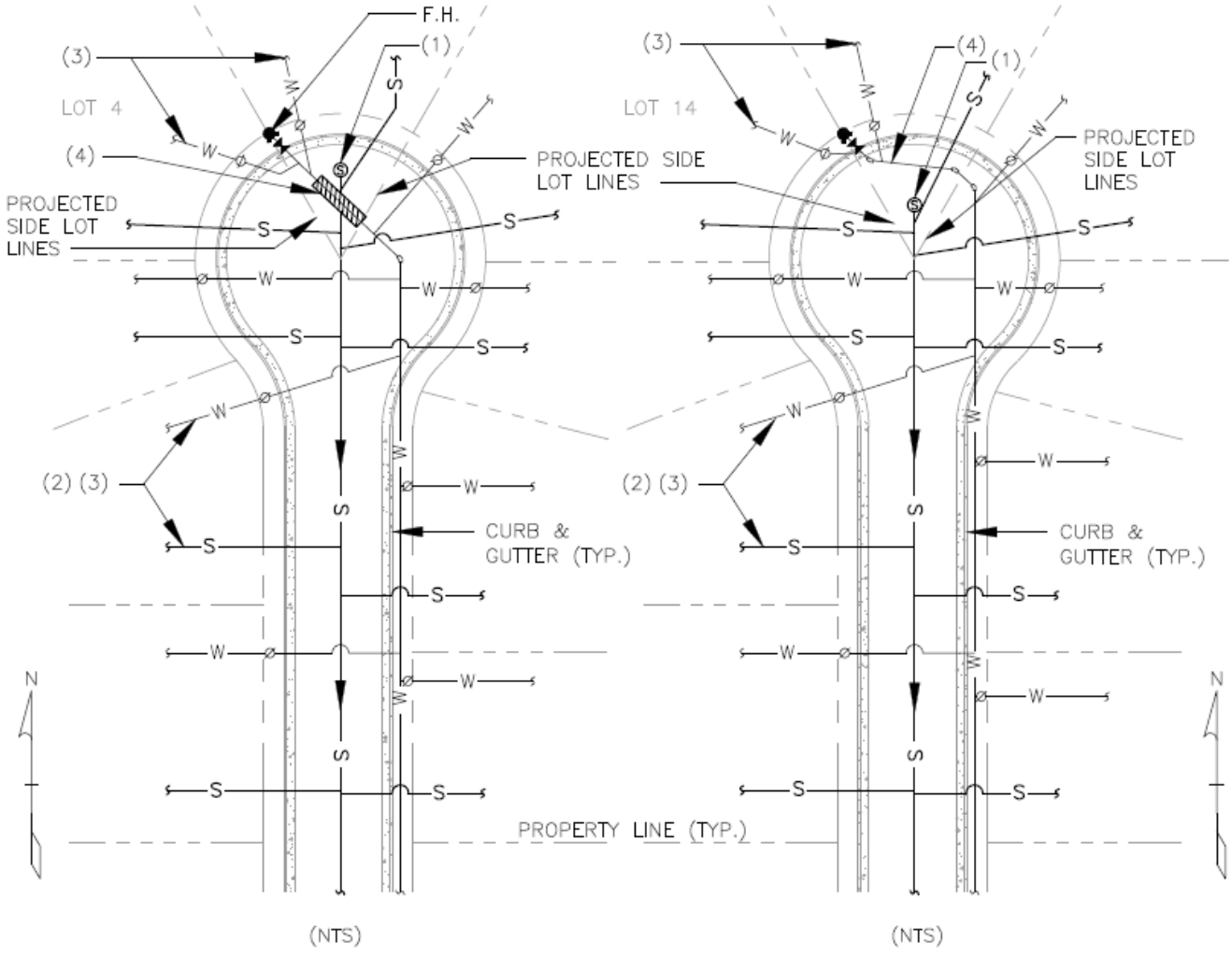
(3) Water service line shall have a minimum horizontal separation from sewer services of 10 feet.

(4) Sanitary sewer services may not be installed within the same trench. Sewer services shall have a minimum 5-foot horizontal separation from each other.

(5) Water services may not be installed within the same trench. Water services shall have a minimum of 5 feet horizontal separation from each other.

(6) For lots with a frontage less than 30 feet, the distance from this side lot line to the service (1) (2) may be reduced from 10 feet to 6 feet.

FIGURE III- 5: TYPICAL WATER DISTRIBUTION AND SANITARY SEWER COLLECTION SYSTEM LAYOUT AND SERVICE LOCATIONS FOR CUL-DE-SACS



Notes:

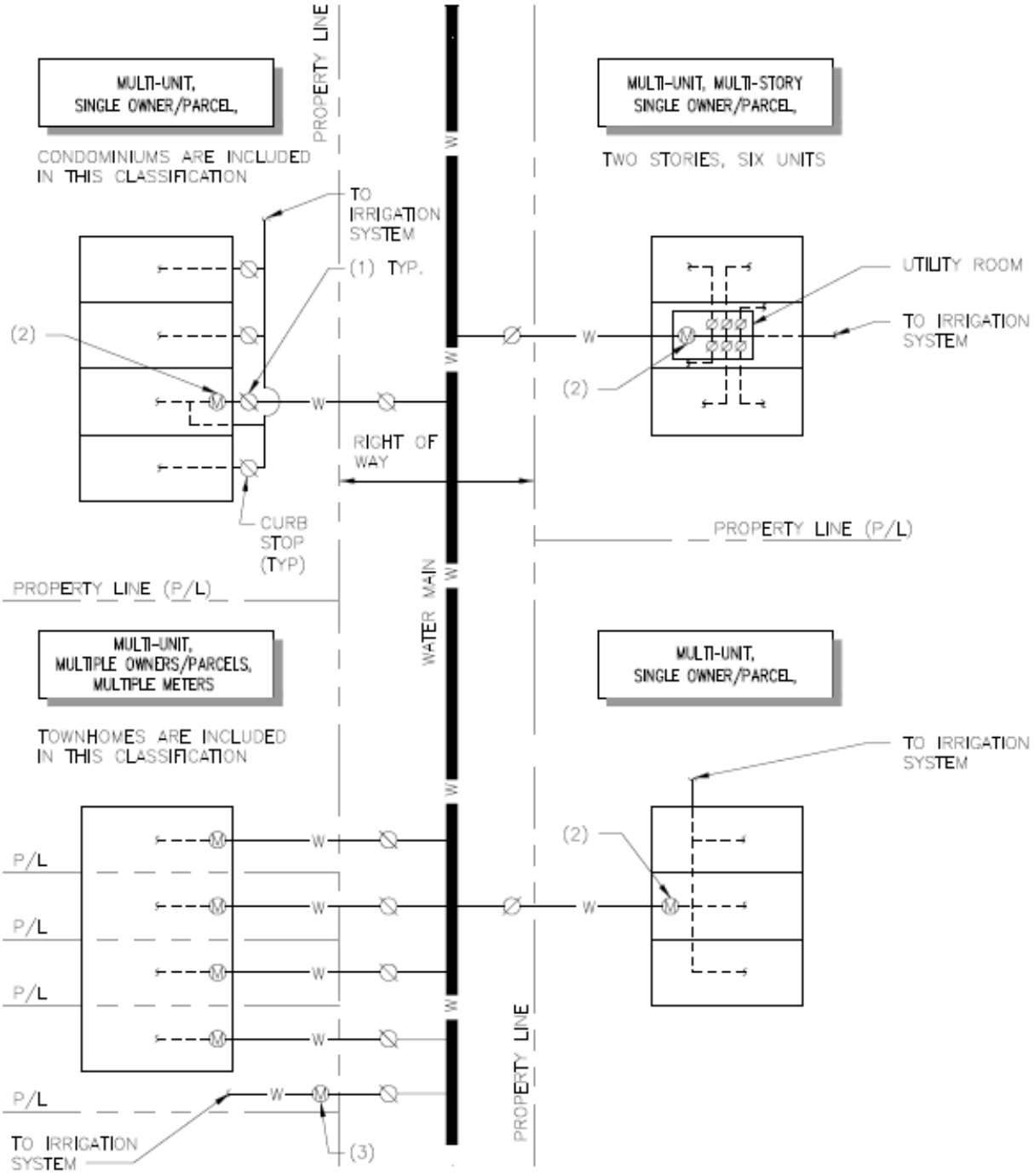
(1) Manhole shall be installed at least 10 feet past the intersection of the projected side lot lines but no closer than 6 feet to the gutter lip.

(2) Services to be installed per Figure III-4.

(3) Services (except for two water services next to the fire hydrants lots 4 and 14) shall be tapped to the main that fronts the parcel and shall be tapped within the projection of the side lot lines.

(4) The water main shall cross the sewer main or cross in front of the MH in a manner such that all parcels have a sewer main and water main fronting them. The only exception will be water service for lots 4 and 14.

FIGURE III- 6: TYPICAL WATER SERVICE LINE LAYOUTS 1



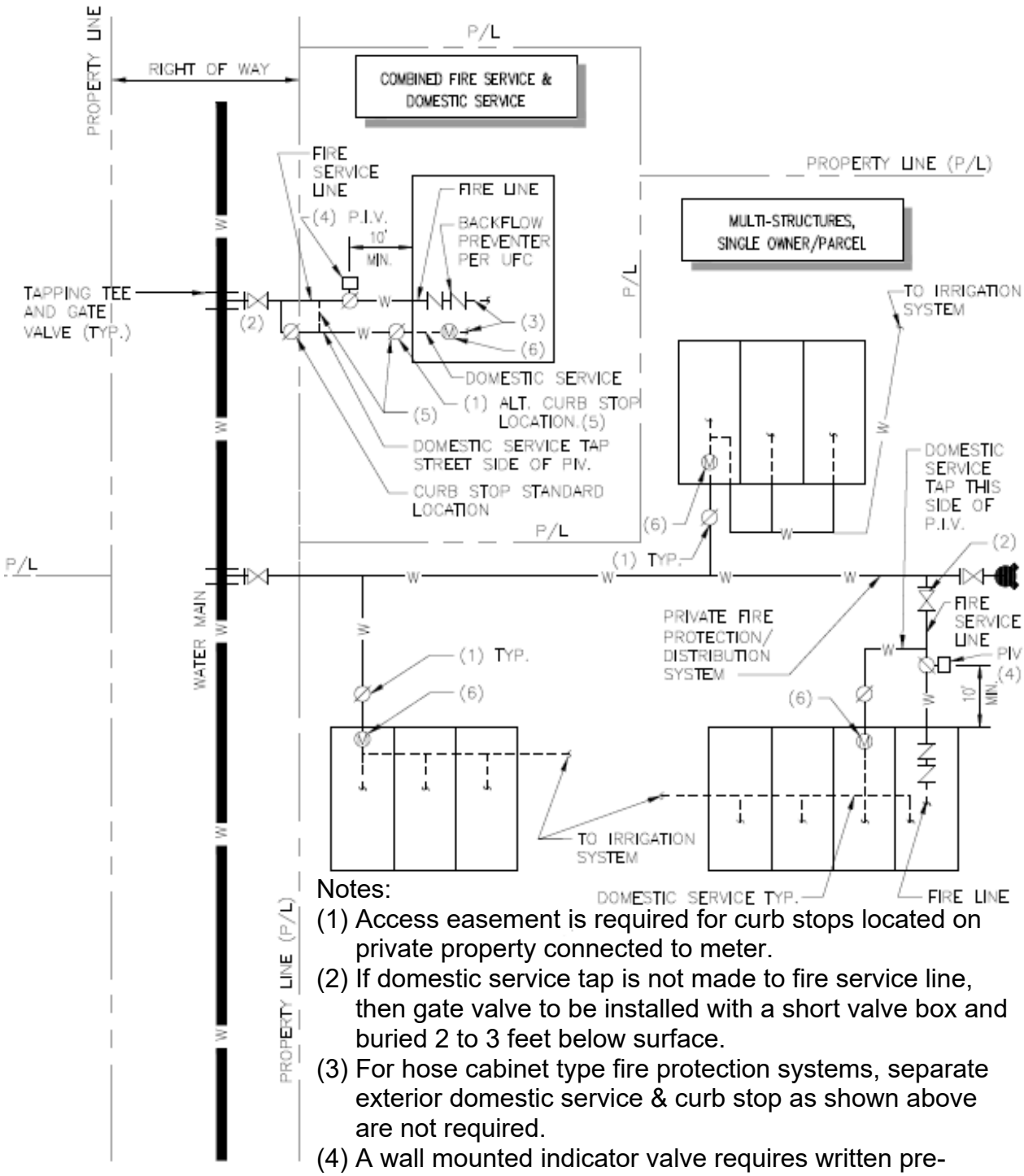
Notes:

(1) Access easement is required for curb stops located on private property connected to meter.

(2) Meter for structure (billing and account holder's responsibility, meter pit required).

(3) Irrigation systems for common areas shall be metered individually. If meter not located in structure, then locate in above-ground irrigation enclosure.

FIGURE III- 7: TYPICAL WATER SERVICE LINE LAYOUTS 2



Notes:

(1) Access easement is required for curb stops located on private property connected to meter.

(2) If domestic service tap is not made to fire service line, then gate valve to be installed with a short valve box and buried 2 to 3 feet below surface.

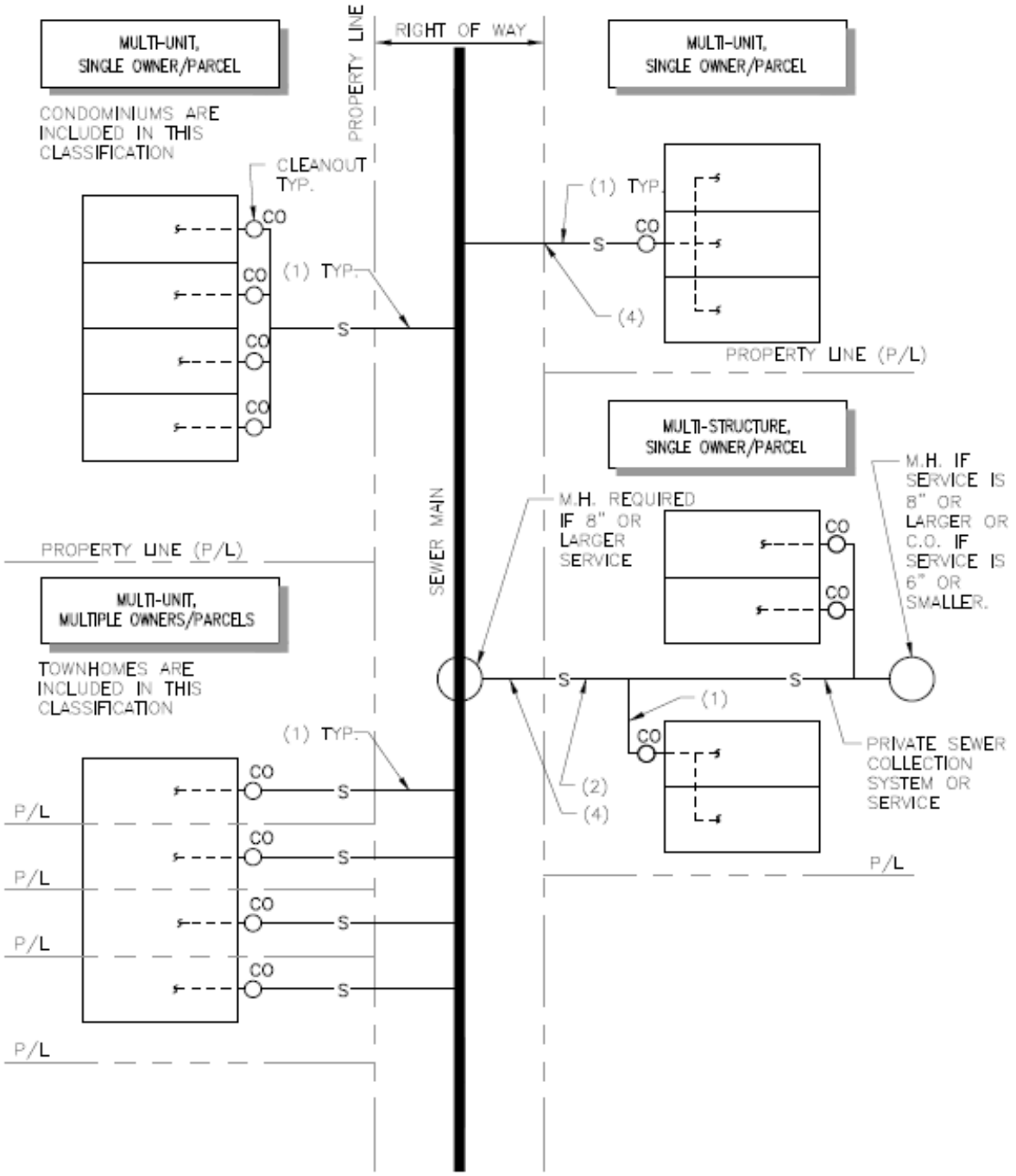
(3) For hose cabinet type fire protection systems, separate exterior domestic service & curb stop as shown above are not required.

(4) A wall mounted indicator valve requires written pre-approval by the fire chief.

(5) If domestic service is longer than 30 feet from property line to building, then the domestic service may be tapped on the street side of the PIV. The curb stop could then be located on private property and would require an access easement.

(6) Meter for structure (billing and account owner's responsibility, meter pit required).

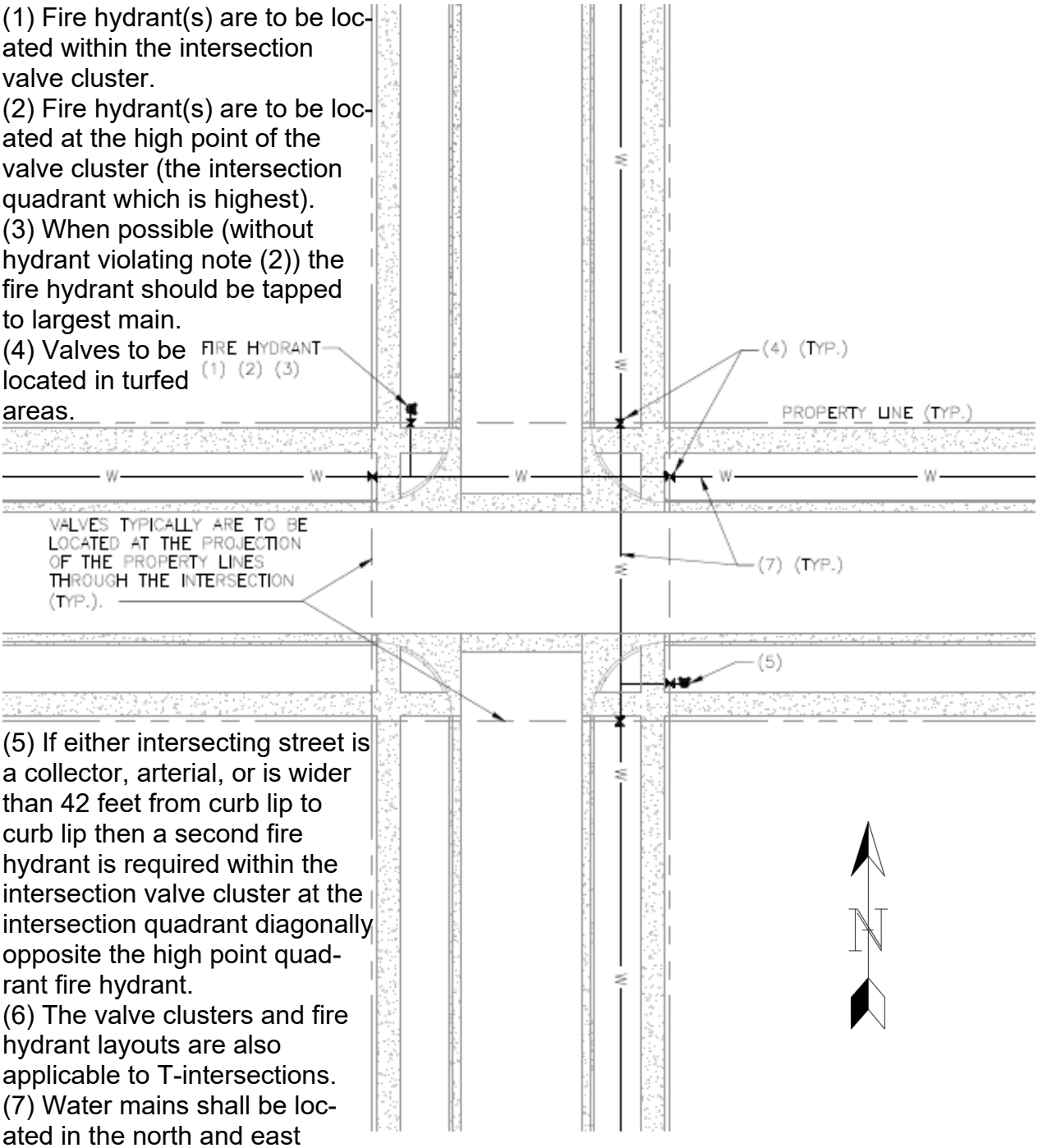
FIGURE III- 8: TYPICAL SANITARY SEWER SERVICE LINE LAYOUTS



Notes:
(1) 4-inch and 6-inch services shall be connected to the sewer main.
(2) 8-inch or larger services shall be connected to the sewer main at a manhole.
(3) Cleanout (CO) spacing & location per design, criteria, and plumbing code.
(4) Services to be sized per plumbing code.
(5) Multi-home structures with over four units and a single owner must have a master meter which will be utilized for billing purposes. The owner may also have individual meters.

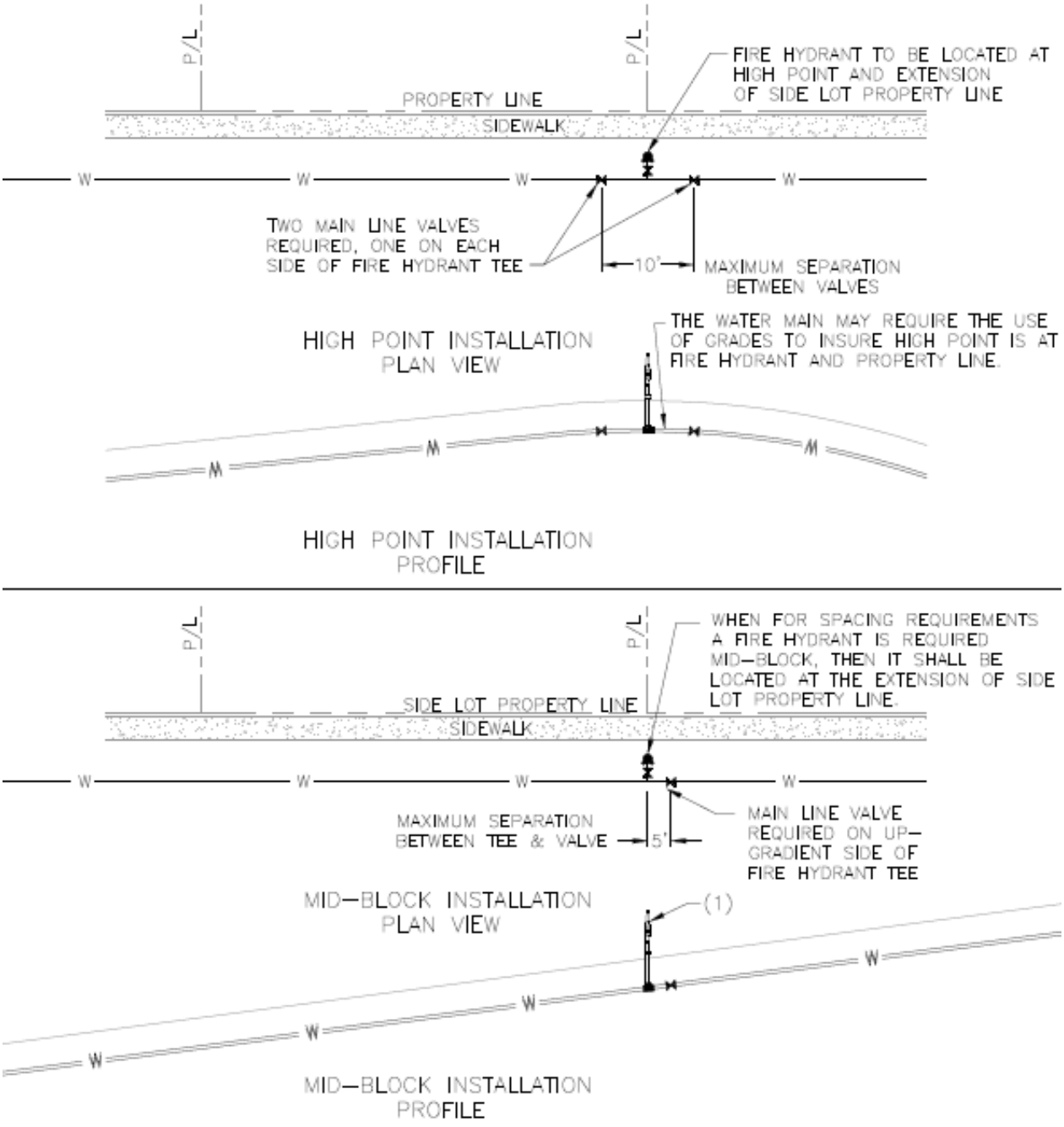
FIGURE III- 9: WATER MAIN VALVE CLUSTERS AND FIRE HYDRANT LAYOUTS FOR INTERSECTIONS

Notes:
(1) Fire hydrant(s) are to be located within the intersection valve cluster.
(2) Fire hydrant(s) are to be located at the high point of the valve cluster (the intersection quadrant which is highest).
(3) When possible (without hydrant violating note (2)) the fire hydrant should be tapped to largest main.
(4) Valves to be located in turfed areas.



(5) If either intersecting street is a collector, arterial, or is wider than 42 feet from curb lip to curb lip then a second fire hydrant is required within the intersection valve cluster at the intersection quadrant diagonally opposite the high point quadrant fire hydrant.
(6) The valve clusters and fire hydrant layouts are also applicable to T-intersections.
(7) Water mains shall be located in the north and east boulevard within the ROW (see Figure III-1).

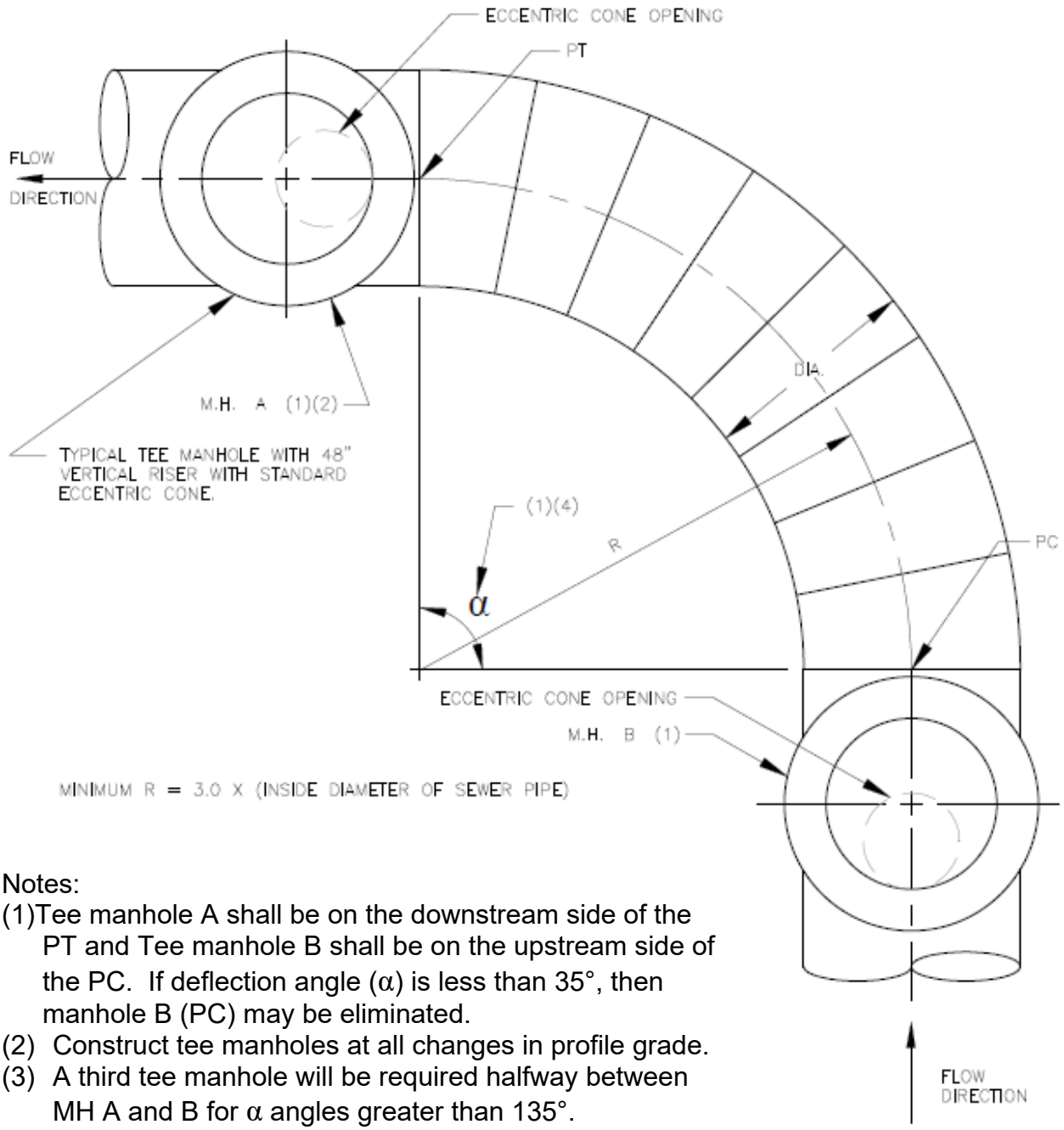
FIGURE III- 10: WATER MAIN VALVE AND FIRE HYDRANT LOCATIONS OUTSIDE OF STREET INTERSECTIONS



Notes:

(1) A fire hydrant shall be installed at all pressure zone separation boundaries. Two main line valves shall be installed at all pressure zone separations, one on each side of the fire hydrant tee.

FIGURE III- 11: ALIGNMENT AND PROFILE CHANGES FOR SEWER MAINS LARGER THAN 24" DIAMETER



Notes:

(1)Tee manhole A shall be on the downstream side of the PT and Tee manhole B shall be on the upstream side of the PC. If deflection angle (α) is less than 35°, then manhole B (PC) may be eliminated.

(2) Construct tee manholes at all changes in profile grade.

(3) A third tee manhole will be required halfway between MH A and B for α angles greater than 135°.

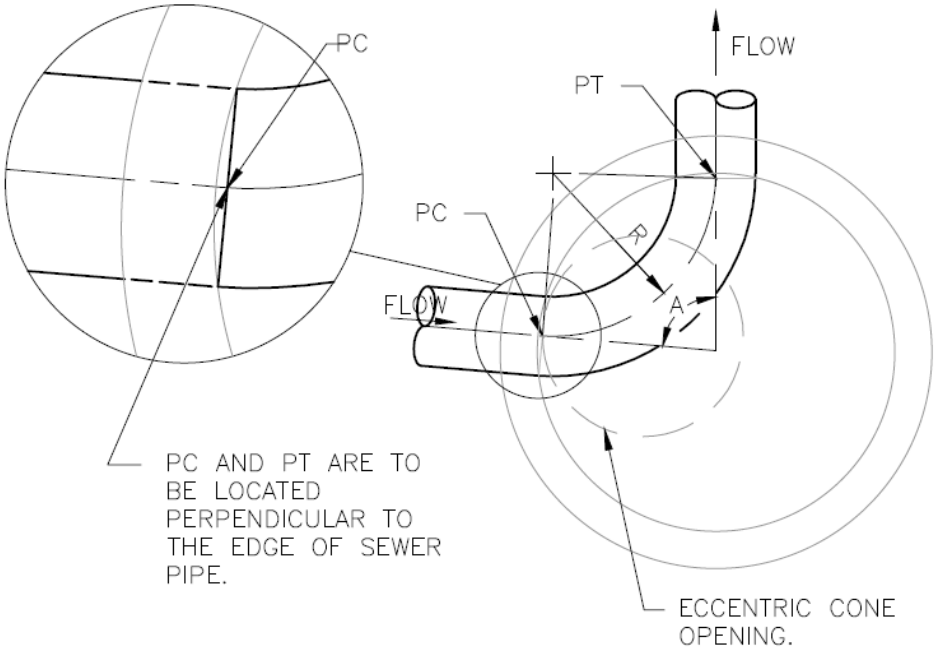
FIGURE III- 12: MINIMUM DEFLECTION ANGLES FOR GRAVITY SANITARY SEWER MAINS AT MANHOLES

Notes:

(1) Angle A less than 90° require the design engineer to submit a written request and justification for a design exception and obtain City approval for the exception. In no case the angle A be less than 75°.

(2) These criteria apply for sewer mains less than 24 inches in diameter.

(3) A minimum radius (R) of 2.5 times the inside diameter (ID) of branch main is required for all sweeps. If 2.5 times the ID of the branch cannot be met, then a larger diameter manhole shall be specified.



PIPE DIAMETER		MINIMUM ANGLE A (DEGREES) FOR MH DIAMETER:				
OUTLET*	INLET	48-INCH	60-INCH	72-INCH	84-INCH	96-INCH
8	**8**	**80**	**75**	**75**	**75**	**75**
10	**8**	**81**	**75**	**75**	**75**	**75**
10	**10**	**94**	**80**	**75**	**75**	**75**
12	**8**	**81**	**75**	**75**	**75**	**75**
12	**10**	**94**	**81**	**75**	**75**	**75**
12	**12**	**104**	**91**	**80**	**75**	**75**
15	**8**	**83**	**75**	**75**	**75**	**75**
15	**10**	**95**	**81**	**75**	**75**	**75**
15	**12**	**106**	**92**	**81**	**75**	**75**
15	**15**	**117**	**104**	**94**	**84**	**77**

* FOR OUTLET PIPES GREATER THAN 15" THE DESIGNER SHALL CALCULATE THE MANHOLE DIAMETER PER NOTE (3).

ANGLES LESS THAN 90° - SEE NOTE (1).

IV. STORMWATER

A. GENERAL

1. Multi-Purpose Use: Multi-purpose use of all drainage facilities shall be considered in the design of those facilities. Small local parks, greenbelts, nature trails, bike trails and similar facilities will be incorporated with major drainage facilities whenever possible, if hydraulic capacity of the facility is not compromised by these alternate uses.

2. Storm Water Transfer: The design of storm water drainage systems shall not result in the inter-basin transfer of drainage, unless no reasonable alternative exists and there is no legal restraint preventing such transfer.

3. Access to Facilities: Easements, rights-of-ways or other legal access shall be provided to all storm water drainage facilities for inspection, maintenance, or repair.

4. Operation and Maintenance: Operation and maintenance of storm water drainage facilities shall be required to ensure that these facilities will perform as designed. Prior to the construction of any storm water drainage facility, the responsibility for the operation and maintenance of that facility shall be determined and detailed within a formal “Development Agreement” between the City and Landowner / Developer needing the facility.

5. Planning Requirements: All development shall conform to an approved drainage basin design plan. If no plan exists for the area of the proposed development, the City may:

    a. Waive this requirement,

    b. Require the development to provide the necessary data; or

    c. Declare a “study area” per City Ordinance until a drainage basin design plan is completed.

6. Drainage Easements: Drainage easements shall be established for the 100-year runoff when the drainage way conveys the runoff from two or more lots. When drainage easements incorporate easements for other utilities the easement shall be increased as necessary to accommodate utilities such that these utilities are not within the main drainage channel. Drainage easements can be incorporated into existing right-of-way as long as the drainage way flow path remains clear of surface obstructions.

7. Storm Water Quality: For storm water quality requirements refer to the South Dakota Department of Agriculture and Natural Resources.

8. Reporting Requirements: Storm water reports submitted for acceptance by the City shall contain at a minimum design input parameters, output, assumptions, and calculations in addition to the other items required by other sections of this manual.

9. Bridge Hydraulic Design: Bridge hydraulic design is beyond the scope of this manual.

B. STORM RUNOFF

1. General

    a. For a drainage basin with an existing drainage basin plan the designer may utilize the storm water runoff volumes contained in those plans.

    b. For drainage basins that do not have an existing drainage basin plan, the designer must use a universally accepted method for determination of runoff volumes within the basin and for modeling of elements or properties within the basin. These would include:

        i. Use the US Army Corps of Engineers Hydrologic Engineering Center Hydraulic Modeling System (HEC-HMS) for determination of runoff volumes within the basin and for modeling of elements or properties within the basin;

        ii. The Colorado Unit Hydrograph Procedure (CUHP) for modeling of specific elements or properties with the basin; or

        iii. The Rational Method (for 160 acres or less).

    c. Any submittal requiring FEMA approval must follow FEMA guidelines.

    d. Modeling must be conducted by a qualified and experienced hydrologist or engineer.

    e. Major drainages within the development shall be platted and conveyed to the City at no cost to the City.

C. STREET DRAINAGE

1. General

    a. Streets serve an important and necessary drainage service even though their primary function is for the movement of traffic. Traffic and drainage uses are compatible up to a point, beyond which, drainage must be secondary to traffic needs.

    b. Gutter flow in streets is necessary to transport runoff water to storm inlets and to major drainage channels. Good planning of streets can substantially help in reducing the size of, and sometimes eliminating the need for, a storm sewer system in newly urbanized areas.

2. Effects of Stormwater on Street Capacity

    a. The storm runoff which influences the traffic capacity of a street can be classified as follows:

        i. Sheet flow across the pavement as falling rain flows to the edge of the pavement.

        ii. Runoff flowing adjacent to the curb.

        iii. Storm water ponded at low points.

        iv. Flow across the traffic lane from external sources, or cross-street flow (as distinguished from water falling on the pavement surface).

        v. Splashing of any of the above types of flow on pedestrians.

    b. Each of these types of storm runoff must be controlled within acceptable limits so that the street's main function as a traffic carrier will not be unduly restricted. The effect of each of the above categories of runoff on traffic movement is discussed in the following sections.

3. Interference Due to Sheet Flow Across Pavement

    a. Rainfall which falls upon the paved surface of a street or road must flow overland as sheet flow until it reaches a channel. Channels can be created either by curbs and gutters or by roadside ditches. The direction of flow on the street may be determined by the vector addition of the street grade and the crown slope, which is equivalent to drawing the perpendicular to a contour line on the road. The depth of sheet flow will be essentially zero at the crown of the street and will increase as it proceeds towards the channel. Traffic

interference due to sheet flow is essentially of two types: hydroplaning and splash.

i. Hydroplaning: Hydroplaning is the phenomenon of vehicle tires being supported by a film of water which acts as a lubricant between the pavement and the vehicle. It generally occurs at speeds commensurate with arterial streets and its effect can be minimized by achieving a relatively rough pavement which will allow water to escape from beneath the tires by pavement grooving to provide drainage, or by reducing travel speed.

ii. Splash: Traffic interference due to splash results from sheet flow of excessive depth caused by water traveling a long distance or at a very low velocity before reaching a gutter. Increasing the street crown slope will decrease both the time and distance required for water to reach the gutter. The crown slope, however, must be kept within acceptable limits to prevent sideslipping of traffic during frozen surface conditions and to allow the opening of doors when parked adjacent to curbs. An exceedingly wide pavement section contributing flow to one curb will also affect the depth of sheet flow. This may be due to super elevation of a curve, offsetting of the street crown due to warping of curbs at intersections, or many traffic lanes between street crown and the gutter. Consideration should be given to all these factors to maintain a depth of sheet flow within acceptable limits.

4. Interference Due to Gutter Flow

a. Water which enters a street, either sheet flow from the pavement surface or overland flow from adjacent land areas, will flow in the gutter of the street until it reaches an outlet, such as a storm sewer or a channel. Figure 4-1 shows the configuration of gutter flow moving down a street when there is a storm sewer system. As the flow progresses downhill and additional areas contribute to the runoff, the width of flow will increase and progressively infringe upon the traffic lane. If vehicles are parked adjacent to the curb, the width of spread will have little influence on traffic until it exceeds the width of the vehicle by several feet. However, on streets where parking is not permitted, as with many arterial streets, whenever the flow width exceeds a few feet, it will significantly affect traffic. Field observations show that vehicles will crowd adjacent lanes to avoid curb flow.

b. As the flow width increases it becomes impossible for vehicles to operate without driving through water, and they again begin to use the inundated lane. At this point the traffic velocities will be significantly reduced as the vehicles begin to drive through the deeper water. Splash from vehicles traveling in the inundated lane obscures the vision of drivers of vehicles moving at a higher rate of speed on the open lane.

c. Eventually, if width and depth of flow become great enough, the street will become ineffective as a traffic carrier. During these periods it is imperative that emergency vehicles such as fire trucks, ambulances, and police cars be able to traverse the street by moving along the crown of the roadway.

d. The street classification is also important when considering the degree of interference to traffic. A local street, and to a lesser extent a collector street, could be inundated with little effect upon vehicular travel. The small number of cars involved could move at a low rate of speed through the water even if the depth was four to six inches. However, reducing the speed of arterial traffic affects a greater number of private, commercial, and emergency vehicles.

5. Interference Due to Ponding

   a. Storm runoff ponded on the street surface because of a change in grade or the crown slope of intersecting streets has a substantial effect on traffic. A major problem with ponding is that it may reach depths greater than the curb and remain on the street for long periods of time. Another problem is that ponding is localized in nature and vehicles may enter a pond moving at a high rate of speed.

   b. The way ponded water affects traffic is essentially the same as for curb flow; the width of spread onto the traffic lane is the critical parameter. Ponded water will often bring a street to a complete halt. In this case, incorrect design of only one facet of an entire street and storm drainage system will render the remainder of the street system useless during the runoff period.

6. Interference Due to Water Flowing Across Traffic Lane

   a. Whenever storm runoff moves across a traffic lane, a serious impediment to traffic flow occurs. The cross flow may be caused by super elevation of a curve or a street intersection exceeding the capacity of the higher gutter on a street with cross fall. The problem associated with this type of flow is the same as for ponding in that it is localized in nature and vehicles may be traveling at high speed when they reach the location. If the velocity of vehicles is naturally slow and use is light, such as on local streets, cross-street flow does not cause sufficient interference to be objectionable.

   b. The depth and velocity of cross-street flow should always be maintained within such limits that it will not have sufficient force to affect moving traffic. If a vehicle which is hydroplaning enters an area of cross street flow, even a minor force could be sufficient to move it laterally towards the gutter.

   c. At certain intersections the flow may be trapped between converging streets and must either flow over one street or be carried underground. If the vehicles crossing the intersection are required to stop, then very little hazard exists to

the traveling public. This is the basis for the assumption that valley gutters are acceptable across a local street where it intersects another local or collector street. Another point in favor of the use of valley gutters is the continuation of the grade of the dominant street. If the crown of the local street is allowed to coincide with the crown of the major street, the outside traffic lanes of the major street will have a "hump" at the intersection.

7. Interference Due to Traffic Medians

    a. Current design of collector and arterial streets suggests that medians are often used to separate traffic flow. Those medians create an impediment to cross flow of water and effectively create a curb flow in the center of a street. When the median ends cross flow of the storm water will exist thereby flooding travel lanes of the street. Care must be exercised in designing these barriers so that the storm water flow is properly accommodated.

    b. A raised median in a street reduces the street width for storm water purposes. As an example, a 4-lane street with a center median is effectively a 2-lane street for storm water conveyance purposes.

8. Effect on Pedestrians

    a. In areas where pedestrians frequently use sidewalks, splash due to vehicles moving through water adjacent to the curb is a serious problem. It must also be kept in mind that under certain circumstances, pedestrians will be required to cross ponded water adjacent to curbs.

    b. Since most of the pedestrian traffic will cease during the actual rainstorm, less consideration need be given to the problem while the rain is actively falling. However, ponded water, remaining after the storm has passed, must be negotiated by pedestrians. Streets should be classified with respect to pedestrian traffic as well as vehicular traffic. As an example, streets which are classified as local for vehicles and located adjacent to a school are arterials for pedestrian traffic. Allowable width of gutter flow and ponding should reflect this fact.

9. Design Criteria

    a. Design criteria for the collection and transport of runoff on public streets is based on a reasonable frequency of traffic interference. That is, depending on the street classification, certain traffic lanes can be fully inundated once during the initial design storm return period. For example, a local street flow is allowed to cover the crown during a 10-year frequency storm. During the 10-year period, lesser storms will occur which will produce less runoff and will not inundate the entire street.

b. Planning and design for urban storm runoff must be considered from the viewpoint of both the regularly expected storm occurrence, that is, the initial storm, and the major storm occurrence. The initial storm will have a frequency of one in ten years. The major storm will have a return period of 100 years. The objectives of the major storm runoff planning and design is to eliminate major damage and loss of life. The initial drainage system is necessary to eliminate inconvenience, frequently recurring initial damage, and high street maintenance costs.

10. Street Capacity for Initial Storms

a. Determination of street capacity for the 10-year storm shall be based upon pavement encroachment. The pavement encroachment for the 10-year storm shall be limited as set forth in the Table IV-1.

Table IV-1: Allowable 10-Year Storm Runoff Encroachment

Street Classification	Maximum Encroachment
Local	**No curb overtopping. Flow may spread to crown of street.**
Collector & 2-Lane Arterials	**No curb overtopping. Flow spread must leave at least 12 feet of pavement free of water.**
3-Lane Arterials	**No curb overtopping. Flow spread must leave at least 24 feet of pavement free of water.**
Arterials with > 3 Lanes*	**No curb overtopping. Flow spread must leave at least 36 feet of pavement free of water.**

* Arterials with raised medians use collector and 2-lane arterial criteria.

b. The storm sewer system should begin at the point where the maximum encroachment is reached. Development of the major drainage system is encouraged so that minor runoff is removed from the streets, thus moving the point at which the storm sewer system must begin further downstream.

c. Calculating Capacity: When the allowable encroachment has been determined, the gutter (that portion of the street used to convey runoff) capacity shall be calculated using a universally accepted method. This would include Manning's Equation.

11. Street Capacity for Major Storm

a. Determination of the allowable capacity for the 100-year storm event shall be based upon allowable depth and inundated area. The allowable depth and inundated area for the 100-year storm event shall be limited as set forth in Table IV-2.

b. Calculating Capacity: Based upon the allowable depth and inundated area as determined from Table IV-2, the street capacity shall be calculated.

Table IV-2: Allowable 100-year Storm Runoff Inundation

Street Classification	Major Storm Frequency	Allowable Depth and Inundated Areas
Local	**100-year**	**Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line, unless buildings are flood proofed. The depth of water over the gutter flow shall not exceed 18 inches.**
Collector & Arterial	**100-year**	**Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line, unless buildings are flood proofed. The depth of water over the gutter flow shall not exceed 12 inches.**

12. Intersection Layout Criteria

a. Intersection Gutter Capacity: The following design criteria are applicable at intersections of urban streets. Gutter capacity limitations covered in the sections above shall apply along the street, while this section shall govern at the intersection.

b. Pavement Encroachment: Limitations at intersections for pavement encroachment shall be as given in Table IV-3.

Table IV-3: Allowable Cross Street Flow

Street Classification	10-year Storm Flow	100-year Storm Flow
Local	**6" of depth in cross pan.**	**18" of depth above gutter flow line.**
Collector	**Where cross pans allowed, depth of flow should not exceed 6".**	**12" of depth above gutter flow line.**
Arterial	**None.**	**No cross flow. 12" max. depth at upstream gutter on road edge.**

D. STORM INLETS

1. General Statement

    a. The hydraulic capacity of a gutter inlet depends upon its geometry and upon the characteristics of the gutter flow. The inlet capacity governs both the rate of water removal from the gutter and the amount of water that can enter the storm drain system. Many costly storm drains flow at less than the design capacity because the storm runoff cannot get into the drains. Inadequate inlet capacity or poor inlet location may cause flooding on the traveled way which creates a safety hazard or at times interrupts traffic.
    b. The inlet is frequently located in or near the path of vehicular traffic. Water-borne debris and trash may be deposited on the inlet causing complete or partial clogging. Often freedom from clogging and noninterference with traffic requires an inlet of a specific type rather than the most efficient inlet from a hydraulic point of view. For example, a curb-opening inlet might be used where a grate inlet would be more efficient.

2. Inlet Types

    a. Gutter inlets can be divided into four major classes, each with many variations. These classes are: 1) curb-opening inlets, 2) gutter inlets, 3) combination inlets, and 4) area inlets. Each type of inlet shall be installed with a depression of the gutter and may be a single or a multiple inlet (two or more closely spaced inlets acting as a unit). Two identical units placed end to end are called double inlets. The inlet types to be used in the City are as follows:

        i. Grate Inlets: Grate inlets consist of an opening in the gutter or ditch covered by a grate. Grate inlets used in Box Elder are Type A, Type B, Type C and Precast Tee Type Manhole. Type B inlets have a vaned grate with curb opening box and are considered a grate inlet for continuous grade capacity calculations. Type A and Type C inlets are flat rectangular surface grates.

        ii. Curb Opening Inlets: Curb opening inlets are vertical openings in the curb covered by a top slab. Curb inlets used in Box Elder are Type E inlets Type E inlets have a depressed gutter throat section.

        iii. Slotted Inlets: Slotted inlets consist of pipe cut along the longitudinal axis with bars perpendicular to the opening to maintain the slotted opening. Slotted inlets are manufactured of CMP. Use of CMP slotted inlets is allowed in Box Elder without the prerequisite of obtaining a variance to use CMP storm sewer.

        iv. Combination inlets: Combination inlets consist of both a curb opening inlet and a grate placed in a side-by-side combination. The Type B inlet in a

sag condition is considered a combination inlet. Type B inlets are considered a grate inlet for continuous grade capacity calculations.

v. SDDOT Median Drain Inlets: These are inlet details prepared by the SDDOT for use in medians and ditches. Inlets are SDDOT Type L median drain, Type M median drain, and Type N median drain.

vi. Special Inlets: Special inlets consist of inlets other than those described above and require written authorization for use.

3. Inlet Capacity

a. The term inlet capacity is used herein to mean the catch of the inlet under a given set of conditions rather than the maximum water that can be intercepted by the inlet if the discharge is increased without limit. The efficiency of an inlet is the percent of total flow that the inlet will intercept under a given set of conditions. The efficiency of an inlet varies with change in cross slope, longitudinal slope, total gutter flow, and pavement roughness.

b. Inlet capacity shall be calculated in accordance with the Federal Highway Administration Urban Drainage Design Manual Hydraulic Engineering Circular No. 22 (current edition).

c. Table IV-4 provides the designer with an adjustment factor, F, to be used to compensate for clogging of inlets.

Table IV-4: Inlet Clogging Factor

Inlet Type	F
Grate Inlets	**40%**
Combination Inlets	**33%**
Curb Openings	**0%**

4. Inlet Location

a. In general, inlets should be placed at all low points in the gutter grade and at intersections to prevent the gutter flow from crossing traffic lanes of the intersecting road. In urban locations, inlets are normally placed upgrade from pedestrian crossings to intercept the gutter flow before it reaches the crosswalk. Where pavement surfaces are warped, as at cross streets, ramps, or in transitions between super elevated and normal sections, gutter flow should be picked up before the cross slope of the pavement begins to change to lessen water flowing across the roadway and to prevent icing.

b. Inlets should also be placed where a curbed roadway crosses a bridge the gutter flow should be intercepted and not be permitted to flow onto the bridge.

c. Spacing of Inlets on a Continuous Grade:

   i. Inlets should be spaced to limit the spread of the water on the pavement to the criteria outlined in previous sections.

   ii. With the maximum spread fixed and with a given pavement cross slope and longitudinal slope, the flow in the gutter is also fixed and can be calculated. The spacing of inlets is equal to the length of pavement needed to generate the discharge corresponding to the allowable spread on the pavement. The flow bypassing each inlet must be included in the flow arriving at the next inlet.

5. Spacing of Inlets in Sag

   a. Three inlets should be placed in a sag vertical curve on all arterial streets, one at the low point and one on each side of this point, where the grade elevation is approximately 0.2 feet higher than that at the low point. The inlets should be spaced to limit the spread of water on the pavement to the criteria outlined in above sections.

   b. Sag vertical curves differ one from another in the potential for ponding, and criteria adopted for inlet spacing in sags should be applied only where traffic could be unduly disrupted if an inlet became clogged or runoff from the design storm were exceeded. Therefore, criteria adopted for inlet spacing in sag vertical curves are not applicable to the sag curve between two positive or two negative longitudinal slopes. Also, they should not be applied to locations where ponding depths could not exceed curb height and ponding widths would not be unduly disruptive, as in sag locations on embankment.

   c. Where significant ponding can occur, in locations such as underpasses and in sag vertical curves in depressed sections, it is good engineering practice to place flanking inlets on each side of the inlet at the low point in the sag.

   d. The flanking inlets should be placed so that they will limit spread on low gradient approaches to the level point and act in relief of the inlet at the low point if it should become clogged or if the design spread is exceeded. Table IV-5 shows the spacing required for various depths at curb criteria and vertical curve lengths defined by the following dimensionless coefficient:

      $K = L / A$

      Where:

      K = dimensionless coefficient, L = length of vertical curve, in feet, and
      A = algebraic difference in approach grades (G2 - G1)

      The AASHTO policy on geometrics specifies maximum K values for Table IV-5.

Table IV-5: Distance X to Flanking Inlets in Sag Vertical Curve Locations

	Depth at Curb (inches)							
K	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
20	**20**	**28**	**35**	**40**	**45**	**49**	**53**	**57**
30	**24**	**35**	**42**	**49**	**55**	**60**	**65**	**69**
40	**28**	**40**	**49**	**57**	**63**	**69**	**75**	**80**
50	**32**	**45**	**55**	**63**	**71**	**77**	**84**	**89**
70	**37**	**53**	**65**	**75**	**84**	**92**	**99**	**106**
90	**42**	**60**	**73**	**85**	**95**	**104**	**112**	**120**
110	**47**	**66**	**81**	**94**	**105**	**115**	**124**	**133**
130	**51**	**72**	**88**	**102**	**114**	**125**	**135**	**144**
160	**57**	**80**	**98**	**113**	**126**	**139**	**150**	**160**
167	**58**	**82**	**100**	**116**	**129**	**142**	**153**	**163**

Notes: X = (200dK) 0.5; where X = distance from the low point.

e. The purpose in providing Table IV-5 is to facilitate the selection of criteria for the location of flanking inlets based on the ponding potential at the site, the potential for clogging of the inlet at the low point, design spread, design speeds, traffic volumes, and other considerations which may be peculiar to the site under consideration. A depth at curb criterion which does not vary with these considerations neglects consideration of cross slope and design spread and may be unduly conservative at some locations. The location of flanking inlets at a fixed slope rate on the vertical curve also neglects consideration of speed facilities and is not at all conservative for high-speed facilities.

f. Except where inlets become clogged, spread on low gradient approaches to the low point is a more stringent criterion for design than the interception capacity of the sag inlet. AASHTO recommends that a gradient of 0.3 percent be maintained within 50 feet of the level point to provide for adequate drainage. It is considered advisable to use spread on the pavement at a gradient comparable to that recommended by the AASHTO Committee on Design to evaluate the location and design of inlets upgrade of sag vertical curves. Standard inlet design and/or location may need adjustment to avoid excessive spread in the sag curve.

E. STORM SEWERS AND APPURTENANCES

1. General

    a. It is the purpose of this section to consider the significance of the hydraulic elements of storm sewers and their appurtenances to a storm drainage system. Hydraulically, storm drainage systems are conduits (open or enclosed) in which unsteady and non-uniform free flow exists. Storm sewers accordingly are designed for open-channel flow to satisfy as well as make possible the requirements for unsteady and non-uniform flow. Steady flow conditions may or may not be uniform.

    b. All storm sewers shall be designed by the application of a universally accepted methodology, e.g., Manning's Equation, assuming open channel flow conditions. The hydraulic grade line shall be checked for storm sewer designs to determine if the open channel flow assumption is valid. In the preparation of hydraulic designs, a thorough investigation shall be made of all existing structures and their performance on the waterway in question.

    c. After the computation of the quantity of storm runoff entering each inlet, the storm sewer system required to carry the runoff is designed. It should be borne in mind that the quantity of flow to be carried by any section of the storm sewer system is not the sum of the inlet design quantities of all inlets above that section of the system but is less than the straight total. This situation is because as the time of concentration increases the rainfall intensity decreases.

    d. Major Storm System: Check the proposed system for the 100-year storm event. Modify the proposed system or provide additional flow capacity as required to accommodate the 100-year storm event runoff according to the requirements stated in the above sections.

2. General Criteria

    a. Frequency of Design Runoff: The frequency of design runoff is a function of operational and economic criteria with a special emphasis on public safety. As discussed in other sections of these standards some types of facilities do not require high levels of protection and periodic flooding is not objectionable. However, for all facilities the designer must consider the impact of a 100-year event.

    b. Pipe Sizes and Material Types

        i. Pipes, which are to become an integral part of the public storm sewer system, shall have a minimum equivalent diameter of 12 inches if there are no bends and 18 inches if there are any bends. Pipe may be “green”

PVC for sizes 12 inches through 18 inches and shall be reinforced concrete pipe (RCP) for all large sizes. All pipe design and installation must meet the manufacturer's recommendations for minimum depth of cover.

ii. Pipe design service life shall be a minimum of 50 years as certified by the manufacturer. All manufacturer requirements for which the design service life is based must be met by the engineer. The minimum allowable coefficient of roughness for concrete pipe for direct solution of Manning's Equation is 0.013 and for PVC pipe is 0.010.

c. Velocities and Grades:

i. Minimum Grades: Storm sewers should operate with velocities of flow sufficient to prevent excessive deposition of solid material; otherwise, objectionable clogging may result. The controlling velocity occurs near the bottom of the conduit and is considerably less than the mean velocity. Storm sewers shall be designed to have a minimum mean velocity of two and a half (2.5) fps for the two (2) year storm condition. Outlets on storm sewers of minimum grade should be designed to avoid sedimentation at the outfall.

ii. Maximum Velocities: Table IV-6 shows the limits of maximum velocity for all storm sewers except downspouts.

Table IV-6: Maximum Velocity in Storm Sewers

Description	Maximum Permissible Velocity
Storm Sewers-Inlet Laterals	**No Limit**
Storm Sewers-Collectors and Mains	**20 fps**

3. Manhole/Inlet Location

a. Manholes/inlets shall be located at intervals not to exceed 400 feet for pipe 30 inches in diameter or smaller. Manholes / inlets shall be located at conduit junctions, changes in alignment, and ends of curved sections as necessary for maintenance equipment operation.

b. Manholes / inlets for pipe greater than 30 inches in diameter shall be located at points where design indicates entrance into the conduit is desirable; however, in no case shall the distance between openings or entrances be greater than 600 feet.

c. Manholes/inlets shall NOT be placed above water mains.

4. Pipe Connections: Prefabricated wye and tee connections are required up to and including 24 inches x 24 inches. Connections larger than 24 inches can be made by field connections.

5. Alignment: In general, storm sewer alignment between manholes shall be straight. Long radius curves may be allowed to conform to street alignment. Short radius curves may be used on pipes 30 inches and larger to reduce head losses at junctions. Pipe deflection shall not exceed manufacturer's recommendations, unless precast or cast-in-place bends are specifically designed for deflection.

6. Flow in Storm Sewers

    a. All storm drains shall be designed by the application of the Continuity Equation and Manning's Equation.

    b. The following items will be followed when designing storm sewers:

        i. Select pipe size and slope so that the velocity of flow will increase progressively, or at least will not appreciably decrease, at inlets, bends, or other changes in geometry or configuration.

        ii. Do not discharge the contents of a larger pipe into a smaller one, even though the capacity of the smaller pipe may be greater due to steeper slope.

        iii. At changes in pipe size from a smaller to a larger pipe, match the soffits (inside top surface) of the two pipes at the same level rather than matching the flow lines. When necessary for minimal fall, match the 0.8 diameter point of each pipe.

        iv. Conduits are to be checked at the time of their design with reference to critical slope. If the slope of the line is greater than critical slope, the unit will likely be operating under entrance control instead of the originally assumed normal flow. Conduit slope should be kept below critical slope if possible. This also removes the possibility of a hydraulic jump within the line.

        v. Inlet and outlet treatments are required on all storm sewers in accordance with Section H. Structures. Inlets and outlets shall be designed to prevent scour and erosion.

7. Hydraulic Gradient and Profile of Storm Sewers

    a. The hydraulic grade line shall in no case be closer than one foot to the ground or street surface based on the maximum storm sewer system input unless otherwise approved by the City. The hydraulic grade line shall be based on

the law of conservation of energy as expressed by the Bernoulli Equation. If the storm sewer system could be extended at some future date, present and future operation of the system must be considered It is not necessary to compute the hydraulic grade line of a conduit section if all three of the following conditions are satisfied:

i. The slope(s) and the pipe size(s) are chosen so that the slope is equal to or greater than friction slope.

ii. The inside top surfaces (soffit) of successive pipes are lined up at changes in size.

iii. The water surface at the point of discharge will not rise above the top of the outlet.

b. In such cases the pipe will not operate under pressure and the slope of the water surface under capacity discharge will approximately parallel the slope of the invert of the pipe.

8. Total Energy Losses at Structures

a. Short radius bends may be used on 24 inches and larger pipes when flow must undergo a direction change at a junction or bend. Reductions in head loss at manholes may be realized in this way. A manhole shall be located at the end of such short radius bends if required for operation and maintenance.

b. Energy head losses at structures shall be determined for inlets, manholes, wye branches, and bends in the design of full flow closed conduits.

9. Minor Head Losses at Structures: A universally accepted methodology, e.g., the standard method, will be used for determining structure head loss based on the exit pipe's velocity.

F. CULVERT HYDRAULIC DESIGN

1. General: The function of a drainage culvert is to pass the design storm flow under a roadway, railroad, or other feature without causing excessive backwater and without creating excessive downstream velocities.

2. Design Criteria

a. The design flow shall be determined as set forth in the sections above.

i. Design Frequency: Culverts shall, at a minimum, pass the 10-year design storm with 1-foot of freeboard. The 100-year storm shall meet the requirements of these standards. If a FEMA flood plain exists the design

shall comply with the City flood plain ordinance or FEMA regulations, whichever is more restrictive.

ii. Culvert Discharge Velocities: The velocity of discharge from culverts should have consideration given to the effect of high velocities, eddies or other turbulence on the natural channel, downstream property, and roadway embankment. Inlet and outlet treatments are required on all culverts in accordance with Section H. Structures. Inlets and outlets shall be designed to prevent scour and erosion. The maximum allowable velocity in a culvert is 20 feet per second.

iii. Culvert Material Types: Material for culverts shall be concrete. Corrugated metal pipes are allowable under residential driveways. Other materials may be considered, and exceptions may be granted by the Director of Public Woks or City Engineer.

iv. Culvert Design Methodologies: Culverts shall be designed in accordance with the current edition of the Federal Highway Administration (FHWA).

G. OPEN-CHANNEL FLOW

1. General

a. Open channels designed for use in drainage systems have significant advantages regarding cost, capacity, multiple use for recreational and aesthetic purposes, and potential for in stream storage and ground water re-charge. Disadvantages include potential right-of-way constraints and maintenance costs. Careful planning and design are needed to increase the benefits and to minimize the disadvantages. The ideal open channel is one that is a stabilized water course developed by nature over time, characterized by stable bed and banks. The benefits of such a channel are as follows:

i. Available channel storage can decrease peak flows.

ii. Maintenance needs can be low when the channel is properly stabilized.

iii. Natural subsurface infiltration of flows is provided.

iv. Native vegetation and wildlife may not have to be disturbed.

v. The channel can provide a desirable green belt and recreational area adding significant social benefits.

b. Generally, a stabilized natural channel, or the man-made channel which most nearly conforms to the character of a stabilized natural channel, is the most efficient and the most desirable.

c. The use of naturally occurring channels and drainage ways is encouraged. Channel stability, particularly in unprotected alluvial materials, is a problem in urban hydrology because of the significant increase in low flow and peak storm runoff rates. A natural channel must be studied in sufficient detail to determine the measures needed to mitigate potential bottom scour and bank cutting. Erosion control measures can be provided at reasonable cost which will preserve the natural appearance without sacrificing hydraulic efficiency. This section provides the necessary criteria for selection and design of open channels.

2. Types of Channels: Channels are defined as natural or artificial. Natural channels include all water courses that have developed by the erosion process. Artificial channels are those constructed or significantly altered by human effort and include roadside ditches and grassed or improved channels.

   a. Natural Channels:

      i. Many natural channels in urbanizing or urbanized areas have mild slopes, are reasonably stable, and are not in a state of serious degradation or sedimentation. However, if a natural channel is to be used for carrying storm runoff from an urbanized area, the altered nature of the runoff peaks and volumes from urban development can and will cause erosion. Hydraulic analyses will be required for natural channels in order to identify the erosion tendencies. Some on-site modification of the natural channel may be required to ensure a stabilized condition.

      ii. The investigations necessary to assure that the natural channels will be adequate are different for every waterway. The designer must prepare cross sections of the channel, define the water surface profile for the initial and major design flood, investigate the bed and bank material to determine flow conditions. Supercritical flow does not normally occur in natural channels, but calculations must be made to assure that the results do not reflect supercritical flow.

   b. Artificial Channels: Artificial channels include:

      i. Grass-Lined Channels: Grass-lined channels are the most desirable of the artificial channels. The presence of grass in channels creates turbulence which results in loss of energy and increased flow retardance. Therefore, the designer must consider sediment deposition and scour, as well as hydraulics.

      ii. Concrete-Lined Channels: If the project constraints dictate the use of concrete channel, such use shall be allowed only upon approval by the City.

iii. Rock-Lined Channels: If the project constraints dictate the use of a riprap or gabion lining, such use shall be allowed only upon approval of the City. Riprap for the purposes of local erosion control is permitted.

iv. Other Channel Linings: The criteria for the design of channels with linings other than grass, rock, or concrete will be dependent on the manufacturer's recommendations for the specific product. The designer will be required to submit the technical data in support of the proposed material. Additional information or calculations may be requested by the City to verify assumptions or design criteria.

3. Design Standards

a. The design standards for open channels cannot be presented in a step-by-step fashion because of the wide range of options available to the designer. Certain planning and conceptual criteria are particularly useful in the preliminary design of a channel. Those criteria which have the greatest effect on the performance and cost of the channel are discussed below. Design submittals shall be in a clear and concise format convenient for review and shall include, but not be limited to:

i. Storm runoff computations and mapping.

ii. Hydraulic design computations, assumptions, references, sketches, and drawings.

iii. Floodplain mapping; and

iv. Any other pertinent data.

b. All designed channels shall be such that the Froude Number is not between the ranges of 0.95 to 1.05. Undulated flow could occur in the prohibited range and cause excessive channel damage.

c. Evaluation of Natural Channels:

i. The evaluation criteria for natural channels are:

- The channel and over bank areas shall have adequate capacity for the major storm runoff.

- Natural channel segments which have a Froude Number greater than 0.95 for any flow shall be protected from erosion.

- The water surface profiles shall be defined so that the major storm flood plain can be mapped.

- Filling of the flood fringe reduces valuable channel storage capacity and tends to increase downstream runoff peaks and is subject to the restriction of floodplain regulations.

- Manning's roughness factors, "n", which are representative of unmaintained or "in need of maintenance" channel conditions shall be used for the analysis of water surface profiles.

- Manning's roughness factors, "n", which are representative of maintained channel conditions, shall be used to determine velocity limitations.

- Erosion control structures such as riprap, check drops or check dams, may be required to control flow velocities, including the initial storm runoff.

- Plan and profile drawings of the major storm floodplain, including flooded limits, shall be prepared. Appropriate allowances for future bridges or culverts, which can raise the water surface profile and cause the floodplain to be extended, shall be included in the analysis.

ii. With most natural waterways, grade control structures should be constructed at regular intervals to decrease the thalweg (point of deepest flow) slope and to control erosion. However, these channels should be left in as near a natural condition as possible. For that reason, extensive modifications should not be undertaken unless they are found to be necessary to avoid excessive erosion with subsequent deposition downstream. Also, modification of the channel within the normal high-water line may require a US Army Corps of Engineers Section 404 permit.

iii. The usual rules of freeboard depth, curvature, and other guidelines which are applicable to artificial channels do not necessarily apply to natural channels. There are significant advantages which may occur if the designer plans for the overtopping of the channel and localized flooding of adjacent areas, which are laid out and developed for the purpose of being inundated during the major storm runoff. The freeboard criteria can be used to advantage in gauging the adequacy of a natural channel for future changes in runoff.

d. Evaluation of Artificial Channels:

i. Grass-Lined Channels: Key parameters in grass-lined channel design include velocity, slopes, roughness coefficients, depth, freeboard,

curvature, cross section shape, and lining materials. Other factors such as water surface profile computation, erosion control, drop structures, and transitions also play an important role. Grass-lined channels shall also meet the following design criteria:

- Maintenance / Access Road: Linear access for maintenance and / or construction vehicles and equipment shall be provided for all major drainage ways from public right-of-way or other easements. The “road” may consist of a 12-foot wide, graded space on one side of the channel.

- Transitions: Scour potential is amplified by turbulent eddies in the vicinity of rapid changes in channel geometry such as at transitions and bridges. Riprap protection for sub critical transitions (Froude Number 0.8 or less) is selected by increasing the channel velocity by 20 percent. Since the channel velocity varies through a transition, the maximum velocity in the transition should be used in selecting riprap size after it has been increased by 20 percent. Protection should extend upstream from the transition entrance at least 5 feet and extend downstream from the transition exit at least 10 feet.

e. Rock-Lined Channels: Design criteria applicable to ordinary and grouted riprap channel linings are present herein.

   i. Channel Coefficient: The Manning’s roughness coefficient for hydraulic computations may be estimated for ordinary riprap using Table 4-14. The “n” values is dependent on the predominant rock size.

   ii. Rock Size and Lining Dimensions: Rock size lining and dimensions shall be per FHWA HEC-22.

   iii. Wire Enclosed Rock (Gabions): The roughness coefficient for gabion linings varies from 0.025 to 0.033 depending on the predominant rock size. An “n” value or 0.026 is recommended based on rock size of four (4”) inches. For gabion linings a larger value of “n” – 0.032 is recommend due to the larger rock size.

   iv. Bedding Requirements for Rock-Lined Channels: Long term stability of riprap and gabion erosion protections is strongly influenced by proper bedding conditions. A large percentage of all riprap failures are directly attributable to bedding failures. Properly designed bedding provides a buffer or intermediate sized material between the channel bed and the riprap to prevent piping of channel particles through the voids in the riprap. Two types of bedding are in common use: 1) granular bedding filter and 2) filter fabric.

4. Water-Surface Profile Analysis

    a. For final design, water-surface profiles must be computed for all channels. The normal depth may be used for the water surface profile if the channel is uniform and continuous with no variance in the channel cross section, slope or channel material. Computation of the water surface profile shall be presented for all open channels, utilizing standard backwater analysis, and should consider all losses due to changes in channel velocity, drops, curves, bridge openings and other obstructions. Computations begin at a known point and extend in an upstream direction from sub critical flow.

    b. Water surface profiles shall be determined using universally accepted standard methods. These would include methods published in *Open-Channel Hydraulics* by Chow and the HEC series computer programs developed by the US Army Corps of Engineers, which can be used to compute water surface profiles for both natural and man-made channels.

    c. When designing bends in open channels, the effects of super elevation and energy losses due to resistance in the bends must be considered in water surface profile computations. In addition to super elevation on bends, flow separation in the bend creates a backwater effect that must also be considered.

H. STRUCTURES

1. General

    a. Hydraulic structures are used to guide and control water flow velocities, directions and depths, the evaluation and slope of the streambed, the general configuration of the waterway, and its stability and maintenance characteristics.

    b. Careful and thorough hydraulic engineering is justified for hydraulic structures consideration of environmental, ecological, and public safety objectives should be integrated with hydraulic engineering design. The proper application of hydraulic structures can reduce initial and future maintenance costs by managing the character of the flow to fit the environment and project needs.

    c. Hydraulic structures include transitions, constrictions, channel drops, low-flow checks, energy dissipaters, bridges, bends, and confluences. Their shape, size, and other features vary widely for different projects depending upon the discharge and the function to be accomplished. Hydraulic design procedures must govern the final design of all structures.

d. Urban drainage facilities should not be built if they cannot be properly maintained on a long-term basis. This means that suitable access must be provided, a maintenance plan must be developed and funded, and the drainage facilities must be maintained in accordance with public works standards.

e. The design of structures must consider the safety of maintenance workers and the public, especially when multiple uses are intended. There are some inherent safety risks in any waterway that must be recognized by the public, designers, and government officials. The designer must use a reasonable standard of care for the structure being designed or retrofitted that includes evaluation of present or likely future public access and uses.

f. Aesthetic appearance of structures in urban areas is also important. Structures can be designed with various configurations, different materials, and incorporation of adjacent landscaping to produce a pleasing appearance and good hydraulic function and to enhance the environmental ecological character of the channel and floodplain.

g. It is not the intent of this section to describe all types of hydraulic structures, rather typical hydraulic structures are presented. Additional information can be obtained from technical references.

2. Energy Dissipaters: Energy dissipaters are often necessary at the end of outfall sewers, culverts, or channels. Sometimes they are useful at locations where the designer wants to change the flow from supercritical to subcritical downstream flow from or conduit to reduce or limit potential erosion. Different types of acceptable energy dissipators include:

   a. Impact-Type Stilling Basins

      i. Generally, impact-type stilling basins lend themselves to use with pipes. They are an effective stilling device even with deficient tail water where the discharge is relatively small. This basin can be used with either an open chute or a closed conduit structure. For larger discharges, multiple basins could be placed side-by-side (parallel).

      ii. This type of basin is subject to local flow turbulences and large dynamic forces which must be considered in the structural design. The structure must be made sufficiently stable to resist sliding due to the impact load on the baffle wall. The entire structure must also resist the severe vibrations inherent in this type of device, and the individual structural members must be sufficiently strong to withstand the large dynamic loads.

      iii. Riprap should be provided along the bottom and sides adjacent to the structure to avoid potential local scour of the outlet channel downstream

from the end sill when a shallow tail water condition exists. Downstream wing walls placed at forty-five degrees (45) may also be effective in reducing scouring tendencies and flow concentrations downstream.

b. Plunge Pools: A plunge pool consists of a free-falling overflow which drops vertically into a pool. The pool must be heavily protected with large riprap or reinforced concrete. A plunge pool may only be used with a continuous low flow in the channel because of the health and safety hazards which could be created by a stagnant pool.

c. Drop Structures

   i. The function of drop structures is to convey water from a higher to a lower elevation (i.e., grade control) and to dissipate excess energy resulting from its fall. A channel located in the same terrain would ordinarily be steep enough to cause severe erosion in earth channels or disruptive flow in lined channels. The water can therefore be conveyed through a drop structure designed to safely dissipate the excess energy.

   ii. Vertical drops are often the most economical for drops of less than 3 feet. They can consist of a simpler weir above a vertical retaining wall and a splash-pool-type energy dissipater that are combined in a single structure. These structures can be constructed from steel sheet pile, riprap, gabion retaining walls and channel mats, soil cement or reinforced concrete.

   iii. Baffled apron drops may be used for nearly any decrease in water-surface elevation where the horizontal distance for a grade drop is relative short. They are particularly adoptable to the situation where the downstream water-surface elevation may vary because of channel degradation or an uncontrolled water surface.

   iv. Rectangular inclined (RI) drops and pipe drops are generally used where the decrease in elevation is in the range of 3 to 15 feet over a relatively short distance. Usually, a pipe drop will be selected for smaller flows and an RI drop will be selected for larger flows. If the drop crosses another waterway or a roadway, it will probably be more economical to use a pipe drop.

d. Chute Structures and Downspouts

   i. Chute structures and downspouts are commonly used where the drop in elevation is greater than 15 feet. A chute structure/downspout may consist of an inlet, a chute section, an energy dissipater, and an outlet transition. They may also be a CMP downspout with inlet and outlet transition. CMP may be used for such structures where soil tests show that the soil is not corrosive. Soil tests must be provided when CMP is proposed as the

downspout material. Chutes and downspouts are like drops except that they carry the water over longer distances, over flatter slopes, and through greater changes in grade. The inlet portion of the structure transitions the flow from the channel upstream of the structure to the chute structure. The chute section, either pipe or open channel, generally follows the original ground surface and connects to an energy dissipater at the lower end. Stilling pools or baffled outlets are used as energy dissipaters on chute structures. An outlet transition is used when it is necessary to transition the flow between the energy dissipater and the downstream channel. In a pipe chute the open section is replaced by a pipe. Pipe chutes may be designed to provide a crossing or to allow farming or grazing over the structure.

ii. The decision as to whether to use a chute structure or a series of smaller drops should be based upon a hydraulic and economic study of the two alternatives. Drops should not be so closely spaced as to possibly preclude uniform flow between outlet and inlet ends of consecutive structures, particularly where checks or control notches are not used at the inlets. The danger is that sufficient tail water depths may not exist to produce hydraulic jumps in the pools, and thus “shooting flow” may develop through the series of drops and possibly damage the channel. Also, with drops too closely spaced on a steep slope, problems of excavation and backfill may make construction undesirable or prohibitive. About 200 feet of channel should be the minimum distance between the inlet and the outlet ends of consecutive drop structures. The economic study should compare cots of a series of drops versus a single chute structure considering advantages and disadvantages pertinent to the specific conditions. Since the maintenance costs for a series of drops is usually considerably more than for a single chute structure that would perform the same hydraulic function, it is sometimes economically justifiable to spend considerably more initial costs for a chute structure than a serious of drops.

e. Flow Transitions

i. A flow transition structure is a change of channel cross section designed to allow for a minimum amount of flow disturbance. Several types of transitions are in common use. Of these, the abrupt (headwall) and the straight line (wing wall) are the most common.

ii. Special inlet transitions are useful when the conservation of flow energy is essential because of allowable headwater considerations. See previous sections for discussion on culvert design with improved inlets.

iii. Outlet transitions (expansions) must be considered in the design of all culvert energy dissipaters and channel protection. The standard wing wall

apron combinations and expansions downstream of dissipater basins are most common.

f. Riprap

i. Placement of riprap is used for preventing or limiting channel bed and bank erosion damage caused by excessive channel flow or surges from energy dissipaters. Placement of riprap on the channel bottom and banks downstream of an energy dissipater structure is required for alleviating possible undermining of the structure.

ii. Experience has shown that a primary reason for riprap failure is placement of undersized individual stones in the maximum size range. Failure has also occurred because of improper engineering design for graduation of riprap, see page control and/or bedding filter requirements.

iii. Design of riprap should consider the following parameters:

- Stone durability
- Stone density
- Stone size
- Stone shape
- Stone gradation
- Velocity of flow against the stone
- Filter bed requirements
- Channel side slopes
- Froude Number

iv. A well-graded riprap layer should contain about 40 percent of the rock pieces smaller than the required design size. Most of the mixture should consist of stones having length, width, and thickness dimensions nearly equal as practical to required design size.

v. The riprap layer should be a minimum of 1.5 times as thick as the dimension of the required design size and should be placed over a gravel or reverse filter layer.

g. Design of Riprap Basins: The design of riprap basins shall be based on universally accepted design practices. Examples of these include Hydraulic

Engineering Circulars published by the Federal Highway Administration and Design Standards published by the US Bureau of Reclamation. The general design recommendations below assume that a flared end section is to be used at the outlet and the channel water depth is not less than one-quarter (1/4) of the pipe diameter.

i. The general geometry of the basin shall be such that the width of the basin at the flared end section outlet shall be 3 times the pipe diameter.

ii. The divergence angle of the rock basin shall be 3L:1W ratio of the length to the width.

iii. The depth of the rock shall be a minimum of 1.5 times as thick as the largest stone.

iv. The maximum slope of the sides of the riprap basing shall be 2H:1V.

v. A riprap basin shall not be used if the pipe velocity is greater than 3.33 times the channel velocity.

vi. The slope of the outlet pipe shall not exceed 5 percent for 5D from the outlet (where D is the pipe diameter).

h. Velocity Reduction Combinations

i. The designer may reduce the cost and/or size of velocity reduction (energy dissipation) structure by utilizing combinations of serval structures. Combining types of structures may also allow a more efficient and more site adaptable structure.

ii. Alternate designs require the designer to determine which of the combinations is the most economical design and is site adaptable. This process is an iterative process and will require familiarity with the site and all the parameters which the design must meet.

i. Scour

i. Essentially, scour is the net result of an imbalance between the capacity of the flow to transport sediment out of an area and the rate of supply of sediment to the area. At a bridge crossing, for instance, the area of interest is the immediate vicinity of the bridge foundation, the piers, and abutments. The imbalance of this capacity and supply can arise from a variety of causes which can be generally categorized as 1) those characteristics of the stream itself, and 2) those due to the modification of the flow by the bridge piers and abutments.

ii. Because of the overall complexity of the hydrodynamic forces existing in a natural stream channel, the detailed flow pattern in an unobstructed stream cannot be predicted over time with great accuracy. Reasonable estimates can be made based on observations along reaches of similar streams, and in some cases, actual records, and measurements for the particular reach of the stream under investigation can be performed.

iii. Scour which occurs because of modification of the flow patterns by a bridge crossing can be further divided into two distinct types of scour, depending upon whether or not sediment is supplied to the scour hole. Equilibrium is attained when a scour hole is enlarged to a size where the capacity to remove material from the scour hole is balanced by the rate at which sediment is supplied to the scour hole. During floods, a scour hole located in the main channel will be supplied with sediment at a rate characteristic of the stream. Ignoring the complexities of material stratification that may exist below the stream bed, the material supplied will be essentially the same as the material removed.

iv. If no sediment is supplied to the scour hole, equilibrium is not attained until configuration of the bed is such that the scouring capacity of the flow is zero. This condition is most likely to occur in over bank areas where vegetation reduces flow velocities, causing the coarser material to drop out of separation, resulting in a greater degree of scour in over bank areas than would otherwise occur in the main channel.

I. STORAGE

1. General

a. On-site detention of runoff is an alternative to other methods of urban storm water management. Storage, which involves collecting excess runoff before it enters the main drainage system, can often be an effective and economical means of reducing peak flow rates and mitigating problems of flooding, pollution, soil erosion, and siltation.

b. Detention facilities will be used to lessen the impact of peak flows on the down-stream property, and for the improvement of water quality. Facilities that retain storm water runoff for an extended period will not be permitted, unless identified in an approved drainage basin design plan. Design of retention facilities is beyond the scope of this manual.

c. State law says that a landowner can drain his/her or her property by artificially accelerating the drainage onto lower land following the natural drainage course unless water is collected or released in unusual or unnatural quantities. Also, that a landowner can reasonably alter flow of runoff on the land if the resultant downstream harm is not unreasonable.

d. The design of a project site drainage system should not only consider the runoff from upstream sites, recognizing their urban development potential, but also should evaluate the downstream conveyance system leading to established drainage facilities to ensure that it is sufficient capacity to accept design discharges without adverse backwater or downstream impacts such as flooding, stream bank erosion, and sediment deposition. If downstream conveyance is not in place to handle increased flows, the landowner must make adequate on-site detention to limit flows.

e. Peak flows should be limited to predevelopment levels, i.e., natural for underdeveloped land and immediate pre-development for partially developed land, for the 2-, 10-, and 100-year runoff event unless the design engineer provides a drainage analysis showing the downstream conveyance system can handle larger post development outflows. This would require that storage facility outlet structures be designed to meter the outflows for the 2-, 10-, and 100-year runoff event.

f. Any drainage basin design plans which have been adopted by the City provide for only major drainages. Localized or minor drainage is required to be evaluated on a site-by-site basis.

g. The purpose of this section is to present the design expectations for on-site detention facilities.

2. On-Site Storage: It is with on-site storage that the greatest potential exists for reducing the cost of urban drainage. Types of on-site storage includes but is not limited to:

   a. Rooftop Ponding,

   b. Parking Lots,

   c. Recreational Areas,

   d. Property Line Swales,

   e. Road Embankments,

   f. On-Site Ponds,

   g. Sub-Surface Storage, and

   h. Combinations of the above.

3. Design Criteria: It is important for an engineer/developer to know when a facility comes under the design criteria of a dam, as defined by the State.

    a. Dam Facility: A dam facility is as defined in the Administrative Rules of South Dakota (ARSD).

    b. Design Storm: A detention facility shall be designed to control the peak rates for the 2-, 10-, and 100-year events to existing conditions. A minimum of 2-foot freeboard shall be added to the 100-year design water surface elevation. It is the responsibility of the designer to determine if additional freeboard is necessary. The City reserves the right to require additional freeboard if the City deems it necessary. Adding the additional freeboard requirement may create a dam as defined in ARSD. The facility must then be modified or designed as per state dam criteria.

4. Detention Facility: A detention facility shall consist of any artificial barrier and associated outlet works intended to detain water. A detention facility that meets the definition of a dam in the ARSD shall be designed in accordance with the ARSD. Peak flows shall be limited to predevelopment levels for the 2-, 10-, and 100-year event unless the design engineer provides a drainage analysis showing the downstream conveyance system can handle larger post development flows. Minimum design standards for detention facilities area as follows:

    a. Minimum bottom slopes – pond slopes shall be designed with a 0.5- percent minimum longitudinal and a 2-percent minimum cross slope.

    b. Side slopes – graded facility side slopes shall be 4H to 1V, maximum. Graded side slopes steeper than 4H to 1V, must be approved by the Public Works Director or City Engineer and, if approved, protected from erosion and instability, and not require routine maintenance.

    c. Trickle Channels – facilities shall have a trickle channel with capacity of 2 percent of the 100-year design storm event inflow to the pond and a minimum slope of 0.2 percent.

    d. Freeboard – detention facilities shall be designed with a minimum freeboard of 2 feet above the emergency spillway water surface elevation or 2 feet above the water surface elevation during a 100-year storm event spill over the emergency spillway, whichever is greater.

    e. Inlets – points of inflow to the facility shall be protected to prevent erosion. The design of protection measures shall be based on no storage in the pond.

    f. Groundwater – the presence of groundwater within detention facilities must be addressed in design so that standing water is avoided, and drainage structures are adequately protected.

5. Principal Outlet Works

    a. Reinforced concrete structures shall be utilized for the principal outlets. The minimum outlet pipe diameter shall be 18 inches. The principal outlet shall be able to completely drain the detention facility within 72 hours of the end of the 100-year storm event by gravity flow through the principal outlets. If a riser is used, a drawdown pipe shall be installed to completely drain the facility. The minimum riser pipe diameter shall be 18 inches.

    b. The formation of vortices can significantly reduce the discharge of a given headwater because of energy losses. The potential for this shall be evaluated during design and anti-vortex devices installed, if necessary.

    c. Depending on the geometry of the outlet structure (either drop-inlet riser or hood-inlet pipe) discharge for various headwater depths can be controlled by the inlet crest (wire control), the riser or barrel opening (orifice control), or the riser or barrel pipe (pipe control). Each of these flow controls shall be evaluated when determining the rating curve of the principal outlet.

6. Emergency Spillways

    a. The designer is responsible for determining if an emergency spillway or a spillway feature is needed for an embankment type detention facility. The City may require the designer to evaluate a more stringent design requirement including a breach analysis if there is a potential for loss of life.

    b. The position, profile, and length of the spillway are influenced by geologic and topographic features of the site. The cross-section dimensions are governed by hydraulic elements and are determined by acceptable reservoir routing of the design storm. Discharge from the spillway(s) shall be directed to the main channel without causing erosion along the downstream toe of the dam. Spillways proposed for the protection of earthen embankments shall be in full cut, if possible, to avoid flows against constructed fill. The side slopes of the excavated channel in earth shall be no steeper than 4H:1V for ease of maintenance. Where the site limitations prevent a full channel cut, a wing dike shall be provided to direct spillway flows away from the downstream toe of the dam. Ready access to the emergency spillway system shall also be provided.

    c. The configuration of the entrance channel from the reservoir to the control section of the spillway shall be a smooth transition to avoid turbulent flow over the spillway crest. The outlet channel of the spillway shall convey flow to the channel below the structure with a minimum of erosion. The slope of the exit channel usually follows the configuration of the abutment. In cases of highly erodible soils, it may be necessary to use other means of protection such as riprap, grouted rock or concrete paving to form the exit channel. Specially,

adapted grasses can be used to provide a stabilizing effect and reduce erosion in the exit channel. As an alternative, detention storage can be increased to reduce the frequency and/or duration of use of the spillway and thereby reduce erosion problems.

7. Hydraulic Design Methods: The acceptable methods for predicting the volume of runoff over the time and the peak flow include the Modified Rational Method and HEC-HMS or other methods identified in the sections above.

J. IRRIGATION

1. General

   a. The combined use of irrigation facilities for storm water drainage is prohibited without the permission of the owner of such facilities and the City.

   b. Urbanization of undeveloped areas could impact existing irrigation systems in one of three ways:

      i. Development could disrupt the source of supply by reducing the quantity of water flow in channels used for irrigation supplies or by reducing the quality of water used for irrigation.

      ii. Development could disrupt irrigation water delivery by adversely impacting the geometry of channels used for irrigation, thus reducing the hydraulic efficiency of the irrigation head gates.

      iii. Development could disrupt irrigation water delivery by increasing the flow in existing ditches, resulting in ditch failure and downstream flooding.

2. Use of Irrigation Channels

   a. The use of irrigation facilities for storm water conveyance generally is not acceptable. Runoff from urban development shall be directed into historic or natural drainage ways, avoiding discharge into irrigation facilities, except as required by water rights or as shown in an approved drainage basing design plan and with the permission of the owners of such facilities and the City.

   b. If the designer proposes to use an existing, manmade canal to convey storm water runoff from developing area, the following information must be provided to the City:

      i. Documentation of consultation between the designer and Ditch Company indicating the intent of the designer, the extent of the affected reach, and the magnitude of expected impacts.

ii. Map showing the affected anal reach, accompanied by engineering drawings of any improvements made to the canal as part of the storm water management system.

iii. A report describing proposed improvements supported by the following:

- A description of the alternatives considered, including the design criteria used to evaluate the alternatives.

- Additional design criteria, if any, required by the ditch company.

- Technical computations indicating:

    - Existing canal capacity, including base flow and/or irrigation flows and residual capacity.

    - Ultimate capacity after improvements.

    - Design storm hydrographs.

    - Areas flooded under existing and ultimate conditions.

- An environmental appraisal of proposed action describing:

    - Temporary and permanent measures to control the production of sediments.

    - Wetlands and navigable streams affected by the proposed action. Wetlands are regulated by Section 404 of the Clean Water Act and streams by Section 10 of the Rivers and Harbors Act of 1899.

    - Expected impacts to water quality.

- A listing of anticipated costs, including alternatives, for capital improvements and annual operation and maintenance.

- A description of the expected maintenance requirements, together with an annual maintenance schedule, including the source of funds to be used for maintenance activities.

- Confirmation of the existence of a viable downstream channel (i.e., drainage easement that it is not filled in).

iv. Resolution(s)/easement(s) made and executed by the affected party (or parties, if necessary) allowing the use of the affected canal for purposes of storm water management.

V. GRADING

A. PERMITTING

1. Grading Permits Requirements: A grading permit is required in accordance with Chapter 153.058 of the Box Elder Municipal Code for work involving grading, excavation, or earthwork within the City, unless otherwise exempted. Grading permits are applicable and issued for work on private property.

2. Work in Streets or Rights-of-Way: Any work within public streets or rights-of-way shall be in accordance with a separate right-of-way work permit issued by the City.

3. Exempt Work

    a. Grading permits are not required for the following situations:

        i. Grading incidental to and identified in plans submitted for construction of a structure for which a building permit has been issued under the International Residential Code (IRC) and is less than one acre in area, including excavation for structures covered by the building permit.

        ii. Grading in an isolated, self-contained area, provided the total amount of grading does not exceed 15 cubic yards, there is no danger to the public, and that such grading will not adversely affect adjoining properties.

        iii. Cemetery graves.

        iv. Refuse disposal sites controlled by other regulations.

        v. Excavations for wells.

        vi. Utility Trenches.

        vii. Mining, quarrying, excavating, processing, or stockpiling of rock, sand, gravel, aggregate, or clay under regulations of other authorities such as the State of South Dakota that such operations do not affect the lateral support of, or significantly increase stresses in, soil on adjoining properties.

        viii. Exploratory excavations performed under the direction of a registered design professional, such as soil borings or test pits. Any pits, borings, or excavations should be suitably backfilled or plugged following completion of tests, sampling, or observations.

b. Interpretations of applicability of exemptions or the need for a Grading Permit will be made by the City Building Official. In evaluating exemptions, factors such as location of the work relative to other properties, quantity of earthwork to be performed, size of the disturbed area, impact on public right-of-way or infrastructure, steep grades or slopes on the property, the existence of stability or soil problems in the vicinity, and drainage impacts will be considered.

4. Grading Permit Requirements

a. Applications for grading permits shall be made to the City of Box Elder Planning Department, on forms available from the Planning Department, or from the City website. Administrative review of the application may take up to 2 weeks after the receipt of all required engineering data. The Permit will not be issued until the administrative review has been completed.

b. Applications shall include the following information:

i. A site plan prepared by a South Dakota registered professional engineer (or a registered landscape architect when the grading permit is for a recreational facility) showing:

- a scaled image of the property on which the work is to be performed.

- the location of the proposed grading work on the property.

- existing and proposed finished grades, with contours at intervals appropriate to the nature and intent of the work and the site (generally the interval between contours should be a minimum of 1 foot, and maximum of 5 feet).

- any existing structures or improvements on the site.

- lot lines.

- any easements located on the property such as for drainage, utility, or access.

- any wetlands or floodplains, floodways located on or immediately adjacent to the property; and

- distance from lot lines to the work location(s).

ii. A soils report prepared by a South Dakota registered soils engineer identifying:

- the nature and distribution of existing soils.

- conclusions and engineering recommendations from grading procedures.

- soil design criteria for any structures or embankments required to accomplish the proposed grading; and

- where necessary; slope accomplish studies, and recommendations and conclusions regarding site geology.

iii. An analysis of site drainage prepared by a South Dakota registered professional engineer, demonstrating that the discharge rate of runoff from the site will not exceed that which existed prior to grading, and the anticipated flows and capacity or all conveyance facilities transporting or receiving the runoff.

iv. Sediment and erosion control plans showing temporary and permanent measures (best management practices) to stabilize the site and prevent sediment discharge during and after completion of the grading activities. The best management practices may include structure or vegetative measures and must be appropriate for all stages of the grading work through the final stabilization. Failure to implement and maintain best management practices or stabilization measures may result in a violation of permit conditions. This plan shall meet all requirements of the SD DANR.

v. Location(s) of off-site sources for fill or waste sites, proposed haul routes and proposed locations for access to public streets, highways, or rights-of-way.

5. Other Permits: Issuance of a grading permit by the City shall not relieve the permit holder from any obligation to determine the need for and to obtain permits from other agencies having jurisdiction, such as South Dakota Department of Agriculture and Natural Resources, the US EPA, the US Army Corp of Engineers, etc. A permit does not give authority to violate, cancel, or set aside any of the provisions of the building code, zoning ordinance, or any other local, State or Federal law or ordinance regulating construction or the performance of construction in the City. A grading permit does not include authorization for construction of retaining walls or other structures which may require a separate permit obtained from the City.

6. Permit Expiration and Renewal

    a. Permits shall be valid for the calendar year they are issued, except permits issued after October 1, may be issued through the end of the following calendar year at the applicant's request. Permits must be maintained in force until completion of the work, including installation of permanent stabilization measures as identified in sediment and erosion control plan for the work and removal of temporary sediment control measures, such as silt fences.

    b. Upon written request of the application, permits may be renewed up to two times for a succeeding calendar year. Application for renewal must be made not later than 1 month after expiration of an active permit. Renewal will be contingent upon determination following a review of the site by city staff that the work has been continuing to progress through the prior permit period, that the work is being performed consistent with the plans and information originally submitted, and that proper measures for stabilization and erosion control are being incorporated into the work. After the second renewal, a new permit application will be required.

B. DESIGN STANDARDS

1. Setbacks

    a. All cut or fill slopes shall be setback from property lines at least 2 feet. Where the vertical height of the cut or fill slope is greater than 10 feet, or where the interceptor drains are required by the Building Code above the cut slopes, additional setback shall be required.

    b. Where setbacks from property line to the location of the work will be less than that specified above, or the grading extends across lot lines, written evidence from affected property owners (i.e. the owners of all lots on which grading is taking place, as well as the adjacent lot owners to areas of reduced setback) shall be submitted to the City prior to issuance of a permit to demonstrate concurrence with and authorization for the proposed grading work.

2. Surface Preparation: Surfaces to receive fills shall be prepared by removing all vegetation, topsoil, and unsuitable materials, and scarifying the exposed surface to a depth of at least 8 inches. Fill shall not be placed on frozen ground.

3. Benches and Keys: Where existing ground surfaces to receive fill are steeper than 5 (horizontal) to 1 (vertical) and the depth to fill will exceed 5 feet (vertical measurement from toe of the slope to the crest of fill), the exposed surface shall be benched, and a key provided at the toe of the slope. The toe key shall be at least ten feet wide and 2 feet deep. Slopes on benches shall generally be no greater than 5 percent. Where recommended by a soils engineer based on analysis alternative standards may be approved.

4. Maximum Slope: Cut or fill slopes may be no steeper than 2 (horizontal) to 1 (vertical) unless use of steeper slopes is analyzed and recommended by a South Dakota registered soils engineer. Recommendations for steeper slopes shall include applicable stabilization measures.

5. Compaction and Oversized Materials: All fill shall be compacted to at least 90 percent of the maximum density as determined by the Modified Proctor (ASTM D1557). No rock or similar irreducible material larger than 12 inches in any dimension, nor any frozen material, shall be included in fills. Alternative compaction specifications shall be subject to jurisdiction based on soils reports or other engineering data.

6. Inspection

    a. Inspection of the work shall be the responsibility of the permit holder.

    b. The City may require the Owner or the Registered Design Professional responsible for the work to provide an inspection in accordance with the International Building Code to review site preparation, placement of fill, and evaluation of in-place density. Generally, in-place density shall provide one test for each 200 cubic yards of fill placed per foot of fill height. Submittal of written reports of inspections and of tests performed in accordance with this section may be required.