CITY DESIGN MANUAL

The City of Van Alstyne, Texas

August 2015

ENGINEERING • WATER • WASTEWATER

TRANSPORTATION • STORMWATER

Record of Revisions

August 2015	City Design Manual adopted by City Council

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SECTION 1

GENERAL REQUIREMENTS

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Section 1 – General Requirements

Section 1 – General Requirements

1.1 Interpretation

In the interpretation and application of the provisions of these regulations, it is the intention of the City Council that the principles, standards and requirements provided for herein shall be minimum requirements for the design of both subdivisions and municipal capital projects in the City, and, where other City ordinances or regulations of the City are more restrictive in their requirements, such other ordinances or regulations shall govern.

The City has adopted various ordinances and master plans, which address various requirements not explicitly included in the City Design Manual, The Developer and his Engineer are responsible for understanding and complying with the City's various ordinances and master plans.

1.2 Enforcement

The technical standards contained herein are issued by the City of Van Alstyne and adopted by the City Council to be enforced as part of this City Design Manual (CDM).

The City of Van Alstyne has adopted (Ord. No. 508) and currently follows the NCTCOG Standard Specifications for Public Works Construction, latest edition.

Projects will be required to comply with all requirements from the date of adoption. The standards include the various design criteria defined in this CDM, Standard Construction Details, technical specifications, currently adopted North Central Texas Council of Governments (NCTCOG) Specifications for Public Works Construction and any City amendment to the NCTCOG specifications are considered **minimum** requirements for the design and construction of adequate public facilities within the City. **The Developer and his Engineer of Record shall bear the sole responsibility for meeting the engineering standard of care for all aspects of the design and providing a design that's required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City's design and construction requirements.**

1.3 Amendment & Acknowledgement

The City, by council action, may amend the City Design Manual. In order to ensure that the Developer and his Engineer has the City's latest design standards, they are directed to the City's website to acquire the City's most current design standards. The City Design Manual will include a Record of Revisions to identify any revisions to the City Design Manual.

Section 2 consists of checklists and forms pertaining to the CDM and may be revised to correspond to changes adopted in the CDM or City Ordinances . Please see the city website for the latest checklists.

At any time if you have a comment or request to modify current design criteria or add new design criteria, a formal request can be submitted to the City for consideration in writing to the City Manager. These comments will be reviewed and responded to.

All proposed revisions will be taken under consideration by the city council and the public will have an opportunity to comment on them.

1.4 Waiver Requests

All waivers (construction material or methodology requests) from the requirements included in the CDM shall be approved by the City Engineer. **A grant of an alternative material, design, or method of construction shall not affect nor relieve the Developer or his Engineer of the obligation and responsibility of such material, design, or method of construction for the intended purposes**.

In the event that specific circumstances dictate requirements not already included in the City Design Manual, it shall be the responsibility of the Developer's Engineer to provide the additional information as deemed necessary by the City Engineer in writing for review.

1.5 Applicability

The Developer's Engineer shall be responsible for the applicability of the information contained in the CDM to the design of their particular project. The Developer's Engineer shall also be responsible for the applicability and accuracy of the information furnished in their design. Acceptance by the City of the plans for construction shall not be construed to relieve the Developer or his Engineer of any responsibility.

1.6 Engineering Criteria – Section Descriptions

The following is a brief description of the contents of each section of the CDM.

Section 1 – General Requirements

This section includes an overview and references used in the CDM. This section also includes general minimum requirements applicable to all projects, including submittal requirements to the City and to other agencies.

Section 2 – Engineering Plan Procedures, Components & Construction Requirements

This section lists the various types of plans processed by the City, minimum components, review and approval procedures along with pre-construction and project acceptance procedures via development checklists.

Section 3 – Survey Requirements

This section is to address survey and monumentation requirements.

Section 4 – Drainage Design Requirements

This section includes minimum storm drainage design requirements to be followed in the design of storm drainage facilities, and demonstrates the design procedures to be

used on drainage projects within the City. This section also addresses floodplains, bridge hydraulics, erosion control and sustainable development techniques.

Section 5 – Utility Design Requirements

This section includes minimum design requirements for public wastewater facilities, water distribution and transmission system facilities.

Section 6 – Stormwater Management Requirements

This section provides additional requirements and standards to address environmental requirements, including stormwater best management practices.

Section 7 – Structural Design Requirements

This section establishes minimum structural design and geotechnical requirements for various items including bridges, concrete structures, retaining walls, and screening walls. This section also addresses slope stability analysis.

Section 8 – Thoroughfare Design Requirements

This section includes minimum requirements associated with the City's thoroughfares, including roadway geometry, street lighting, signage and markings, geotechnical, pavement design, and traffic signals, and related improvements.

Section 9 – Landscape and Screening Requirements

This section establishes requirements for landscape and screening for non-residential and multi-family districts, as required.

Section 10 – Lighting Requirements

This section includes lighting requirements for development in Van Alstyne.

1.7 Other Local, State and Federal Environmental Regulations

The list below is not intended to be a complete list and is provided for informational purposes only, but may apply to any proposed development. The Developer and his Engineer are responsible for compliance of any applicable regulation.

- Section 404 of the Clean Water Act (33 USC 1344)
- Water Rights: https://www.tceq.state.tx.us/permitting/water_rights/water_rights.html
- Migratory Bird Treaty Act: http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html
- Threatened and Endangered Species: http://www.tpwd.state.tx.us/huntwild/wild/species/endang/index.phtml
- The Antiquities Code of Texas: http://www.thc.state.tx.us/project-review/antiquities-code-texas
- Air Quality: http://www.tceq.state.tx.us/permitting/air/newsourcereview/before.html
- TCEQ Dam Requirements

1.8 Texas Accessibility Standards (TAS)

All plans and specifications for the construction or alteration of public buildings and facilities, privately owned buildings and facilities leased or occupied by state agencies, places of public accommodation, pedestrian facilities within public right of way, and commercial facilities must be in compliance with the Texas Accessibility Standards (TAS) for individuals with disabilities and must conform to the standards required by regulations issued by the Texas Department of Licensing and Regulation (TDLR), under the Architectural Barriers Act, codified as Article 9102, Texas Civil Statutes (see Architectural Barriers Administrative Rules – Section 68.30 for exemptions), as currently exist or may be amended. Sidewalks within public Right of Way shall also conform to Title II of the ADA & part 1190 - Accessibility Guidelines for Pedestrian Facilities in the public right of way http://www.access-board.gov/guidelines-and-standards/streets- sidewalks/public-rights-of-way.

Projects with a total estimated construction cost of $50,000 or more are required to submit a full set of construction documents in accordance with Administrative Rule 68.20 to TDLR for registration and review. For public right of way projects, the estimated cost for the project shall be based on pedestrian elements only in accordance with Administrative Rule 68.102. If a project's total estimated construction cost is less than $50,000, it is not required to be submitted to TDLR for registration and review; however, the project is still required to comply with TAS. An architect, engineer, interior designer, or landscape architect with overall responsibility for the design of a building or facility subject to subsection 5(j) of the Architectural Barriers Act, shall mail, ship, or hand-deliver the project registration form, review and inspection fees, and construction documents to the TDLR, a registered accessibility specialist, or a contract provider not later than thirty (30) business days after the design professional seals and signs the construction documents. An Architectural Barriers Project Registration form must be completed for each subject building or facility and submitted with their building permit.

1.9 Reports

Any reports required by the CDM shall be typed, legible, and prepared on 8 ½ inch by 11 inch paper. Each submitted report must be complete onto itself with all supporting calculations, figures, maps, and tables included. Staple or bind all sheets and exhibits comprising the report. Loose-leaf three ring binders are not acceptable. Provide a table of contents with page numbers for lengthy reports having more than 10 pages. Re-submittals shall include the most recent redlined report with the design professional's written response referenced to the comment and page number in the report.

SECTION 2

ENGINEERING PLAN PROCEDURES, COMPONENTS AND CONSTRUCTION REQUIREMENTS

Section 2 – Index

Section 2 – Plan Types, Components, Review Procedures & Construction Requirements

Section 2 – Engineering Plan Procedures, Components and Construction Requirements

2.1 Site Development Plan Review Process

Site development plan review is an integral component in the City's administrative process that enforces standards and regulations on private development and land use. Depending on the existing site conditions and the specific elements of your development and your plans, development review can comprise several separate approval processes. It is the intent of the CDM and the Checklists to expedite plan preparation and review to assist the Developer and his design staff in getting the appropriate city approvals.

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2.2 Preliminary Plat / Replat Checklist

For the current version of this checklist, please see the City of Van Alstyne Wesbite.

For the current version of this checklist, please see the City of Van Alstyne Wesbite.

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2.3 Final Plat / Replat Checklist

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2.4 Conceptual / Preliminary Site Plan Checklist

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For the current version of this checklist, please see the City of Van Alstyne Wesbite.

2.5 Site Plan / Revised Site Plan Checklist

For the current version of this checklist, please see the City of Van Alstyne Wesbite.

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2.6 Civil Engineering Plan Standards & Checklist

For the current version of this checklist, please see the City of Van Alstyne Wesbite.

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SECTION 3

SURVEY REQUIREMENTS

Section 3 – Survey Requirements

Section 3 – Survey Requirements

3.1 General

In the interpretation and application of the provisions in these survey requirements, it is the intention of the City that the principals, standards and requirements provided herein and the General Rules of Procedures and Practices of the Texas Board of Professional Land Surveying, shall be minimum standards for the projects involving survey, and where other Ordinances of the City are more restrictive, such Ordinances shall control, as they exist or may be amended. Professional Surveying is defined by the State of Texas Occupations Code, Sec. 1071.002 thusly; "Professional surveying" means the practice of land, boundary, or property surveying or other similar professional practices. The term includes:

A. performing any service or work the adequate performance of which involves applying special knowledge of the principles of geodesy, mathematics, related applied and physical sciences, and relevant laws to the measurement or location of sites, points, lines, angles, elevations, natural features, and existing man-made works in the air, on the earth's surface, within underground workings, and on the beds of bodies of water to determine areas and volumes for:

   1. locating real property boundaries;

   2. platting and laying out land and subdivisions of land; or

   3. preparing and perpetuating maps, record plats, field note records, easements, and real property descriptions that represent those surveys; and

B. consulting, investigating, evaluating, analyzing, planning, providing an expert surveying opinion or testimony, acquiring survey data, preparing technical reports, and mapping to the extent those acts are performed in connection with acts described by this subdivision.

All work products submitted to the City of Van Alstyne for requirements outlined herein, must be signed and sealed by a Registered Professional Land Surveyor registered with the Texas Board of Professional Land Surveying.

3.2 Horizontal/Vertical Datums

The City of Van Alstyne geodetic control network is published on the North American Datum of 1983 (NAD83) and on the North American Vertical Datum of 1988 (NAVD88). Unless specified otherwise, the datum for capital improvement projects and private development projects must be NAD83 for horizontal datum and NAVD88 for vertical datum. Refer to the Van Alstyne Geodetic Network for monument information.

A. Van Alstyne-Geodetic Monument Map

B. Van Alstyne-Geodetic Monument Sketches

3.3 Horizontal Control/Geodetic Monuments

All projects, public and private, shall be tied to the North American Datum of 1983 (NAD83), with sufficient number of State Plane Coordinate pairs to enable retracement. Scaled coordinates, surface coordinates, or other datums shall not be accepted and revisions shall be required if attempted. When identifying State Plane Coordinates on any project, the Registered Professional Land Surveyor ("RPLS") shall:

A. Provide a metadata statement (see example in Section 3.6.C to include a reference to the datum, properly cited as the "Texas Coordinate System of 1983, North Central Zone", as stated in Title 2, Subtitle B, Chap. 21, Subchapter D, Sec. 21.075 (b) of the Texas Natural Resources Code, and the following items;

B. Statement of the method by which the coordinates were obtained;

   1. Conventional ties to City of Van Alstyne Geodetic Monuments (state which monuments were used and their coordinates, and City of Van Alstyne datum year);

   2. Via OPUS;

   3. Via static post-processed data;

   4. Via RTK ties to City of Van Alstyne Geodetic Monuments (state which monuments were used and their coordinates, and City of Van Alstyne datum year);

   5. Via VRS-RTK (state VRS network).

For Subdivision Monumentation requirements, see Section 3.6.

3.4 Vertical Control/Benchmarks

All projects, public and private, shall have, at a minimum, a primary/source and secondary/onsite benchmark shown, along with a locative description and elevation, on all plan sheets. Benchmark/Geodetic Control information is also available on the City of Van Alstyne and NGS websites at, Van Alstyne Geodetic Network and www.ngs.noaa.gov/cgi- bin/datasheet.prl. All benchmarks shall be tied to City of Van Alstyne or National Geodetic Survey (NGS) geodetic monuments. Include metadata in descriptions, NAVD88 or NGVD29 (with conversion to NAVD88 shown) datum with monument identifier when available. The vertical datum (benchmarks, geodetic monuments) used for topographic surveying and civil engineering design must be approved by the City Engineer. Significant plan revision may be required if the vertical datum is not approved. Therefore, it is incumbent upon the applicant to contact the City Engineer prior to topographic surveying or civil engineering design. Contact the City Engineer for questions regarding benchmarks.

3.5 Subdivision Plats

A plat is the legal document and graphic presentation of one (1) or more lots or tracts of land, or of a subdivision, re-subdivision, combination or re-combination of lots or tracts. It typically includes a drawing and written description of property boundaries, easement and right of way dedications, owner's certificate, approval statements and signatures. Platting is the process for subdividing land and allowing public infrastructure to be planned in a comprehensive manner. Platting is required to divide a lot or tract into two or more parcels for purposes of transfer of ownership or development of the parcels. Although a conveyance of property may be accomplished through a metes and bounds description without the necessity of platting, the conveyance will not be recognized as a building site, nor will the lines of ownership be recognized for the purpose of determining development rights on the conveyed parcel. The plat becomes part of the public record through recordation in the County Clerk's office. It is the policy of the City of Van Alstyne to subject the subdivision, platting and replatting of land to the control of the City ordinances, state law, and all other rules, regulations, and policies the City may adopt. Consult the Final Plat checklist in Section 2 for plat submittal requirements and the City of Van Alstyne website for submittal schedules.

Properties must be platted within the city limits and the ETJ, in order to obtain an approval of a Site Plan or Building Permit in the City of Van Alstyne. See submittal requirements as defined in the checklists Section 2 prior to submitting a platting application to the City Clerk.

Final approval of construction plans is not necessary in order for a plat to be considered for placement on the Planning & Zoning Commission Agenda for approval, but the exact alignment and dimensions for all rights of way, utility, drainage and detention easements to be dedicated must be established and approved by the City Engineer. Final construction plans will be compared to Plat documents to confirm they accurately represent right of way and easement alignments.

Since the plat becomes a legal document, revising it is very time consuming and typically involves replatting. To avoid replatting and unexpected delays, ensure accuracy by thoroughly checking all metes and bounds descriptions. Furthermore, thoroughly check the current City of Van Alstyne Plat Checklist, in Section 2 and ensure all City requirements are met including but not limited to the items listed below. ***The Plat Checklist outlines all technical requirements, such as sheets size, text size, plat elements, etc.*** Additionally, use the appropriate dedication language as required by city ordinance and shown in the checklists in Section 2. The Developer's Surveyor/Engineer is responsible for ensuring that the plat matches the proposed easements shown on the public works and site engineering construction plans. Compare utility, drainage and street construction plans with the plat and make sure all easements are properly reflected.

3.6 Subdivision Monumentation

Survey Monumentation for all subdivisions shall conform to the following:

A. Install new subdivision monuments on at least (2) two corners of the boundary (if monumentation is not found) of the proposed subdivision in unobstructed areas if possible, or at alternate locations specified by the City Engineer. Visibility between monuments or from a third random traverse point before and after the subdivision is

constructed is preferred. Monument specifications (available from Berntsen International. Inc. 1-800-356-7388 or at www.bernsten.com) are as follows:

1. Berntsen RBD5325 - 3 1/4" Domed cap for 5/8" Rebar (Aluminum) set in concrete.

2. 3-1/4" Domed cap engraved "Subdivision Monument" including the subdivision name and year set, (i.e. - "Joe Q. Public Estates - 2001", and "Do Not Disturb"). Berntsen item # MTSD14: Cap, domed top 3-1/4" for 3/4" aluminum. Example:

   Top outer circle- CITY OF VAN ALSTYNE
   Top inner circle- SUBDIVISION MONUMENT Lower inner circle- JOE Q. PUBLIC ESTATES-2001 Lower outer circle- DO NOT DISTURB

3. 6" schedule 40 PVC sleeve, 3 feet long housing for monument - Berntsen item # 6PVC36: PVC pipe, 6" x 36".

4. Berntsen Bench Mark access cover with engraving "City of Van Alstyne Subdivision Monument" including the subdivision name and year set, (i.e. - "Joe Q. Public Estates - 2001"). Berntsen item # BMAC6 for 6" PVC with engraving.

5. Adhesive for access cover - Berntsen item # UV6800: Eclectic UV-6800 adhesive for BMAC clear with UV protection.

B. Provide horizontal/vertical data, including metadata, on plat for each new monument (unless otherwise directed by City Surveyor) including:

   1. NAD 83 Texas North Central Zone (4202) State Plane Coordinates in feet.

   2. NAVD88 elevation in feet.

   3. Appropriate metadata (see example in Item C below).

If monumentation on the boundary of the subdivision is found at time of platting, alternate locations within the subdivision (i.e. – block corners, lot corners, etc.) must be used for subdivision monuments, the locations of which may be specified by the City Engineer.

C. ALL SUBDIVISION PLATS, REGARDLESS OF THE TYPE OF MONUMENTATION REQUIRED HEREIN, MUST HAVE STATE PLANE COORDINATES (referenced as "Texas Coordinate System of 1983, North Central Zone (4202)" as set forth in the Texas Natural Resources Code) SHOWN ON THE FACE OF THE PLAT ON AT LEAST TWO (2) CORNERS OF THE SUBDIVISION BOUNDARY INCLUDING METADATA NOTE. IF THE COORDINATES ARE OBTAINED INDEPENDENT OF THE CITY'S GEODETIC CONTROL, VIA OPUS, STATIC POST-PROCESSED, OR VRS-RTK METHODS, STATE SUCH. IF CITY GEODETIC MONUMENTS WERE USED (MUST TIE TO MINIMUM OF TWO), LIST METHOD OF TIE (CONVENTIONAL, RTK, STATIC, ETC.). A METADATA NOTE SIMILAR TO THE ONE BELOW MUST BE ON THE SUBDIVISION PLAT**.**

EXAMPLE METADATA STATEMENT, DO NOT COPY THE NUMERIC VALUES IN THIS EXAMPLE:

*COORDINATES (*insert "AND BEARINGS" here if used for basis of bearings also) SHOWN HEREON ARE NAD83 (CORS??, EPOCH ????*) TIED TO THE TEXAS COORDINATE SYSTEM OF 1983, NORTH CENTRAL ZONE (4202) USING CITY OF VAN ALSTYNE*

GEODETIC CONTROL MONUMENTS 24 AND 25 (state which specific monuments were used);

GPS24 - N=7021483.019 GPS25 – N=7023392.672 E=2538741.969

E=2545208.193

Z=554.14 Z=526.18

D. Unless otherwise indicated herein, all lot corners shall be monumented with a 1/2" iron rod or larger, with a cap stamped with the responsible RPLS Registration number (i.e.- RPLS 9999), Firm name or T.B.P.L.S Firm number of the surveyor of record. Lot monumentation size, material, cap color and inscription shall be noted on the plat. More substantial materials, such as aluminum, bronze, or brass caps are recommended.

E. Placement of monuments on and within the boundary of property being platted in which areas are to be dedicated to the public;

1. Monuments shall be installed on the boundary of such property being platted at all corners, angle points, and points of curvature and tangency, except those points falling within areas to be dedicated. In areas to be dedicated, all points on new right-of-way lines shall be monumented. Monuments shall be installed within the boundary of such property being platted at the following points:

   a. All corners of parks, squares, or other portions intended for public use.

   b. All block corners.

   c. On the right of way lines of all alleys and public and private streets at all points of intersection, angle points, and points of curvature and tangency.

F. If new construction will damage, destroy, or alter existing survey markers, monuments, or property corners, they must be re-set prior to final acceptance of the subdivision by the City of Van Alstyne.

3.7 Offsite Easements/Easements by Separate Instrument

When an offsite easement or easement by separate instrument are required, provide exhibits, metes and bounds description with your initial plan submittal. Plan ahead, securing and coordinating approval of offsite easements is a time consuming process and may cause delays. Descriptions and drawings for all offsite easements or easements by separate instrument shall substantially conform to the standard City of Van Alstyne requirements. All offsite easements/easements by separate instrument required for development shall be filed of record (by the city) with the County Clerk, a copy provided to the City Clerk, and the recording information shown on the plat ***after approval by staff and Planning & Zoning Commission consideration***. Plats are not allowed on the Planning & Zoning Commission agenda without recording information for offsite easements/easements by separate instrument or abandonments. Whether or not a plat is involved, the required documents must be filed of record and a filed copy provided to the City Clerk.

3.8 Right of way & Easement Abandonment

Rights of way and easements are dedicated to the City and are held in trust for public use for the purpose intended. Public right of way and easement abandonment is the process by which the City releases the public's interest, if any, in rights of way or easements. Public rights of way or easements may have been acquired using different methods, including by plat, deed, or separate instruments. Typically, the easement would need to be abandoned in the manner in which it was dedicated. That is to say, if the easement was created by plat, it would need to be abandoned by replat, or if created by separate instrument, then it would need to be abandoned by a separate instrument. Only the City Council can formally abandon City of Van Alstyne rights of way or easements. Additionally, some form of consideration may be required for abandoned rights of way and easements, which shall be determined at the time of application review.

Areas to be abandoned (if acquired by separate instrument) within the platted area shall be processed by separate document/instrument and recording data, ordinance or resolution numbers shall be noted on the plat prior to approval by staff and Planning & Zoning Commission consideration. All abandonment requests require approval letters from franchise utilities, and are subject to a public hearing before City Council. Any letters of agreement from other entities including, but not limited to, City of Van Alstyne, C.G.M.A., N.T.M.W.D., etc. shall be provided to the City Clerk. Franchise utility contact information is available from the City Clerk. It is the applicant's responsibility to obtain current contact information for franchise utilities if provided list has changed.

In instances where a replat is required, the applicant should follow the platting procedure as required by the Subdivision Ordinance.

The following documents are required for easement or right of way abandonment:

A. Letter to the City Clerk requesting the abandonment of a City right of way or easement, and the subsequent purpose for which the property shall be used. Accompanying the letter shall be:

    1. A boundary survey with metes and bounds description and graphical depiction of the area to be abandoned depicting all existing easements of record, both signed and sealed by a registered professional land surveyor in the State of Texas;

    2. Provide a separate improvement survey drawing, locating and labeling on the ground locations of all adjacent, contiguous and intersecting public and private utility lines, structures, or other facilities within the abandonment area;

    3. Approval signatures in letters of consent from all public/franchise utility companies (if applicable);

    4. Approval signatures in letter of consent from all abutting property owners (if applicable).

SECTION 4

DRAINAGE DESIGN REQUIREMENTS

Section 4 – Index

Section 4 – Drainage Design Requirements

Section 4 – Drainage Design Requirements

4.1 General

This section contains the minimum storm drainage design criteria to be followed in the design of storm drainage facilities and demonstrates the design procedures to be used on drainage projects in the City of Van Alstyne.

A. The design factors, formulas, graphs and procedures described are intended to serve as guidelines. Responsibility for the actual design remains with the Development Engineer. Alternative design methods that deviate from the requirements of these standards shall be approved by the City Engineer.

B. The Development Engineer shall prepare the design plans in accordance with the Civil Engineering Plan checklist in Section 2.

C. It is the responsibility of the Development Engineer to provide all necessary calculations and designs described herein. He or she shall provide the City the data, calculations, and designs necessary to demonstrate the design does not adversely impact the surrounding or downstream property and meet local, state, and federal rules, regulations, and requirements.

D. The Development Engineer shall use the city's base models for development along floodplain areas. If a model is not available, they shall be required to provide a floodplain model in accordance with city standards and guidelines.

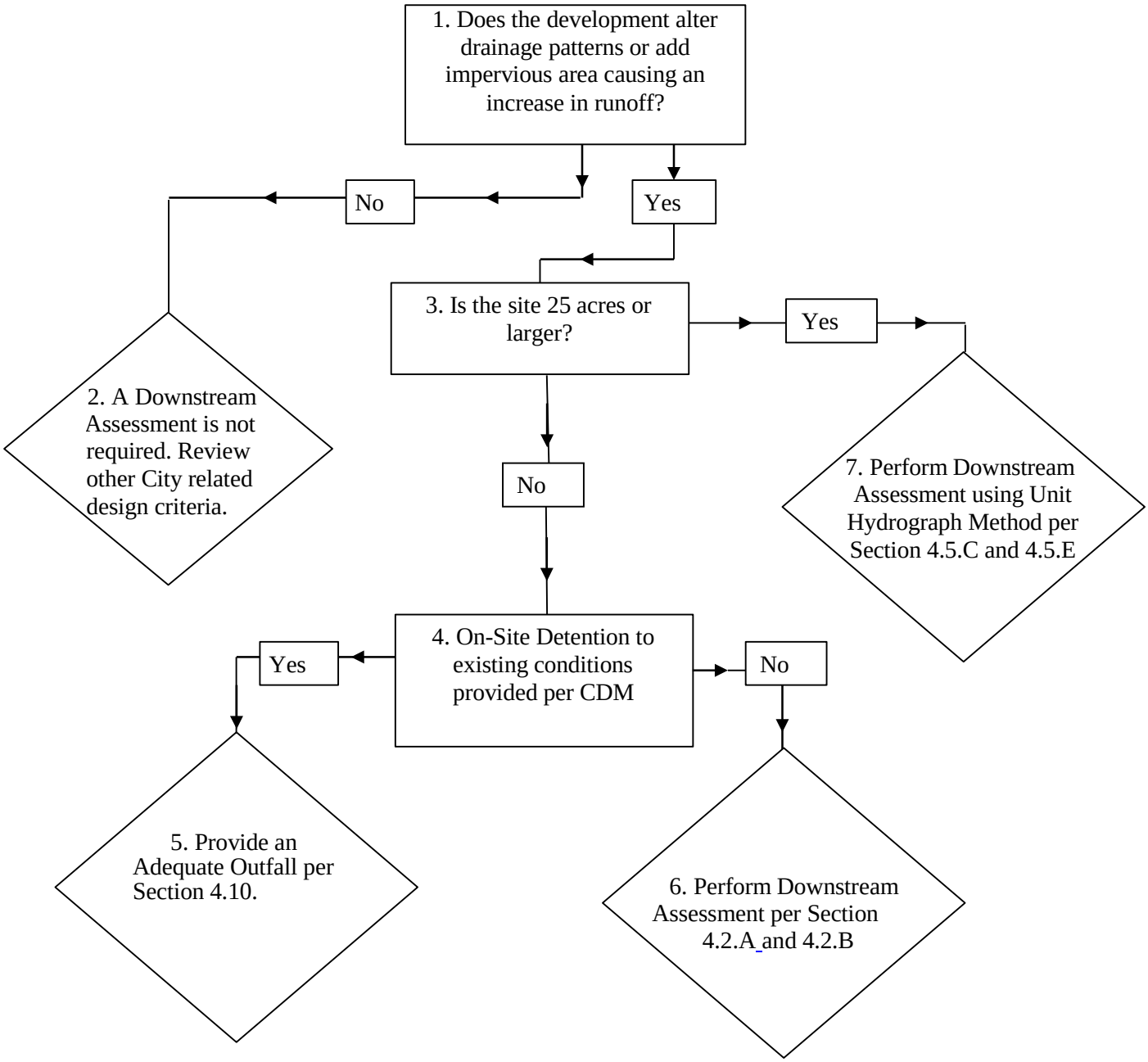
E. The proposed project must be designed to minimize exposure of subdivisions and surrounding property to flood damage and provide adequate utility service as required by the City of Van Alstyne. Although staff reviews plans for these issues, the project Engineer is ultimately responsible for the accuracy, completeness and conformance with City ordinances, policies and standards. The City's review is limited to the facts as presented on the submitted plans. The City has no project engineering responsibility and will not provide any specific design instructions. The Development Engineer sealing the plans is responsible for the accuracy and completeness of the documents submitted for review. The City reserves the right to require corrections for actual field conditions which are found to be different or information omitted on the plans.

4.2 Downstream Assessment

A Downstream Assessment identifies all contributing factors in determining the impact of stormwater on a proposed development and the downstream drainage system. Utilize the flowchart in Figure 1 to determine whether a Downstream Assessment is required.

A. The design of a storm drain facility must account for the offsite flows that are routed through the development, flows generated by the development, and the impacts of the development and the drainage system on downstream facilities. The stormwater discharge from the development shall not cause adverse impacts to adjacent or downstream properties or facilities. In order to determine the impacts to the downstream properties or facilities, a Downstream Assessment may be required. The following summarizes the process for a Downstream Assessment.

Figure 1: Downstream Assessment Flow Chart



B. Where applicable, a Downstream Assessment shall be prepared and submitted to the City with the schematic drainage plans described in Section 4.3. The study shall demonstrate the development will produce no adverse impacts. No adverse impacts may include, but are not limited to:

1. No new or increased flooding of existing insurable (FEMA) structures (habitable buildings).

2. No increases in water surface elevations for the 2, 25, and 100 year storm events unless contained in existing channel (with minimum 1' of freeboard), roadway, drainage easement and ROW. Dry lane and gutter capacity requirements set forth in Section 4.6 shall also be met.

3. Post-development channel velocities shall not be increased above pre-development velocities. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion.

4. No increases in downstream discharges caused by the proposed development that, in combination with existing discharges, exceeds the existing capacity of the downstream storm drainage system.

5. When a storm sewer analysis has determined the existing downstream system does not have capacity for fully developed conditions and the total increase in unrestricted post-developed Q-100 leaving the site is less than or equal to 5.0 cfs versus pre- developed Q-100, then onsite flow regulation methods may be used to decrease the post-developed Q-100 to be equal to or lower than the pre-developed Q-100 leaving the site. If the unrestricted post-developed Q-100 is greater than the pre-developed Q-100 by more than 5.0 cfs, then detention of stormwater runoff per the remaining sections shall be applicable.

6. The Downstream Assessment shall extend to a point downstream where the proposed development creates no adverse impacts. The downstream point is known as the Zone of Influence. The Development Engineer shall determine how far downstream the analysis for the Downstream Assessment shall extend. For properties less than 25 acres, the Downstream Assessment may use the 10% rule to determine the Zone of Influence. For all other properties, the Zone of Influence will be defined by a detailed hydrologic and hydraulic modeling analysis.

7. The 10% rule states the Zone of Influence can be considered to be the point where the drainage area controlled by the drainage facility comprises 10% of the total drainage area. As an example, if a structural control drains 10 acres, the Zone of Influence ends at a point where the total drainage area is at least 100 acres.

8. If a portion of a larger property is being developed, the Zone of Influence shall be determined based on the entire property.

C. Separate analysis is required for each major outfall from the proposed development. Once the analysis is complete, the designer must answer the following three questions at each determined junction downstream:

1. Are the post-development discharges greater than the pre-development discharges?

2. Are the post-development velocities greater than the pre-development velocities?

3. Are the post-development velocities greater than the velocities allowed for the receiving system?

These questions shall be answered for each of the three storm events. The answers to these questions will determine the necessity, type, and size of non-structural and structural controls to be placed on-site or downstream of the proposed development.

4.3 Schematic Drainage Plan for use with Private Development Projects

A. Schematic designs provide preliminary concepts on how the proposed development will handle existing and post development runoffs.

B. It is important that the Schematic Drainage Plan identify and locate existing and proposed rights of way, drainage facilities, flood plains, landscape buffers, utility lines and easements, since these features have a strong influence and often dictate the placement of structures, parking, and other permanent site improvements. Basically, the schematics show the project can work with the existing infrastructure or if it cannot, it identifies any needed on- or off-site improvements. The schematics, while not to the level of detail of construction drawings, allows staff the means to assess the project's potential impact on surrounding properties, infrastructure and flood plains. The importance of these plans cannot be overemphasized. Frequently, inadequate schematics are detrimental to all succeeding project phases.

C. Staff may waive the need for certain aspects of the schematic plans. This occurs when a development's impact on surrounding infrastructure and other properties are minimal; or when the adequacy of existing infrastructure is not in question.

4.4 Schematic Drainage Plan and Capacity Analysis

A. Include an engineer-scaled drawing showing the topography of the property on and within 50 feet of the development, along with all other applicable information defined in this section.

B. Provide a drainage area map for pre- and post-developed conditions; where applicable include offsite contributing areas.

C. Locate and identify existing and proposed drainage patterns, storm sewer layout, sizes, inlets, streams, swales, stream crossings, retaining walls, total additional imperviousness, boundaries of wooded areas and tree clusters 100-year runoff entering and leaving the site and disposition of the stormwater runoff before and after development. Where applicable, label public and private storm sewer segments; refer to Section 4.19 B for more information.

D. Define how the existing system will function under the new loading and any sustainable features that are proposed.

E. Where required by the downstream assessment analysis, show the location and preliminary sizing of offsite improvement required to connect to the public drainage system, including any easement needs.

F. Locate and label any amenity, retention and detention pond(s), easement(s), and outlet structure(s), include preliminary sizing calculations. Define water quality enhancement feature and probable location; provide dimensional control from property lines.

G. Environmental feature assessments shall include a delineation of onsite flood plains, creeks, seeps, springs, steep slopes, significant tree clusters, landfills, underground storage tanks, archaeological features, wetlands and Waters of the U.S. This information does not need to be on a separate sheet.

H. Plot and label the FEMA effective 100-year flood plain and floodway, reclamation areas, ditches, creeks, ponds, wetlands, and mitigation areas on and within 100 feet of the development.

I. If flood plain reclamation is proposed provide bound copies and a digital file of the effective, pre- and post-project computer models along with all supporting information including but limited to cross sections, profiles, and work maps. The analysis must show that the development will be safe from flooding during the 100-year storm.

   1. Be advised the City of Van Alstyne requires changes to be made to the effective FIRM maps and FIS documents if any of the following occurs as a result of the proposed work in a designated 100-year flood plain:

      a. A change in water surface elevation
      b. A change in the floodplain boundaries
      c. A physical change to the hydraulic model (e.g., fill or excavation, roadway, structures).

J. State and Federal permits may be required when developing property particularly when development occurs within the floodplain, along Waters of the U.S. or on property containing wetlands. Define whether State or Federal permits are expected. It is critically important that you contact State and Federal agencies early in the process so their requirements can be incorporated into your development plan and schedule. While staff will attempt to inform you what permits may be required, it is the Development Engineer's responsibility to comply with all State and Federal regulations.

4.5 Determining Design Discharge

The Rational Method (using the Rational Formula) may be used to determine the runoff generated from a property when a contributing drainage area is less than 200 acres. A unit hydrograph method shall be used to determine the runoff generated from a property with a contributing drainage area greater than 200 acres. The City Engineer may require developments with contributing drainage areas less than 200 acres to use a unit hydrograph method if the hydrologic results of the contributing drainage area or components within the drainage area more accurately reflect a unit hydrograph.

A. Rational Formula (Drainage Areas < 200 acres)

The Rational Formula for computing peak runoff rates is as follows:

$$Q = C * I * A$$

Q	=	runoff rate (cfs)
C	=	runoff coefficient (dimensionless)
I	=	rainfall intensity (in/hr)
A	=	drainage area (ac)

B. Runoff Coefficient (C)

1. Runoff coefficients shall be based on the future land use plan, which is available on the City's website under the Planning and Zoning tab. Runoff coefficients reflecting other conditions may be used based on the guidelines set forth in Section 4.5.F.

2. Table 4.1 below provides guidelines for runoff coefficients for typical land use within the city; however, a weighted runoff coefficient may be used for the design if it is more representative of the site conditions.

3. A lower runoff coefficient may be used if sustainable elements are included in the design. The project Engineer shall notify the City Engineer of the design intent and provide the necessary data, calculations and design to support the desired runoff coefficient.

Table 4.1 Runoff Coefficients and Inlet Time Guidelines

Land Use	Runoff Coefficient "C"	Inlet Time (Minutes)
Single Family Residential	0.55	15
Two Family, Patio Home, Town Home	0.70	10
Multiple Family	0.80	10
Non-Residential Uses	0.90	10
Park Area	0.35	20
School	0.70	10
Church	0.80	10
Undeveloped	0.30	20
Hospital	0.90	10
Streets	0.90	10

C. Time of Concentration (Tc)

SCS methodology shall be used to determine the time of concentration (Tc). This method separates the flow through the drainage area into sheet flow, shallow concentrated flow, and open channel flow. The Tc is the sum of travel times for sheet flow, shallow flow and open channel flow. The time of concentration flow path and sheet flow path shall be made available to the City upon request.

1. Sheet Flow: The maximum allowable length for sheet flow is 300' for undeveloped drainage areas and 100' for developed areas. When selecting n for sheet flow, consider cover to a height of about 0.1'. This is the only part of the plant cover that will obstruct sheet flow. The T_t in minutes for sheet flow is determined using the following equation:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

T_t = travel time (hr)
n = Manning's roughness coefficient (Table 4.2)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall, 3.6"
S = slope of hydraulic grade line (land slope, ft/ft)

Table 4.2 Sheet Flow 'n' Values

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	**0.011**
Fallow (no residue)	**0.05**
Cultivated soils	
Residue cover less than 20%	**0.06**
Residue cover greater than 20%	**0.17**
Grass:	
Short Prairie Grass	**0.15**
Dense grasses	**0.24**
Range (natural)	**0.13**
Woods:	
Light underbrush	**0.40**
Dense underbrush	**0.80**

2. Shallow Concentrated Flow

Shallow concentrated flow begins where sheet flow ends. A projected slope should be established along the flow line for the shallow concentrated flow length. The T_t in minutes for shallow concentrated flow is determined by the following equation:

$$T_t = \frac{L}{3600V}$$

T_t = travel time (hr)
L = flow length (ft)
V = velocity (fps):

Unpaved = 16.1345*(S)^0.5
Paved = 20.3282*(S)^0.5

3. Open Channel Flow

Open Channel Flow is where the runoff is located within a defined channel or in some cases, closed storm systems. The T_t for open channel flow is determined using the following equation:

$$T_t = \frac{L}{3600V}$$

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

T_t = travel time (hr)
V = average velocity (ft/s)
r = hydraulic radius (ft)
A = cross sectional flow ($ft^{2)}$
P = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient

The Engineer shall compare the calculated time to the time listed in Table 4.1. If the calculated Tc differs from the value in Table 4.1, the Engineer shall provide information to justify the Tc calculations.

D. Rainfall Intensity (I)

The rainfall intensity (I), shall be based on the National Weather Service Rainfall Frequency Data presented in Technical Memorandum NWS Hydro-35, dated June 1977 (2 to 100 year), U.S. Geologic Survey Frequency Data presented in Water Resources Investigations Report 98-4044, dated 1998 (500 year) and iSWM Technical Manual. The intensity for a particular duration can be obtained using the coefficients from Table 4.3 below. If the calculated inlet time differs from the value in Table 4.1, the Engineer shall provide information to justify the inlet time calculations. The equation used to determine the intensity values for various storm events and durations is provided below.

$$I = \frac{b}{(Tc + d)^e}$$

Refer to Table 4.3 below for b, d, and e values. Incremental rainfall intensities for Grayson–County from 5 minutes to 24 hours with 1, 2, 5, 10, 25, 50 and 100 year return periods are also shown, from the April 2010 iSWM Technical Manual-Hydrology.

Table 4.3

Table A-6 Grayson County								
		Return Period (Years)						
	Coefficients	1	2	5	10	25	50	100
	e	0.81558	0.79997	0.78004	0.77400	0.75825	0.74672	0.73522
	b	43.546	50.367	59.963	68.347	75.379	80.570	85.722
	d	8	9	10	11	11	11	11
Hours	Minutes	Rainfall Intensity (inches per hour)						
0.083	5	5.38	6.10	7.25	7.99	9.21	10.16	11.16
	6	5.06	5.77	6.90	7.63	8.80	9.71	10.68
	7	4.78	5.48	6.58	7.30	8.42	9.31	10.24
	8	4.54	5.22	6.29	7.00	8.08	8.94	9.84
	9	4.32	4.99	6.03	6.73	7.78	8.60	9.47
	10	4.12	4.78	5.79	6.48	7.49	8.30	9.14
	11	3.94	4.59	5.58	6.25	7.23	8.01	8.83
	12	3.78	4.41	5.38	6.04	6.99	7.75	8.55
	13	3.64	4.25	5.20	5.84	6.77	7.51	8.29
	14	3.50	4.10	5.03	5.66	6.57	7.28	8.04
0.250	15	3.38	3.96	4.87	5.49	6.37	7.07	7.81
	16	3.26	3.84	4.72	5.33	6.19	6.88	7.60
	17	3.15	3.72	4.59	5.18	6.02	6.69	7.40
	18	3.05	3.61	4.46	5.04	5.87	6.52	7.21
	19	2.96	3.50	4.34	4.91	5.72	6.36	7.03
	20	2.88	3.41	4.22	4.79	5.58	6.20	6.86
	21	2.79	3.32	4.12	4.67	5.44	6.06	6.71
	22	2.72	3.23	4.02	4.56	5.32	5.92	6.56
	23	2.65	3.15	3.92	4.46	5.20	5.79	6.41
	24	2.58	3.07	3.83	4.36	5.09	5.66	6.28
	25	2.51	3.00	3.75	4.27	4.98	5.55	6.15
	26	2.45	2.93	3.66	4.18	4.88	5.43	6.03
	27	2.40	2.87	3.59	4.09	4.78	5.33	5.91
	28	2.34	2.80	3.51	4.01	4.69	5.23	5.80
	29	2.29	2.74	3.44	3.93	4.60	5.13	5.69
0.500	30	2.24	2.69	3.37	3.86	4.51	5.03	5.59
	31	2.19	2.63	3.31	3.79	4.43	4.94	5.49
	32	2.15	2.58	3.25	3.72	4.35	4.86	5.40
	33	2.11	2.53	3.19	3.65	4.28	4.78	5.31
	34	2.07	2.49	3.13	3.59	4.20	4.70	5.22
	35	2.03	2.44	3.08	3.53	4.13	4.62	5.14
	36	1.99	2.40	3.03	3.47	4.07	4.55	5.06
	37	1.95	2.35	2.98	3.42	4.00	4.47	4.98
	38	1.92	2.31	2.93	3.36	3.94	4.41	4.90
	39	1.88	2.28	2.88	3.31	3.88	4.34	4.83
	40	1.85	2.24	2.84	3.26	3.82	4.28	4.76
	41	1.82	2.20	2.79	3.21	3.77	4.22	4.69
	42	1.79	2.17	2.75	3.16	3.71	4.16	4.63
	43	1.76	2.13	2.71	3.12	3.66	4.10	4.56
	44	1.74	2.10	2.67	3.07	3.61	4.04	4.50
0.750	45	1.71	2.07	2.63	3.03	3.56	3.99	4.44
	46	1.68	2.04	2.60	2.99	3.51	3.94	4.39
	47	1.66	2.01	2.56	2.95	3.47	3.89	4.33
	48	1.63	1.98	2.53	2.91	3.42	3.84	4.28
	49	1.61	1.96	2.49	2.87	3.38	3.79	4.22
	50	1.59	1.93	2.46	2.84	3.34	3.74	4.17
	51	1.57	1.90	2.43	2.80	3.30	3.70	4.12
	52	1.54	1.88	2.40	2.77	3.26	3.65	4.08
	53	1.52	1.85	2.37	2.73	3.22	3.61	4.03
	54	1.50	1.83	2.34	2.70	3.18	3.57	3.98
	55	1.48	1.81	2.31	2.67	3.14	3.53	3.94
	56	1.47	1.79	2.28	2.64	3.11	3.49	3.90
	57	1.45	1.76	2.26	2.61	3.07	3.45	3.85
	58	1.43	1.74	2.23	2.58	3.04	3.41	3.81
	59	1.41	1.72	2.21	2.55	3.01	3.38	3.77
1	60	1.39	1.70	2.18	2.52	2.98	3.34	3.73
2	120	0.83	1.03	1.35	1.57	1.87	2.11	2.38
3	180	0.61	0.76	1.00	1.17	1.40	1.60	1.80
6	360	0.35	0.45	0.60	0.70	0.85	0.97	1.11
12	720	0.20	0.26	0.35	0.42	0.51	0.59	0.67
24	1440	0.12	0.15	0.21	0.24	0.30	0.35	0.41

E. Unit Hydrograph Method (Drainage Areas > 200 acres)

1. The use of a unit hydrograph method shall be based upon standard and accepted engineering principles normally used in the profession subject to the approval of the City Engineer. Acceptable methods include the Soil Conservation Services (SCS) Technical Release Number 55 (TR-55) for drainage areas 200 acres to 2,000 acres and SCS's Technical Release Number 20 (TR-20), or the United States Army Corps of Engineers HEC-HMS models for drainage areas 200 acres or more.

2. The post development unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from upstream or on-site detention facilities, unless the requirements set forth in Section 4.2.B are met, or as directed by the City Engineer. The project Engineer should discuss the approach method with the City Engineer prior to design.

3. Circumstances that may require the use of a unit hydrograph method include open channels, reclaiming floodplains, creating lakes, regional detention/retention facilities or building other types of drainage related facilities on major drainage courses. The city requires fully developed watershed conditions be used for all modeling. FEMA's flows shall not be used as the flows are generally based upon existing watershed conditions.

4. Coincident peak flows can also be considered using Table 4.4.

Table 4.4: Frequencies for Coincidental Occurrences

Area Ratio	100 year design	
	Main Stream	Tributary
10000:1	2	100
	100	2
1000:1	10	100
	100	10
100:1	25	100
	100	25
10:1	50	100
	100	50
1:1	100	100
	100	100

5. Modeling Requirements

HEC-HMS shall be used in developing all hydrologic models. Other hydrologic models may be used upon approval from the City Engineer. The following criteria should be used:

a. 24-hour storm duration using an SCS Type II distribution.

b. Rainfall values calculated using coefficients provided in Table 4.3.

c. The SCS Curve Number (CN) method shall be used to determine the loss rate. CN values shall be taken from TR-55.

d. Tc values shall be calculated as shown in Section 4.5.C.

e. Muskingum Cunge method shall be used for routing of the Unit Hydrograph through the drainage system. The City Engineer may request for other routing methods, such as the Modified Puls Routing Method, to be used in the design if the method is more characteristic of the hydrologic and hydraulic conditions of the watershed.

F. Runoff from Off-Site Developments

1. Off-site Flows for Developed Upstream Watershed

The project Engineer may take the effects of upstream detention into account if the hydrologic and hydraulic information for the existing upstream ponds are shown on the construction plans and the information can be verified by record drawings or a record survey. An emergency overflow path between the existing detention ponds and the proposed site shall be identified and clearly indicated on the construction plans. The project Engineer shall confirm the hydrologic and hydraulic effects of upstream facilities in accordance with Section 4.11.

2. Off-site Flows for Undeveloped Upstream Watershed

If an undeveloped upstream property exists, the project Engineer shall assume fully developed conditions without detention for the off-site area unless a Downstream Assessment shows the downstream facilities cannot convey the fully developed peak flows.

4.6 Street Capacity

A. Straight Crown Streets:

1. Minimum grade of public streets and alleys shall be 0.50%.

2. All straight crown street capacities shall be hydraulically designed using Manning's equation:

$$Q = \left(\frac{1.486}{n}\right) A \left(R^{2/3}\right) \left(S^{1/2}\right)$$

Q = Gutter flow (cfs)
n = Manning's roughness coefficient, (0.0175 for concrete street)
A = Cross section flow area (ft^2)
R = Hydraulic radius of the conduit in feet, which is the area of the flow divided by the wetted perimeter (R=A/P)
P = Wetted perimeter (ft)
S = Slope of the hydraulic gradient (ft/ft)

3. The City requires a minimum of 9' of pavement in each direction on a divided roadway and a 9' dry lane in an undivided roadway shall remain dry during the 100-year event.

4. The dry lane criteria shall be met in both the interim and future conditions.

B. Parabolic Crown Streets

1. All parabolic crown street capacities shall be hydraulically designed using Manning's equation.

2. During a 100 year storm event, the gutter depth on thoroughfares are required by the City not to exceed 6" or top of curb, whichever is less.

4.7 Alley Capacity

A. All alley capacities shall be hydraulically designed using Manning's equation.

B. The 100 year storm event shall be contained within the edge of pavement.

C. In residential areas where the standard alley section capacity is exceeded, storm sewer systems with inlets shall be provided.

D. Inlets shall be located in alleys upstream from an intersection and where necessary to prevent water from entering intersections in amounts exceeding allowed street capacity.

4.8 Valley Gutters

A. The use of valley gutters to convey stormwater across a street intersection is subject to the following criteria:

1. Valley gutters shall not cross thoroughfares or streets.

2. Valley gutters are only permitted a Tee intersections, where the there is a stop condition for the leg that is not continuous.

4.9 Inlet Location and Capacity

A. Gutter Flow

Curb inlets shall be placed to ensure that the 100 year flow in a street does not exceed the dry lane requirements for straight crown streets and top-of-curb elevation for parabolic crown streets as per Section 4.6. The following form of the Manning's equation should be used to evaluate gutter flow hydraulics:

$$Q = \left[\frac{0.56}{n}\right] Sx^{5/3} S^{1/2} T^{8/3}$$

Q = Gutter flow rate (cfs)
S_x = Pavement cross slope (ft/ft)
S = Longitudinal slope (ft/ft)
T = Width of flow in roadway (ft)
n = Manning's roughness coefficient

Depth of flow in the gutter can be calculated using the following modified form of the equation above:

$$y_o = z\left(\frac{QnS_x}{S^{1/2}}\right)^{3/8}$$

y_o = depth of water in the curb and gutter cross section (ft or m)
Z = 1.24

If the flow in the gutter is still excessive, the storm sewer shall be extended to a point where the gutter flow can be effectively intercepted by curb inlets.

B. Grated Catch Basins & Combination Inlets

1. Combination grate inlets and grated catch basins are typically not to be used in public Right of Way except in alleys and easements. They may be allowed on a case by case basis where site and flow conditions dictate with the approval of the City Engineer.

2. Grated catch basins and inlets may be used on private storm sewer systems but shall be designed assuming 40% blockage. Calculations shall be provided in plans to insure buildings do not flood and that excess runoff does not enter into public Right of Way.

C. Capacity of Curb Inlet on Grade

To determine the capacity of a curb inlet on grade, first determine the ratio of the flow in the locally depressed gutter section to the total flow in the road.

$$E_0 = 1/\left\{1 + \frac{S_w}{S_X}\left[\left(1 + \frac{S_w/S_x}{(T/W) - 1}\right)^{2.67} - 1\right]^{-1}\right\}$$

E_0 = Ratio of flow in the depressed gutter to the total flow
S_W = Gutter cross slope (ft/ft)
S_x = Roadway cross slope (ft/ft)
T = Width of flow in roadway (ft)
W = Width of depressed gutter section (ft)

Then calculate the equivalent cross slope at the depressed curb inlet opening.

$$S_e = S_x + \frac{a}{w}E_0$$

S_e = Equivalent cross slope (ft/ft)
S_x = Roadway cross slope (ft/ft)
a = Gutter Depression Depth (ft)
W = Width of depressed gutter section (ft)
E_0 = Ratio of flow in the depressed gutter to the total flow

Then calculate the inlet length required to capture 100% of the gutter flow.

$$L_T = 0.60 Q^{0.42} S^{0.3} \left(\frac{1}{nS_e}\right)^{0.6}$$

L_T = Required length of inlet (ft)
Q = Total flow in the roadway (cfs)
S = Roadway longitudinal slope (ft/ft)
n = Manning's roughness coefficient
S_e = Equivalent cross slope (ft/ft)

The efficiency of a curb inlet opening shorter than L_T is:

$$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8}$$

E = Inlet efficiency
L = Length of the curb inlet opening (ft)
L_T = Required length of inlet to capture 100% of the roadway flow (ft)

The total flow captured by the curb inlet is:

$$Q_i = EQ$$

Q_i = Flow capture by inlet (cfs)
E = Inlet efficiency
Q = Total flow in the roadway (cfs)

D. Capacity of Curb Inlets in Sag

The capacity of a curb inlet in sag depends on the water depth at the curb opening and the height of the curb opening. The inlet operates as a weir to a depth equal to the curb opening height and as an orifice at depths greater than 1.4 times the opening height. At depths between 1.0 and 1.4 times the opening height, flow is in a transition stage and the capacity should be based on the lesser of the computed weir and orifice capacities.

1. If the depth of flow in the gutter (d) is less than or equal to 1.4 times the inlet opening height (h), ($d \leq 1.4H$), determine the length of inlet required considering weir control. Calculate the capacity of the inlet when operating under weir conditions with the following equation:

$$Q = C_W(L + 1.8W)d^{1.5}$$

2. Rearrange above equation to produce the following relation for curb inlet length required:

$$L = \left(\frac{Q}{C_w y_o^{1.5}}\right) - 1.8W$$

Q = total flow reaching inlet (cfs)
C_w = weir coefficient (3.0)
y_o = head at inlet opening (ft)
L = length of curb inlet opening (ft)
W = lateral width of depression (ft)

$$y_o = z\left(\frac{QnS_x}{S^{1/2}}\right)^{3/8}$$

y_o = depth of water in the curb and gutter cross section (ft or m)
Q = gutter flow rate (cfs)
n = Manning's roughness coefficient
S = longitudinal slope (ft/ft)
S_X = pavement cross slope (ft/ft)
Z = 1.24

3. If the depth of flow in the gutter is greater than the inlet opening height (d>h), determine the length of inlet required considering orifice control. The equation for interception capacity of a curb opening as an orifice follows:

$$Q = C_0 h L \sqrt{2gd_e}$$

Q = total flow reaching inlet (cfs)
C_0 = orifice coefficient = 0.70
h = depth of opening (ft) (this depth will vary slightly with the inlet detail used)
L = length of curb opening inlet (ft.)
g = acceleration due to gravity = 32.2 ft/s^2
d_e = effective head at the centroid of the orifice (ft) d_e=d - h/2

Rearranging equation allows a direct solution for required length:

$$L = \frac{Q}{C_0 h \sqrt{2gd_e}}$$

4. If both steps 1 and 2 were performed (i.e., h<d≤1.4h), choose the larger of the two computed lengths as being the required length.

5. Select a standard inlet length that is greater than the required length (10' minimum).

E. Capacity of Wye Inlets

$$\frac{Q}{P} = 3.1y^{3/2}$$

Q = flow (cfs)
P = perimeter of opening (ft)
y = head/depth (ft)

Wye (drop) inlets shall be located to collect water on non-paved areas where it is not practical to use a headwall. No double Wye inlets shall be allowed.

F. Curb Inlet Placement

1. Placing several curb inlets at a single location is only permitted in areas with steep grades (4% or greater) to prevent flooding and avoid exceeding street capacity in flatter reaches downstream.

2. No more than 20' of inlet shall be constructed at one location along one curb line.

3. Curb inlets shall be placed upstream from right angle turns and street intersections a minimum of 10' from radius return.

4. Curb inlet depth shall not be less than 4.5' from top of curb for all public improvements, unless approved by City Engineer.

5. Recessed inlets are required on collectors and arterials streets.

6. Inlets are required at the low point of a superelevation to prevent flow across the roadway.

7. Multiple sag inlets shall be located no closer than 300'.

8. Curb inlets shall not be located directly above storm drain lines.

9. Any discharge of concentrated flow into streets and alleys requires a hydraulic analysis of street and alley capacities.

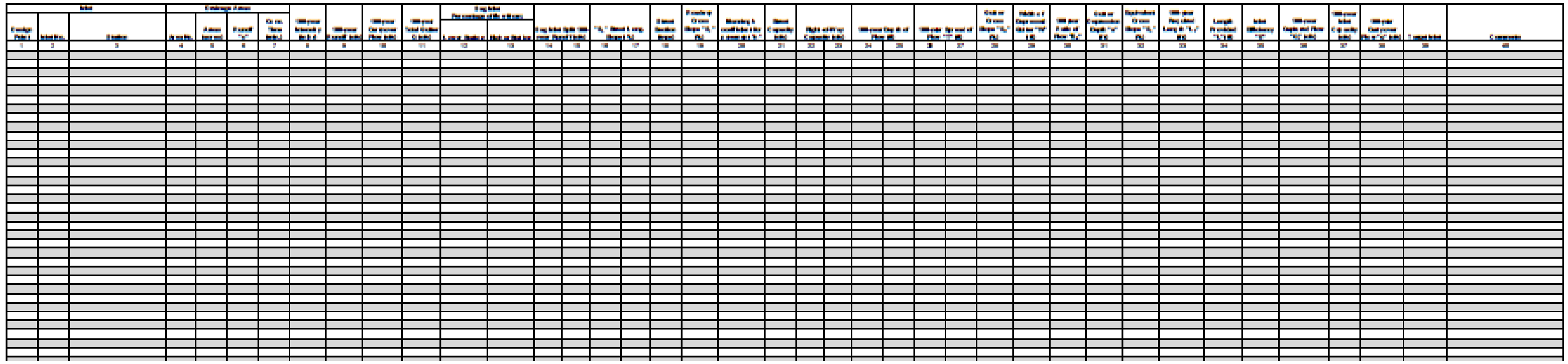
10. Capacity calculations for inlets located in a non-residential private drainage system shall be provided by the design engineer and approved by the City Engineer.

11. Data shown for each curb inlet shall include paving or storm sewer stationing at centerline of curb inlet, size of curb inlet, type of curb inlet, top-of-curb elevation and flow line elevation of curb inlet. Flow to curb inlet and bypass flow, if applicable, shall be shown to each inlet on storm sewer plan.

12. A paved emergency overflow path (5' minimum width) shall be provided and located on the plans for sag locations. An emergency overflow path is the path the stormwater will take if the drainage facility becomes clogged or ceases to function as designed. The emergency overflow path must be located within public right of way or drainage easement.

FIGURE 2: Inlet Spreadsheet

FIGURE 2: Inlet Capacity Calculation Table



Enlargement of FIGURE 2: Inlet Capacity Calculation Table

Inlet			Drainage Areas								Sag Inlet Percentage of flow from:											
Design Point	Inlet No.	Station	Area No.	Areas (acres)	Runoff "c"	Conc. Time (min.)	100-year Intensity (in/hr)	100-year Runoff (cfs)	100-year Carryover Flow (cfs)	100-year Total Gutter Q (cfs)	Lower Station	Higher Station	Sag Inlet Split 100-year Runoff (cfs)		"S_L" Street Long. Slope (%)		Street Section (type)	Roadway Cross Slope "S_x" (%)	Manning's coefficient for pavement "n"	Street Capacity (cfs)	Right-of-Way Capacity (cfs)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

100-year Depth of Flow (ft)		100-year Spread of Flow "T" (ft)		Gutter Cross Slope "S_w" (%)	Width of Depressed Gutter "W" (ft)	100-year Ratio of Flow "E_0"	Gutter Depression Depth "a" (ft)	Equivalent Cross Slope "S_e" (%)	100-year Required Length " L_T" (ft)	Length Provided "L" (ft)	Inlet Efficiency "E"	100-year Captured Flow "Q_i" (cfs)	100-year Inlet Capacity (cfs)	100-year Carryover Flow "q" (cfs)	Target Inlet	Comments
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

G. The Inlet Spreadsheet provided in Figure 2, or similar table conveying the information below, shall be provided with the construction plans for review by the City. A description of each of the columns shown in the inlet spreadsheet is provided below:

- Column 1: Design Point for Inlet
- Column 2: Inlet number
- Column 3: Location of inlet by storm drain station number
- Column 4: Drainage area designation for incremental area
- Column 5: Drainage area size (acres)
- Column 6: Runoff coefficient (C)
- Column 7: Time of concentration (minutes)
- Column 8: 100-year intensity (in/hr)
- Column 9: 100-year runoff, Q=CIA (cfs)
- Column 10: 100-year carryover flow from upstream inlet (cfs)
- Column 11: 100-year total gutter flow (Column 9 + Column 10) (cfs)
- Column 12: Percentage of flow traveling from lower station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- Column 13: Percentage of flow traveling from higher station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- Column 14: 100-year total gutter flow reaching the lower station side of the sag inlet (Column 11 times Column 12) (cfs)
- Column 15: 100-year total gutter flow reaching the higher station side of the sag inlet (Column 11 times Column 13) (cfs)
- Column 16: Longitudinal slope of the approach gutter. For sag inlets, half the longitudinal slope of the approach gutter on the lower station side of the inlet (S_0) (ft/ft)
- Column 17: Not used for on-grade inlets. For sag inlets, half the longitudinal slope of the approach gutter on the higher station side of the inlet (S_0) (ft/ft)
- Column 18: Street crown section type (straight crown [“rooftop”] or parabolic)
- Column 19: Roadway cross slope “Sx” (%)
- Column 20: Manning’s roughness coefficient (n) for pavement (0.0175 for concrete pavement)
- Column 21: Street capacity based on Manning’s equation. For sag inlets calculate the street capacity for both the lower and higher station sides of the inlet and use the greater of the two. (cfs)

- Column 22: Total right of way capacity as a function of the cross-sectional area of the right of way at the inlet. For sag inlets, the total right of way capacity on the lower station side of the inlet. (cfs), this column is for informational purposes only.

- Column 23: Not used for on-grade inlets. For sag inlets, the total right of way capacity on the higher station side of the inlet. (cfs), this column is for informational purposes only.

- Column 24: Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the lower station side of the inlet. (ft)

- Column 25: Not used for on-grade inlets. Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the higher station side of the inlet. (ft)

- Column 26: Spread of water (T) or width of ponding in the gutter measured from the face of curb. Column 19 times column 24, or the distance from the gutter to the crown, if the crown height is exceeded. For sag inlets, the spread of flow on the lower station side of the inlet. (ft)

- Column 27: Not used for on-grade inlets. Spread of water (T) or width of ponding in the gutter measured from the face of curb. Column 19 times column 25, or the distance from the gutter to the crown, if the crown height is exceeded. For sag inlets, the spread of flow on the higher station side of the inlet. (ft)

- Column 28: Gutter cross slope (Sw) (%)

- Column 29: Width of depressed gutter section (ft)

- Column 30: 100-year ratio of flow in the depressed gutter to the total flow (E_0)

- Column 31: Gutter depression depth (a) (ft)

- Column 32: Equivalent cross slope (Se) (%)

- Column 33: 100-year inlet length required to capture 100% of the gutter flow (L_T) (ft)

- Column 34: Actual length (L) in feet of inlet which is to be provided (10', 15' or 20'). For wye inlets the length provided is equal to the perimeter of the opening intercepting flow. The length for wye inlets may be less than the total perimeter if the wye is not located in a sag location.

- Column 35: Efficiency of a curb inlet where the length provided is shorter than the length required. (E)

- Column 36: Discharge (Q) in cubic feet per second which the inlet in question actually intercepts.

- Column 37: Discharge capacity of the inlet (Q) (cfs)

- Column 38: Carryover flow (q) is the amount of water which passes the inlet in a 100-year storm. A substantial portion of the 100-year flow should be picked up by the inlet. The carry-over flow should be accounted for in further downstream

inlets and should be reflected in the inlet bypass flow in the Storm Drain Hydraulics Table (minor variances may occur due to travel time routing in the Hydraulics Table).

- Column 39: Downstream inlet that carryover flow travels to
- Column 40: Important comments relating to inlet

4.10 Design of Enclosed Storm Sewer System

A. Design Flow

All enclosed systems shall be hydraulically designed and all required calculations shall be provided on the construction plans. The hydraulic gradient and full-flow velocity shall be calculated using the design flow, appropriate pipe size, and Manning's equation:

$$Q = \left(\frac{1.486}{n}\right) A \left(R^{2/3}\right) \left(S^{1/2}\right)$$

Q = Runoff rate (cfs)
A = Cross sectional area of the conduit (ft^2)
n = Manning's roughness coefficient (0.013 for concrete)
R = Hydraulic radius (ft) (Area of conduit divided by wetted perimeter (R=A/P)
S = Slope of the hydraulic gradient (ft/ft)

B. Hydraulic Gradient

1. The City requires that all hydraulic gradient calculations begin at the outfall of the system.

2. The starting hydraulic grade line (HGL) shall be based upon the results of the Downstream Assessment per Section 4.2 if a downstream assessment is conducted. The results of the Downstream Assessment will provide the Engineer with the capacity and resulting design storm of the downstream facilities.

3. The starting HGL at an outfall into a creek or channel shall be the 100-year fully developed water surface unless an approved flood hydrograph is available to provide a coincident flow elevation for the system's peak.

4. When a proposed storm sewer is to connect to an undersized existing storm sewer system, calculation of the hydraulic gradient for the proposed storm sewer shall start at the outfall of the existing storm sewer system.

C. Hydraulic Design

1. The hydraulic grade line (HGL) must be calculated for all storm drain mains and laterals using appropriate head loss equations. In all cases, the public storm drain HGL must remain below lime-cement treated subgrade and must be at least 2' below top of curb at each inlet.

2. In partial flow conditions, the HGL represents the actual water surface within the pipe. The velocity of the flow should be calculated based on actual area of flow, not the full flow area of the pipe or box.

3. Unless partial flow conditions exist, the beginning hydraulic gradient shall begin at either the top of pipe or at the hydraulic gradient of the receiving stream at the coincident frequency, whichever is higher.

D. Lateral Design

1. The HGL shall be calculated for all proposed laterals and inlets, and for the existing laterals being connected into a proposed drainage system

2. Laterals shall intersect the storm drain at standard angles. Connecting more than one lateral into a storm drain at the same joint localizes head losses; however, the engineer shall provide a manhole or junction structure. An exception to this rule may be considered when the diameter of the main line is more than twice as great as the diameter of the largest adjoining lateral.

3. Private storm sewer laterals shall not connect into downstream inlets without approval of the City Engineer.

4. Laterals shall not connect to the sides of an inlet unless the lateral can be fully inserted into the side of the inlet with 6 inches of clearance from that adjacent inlet sidewall.

E. Velocity Head Losses (H_L)

1. Adjustments are made in the HGL whenever the velocity in the main changes due to conduit size changes or discharge changes. Laterals in partial flow must be designed appropriately and the partial flow velocity shall be used in the calculations

2. In determining the HGL for the lateral, begin with the hydraulic grade of the trunk line at the junction plus the HL due to the velocity change. Where the lateral is in full flow, the hydraulic grade is projected along the friction slope calculated using Manning's Equation.

3. HL losses or gains for wyes, pipe size changes, and other velocity changes will be calculated by the following formulas:

$$H_L = \left[\frac{(V_2)^2}{2g}\right] - \left[\frac{(V_1)^2}{2g}\right]$$

H_L = Head loss or gain (ft)
v_1 = Upstream velocity (fps)
v_2 = Downstream velocity (fps)
g = Gravity constant (32.2 ft/s^2)

4. H_L for pipe in full flow at manholes, bends, and inlets, where the flow quantity remains the same, shall be calculated as follows:

$$H_L = K_j \left[\frac{V^2}{2g}\right]$$

H_L = Head loss or gain (ft)
v = Velocity in the lateral (fps)
g = Gravity constant (32.2 ft/s^2)
K_j = Coefficient of loss per Table 4.5

5. Head losses or gains at manholes and junction boxes where there is an increase in flow quantity shall be calculated as follows:

$$H_L = \left[\frac{(V_2)^2}{2g}\right] - K_j \left[\frac{(V_1)^2}{2g}\right]$$

H_L = Head loss or gain (ft)
v_1 = Upstream velocity (fps)
v_2 = Downstream velocity (fps)
g = Gravity constant (32.2 ft/s^2)
K_j = Coefficient of loss per Table 4.5

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Table 4.5 Velocity Head Loss in Closed Conduits

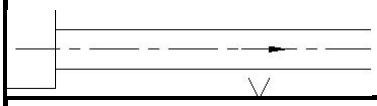
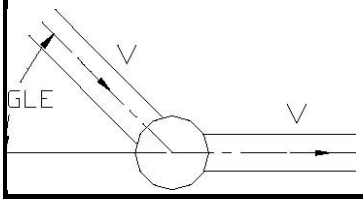
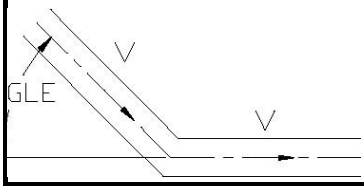
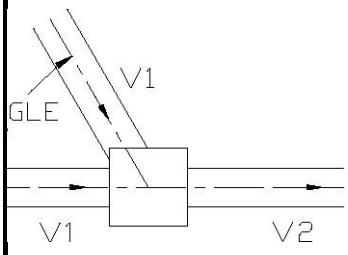
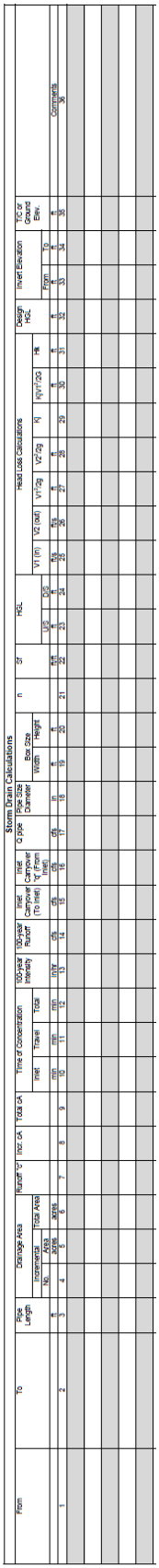
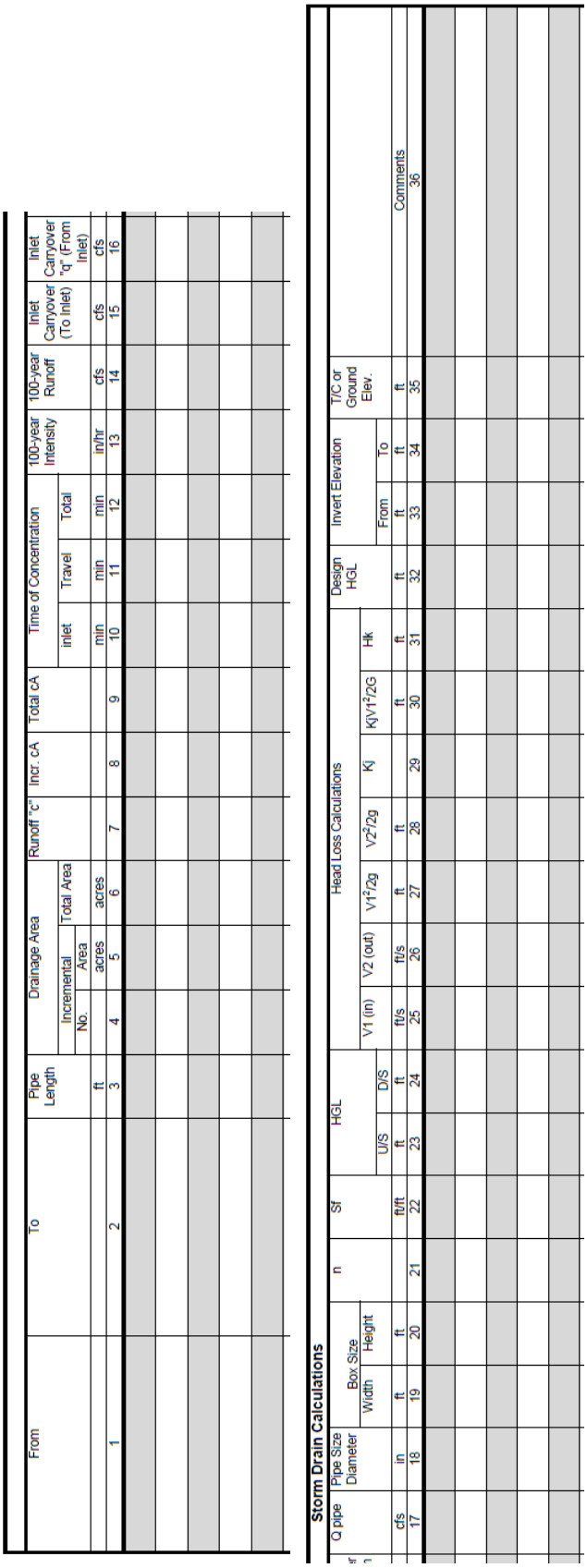
Inlet		
Schematic		**Kj**
		1.25
Manhole at Change in Pipe Direction		
Schematic	**Angle**	**Kj**
	90°	0.55
	60°	0.48
	45°	0.42
	30°	0.30
	0°	0.05
Bend in Pipe		
Schematic	**Angle**	**Kj**
	45°	0.35
	30°	0.20
Manhole		
Schematic	**Angle**	**Kj**
	0°	1.00
	22 1/2°	0.75
	45°	0.50
	60°	0.35
	90°	0.25

FIGURE 3 Storm Drain Calculations Spreadsheet

FIGURE 3: Storm Drain Calculations Spreadsheet



Enlargement of FIGURE 3: Storm Drain Calculations Spreadsheet



F. The project Engineer shall include a completed Storm Drain Calculations Spreadsheet (see Figure 3) or similar table conveying the information below, in the construction plans. A description of the runoff calculations is provided below followed by a description of the hydraulic design calculations:

- Column 1: Enter the downstream storm drain station number.
- Column 2: Enter the upstream storm drain station number. This is the design point. Design should start at the farthest upstream point.
- Column 3: Enter the distance (in feet) between the storm drain stations.
- Column 4: Enter the designation of the drainage area(s) at the design point in Column 2 corresponding to the designations shown on the drainage area map.
- Column 5: Enter the area in acres for the drainage area identified in Column 4.
- Column 6: Enter the total drainage area in acres within the system corresponding to storm drain station shown in Column 2.
- Column 7: Enter the runoff coefficient "C" for the drainage area shown in Column 5.
- Column 8: Multiply Column 5 by Column 7 for each area.
- Column 9: Determine the total "CA" for the drainage system corresponding to the inlet or manhole shown in Column 2.
- Column 10: Determine inlet time of concentration.
- Column 11: Determine flow time in the storm drain in minutes. The flow time is equal to the distance in Column 3 divided by 60 times the velocity of flow through the storm drain in ft/sec.
- Column 12: Total time of concentration in minutes. Column 10 plus Column 11. Note that time of concentration only changes at a downstream junction with another drainage area(s). It remains the same from an inlet or junction to the next inlet or junction picking up additional drainage areas. The junction of two paired inlets with each other is not a downstream junction.
- Column 13: The intensity of rainfall in inches per hour for the 100-year storm frequency.
- Column 14: The 100-year storm runoff in cfs. Column 9 times Column 13.
- Column 15: The proposed inlet carryover from upstream inlets during a 100-year storm. This should generally correspond to the carryover flow in Column 10 of the Inlet Spreadsheet (minor variances may occur due to travel time routing in the Hydraulics Table).
- Column 16: The proposed inlet carryover during a 100-year storm. This should generally correspond to the carryover flow "q" in Column 38 of the Inlet Spreadsheet (minor variances may occur due to travel time routing in the Hydraulics Table).
- Column 17: Design Discharge for the storm drain system ("Qpipe") in cfs

- Column 18: Enter the selected pipe size for circular pipe.
- Column 19: Enter the selected width for box pipe.
- Column 20: Enter the selected height for box pipe.
- Column 21: Enter the appropriate Manning's roughness coefficient "n" (0.013 for concrete pipe and box culverts).
- Column 22: Enter the slope of the frictional gradient (hydraulic gradient) determined by Manning's equation. In a partial flow condition, the friction slope is the slope of the water surface and should follow the slope of the pipe.
- Column 23: This is the upstream HGL before the structure and is calculated as Column 24 plus the friction loss (Column 3 times Column 22).
- Column 24: This is the beginning hydraulic gradient of the line. It is equal to the Design HGL (Column 32) for the next downstream segment, or the beginning HGL of the system as described above.
- Column 25: Velocity of flow in incoming pipe at the junction, inlet or manhole at the design point identified in Column 2.
- Column 26: Velocity of flow in outgoing pipe (i.e. the pipe segment being analyzed) at junction, inlet or manhole at design point identified in Column 2.
- Column 27: Velocity head of the velocity in Column 25.
- Column 28: Velocity head of the velocity in Column 26.
- Column 29: Head loss coefficient "Kj", at junction, inlet or manhole at design point from Table 4.5.
- Column 30: Multiply Column 27 by Column 29.
- Column 31: Head Loss at Structure. At a junction or change in pipe size, this is Column 28 minus Column 30. At a bend or inlet, this is Column 26 times Column 29. In all cases this is 0.10' minimum.
- Column 32: Design HGL at the design point identified in Column 2. Column 24 plus Column 31. This is the beginning HGL (Column 24) for any upstream pipe discharging into that junction.
- Column 33: Invert elevation for the pipe being analyzed at the downstream storm drain station in Column 1.
- Column 34: Invert elevation for the pipe being analyzed at the design point (upstream storm drain station) in Column 2.
- Column 35: Top of curb elevation at the design point in Column 2.
- Column 36: Comments regarding pipe being analyzed.

G. Storm Drain

1. Alignments of proposed storm drain systems shall use existing easements and rights-of-way. If located within an easement, the storm sewer shall be centered within the easement. If located within rights-of-way, the centerline of the storm sewer shall be located under paving 5' from the back of curb, generally from the south or west curb. No part of the storm sewer is to be designed within the improved subgrade of a proposed pavement

2. Horizontal and vertical curve design for storm sewers shall take into account joint closure. Where vertical and/or horizontal alignments require greater deflection, radius pipe on curved alignment shall be used

3. A minimum full flow velocity of 2.5 fps and a minimum slope of 0.5% shall be maintained in the pipe unless otherwise approved by the City Engineer. The maximum hydraulic gradient shall not produce a velocity that exceeds 15 feet per second (fps).

4. Only standard sizes shall be used. For public storm sewers, the minimum allowable pipe size is 18". Pipe sizes shall not be decreased in the downstream direction, unless otherwise approved by the City Engineer.

5. End-to-end connections of different size pipes must match at the crown of the pipe unless utility clearance dictates otherwise and approved by the City Engineer.

6. Concrete pipe collars are required at connections to existing storm sewer pipe or at grade breaks as directed by the City Engineer.

7. In situations where only the lower portion of an enclosed storm sewer system is being built, stub-outs for future connections must be included.

8. The required storm drain capacity to meet existing and future needs, if applicable, shall be provided.

H. Storm Drain Materials

1. All public storm sewers shall be reinforced concrete, minimum Class "III" pipe.

2. Any storm sewer or structure under a fire lane must be designed to withstand applicable loadings, including loading of a fire apparatus.

I. Manhole Placement

Storm sewer manholes should not be used except in special cases at the discretion of the City Engineer.

J. Outfall Design

The Engineer shall demonstrate the drainage from the site is conveyed to an adequate outfall. An adequate outfall is a structure or location that is adequately designed as to not cause adverse flooding conditions, erosion, or any other adverse impacts. An adequate outfall shall also have capacity to convey the increased runoff. Streambank stabilization shall be provided, when appropriate, as a result of any stream disturbance and encroachment and shall include both upstream and downstream banks.

1. Discharge flow lines of storm sewers shall be a maximum of 2' above the flow line of creeks and channels unless channel lining is present.

2. The last 10' of the storm sewer pipe shall be laid on a maximum 1.0% grade.

3. Energy dissipation shall be provided when the outfall velocities exceed maximum allowable discharge velocities for the given soil condition, typically 8 fps for vegetated clay soils and 5 fps for vegetated sandy soils. When storm sewer pipe is in partial flow at outfalls, provide partial flow velocity on storm sewer profiles.

K. Construction Plan/Profile Sheets

1. Plan-profile sheets are required for all public storm sewer systems as described below. Profiles shall be provided for private storm sewer lines when they cross existing or proposed public utilities.

2. Plan-profile sheets must be prepared on a horizontal scale no greater than 1" = 40' and a vertical scale of 1" = 4'. All grades shall be shown to the nearest one- hundredth of a foot (0.01') and shall be based on NAVD 88 datum. Unusually large conduits may require different scales to show the system adequately. Any variation in scale must be approved by the City Engineer.

3. In the plan view the storm drain designation and size of pipe must be shown adjacent to the storm drain. The storm drain plan must be stationed at 100-foot intervals with changes in size clearly indicted as they occur. If the storm drain alignment requires a horizontal curve, the following curve data must be shown on the plan:

   a. P.I. Station
   b. Tangent Distance
   c. Deflection Angle
   d. Length of Curve
   e. Radius
   f. PC Station and PT Station

3. The lateral size and item number must be shown on the plan. Where required, manholes must be shown on the plan-profile sheet. Existing topography, storm drains, sprinkler heads, double check assemblies, inlets, curbs, driveways, pavement, manholes, meters, valve boxes, trees, shrubs, fences, and other public and private utility lines within the right of way, must be shown on the plans, define the existing pavement type and thickness. Permanent City of Van Alstyne controlling benchmarks must be referenced in the lower right corner of each plan view sheet.

4. For Capital Improvement Projects, the item numbers must be shown for all items of work and a summary of quantities sheet shall be provided.

5. The storm drain profile stationing must be adjacent to the stationing on the plan. Even 100-foot stations must be shown at the bottom of the profile, and elevations must be shown on the left and right sides of the profile sheet. Stationing for drainage and paving profiles must be oriented in the same direction.

6. Laterals must be shown in the profile when they cross an existing utility, when they drain a sag inlet, or when they exceed 12' in length.

7. The profile portion of the storm drain plan-profile sheet must provide the following:

   a. Elevations of rock line (at boring locations)
   b. Soffit

c. Invert
d. Hydraulic grade line
e. Top of pipe
f. Existing ground and proposed finished grade
g. Elevation of intersecting utilities
h. Diameter of the proposed pipe
i. Pipe grade in percent

8. Hydraulic data for each length of storm drain between interception points must be shown on the profile. This data must include of the following:

a. Pipe diameter in inches
b. Design discharge in cubic feet per second
c. Slope of hydraulic gradient (in ft. /ft.)
d. Capacity of pipe in cubic feet per second (Assuming the hydraulic gradient equals the pipe grade).
e. Velocity in feet per second
f. Velocity head in feet V2/2g
g. Limits and velocity of partial flow where applicable.

L. The hydraulic grade adjustment at each interception point must be shown. Partial flow must be shown at the starting and ending stations clearly. Flow line elevations for the proposed storm drain must be shown at 100-foot intervals on the profile. Stationing and flow line elevations must be shown at all pipe grade changes, pipe size changes, lateral connections, manholes, and wye connections. Pipe wyes connecting to the storm drain must be made centerline to centerline, shown in the profile with the size of lateral, flow line of wye, and stationing of storm sewer indicated.

M. Boring locations with elevations of top of rock must be included on the drainage plans, and all existing and proposed easements, and right of ways.

N. Proposed paving plans and pavement location must be cross-referenced and agree horizontally and vertically with the storm drain plans inlet and manhole locations, cross-sections, and existing topographic features.

4.11 Detention/Retention Facility Design

A. Should the Downstream Assessment results show that downstream facilities are adequate and on-site detention is not required, fully developed off-site conditions must be taken into account for the on-site design facilities.

B. Define maximum design water surface elevation for the 2, 10 and 100-year storms and the first 1" of rainfall.

C. Detention facilities shall be designed based upon the following minimum criteria:

1. Detention shall be provided for the 2, 10, and 100 year design storms based on the results of a downstream assessment. Sites without a downstream assessment will be required to provide detention to undeveloped runoff rates.

2. All detention basins must include provisions to improve stormwater quality. Water quality enhancement measure shall be designed using the 1-year, 6-hour duration storm with an intensity of 0.35 inches per hour as shown in Table 4.3 (derived from *"iSWM Design Manual for Site Development").*

a. Industry standards have determined holding the first 1 inch of rainfall over a 24 hour period is the minimum time necessary to permit settlement of the suspended solid particles 100 microns or larger.

b. The City Engineer may approve alternate methods for detention and for achieving improved stormwater quality. Alternate methods may include utilization of mechanical filters, traps, or other prefabricated systems provided that the alternative methods prevent seventy percent (70%) or more of the total suspended solids, up to a one-hundred micron-sized particle, from passing through the outlet structure and entering the MS4 and so long as the intent of the provisions are met. If using a prefabricated stormwater screening device, the applicant shall provide supporting literature/data from the manufacturer indicating that the selected unit is properly sized for the project and that it complies with the intent of this CDM.

3. All detention/retention facilities shall demonstrate and provide an adequate outfall in accordance with City Requirements.

4. Criteria established by the State of Texas for dam safety (TAC Title 30, Part 1, Chapter 299) and impoundment of state waters (Texas Water Code Chapter 11) shall apply where required by the state, and where, in the Engineer's judgment, the potential hazard requires these more stringent criteria.

D. Detention Storage Calculation

1. Detention facilities without upstream detention areas and with drainage areas of 25 acres or less can be designed using the Modified Rational Method otherwise the Unit Hydrograph Method shall be used.

2. If the Unit Hydrograph Method is used, the model shall extend through the Zone of Influence (see Section 4.2.B) and include existing detention facilities within the Zone of Influence watershed.

3. No required parking space may be located within a surface drainage pond. A maximum depth of 6" of ponded water is allowed in a parking lot.

E. Provide outlet restrictor details, hydraulic calculations, design, orifice diameter and/or weir length, elevation, details, include stage discharge table on the construction plans

F. Provide stage versus storage tables on the construction plans.

G. When stormwater screening device used, provide plan and details.

H. When using perforated riser for water quality, specify number, spacing and diameter of perforations per iSWM Technical Manual, Hydraulics, Chapter 2.0 Storage Design. Verify water quality feature design used 1yr, 6-hr intensity of 0.35 in/hr (*iSWM)*.

I. Reinforced low flow pilot flumes are required for detention facilities between inlet / outlet and at point discharges to pond bottom, minimum paving slope 0.5%.

J. Pond and Spillway Geometry

1. Detention structures shall have a minimum of 1' of freeboard above the 100-year water surface elevation.

2. Where embankments are used to temporarily impound detention, the effective crest of the embankment will be a minimum of 1' above the 100-year water surface elevation.

3. The steepest side slope permitted for a vegetated embankment is 4:1.

4. Earth embankments used to temporarily or permanently impound surface water must be constructed according to specifications as required based on geotechnical investigations of the site and all regulatory requirements.

5. Detention facilities shall be designed with an emergency spillway in case the primary outfall ceases to function as designed. The spillway shall be designed to pass a minimum of the 100-year flood event.

6. The detention facility bottom must be designed to provide positive drainage, minimum 1.0% pond bottom slopes to outfall.

7. All weather access drive shall be provided to the banks and bottom of a detention facility for maintenance, 10-feet wide minimum with 20% maximum longitudinal slope and 10% maximum traverse slope. The access drive must be from the detention facility to an adjoining public right of way or access easement. Provide standard driveway approach at public way and install removable bollards per standard City details.

8. Provide minimum 10' wide unobstructed access around pond, maximum 10% traverse slope.

9. It is the responsibility of the Engineer to consider pedestrian and vehicular safety in the design of detention facilities. Perimeter rails or fencing may be required.

10. Ponds should follow the Landscaping Standards as indicated in the CDM Section 9.

11. Ponds must be equipped with a permanent irrigation system per the CDM Section 9.

K. Facilities with permanent pools shall address dewatering procedures.

L. Where underground detention facilities are utilized, the paving shall be designed with reinforced concrete with H-20 loading if located under parking and fire lanes.

M. A permanent detention pond easement shall be granted to the City containing the facility and the area surrounding the facility needed for maintenance of the facility. The acceptance of the easement by the City shall not obligate the City to provide care or maintenance for the facility in any manner.

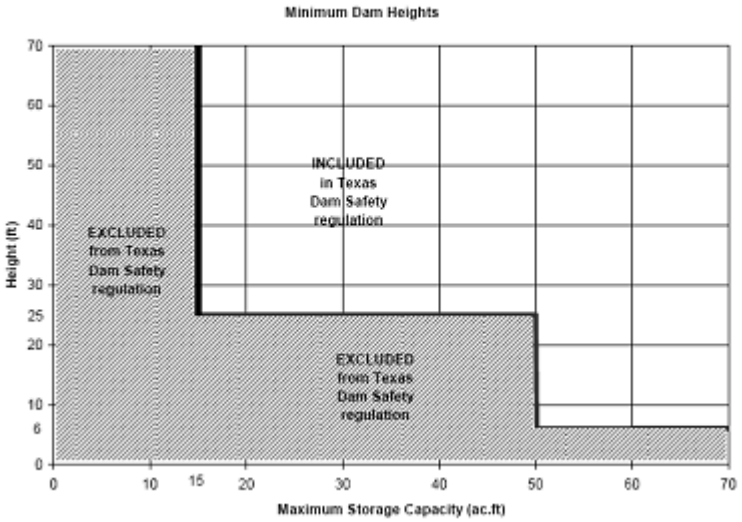
N. The project Engineer shall provide An Operation and Maintenance Manual for the detention facility including amenity ponds as part of the design. The maintenance plan shall indicate the ingress and egress locations to enter and maintain the pond, maintenance roles and responsibilities, standard detention general notes, contact information for the party responsible for the maintenance, and a maintenance schedule.

O. Texas Commission Environmental Quality Requirements for Dams

The Texas Commission on Environmental Quality (TCEQ) provides design and review criteria for construction plans and specifications, construction, operation and maintenance, inspection, repair, removal, emergency management, site security, and enforcement of dams. As of the date of these design standards, dams that fall under TCEQ dam safety regulations meet the following criteria:

- have a height greater than or equal to 25', and a maximum storage capacity greater than or equal to 15 acre-feet
- have a height greater than 6', and a maximum storage capacity greater than or equal to 50 acre-feet

Figure: 30 TAC §299.1(a)(2)



The design engineer shall refer to the Texas Administrative Code, Title 30, Part 1, Chapter 299 Dams and Reservoirs for current dam safety criteria. All proposed construction or modification of dams are required to adhere to TCEQ dam safety criteria. Should the design engineer desire to utilize an existing facility that would qualify under this criteria and the use of the facility changes from an agricultural use to another use, the existing facility may need to be brought into compliance with the TCEQ dam safety criteria. If dams that fall under the TCEQ dam safety criteria, the City will require review and approval from TCEQ prior to authorizing construction.

Water features and detention facilities with permanent pools must obtain a TCEQ water rights permit if applicable. Refer to TCEQ for water rights regulations.

For permanent pool ponds without a water rights permit, the Engineer shall provide a signed statement to the City stating the water rights permit is not required.

4.12 Miscellaneous Drainage Requirements

A. The maximum surface water discharge from a driveway shall be 5 cfs where the street has sufficient capacity.

B. Public water from a street or alley entering private property via a driveway or flume is prohibited without a drainage easement approved by the City Engineer.

C. The minimum slope for non-paved areas shall be 1.00%. The minimum slope for paved areas shall be 0.50%.

D. Lot Drainage - Lot to lot surface drainage is prohibited. **Pad elevations shall be no less than 12" above the lowest point of primary drainage across the lot.** Figure 4 is provided below for reference when performing lot grading designs. Lot grading type and finished floor elevations shall be shown on the construction plans. Type B, Type C and Type D Lot Grading must back to alleys, open space, or drainage easement. Refer to the International Residential Building Code (IRC) Section 401.3 (latest version) for additional requirements.

E. Grading plans shall be of sufficient clarity to fully indicate the extent of the work proposed and shall show in detail, work conforms to all applicable standards and regulations. A licensed Professional Engineer in the State of Texas shall provide and seal grading plans. Ideally, grading plans will have 1-foot contours and show existing and proposed contours, including those on adjacent properties within 50' of the project site sufficient to show existing and proposed drainage patterns, finish floors, and pad elevations tied to the City of Van Alstyne benchmark network.

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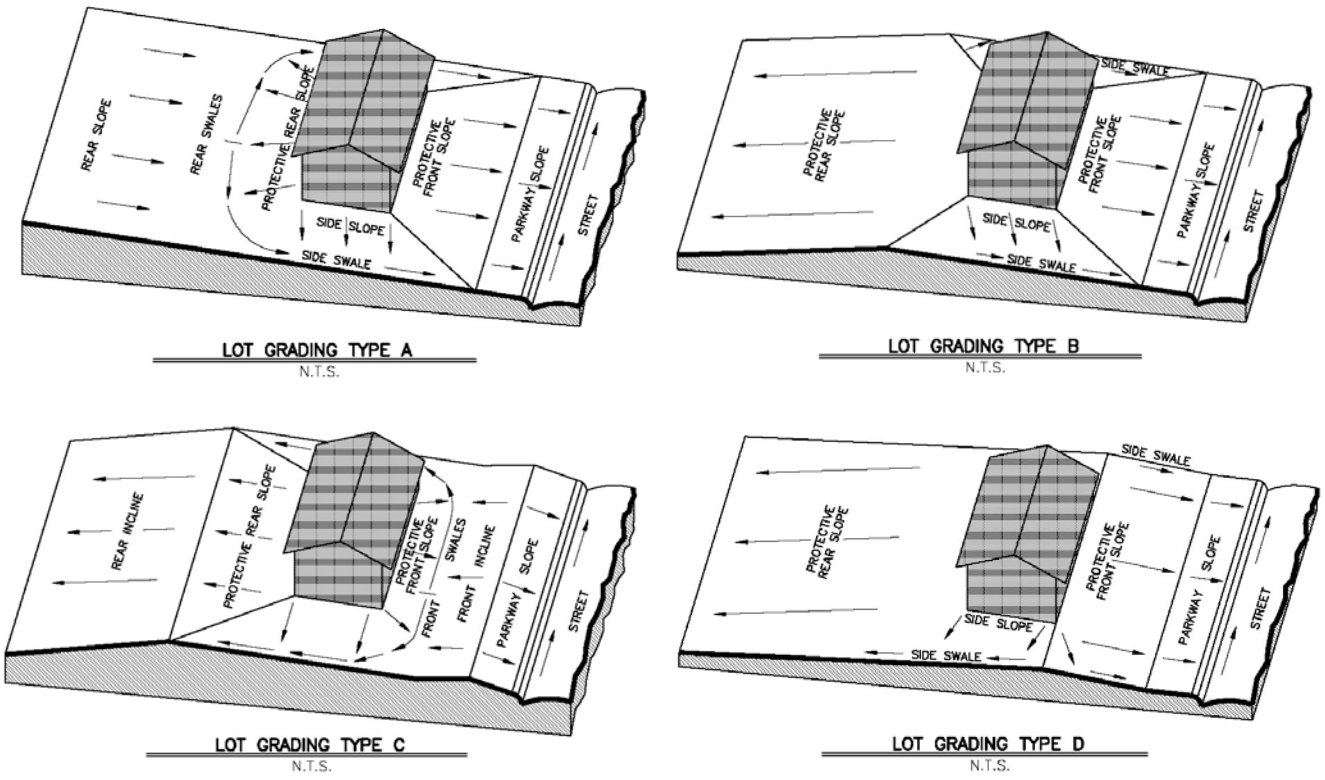
Figure 4: Typical Lot Grading Patterns



F. Residential Single-Lot Grading Plans shall follow the Residential Single-Lot Grading Plan Checklist.

G. The minimum finished floor elevation for any lot adjacent to a drainage feature shall be 2' above the adjacent 100 year fully developed water surface elevation and shall be shown on the final plat.

H. Should mitigation be required under Section 404 of the Clean Water Act, the areas shall be identified on the engineering construction plans.

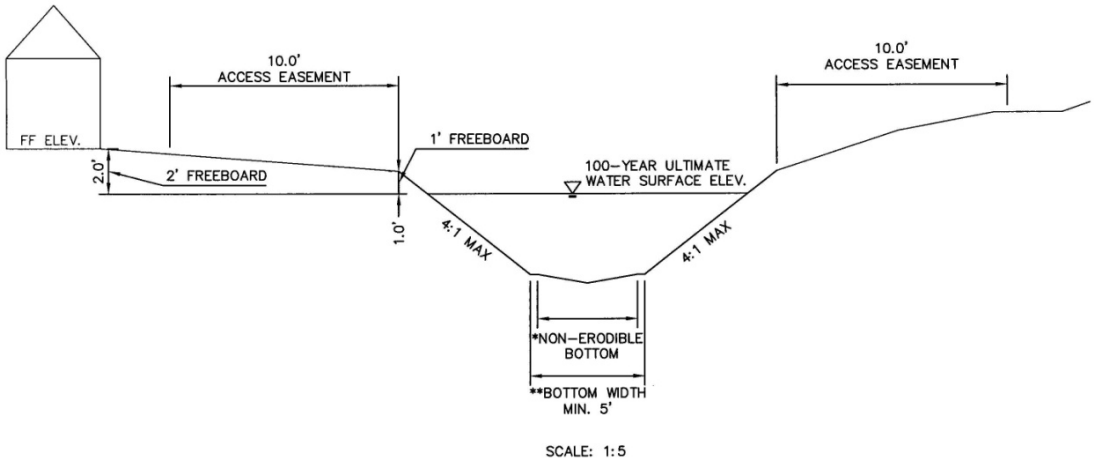
I. Refer to Section 4.17 for floodplain reclamation requirements.

4.13 Open Channel Design

The City prefers natural channels. Excavated open channels may be used to convey stormwaters where the construction costs and/or long-term maintenance cost involved with a closed storm sewer system is not justified economically. Open channels shall be designed to convey the 100-year, 24 hour design storm event discharge using fully developed conditions with low flow protection measures included for bank and bottom stability. HEC-RAS, or similarly capable software approved by the City, shall be used to confirm the water surface profiles and velocities in open channels.

The allowable excavated channel cross section is shown on Figure 5 below. The maximum velocities allowed for various types of excavated channel cover are shown in Table 4.6. These maximum velocities do not apply for drainage facilities discharging off- site. A downstream assessment in accordance with Section 4.2 shall be performed to determine maximum discharge velocities.

FIGURE 5: Open Channels –Excavated



*NON–ERODIBLE BOTTOM SHALL BE DESIGNED BY THE ENGINEER AND DOCUMENTATION AND CALCULATIONS SHALL BE PROVIDED TO CITY STAFF FOR REVIEW. GRADES SHALL ENSURE POSITIVE DRAINAGE THROUGHOUT THE CHANNEL.

**MINIMUM BOTTOM WIDTH SHALL BE BASED UPON PROJECT SPECIFIC CHANNEL MAINTENANCE NEEDS. BOTTOM WIDTHS SMALLER THAN WHAT IS SHOWN SHALL BE APPROVED BY THE DIRECTOR OF ENGINEERING

THE DIRECTOR OF ENGINEERING MAY REQUIRE HYDRAULIC MODELING OF THE CONSTRUCTED CHANNEL TO CONSIDER A MANNINGS VALUE THAT REFLECTS A "MAINTAINED CHANNEL (0.25–0.35)" AND A "NON–MAINTAINED CHANNEL (0.35–0.055)".

A. Unlined unvegetated excavated channels are not allowed. Construction of excavated channels will not be considered complete until the channel banks are stabilized. Public rights of way, easements and common areas must be stabilized with perennial vegetation cover, fully established with 100% coverage or approved stabilization method prior to project final acceptance by the City.

B. Supercritical flow shall not be allowed in channels except at drop structures and other energy dissipators.

C. If relocation of a stream channel is unavoidable, the cross-sectional shape, meander, pattern, roughness, sediment transport, and slope shall conform to the existing conditions insofar as practicable. Energy dissipation will be necessary when existing conditions cannot be duplicated.

D. Streambank stabilization shall be provided, when appropriate, as a result of any stream disturbance such as encroachment and shall include both upstream and downstream banks as well as the local site

E. At transitions in channel characteristics, velocities must be reduced to the maximum velocity per the downstream assessment in accordance with Section 4.2.B. Velocities must be reduced before the flow reaches the natural channel using either energy dissipators and/or wider less steep channel.

F. Channel armoring for erosion control shall be provided where deemed necessary by the City Engineer. Supporting calculations and/or documentation that the downstream velocities do not exceed the allowable range once the downstream modifications are installed must be provided. Allowable bank protection methods include stone riprap, gabions, and bio-engineered methods.

G. If the channel cannot be maintained from the top of the bank, a reinforced concrete stormwater access drive and ramp shall be provided from the drainage easement to an adjoining public Right of Way or access easement unless waived by the City Engineer. The drive shall be 12' wide minimum with 20% maximum longitudinal slope and 10% maximum traverse slope. Provide standard driveway approach at public way and install removable bollards per standard City details.

H. Minimum channel bottom widths are recommended to be equal to twice the depth of the channel. Any permanent open channel shall have a minimum bottom width of 5'.

I. All open channels require a minimum freeboard of 1' freeboard.

J. The minimum slope for an excavated improved channel is 1% unless a pilot channel is constructed, or otherwise approved by the City Engineer.

Table 4.6 provides allowable ranges for roughness coefficients of open channels.

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Table 4.6 Channel Roughness Coefficients

Channel Description	Roughness Coefficient		
	Minimum	Normal	Maximum
Minor Natural Streams			
Moderately Well Defined Channel			
-grass and weeds, little brush	0.025	0.030	0.033
-dense weeds, little brush	0.030	0.035	0.040
-weeds, light brush on banks	0.030	0.035	0.040
-weeds, heavy brush on banks	0.035	0.050	0.060
-weeds, dense willows on banks	0.040	0.060	0.080
Irregular Channel with Pools and Meanders			
-grass and weeds, little brush	0.030	0.036	0.042

Channel Description	Roughness Coefficient		
	Minimum	Normal	Maximum
-dense weeds, little brush	0.036	0.042	0.048
-weeds, light brush on banks	0.036	0.042	0.048
-weeds, heavy brush on banks	0.042	0.060	0.072
-weeds, dense willows on banks	0.048	0.072	0.096
Flood Plain, Pasture			
-short grass, no brush	0.025	0.030	0.035
-tall grass, no brush	0.030	0.035	0.050
Flood Plain, Cultivated			
-no crops	0.025	0.030	0.035
-mature crops	0.030	0.040	0.050
Flood Plain, Uncleared			
-heavy weeds, light brush	0.035	0.050	0.070
-medium to dense brush	0.070	0.100	0.160
-trees with flood stage below branches	0.080	0.100	0.120
Major Natural Streams			
Moderately Well Defined Channel	0.025	-----	0.060
Irregular Channel	0.035	-----	0.100
Unlined Vegetated Channels			
Mowed Grass, Clay Soil	0.025	0.030	0.035
Mowed Grass, Sandy Soil	0.025	0.030	0.035
Unlined Unvegetated Channels			
Clean Gravel Section	0.022	0.025	0.030
Shale	0.025	0.030	0.035
Smooth Rock	0.025	0.030	0.035
Lined Channels			
Smooth Finished Concrete	0.013	0.015	0.020
Riprap (Rubble)	0.30	0.40	0.50

K. Water surface elevations and flow velocities in channels are impacted by the maintenance condition in the channel. Calculations shall be performed assuming maintained and unmaintained vegetative conditions. Lower (maintained) Manning's values shall be used to determine maximum velocities, while higher (unmaintained) Manning's values shall be used to determine water surface elevations per Figure 5.

L. Any channel modification must meet the applicable requirements of all Local, State and Federal Regulatory Agencies.

M. An erosion hazard setback shall be included within the Drainage Easement for the channel. The purpose of this setback is to reduce the potential for any damage to a private lot or street right of way caused by the erosion of the bank. The erosion hazard setback shall be determined as follows, and is provided in Figure 6 below:

1. For stream banks composed of material other than rock, locate the toe of the natural stream bank. Project a 4:1 line sloping away from the bank until it intersects finished grade. From this intersection add 15' away from the bank. This shall be the limit of the erosion hazard setback.

2. Figure 6 is intended to illustrate various scenarios under which the erosion hazard setback can be applied and how it interacts with the floodplain access easement. Scenario 1 shows a situation where the setback may be located outside the 100-year floodplain and drainage easement boundaries. Scenarios 2 and 3 show locations where the erosion hazard setback will be located inside the 100-year floodplain and drainage easement boundaries.

N. Any modifications within the area designated as erosion hazard setback, will require a geotechnical and geomorphological stability analysis.

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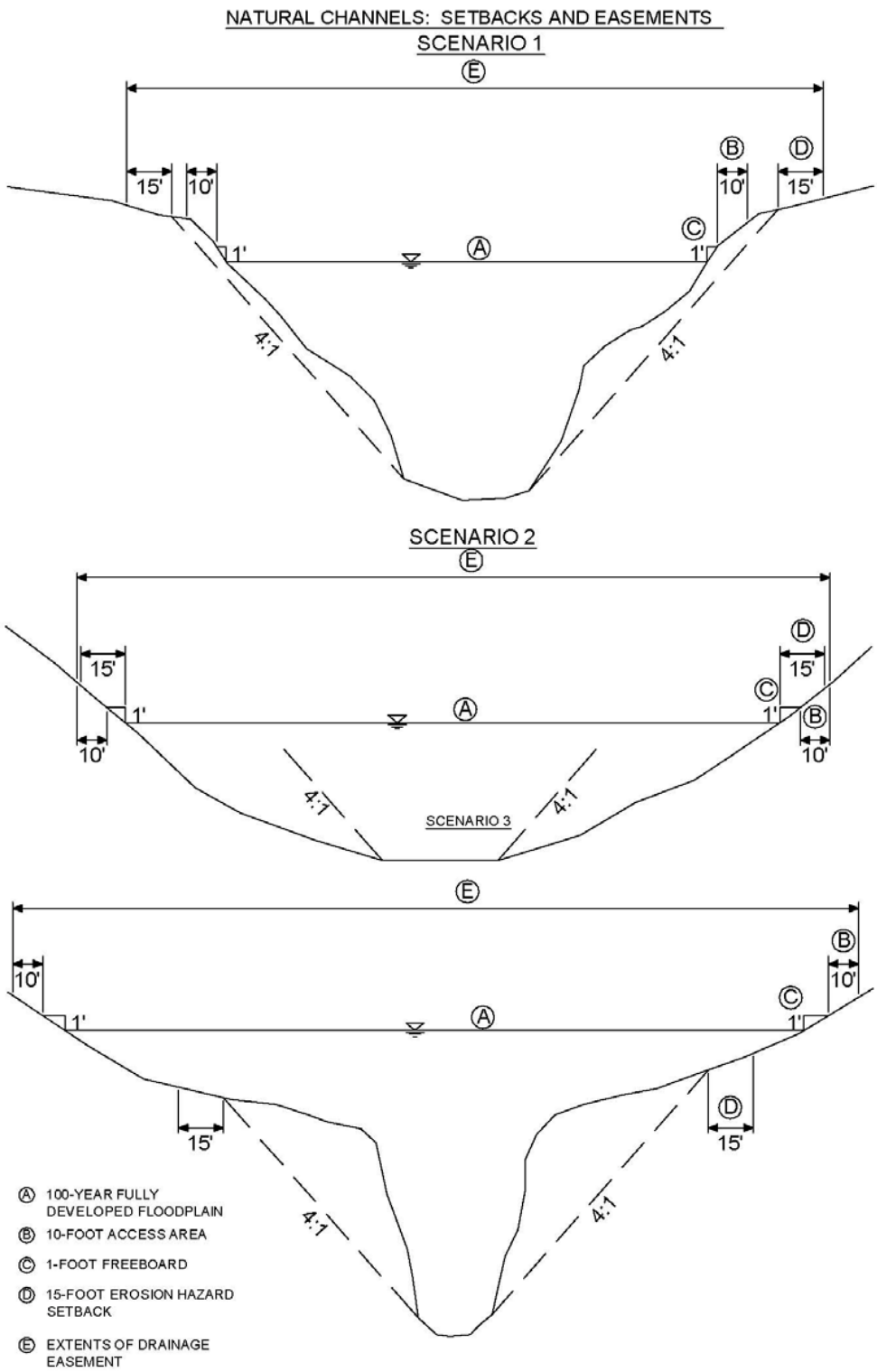
Figure 6 Natural Open Channels



4.14 Hydraulic Design of Culverts

All culverts, headwalls, wingwalls, and aprons shall be designed in conformance with the Texas Department of Transportation Details and Standards. The project Engineer is responsible for selecting the applicable detail.

A. Culvert calculations shall be provided to the City for review. For creeks that have been modeled in the HEC-2 or HEC-RAS program, culverts and bridges can be sized using the HEC-2 or HEC-RAS model. Calculations may include, but are not limited to, headwall, tailwater, and flowline elevations, lowest adjacent grade and structure elevations, inlet and outlet control calculations and velocity calculations.

B. The design storm event for culverts is the 100-year, 24 hour storm event using fully developed conditions. Minimum 1-foot freeboard is required for culvert crossings.

C. Culverts should always be aligned to follow the natural stream channel. The project Engineer shall provide sufficient information to analyze the upstream and downstream impacts of the culvert and illustrate the interaction of the channel and culvert alignment. Survey information of the stream channel must be provided for 100' upstream and downstream from the proposed culverts, so that the channel alignment is evident.

D. To minimize the undesirable backwater effects and erosive conditions produced where the total width of box culverts exceeds the bottom width of the channel, a transition upstream and downstream of the culverts must be provided. The transition must have a minimum bottom width transition of 2 to 1 and include warping of side slopes as required. The 2 to 1 transition is 2 along the centerline of the channel and 1 perpendicular to the centerline.

E. Headwalls and Entrance Conditions:

1. The Engineer shall be responsible for the headwall and wingwall designs. Headwalls and endwalls refer to the entrances and exits of structures, respectively, and are usually formed of cast-in-place concrete and located at either end of the drainage system. Wingwalls are vertical walls, which project out from the sides of a headwall or endwall.

2. The culvert entrance losses are provided in Table 4.7 below. The values of the entrance coefficient Ke represent a combination of the effects of entrance and approach conditions. Losses shall be completed using the following formula:

$$He = Ke\left[\frac{V^2}{2g}\right]$$

He = Entrance head loss (ft)
Ke = Entrance loss coefficient
v = Velocity (fps)
g = Gravity constant (32.2 ft/s^2)

Table 4.7 Culvert Entrance Losses

Type of Structure	K_e
Pipe, Concrete	
-projecting from fill, socket and (groove end)	0.2
-projecting from fill, square cut end	0.5
-headwall or headwall and wingwalls: socket end of pipe (groove end)	0.2
-headwall or headwall and wingwalls: square edge	0.5
-headwall or headwall and wingwalls: rounded (radius = 0.0933D)	0.2
-mitered to conform to fill slope	0.7
-beveled edges, 33.7° or 45°	0.2
-side or sloped tapered inlet	0.2
Pipe, or Pipe-Arch	
-projecting from fill (no headwall)	0.9
-headwall or headwall and wingwalls: square edge	0.5
-mitered to conform to fill slope, paved / unpaved slope	0.7
-beveled edges, 33.7° or 45°	0.2
-side or sloped tapered inlet	0.2
Box, Reinforced Concrete	
-headwall parallel to embankment (no wingwalls): squared on three sides	0.5
-headwall parallel to embankment (no wingwalls): rounded on three sides to radius 1/12 barrel dimension on three sides	0.2
-wingwalls at 30° to 75° to barrel: square edged at crown	0.4
-wingwalls at 30° to 75° to barrel: crown edge rounded to radius of 2/12 barrel dimension, or beveled top edge.	0.2

4.15 Bridge Design Hydraulics

A. The City requires that head losses and depth of flow through bridges be determined with a HEC-RAS program or other approved program. The following guidelines pertain to the hydraulic design of bridges:

1. The design storm event for bridges is the 100-year, 24 hour discharge using fully developed conditions.

2. Fully developed 100 year water surface must not be increased upstream of the bridge.

3. Excavation of the natural channel is not allowed as compensation for loss of conveyance.

4. Channelization upstream or downstream of the proposed bridge will normally only be permitted when necessary to realign the flow to a more efficient angle of approach.

5. Side swales may be used to provide additional conveyance downstream of and through bridges.

6. Bridges are to be designed with the lowest point (low beam) low chord at least 2’ above the water surface elevation of the design storm.

7. Bents shall not be in channel when possible. Bents must be aligned parallel to flow.

B. A scour analysis shall be submitted with design plans.

4.16 Energy Dissipators

A. The project Engineer shall be responsible for all energy dissipation designs.

B. Grouted rock rip-rap or gabion baskets or mattresses are required for energy dissipation. Other designs may be considered.

C. All energy dissipation designs shall include supporting calculations showing the design is adequate. The City may require the Engineer to provide a hydraulic model as supporting documentation.

D. All energy dissipators should be designed to facilitate future maintenance. The design of outlet structures in or near parks or residential areas shall give special consideration to appearance and shall be approved by the City Engineer.

4.17 Floodplain Alterations

A. No new construction is allowed in floodplain areas, unless a flood study is prepared by a Texas-licensed Professional Engineer that certifies that said construction shall not cause any rise in 100-year water surface elevations in the stream. This study must be reviewed and approved by the City Engineer before a Floodplain Development Permit will be issued.

Construction is allowed in those areas that have been reclaimed from the floodplain, subject to the requirements of Paragraph B below.

B. Floodplain alteration shall be allowed only if the following criteria are met:

1. Flood studies shall include flows generated for existing conditions and fully- developed conditions where available for the 10, 50, and 100 year storm events.

2. Alterations of the floodplain shall not increase the water surface elevation of the design flood of the creek on other properties.

3. Alterations shall be in compliance with FEMA guidelines.

4. Alterations of the floodplain shall meet the requirements of Section 4.2

5. Any alteration of floodplain areas shall not cause any additional expense in any current or projected public improvements, including maintenance.

6. The floodplain shall be altered only to the extent permitted by equal conveyance on both sides of the natural channel, as defined by the United States Army Corps of Engineers in a HEC-RAS analysis. The right of equal conveyance applies to all owners and uses, including greenbelt, park areas, and recreational areas

7. The toe of any fill shall parallel the natural direction of the flow.

8. Incorporates and considers other city planning documents and ordinances.

C. The above criteria shall be met before any floodplain alteration may occur. Typical projects requiring a floodplain alteration include placing fill (whether or not it actually raises the property out of the floodplain) constructing a dam, straightening channel sections, making improvements, (substantial or otherwise), to existing structures in a floodplain in which the existing outside dimensions of the structure are increased, and temporary storage of fill materials, supplies and equipment.

D. In general, the information needed for the application shall be performing by running a backwater model, such as HEC-2 or HEC-RAS, and a flood routing model, such as TR- 20, HEC-1, or HEC-HMS. Unless a pre-existing model is in place, HEC-HMS and HEC- RAS shall be used. The backwater information shall be used to determine that upstream water surface elevations and erosive velocities have not increased. Flood routing information shall be used to insure that the cumulative effects of the reduction in floodplain storage of floodwater will not cause downstream increases in water surface elevations and erosive velocities.

E. The Engineer is responsible for providing documentation of the relevant USACE approved permits prior to beginning modification to the floodplain, or for providing a signed and sealed statement detailing why such permits are unnecessary.

F. The City of Van Alstyne requires that changes be made to effective Flood Insurance Rate Maps (FIRM) maps and Flood Insurance Study (FIS) documents if any of the following will occur as a result of the proposed work in a designated 100-year flood plain:

1. A change in water surface elevation

2. A change in the 100-year flood plain or floodway boundaries

3. A physical change to the flood plain and effective hydraulic model. (e.g., fill or excavation, roadway, structures)

G. Construction permits will not be issued until a Conditional Letter of Map Revision (CLOMR) or amendment has been accepted by the City Engineer for submittal to FEMA. Where a floodway is being impacted, the applicant must submit and obtain approval from FEMA for a conditional Letter of Map Revision prior to construction in the floodway.

H. The Developer is solely responsible for obtaining the necessary CLOMR, LOMR, and/or LOMA. FEMA charges a review fee for processing these requests. Contact FEMA for current rates and submittal requirements.

I. Verification of Floodplain Alterations:

1. Prior to final acceptance by the City, a certified statement shall be prepared by a Licensed Professional Engineer showing that all lot elevations, as developed within the subject project, meet the required minimum finished floor elevations shown on the construction plans. This certification shall be filed with the City Engineer.

4.18 Erosion and Sedimentation Control

A. See Section 4.20 and CDM Section 6 for requirements for Stormwater Best Management Practices and Stormwater Management Plan.

4.19 Drainage Easements

A. The following minimum width exclusive drainage easements are required when facilities are not located within public rights-of-way:

1. Storm sewers are to be located within the center of a 20' drainage easement.

2. Overflow flumes are to be sized for the projected emergency overflow and centered within a minimum 10' drainage easement.

B. Storm drain lines are considered public only if they collect runoff from public property, public rights of way or easements. Only public storm drain lines require drainage easements that shall be dedicated on the subdivision plat.

C. Any lot to lot stormwater or system that does not collect public water is considered private. For any private storm sewer system crossing an adjacent lot(s), the developer shall provide the City Engineer with a copy of the subdivision covenants or letter stating the private stormwater conveyance is acceptable to the adjacent owner prior to the plans being "Released for Construction".

D. Drainage easements shall be dedicated on the subdivision plat. For single-family residential developments, storm drain lines shall not cross residential lots. If drainage easements cross residential lots, they should be contained fully on one lot.

E. Drainage Easements shall be dedicated on the subdivision plat for all floodplains and shall include 1' freeboard, a minimum 10' stormwater access way on both sides of the channel, and an erosion hazard setback to reduce the potential for damage due to erosion of the bank.

F. Detention Pond Easements shall be dedicated on the subdivision plat for all detention facilities containing the facility and the area surrounding the facility needed for maintenance of the facility.

4.20 Sustainable Development

The City encourages developments to implement sustainable designs, concepts, and practices on site. The Engineer shall notify the City of the design intent and provide the necessary information, data, and calculations on the construction plans. The following items are potential concepts and designs that may be considered in a sustainable design. Concepts and designs not included on this list may be proposed by the Engineer. Refer to CDM Section 6: Stormwater Management for more information.

- Rainwater Harvesting
- Green Roofs
- Modular Porous Paver Systems
- Porous Concrete
- Extended Detention
- Bio Retention

- Reduction of impervious surfaces
- Preservation of natural drainage paths

The Engineer shall refer to published technical resources for the design of these sustainable designs, concepts, and practices. Such technical resources may be found on the North Central Texas Council of Governments' (NCTCOG) stormwater website or the Environmental Protection Agency's (EPA) website for Low Impact Development.

SECTION 5

WATER & WASTEWATER DESIGN REQUIREMENTS

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Section 5 – Water & Wastewater Design Requirements

Section 5 – Water & Wastewater Design Requirements

5.1 Water and Wastewater System Capacity Analysis

Capacity analysis for water and wastewater systems shall note the source of the domestic and fire flow quoted, such as the latest edition of the International Building and Fire Codes, industry specific historical data, or other authoritative sources adopted by the City. Design criteria for all water and wastewater systems shall comply with Texas Commission on Environmental Quality (TCEQ) requirements of Chapter 290 (Rules and Regulations for Public Drinking Water) and Chapter 217 (Rules and Regulations for Design Criteria for Domestic Wastewater Systems), as they exist or may be subsequently amended.

For the water analysis contact Public Works Department at 903-482-5426 to set up fire hydrant flow test. The analysis shall include but not limited to the following:

A. Zoning

B. Area in acres

C. Type of Development

D. Number of units and/or building square footage

E. Exhibit with connection locations and proposed water main schematic

F. Peak Hourly Flow and Peak Daily Flow in gallons per day

G. Fire Flow

H. Projected Average Daily Water Demands

For the wastewater analysis, in the absence of historical and existing flow data, all capacity analyses shall use the daily wastewater flow – gallons per person and other generally accepted parameters established by one of or combination of the following to determine the Average Daily Dry weather flow (ADDF):

- The Texas Commission on Environmental Quality, Chapter 217 Subchapter B, 217.32(a)(3)
- Actual fixture count for the project
- Current City Wastewater Master Plan estimated design flows. Contact the City Engineer for copy of document.

Calculate the Total Peak flow for the project by one of the following methods:

- Calculate using TCEQ Peaking Factor of 4.0 where Total Peak Flow = ADDF * 4.0

Sewer analysis of existing mains and sewer sizing for new mains shall use 2/3 full (d/D=0.67) for 15" pipe and smaller and 3/4 full (d/D=0.75) for 18" pipes and larger where d = depth of fully developed flow and D = diameter of pipe. Any pipes above the d/D listed will be under capacity.

For Capacity Analysis, the capacity of all sewer mains downstream of the site shall be analyzed to determine if they have adequate capacity for the drainage service area's fully developed

conditions based on the d/D criteria above using the existing slopes. The analysis can be stopped once it reaches a sewer main that has been modeled in the latest City's Wastewater Master Plan, which is typically 8" lines and larger. The City Engineer will make a determination on the analysis and determine if any increases are necessary for the downstream large trunk mains modeled in the Wastewater Master Plan. Any lines that are shown to be under capacity based on the proposed development and fully developed conditions shall be improved to add the necessary capacity by the Developer, unless otherwise approved by the City Engineer.

Include a service area map of the wastewater trunk line(s) servicing the development. This map shall include the locations and sizes of existing and proposed wastewater main improvements. Define on the service area map the peaking factor, infiltration/inflow contribution and fully developed population used. Determine and define on the service area map the average daily and peak domestic flow in gallons per day in the trunk main and projected contribution generated by the development. Note and provide supporting exhibits and references for variables assumed and used. Identify any existing or projected major commercial / retail, industrial, and institutional contributors if present or proposed within the service area.

For private development projects, indicate on the service area map any improvements to be made by the Developer that may be necessary to existing facilities that are affected by the proposed development. Proposed Developer installed utility lines shall be designed using fully developed conditions.

For certain types of developments with a large projected impact on the City's water and or sanitary sewer system, it is at the City Engineer's discretion to require an applicant to pay for a City system modeling update to model the development's impact on the City's existing water and sanitary sewer system by the City's modeling consultant.

5.2 Water System - General

A. The intent of the water system design requirements is to list minimum requirements for public water distribution and transmission system facilities and appurtenances. See the Civil Engineering Plan Standards checklist for items to represent on public works and site engineering, utility plans where connections to and extension of existing City water lines are proposed. Private fire service mains shall be designed according to these water system design requirements and the City's Fire Code and the National Fire Protection Association (NFPA) 24, Standard for the Installation of Private Fire Service Mains and Appurtenances, latest revision.

B. Design criteria for all water systems shall comply with Texas Commission on Environmental Quality (TCEQ) Chapter 290, Subchapter D (Rules and Regulations for Public Water Systems), as they exist or may be amended.. Chapter 290 is included in Part I of Title 30 of the Texas Administrative Code.

C. Line sizes shall comply with the City's current Water & Wastewater Capital Improvement Plan.

D. Water mains shall be sized and extended through the limits of a development to serve adjacent properties.

E. In phased developments, each phase shall be able to exist independently and water mains must extend at least one joint pass the end of pavement.

F. Water mains shall be looped to provide two independent sources of water.

G. Developer shall, at a minimum, install all water taps, locate and raise to grade all water services, and properly install all meter boxes for each service per this Section and Standard Details.

5.2.1 Dead End Water Mains

A. Dead end water mains greater than 150' are not allowed without prior written approval by the City Engineer; if approved, a flushing device shall be provided.

B. Dead end water mains shall extend a minimum of 5' beyond the edge of the pavement. If adjacent to a fitting, extend a minimum of 20' or one pipe joint beyond fitting.

5.2.2 Horizontal and Vertical Alignment

A. Water mains shall be installed 3' from the back of the proposed curb or edge of paving generally along the north and east side of the streets. This shall also apply if the street is divided by a median.

B. Water mains shall be designed to minimize bends, 45 degree bends are preferred, follow the curb, edge of paving, or centerline alignment, curve sections shall be placed at a uniform distance from the curb, edge of paving, or centerline.

C. Water mains that are not located in right of way shall be centered within a minimum 15' wide utility easement.

D. A clearance of 18" shall be maintained when crossing storm drain systems. Where minimum clearance cannot be achieved, water mains shall be encased with steel pipe.

E. Lines 8" and smaller shall have a minimum cover of 4'

F. 10" and 12" lines shall have minimum 5' of cover.

G. Lines larger than 12" shall have a minimum cover of 6'.

H. Profiles are required for all bores across public rights of way and for mains greater than 8" in diameter. All 8" or larger water mains installed in an unimproved future street shall be profiled.

I. A minimum 10' spacing is required between adjacent water lines.

J. Buildings, building slabs or structures proposed outside of the utility easement but parallel to a water main shall be no closer than 12' minimum from the centerline of the water main unless structural and soil calculations are submitted by a licensed professional engineer in the State of Texas and approved by the City Engineer. The structural and soil calculations shall verify the integrity of the proposed structure under the condition of a water main failure adjacent to the structure.

K. Water mains shall be designed as straight as possible following the existing or proposed grade at the minimum depth of cover. Bends shall be provided where vertical slope changes exceed 80% of the manufacturer's recommended joint deflection.

L. Excessive high points that trap air and restrict water flow shall be avoided. High points shall be designed to coincide with the location of fire hydrants where possible. Where high points are unavoidable, air valves shall be considered.

5.2.3 Separation Distance between Water and Wastewater

A. The separation distance between water and wastewater mains, manholes or other appurtenances is governed by Title 30 of the Texas Administrative Code, Part 1, Chapter 290, Subchapter D, Rule 290.44(e) and Chapter 217, Subchapter C, Rule 217.53(d).

B. Water mains shall have a minimum separation distance of 9' in all directions from wastewater collection facilities. Separation distances shall be measured from the outside surface of each of the respective facilities.

C. SDR 35 PVC wastewater mains are required for all new systems, however if the minimum separation distances cannot be achieved for parallel water and wastewater mains on existing systems, the separation distances may be reduced if the wastewater main is a minimum of SDR 26 and has a pressure rating of 150 psi. In these cases, the water main shall be placed above the wastewater main with minimum separation distances of 4' horizontally and 2' vertically.

D. If the minimum separation distances cannot be achieved for crossing water and wastewater mains, the separation distances may be reduced under two scenarios:

1. The wastewater main has a minimum pressure rating of 150 psi.

2. The water or wastewater main is cased for a minimum of 18' with a casing pipe having a minimum pressure rating of 150 psi. The casing pipe shall be centered on the water main crossing, be a minimum of two nominal pipe sizes larger than the wastewater main and be sealed at each end with watertight non-shrink cement grout, or a manufactured watertight seal.

Under each scenario, the water main shall be centered on the wastewater main crossing with a minimum separation distance of 12".

E. When water mains are designed to be closer than 9' to wastewater manholes or cleanouts, the water main shall be cased as described in Section 5.2.3(D) above.

5.2.4 Water Main Sizing

A. Water mains shall be sized in accordance with the current City's Water & Wastewater Capital Improvement Plan

B. Water mains shall be a minimum of 8" and shall be extended to provide service to adjacent properties.

5.2.5 Water Main Materials

A. Polyvinyl Chloride (PVC) Pipe

1. PVC water mains from 8" to 16" in diameter shall be AWWA C900 DR18.

2. Reinforced Concrete Cylinder Pipe (RCCP) is required for pipe diameters greater than 16" unless approval is granted by the City Engineer.

B. Fittings

1. All fittings shall be ductile iron and have mechanical restraints (EBBA series 2000 PV or equal) and standard thrust blocking.

5.2.6 Water Services

Minimum requirements for water services are as follows:

A. Minimum 3/4" meter and 3/4" services are required for all residential and commercial services. The size necessary shall be selected based on design calculations of actual demands.

B. Twin meters in parallel may be used if approved by the City Engineer. Meter size shall correlate to the line size. Bullhead connections with a minimum size of 1" or size of the largest meter, may be utilized if approved by the City Engineer.

C. Meters 3" and larger are required to be in a concrete vault.

D. Services less than or equal to 2" shall be copper, larger services lines shall be PVC AWWA C900 DR18.

E. Domestic or irrigation service connections shall not be allowed on a fire hydrant lead.

F. A domestic or irrigation service connection shall not exceed 90' in length.

G. The water meter size shall be the same size as the service line, except that 3" meters shall have a minimum 4" service line.

H. For a water service requiring a vault, a minimum 4" water line shall be required off the water main with a minimum 4" gate valve prior to reducing in size.

I. Meter boxes shall be placed within the right of way or in a dedicated utility easement in an unpaved area unless approved by the City Engineer.

J. If allowed, meter boxes shall be protected from vehicular traffic with bollards. If not protected by bollards, either a traffic-rated vault or curb is required.

K. Meters shall be placed generally in the center of residential lots according to the Standard Details. If bullheads are approved, water meters shall be placed on the property being served and may be placed near the property line.

L. Water services shall be installed to avoid future driveway and sidewalk conflicts. If a conflict occurs, the water service will be relocated by the developer or builder at his expense.

M. When required, water services shall be abandoned at the main by removing the service line from the main.

5.2.7 Valves

A. Isolation Valves

1. Isolation valves shall be placed on or near street right of way lines.

2. Isolation valves shall not be over 600’ apart in residential and multi-family areas.

3. Isolation valves shall not be over 500’ apart in all other non-residential areas on lines 12” and smaller. For lines 16” and larger, valves shall not be over 1000’ apart.

4. Two isolation valves shall be placed such that only one fire hydrant / firefighting apparatus and one fire sprinkler private service system is shut down at a time. No more than three isolations valves shall be used to shut down the combined fire hydrant / firefighting apparatus and fire sprinkler system private service main.

5. An isolation valve shall be placed between a fire hydrant and the main.

6. Water mains supplying an automatic fire sprinkler system shall include isolation valves on the private fire service main located at property line.

7. Isolation valves shall not be located in parking spaces, curbs, sidewalks, or paved areas.

8. In undeveloped areas, main line isolation valves shall be spaced every 1,200’ and adjacent to fire hydrants.

B. Air Release Valves

1. The project Engineer shall be responsible for locating and sizing air release valves in accordance with AWWA Manual M51: Air-Release, Air/Vacuum & Combination Air Valve.

2. Air release valves shall be installed on water mains 16” and larger. Vent pipes shall discharge air above grade and above 100-year floodplain elevation if applicable.

3. Air valves are not required on water distribution mains smaller than 12” where fire hydrants and service connections provide a means for venting trapped air.

4. Air valve manholes shall not be located in paved areas.

C. Blowoff Valves

1. Blowoff valves shall be provided on water mains 16” and larger, at low points and at isolation valves where the water main slopes toward the valve.

2. Blowoff valves shall discharge to a drainage channel, creek, storm sewer or culvert as approved by the City Engineer.

5.2.8 Fire Hydrants

Fire hydrants shall be provided as recommended by the “Guide for Determination of Required Fire Flow” published by the Insurance Service Office. The following minimum guidelines shall be met:

A. Fire hydrants shall be installed at a minimum of 10’ from the curb return on a street or driveway.

B. Fire hydrants shall be installed at a minimum of 2’-6” and a maximum of 8’ from the edge of pavement on all streets and fire lanes and as per the Fire Code.

C. Fire hydrants shall be installed a minimum of 5' from curb inlets or other structures.

D. Install 2-way blue reflector button per the Standard Details just off the center of the street or fire lane opposite fire hydrants.

E. Fire hydrant leads exceeding 150' shall be looped with a minimum 8" line.

F. Fire hydrant leads of 50' or less may be 6" in diameter and single valved. Leads greater than 50' shall be a minimum 8" in diameter and double valved. Leads shall be PVC AWWA C900 DR18. No service taps allowed on fire hydrant leads less than 8"

G. Fire hydrants shall be provided within developments as measured along the route that a fire hose is laid by a fire apparatus per the latest requirements of the Fire Marshall's office.

H. The fire hydrant shall not be located in the sidewalk or paved area.

I. Fire hydrant valves shall be positioned to one side of the fire hydrant pumper nozzle.

J. Fire hydrants required to supplement water supply for automatic fire protection systems shall be located near the Fire Department connection per the current requirements of the Fire Marshall's office.

K. Fire hydrants on private property shall be located within utility easements and protected by curb stops or bollards. The property owner is responsible for keeping the curb stops or bollards in place and the maintenance of which shall be the responsibility of the property owner.

L. Fire hydrants on private property shall be accessible to Fire Department vehicles at all times.

M. Fire hydrant location is subject to approval of the Fire Department.

5.2.9 Fire Service Lines

A. A fire service line shall be a minimum of 6" unless otherwise approved by the Fire Marshall's office.

B. Public works and site engineering construction plans shall show and identify the fittings required and the alignment of the fire line within 5' of the structure. Note on drawings location of backflow device, Fire Department Connection (FDC), fire hydrants and fire lanes in accordance with the Fire Marshall requirements.

5.2.10 Connections to Existing Water Mains

A. Connections to 12" water mains and larger shall be made with a pipe a minimum of one size smaller than the line being tapped.

B. Tapping sleeve and valve shall be used whenever possible for connections to existing mains in order to avoid interruption of water service. When using a tapping sleeve and valve, the tap is restricted to a maximum of one standard pipe size smaller than the tapped pipe.

C. If a tapping sleeve and valve cannot be used, then a cut-in valve and tee shall be required.

D. Connections on Reinforced Concrete Cylinder Pipe, (RCCP) shall be performed by the pipe manufacturer, provide an instructional note on the public works and site engineering construction drawings.

E. The smallest pipe connection to water mains 16" and larger is 6".

5.2.11 Backflow Prevention

Backflow prevention devices, incompliance with current city codes, shall be located outside of rights of way and utility easements and required at the following locations in order to protect the public water system from cross contamination:

A. Non-residential property water service lines

B. Dedicated irrigation lines

C. Private fire service main supplying fire sprinkler systems

D. Multi-family residential water service lines

E. Backflow prevention devices can be located within a building and if so, must be clearly indicated on construction drawings.

5.2.12 Automatic Flushing Valve

A. Automatic Flush Valves (AFV) shall be placed on dead-end water mains if ordered by the City Engineer. Water mains anticipated to be extended in the future may be required to install an automatic flush valve, depending on the timing of future work and the specific location.

B. Refer to Standard Detail for typical installation.

C. AFV's should not be placed in paved areas.

5.3 Wastewater System - General

A. Wastewater main sizes shall comply with City's Water & Wastewater Capital Improvement Plan.

B. Wastewater mains shall be sized in accordance with the City's current Water & Wastewater Capital Improvement Plan and extended through the limits of a development to serve adjacent properties. The sizing of the wastewater main shall be based on an engineering analysis of initial and future flow of the area to be served. The mains shall be sized for the peak flow which is based on the estimated average daily flow. When site-specific data is unavailable, the designer shall use the most conservative data and meet or exceed the requirements found in TCEQ Chapter 217 (Design Criteria for Domestic Wastewater Systems), latest revision. Chapter 217 is included in Part 1 of Title 30 of the Texas Administrative Code. And per the Schematic Wastewater design requirements from Section 5.1. Public sewer main

abandonments shall be verified by the requestor and sanitary sewers shall be televised for the presence of active service connections.

C. See the Civil Engineering Plan Standards checklist for items to represent on public works and site engineering, utility plans where connections to and extension of existing City wastewater lines are proposed.

D. In phased developments, each phase shall be able to exist independently and wastewater mains must extend at least 1 joint passed the end of pavement.

5.3.1 Wastewater Main Location

A. Wastewater mains serving subdivisions and commercial developments shall be located under street paving along the center of the street. In areas where the paving is divided by a median, the wastewater main shall be designed generally 6-feet from the back of the median curb or edge of paving on the south and west side of the street.

B. Wastewater mains shall not be located in alleys unless approved in writing by the City Engineer.

C. Wastewater mains located near open waterways shall follow the alignment of the waterway along the high bank and be located a minimum of 15' beyond the top of bank. Wastewater manholes located in the flow line of an existing waterway and or located within the 100-year flood plain shall be a Pressure Type.

D. No wastewater main shall be located inside the storm sewer system.

5.3.2 Horizontal and Vertical Alignment

A. Wastewater mains shall be designed as straight as possible between manholes.

B. Wastewater mains running parallel with public right of ways shall match change in street direction. When streets have horizontal curvature, curved sewers are acceptable to maintain parallel alignment. The curves if used shall be designed with a radius that requires not more than 80% of the manufacturer's recommended joint deflection to install the curved section.

C. Minimum cover for 8" wastewater main shall be 4', and for 10" to 12" mains 5', for mains greater than 12", the minimum cover shall be 6'.

D. All grades shall be shown to the nearest one-hundredth of a foot (0.01').

E. In general, the minimum depth for a wastewater main to serve a given residential property with a 6" lateral shall be 3' plus 2% times the length of the house lateral (the distance from the wastewater main to the center of the house). Thus, for a house 135' from the wastewater main, the depth would be 3' plus 2% x 135' = 3.0 + 2.7 = 5.7'. The depth of the flow line of the wastewater main should then be at least 5.7' below the elevation of the ground at the point where the service enters the house. Profiles of the ground line 20' past the building line will be required to verify that this criteria is met.

F. Buildings, building slabs or structures proposed outside of the utility easement but parallel to a sewer main shall be no closer than 12' minimum from the centerline of

the sewer main unless structural and soil calculations are submitted by a licensed professional engineer in the State of Texas and approved by the City Engineer. The structural and soil calculations shall verify the integrity of the proposed structure under the condition of a sewer main failure adjacent to the structure.

G. No vertical bends or vertical curves shall be allowed.

H. A parallel wastewater main shall be required for wastewater lateral connections on wastewater mains deeper than 12'.

I. Wastewater mains shall be placed on such a grade that the velocity is not less than 2.0 fps or more than 10 fps at design peak flow. The following table of values may be used:

Table 5.3: Minimum and Maximum Grades for Wastewater Mains*

Size of Pipe (inches)	Minimum Slope in (Percent)	Maximum Slope in (Percent)
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65
30	0.055	1.43
33	0.05	1.26
36	0.045	1.12
39	0.04	1.01
>39	**	**

*The slopes were calculated using Manning's Equation and a roughness coefficient of 0.013.
**For lines larger than 39" in diameter, the slope shall be determined using the following equation.

$$V = \left(\frac{1.486}{n}\right) * \left(R^{2/3}\right) * \left(S^{1/2}\right)$$

where:

V = velocity of flow in wastewater main (fps)
n = roughness coefficient of the wastewater main
R = hydraulic radius of the wastewater main (ft), which is equal to the area of the flow divided by the wetted perimeter (R=A/P)
S = Slope of the hydraulic gradient (ft/ft)

5.3.3 Separation Distance between Wastewater and Water Mains

A. Refer to Section 5.2.3.

B. Wastewater mains shall be installed in trenches separate from water mains.

C. If the minimum separation distances cannot be achieved for crossing wastewater and water mains, the separation distances may be reduced if the wastewater main has a pressure rating of 150 psi. In these cases the wastewater main shall be cased for a minimum of 18'. The casing pipe shall be centered on the water main crossing, be a minimum of two nominal pipe sizes larger than the wastewater main and be sealed at each end with watertight non-shrink cement grout, or a manufactured watertight seal. The minimum separation distance is 12".

5.3.4 Wastewater Main Sizing

A. Although the City's current Water & Wastewater Capital Improvement Plan may be used as a guide for sizing wastewater mains, sizing should be based on an engineering analysis of initial and future flow of the total service area to be served.

B. Proposed wastewater mains 15" and smaller shall be sized based on total peak flow flowing 2/3 full (d/D=0.67) and for 18" pipes and larger flowing 3/4 full (d/D=0.75) where d = depth of peak flow and D = diameter of pipe. The minimum public wastewater main shall be 8".

C. The analysis must verify that the existing trunk lines can handle the increased demand generated by the proposed development.

D. Include a service area map of the trunk line(s) servicing the development. Define on the service area map the peaking factor, infiltration/inflow contribution and fully developed population used. Determine and define on the service area map the average daily and peak domestic flow in gallons per day in the trunk main and projected contribution generated by the development. Note and provide supporting exhibits and references for variables assumed and used. Identify any existing or projected major commercial / retail, industrial, and institutional contributors if present or proposed within the service area.

E. Indicate on the service area map any improvements to be made by the Developer that may be necessary to existing facilities that are affected by the proposed development. Proposed Developer installed utility lines shall be designed using fully developed conditions and the City's Water & Wastewater Capital Improvement Plan.

F. Pipe capacity shall be calculated using Manning's equation. A roughness coefficient of 0.013 shall be used.

5.3.5 Wastewater Main Materials

A. Polyvinyl Chloride (PVC) Wastewater Pipe

1. PVC gravity wastewater mains from 8" to 15" in diameter are to be SDR 35 (ASTM D3034) at a minimum stiffness of 46 psi.

2. PVC pressure rated gravity wastewater mains and force mains from 8" to 15" in diameter shall be SDR 26 (ASTM D2241) with a minimum pressure rating of 150 psi.

3. PVC pressure rated gravity wastewater mains and force mains greater than 15" in diameter shall be AWWA C905 DR26 with a minimum pressure rating of 150 psi.

4. PVC gravity and pressure rated wastewater mains to be installed more than 12' in depth shall be SDR 26 (ASTM 2241 with a minimum pressure rating of 150 psi.

5. PVC profile wall pipe will not be allowed.

6. Other pipe materials may be considered by the City Engineer and Public Works Department and will only be acceptable if approved in writing.

B. Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe

1. Fiberglass non-pressure rated gravity wastewater mains 18" in diameter and greater shall be in accordance with ASTM D3262 with a minimum pipe stiffness of 46 psi and Class "B-2" embedment in accordance with NCTCOG.

2. Fiberglass pressure rated gravity wastewater mains and force mains 18" in diameter and greater shall be in accordance with ASTM D3754 with a minimum pressure rating of 150 psi and Class "B+" embedment in accordance with NCTCOG.

C. Vitrified clay, concrete, ductile and cast iron pipe are not be allowed on wastewater mains or services.

5.3.6 Wastewater Service Laterals

A. Wastewater services shall be of the same material as the mainline. The sizes and locations of laterals shall be designated as follows:

B. Wastewater service laterals for single-family residential shall be a minimum of 6" in diameter. Laterals shall be installed 10' downstream from the center of the lot and have a minimum separation distance of 10' separation from the water service.

C. Wastewater service laterals shall extend past retaining walls.

D. A single stack double sweep cleanout shall be installed on all wastewater service laterals at the right of way or utility easement line unless waived in writing by the City Engineer.

E. Wastewater service laterals for multiple units, apartments, restaurants, local retail, non-residential and commercial developments shall be a minimum of 6" in diameter.

F. Wastewater service laterals for manufacturing and industrial shall be a minimum of 8".

G. Manholes are required on 6" and larger wastewater service laterals where they connect to the main line.

H. Wastewater service laterals shall not be attached to wastewater mains that are deeper than 12'. Deep cut or drop connections will not be permitted unless approved by the City Engineer.

I. Each property shall have only one wastewater service lateral unless otherwise approved by the City Engineer in writing, except duplexes which shall have two wastewater service laterals independently attached to the main.

J. All mains installed for future developable areas shall include wastewater service laterals for properties that are scheduled for short-term development. Laterals will not be installed for properties that do not have plans for development.

K. All wastewater service laterals crossing water mains shall conform to the requirements of the TCEQ Chapter 217, Subchapter C, Rule 217.53(d), latest revision, or Section 5.3.3 of this manual.

5.3.7 Manholes and Cleanouts

A. Manholes shall be installed at all changes in grade and/or direction, and have a maximum spacing of 500'.

B. Spacing between a manhole and an upstream cleanout shall be a maximum of 250'. A cleanout or manhole shall be located at the end of a wastewater main.

C. Manholes on curved wastewater mains shall be located at the P.C. and P.T. of the curve and have a maximum spacing of 300' along the curve per TCEQ 217.53(m)(6).

D. Manholes shall be constructed of monolithic, cast-in-place concrete or precast concrete.

E. Manholes shall be concentric type unless otherwise approved by the City Engineer.

F. Drop manholes shall be required when the inlet pipe flow line elevation is more than 24" above the outlet pipe flow line elevation, as required by TCEQ 217.55(l)(2)(G). Drops shall be inside the manhole unless otherwise approved by the City Engineer.

G. Manholes shall be the minimum size as follows and larger diameters as needed for multiple connections and spacing:

1. 4' in diameter for 8", 10", and 12" pipe.

2. 5' in diameter for 15", 18", 21", 24" and 27" pipe.

3. 6' in diameter for 30" and 36" pipe.

4. 5' in diameter minimum for manholes deeper or equal to 15'.

H. In Flood Plains, pressure type sealed manholes shall be used. Where more than three manholes in sequence are to be bolted and sealed, every third manhole shall be vented 2' above the 100-year floodplain elevation or 10' above the adjacent ground line, whichever is higher. The project Engineer shall provide the elevation of the 100-year floodplain on the profile.

I. Construct manholes within 30' of each end of wastewater mains that are installed by other than open cut and within 30' of each end of aerial crossings.

J. A manhole with pipes of different sizes must have the tops of the pipes at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe.

K. A minimum of 0.1' of fall through a manhole is required. However, a 0.2' of fall through a manhole is recommended where achievable.

5.3.8 Inverted Siphons

The use of an inverted siphon to miss obstructions along the alignment of the wastewater main should be avoided. If no other option exists, inverted siphons require approval by the City Engineer. The Engineer shall provide a detailed design for a proposed inverted siphon with the Engineer's Seal of an Engineer licensed in the State of Texas. Should an inverted siphon be necessary, the design shall include:

A. Two or more barrels (pipes).

B. A minimum pipe diameter of 6".

C. The necessary appurtenances for convenient flushing and maintenance.

D. One upstream and one downstream manhole for cleaning equipment, inspection and flushing.

E. The siphon must be sized with sufficient head to achieve velocity of at least 3 fps at initial and design flows.

F. The inlet and outlet shall divert the normal flow to one barrel.

G. The system shall be designed to allow any barrel to be taken out of service for cleaning.

H. The system shall be designed to minimize nuisance odors.

5.3.9 Wastewater Lift Stations

Subdivisions shall be laid out so that all wastewater mains shall flow by gravity. Where this is not possible the project Engineer shall prepare an engineering design report for the wastewater lift station. Lift station design shall meet the minimum requirements of TCEQ Chapter 217 Design Criteria for Domestic Wastewater Systems except where exceeded as follows:

A. Power Supply (Primary): 3-Phase from Electric Utility. Single Phase to 3-Phase Converters Are Not Allowed.

B. Pumps: Minimum of Two Flygt Submersible Pumps, Each Pump Sized to Convey the Peak Flow. *Pump Motor Starter:* Soft Starter for each pump. *Pump Control (Primary):* Submersed pressure transducer with (4 – 20 ma) output. Pump Control (Secondary): Floats

C. Wet Well: Cast-in-place or pre-cast concrete with interior "Raven" coating system suitable for this environment. Joints and openings shall be sealed to prevent water infiltration / exfiltration. Wet well shall be accessed through the top using Flygt aluminum

hatches with integral safety grate. All metallic appurtenances located inside the wet well (guide rails, brackets, fasteners, etc.) shall be stainless steel. Removable conduit seals shall be installed where conduits penetrate the wet well. Adequate storage shall be provided for normal pump operation based on a minimum 10-minute cycle time. The lead and lag pump "on" elevations shall be located below invert of the influent line. Additional storage is not necessary due to the city's requirement for secondary power supply.

D. Valve Vault: Cast-in-place or pre-cast concrete. Joints & openings shall be sealed to prevent water infiltration. Valve vault shall be accessed through the top using Flygt aluminum hatches. A floor drain with p-trap shall be provided in the floor of the valve vault to drain water into the wet well. A flap valve shall be provided on the drain pipe where it enters the wet well.

E. Lift Station Piping: Piping in the wet well and valve vault shall be Ductile Iron (DIP) with flanged connections. Pipe shall be rated to withstand external loadings and internal working pressure and shall meet or exceed minimum TCEQ requirements.

F. Interior and exterior of pipe shall be lined with fusion bond epoxy. A thrust harness assembly, check valve and gate valve shall be located on each pump discharge pipe in the valve vault. Check valves shall be lever and weight type. Gate valves shall be rising - stem type.

G. Force Main Piping: Polyvinyl Chloride (PVC), Fusible Polyvinyl Chloride (FPVC) or Fusible High Density Polyethylene (HDPE). Pipe shall be rated to withstand external loadings, internal working pressure, installation loads (as required when installing using directional drill techniques) and shall meet or exceed minimum TCEQ requirements. A combination sewage air/vacuum valve shall be provided at each high point.

H. All-Weather Electrical Equipment Enclosure: All lift station control equipment including motor control centers, pump starters, pump controls, automatic transfer switch and any other equipment that could require access during inclement weather shall be mounted in a ventilated electrical building. Enclosure shall at minimum be an architecturally treated pre-cast concrete structure acceptable to the City.

I. SCADA: The Engineer shall provide the proposed lift station with a System Control and Data Acquisition (SCADA) system that is capable of reporting flow, wastewater levels, and pump status data to the City's central operations and control center. The system is required to be compatible with the City's existing SCADA system.

J. Lift Station Site: Site shall be accessed using a reinforced concrete driveway in accordance with City standards. Site shall be secured with an 8' high welded steel perimeter fence and 16 ft. sliding gate.

5.3.10 Force Mains

A. Use white-colored pipe material whenever available.

B. 12" and smaller pipe shall be PVC ASTM D2241 SDR 26, or as determined by the project Engineer and approved by the City Engineer.

C. Pipes larger than 12" shall be PVC AWWA C905 DR 18 or as determined by the project Engineer and approved by the City Engineer.

D. Minimum size for force mains is 6".

5.4 Easements

A. In single-family residential developments, water and wastewater mains shall not cross residential lots unless specifically approved by the City Engineer, in which case the easement shall be located within a single lot and be a minimum of 15' in width.

B. Where private streets are utilized, utility easements shall be provided covering public water and sanitary sewer lines and appurtenances with the minimum widths as described here in.

C. Wastewater mains servicing more than one property are public and shall be contained and located in utility easement or street rights of way.

D. Water mains 24" and larger shall be located in a minimum 30' easement parallel and adjacent to the right of way.

E. All easements required by the City shall be dedicated by plat if within the platted boundary. If outside the platted boundary, provide easement by separate instrument.

F. Site paving, such as, parking, fire lanes and access drives are allowed over utility easements.

G. The following minimum width exclusive utility easements are required when facilities are not located within public rights-of-way:

1. Water mains 12" and smaller are to be located within the center of a minimum 15' utility easement.

2. Easement widths for water mains 16" and larger not paralleling the Right of Way shall be a minimum of 20' subject to the approval of the City Engineer.

3. Wastewater mains with a depth up to 15' are to be located in the center of a minimum 15' utility easement.

4. Wastewater mains with a depth between 15' and 20' are to be located in the center of a minimum 20' utility easement.

5. Wastewater mains with a depth greater than 20' are to be located in the center of a minimum 30' utility easement.

6. For water and sewer in the same easement, a minimum of 10' separation between lines is required and on either side of the water and sewer line a minimum 7.5' distance provided to the easement limit. Any greater requirements in width from above will supersede.

H. Fire hydrants and automatic flushing valve located outside of public rights-of-way shall be located within a 15' x 15' utility easement.

I. 2" and smaller meters serving multi-family residential and non-residential developments shall be located within the right of way or in a minimum 15' x 15' utility easement.

J. 3" and larger meters shall be located within a minimum 15' x 15' utility easement outside the right of way.

K. All water main appurtenances such as air release valves with vents must be contained within utility easements with a minimum 3' clearance from the edge of the easement.

5.5 Thrust Restraint

A. All pressurized water and wastewater mains shall be restrained against thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.

B. Thrust restraint shall be accomplished by concrete thrust blocks and restrained joints.

C. All valves, fittings and changes in elevation shall have concrete thrust blocks and restrained joints installed.

D. Thrust blocking shall be able to withstand a minimum 200 psi test pressure with a minimum safety factor of 1.5 without exceeding the soil bearing capacity.

E. Restrained joints lengths shall be calculated to withstand a minimum 200 psi test pressure with a minimum factor of safety of 2.0.

F. The following technical references are available for calculating thrust restraint systems:

1. AWWA Manual M9: Concrete Pressure Pipe by AWWA, Latest Edition.
2. AWWA Manual M11: Steel Pipe – A Guide for Design and Installation by AWWA, Latest Edition.
3. AWWA Manual M23: PVC Pipe – Design and Installation by AWWA, Latest Edition.
4. Thrust Restraint for Ductile Iron Pipe by Ductile Iron Pipe Research Association (DIPRA), 2006, or Latest Edition.
5. Thrust Blocking, National Fire Protection Association Standard 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances, latest edition

5.6 Pavement Cut and Repair

A. Water and wastewater main improvements shall be designed to minimize the impact to existing pavement, where feasible.

B. No pavement shall be cut unless approved in writing by the City Engineer.

C. Typically a full panel concrete pavement replacement will be required if pavement must be cut.

5.7 Trenchless Construction

A. Launching and receiving pits for trenchless construction shall be a minimum of 5' from the edge of pavement unless approved by the City Engineer.

B. The location, size and depth of the launching and receiving pits for trenchless construction shall be evaluated during construction plan review.

C. Approved Methods

1. Horizontal Boring - Horizontal boring shall require a steel casing pipe with a minimum yield strength of 35,000 psi and minimum wall thickness of (1/4") unless alternate methods are approved by the City Engineer. Actual wall thickness shall be designed based on a highway loading of HL-20, a maximum deflection of 5% and a minimum factor of safety of 2.0.

2. Pipe Jacking - Pipe shall be designed to withstand all jacking forces with a factor of safety of 2.0 during construction.

3. Tunneling

5.8 Crossings

A. Highway Crossings

1. The design of water and wastewater mains within a state highway must be in compliance with all applicable requirements of the Texas Department of Transportation (TXDOT), unless a variance is approved by TXDOT. The following reference applies: Title 43 of the Texas Administrative Code, Part 1, Chapter 21, Subchapter C – Utilities Accommodation

2. The Developer's Engineer communicates with TXDOT for preliminary approval. The project Engineer shall prepare the permit application with location map and exhibits for the permit application. Submit three sets of plans on 11"x17" of the project area within TXDOT right of way with plan, and profile views. After the City reaches agreement with the project Engineer, he or she will submit documentation required to the City such that the City can submit the application to TXDOT.

3. Water and wastewater mains shall be located so as to avoid or minimize the impact to future highway projects and improvements, to allow other utilities in the right-of- way, and to permit access to water and wastewater mains and other utility facilities for their maintenance with minimum interference to highway traffic.

4. New water and wastewater mains crossing a highway shall be installed at approximately 90° to the centerline of the highway.

5. New water and wastewater mains located longitudinally along a highway shall be designed in an easement parallel to the right of way.

6. All water and wastewater crossings shall be encased with steel casing pipe in accordance with Section 5.7C(1) , or approved equal. Casing pipe shall be extended to 5-feet beyond the street pavement.

7. Water valves, manholes and other appurtenances shall not be placed in the pavement or shoulder of highway.

8. Water main crossings shall include a valve on each side of the highway crossing.

B. Railroad Crossings

1. The design of water and wastewater mains within railroad right of way must be in compliance with the requirements of the appropriate railroad authority. The designer should determine which railroad company right of way is being crossed and obtain their utility accommodation policies prior to beginning the design. The following references may be applicable:

   a. American Railway Engineering & Maintenance Association (AREMA), Latest Edition.

   New water and wastewater mains crossing a railroad shall be installed at approximately 90° to the centerline of the railroad. All water and wastewater crossings shall be encased with steel casing pipe in accordance with Section 5.7C(1), or approved equal. Casing pipe crossing railroad tracks shall be designed to withstand E80 railroad loadings and shall extend to the railroad right of way lines.

2. New water and wastewater mains located longitudinally along a railroad shall be designed in an easement parallel to the right of way.

3. Water valves, manholes, meters and other appurtenances shall be placed outside the limits of the railroad right of way and in an approved utility easement.

4. Water main crossings shall include a valve on each side of the railroad crossing.

C. Creek Crossings

1. All water and wastewater mains crossing under a flowing stream or semi-permanent body of water such as a marsh or pond shall be encased with steel casing pipe in accordance with Section 5.7C(1) Horizontal Boring, or approved equal.

2. Wastewater main crossings shall include a manhole on each side of the creek crossing beyond the top of creek bank.

3. Water main crossings shall include a valve beyond the top of creek bank on each side.

4. Water mains installed under and across creeks or ditches shall be designed according to the following:

   a. Trench backfill under creeks and ditches shall consist of flowable backfill.

   b. Rock bottom creeks and ditches shall include a 6” concrete cap at the surface.

   c. Bank stabilization shall be required at all crossings to resist scour and shear forces on all disturbed areas.

D. Elevated Crossings

1. Elevated crossings for water and wastewater mains should be avoided, and only allowed upon approval of the City Engineer.

SECTION 6

STORMWATER MANAGEMENT REQUIREMENTS

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Section 6 – Stormwater Management Requirements

Section 6 – Stormwater Management Requirements

6.1 General

The Developer must provide proof of compliance with applicable local, state, and federal environmental regulations upon request by the City.

6.2 Impervious Area Status Sheet

For all non-residential projects an Impervious Area Status Sheet must be completed and submitted to the City Engineer with the first submittal of Site and/or Building Permit plans.

6.3 Stormwater Management Plan (SWMP) – Permanent Controls

A. General Requirements

A Storm Water Management Plan (SWMP) shall be prepared for all developments (see Section 6.4 for submittal requirements based on size) The SWMP shall be developed and coordinated with the site drainage plan and may be shown on the same sheet. The SWMP shall identify permanent site features and controls that will be constructed with the project to minimize and mitigate the project's long-term effects on stormwater quality and quantity.

The SWMP should also be coordinated with the landscaping plan to prevent conflicts and ensure compatible land use.

B. Site Development Controls (Permanent)

It is the responsibility of the engineer to design permanent controls that address site specific conditions using appropriate design criteria for the North Central Texas region. Refer to NCTCOG iSWM Technical Manual for current recommended practices. Some of the factors to be considered when evaluating and selecting controls for a development are as follows:

- Effect of the development on runoff volumes and rates
- Potential pollutants from the development
- Percent of site treated by the control
- On-site natural resources
- Configuration of site (existing waterways, topography, etc.)

The following are some examples of permanent controls:

- Preservation of natural creeks
- Site specific stormwater controls
- Vegetated swales
- Preservation of the 100-year floodplain
- Detention ponds
- Retention ponds

6.4 TCEQ Construction General Permit (CGP)

Construction activities that discharge stormwater runoff into or adjacent to any surface water of the state are regulated by the State of Texas under the, most current, Construction General Permit (CGP) (TXR150000). The governing agency is the Texas Commission on Environmental Quality (TCEQ). Construction activities are regulated according to the area of land disturbed.

Large construction activities

For sites that disturb five or more acres, or are part of a larger common plan of development that will disturb five or more acres, and meet the definition of an operator, the following applies:

- Prepare and implement a Storm Water Pollution Prevention Plan (SW3P)
- Submit a copy of the Site Notice to the MS4 Operator
- Submit a Notice of Intent (NOI) to TCEQ
- Submit a copy of the NOI to the MS4 Operator
- Post the NOI and Site Notice

Small construction activities

For sites that disturb at least one but less than five acres, or are part of a larger common plan of development that will disturb at least one, but less than five acres and meet the definition of an operator, the following applies:

- Prepare and implement a SW3P
- Submit a copy of the Site Notice to the MS4 Operator
- Post a Site Notice

Projects Disturbing 5,000 SF to Less than One Acre

Sites that disturb less than one acre and that are not part of a larger common plan of development that would disturb one or more acres, are not required to have coverage under the general permit. The following applies:

For sites that disturb 5,000 sf to less than one acre and are not a part of a larger common plan on development, the following applies:

- Prepare and implement an Erosion Control Plan

Refer to the General Permit definitions for Operator and Primary Operator. Additional information on the Texas Construction General Permit can be found at the following link:

http://www.tceq.texas.gov/permitting/stormwater/

6.5 Storm Water Pollution Prevention Plan (SW3P)

One of the requirements of the Construction General Permit is to develop a SW3P. The purpose of the SW3P is to provide guidelines for minimizing sediment and other pollutants that may originate on the site, from flowing into municipal storm systems, or jurisdictional waters during construction. The plan must also address the principal activities known to disturb significant amounts of ground surface during construction.

The stormwater management controls included in the SW3P should focus on providing control of pollutant discharges with practical approaches that use readily available techniques, expertise, materials, and equipment. The SW3P must be implemented prior to the start of construction activity.

A. Construction Controls

Structural and non-structural controls may be used for controlling pollutants for stormwater discharges from small and large sites. Structural controls shall comply with details and specifications in the latest edition of the NCTCOG iSWM Technical Manual and these standards. When the NCTCOG Manual and these standards are in conflict, these standards shall govern.

The following are acceptable temporary controls for use during construction: Non-

Structural

- Minimizing the area of disturbance
- Preserving existing vegetation
- Hydromulch

Structural

- Silt fence
- Inlet protection
- Rock check dams
- Stabilized construction entrances
- Sediment traps
- Vegetated buffer strips
- Temporary detention structure
- Rock check dams

Suggested construction controls can be found on the NCTCOG iSWM websites.

It is the responsibility of the design engineer to select and design appropriate construction controls for each site. If the most appropriate control is not shown in the iSWM Technical Manual, the design engineer shall submit calculations and references for design of the control to City Engineer for review and approval.

B. Waste and Hazardous Material Controls

Covered containers shall be provided for waste construction materials and daily trash. Hazardous materials shall be stored in a manner that prevents contact with rainfall and runoff. Onsite fuel tanks and other containers of motor vehicle fluids shall be placed in a bermed area with a liquid-tight liner or be provided with other secondary containment and spill prevention controls.

The SW3P shall require federal, state and local reporting of any spills and releases of hazardous materials greater than the regulated Reportable Quantity (RQ) and reporting to City Engineer of all spills and releases to the storm drainage system.

C. Temporary Stabilization

Portions of a site that have been disturbed, but where no work will occur for more than 21 days shall be temporarily stabilized as soon as practicable, and no later than 14 days, except when precluded by seasonal arid conditions, or prolonged drought.

Temporary stabilization shall consist of providing a protective cover, designed to reduce erosion on disturbed areas. Temporary stabilization may be achieved using temporary seeding, soil retention blankets, hydro-mulches and other techniques that cover 100 percent of the disturbed areas until either final stabilization can be achieved or until further construction activities take place.

Perimeter controls such as silt fence, vegetated buffer strips or other similar perimeter controls are intended to act as controls when stabilization has not occurred. Perimeter controls shall remain in place during temporary stabilization.

D. Final Stabilization

Final stabilization consists of soil cover such as vegetation, geo-textiles, mulch, rock, or placement of pavement. For stabilizing vegetated drainage ways, sod or seeded soil retention blankets shall be used. Hydromulch will not be allowed in vegetated swales, channels or other drainage ways.

The plan for final stabilization shall be coordinated with permanent controls in the SWMP and with the landscaping plan, if applicable.

E. Notice of Intent (NOI)

If applicable, copies of the NOI shall be sent to the City Clerk at least 2 days prior to commencing construction.

F. TCEQ Site Notice

A signed copy of the Construction Site Notice shall be posted at the construction site in a location where it is readily viewed by the general public during all construction activity.

G. Notice of Termination (NOT)

All parties that submitted a NOI shall submit a NOT to the City Clerk and TCEQ within 30 days after final stabilization is established. When the owner of a residential subdivision transfers ownership of individual lots to builders before final stabilization is achieved, the SW3P shall include controls for each individual lot in lieu of final stabilization. These controls shall consist of stabilization of the right of way and placement of structural controls at the low point of each individual lot or equivalent measures to retain soil on each lot during construction. Additionally, the builder must submit a valid NOI before an NOT can be submitted by the owner.

H. Inspection and Maintenance during Construction

The owner shall construct all controls required by the SW3P. The owner shall have qualified personnel inspect the controls at least every two weeks during construction and within 24 hours after a storm event of 0.5", or greater. Alternately, inspections may be performed every 7 days with no additional inspections after rain events.

Certified inspection reports shall be retained as part of the SW3P. Within seven days of the inspection, controls identified as damaged or deteriorated shall be repaired or replaced, as appropriate. Controls shall also be routinely cleaned to maintain adequate capacity.

Changes or additions shall be made to the controls within 7 days to prevent discharges from the site. The owner shall implement procedures to remove discharged soil from all portions of the storm drainage system including streets, gutters, inlets, storm drain, channels, creeks, ponds, etc.

Notes requiring the inspection and maintenance shall be placed on SW3P drawings. The SW3P shall identify the responsible party for inspecting and maintaining each control. If no party is identified, each owner and operator that submitted a NOI for the site shall be fully responsible for implementing all requirements of the SW3P.

I. Construction and Maintenance

The owner shall construct all permanent controls and is responsible for maintenance of the controls. When the control falls within a drainage easement, the plat or separate instrument dedicating the easement shall include a statement of the owner's responsibility for maintenance.

SECTION 7

STRUCTURAL DESIGN REQUIREMENTS

Section 7 – Index

Section 7 – Structural Design Requirements

Section 7 – Structural Design Requirements

7.1 General

A. The Design Engineer of record shall bear the sole responsibility for meeting the engineering standard of care for all aspects of the design and providing a design that's required by the site-specific conditions and intended use of the facilities.

B. For the purposes of this section of the City Design Manual, the following items shall be considered structures: bridges, foundations, retaining walls (structural and gravity), headwalls and wingwalls, culverts, slopes and embankments, and screening walls.

C. All walls greater than or equal to 4-feet in height are permitted by the Building Inspection Department. Engineering design and details for retaining walls within or supporting public rights of way and easements shall be submitted and included with the Site Plans.

D. The City's review of any structural design is limited to determining whether the construction plans are in general compliance with the City's Master Plans and this manual. The City's review and release of the construction plans does not represent that the City has re-engineered or verified the engineering of the proposed improvements.

E. The structural design must be signed and sealed by a structural engineer or civil engineer competent in structural engineering licensed in the State of Texas. The Design Engineer is responsible for all engineering and recognizes that specific site circumstances or conditions may require improvements constructed to exceed minimum standards contained in the City's Design Manual. The Design Engineer is responsible for the applicability and accuracy of the construction plans and specifications.

F. Walls shall be permitted and constructed in accordance with all requirements of this manual. If required, third-party inspections shall be performed during construction, and reports provided to the City. A third-party shall certify wall was constructed in general compliance with the City-approved plans and specifications, and a certification shall be provided to the City.

7.2 Code Requirements

A. All structural design shall comply with the City's currently adopted version of the *International Building Code*. All walls within or supporting public rights of way and easements shall also comply with City Standard Details and/or TxDOT Details.

B. The design and construction of structural concrete for buildings and where applicable in non-building structures shall be provided in accordance with the requirements of the current version of "Building Code Requirements for Structural Concrete (ACI 318)" as published by the American Concrete Institute.

C. Reinforcing steel in reinforced concrete structures shall be fabricated and placed in accordance with the requirements of the current version of the "ACI Detailing Manual (ACI 315)" as published by the American Concrete Institute.

D. The design and construction of concrete tanks, reservoirs, and other structures commonly used in water and wastewater treatment works where dense, impermeable concrete with high resistance to chemical attack is required shall be provided in

accordance with the requirements of the current version of "Environmental Engineering Concrete Structures (ACI 350)" as published by the American Concrete Institute. This code places special emphasis on structural design that minimizes the possibility of cracking and accommodates vibrating equipment and other special loads. ACI 350's minimum requirements for proportioning of concrete, placement, curing, and protection against chemicals shall be met or exceeded. The design and spacing of joints shall also meet or exceed the minimum requirements of ACI 350.

E. The design and construction of roadway bridges shall be provided in accordance with the requirements of the current version of the "Standard Specifications for Highway Bridges" as published by the American Association of State and Highway Transportation Officials (AASHTO).

F. More stringent requirements may be required for unusual designs or specific site conditions. The codes cannot replace sound engineering knowledge, experience, and judgment.

G. For any structure, the City or the structural engineer may require the quality of materials and construction to be higher than the minimum requirements as stated in the codes.

7.3 Geotechnical Performance Specifications

A. Field investigation, geotechnical testing, and geotechnical engineering shall be performed in accordance with the standard of care taking into account local experience and conditions. The geotechnical recommendations shall establish the minimum design criteria upon which the Design Engineer can rely. However, based on the Design Engineer's experience and engineering judgment, if the Design Engineer is compelled to use more conservative geotechnical design criteria for his/her structural design, that is the Design Engineer's prerogative. In no case shall the Design Engineer use geotechnical design criteria less conservative than the geotechnical engineer's recommendations.

B. A letter requesting permission to drill must be obtained prior to performing any boring within the City's right of way.

C. The complexity of geological conditions and the type, length, and width of structure will determine the number and locations of test holes required. The following should be considered by the Design Engineer in coordination with the geotechnical engineer: Depth of test hole, location of proposed grade relative to existing grade, channel relocations and/or channel widening, scour, foundation loads, foundation types.

D. Locations required by (C) above whether accessible or difficult use extreme care when boring near overhead power lines and underground utilities, avoid steep slopes and standing or flowing water. Identify test hole locations on the plans.

E. Provide a complete soil and bedrock classification and log record for each test hole, including all pertinent information to complete the standard log. Location and surface elevation shall be shown on the boring logs.

F. Perform the appropriate field and laboratory tests necessary to determine the soil shear strength for proper soil evaluation and geotechnical design criteria. The geotechnical engineer shall consider the short-term and long-term conditions. In addition, special attention is required when testing highly plastic clays. Tests of these soil types shall be performed at a slow enough rate such that any excess pore water pressure is dissipated, or in a manner that measures pore water pressure.

G. Ground water elevations shall be included as part of the data acquisition. Site conditions may require the installation of piezometers to establish a true groundwater surface elevation and method of monitoring water surface fluctuations

H. Minimum boring requirements are as follows:

1. Slopes and Embankments including Bridge Approaches**.** Obtain soil borings for cuts greater than 10' or embankments taller than 10'. The exploration shall include the following:

   a. The soil under future embankments. Advance borings to a depth at least equal to the embankment height or 20', whichever is greater, unless a greater depth is recommended by the geotechnical engineer.

   b. Soil in proposed cuts. Advance borings to a depth of at least 15' below the bottom of the proposed cut, unless a greater depth is recommended by the geotechnical engineer.

2. Bridges

   a. In general, drill test holes 10' to 15' deeper than the probable top elevation of the bridge foundation.

   b. Test holes near each abutment of the proposed structure plus a sufficient number of intermediate holes to determine depth and location of all significant soil and rock strata.

   c. Stream crossings with foundation structures in the channel require borings at the proposed structure.

   d. If boring information varies significantly from one side of the channel to the other, a boring in the channel may be required by the City Engineer.

   e. Grade Separations. If the borings indicate soft surface soils (fewer than 10 blows per foot), additional borings and testing shall be required for the design of the bridge approach embankments.

3. Retaining Walls Obtain soil borings for **walls taller than 4-ft**.

   a. Soil boring shall be obtained at the discretion of the geotechnical engineer and standard engineering practice. Soil borings and associated laboratory testing and design recommendations shall be performed by a competent geotechnical consulting firm experienced with retaining structures.

   b. Fill Walls. For spread footing walls and Mechanically Stabilized Earth (MSE) walls, the depth of the boring shall be greater than or equal to the wall height depending on the wall type and existing and proposed ground lines. The minimum boring depth is ten feet (10') below the bottom of the proposed wall footing unless rock is encountered. Extend borings at least 5' into rock for fill walls unless additional depth is recommended by the geotechnical engineer.

   c. Cut Walls. For drilled shaft walls, tied-back walls, and soil and rock nail walls, the depth of the boring is based on the proposed ground line. Cantilever drilled shaft walls require the depth of boring to extend the anticipated depth of the shaft below the cut, which is typically between one and two times the wall height unless additional depth is recommended by the geotechnical engineer of record.

Borings for soil nail and rock nailed walls need to be advanced through the material that is to be nailed. The minimum boring depth is 15' below the bottom of the proposed wall. Borings for proposed cut walls may need to penetrate rock significant distances depending on the depth of the cut and wall height.

d. Provide additional testing for taller walls, walls on slopes, or walls on soft founding strata as necessary, or recommended by the geotechnical engineer of record, to completely evaluate wall stability.

4. Borings Encountering Rock

a. Based on the geotechnical engineer's experience and engineering judgment, if rock is encountered, the minimum boring depths specified above may be reduced but only at the direction of the geotechnical engineer.

7.4 Bridge Design

A. The structural engineer shall be responsible for selecting the appropriate bridge foundation. He or she shall consider the following factors in that selection:

1. Design load. The magnitude of the design load dictates the required size of the foundation.

2. Geotechnical engineering recommendations. The strength and depth of subsurface formations determine the type of foundation chosen. In general, drilled shafts are well suited to areas with competent soil and rock, and is the preferred foundation type subject to concurrence of the geotechnical and structural engineers' concurrence.

3. Corrosive conditions. Salts, chlorides, and sulfates are detrimental to foundations. Where these conditions exist, the Design Engineer shall specify sulfate-resistant concrete.

B. The structural engineer shall use the geotechnical investigation recommendations as minimum design criteria. If in the structural engineer's judgment, the structural design needs to be based upon more conservative geotechnical design criteria, the structural engineer shall provide the more conservative design.

C. Disregard surface soil in the design of drilled shaft foundations. The disregarded depth is the amount of surface soil that is not included in the design of the foundation due to potential erosion from scour, future excavation, seasonal moisture variation (shrinkage and swelling), lateral migration of waterways, and recommendations of the geotechnical investigation.

D. Drilled shaft capacity relies upon penetrating a specific stratum a specified depth. The plans shall provide a note instructing the contractor and field personnel of the penetration requirement. The plans shall identify the specific type of material to be penetrated and the minimum penetration depth. The plan may allow for the drilled shaft to be shortened if the founding stratum is encountered at a shallower depth, and it requires the shaft to be lengthened if the founding stratum is not encountered at the expected elevation.

When the founding stratum is present at or near the surface, the structural engineer shall consider the load-carrying capacity along with the stability of the superstructure on the foundation. For these conditions, a minimum drilled shaft length shall be specified on the

plans and the drilled shaft will not be allowed to be shortened from plan length, but it may be lengthened if the founding stratum is not encountered at the expected elevation.

E. Bridge foundations for new bridges over waterways require a scour analysis. A scour analysis shall be conducted in accordance with the following:

1. TxDOT guidelines in "Evaluating Scour at Bridges" (HEC-18).

2. Abutment scour does not need to be calculated. However, abutments shall be protected against potential scour through use of flexible revetment, where possible or hard armoring.

3. Design bridge foundations to withstand the scour depths for either the 100-year flood or smaller flood if it will cause scour depths deeper than the 100-year flood.

4. Check the bridge foundations against the scour depth associated with the 500-year flood. This flood event is considered an extreme event and the factor of safety on the bridge foundations shall be greater than or equal to 1.

7.5 Retaining Wall Design

A. The Design Engineer is responsible for ensuring that the retaining wall selected for a given location is appropriate. The retaining wall selection process shall consider the following:

1. Height. Any retaining wall exceeding 4-ft. in height measured from the top of foundation and/or pier to the top of wall shall be engineered. The structural design shall be provided in accordance with the geotechnical recommendations and minimum design criteria provided in Section 7.3.

2. Geometry. Determine applicability of wall type - cut, cut/fill, or fill – based on geometry, site constraints, existing and proposed topography, and wall alignment and location. Identify available ROW and any necessary ROW or easements to accommodate the proposed improvements and the access necessary to accommodate access for maintenance. Identify location and type of existing and proposed utilities and drainage structures. Private walls are prohibited in right of way and city easements without prior written approval from the City Engineer.

3. Economics. For walls installed with Capital Improvement Projects, evaluate the total installed cost of the wall and consider long-term maintenance requirements. Identify necessary excavation requirements (including shoring), required utility adjustments and costs, project schedule, construction phasing requirements, and these effects on the wall design and construction.

4. Stability. The Design Engineer is responsible for the global stability of the wall. Evaluate all walls to ensure that the minimum applicable factors of safety are a least met (see Section 7.5.C), if not exceeded depending on the Design Engineer's judgment. When possible, avoid placing walls on slopes. A slope in front of the wall dramatically reduces the passive earth pressure (resistance), increasing the chance for wall failure. Additionally a slope in front of the wall will have a significant effect on global stability of the wall and embankment in which it resides. For situations where the walls above a slope cannot be avoided, a rigorous slope stability analysis shall be required in accordance with these Technical Standards.

5. Constructability. Determine whether walls are near water or subject to inundation or groundwater. Identify access limitations for equipment both during and after construction. Ensure adequate horizontal and vertical clearances are provided.

6. Drainage. Design the wall to prevent the build-up of hydrostatic pressure behind the wall. If conditions warrant, the City may require the wall design to withstand full hydrostatic pressure load. The wall design shall consider potential deleterious short and long term effects of water inundation including scour and rapid draw down.

7. Aesthetics. Ensure that aesthetic treatments of walls complement the retaining wall and does not interfere with the functionality of the wall. Detailed consideration shall be given to aesthetic treatments of retaining walls that involve landscaping. Additionally, the wall's drainage system design shall avoid potential compromise of the wall aesthetics because of water related damages. All private walls shall conform to the CDM requirements.

8. Loading. Design loads shall be in accordance with these Technical Standards (for building code references, see Section 7.2), including construction loads and surcharge loads from slopes, structures, and vehicles.

B. Analyze and design walls following accepted geotechnical engineering industry standards for this geographical area. In analysis, use earth pressures that follow the requirements of the project's geotechnical investigation specifically addressing the retaining wall design requirements for the project's specific location.

C. The Design Engineer must ensure that the retaining wall system is appropriate for its location and application. The Design Engineer shall design for all potential modes of wall system failure; including, sliding, overturning, bearing pressure, global stability, and structural capacity of the wall itself. The design of the retaining wall shall meet the following minimum factors of safety:

a.	Sliding:	1.5
b.	Overturning:	2.0
c.	Bearing Pressure:	3.0
d.	Global Stability:	1.5

D. Avoid perching wall on slopes steeper than 8H:1V. When walls must be placed on slopes steeper than 5H:1V, or the retaining wall height or the combined wall and slope heights exceed 8-ft., the geotechnical engineer shall conduct a short-term and long-term global stability analysis using applicable soil strength characteristics, geometry, and loading conditions (including load surcharge, hydrostatic, etc.). The Design Engineer is responsible for the design of the wall system, including its global stability.

E. A series of two or more walls built in tiers shall be considered a single wall in height for the purposes of conforming to these Standards when the base of the upper tier is set back from the base of the lower tier less than two times the height of the lower tier wall.

F. If TxDOT standard detail sheets pertaining to cast-in-place spread footing structural retaining walls are utilized, the Design Engineer shall ensure that the actual wall geometry, loading conditions, and soil characteristics are applicable to the standard wall design selected. The Design Engineer shall ensure that interruptions to the wall stem or footing reinforcement by openings, utilities, geometric changes or curved sections of the wall do not compromise the design and performance of the wall. No TxDOT standard wall design shall be modified unless the Design Engineer designs, draws, and seals the modified standard.

G. TxDOT standard sheets pertaining to cast-in-place spread footing walls provide a choice between high pressure (HP) and low pressure (LP) footings. Selection by the Design Engineer is a function of the loading, geometry, and allowable soil pressures. **TxDOT standard sheets pertaining to cast-in-place spread footing walls are developed based on the wall being drained, and the design parameters for foundation and retained soils of a cohesion factor of zero, a friction factor of 30 degrees, and a unit weight of 120 pounds/cubic foot.** Give special consideration to the site-specific geotechnical requirements and whether a TxDOT standard wall design is applicable. Also give special consideration to walls subject to potential inundation. The Design Engineer is solely responsible for the suitability of TxDOT standard detail sheets selected for use at the specific site.

7.6 Slope Stability Design Criteria

A. All slopes exceeding 8-ft. in height with a steepness of 4H:1V or greater, regardless of soil type, cut, or fill, shall be evaluated for global stability for both the short-term and the long-term conditions. Additionally, any known areas of existing fill, deleterious material, or soft soils which have a height over 4 feet or slope angle greater than 6H:1V shall be evaluated for global stability for both the short-term and the long-term conditions. Specific site conditions may require evaluation for additional types of slope failure, such as bearing capacity, settlement, shear, and undercutting. Calculations pertinent to the analysis shall be submitted with the construction drawings when required by the City.

B. Use the following data to analyze global stability of a slope:

1. Geometry (cross section and loading conditions);
2. Location of the water table;
3. Soil/rock stratigraphy; and
4. Soil/rock properties (unit weight, Atterberg Limits, undrained and drained shear strength).

C. For global stability of a slope, the minimum factor of safety of 1.5 is required unless the geotechnical engineer recommends a higher value.

7.7 Screening Wall Design Criteria

A. Screening Walls shall meet or exceed the minimum requirements included in the CDM, and the City's Standard Details for Screening Wall Standards.

B. An opening designed to allow for stormwater drainage shall be provided unless it has been determined by the City Engineer that no drainage problems are anticipated. The opening shall be a uniform 4" high the full length between columns.

C. Walls shall be designed to meet or exceed the minimum structural integrity of the screen walls shown in the City's Standard Details and designed by a Professional Engineer licensed in the State of Texas. These plans shall be signed, sealed and dated and submitted to the City for review and permitting.

7.8 Excavation Support

A. All excavation must be done in compliance with Occupational Safety Heath Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations."

B. Temporary special shoring is used for installations of walls, footings, and other structures that require excavations deeper than 5'. Temporary special shoring is designed and constructed to hold the surrounding earth, water, or both out of the work area. It provides vertical or sloped cuts, benches, shields support systems, or other systems to provide the necessary protection in accordance with the approved design. Unless a complete design for temporary special shoring systems are included in the plans, the contractor is responsible for the design of the temporary special shoring system. The Contractor must submit to the City, for informational purposes only, the design calculations and details sealed by a Professional Engineer licensed in the State of Texas before constructing the shoring. The design of the shoring must provide protection in accordance with Occupational Safety Heath Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations."

7.9 Construction Plans

A. Construction drawings and technical specifications for **all structural** construction shall include the following:

1. Design engineer's seal, date, signature, and Texas Board of Professional Engineers (TBPE) firm registration number;

2. Name and date of issue of the codes and supplements to which the design conforms;

3. Name and date of the project-specific geotechnical engineering report upon which the Design Engineer relied;

4. Live load and other loads used in the design, including surcharge loads and potential exposure to stormwater inundation. Specifically identify the applicable loads and their load factors;

5. Identification of geotechnical investigation and report to which the design conforms (including report name and number (if applicable), date of issuance, engineering firm name and address, firm TBPE firm registration number, and name of geotechnical engineer of record).

6. Where plans indicate compacted soil, provide compaction specification.

7. Specified compressive strength of concrete at stated ages or stages of construction for which each part of the structure is designed.

8. The design shall specifically address construction loading and sequencing. Service loads shall not be applied until the concrete has reached its minimum specified compressive strength or the structure is adequately shored to withstand the service loads;

9. Drainage system (if applicable), including material specification, diameter, daylight point, and outfall connection detail (if applicable), granular material (if applicable) specification, filter fabric material specification and installation requirements, and weepholes (if applicable), including material type, diameter, and spacing;

10. Size and location of all structural elements, reinforcement, and anchors;

11. Identification of shop drawing requirements for fabrication, bending, and placement of concrete reinforcement. Provide bar schedules, stirrup and tie spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Provide additional details for reinforcement of openings in concrete walls and slabs. Shop drawings shall be provided in accordance with the requirements of the technical specifications and submitted to the City for review and approval.

12. Provisions for dimensional changes resulting from creep, shrinkage, and temperature;

13. Details of all contraction, isolation joints, or expansion joints and the appropriate spacing specified;

14. Anchorage length of reinforcement and location and length of lap splices (if applicable);

15. Type and location of mechanical splices of reinforcement (if applicable). Welding of reinforcement shall not be permitted unless approved by the Design Engineer and the City Engineer;

16. The technical specifications for concrete mixtures shall be provided. Responsibility for maintenance of the structure shall be clearly noted on the plans. The plans shall clearly reference a structure maintenance plan and schedule. The maintenance plan shall clearly identify any drainage system required to relieve hydrostatic pressure on the structural system and ensure that it remains fully functional throughout the life of the structure; and

17. Sight visibility triangles (where applicable).

B. **Retaining wall** plans shall also include the following information:

1. Plan view. The plan view shall include location of soil borings, surface and subsurface drainage structures and utilities that could be affected by wall construction.

2. Elevation view. The elevation view shall include a profile of the existing ground line along the wall alignment, proposed finished grade at face of wall, limits of wall payment (if applicable), top of wall profile, soil boring log shown at the correct elevation and scale, wall rail if applicable, drainage structures and utilities as noted above. Pedestrian safety guard railing shall be provided at or directly adjacent to the wall in areas with an elevation difference (drop-off) exceeding thirty inches (30") per the most current International Building Code adopted by the City.

3. Estimated quantity table. Include the estimated quantity table for each retaining wall type. The table should contain the area of wall (for payment) and linear footage of railing (if applicable). Wall quantities shall be based upon the surface area of the wall from the top of wall to the bottom of wall. The bottom of wall is defined as the proposed finished grade at the face of the wall. The bottom of wall shall not be measured from the top of footing unless the top of footing is the proposed finished grade at the face of the wall.

4. Typical section. The typical section shall include a cross section with wall dimensions and showing the relationship of the wall to the roadway, property line, or controlling adjacency, control point(s) for horizontal and vertical alignment (typically the top outermost corner of the wall), indication of maximum slope on top of and in front of

the wall, location of proposed finished grade, railing type, flume, and mow strip, etc. if applicable.

5. General notes. The general notes shall include a note stating the required minimum embedment depth of the footing.

C. **Spread Footing Retaining Wall** plans shall also include the following:

1. If TxDOT retaining wall standards are used, provide the panel design designation (for example, LC-10-32) for each wall panel corresponding to the appropriate cast-in-place spread footing wall standard sheet. The designation includes a reference to the controlling standard drawing, design height, and panel width.

2. Location of expansion and allowable construction joints (assuming 32' panels, every third joint is typically designated as an expansion joint).

3. Set bottom of wall (top of footing) horizontal and stepped to meet minimum embedment depth criteria. Distance from one step to the next is typically greater than 12". Provide bottom of wall elevations for all panels.

4. Include the appropriate TxDOT standard sheets pertaining to cast-in-place spread footing walls if applicable. Otherwise provide typical section details including a cross section with dimensions and reinforcement layout and callouts.

5. If TxDOT standard sheets pertaining to cast-in-place spread footing walls are not applicable to the design, a custom structural wall design shall be provided. The general notes shall specifically identify the applicable concrete specification, the requirement that no service loads shall be imposed until after the concrete has reached its specified minimum compressive strength, and that shop drawing submittals shall be required for fabrication, bending, and placement of concrete reinforcement.

D. **Screening Wall** plans shall include the following information (in addition to the information included under Section 7.9A):

1. The title shall include the legal name of the property on which the wall is being constructed;

2. A plan view of the wall showing its location, limits, and stationing;

3. Wall material specification;

4. Mortar specification.

5. A profile of the wall including grades for the top of the concrete mow strip, adjacent top of curb, sidewalk and finished floor of proposed and/or existing adjacent slabs;

6. Elevation view of a typical column;

7. Elevation view of the wall;

8. Mow-strip detail;

9. Drainage clearance under wall (uniform 2");

10. Steel tensile strength;

11. Concrete compressive strength; and

12. Wind load calculations

E. **Gravity Retaining Walls**, Gravity walls supporting or inside of City right of way are prohibited. Gravity walls supporting or inside easements are not allowed except for the following: along creeks and drainage ways supporting private property and City open spaces.

Gravity Retaining Wall Plans shall also include the following:

1. Wall height, including batter requirements;

2. Wall material specification;

3. Base embedment depth and width requirements, including key depth if applicable;

4. Wall thickness at bottom and top of wall;

5. Mortared zone requirements (if applicable), including zone thickness and the specification to mortar on all sides and no voids;

6. Mortar specifications;

7. Drainage and backfill material specifications; and

8. Clay cap, including material specification and dimension requirements.

F. Calculations pertinent to the design of any and all walls shall be submitted with the construction drawings when required by the City.

G. Drawings must be site specific and show actual dimensions to be used.

H. All wall construction plans and specifications submitted to the City for review must include a permit application submittal.

7.10 Construction Inspection and Certification

A. A permit is required for the construction of any wall as defined in these Standards.

B. Third-party inspections shall be performed during construction, and reports provided to the City. The inspections and reports shall be performed at the following stages of construction (at a minimum):

1. Sub-base preparation geotechnical testing;

2. Pre-pour / sub-base / footing:

   a. Drilled shaft drilling and concrete placement (if applicable); and
   b. Forming of footing, beam, placement of reinforcement (if applicable)

3. Wall construction;

4. Backfill placement - geotechnical testing;

5. Drainage system construction (if applicable); and

6. Final completion

C. A third-party shall certify wall construction inspections were performed at the prescribed stages of construction in accordance with Section 7.10.B. The inspection reports and final certificate of compliance shall be submitted to the City and include the following:

1. Specific reference to the City-approved plans and specifications for the wall;

2. Specific reference to the address and/or legal description for the wall construction location;

3. Specific reference to the name and date of the project-specific geotechnical engineering report; and

4. A certification letter signed and sealed by a licensed professional engineer in the State of Texas, that includes a statement that the wall system was constructed in general compliance with the geotechnical design criteria identified in the plans and specifications and the City-approved construction plans and specifications.

SECTION 8

THOROUGHFARE DESIGN REQUIREMENTS

.

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Section 8 – Thoroughfare Design Requirements

Section 8 – Thoroughfare Design Requirements

8.1 General

The arrangement, character, extent, width, alignment, and location of all streets, public ways, alleys, and driveways shall be in conformity with the City's Thoroughfare Plan and Comprehensive Plan and should be considered in their relation to existing and planned streets, alleys and driveways, topographical and environmental features, scenic views, and the land uses proposed to be served by such streets. From the date of passage of the City Design Manual, the City requires streets to be constructed of concrete. Streets proposed of alterative materials require a variance from City Council.

All thoroughfare designs shall meet the guidelines in AASHTO's current A Policy on Geometric Design of Highways and Streets.

8.2 Street Design

A. Thoroughfare Definitions – The City recognizes five basic classifications of public roadways that include highways, major collectors, minor collectors, local collectors, and local streets as identified in the transportation element of the Comprehensive Plan. Each class provides a certain degree of continuity, capacity, and accessibility to adjacent land uses. While differentiated by function, there is also a variance in geometric design. Table 8.1 summarizes the general design criteria of roadways within the City. The typical cross sections are depicted in Figure 8.1.

1. Major Collectors – Six-lane divided roadways defined herein as Type A thoroughfares. Type A thoroughfares are typically initially constructed as four-lane divided roadways with a wider median and then widened to six lanes at a later date. Frontage roads are also considered major collectors.

2. Minor Collectors – Four-lane divided roadways defined herein as Type B thoroughfares.

3. Local Collectors – Commercial collectors provide access from a Type A or B thoroughfare to non- residential properties and are defined herein as Type C thoroughfares. Residential collectors connect to a Type A or B thoroughfare, extend more than six hundred feet (600') into a residential neighborhood, and may have no homes fronting on them. Residential collectors can be built with the cross section of a Type C thoroughfare.

4. Local Streets – Residential streets with homes fronting on them are defined herein as Type D and E thoroughfares, each with different design characteristics depending on whether the homes are front entry or alley served and whether or not the street is adjacent to a school or park.

5. Private Streets – Are not allowed within the city limits or ETJ. If a private street is permitted through action of the city council, the private street shall be design and constructed to the same standards as public streets. Any gated entrances shall also meet the requirements of Section 8.5.K.

B. Roadway Geometrics – Geometrics of City streets shall be defined as the geometry of the pavement and curb areas that govern the movement of traffic within the confines of the right of way (ROW). Included in the geometrics are pavement width, horizontal curvature, width of traffic lanes, median nose radii, curb radii at street intersections, pavement cross-slope, crown height, pavement thickness, and geometric shapes of islands separating traffic movements and other features.

1. Design Speed – The design speed is a primary factor in the horizontal and vertical alignment of roadways. Design features such as curvature, super-elevation, turning movement radii, and sight distance affects roadway lane width, pavement width, pavement cross-slope, pavement crown, and clearances. Refer to Table 8.1.

2. Grades – Roadway grades shall be a minimum of five-tenths percent (0.5%) in order to insure proper flow of surface drainage toward inlets and a maximum of six percent (6%). Steeper grades may be permitted on local residential streets and where required by topographical and/or natural features, as approved by the City Engineer.

3. Roadway Centerline

   a. Roadways shall be placed in the center of the ROW. The centerline of curves shall be tangent to the centerline of street at each end of curve.

   b. If offset, roadway centerlines for Type C, D, and E thoroughfares shall be offset a minimum of one hundred and twenty five feet (125'). If offset, Type A and B thoroughfares shall be offset to meet the median requirements in Section 8.3.

4. Cross-Slope/Crown Height – Type A and B thoroughfares shall have a two-percent (2%) cross-slope. The cross-slope can vary where there is a transition into or out of a maximum two percent (2%) superelevation. Type C and D thoroughfares shall have six-inch (6") parabolic crowns, and Type E thoroughfares a four-inch (4") parabolic crown.

5. Pavement Thickness and Reinforcement – See Section 8.13 for subgrade and pavement design requirements.

6. Transitions – A concrete transition shall be constructed where four (4) lanes of a thoroughfare connect to a two (2) lane thoroughfare. The transition occurs only in the direction in which traffic needs to be shifted laterally to join the thoroughfare with a different cross section.

   a. Transitions from a four (4) lane to a two (2) lane thoroughfare shall be a minimum of sixteen feet (16') wide, a minimum of three hundred feet (300') long, and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.

   b. A transition from a two (2) lane to a four (4) lane thoroughfare that occurs less than one thousand feet (1,000') from a traffic signal, or from an intersecting Type A or B thoroughfare, shall be a two (2) lane transition twenty-four feet (24') wide, a minimum of three hundred feet (300') long, and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.

c. A transition from a two (2) lane thoroughfare to a four (4) lane thoroughfare that occurs more than one thousand feet (1,000') from a traffic signal, and from an intersecting Type A or B thoroughfare, shall be a one (1) lane transition sixteen feet (16') wide, a minimum of three hundred feet (300') long, and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.

7. Dead-End Streets/Cul-de-Sacs/Stub Streets

a. All dead-end streets shall have a turn-around unless otherwise allowed in Subsection d below. Turn-arounds at the end of dead-end streets (cul-de-sacs) shall have a circular driving surface that has a minimum radius of fifty feet (50') and a street right of way that has a minimum radius of sixty feet (60').

b. The maximum length of a dead-end street with a turn-around (cul-de-sac) shall be six hundred feet (600'), measured from the right of way line of the intersecting street to the center point of the turn-around, except in conditions of unusual topography.

c. If any residential lot fronts onto the dead-end portion of a street that will be extended in the future, a temporary turn-around that meets the standards described above shall be constructed at the end of the dead-end street within a temporary street easement. The following note shall be placed on the plat: "Cross-hatched area is temporary street easement for turn-around until street is extended (give direction) with future development of abutting property".

d. A stub street is an undivided dead-end street that will be extended in the future that does not have a turn-around, which is only allowed under the following conditions:
- No residential lots shall front onto a stub street.
- Non-residential lots adjacent to a stub street shall have access to another street.
- If the length of a residential stub street exceeds the depth of the adjacent residential lots, it shall be temporarily blocked at the rear edge of the lots (or alley) with barrel-mounted barricade.
- If a non-residential stub street extends more than one hundred feet (100') beyond the last driveway on the street, it shall be temporarily blocked at the last driveway with barrel-mounted barricade.

e. A stub street shall have a permanent Type III barricade installed at its terminus. A residential stub street shall also have a 24"x30" sign prominently posted at its terminus with black letters on a white background that state, "NOTICE – This street will be extended as part of a future development." The installation and cost of these barricades and signs shall be the responsibility of the developer.

C. Minimum Horizontal Design Radius

1. The minimum centerline radius is a function of design speed, superelevation, and the vehicle side friction factor. Side friction is the force that keeps a vehicle from sliding off of the roadway.

2. The minimum horizontal radii are shown in Table 8.2 and are in accordance with the guidelines in AASHTO's 2011 edition of A Policy on Geometric Design of Highways and Streets.

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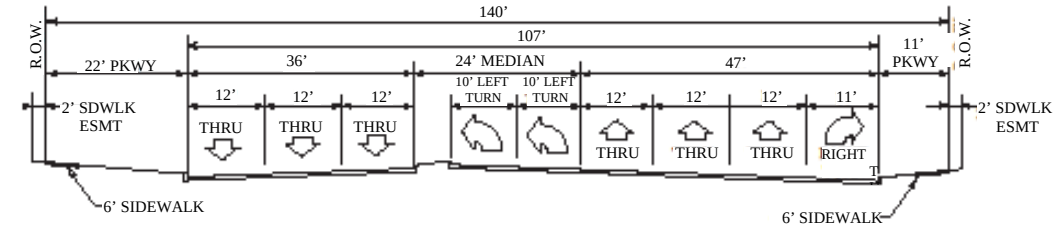
TABLE 8.1: General Roadway Design Criteria

Criteria	Thoroughfare Class				
	Major Type A	Minor Type B	Commercial Collector Type C	Local Type D	Local Type E
Right-of-Way (ROW)	120'(1)	90'(2)	60'	60'	50'
Pavement Width (face to face)	36' in each direction	24' in each direction	36'	36'	30'
Traffic Lanes	6	4	2	2	2
Left Turn-lane Width	2 @ 10'	1 @ 11'	N.A.	N.A.	N.A.
Right Turn-lane Width	11'	11'	N.A.	N.A.	N.A.
Median Width	24'	18'	N.A.	N.A.	N.A.
Parkway Width	12'	12'	12'	12'	10'
Design Speed, V (MPH)	45	45	30	30	25
Minimum Grade	0.5%	0.5%	0.5%	0.5%	0.5%
Maximum Grade	6%	6%	6%	6%	6%
Min. Horizontal Radii	See Table 8.2				
Min. Tangent Between Curves	100'	100'	100'	100'	N.A.
Min Length of Vertical Curve	See Table 8.3 and Table 8.4				
Stopping Sight Distance	425'	360'	200'	200'	155'
Parking	Prohibited	Prohibited	Prohibited	Allowed	Allowed
Volume Range (VPD)	36-45,000	20-28,000	12-18,000	6-12,000	N.A.

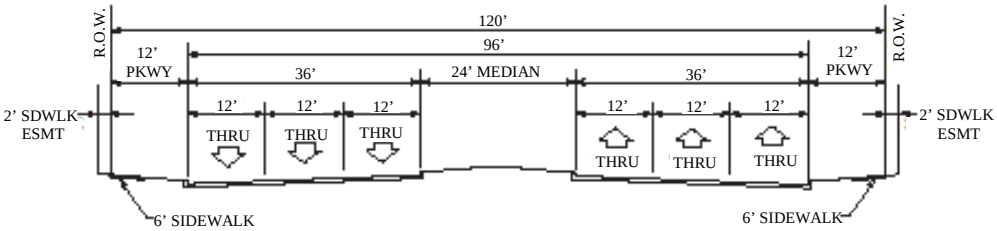
(1) 140' or 160' ROW at intersections (See Figures 8.2 and 8.4)
(2) 110' or 120' ROW at intersections (See Figures 8.3 and 8.5)

FIGURE 8.1: Typical Cross Sections

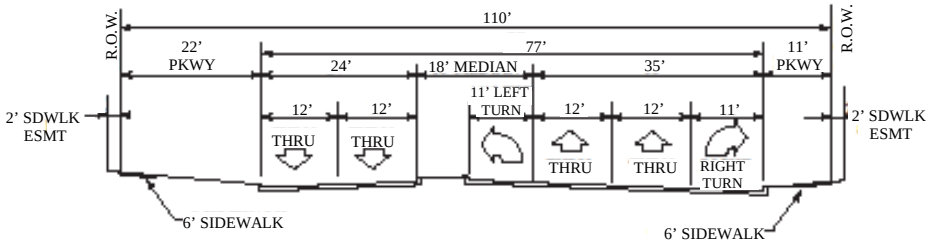
Major Collector Type A (Intersection)



Major Collector Type A (Midblock)



Minor Collector Type B (Intersection)



Minor Collector Type B (Midblock)

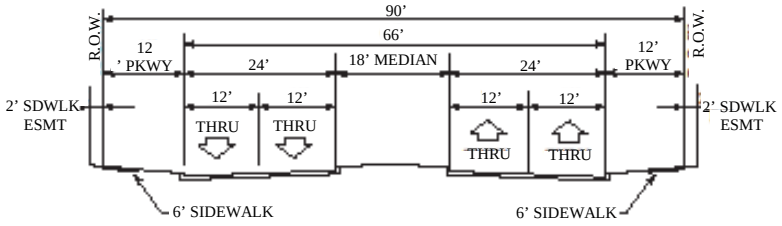
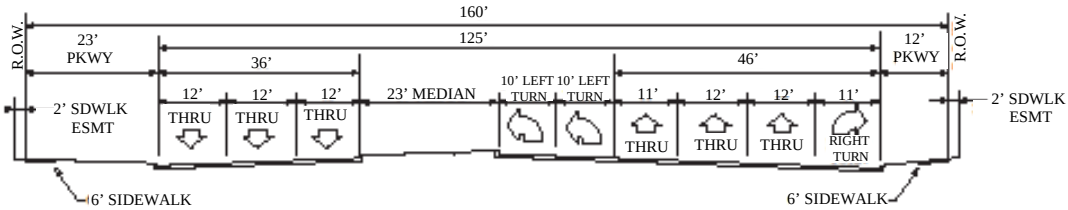
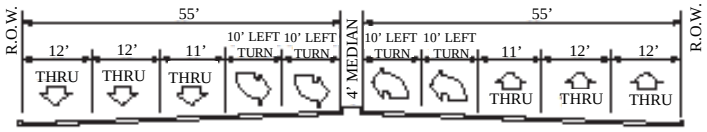


FIGURE 8.1 (Cont): Typical Cross Sections

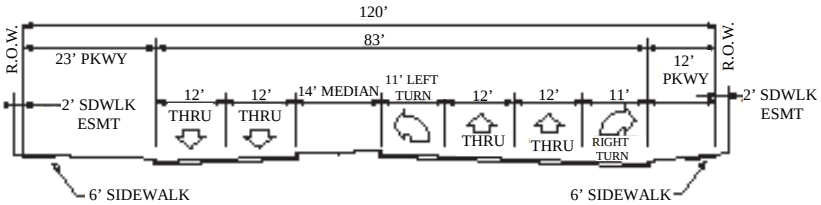
Major Collector Type A (At Frontage Road)



Major Collector Type A (Between Frontage Roads)



Minor Collector Type B (At Frontage Roads)



Minor Collector Type B (Between Frontage Roads)

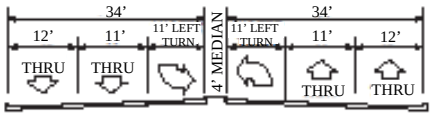
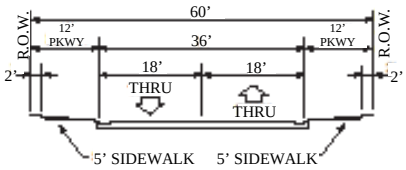
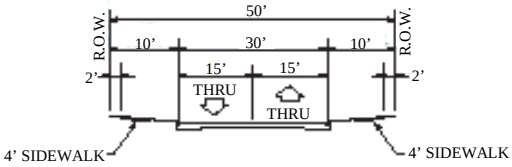


FIGURE 8.1 (Cont): Typical Cross Sections

Commercial Collector Type C and Local Type D



Local Type E



Residential Collector

Use the cross-section of Type D

Divided Residential Subdivision Entrance

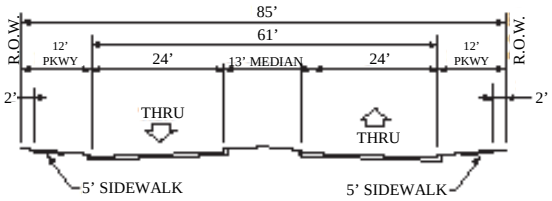


TABLE 8.2: Minimum Horizontal Centerline Radius

Design Speed, V (MPH)	Friction Factor, F	Superelevation, e (ft/ft)	Radius, R (ft) (Rounded for Design)
25	0.23	-0.02	250(1)
30	0.20	-0.02	350
35	0.18	-0.02	525
40	0.16	-0.02	775
45	0.15	-0.02	1100
50	0.14	-0.02	1400

(1) May be reduced to two hundred feet (200') radius at mid-block locations provided that it is shown that the general public safety is not compromised (e.g., stopping sight distance). A curve, with a radius less than two hundred fifty feet (250') must be a minimum of three hundred feet (300') from a street or alley intersection.

D. Minimum Vertical Alignment

1. Vertical curves are utilized in roadway design to affect gradual change between tangent grades and will result in a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide Stopping Sight Distance (SSD) in all cases. SSD is a function of design speed, perception-reaction time, and deceleration rate. The perception-reaction time is assumed to be 2.5 seconds and is in accordance with the guidelines in AASHTO's 2011 edition of A Policy on Geometric Design of Highways and Streets. The equation for SSD appears below:

$$SSD = 1.47Vt + 1.075\frac{V^2}{a}$$

$SSD =$ stopping Sight Distance (ft)
$t =$ brake reaction time (2.5 sec.);
$V =$ vehicle design speed (MPH); and
$a =$ deceleration rate, (11.2 ft/s^2)

2. To determine the minimum acceptable length of Crest and Sag curves shown in Tables 8.3 and 8.4, it is assumed that approach grades are between -3% and 3% in the SSD calculation. The SSD for grades steeper than -3 % or 3% shall be in accordance with the guidelines in AASHTO's current A Policy on Geometric Design of Highways and Streets. Tables 8.3 and 8.4 also show values of K. K is defined as the rate of vertical curvature and is equivalent to the horizontal distance in feet required to make a one percent (1%) change in grade. The values of A are equivalent to the algebraic difference in grade between the two grades that are being joined together by the vertical curve.

TABLE 8.3: Minimum Acceptable Crest Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft)	K	Length of Vertical Curve (L=KA)									
			A=1.6	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	12	50	50	50	50	60	80	90	100	110	120
30	200	19	50	50	60	80	100	120	140	160	180	190
35	250	29	50	60	90	120	150	180	210	240	270	290
40	305	44	70	90	140	180	220	270	310	360	400	440
45	360	61	100	130	190	250	310	370	430	490	550	610
50	425	84	140	170	260	340	420	510	590	680	760	840

TABLE 8.4: Minimum Acceptable Sag Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft)	K	Length of Vertical Curve (L=KA)									
			A=1.6	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	26	50	60	80	110	130	160	190	210	240	260
30	200	37	60	80	120	150	190	230	260	300	340	370
35	250	49	80	100	150	200	250	300	350	400	450	490
40	305	64	110	140	200	260	320	390	450	520	580	640
45	360	79	130	160	240	320	400	480	560	640	720	790
50	425	96	160	200	290	390	480	580	680	770	870	960

E. Standard Intersection Layout

1. Street intersections shall intersect at ninety degree (90º) angles. Intersection approaches for Type A and B thoroughfares shall remain perpendicular for a minimum distance equal to the corresponding design speed Stopping Sight Distance (SSD) identified in Table 8.1. For residential collector and/or local street intersections, up to a five degree (5º) tolerance is allowable .

2. When the classification of a thoroughfare changes as it crosses an intersecting street, the design of both thoroughfare approaches shall maintain the characteristics of the higher class thoroughfare.

3. The through lane(s) on one approach shall align with the receiving lane(s) on the other side of the intersection. If pre-existing physical encroachments make an offset necessary, a through lane can be offset no more than six feet (6') from its receiving lane when crossing a Type B or smaller thoroughfare and offset no more than eight feet (8') when crossing a Type A thoroughfare. These requirements apply to both public street and private driveway approaches to an intersection.

4. The curb radii shall be a minimum of thirty feet (30') where Type D and E thoroughfares intersect with Type D and E thoroughfares. The curb radii shall be a minimum of forty feet (40') where Type A, B, and C thoroughfares intersect with Type A and B thoroughfares. The curb radii at all other

intersecting streets shall be a minimum of thirty feet (30'). Larger curb radii may be required to accommodate fire trucks and/or commercial trucks.

5. Type A-A, A-B, and B-B intersections shall maintain a maximum slope of two percent (2%) a minimum distance of two hundred feet (200') upstream and downstream of the intersection.

6. Roadway connections to a Type A or B thoroughfare shall maintain a maximum slope of two percent (2%) a minimum distance of one hundred feet (100') upstream and downstream of the intersection.

7. A separate grading plan shall be provided for Type A-A, A-B, and B-B intersections. Grading plans shall account for future extensions of Type A and Type B thoroughfares for a minimum distance of six hundred feet (600') beyond the curb return of the intersection in all directions.

8. At four-way intersections of parabolic streets, the reduction of the crown height shall occur on the thoroughfare with the through gutter.

    a. For Type C and D thoroughfares, the crown height reduction from six inches (6") to three inches (3") shall occur through the intersection and transition from the curb return to a point fifty feet (50') past the curb return.

    b. For Type E thoroughfares, the crown height reduction from four inches (4") to two inches (2") shall occur through the intersection and transition from curb return to a point thirty feet (30') past the curb return.

9. A minimum of nine and a half feet (9.5') of parkway shall be maintained from the back of the curb along the curb's radius .

10. ROW width for a Type A thoroughfare that intersects a Type A or Type B thoroughfare shall be one hundred forty feet (140') for a distance of two hundred feet (200') and then taper at a 15:1 ratio to the standard ROW width. See Figure 8.2.

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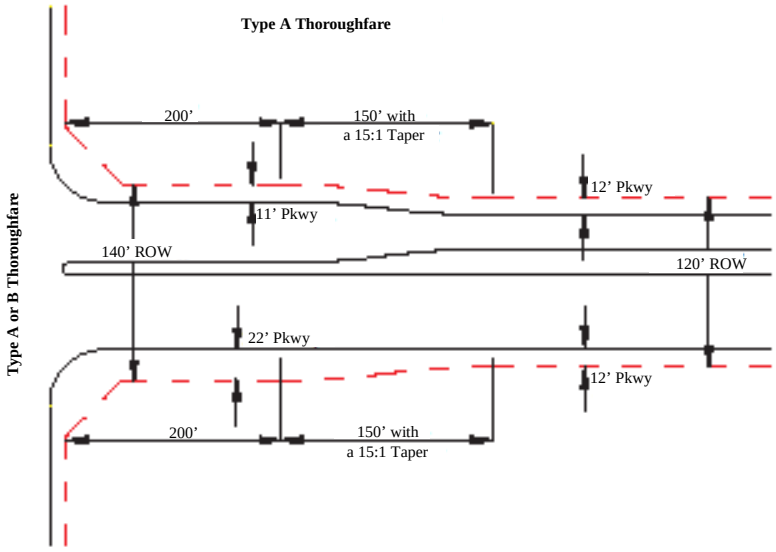
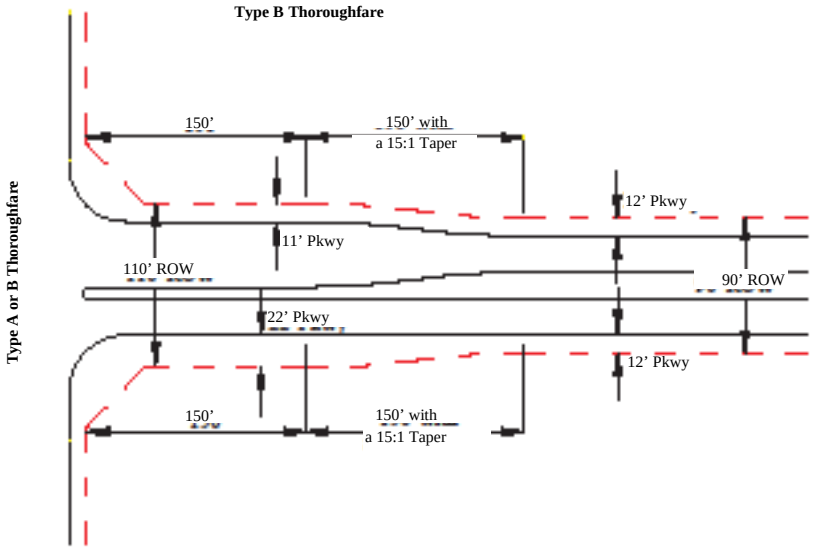
FIGURE 8.2: Type A Thoroughfare Intersection Detail



11. ROW width for a Type B thoroughfare that intersects a Type A or Type B thoroughfare shall be one hundred ten feet (110') for a distance of one hundred fifty feet (150') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figure 8.3.

FIGURE 8.3: Type B Thoroughfare Intersection Detail



12. The ROW width for a Type A thoroughfare that intersects with a pair of highway frontage roads shall be one hundred sixty feet (160') for a distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figure 8.4.

The ROW width for a Type B thoroughfare that intersects with a pair of highway frontage roads shall be one hundred twenty feet (120') for a

distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build out of the intersection. See Figures 8.4 and 8.5.

FIGURE 8.4: Type A Thoroughfare Intersection with Frontage Road

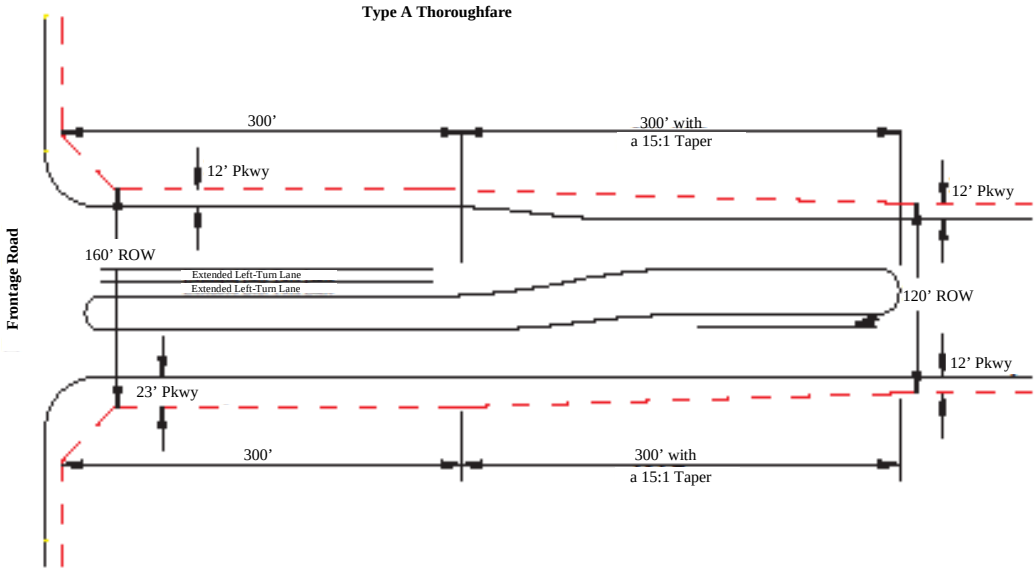
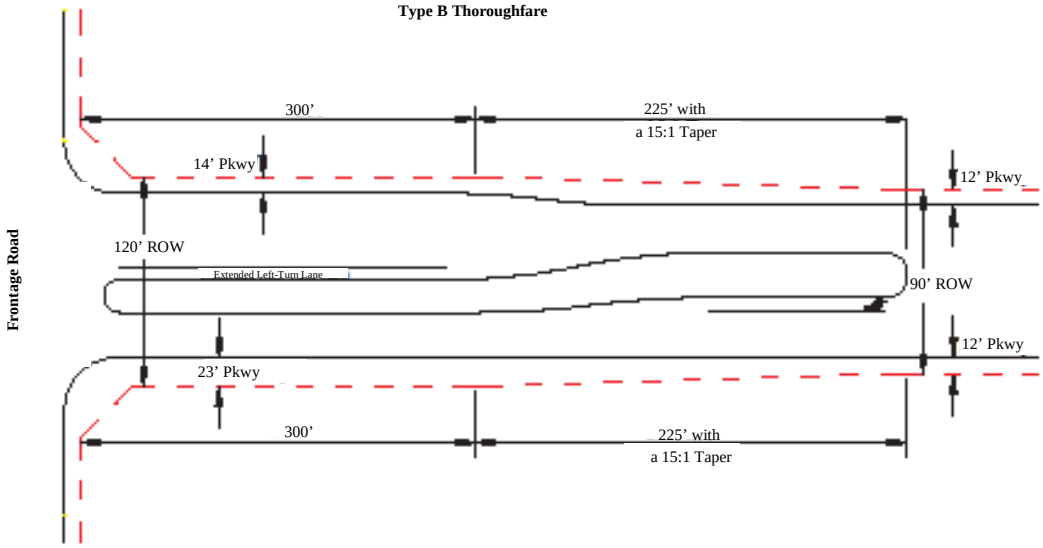


FIGURE 8.5: Type B Thoroughfare Intersection with Frontage Road



F. Roundabouts

1. Roundabouts may be considered for the intersection of Type B, C, D, or E thoroughfares with Type C, D, or E thoroughfares. Roundabouts shall not be installed at a Type A-A, A-B, or B-B intersection without a detailed traffic simulation and cost-benefit analysis approved by the City Engineer Services. Roundabouts shall not be installed along a six-lane Type A thoroughfare.

2. Roundabouts on private property that connect to a private street or to a fire lane shall be designed to the standards in these design requirements.

3. Roundabouts shall be designed to accommodate a City fire truck making all possible entry and exit movements. A fire truck shall be able to make the "through" movement without traveling on a truck apron.

4. Roundabouts shall include the typical features of a modern roundabout shown in Figure 8.6 and described in these design requirements.

5. The curb surrounding the central island shall be six inch (6") vertical curb if a truck apron is provided and six inch (6") mountable curb if no truck apron is provided. The curb surrounding a truck apron shall be three inch (3") mountable curb. The curb surrounding all faces of each splitter island shall be four inch (4") mountable curb.

6. The inscribed circle radius shall be a minimum of fifty five feet (55') and a maximum of eighty feet (80') for a single lane roundabout, and a minimum of seventy-five feet (75') and a maximum of a hundred feet (100') for a two-lane roundabout.

7. The circulatory roadway shall have a minimum width of sixteen feet (16'), face-to-face. The circulatory roadway shall be at least as wide as the maximum entry width at the roundabout. If the circulatory roadway is less than twenty nine feet (29') wide, face-to-face, a truck apron shall be provided. The combined width of the circulatory roadway and the truck apron shall be a minimum of twenty nine feet (29'). Truck aprons shall provide a solid surface of concrete pavers that are a contrasting color compared to the pavement of the circulatory roadway and shall not give the appearance of being a sidewalk.

8. Single lane entries and exits shall be a minimum of sixteen feet (16') wide, face to face. Two-lane entries and exits shall be a minimum of twenty four feet (24') wide, face to face.

9. Splitter islands shall provide a solid surface of concrete pavers unless the entry and exit on the same leg of the roundabout are both at least twenty four feet (24') wide, face-to-face. The pavers shall be a contrasting color compared to the street pavement and no signs shall be installed in the splitter island. If pavers are not required, the splitter island can contain landscaping provided it does not interfere with the necessary sight distance.

10. Crosswalks shall pass through or in advance of each splitter island.

11. All streets, fire lanes, and approved driveways shall intersect radially with a roundabout. Residential driveways shall not intersect with a roundabout.

12. Landscaping and/or monuments within the central island are encouraged, but shall be limited so that the minimum sight distances described in FHWA's Roundabouts: An Informational Guide are provided at the roundabout. For vehicles approaching the roundabout, this includes the approach stopping sight distance to the crosswalk or the yield line, the stopping sight distance to the crosswalk on the next exit, and the intersection sight distance to circulating vehicles and vehicles entering at the immediate upstream entry. For circulating vehicles, this includes the stopping sight distance on the circulatory roadway.

13. Parking is prohibited within a roundabout.

14. On any approach to a roundabout, driveways, alley connections, and on-street parking shall not be permitted between the crosswalk and the yield line nor along any portion of street that contains a splitter island.

15. The ROW for a roundabout shall extend a minimum of twelve feet (12') beyond the back of its outer curb. The ROW for any street entering the roundabout will flare out (15:1) as the street flares so that a minimum of twelve feet (12') is provided beyond the back of curb on each side of the street.

16. The roundabout entries and exits and the pavement contained within the inscribed circle radius shall be constructed on a uniform plane of the same grade, which shall not exceed two percent (2%). Roadway approaches to the roundabout shall have a maximum slope of two percent (2%) for a distance of at least two hundred feet (200') for Type B thoroughfares and at least one hundred feet (100') for Type C, D, and E thoroughfares .

17. Roundabouts shall be illuminated by street lights as described in FHWA's Roundabouts: An Informational Guide.

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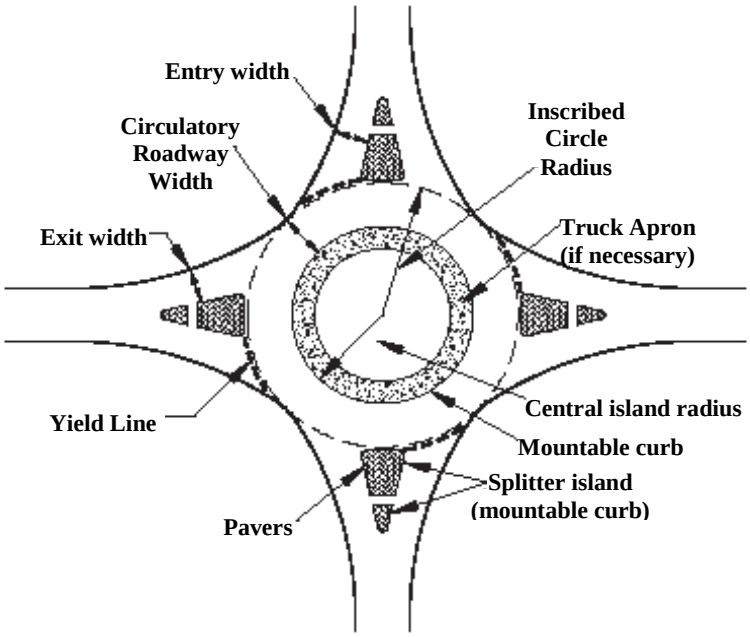
FIGURE 8.6: Typical Roundabout



G. Residential Frontage

1. Residential lots shall not front onto a Type A, B, or C thoroughfare or a residential collector unless parallel access roads are provided. The minimum distance between adjacent curbs of the thoroughfare and the access road shall be twenty feet (20'). Access road ROW shall be in addition to the thoroughfare ROW and access roads shall not connect to the adjacent thoroughfare.

2. Residential lots shall not front onto a Type D or E thoroughfare within one hundred feet (100') of the ROW line of the nearest Type A or B thoroughfare.

3. Residential lots shall not front onto any portion of a Type D or E thoroughfare that is part of a residential collector, which is a street that connects to a Type A or B thoroughfare and extends into a neighborhood for more than six hundred feet (600') without changing direction (see Section 8.2.I.5).

4. Residential lots shall not front onto a roundabout. Residential lots adjacent to roundabouts shall be oriented so that their houses do not face the roundabout and their driveways do not intersect with the roundabout or along any section of street with a splitter island.

H. Partial Streets

1. Longitudinal partial dedications of Type A and B thoroughfares shall be permitted when only one side of a future thoroughfare is being developed. In such a case, one-half of the total right of way shall be dedicated and a minimum of twenty four feet (24') of pavement, face- to-face, shall be constructed .

2. Longitudinal partial dedications of Type C, D, or E thoroughfares shall be prohibited, except when essential to the reasonable development of a property in conforming with the requirements of the Subdivision Ordinance, and where the Planning & Zoning Commission finds that it will be practical to require the dedication of the other portion of the street when the adjoining property is developed. Whenever a partial street exists along a common property line, the other portion of the street shall be dedicated when the adjoining property is subdivided or developed. Where a partial street is being dedicated along a common property line and the ultimate planned ROW width is sixty feet (60'), the first ROW dedication will be thirty-five feet (35').

   a. The developer shall construct a minimum of twenty four feet (24') of pavement, face-to- face, for all Type C or D thoroughfares that are partial streets at the time of development.

   b. The developer shall construct the full width of pavement face-to-face for all Type E thoroughfares that are partial street dedications at the time of development.

I. Street Lengths

1. Type A, B, and C thoroughfares have no street length restrictions. Residential streets (Type D and E thoroughfares in a single-family, duplex, or townhome neighborhood) shall have street length restrictions to discourage speeding and cut-through traffic.

2. A residential street that intersects with a Type A or Type B thoroughfare and has residential lots fronting any portion of the street shall not exceed a maximum length of six hundred feet (600') measured from the Type A or Type B thoroughfare ROW line.

3. Residential streets that do not intersect with a Type A or Type B thoroughfare shall not exceed one thousand two hundred feet (1,200') in length before changing direction. A change in direction occurs when one of the following elements is used:

   a. A horizontal curve radius of three hundred fifty feet (350') for a Type D thoroughfare or of two hundred fifty feet (250') for a Type E thoroughfare that changes the course of the street between ninety (90°) and one hundred twenty degrees (120°) (see Figure 8.8). A tangent that is a minimum of one hundred feet (100') long shall be provided between reverse curves.

   b. A street offset using two elbow intersections, each between ninety (90°) and one hundred twenty degrees (120°). The minimum distance between reverse elbows shall be one hundred fifty feet (150'). See Figure 8.8.

FIGURE 8.7: Change in Street Direction: Curve

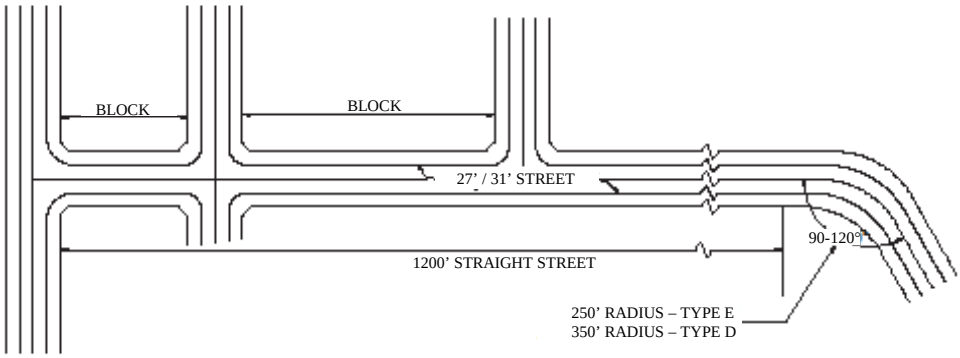
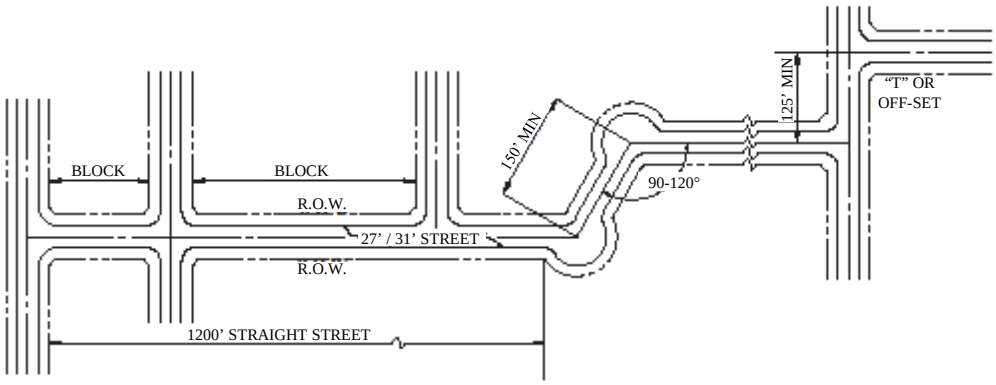


FIGURE 8.8: Change in Street Direction: Offset



4. Residential streets that do not intersect with a Type A or B thoroughfare may extend to a length of one thousand two hundred feet (1,200') without a change in direction when one of the following is provided:

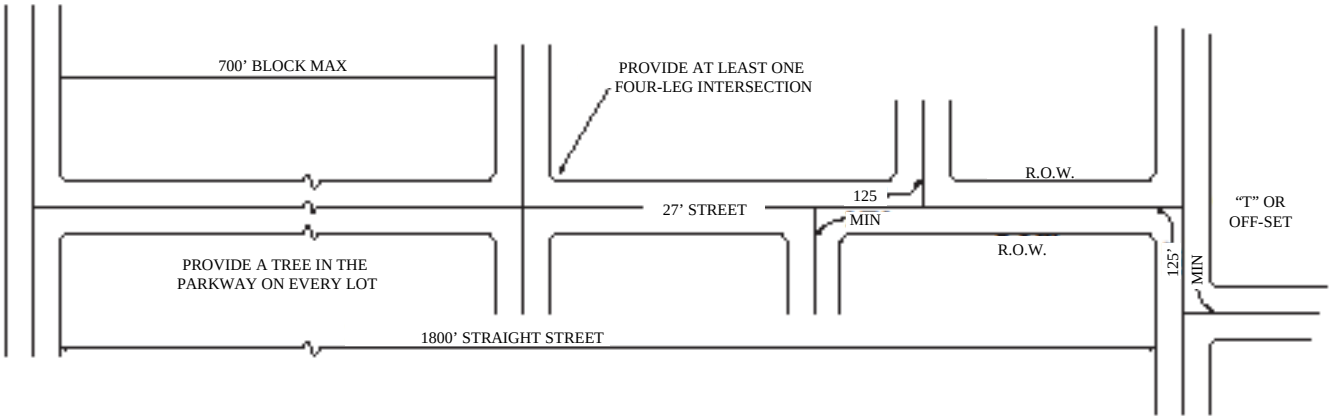
   a. A Type E residential street with street trees, block lengths that do not exceed seven hundred feet (700'), and at least one four-leg intersection. See Figure 8.9.

   b. A roundabout installed at one or more of the intersections along the street, not counting a roundabout installed at the start or end point of the street.

5. A residential collector shall have no street length restriction provided that no residential lots front onto any part of the collector and the collector shall not have any straight sections exceeding one thousand feet (1,000'). A residential collector is a street that connects to a Type A or B thoroughfare and extends into a neighborhood for more than six hundred feet (600') without changing

direction. A residential collector shall be constructed with the cross section of a Type D thoroughfare.

FIGURE 8.9: Maximum Street Length: Short Blocks, Trees and a Four-Leg Intersection



J. Block Requirements

1. Block Length – Blocks shall not exceed one thousand two hundred feet (1,200') in length, measured from street ROW line to street ROW line. In the case of non-rectangular blocks, each side of the block with lots fronting it shall not exceed one thousand two hundred feet (1,200'), measured between the vertices formed by the extension of ROW lines at each corner of the block. Blocks shall be further restricted so that they shall contain no more than twenty (20) lots on one side. Blocks with a continuous series of lots longer than one thousand two hundred feet (1,200'), measured along one or more sides, may be required to be bisected by a pedestrian easement and a sidewalk (see Section 8.6) .

2. Block Width – Blocks shall be wide enough to allow two (2) tiers of lots and shall have a block width no less than two hundred feet (200'), except when only one tier of lots is possible due to the size of the property or the need to back up to a Type A or B thoroughfare.

8.3 Median, Left-Turn Lane, Right-Turn Lane, Deceleration Lane, and Island Design

A. Required Median Openings and Left-Turn Lanes

1. Median openings on divided thoroughfares shall be required at all street intersections. Median openings may be constructed to serve non-residential drives provided that the minimum spacing requirements herein are met. Left-turn lanes are required for each street or driveway that connects to a median opening. The design of median openings and left-turn lanes shall accommodate potential future left-turn lanes that might serve undeveloped land.

2. All non-residential lots on a divided thoroughfare shall have direct or indirect access to a median opening. Indirect access shall be provided through a series of fire lane and access easements.

3. Multi-family developments on a divided thoroughfare shall have direct access to a median opening.

4. The City can modify, relocate, or remove any existing or planned median opening to facilitate traffic flow and/or preserve the health, safety and welfare of the Public, as reasonably determined by the City Engineer utilizing recognized industry standards as they exist, may be amended, or in the future arising.

B. Minimum Left-Turn Storage, Taper Length, and Median Opening Width, Location, and Spacing Requirements

1. Left-Turn Lane Storage

a. All single left-turn lanes constructed on divided thoroughfares of ultimate cross section width shall be a minimum of eleven feet (11') wide. Where double left-turn lanes are provided, each left-turn lane shall be a minimum of ten feet (10') wide.

b. All left-turn lanes constructed as future through lanes on divided thoroughfares shall be twelve feet (12') wide for the entire storage and taper length requirements as listed in Table 8.5.

c. Minimum storage requirements are listed in Table 8.5. Storage requirements may be increased by the City based upon actual and projected traffic demands of the properties that will be served by the left-turn lane.

d. Left-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.

e. Concrete pavers shall be required in the median where the median width is six feet (6') or less, back of curb to back of curb. If the median width is greater than six feet (6'), then concrete pavers shall be required for a minimum distance of ten feet (10') from the median nose. See Figure 8.11.

2. Taper Length – The taper specifications for left-turn lane entrance areas are specified in Table 8.5. The variables used for the specifications are shown in Figure 8.10.

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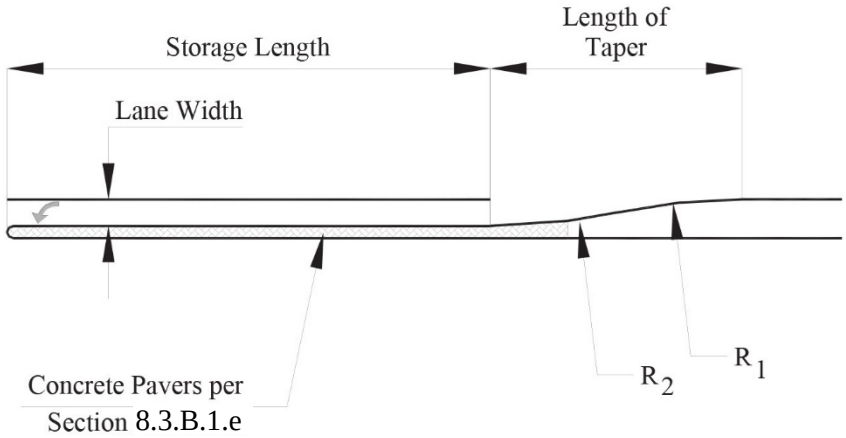
TABLE 8.5: Minimum Left-Turn Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width(s) (ft)	Length of Full-Width Storage(ft)	Taper Specifications		
				Length(ft)	R_1(ft)	R_2(ft)
A	A, B	10[1][4]	150,250[2]	200	505	505
B	A, B	11	150	100	250	250
A, B	C, Residential Collector	11[4]	150	100	250	250
A, B	D, E	11[4]	100[3]	100	250	250
A, B	Non-Residential Driveway	11[4]	150	100	250	250
TxDOT Road	A,B,C,D,E, and Non-Residential Driveway	See TxDOT's *Roadway Design Guide* and Specifications[5]				
Frontage Road	A,B,C,D,E, and Non-Residential Driveway	Apply TxDOT specifications to US 75				

1. Double left-turn lanes
2. 150 feet for the inside left-turn lane; 250 feet for the outside left-turn lane
3. 150 feet of storage shall be required for gated communities.
4. Left-turn lanes that will become a future through lane shall be twelve feet (12') in width and be square at the end and incorporate a street header.
5. Turn lane designs on Preston Road (SH 289) shall also meet the requirements set forth in the Preston Corridor Access Management Plan.

FIGURE 8.10: Typical Left Turn Lane Dimensions



3. Median Openings

   a. Median openings shall accommodate all turning paths and crosswalks.

   b. The width of mid-block median openings shall not be less than sixty feet (60'). They may be greater than sixty feet (60') where necessary to accommodate turning paths and crosswalks subject to approval by the City Engineer.

   c. Median openings shall not be less than seventy feet (70') wide at divided high capacity driveways.

4. The minimum distance to the first mid-block median opening along a Type A or B thoroughfare that is immediately downstream from a Type A or B thoroughfare is shown in Figure 8.12. This distance varies from three hundred fifty feet (350') to six hundred feet (600'), measured nose to nose, depending on the thoroughfare type and the type of mid-block opening.

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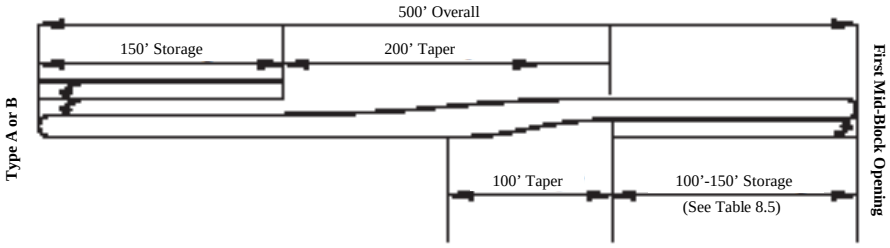
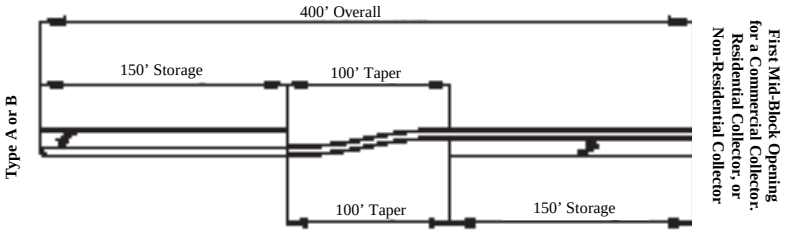
FIGURE 8.11: Minimum Spacing between Type A or B Thoroughfares and First Mid-Block Median Opening on a Type A or B Thoroughfare

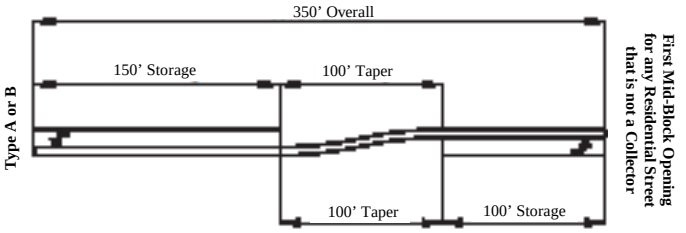
Type A Thoroughfare



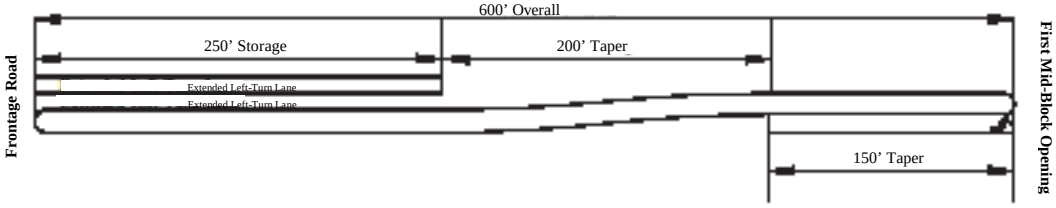
Type B Thoroughfare



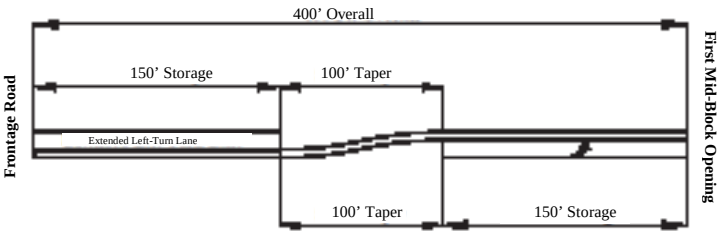
Type B Thoroughfare



Type A Thoroughfare

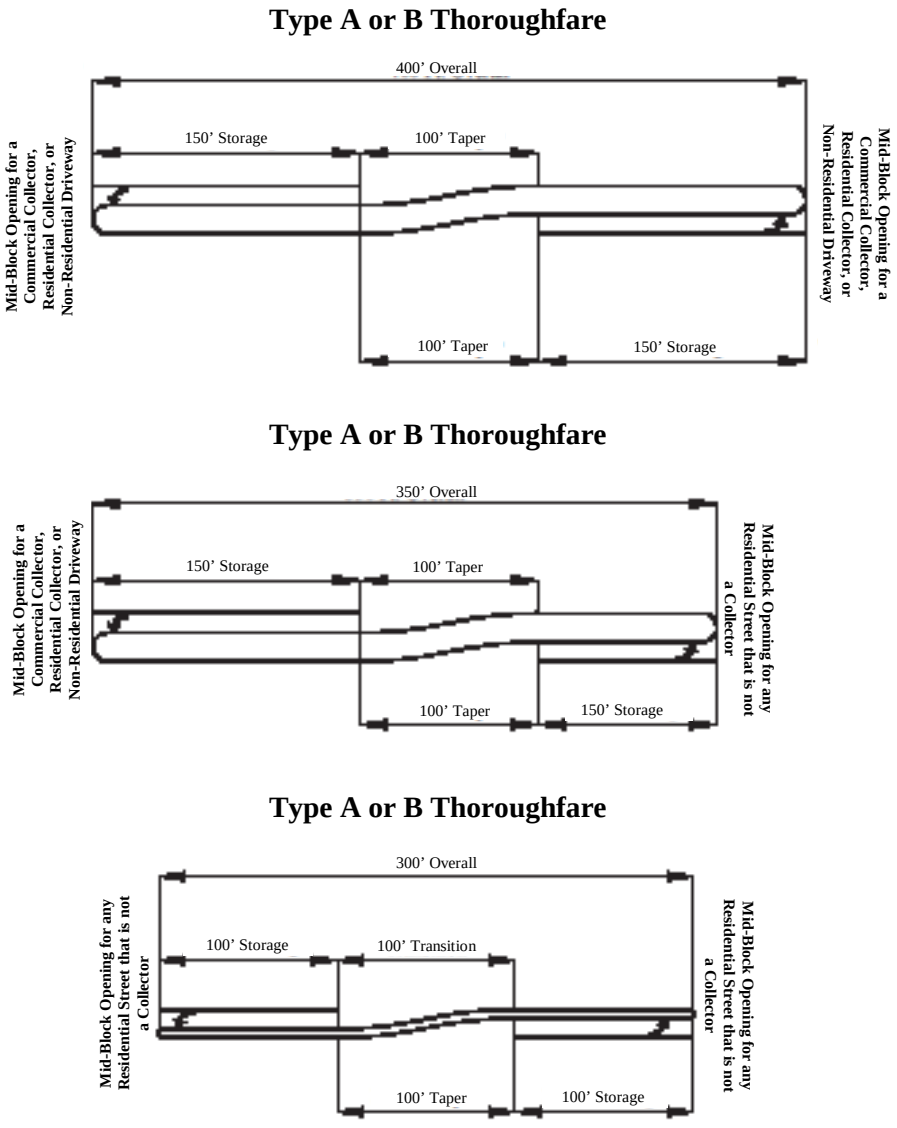


Type B Thoroughfare



5. The minimum distance between median openings on a Type A or B thoroughfare where left- turn storage is provided in both directions for Types C, D, and E intersecting thoroughfares and driveways is shown in Figure 8.12. The distances shown are measured nose to nose. Refer to Table 8.11 for driveway design requirements.

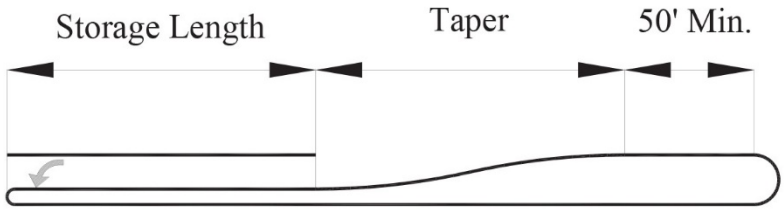
FIGURE 8.12: Minimum Distance between Mid-Block Median Openings on a Type A or B Thoroughfare



6. Medians without Left-Turn Lanes in Both Directions

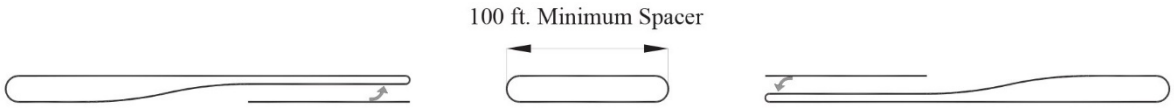
   a. If a left-turn lane is required in only one direction, the minimum length of the median shall be the sum of the required left-turn storage, taper length, fifty foot (50') tangent, and length of median nose. This requirement is reflected in Figure 8.13. This median design is only allowed if access is not compromised for vacant property on the opposite side of the thoroughfare.

FIGURE 8.13: Minimum Length of Median Where A Left-Turn Lane is Needed in Only One Direction



b. If the left-turn storage is not required in either direction, but the median is simply a spacer between two median openings, the minimum length of the spacer must be one hundred feet (100') (see Figure 8.14). A minimum spacing of one hundred feet (100') from the median opening to the first non-residential driveway shall be maintained.

FIGURE 8.14: Minimum Spacer Length



c. If a driveway is not served by a left-turn lane, then seventy-five feet (75') of separation shall be provided from edge of driveway to the median opening.

7. Medians on Public Street Entrances to Developments

a. Medians installed on undivided thoroughfares at entrances to subdivisions for aesthetics or any other purpose shall be a minimum of thirteen feet (13') wide and one hundred feet (100') long (see Figure 8.1 for Divided Residential Subdivision Entrance cross section).

b. A divided residential subdivision entrance shall transition to the normal residential street width upstream or downstream of the first street intersection. No part of the transition shall occur within an intersection.

c. If specified by zoning, alternative design standards may be required for these types of subdivision entrances.

C. Minimum Right-Turn Storage and Taper Length

1. Right-Turn Lane Storage

a. At all intersections on Type A and B thoroughfares, right-turn lanes shall be constructed at the time of development.

b. All right-turn storage areas shall be eleven feet (11') wide.

c. Additional ROW shall be required adjacent to right-turn lanes so that there is a minimum of ten feet (10') of ROW from the back of curb.

d. Right-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.

e. Minimum storage requirements are listed in Table 8.6. Storage requirements may increase based upon actual and projected traffic demands.

f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveway or cross street curb return and the taper of a right-turn lane.

2. Taper Length – The taper specifications for right-turn lane entrance areas are specified in Table 8.6. The variables used for the specification are shown in Figure 8.15.

3. Driveways shall not be allowed within 100' of an intersection along a right turn lane.

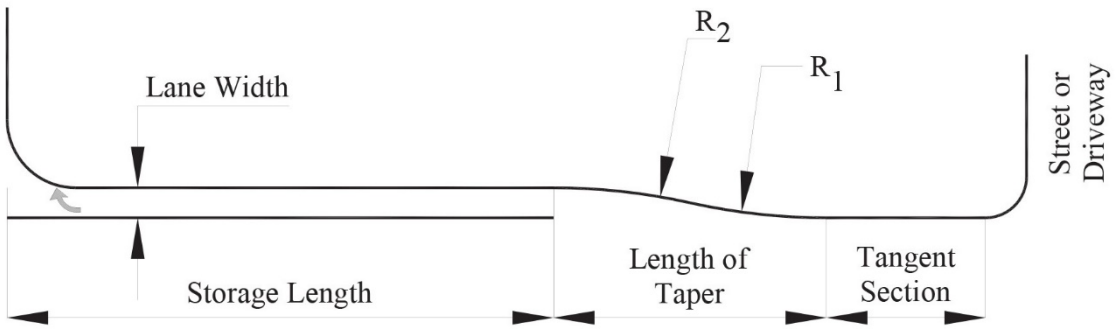
4. Driveways shall not be allowed within the taper section of a right turn lane.

TABLE 8.6: Minimum Right-Turn Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width(s) (ft)	Length of Full-Width Storage(ft)[1]	Taper Specifications[2]		
				Length(ft)	R_1(ft)	R_2(ft)
A	A, B	11	225	150	515	515
B	A, B	11	175	150	515	515
A, B	C, Residential Collector	11	150	110	280	280
A, B	D, E	11	100	110	280	280
TxDOT Road	A,B,C,D,E	See TxDOT's *Roadway Design Guide* and Specifications				
Frontage Road	A,B,C,D,E	Apply Type A Thoroughfare specifications to Dallas Pkwy Apply TxDOT specifications to SH 121 and US 380				

1. Measured from the intersecting thoroughfare face of curb.
2. No driveways are permitted within the taper area.

FIGURE 8.15: Typical Right-Turn / Deceleration Lane Dimensions



D. Minimum Deceleration Lane Storage and Taper Length

1. Deceleration Lane Storage

a. Deceleration lanes may be required on Type A and B thoroughfares at all non-residential and multi-family driveways. City Engineer will determine if deceleration lane is needed.

b. All deceleration lane storage areas shall be eleven feet (11') wide.

c. In locations where there will be less than ten feet (10') of ROW adjacent to the deceleration lane, a street easement shall be dedicated such that the combination of ROW and street easement extends at least ten feet (10') from the back of curb of the deceleration lane. Street easements shall extend along the street a minimum of forty feet (40') beyond the far edge of the driveway to allow for utility connections.

d. Deceleration lanes will be delineated by using the City's current Pavement Markings and Markers standard details.

e. Minimum storage requirements are listed in Table 8.7. Storage requirements may increase based upon actual and projected traffic demands.

f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveway or cross street curb return and the taper of a deceleration lane.

g. A tangent section is not required when a deceleration lane is immediately downstream from an intersecting Type A or Type B thoroughfare.

2. Taper Length – The taper specifications for deceleration lane entrance areas are specified in Table 8.7. The variables used for the specification are shown in Figure 8.16.

TABLE 8.7: Minimum Deceleration Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width(s) (ft)	Length of Full-Width Storage(ft)[1]	Taper Specifications		
				Length(ft)	R_1(ft)	R_2(ft)
A	Non-Residential Driveway	11	110[2]	110[2]	280	280
B	Non-Residential Driveway	11	90	110[2]	280	280
TxDOT Road	Non-Residential Driveway	See TxDOT's *Roadway Design Guide* and Specifications				
Frontage Road	Non-Residential Driveway	Apply Type A Thoroughfare specifications to Dallas Pkwy Apply TxDOT specifications to SH 121 and US 380				

1. Measured from the edge of the driveway.
2. When a deceleration lane is immediately downstream from an intersecting Type A or B thoroughfare, its storage can be reduced to 100 feet and its taper can be reduced to 70 feet (see Figure 2.23)

E. Cost of Median Openings and Turn Lanes

1. Median openings, left-turn lanes, and right-turn lanes constructed for residential streets and/or subdivision entrances not referenced on the Thoroughfare Plan shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.

2. Median openings, left-turn lanes and deceleration lanes for multi-family and non-residential developments shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.

3. If median openings, left-turn lanes, deceleration lanes or right-turn lanes are not constructed at the time of development, the developer shall escrow funds for such future improvements prior to final acceptance. The escrow amount shall include all costs for engineering, inspection, and construction.

8.4 Alley Design

A. Alley Intersections

1. Alleys shall not intersect any Type A, B, or C thoroughfare nor any residential collector.

2. Alleys that are parallel to and share a common ROW line with a Type A, B, or C thoroughfare or a residential collector shall turn away from that thoroughfare not less than forty feet (40') or one subdivision lot width (whichever is greater) from the cross street ROW as shown in Figure 8.16.

3. Alleys shall intersect with a residential street so that the alley ROW line is not less than forty feet (40') or one subdivision lot width (whichever is greater) from the ROW of the nearest cross street as shown in Figure 8.16.

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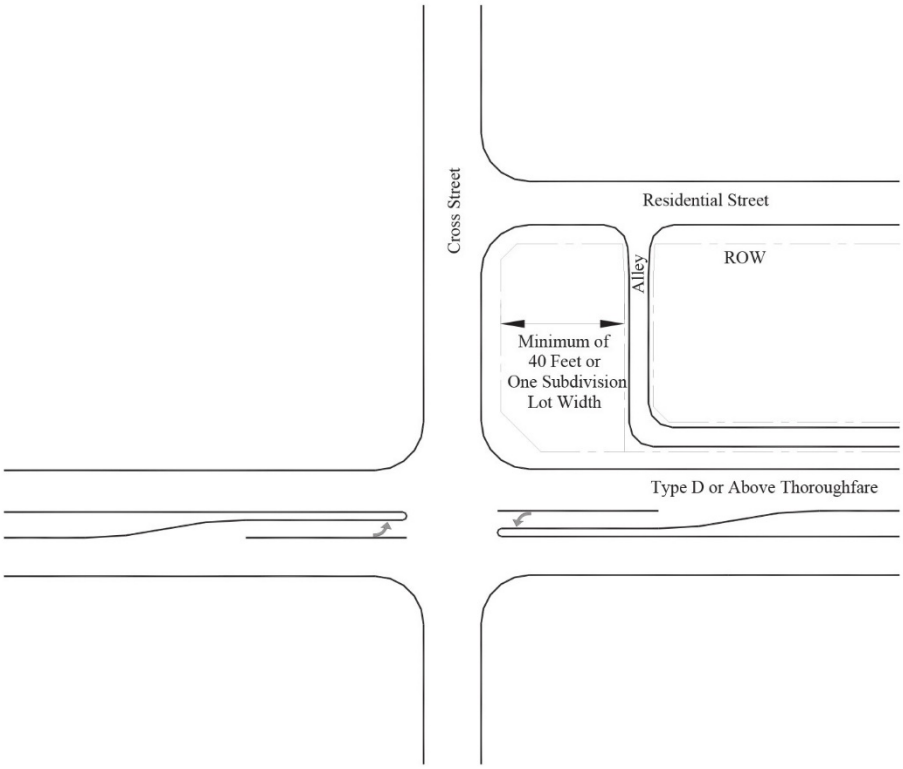
FIGURE 8.16: Minimum Distance from Intersection for Parallel Alley



4. All alley intersections with streets shall be perpendicular or radial, within a five degree (5°) tolerance, at the intersection of the ROW lines.

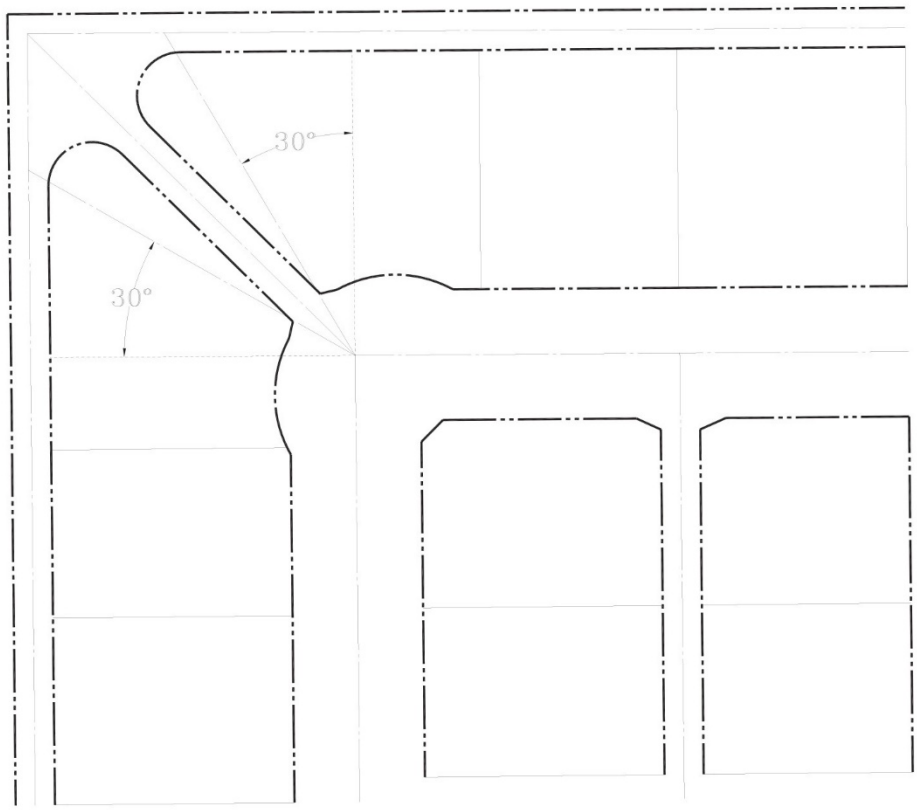
5. The offset between alleys on opposite sides of a residential street shall be less than three feet (3') or greater than seventy-five feet (75') measured from edge of alley to edge of alley.

6. Alleys shall not align with existing or future streets or driveways on the opposite side of a street. Alleys shall be offset from such a street or driveway by a minimum of seventy-five feet (75') measured from edge of alley to edge of street or driveway.

7. Alleys that intersect at "elbow" street intersections shall not intersect within thirty (30°) degrees of the centerline of the adjacent streets. See Figure 8.17.

8. Alleys shall not intersect with a roundabout.

FIGURE 8.17: Alley Intersecting an Elbow



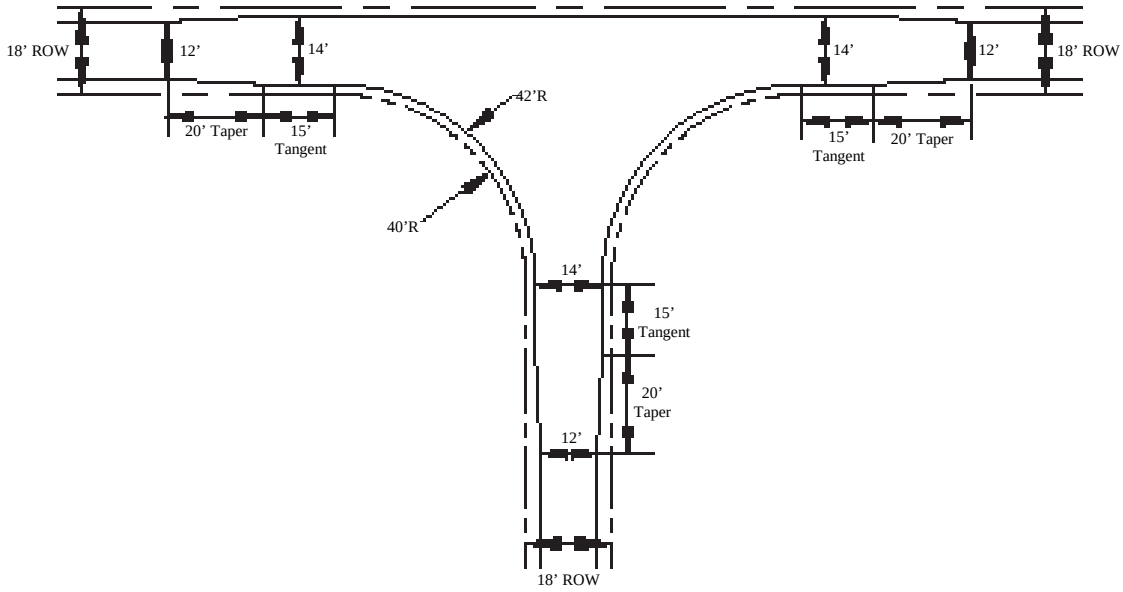
9. Internal alley intersections shall consist of no more than three alley approaches.

10. The offset between alleys on the opposite side of an intersecting alley shall be a minimum of one hundred feet (100') measured from centerline to centerline.

11. As an alley approaches an intersection with another alley, the pavement width shall increase to fourteen feet (14') using a taper twenty feet (20') long. The wider pavement shall be maintained for a distance of fifteen feet (15') prior to the radius of the intersection. Two feet (2') of parkway shall be maintained between the pavement and the ROW line at all times. See Figure 8.18.

12. No permanent dead end alley shall be permitted in new subdivisions. Alleys shall connect and/or be aligned with alleys in adjacent subdivisions.

FIGURE 8.18: Alley to Alley Intersection



13. The radius of alley pavement at street intersections shall not be less than fifteen feet (15'). At the intersection of two alleys, the radius of the alley ROW is dependent upon the alley ROW intersection angle as listed in Table 8.8. At the intersection of two alleys, the radius of the alley pavement shall be two feet (2') greater than the radius of the alley ROW.

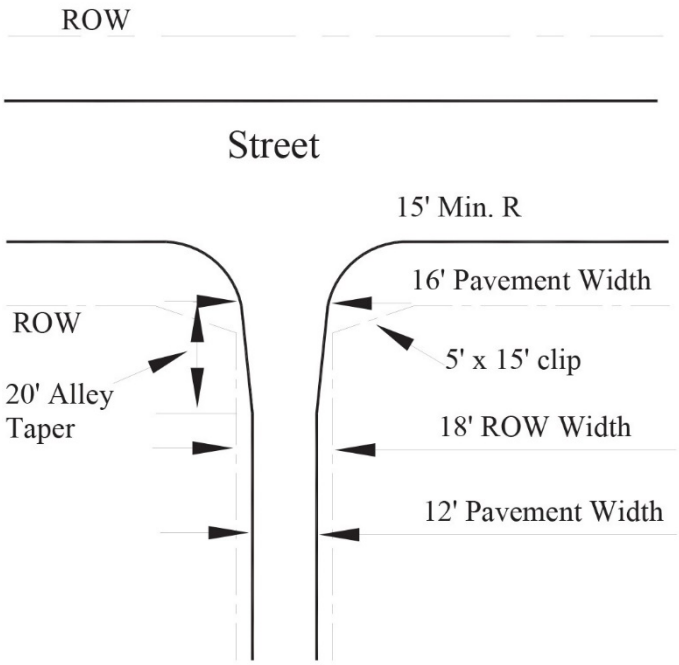
TABLE 8.8: Alley Intersecting Alley Radius

Alley ROW Intersection Angle	Minimum Required ROW Radius (ft)
1°-40°	70
41° -70°	50
71° -90°	40
> 90°	50

B. Alley ROW Width – Alley ROW shall be eighteen feet (18') wide in single family, town home, and two-family zoned areas. For multi-family and non-residential areas, the alley shall have a twenty foot (20') ROW.

C. Alley Pavement Width – Alley pavement shall be twelve feet (12') wide except near alley intersections, as shown in Figure 8.18, and except near street intersections as shown in Figure 8.19. Multi-family and non-residential alleys shall be a minimum of fifteen feet (15') wide.

FIGURE 8.19: Alley to Street Intersection



D. Alley Length – Alleys shall not exceed eight hundred feet (800') in length without an intermediate connection to a residential street.

E. Alley Pavement Thickness – See Section 8.13 of the CDM for alley subgrade and pavement design requirements.

F. Alley as Fire Lane – An alley that also serves the purpose of a fire lane shall be constructed to the standards of a fire lane as required by the Fire Department. These standards include, but are not limited to, a minimum pavement width of twenty four feet (24') and a minimum radius of alley pavement of twenty feet (20') at street intersections.

G. Rear Alley Frontage – The minimum alley rear frontage shall be twenty feet (20').

H. Alley Visibility Obstructions

1. No fence, wall, screen, sign, structure, landscaping rock greater than four inches (4") in height, or foliage of hedges, trees, bushes, or shrubs shall be erected, planted or maintained in any alley ROW.

2. Foliage of hedges, trees, bushes, and shrubs planted adjacent to the alley ROW shall be maintained by the property owner such that the overhang or encroachment shall be no less than fourteen feet (14') above the alley surface and no less than one foot (1') outside the edge of the pavement.

I. Alley Grade

1. Alleys shall have a maximum grade of six percent (6%). Steeper grades may be permitted where required by topographical and/or natural features, as approved by the City Engineer.

2. Alleys shall maintain a maximum cross-slope of two percent (2%) at the intersection of the adjacent sidewalk.

J. Vertical Curves in Alleys – Vertical curves in alleys shall be used in order to provide a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide stopping sight distance in all cases based on a design speed of 20 mph.

K. Alley Screening Walls – The area between screening walls and alleys (mow strip) shall be paved and graded to drain to the invert. The mow strip shall have a minimum thickness of six inches (6") and have #3 rebar 18" OC.

8.5 Driveway Design

A. Introduction – Driveway design standards are needed to provide safe and efficient vehicular access to and from the public street system, to provide public street capacity for accommodating peak traffic volumes of public streets, to maintain smooth traffic flow, and to maintain street ROW and drainage. The intent of driveway design standards is to achieve the following:

1. Prohibit the indiscriminate location and spacing of driveways while maintaining reasonable vehicular access to and from the public street system.

2. Reduce conflicting turning movements and congestion thereby reducing vehicular crashes.

B. Definition of Driveway Types

1. Residential Driveway – Provides access to a single-family residence, duplex, or multi-family building containing four or fewer dwelling units. Residential driveways shall intersect Type D and E thoroughfares only (according to the restrictions described below).

2. Non-Residential Driveway

a. Commercial Driveway – Provides direct access to an office, retail or institutional building, or multi-family building having more than four dwelling units. It is anticipated that such buildings will have incidental truck service. Commercial driveways shall typically access Type A, B, or C thoroughfares only, with a maximum of one (1) driveway accessing a residential collector. In the case of multi-family developments, the primary driveway shall access a Type A or B thoroughfare.

b. Industrial Driveway – Serves truck movements to and from loading areas of an industrial facility, manufacturing, warehouse, or truck terminal. A retail development may have one or more driveways specially designed, signed, and located to provide access for trucks, which shall be considered industrial driveways. Industrial plant driveways whose principle function is to serve administrative or employee parking lots shall be considered commercial driveways. Industrial drives shall access Type A, B, and C thoroughfares only.

3. Standard Driveway – Provides two-way access at a single, undivided curb opening. The minimum width of a standard driveway depends on land use and is shown in Table 8.9.

4. One-Way Driveway – Provides only inbound or outbound access and can only be permitted when the orientation of on-site circulation and parking layout clearly utilize the driveway for one-way movements. The minimum width for a one-way driveway depends on land use and is shown in Table 8.9.

5. High Capacity Driveways – Intended to provide two-way access with geometric provisions which more adequately respond to greater driveway volumes and/or access limitations than standard driveways. These provisions include increased width, increased internal storage and a median divider.

   a. Divided high capacity driveways are required at the first median opening downstream of a Type A-A, A-B, or B-B intersection.

   b. The primary multi-family driveway shall be a divided high capacity driveway at a median opening.

   c. Divided high capacity driveways are required on Type A or Type B thoroughfares when the number of parking spaces per driveway exceeds two hundred (200), except along a frontage road.

C. General Driveway Design Parameters

1. The centerline angle for a driveway approach shall be ninety degrees (90º) to the street curb line for all driveways.

2. Driveways shall not be permitted in the taper area of any right-turn lane or deceleration lane.

3. Driveways that intersect at a mid-block median opening shall have the driveway centerline intersect with the midpoint of the median opening (measured nose-to-nose).

4. Driveway connections can be required by the City Engineer to ensure adequate circulation.

5. Driveway elevations at the ROW line of a public street shall be a minimum of eight inches (8”) above the street gutter. A residential driveway that intersects an alley shall be a minimum of three inches (3”) above the edge of the alley pavement at the ROW line and shall be high enough to maintain gutter capacity.

6. Cross access is required between adjacent non-residential properties so that each property can share the use of the driveway(s) on the adjacent property. A shared driveway that is centered on the common property line is also encouraged. When one non-residential property develops before the adjacent property develops, the full width of the shared driveway shall be constructed at that time.

7. Driveway grades in a fire lane shall not exceed six percent (6%). Steeper grades may be permitted in areas where buildings are not present, as approved by the City Engineer and the Fire Department.

8. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.

9. Differential grades on driveways shall not exceed ten percent (10%).

10. Any sidewalk access across a driveway shall meet all state and federal ADA requirements for accessibility.

11. Residential driveways shall be prohibited:

    a. Along a Type D or E thoroughfare within one hundred feet (100') of an intersection with a Type A or Type B thoroughfare measured from the ROW line.

    b. Along any part of a Type A, B, or C thoroughfare or a residential collector.

12. Residential driveways shall provide access to an alley or an eligible public street according to the following restrictions:

    a. A residential lot shall be allowed a maximum of one (1) driveway onto a public street, except in the case of a circular driveway approved by the City Manager.

    b. A residential driveway that provides access to a garage shall connect to an alley or a residential street that is at least thirty feet (30') wide, face-to-face.

    c. A residential lot bordered by an alley and a residential street that is at least thirty feet (30') wide shall provide a driveway to the alley if trash pick-up services cannot be easily provided on the residential street, as determined by the City. Factors that will be considered include, but are not limited to, trash truck routing and whether existing or planned homes on the block already connect to the alley.

    d. A residential lot shall be prohibited from having multiple driveway connections in a configuration that would create the possibility of a cut-through route between a public street and an alley that do not intersect or between two public streets that do not intersect, as determined by the City Manager.

    e. If a residential driveway is shared between two properties, the driveway shall be centered on the common property line unless otherwise approved by the City Manager.

    f. A residential driveway connecting to an alley shall not be located within twenty feet (20') of the ROW line of a public street so as to prevent the driveway from being located in the alley taper

g. A residential driveway connecting to a public street shall be located so its upstream edge is no closer than fifteen feet (15') from the curb return of an upstream intersection and so its downstream edge is no closer than five feet (5') from the curb return of a downstream intersection.

h. A residential driveway that changes in width as it extends onto the property shall do so with a curved transition or an angled transition that does not exceed a taper of one to one (1:1) within ten feet (10') of the property line.

13. Driveways shall be located so that they meet the required spacing from other driveways and streets, as described in Subsections F, G, and H below. The spacing and location of driveways shall be related to existing driveways and streets and to future driveways and streets that are shown on approved preliminary site plans and/or site plans that have not expired.

D. Driveway Width – The width of a driveway refers to the width of pavement at the property line and is measured where the curb return radii ends perpendicular to the street curb or edge of pavement. The minimum and maximum widths of driveways are listed in Table 8.9. A driveway may transition to a different width as it extends onto the property, but its width shall not change abruptly at the property line.

TABLE 8.9: Minimum and Maximum Driveway Widths[1]

Driveway Type	Land Use	Width in Feet (face to face)[2]	
		Minimum (ft)	Maximum(ft)
Standard Driveway	Residential	10	24 to a street 32 to an alley[3]
	Commercial	30	36 (40 at a gas station)
	Industrial	30	40
One-Way Driveway	Residential (circular)	10	16
	Commercial	24	24
	Industrial	24	24
Divided High Capacity Driveway	Entrance	24	24
	Exit: Two Lanes	24	24
	Three Lanes	30	36
Driveway Medians		4	11

1. Driveway width at the property line. A driveway may transition to a different width as it extends onto the property.
2. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.
3. A residential driveway connecting to an alley may have a width up to a maximum of thirty-two feet (32') if the garage faces onto the alley; otherwise, its width is limited to twenty-four feet (24').

E. Driveway Radius

1. All driveways intersecting dedicated streets shall be built with a circular curb radius connecting the six-inch (6") raised curb of the roadway to the design width pavement of the driveway.

2. Driveway radii shall fall entirely within the subject property so as to begin at the street curb at the extension of the property line.

3. Table 8.10 presents the minimum and/or maximum standards to be applied in designing and locating driveways on public streets.

4. High capacity driveways shall meet the same standards as those defined in Table 8.10.

TABLE 8.10: Driveway Design Requirements

Criteria	Thoroughfare Classification	Residential Driveway (ft)	Commercial or Multi-family Driveway (ft)	Industrial Driveway (ft)
Driveway Curb Radius	Type A	N.A.	30	40
	Type B	N.A.	30	40
	Commercial Collector Type C	N.A.	30	40
	Residential Collector	N.A.	30	N.A.
	Local D, E	5-10	N.A.	N.A.
Minimum Driveway Spacing Along Roadway (edge to edge)	Type A	N.A.	280	280
	Type B	N.A.	260	260
	Commercial Collector Type C	N.A.	90	90
	Residential Collector	N.A.	max. of 1 drive	N.A.
	Local D, E	20 (10 when enclosing both mailboxes)(2)	N.A.	N.A.
Minimum Distance to Intersection Along Roadway (edge to ROW line of intersecting street)(1)	Type A	N.A.	75 / 200	75 / 200
	Type B	N.A.	75 / 200	75 / 200
	Commercial Collector Type C	N.A.	100 / 100	100 / 100
	Residential Collector	N.A.	100 / 100	N.A.
	Local D, E	15 / 5 from curb return to edge of drive	N.A.	N.A.

1. Upstream / downstream distance to intersection. See Figure 8.21.
2. If both mailboxes are located between two driveways, those driveways can be exactly 10 feet apart. If they are more than 10 feet apart, they must be 20 feet apart or more.

F. Driveway Spacing

1. Spacing between driveways is measured along the property line from the edge of one driveway to the closest edge of the next driveway.

2. Table 8.10 defines minimum driveway spacing as a function of thoroughfare classification.

3. In the vicinity of a railroad crossing, the closest edge of a driveway shall be a minimum of one hundred feet (100') from the railroad ROW line.

4. Non-residential and multi-family driveways on opposite sides of an undivided street shall align with each other or be spaced a minimum of seventy-five feet (75') apart, measured edge to edge, to ensure that conflicting movements do not overlap. This spacing shall also apply to a driveway that is on the opposite side of an undivided street from an intersecting street. See Figure 8.20.

FIGURE 8.20: Driveway Spacing on Opposite Sides of an Undivided Street

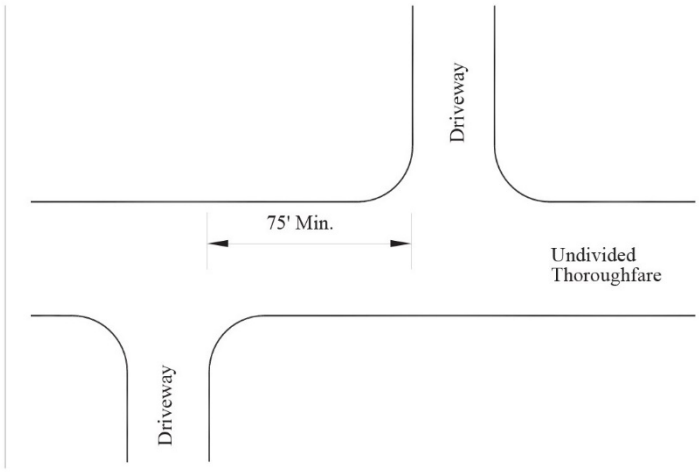
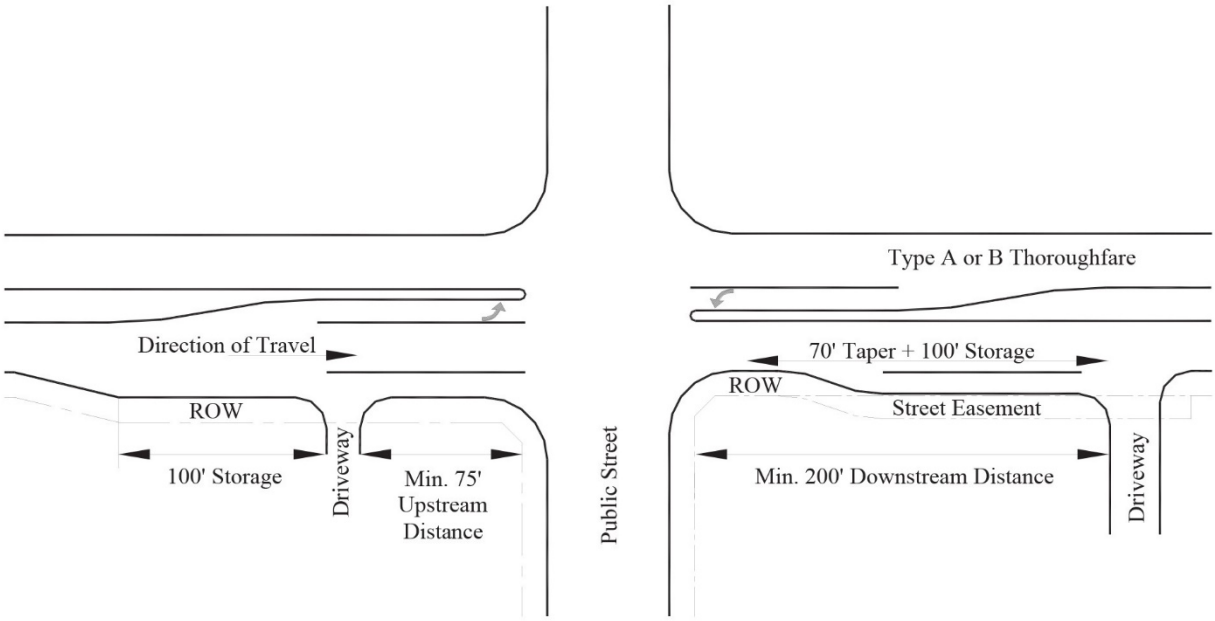


FIGURE 8.21: Distance Between Driveway and Intersection



G. Distance between Driveway and Intersection

1. Adequate distance between cross street intersections and access driveways shall be provided to ensure intersection/driveway conflict areas are minimized.

2. Table 8.10 defines the upstream and downstream distance from an intersection as a function of thoroughfare classification. The distances required from an intersection along a Type A or B thoroughfare are shown in Figure 8.22

H. Driveways Located in Right-Turn Lanes

1. A driveway located within the right-turn lane of a public street intersection shall be spaced so that its closest edge will be a minimum of seventy-five feet (75') in advance of the ROW line of the intersecting street. See Figure 8.22.

2. If a driveway is located within the right-turn lane of a public street intersection, the storage length of the right-turn lane shall extend a minimum of one hundred feet (100') beyond the upstream edge of the driveway (see Figure 8.21). No driveway shall be permitted within the taper area of a right-turn or deceleration lane.

I. Driveway Deceleration Lanes - Deceleration lanes are required on Type A and B thoroughfares at all non-residential and multi-family driveways and shall meet the requirements of Section 8.3.D.

J. Driveway Storage Lengths

1. On-site internal storage shall be provided at all non-residential and multi-family driveways for queuing of vehicles off-street, to minimize congestion, and increase safety both on the public street and within the driveway.

2. Internal storage requirements shall be based on the number of parking spaces accessible by the affected driveway. Divide the total number of parking spaces by the number of driveways and then use Table 8.11 to determine the amount of internal storage required. This calculation shall be based on the preliminary site plan for an overall development or the site plan for a specific lot, whichever produces the largest ratio of parking spaces per driveway.

3. Internal storage length shall be measured from the ROW line to the first intersecting aisle, internal driveway, or parking stall.

4. A circulation study will be required for all multi-story parking structures. Driveway storage requirements will be determined as a result of the study.

TABLE 8.11: Minimum Driveway Storage

Parking Spaces per Driveway	Storage Required (ft)			
	Multi-family or Commercial Uses		Industrial Land Uses	
	Non-Median Opening[1]	Median Opening[2]	Non-Median Opening[1]	Median Opening[2]
Less than 25	25	25	25	25
25-50	25	40	25	40
51-100	25	40	40	40
101-200	40	80	40	60
More than 200	100	150	40	100

1. Includes driveways that connect to one-way frontage roads.
2. Includes any driveway where a left-turn exit can be made, including driveways that connect to undivided roadways.

K. Entrance Streets and Driveways for Gated Developments

1. To ensure that the minimum dimensions are adequate, a traffic study is required with the submission of a Specific Use Permit application for all gated communities.

2. Residential/Multi-family Developments

   a. Gated developments shall have a median divided street or driveway that will allow for a vehicular turn-around prior to the gate in the event that access is denied.

   b. The turn-around shall be a minimum of eighteen feet (18') in width.

   c. Entry gates shall be set back from the ROW line a minimum of one hundred thirty five feet (135') or as indicated in the traffic study. The card reader, or first stop, shall be set back from the ROW line a minimum of one hundred feet (100'), or as indicated in the traffic study, to provide storage for the longest queue of vehicles expected to access the gate. See Figure 8.23.

   d. Each direction of the divided street or driveway shall be a minimum of twenty-four feet (24') in width with curb radii of thirty feet (30'). See Figure 8.23.

   e. The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb. The gate shall open to twenty-four inches (24") behind back of curb.

   f. Gates shall open sideways or swing open in the direction of travel on each side of the divided street.

   g. Gates shall be equipped with emergency access devices as required by the Fire Department.

   h. All gates shall provide pedestrian access. The movement of the gates shall not encroach on sidewalks.

   i. Gates shall remain open between 7:00 a.m. and 7:00 p.m. whenever a guard is not on-duty during that time.

   j. Any alternative designs shall require the approval of the City Engineer.

3. Non-Residential Developments

   a. Gated developments shall have a median separating ingress and egress traffic flow allowing for a vehicular turn-around prior to the gate in the event that access is denied.

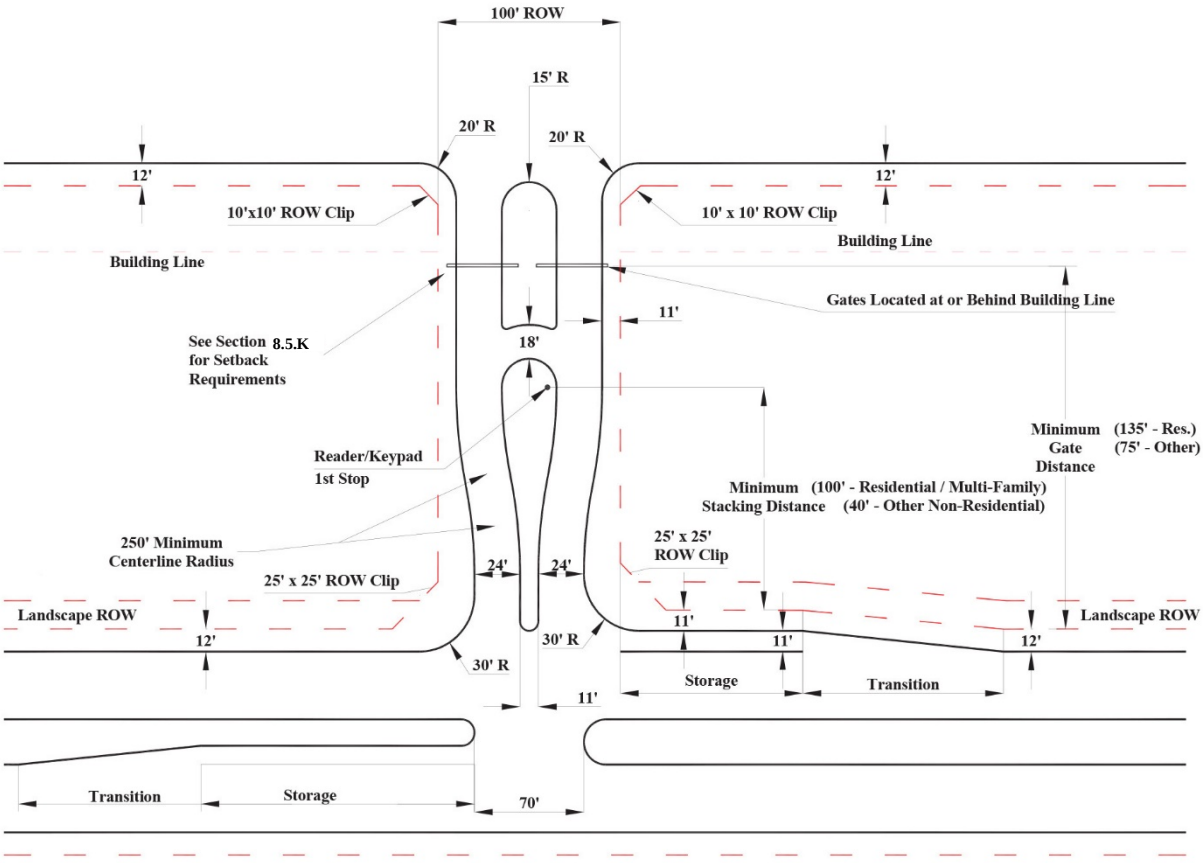
   b. The turn-around shall be a minimum of eighteen feet (18') in width.

   c. Entry gates shall be set back from the ROW line, or fire lane, a minimum of seventy-five feet (75'), or as indicated in the traffic study. The card reader, or first stop, shall be set back from the ROW line a minimum of

forty feet (40’), or as indicated in the traffic study, to provide storage for the longest queue of vehicles expected to access the gate.

d. Each direction of the driveway shall be a minimum of twenty-four feet (24’) in width with curb radii of thirty feet (30’). See Figure 8.23.

FIGURE 8.23: Gated Entrance Detail



e. The hinge point of the gate shall be a minimum of eighteen inches (18”) behind back of the curb. The gate shall open to twenty-four inches (24”) behind back of curb.

f. Gates shall open sideways or swing open in the direction of travel on each side of the divided entrance.

g. Gates shall be equipped with emergency access devices as required by the Fire Department.

h. All gates shall provide pedestrian access. The movement of the gates shall not encroach on sidewalks.

4. Individual gated single-family residences shall have a minimum setback of twenty feet (20’) from the property line. The movement of the gate(s) shall not encroach on a sidewalk, alley, or street.

L. Non-Conforming Driveways

1. All nonconforming driveways on a lot, tract, parcel or site shall be allowed to remain in use until the occurrence of one or more of the following events:

   a. A change in use, or an increase in intensity of use, occurs such that the site requires a ten percent (10%) increase in required parking spaces.

   b. Addition or expansion of required stacking spaces.

   c. Any modification that changes the design or function of the existing driveway.

   d. The addition of a median opening on the public street by a developer. All driveways that are served by the new median opening shall comply with the requirements of these standards.

2. Upon the occurrence of the events described above, the nonconforming driveway shall either be reconstructed in accordance with these design requirements, or eliminated.

8.6 Sidewalk Location and Design

A. Definition of Sidewalk – A sidewalk is defined as the paved area designated for pedestrian use which is generally located between the curb of the roadway and the adjacent property line. The inside edge of the sidewalk is the edge closest to the street while the outside edge of the sidewalk is farthest from the street.

B. Sidewalk Design – Sidewalks shall conform to the most current federal, state, and local ADA requirements and to the following standards:

1. Sidewalk Grade – The maximum grade of the sidewalk shall be five percent (5%) or the grade of the adjacent street, whichever is greater. The maximum cross-slope of the sidewalk shall be two percent (2%).

2. Zoning Classification Requiring Sidewalks – Concrete sidewalks designed and located according to City standards shall be constructed along all streets in all zoning classifications except agriculture uses in agricultural zoned areas. Prior to developing any single-family, duplex, or townhome residential lots, residential developers shall build sidewalks along all streets adjacent to the subdivision and along the portions of any street within the subdivision where residential lots do not front or side onto the street. Sidewalks along residential lots shall be constructed by the homebuilder at the time each lot develops. Sidewalks adjacent to non-residential and multi-family land uses shall be built at the time of lot development.

3. Hike and Bike Master Plan – Sidewalks shall be constructed with the width specified in the Hike and Bike Master Plan along thoroughfares that are designated as off-street hike and bike trail routes.

4. Type A and B Thoroughfares – A concrete sidewalk, a minimum six feet (6') in width, shall be located along all Type A and B thoroughfares. The sidewalk should typically be located within the street ROW, but may extend into a

sidewalk easement. The inside edge of the sidewalk shall be no closer than five feet (5') from the back-of-curb.

5. Type C and D Thoroughfares – A concrete sidewalk, a minimum five feet (5') in width, shall be located along all Type C and D thoroughfares. The sidewalk shall be located within the street ROW unless pre-existing physical encroachments (e.g., utility infrastructure or trees) dictate otherwise. The outside edge of the sidewalk shall be located two feet (2') inside the ROW line on Type C and D thoroughfares. On Type E thoroughfares, the outside edge of the 4' sidewalk shall be placed 1' inside the ROW line and a two-foot (2') sidewalk easement shall be provided adjacent to the ROW line.

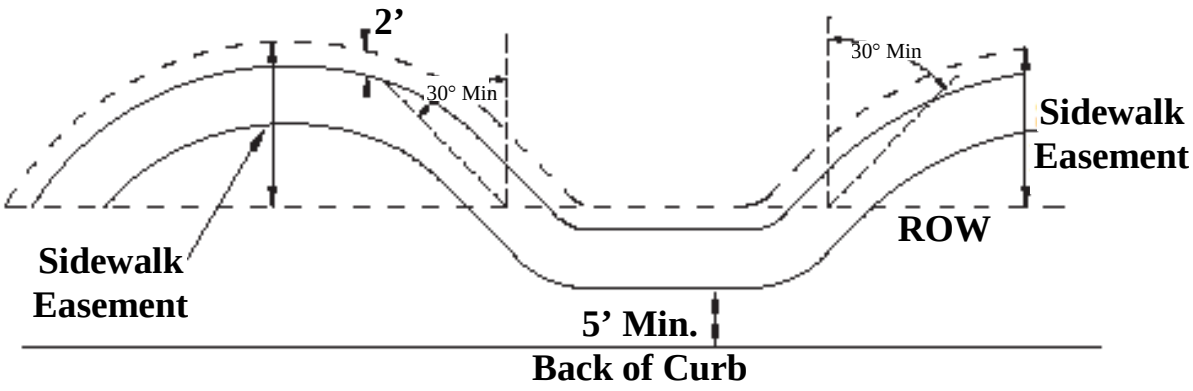
6. See Section 8.13 of the Engineering Standards for sidewalk thickness requirements.

7. Sidewalk Easements – A minimum of two feet (2') of ROW or sidewalk easement shall be provided adjacent to the outside edge of the sidewalk. Any portion of sidewalk extending outside the ROW shall be contained within a sidewalk easement, the inside edge of which extends to the ROW line and the outside edge of which extends a minimum of two feet (2') beyond the outside edge of the sidewalk.

8. Parkways – The area between the curb and ROW line shall be graded at two percent (2%) above the top of street curb. If the area between the curb and the sidewalk is at least three feet (3') wide, it shall contain grass that is maintained by the adjacent property owner. If the area between the curb and sidewalk is less than three feet (3') wide, it shall be paved with concrete for a minimum length of fifteen feet (15'). If a parkway is adjacent to a non-residential or multi-family land use, the area between the curb and the sidewalk may be paved with concrete or concrete pavers in lieu of grass.

9. Meandering Sidewalks – Sidewalks along Type A, B, and C thoroughfares and residential collectors may meander for aesthetics and/or to avoid pre-existing physical encroachments. Sidewalk easements adjacent to the standard ROW line will be required to contain any portion of the meandering sidewalk that extends beyond the ROW. Sidewalk easements shall provide a minimum clearance of two feet (2') beyond the outside edge of the sidewalk. The inside edge of a meandering sidewalk shall never be less than five feet (5') from the back-of- curb. A tangent calculated at any point along the centerline of a meandering sidewalk shall not be less than thirty degrees (30°) from perpendicular to the street. These requirements are shown in Figure 8.23.

FIGURE 8.23: Meandering Sidewalk Detail



10. Sidewalks Adjacent to Screening Walls – In areas where a screening wall is provided along a thoroughfare, the outside edge of the sidewalk shall either remain a minimum of two feet (2’) from the wall or the sidewalk shall be paved up to the wall.

11. Access Ramps – Barrier-free ADA access ramps shall be provided at all street intersection corners, at all crosswalks, and across any non-residential or multi-family driveway.

12. Sidewalks on Bridges

    a. All street bridges shall have a sidewalk constructed on each side of the bridge. The sidewalk shall have a minimum width of six feet (6’) with a parapet wall that is separated from the travel lane by an eighteen inch (18”) shoulder. See Figure 8.24.

    b. A standard pedestrian bridge rail protecting the sidewalk shall be provided on the outside edge of the bridge. See Figure 8.24.

    c. When an eight foot (8’) sidewalk is required on the bridge as part of a hike and bike trail, the center lane may be reduced to eleven feet (11’) and the shoulders may be reduced to twelve inches (12”).

13. Sidewalks Under Bridges – When new bridges are built as a part of the construction of a roadway or the reconstruction of a roadway and a pedestrian crossing is needed beneath the bridge, a sidewalk shall be built as a part of the embankment design underneath the structure for future hike and bike trails. The Hike and Bike Master Plan will designate whether a sidewalk is built on one or both sides of the waterway and whether the sidewalk shall be ten feet (10’) or twelve feet (12’) wide.

14. Sidewalks on Culverts – All culvert crossings shall have a sidewalk, a minimum of six feet (6’) wide, constructed on each side of the culvert. A standard pedestrian hand rail as shown in Figure 8.25 shall be provided on the outside edge of the culvert. A parapet wall may be required by the City Engineer.

FIGURE 8.24: Typical Sidewalk on Bridge Section

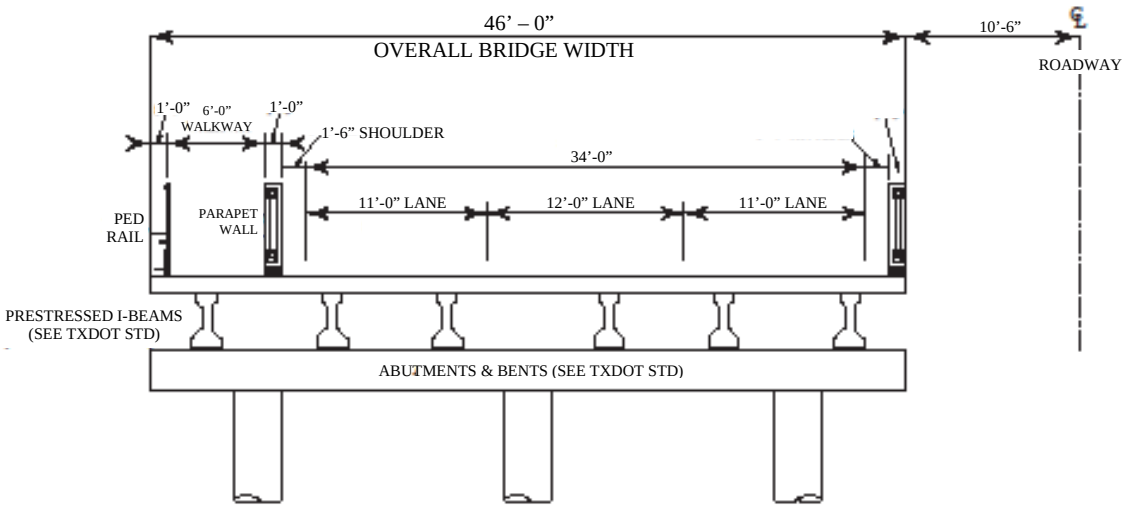
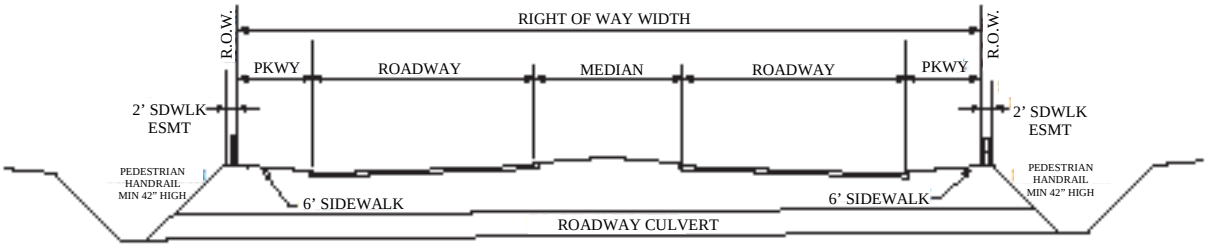


FIGURE 8.25: Typical Pedestrian Handrail Over Culvert

Typical Thoroughfare



15. Sidewalks between Residential Lots

a. Where deemed necessary by the City Engineer, a block with a continuous series of lots longer than one thousand two hundred feet (1,200’), measured along one or more sides, shall be bisected by a thirty foot (30’) wide pedestrian easement containing a sidewalk that is a minimum of eight feet (8’) wide. Such a mid-block pedestrian connection will be necessary where it would be beneficial to create a short-cut to walk to a school, park, trail, or group of homes on the other side of the long block.

b. Pedestrian easements and sidewalk connections shall be provided between cul-de-sacs and adjacent streets as required by the Subdivision Ordinance.

16. Sidewalk Escrow – When the delay of sidewalk construction is deemed appropriate by the City due to future right of way improvements, escrow funds in lieu of the construction of sidewalks may be approved by the City Manager. Such funds shall be escrowed with the City prior to final acceptance of the development. The escrow amount shall be determined by the square footage of sidewalk to be constructed, as estimated by the developer, and approved by the City Engineer.

17. Sidewalk Reimbursement – If the City constructs the sidewalk along any street before the adjacent property develops, the owner of that property shall reimburse the City for its construction costs when the property is to be subdivided or developed. This amount shall be determined by multiplying the City's square foot cost of constructing the sidewalk by the square footage of sidewalk that is required along the property, subtracting out the square footage of sidewalk the developer will remove or replace while developing the site, and adding any cost associated with City-installed ADA access ramps, retaining walls, and protective railing. The reimbursement shall be paid before any plat may be filed for the property. If the property has already been platted or a plat is not required, the reimbursement shall be paid prior to final acceptance or Certificate of Occupancy, whichever occurs first.

C. Sidewalks within Non-Residential and Multi-family Developments – All sidewalks within non- residential and multi-family developments shall be a minimum of five feet (5') in width. At least one ADA accessible sidewalk connection shall be made between each building and the public sidewalk.

8.7 Public Right of way Visibility Requirements

A. Adequate sight distance at the intersection of a thoroughfare and a proposed thoroughfare, driveway, or alley must be ensured. This sight distance is provided through the use of Corner Visibility Triangles and/or Sight Line Triangles. Corner Visibility Triangles are also known as ROW Corner Clips and Sight Line Triangles are also known as Visibility, Access and Maintenance Easements (VAMs). All intersection visibility requirements shall meet the guidelines for sight triangles in AASHTO's current A Policy on Geometric Design of Highways and Streets.

1. Corner Visibility Triangles shall be provided on all corners of an intersection between two thoroughfares or an intersection between an alley and a thoroughfare.

2. Sight Line Triangles shall be provided where a driveway, an alley, or a stop-controlled thoroughfare intersects an uncontrolled thoroughfare and on any signalized intersection approach where right turn on red operation is permitted.

3. No fence, wall, screen, sign, structure, foliage, hedge, tree, bush, shrub, berm, driveways, parking, drive aisles, or any other item, either man-made or natural shall be erected, planted, or maintained in a position that will obstruct or interfere with a driver's clear line of sight within a corner visibility triangle or a sight line triangle (i.e., a VAM).

4. The City has the right to prune or remove any vegetation within City right of way, including within the corner visibility triangle, and within sight line triangle easements (including VAMs), to abate a safety hazard and/or a nuisance.

B. Corner Visibility Triangles

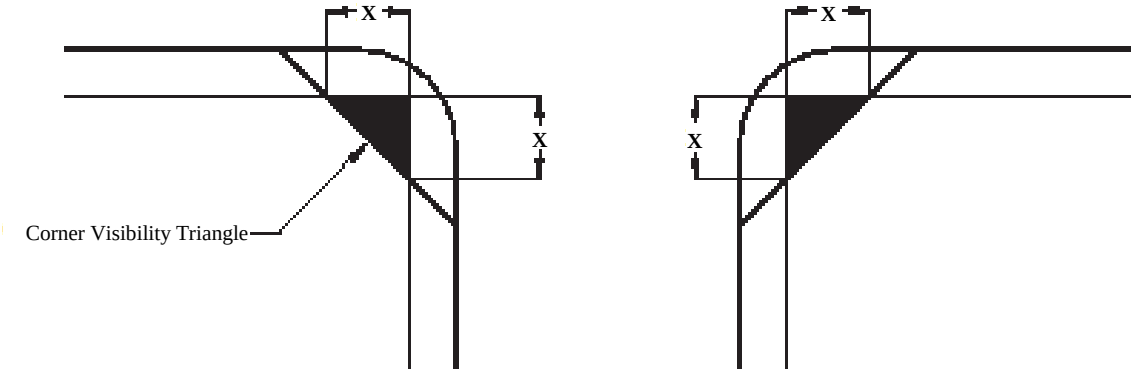
1. The corner visibility triangle is defined at an intersection of two thoroughfares by extending the two ROW lines from their point of intersection to a distance as shown on Table 8.12. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 8.26. This corner visibility triangle shall be dedicated as ROW.

TABLE 8.12: Corner Visibility Triangle Distances

Type of Thoroughfare On	Type of Thoroughfare At	Distance[1] (X)
A, B, C	A, B, C, D, or any residential street that potentially will be signalized	40’
A, B, C	E that will remain unsignalized	25’
D, E	D, E	10’
TxDOT Road, Frontage Road	Use the specifications for a Type A Thoroughfare	
Unimproved Road	D, E	30’

1. The corner visibility triangle shall have the same dimension on all corners of the intersection.

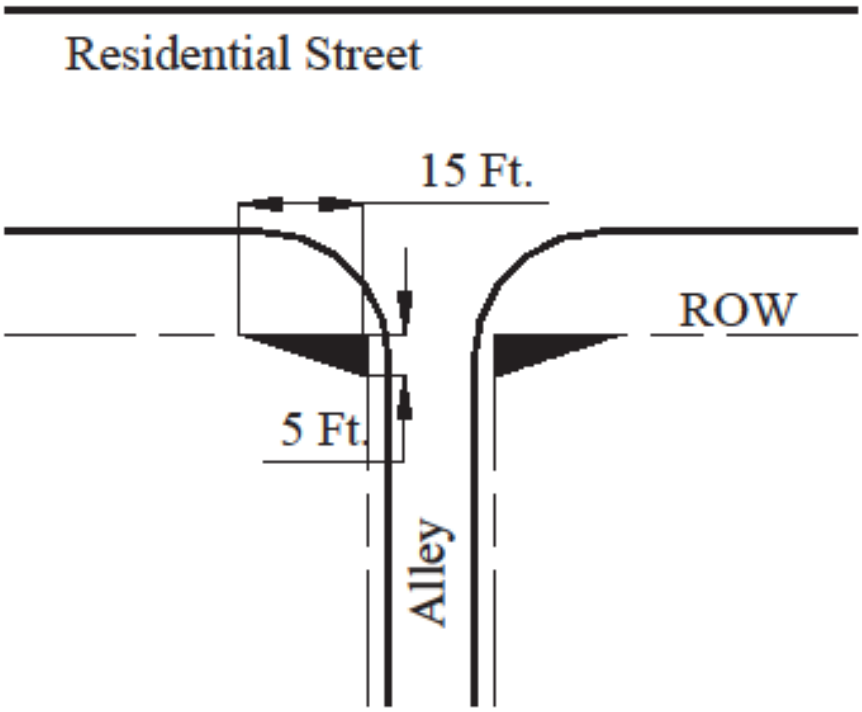
FIGURE 8.26: Corner Visibility Triangle for an Intersection



2. Vision at all intersections of thoroughfares shall be clear at elevations between thirty inches (30”) and nine feet (9’) above the average gutter elevation within the corner visibility triangle and meet AASHTO’s current minimum requirements.

3. Where alleys intersect residential Type E thoroughfares, the corner visibility triangle is measured as fifteen feet (15’) along the residential street ROW and five feet (5’) along the alley ROW from the point of intersection. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 8.27. The alley corner visibility triangle shall be dedicated as ROW.

FIGURE 8.27: Corner Visibility Triangle for an Alley



C. Sight Line Triangles

1. The sight line triangle is formed by first extending a line along the center line of the proposed thoroughfare or driveway that begins at the tangent curb of the intersecting thoroughfare and extends to its endpoint fifteen feet (15') into the proposed thoroughfare or driveway. For the sight line triangle to the left, construct a second imaginary line that is parallel to and five feet (5') out from the intersecting thoroughfare's curb that begins at the centerline of the side street and continues to the left for a distance L (see Table 8.13) to its endpoint. To complete the sight line triangle, connect the endpoints of the first two lines as shown in Figures 8.29 and 8.30. In the case of the sight line triangle to the right, the second imaginary line is parallel and five feet (5') out from the nearest edge of the conflicting traffic flow (or adjacent median in the event of a divided thoroughfare). It begins at the centerline of the side street and continues to the right for a distance R (see Table 8.13) to its endpoint. See Figures 8.29 and 8.30.

2. Distance to driver's eye for driveways that intersect a street is fifteen feet (15') from the intersecting curb line as shown in Figures 8.28 and 8.29.

3. In the case where the thoroughfare contains existing horizontal curvature, the distances L and R must be measured along the horizontal curve.

4. Sight Line Triangles that extend outside of the ROW shall be identified and dedicated as Visibility, Access and Maintenance Easements (VAMs) on the plat using City-approved VAM language.

FIGURE 8.28: Sight Line Triangle for Undivided Thoroughfare

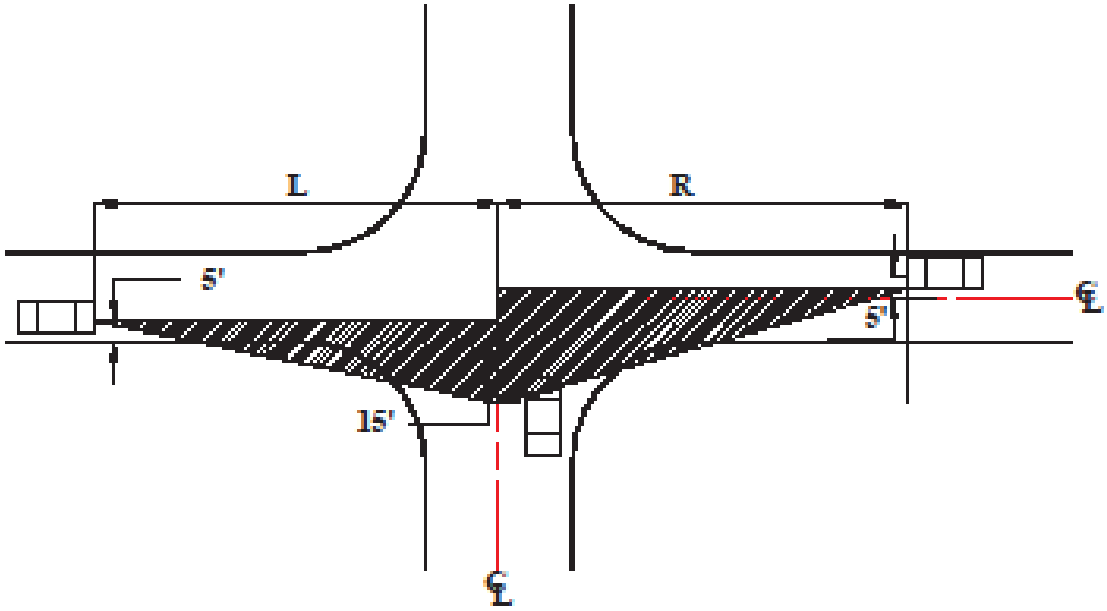


FIGURE 8.29: Sight Line Triangle for Divided Thoroughfare

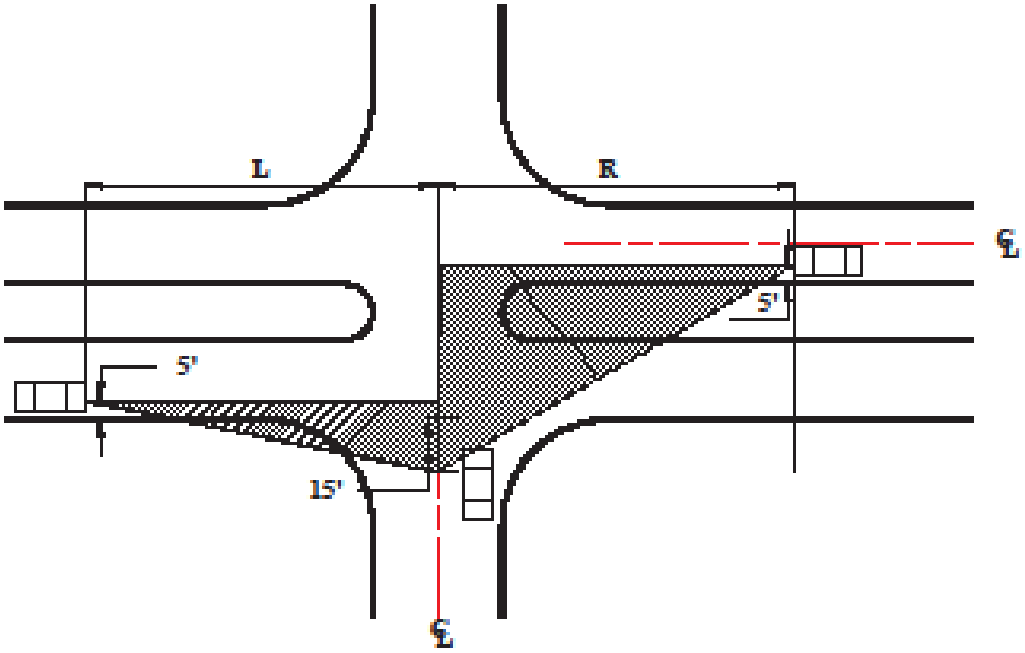


TABLE 8.13: Sight Line Triangle Distances

Design Speed V (MPH)	Sight Distance by Lanes in Cross Section L and R (ft)		
	2	4[2]	6[2]
25	280[3]	N/A	N/A
30	335	N/A	N/A
35	390	N/A	N/A
40	445	N/A	N/A
45	500	530	565
50	555	590	625

(1) Source AASHTO's 2011 *A Policy on Geometric Design of Highways and Streets* – Chapter 9.
(2) Manual calculations of the procedures in AASHTO's 2011 *A Policy on Geometric Design of Highways and Street s*– Chapter 9
(3) 150 feet with approval by the City Engineer.

D. Traffic Control Devices - Any landscape requirements in the Engineering Standards, the Subdivision Ordinance, the Zoning Ordinance, or any other City ordinance shall not interfere with the placement, visibility or maintenance of traffic control devices under governmental authority and control.

8.8 Frontage Road Design

A. Frontage roads are typically a pair of one-way roadways found adjacent to existing or planned freeway or tollway facilities.

B. Frontage roads are considered Type A thoroughfares. Frontage roads shall be designed to the Type A standards set forth in this document. Frontage roads along state highways shall follow TxDOT design guidelines.

C. Access to frontage roads shall also conform to the standards set forth for Type A thoroughfares. In addition, the following access restrictions apply to frontage road design:

1. Exit Ramp Restrictions:

   a. No driveway shall be located less than fifty feet (50') in advance of the concrete curb gore of an exit ramp, measured from the edge of the driveway.

   b. No driveway shall be located less than four hundred feet (400') beyond the concrete curb gore of an exit ramp, measured from the edge of the driveway.

2. Entrance Ramp Restrictions:

   a. No driveway shall be located less than two hundred feet (200') in advance of the concrete curb gore of an entrance ramp, measured from the edge of the driveway.

   b. No driveway shall be located less than fifty feet (50') beyond the concrete curb gore of an entrance ramp, measured from the edge of the driveway.

8.9 Traffic Signal Installation

A. Introduction – According to the Texas Manual of Uniform Traffic Control Devices (TMUTCD), traffic control signals should not be installed unless one or more of the signal warrants in the manual are met. The satisfaction of a warrant or warrants is not in itself justification for a signal. Information should be obtained by means of engineering studies and compared with the requirements set forth in the warrants. The engineering study should indicate the installation of a traffic signal will improve the overall safety and/or operation of the intersection. If these requirements are not met, a traffic signal should neither be put into operation nor continued in operation (if already installed).

B. Warrant Criteria

1. To justify the installation of a traffic signal, Part IV in the TMUTCD shall be followed. Part IV describes the warrants for a traffic signal installation and provides guidelines and requirements for the actual design and operation of a traffic signal.

2. Engineering studies must be conducted in order to assess whether a particular location satisfies the warrant criteria listed in the TMUTCD. These studies may include one or more of the following:

   a. Traffic volume counts

   b. Pedestrian volume counts

   c. Delay studies

   d. Speed studies

   e. Gap studies

   f. Diagram of physical conditions

   g. Accident studies

C. Traffic Signal Spacing – Signal spacing is an important factor in being able to provide progressive flow for a platoon of traffic. Traffic signal spacing shall be determined by the City Engineer.

D. Traffic Signal Design and Installation – The design and installation of traffic signals shall follow the City's Standard Details.

E. Cost of Traffic Signal Installation

1. Traffic signals where a private driveway or a residential street intersects with a Type A or B thoroughfare – The developer is responsible for the total cost of designing and constructing a traffic signal that would only be warranted based on the traffic generated by the development. The developer shall escrow funds for the cost of the traffic signal and the City shall construct the traffic signal at the time of development or when the development reaches a certain level of activity, as determined by the City Engineer. If a future traffic

signal will equally serve a development on each side of the thoroughfare, each development shall be responsible for half the cost of the traffic signal.

2. Traffic signals at Type A-A, A-B, and B-B intersections – The developer on each corner of a Type A-A, A-B, or B-B intersection is responsible for a portion of the cost of designing and constructing a future traffic signal at the intersection and shall escrow such funds with the City at the time of development. The total cost of designing and constructing the traffic signal shall be divided equally among each of the four corners of the intersection and then proportionally assessed to each lot within a fifteen (15) acre area at each corner, measured eight hundred eight feet (808') in each direction from the corner. In the case of a three-leg intersection, an imaginary fourth leg shall be assumed for the purposes of creating four corners. As each lot develops as a portion of each corner, the trips generated by that land use shall be calculated and compared to the trips that would be generated by the total fifteen (15) acre area, the ratio of which determines the proportion of the traffic signal escrow that shall be assessed to that lot. If a preliminary site plan has not been approved for the whole fifteen (15) acre area, the land uses of a typical shopping center shall be assumed. If there are less than fifteen (15) acres that can be developed on a corner, the trips generated by a developing lot will be compared to a hypothetical fifteen (15) acre shopping center.

8.10 Street Lighting

A. The following standards shall apply to all Type A and Type B Thoroughfares:

1. Street lighting shall be placed in the medians, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred fifty feet (150') depending on median breaks and intersections.

2. Unless a photometric analysis suggests the use of a different type of luminaire, street lighting shall use Full Cutoff, Type 3 Luminaires on thoroughfares with one hundred twenty feet (120') of ROW and Full Cutoff, Type 2 Luminaires on thoroughfares with ninety (90') of ROW.

3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt Metal Halide single or double head with davit arm(s) traffic black (RAL9017-traffic black) in color, or the equivalent approved by the City Engineer shall be used.

4. Street lighting shall be installed prior to final acceptance of the construction of a thoroughfare. When partial thoroughfares are constructed, the City Engineer may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect thoroughfares, each Owner (Developer) is responsible for one- half the total cost of fully developed street lighting along that segment of the thoroughfare.

5. When development occurs along a Type A or Type B thoroughfare, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the thoroughfare.

6. Poles are to be round and tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details.

7. Type A ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.

8. Street lighting foundations shall be thirty inches by ninety six inches (30" x 96") in accordance with the City's Standard Details and specifications.

9. Street lighting conduit shall be two inch (2") Schedule 80 PVC.

10. Street lighting shall use #12 AWG wiring inside the poles.

11. Electrical service pedestals shall be 240V/480V and meet the local service provider's specifications.

12. Conduit shall be installed in accordance with the City's Standard Details and Specifications.

B. The following standards shall apply to all Type C commercial collectors:

1. Street lighting shall be placed in the parkway between the curb and the sidewalk, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred fifty feet (150').

2. Street lighting shall use Full Cutoff, Type 2 Luminaires.

3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt Metal Halide single head with davit arm traffic black (RAL-9017 traffic black) in color, or equivalent approved by the City Engineer shall be used.

4. Street lighting shall be installed prior to final acceptance of the construction of a commercial collector. When the delay of installing street lighting is deemed appropriate by the City Engineer, the City Engineer may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect collectors, each owner (Developer) is responsible for one-half of the total cost of fully developed street lighting along that segment of the collector.

5. When development occurs along a Type C commercial collector, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the collector.

6. Poles are to be round tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details and specifications.

7. Type A ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.

8. Street lighting foundations shall be thirty inches by ninety six inches (30" x 96") in accordance with the City's Standard Details and specifications.

9. Street lighting conduit shall be two inch (2") Schedule 80 PVC.

10. Street lighting shall use #12 AWG wiring inside the poles.

11. Electrical service pedestals shall be 240V/480V and meet the local service provider's specifications.

C. The following standards shall apply to all Type D and E Residential Streets:

1. Poles are to be round tapered, American style with Barrington base, black in color. Pole height shall be twelve feet (12') for Type D and E local streets and fourteen feet (14') for residential collectors.

2. Lamp wattages shall be 100 watts High Pressure Sodium.

3. Luminaires shall be Acorn with refractive globes, metal cap and finial.

4. The Developer may install additional banding and/or medallions with prior approval from the City Engineer. The cost for maintenance and/or replacement of the banding and/or medallions shall be the responsibility of the developer or Homeowners' Association.

5. Street lights shall be installed without multiple luminaires.

6. Street lights shall typically be located at intersections and at mid-block locations if the block length is greater than six hundred feet (600'). Cul-de-sacs over two hundred twenty five feet (225') in length, measured from centerline of cross street to center point of cul-de-sac, shall have a street light installed at the street intersection and at the beginning of the bulb. Other locations may be required as deemed necessary by the City Engineer. Street lights shall not be closer than one hundred fifty feet (150') nor greater than six hundred feet (600') apart.

7. Subdivisions bounded by Type A or Type B thoroughfares shall have a common type of luminaire throughout. Street lighting shall be installed prior to acceptance by the City Engineer.

D. A lighting plan shall be required anytime street lighting is proposed, or modified. The lighting plan shall be submitted to the City Engineer as part of the development submittal. A certified engineer, architect, landscape architect, lighting engineer or designer shall prepare the plan. The plan shall also contain a certification by the property owner or agent and the preparer of the plan that the street lighting depicted on the plan complies with these requirements. The submission shall contain but shall not necessarily be limited to the following:

1. Plans indicating the location of the lighting, and the type of illuminating devices, fixtures, lamps, supports, reflectors, and other devices;

2. Description of the illuminating devices, fixtures, lamps, supports, reflectors, and other devices and the description may include, but is not limited to, catalog cuts by manufacturers and drawings (including sections where required) and height of the luminaires;

3. Photometric plan and data sheets, such as that furnished by manufacturers, or similar to that furnished by manufacturers or the lighting designer, showing the angle of cut off or light emissions; and

4. Water, sewer and storm sewer locations along with any other existing utilities lightly shaded on plans showing any possible location conflicts with proposed lighting.

E. The following are exempt from these requirements:

1. "Cobra head" type lighting fixtures having dished or "drop" lenses or refractors which house other than incandescent light sources in undeveloped areas.

2. Temporary lighting approved in writing by the City Engineer.

3. Where existing or phased subdivisions are currently under construction, the continued use of previously approved street lighting will be permitted. When a new phase of a subdivision is divided by a residential collector, the street lighting standards contained in these requirements shall be required.

4. City Council may vary from these requirements as part of the approval of public street and sidewalk projects in overlay districts and Planned Developments.

5. Lighting luminaires in existence on the effective date of these requirements shall be exempt from these standards and shall be considered legally non-conforming. Such fixtures may be repaired, maintained and/or replaced. If an identical replacement of non-conforming luminaires is not available, the new luminaires shall comply with these requirements.

8.11 Street Name Signs

A. Street name signs shall be installed at all intersections of public streets, private streets, and public ways in accordance with the City's Standard Details.

B. Street name blades shall be nine inch (9") tall extruded aluminum.

C. The street name shall be left justified, with block numbers located in the upper right-hand corner. Abbreviated street designations shall be located in the lower right-hand corner and right-justified.

D. The lettering of the street name shall be Clear View 2W, six inches (6") tall and upper/lower case. Letters of abbreviated street designations shall be three inches (3") tall and all uppercase (i.e., LN, PKWY, DR, CT, etc.). Block numbers shall be 3" tall.

E. A street name shall be limited to sixteen (16) characters, not including the street designation. A street name shall either consist of one word no longer than sixteen (16) letters or two words separated by one space where the two words have no more than fifteen (15) letters combined.

F. Sign sheeting shall be diamond grade intensity. The background shall be blue and the legend shall be white.

G. For a street with only one cul-de-sac end, a standard W 14-2a shall be mounted over the street name blade. In the case of a street with two cul-de-sac ends, two standard W 14-2a signs shall be mounted over the street name blade in the appropriate directions.

H. Owners, developers, and/or contractors should contact the City Clerk to obtain block numbers. Block numbers are required on all street name blades, even if no homes or buildings front onto the street.

8.12 Traffic Impact Analysis and Mitigation

A. Purpose – The purpose of a Traffic Impact Analysis (TIA) is to assess the effects of specific development activity on the existing and planned thoroughfare system. Development activity may include but is not limited to rezoning, preliminary site plans, site plans, preliminary plats, driveway permits, certificates of occupancy, and Thoroughfare Plan amendments.

B. Pre-submission Meeting – Prior to the commencement of a TIA, an initial or pre-submission meeting with City staff is required to establish a base of communication between the City and the applicant. This meeting will define the requirements and scope relative to conducting a TIA and ensure that any questions by the applicant are addressed.

C. Applicability of TIA Requirements

1. Zoning – These TIA requirements shall apply to all zoning requests for land uses which will generate 2,500 or more vehicle trips per day or contain a density of 0.75 Floor Area Ratio (FAR) or greater. Applicable requests include zoning requests and Thoroughfare Plan amendments, if no previous traffic assessment was performed. Special circumstances, including but not limited to development with no case history, which do not meet the daily trip generation threshold, may also require a TIA. Such circumstances, as determined by the City Engineer may include, but are not limited to, impacts to residential neighborhoods from non-residential development, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the proposed land use differs significantly from that contemplated in the Comprehensive Plan, or the internal street or access is not anticipated to accommodate the expected traffic generation.

2. Development – These TIA requirements shall apply to all development requests for land uses, except single-family residential development, which will generate over 100 total trips during the AM or PM peak hour. Applicable development requests include concept plans, preliminary site plans, site plans and preliminary plats. Special cases, in which site generated peak hour trip activity is different from that of the adjacent street (weekdays 7:00-9:00 a.m. and 4:00-6:00 p.m.), may require an additional separate analysis as determined by the City Engineer. Such circumstances may include, but are not limited to, commercial/retail, entertainment or institutional activity. The City Engineer may waive the TIA for a development request if a TIA was

performed previously with the Zoning request and conditions listed in the report are still current.

3. Single-Family Residential Exception – A TIA for single-family residential development will not be required if the development contains fewer than six dwelling units unless special circumstances exist, as determined by the City Engineer. These special circumstances may include, but are not limited to, impacts to other residential development from cut-through traffic, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the internal street or access system is not anticipated to accommodate the expected traffic generation, or the development is outside the urban core of the community

4. Daycares and Schools – All development requests and/or specific use permit requests for a daycare, Montessori school, private school, charter school, or public school shall include, at a minimum, a traffic circulation study. This study shall include the estimated maximum peak hour trip generation of the facility, the planned circulation of inbound and outbound traffic during drop-off and pick-up operations, and the estimated length of the queue of cars waiting to pick up students. The design of the site and the circulation plan shall ensure that school traffic does back up onto any public street. The traffic circulation study shall include a statement that the owner and/or operator of the daycare or school agrees to operate the facility in accordance with the approved circulation plan. The circulation plan must be approved by the City Engineer before the development request or the specific use permit can be approved.

5. Determination of Applicability – The need for a TIA shall be determined by the City Engineer based upon the results and recommendation from a pre-submission meeting. It shall be the responsibility of the applicant to demonstrate that a TIA should not be required. If a TIA is required, the level of effort for a TIA submission shall be determined based on the criteria set forth in Table 8.14. Depending upon the specific site characteristics of the proposed development, one or more of the following elements may also be required as part of the TIA: an accident analysis, sight distance survey, traffic simulation, traffic signal warrant analysis, queuing analysis, turn lane analysis, and/or traffic circulation plan.

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TABLE 8.14: Criteria for Determining TIA Study Requirements

Analysis Category	Site Trips Generated at Full Build-Out	TIA Analysis Periods[1]	Minimum Study Area[3]
I	>50 peak hour driveway trips; or 100-500 total peak hour trips	1. Existing year 2. Opening year[2] 3. Five years after opening	1. All site access drives 2. All signalized intersections and/or major unsignalized intersections within 0.5 mile to 1 mile of site boundary
II	>500 total peak hour trips	1. Existing year 2. Opening year of each phase 3. Five years after initial opening 4. Ten years after final opening with full build-out	1. All site access drives 2. All signalized intersections and/or major unsignalized intersections within 1.5 miles of site boundary

1. Analysis periods shall include build and no-build scenarios. Assume full occupancy when each phase opens.
2. Assume full build-out.
3. For certain projects, the City may require an enlarged study area. Land uses within the study area should include recently approved or pending development adjacent to the site.

D. Requirements for TIA Updates – A TIA shall be updated when time or circumstances of the original study fall within the parameters presented in Table 8.15. The applicant is responsible for preparation and submittal of appropriate documentation in order for City staff to process the zoning or development application. A TIA for site development requests must be updated if two years have passed since the original submittal, or if existing or assumed conditions have changed within the defined study area. The City Engineer shall make the final determination as to the extent of a TIA update.

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TABLE 8.15: Criteria for Determining TIA Update Requirements

Original TIA Report was based on:	Changes to the Originally Proposed Development:	
	Access Changed[1] or Trip Generation Increased by more than 10%	Access Not Changed and Trip Generation Increased by less than 10%
Zoning; or Preliminary Site Plan or Site Plan that is less than 2 years old	Letter Amendment Required: Identify and report only analysis conditions that have changed	Letter Documenting Change (No analysis is required)
Preliminary Site Plan or Site Plan that is more than 2 years old	Prepare New Study. Must meet all current TIA requirements	Prepare New Study. Must meet all current TIA requirements.

1. Changed access includes proposed new access or refinement of general access locations not specifically addressed in original proposed development.

E. Responsibility of TIA Preparation and Review

1. A TIA shall be prepared in accordance with all of the guidelines in this section and submitted in accordance with the Development Review Schedule set by the City. The responsibility for TIA preparation shall rest with the applicant and must be performed by a Professional Engineer (P.E.) licensed in the State of Texas with experience in traffic and transportation engineering. The final TIA report must be signed and sealed by the P.E. responsible for the analysis to be considered for review by the City. Application and review fees are due at the time of each submittal. The City Engineer shall serve primarily in a review and advisory capacity and will only provide data to the applicant when available.

2. It shall be the responsibility of the applicant to submit four (4) draft TIA reports and executive summaries with the zoning and/or development request submission. The proper number of reports, the timing for submission, and the review of these reports shall be based on standard City development review procedures. Incomplete TIAs or failure to submit a TIA with the submission shall delay consideration of zoning and development requests. Should it be determined during the review of any zoning and/or development plans that a TIA is required, consideration shall be deferred until the applicant submits a completed TIA and the City has reviewed the assessment.

3. The City shall review the TIA and provide comments to the applicant. It shall be the responsibility of the applicant to submit four (4) finalized TIA reports and executive summaries once all review comments have been addressed.

F. TIA Standards

1. Design Level of Service – The minimum acceptable level of service (LOS) within the City shall be defined as LOS “D” in the peak hour for all critical movements and links. All development impacts on both thoroughfare and intersection operations must be measured against this standard.

2. Trip Generation Resources – The City's standard for trip generation rates for various land use categories shall be those found in the latest edition of Trip Generation published by the Institute of Transportation Engineers (ITE) or other published or recognized sources applicable to the region. Alternate trip generation rates may be accepted on a case-by-case basis if the applicant can provide current supporting data substantiating that their development significantly differs from the ITE rates. The City Engineer must approve alternative trip generation rates in writing in advance of the TIA submission.

3. Trip Reductions – Trip reductions for passer-by trips and mixed-use developments will be permitted, subject to analytical support provided by the applicant and approval by the City Engineer on a case-by-case basis. Assumptions relative to automobile occupancy, transit mode share, or percentage of daily traffic to occur in the peak hour must be documented and will be considered subject to analytical support provided by the applicant.

4. Study Horizon Years – The TIA must evaluate the impact of the proposed development on both existing traffic conditions and future traffic conditions for the horizon year(s) as specified in Table 8.14. However, applications for densities of 0.75 Floor Area Ratio (FAR) or greater within the U.S. 75 corridor (throughout the City Limits) shall require that the horizon year land use assumptions be updated to reflect full development based on all proposed zoning. These applications should also assume full development of the Master Thoroughfare Plan or pending amendments.

G. TIA Methodology

1. Site Location/Study Area – A brief description of the size, general features, and location of the site, including a map of the site in relation to the study area and surrounding vicinity.

2. Existing Zoning – A description of the existing zoning for the site and adjacent property, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate);

3. Existing Development – A description of any existing development on the site and adjacent to the site and how it would be affected by the development proposal;

4. Proposed Zoning / Site Development – A description of the proposed zoning/development for the site, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate); identify other adjacent land uses that have similar peaking characteristics as the proposed land use; identify recently approved or pending land uses within the area;

5. Thoroughfare System – A description and map of existing planned or proposed thoroughfares and traffic signals for horizon year(s) within the study area;

6. Existing Traffic Volumes – Recent traffic counts for existing thoroughfares and major intersections within the study area;

7. Projected Traffic Volumes – Background traffic projections for the planned thoroughfare system within the study area for the horizon year(s);

8. Density of Development – A table displaying the amount of development assumed for existing zoning and/or the proposed development (using gross floor area, dwelling units, occupied beds, etc., as required by the trip generation methodology);

9. Existing Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy based on existing zoning (if applicable), and including all appropriate trip reductions (as approved by the City Engineer);

10. Proposed Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy for the proposed development, and including all appropriate trip reductions (as approved by the City Engineer);

11. Net Change in Trip Generation (for rezoning cases) – Proposed trip generation minus existing trip generation (if applicable); the net increase in trips to be added to base volumes for the design year;

12. Trip Distribution and Traffic Assignment – Tables and figures of trips generated by the proposed development (or net change in trips, if applicable) added to the existing and projected volumes, as appropriate, with distribution and assignment assumptions, unless computer modeling has been performed;

13. Level of Service Evaluations – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for both existing conditions and horizon year projections for intersections, thoroughfare links, median openings and turn lanes associated with the site, as applicable;

14. Traffic Signal Evaluations – The need for new traffic signals based on warrants and their impact on the performance of the transportation system;

15. Evaluation of Proposed/Necessary Mitigation – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for intersections, thoroughfare links, median openings and turn lanes associated with the site under proposed/necessary traffic mitigation measures;

16. Conclusions – Identification of all thoroughfares, driveways, intersections, and individual movements that exceed LOS D or degrade by one or more LOS, the percentage of roadway volume change produced by the proposed development, and any operational problems likely to occur;

17. Recommendations – Proposed impact mitigation measures consistent with Subsection I below; and

18. Other information required for proper review – As requested by the City Engineer.

H. TIA Report Format

1. The TIA report must be prepared on 8½" x 11" sheets of paper. However, it may contain figures on larger sheets, provided they are folded to this size. All text and map products shall be computer-based and provided in both published format and computer file format (PDF). In addition, all electronic files used as part of the traffic analysis (i.e., Synchro, HCS, Passer II/III, CORSIM, VISSIM, etc.) shall be provided.

2. The sections of the TIA report should be categorized according to the outline shown below:

Executive Summary

I. Introduction
   - A. Purpose
   - B. Methodology

II. Existing And Proposed Land Use
   - A. Site Location/Study Area
   - B. Existing Zoning
   - C. Existing Development
   - D. Proposed Zoning (if applicable)

III. Existing And Proposed Transportation System
   - A. Thoroughfare System
   - B. Existing Traffic Volumes
   - C. Projected Traffic Volumes

IV. Site Traffic Characteristics
   - A. Existing Site Trip Generation (if applicable)
   - B. Proposed Site Trip Generation
   - C. Net Change in Trip Generation (if applicable)
   - D. Trip Distribution and Traffic Assignment

V. Traffic Analysis
   - A. Level of Service Evaluations
   - B. Traffic Signal Evaluations

VI. Mitigation

VII. Conclusions

VIII. Recommendations

Appendices

I. Traffic Impact Mitigation

1. Mitigation of traffic impacts shall be required if the proposed development would cause a facility or traffic movement to exceed LOS D, or where it already exceeds LOS D and the development would contribute five percent (5%) or more of the total traffic during any projected horizon year. If mitigation is required, the applicant must only mitigate the impact of the proposed development, and would not be responsible for alleviating any deficiencies in the thoroughfare system that may occur without the proposed development.

2. Acceptable mitigation measures shall include:

a. Staging of development in order to relate site development to the construction of the required thoroughfare system;

b. Staging of development so that the site contributes less than five percent (5%) of the total traffic to the affected facility or traffic movement during the projected horizon year;

c. Off-site improvements, including the provision of right of way and/or the participation in funding for needed thoroughfare and intersection improvement projects (including, but not limited to, through lanes, turn lanes or traffic signals); and

d. On-site improvements, including access controls and site circulation adjustments.

3. Mitigation is not required if it can be shown that the traffic impacts of the project are fully mitigated ten (10) years after the final opening with any improvements that are already programmed to be implemented within five (5) years of the initial opening.

J. Administration of the TIA – Based on the results of the TIA and actions recommended by the City Engineer, the Planning & Zoning Commission and/or the City Council, as appropriate, shall take one or more of the following actions:

1. Approve the zoning or development request, if the project has been determined to have no significant impact or where the impacts can be adequately mitigated;

2. Approve the development request, subject to a phasing plan;

3. Recommend study of the City Thoroughfare Plan to determine amendments required to increase capacity;

4. Recommend amendment of the Capital Improvement Program (CIP) to expedite construction of needed improvements; or

5. Deny the zoning or development request, where the impacts cannot be adequately mitigated.

K. Cost of TIA Review by City – The cost for review of TIA submittals shall be based on the parameters set forth in the City's Development Fee Schedule and paid in full at time of submission.

8.13 Pavement and Subgrade Design Requirements

A. General - The following specifies minimum standards required for the design of pavement and subgrade for roadways within the City. These minimum standards are not intended to replace the professional judgment of the project Engineer for any specific pavement project. The standards may need to be expanded or modified on a case by case basis as determined necessary and appropriate by the project Engineer, and as approved by the City Engineer.

1. All roadway, alley, and fire lane pavements shall have a subgrade investigation and pavement design.

2. Pavement and subgrade designs shall be submitted to the City for review in accordance with these requirements. However, any such review shall be conducted as a means to verify if the design has been performed in general conformance to the City's requirements, and shall not be considered a detailed technical review of the design for adequacy, accuracy, or completeness. The project Engineer performing the pavement design shall remain responsible for the technical adequacy, accuracy, and completeness of the pavement and subgrade design and shall not be relieved of any responsibility for such as a result of the City's review.

3. When performing the pavement and subgrade designs and providing submittals of such to the City, the project Engineer shall specifically document in writing any intended deviations from the City's minimum standards, and shall provide adequate justifications as deemed necessary by the City Engineer.

4. Refer to the City's Standard Details and Technical Specifications for additional specific requirements.

B. Subgrade and Pavement Design Report

1. Results of the field and laboratory investigations, engineering analyses and recommendations shall be presented in a report.

2. The report shall be signed and sealed by a Licensed Professional Engineer in the State of Texas trained and qualified to provide geotechnical engineering analysis, and design recommendations.

3. The report shall contain a specific list of pavement and subgrade thickness, moisture conditioning of subgrade soils (if applicable), and stabilization requirements including lime source, type, and concentration (by dry weight) which can be easily incorporated to plans and specifications.

4. All calculations and laboratory tests shall be included in the report along with boring location plan and geology maps.

5. The information and recommendations contained in the report must be accepted by the City Engineer in writing.

C. Subgrade Design Requirements

1. Subgrade investigation may be conducted according to either of two methods: the Swell Test Alternative or the calculated Potential Vertical Rise (PVR) - TxDOT Tex-124-E Alternative.

2. The subgrade investigation shall consist at a minimum of a field investigation and a laboratory investigation.

3. Field Investigation elements include:

a. Swell Test Alternative: Borings shall be drilled on center of roadway at 250’ spacing (or less), alternating between each roadway direction or on a 200’ grid throughout a subdivision to a depth of at least 10’ below finished subgrade.

b. PVR-TxDOT Tex-124-E Alternative: Borings shall be drilled on center of roadway at 250’ spacing (or less), alternating between each roadway direction or on a 200' grid throughout a subdivision to a depth of at least 20’ below finished subgrade.

c. Borings shall be sampled at 3’ intervals or less to a depth of 10’ and at 5’ intervals or less thereafter.

d. Bulk samples of each soil type encountered in the upper 5’ shall be taken.

e. Logs shall be developed to provide a lithographic log of the soil types encountered in each boring, descriptions of each layer and groundwater conditions.

4. Laboratory Investigation elements include:

a. Swell characteristics and movement potential shall be determined using either the Swell Test Alternative or calculated Potential Vertical Rise for a 20’ depth of moisture penetration. Assumptions involved in calculating the PVR shall be documented and submitted to the City upon request.

- Swell Test Alternative: Test for swell potential using ASTM D 4546 at 200 psf stress at least two samples per boring at varying depths from 0’ to 10’ to determine with reasonable certainty the average swell potential of the subgrade.

- PVR-TxDOT Tex-124-E Alternative: Test for swell potential using swell tests (ASTM D4546) and/or soil suction tests (ASTM D5298) necessary to calculate PVR for a 20’ moisture penetration.

b. Moisture Content Tests (ASTM D 2216) shall be performed. Due to the variability in moisture contents, the Geotechnical Engineer shall assess the condition of the samples and the season. When in the Geotechnical Engineer's opinion the samples are wetter than should normally be expected, the samples may be air dried such that the samples represent the drier portion of the year. Average all swell test results to determine the mean maximum swell percentage and the standard deviation. For samples taken during the months of June through September use the mean swell percentage. For samples taken during all other time periods use the mean plus one standard deviation to determine the design swell percentage.

c. Soil types in each boring shall be subjected to classification tests; Atterberg limits (ASTM D 4318) and Percent Passing the No. 200 sieve (ASTM D 1140) and moisture/density. Where logs show uniform conditions, the number of tests can be reduced by visual classification, as long as there is at least one set of classification tests per each two borings.

d. Based upon the results of classification tests, group the samples and identify the subgrade soil types in the upper 5' which impact the pavement design

e. Test for sulfates in the upper 3' of the subgrade in each boring using EPA 9038 or EPA 375.4 with 10:1 dilution ratio. Provide sufficient testing to determine with reasonable certainty the levels of sulfate present.

f. Provide engineering recommendation regarding acceptable sulfate levels for each soil type at the required lime stabilization content.

g. Perform a lime stabilization series for each soil type expected to be in the upper 12" of the subgrade. The Eades-Grimm method of pH testing shall be used to obtain a beginning point. Additional testing shall be performed for each soil type to determine lime content. Minimum Design Criteria are:

- pH = 12.4 after mellowing (ASTM D 2976)
- Swell potential <1.0 percent under 200 psf stress test (ASTM D 4546)
- The minimum lime content shall be the percentage, by weight, of hydrated lime required to meet the City's minimum requirements plus 1.0%.
- For light brown Eagle Ford formation clays, the minimum lime percentage shall be 7.0 percent hydrated lime (plus 1% for field variations for a total of 8%). For dark brown Eagle Ford formation clays, the minimum lime percentage shall be 10.5 percent hydrated lime (plus 1% for field variations for a total of 11.5%).

5. Weathered Eagle Ford formation shale material encountered within 8' below finished subgrade shall be excavated to a depth of at least the depth of required moisture treatment and replaced with on-site light brown or dark brown clays or other approved material.

6. Light brown Eagle Ford formation clays having over 5,000 ppm (0.5%) sulfate, and dark brown Eagle Ford formation clays having over 25,000 ppm (2.5%) sulfate shall be stabilized using double application method.

7. Weathered Eagle Ford formation shale is not suitable for stabilization without appropriate detailed engineering and laboratory design and acceptance by the City. Weathered Eagle Ford formation shale having over 15,000 ppm (1.5 %) sulfate level shall be lime stabilized using double application method.

8. The results of the field and laboratory investigation shall be used to provide a subgrade design typically consisting of moisture treated subgrade and lime stabilized subgrade.

9. Alternative subgrade treatment and stabilization with comparable performance may be proposed if recommended by the Geotechnical Engineer and if approved by the City Engineer in writing.

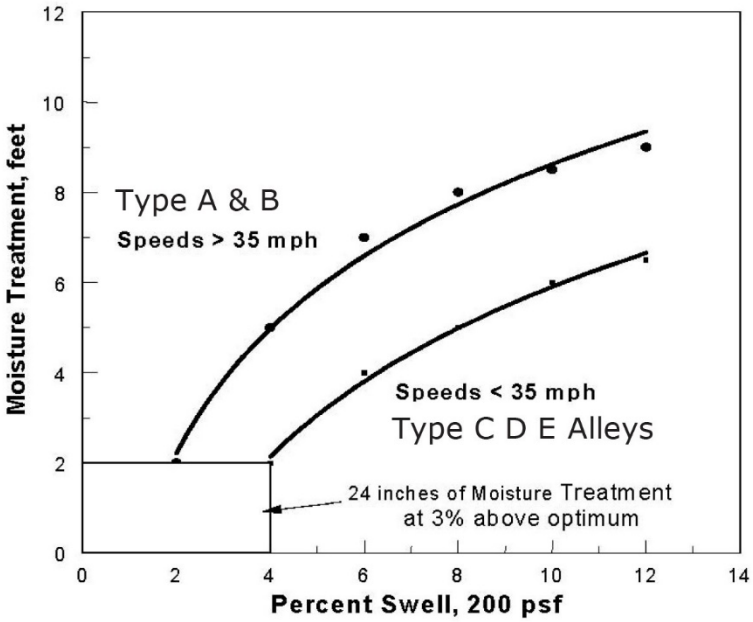
10. The following engineering requirements will apply to the moisture treated subgrade:

    a. Swell Testing Alternative: Use Figure 8.30 to determine the minimum depth of moisture treatment based on average swell potential percentage to 10' (mean plus one standard deviation) and anticipated speed limit.

    b. The PVR shall be calculated based upon 20' moisture penetration and shall provide moisture treatment depth to limit the PVR to 4.5". Submit all calculations and assumptions involved in calculating the PVR and the recommended depth of moisture treatment to the City for review upon request.

    c. Moisture treatment to a minimum of 3 percentage points above optimum moisture content at a minimum of 95 percent standard Proctor (ASTM D 698) shall be required for at least 2' of the subgrade. Thicker zones of moisture treatment may be required depending upon the average swell potential. The thickness shall be determined in accordance with Figure 8.31 or as determined by calculations.

FIGURE 8.30: Recommended Depth of Moisture



11. The upper portion of the subgrade shall be lime stabilized in accordance with the laboratory determined lime percentage. A minimum subgrade thickness of 8" for residential streets and 12" for arterial streets shall be lime stabilized.

12. Moisture treatment and lime stabilization shall extend at least 4' beyond the edge of pavement. A moisture barrier consisting of at least 10 mil poly sheeting shall be placed horizontally on the subgrade beyond the pavement edge and extend at least 6' on either side of the pavement neat line after final compaction. The barrier shall be covered with at least 8" of lightly compacted soil.

D. Pavement Design Requirements

1. Roadway pavement thickness shall be based on subgrade investigation and Pavement Design Catalog.

2. Pavement Design Catalog is provided for each of the two main soil formations in Van Alstyne: the Eagle Ford and the Austin Chalk. Adequate testing is required to determine which soil formation the project site lies within.

3. The Pavement Design Catalog is based on the data contained in Table 8.16. Any alternate designs shall be based on the same data.

4. All concrete for paving shall be Class C unless otherwise approved by the City Engineer.

5. All concrete which comes into contact with soils containing more than 0.1% (1,000 ppm) sulfate shall be designed to resist sulfate attack.

6. All asphalt shall be Type C.

7. Reinforcement shall be no less than #4 bars on 18" spacing.

8. Within the Pavement Design Catalog, the following applies :

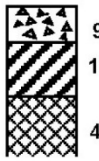
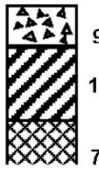
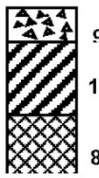
   a. Each option correlates to a specified range of swell potential.

   b. Layer thickness is shown in inches and is not to scale.

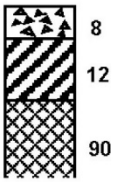
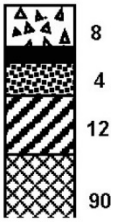
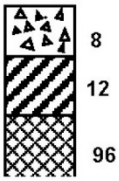
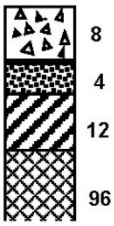
   c. Thoroughfare classes correspond to a specific range of average daily traffic (ADT).

   d. For simplicity, Options 2.1-2.6 only show Type A & B Thoroughfares since Types C-E Thoroughfares will not incorporate a nonwoven geotextile interlayer and CTB

Eagle Ford Shale Formation

Option	Layer	Thoroughfare Class			
		Type A	Type B	Type C	Type D,E Alley, Fire Lane
1.1	Concrete Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		2% ≤ Avg. Swell < 4%			
2.1	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		2% ≤ Avg. Swell < 4%			
1.2	Concrete Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		4% ≤ Avg. Swell < 6%			
2.2	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		4% ≤ Avg. Swell < 6%			
1.3	Concrete Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		6% ≤ Avg. Swell < 8%			
2.3	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		6% ≤ Avg. Swell < 8%			

Eagle Ford Shale Formation (continued)

1.4	Concrete Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		8% ≤ Avg. Swell < 10%			
2.4	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		8% ≤ Avg. Swell < 10%			
1.5	Concrete Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		Swell ≥ 10%			
2.5	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Subgrade Moisture Conditioned Subgrade				
		Swell ≥ 10%			

Austin Chalk Formation

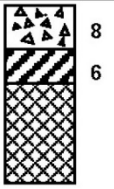
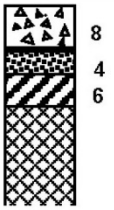
Option	Layers	Thoroughfare Class			
		Type A	Type B	Type C	Type D,E Alley, Fire Lane
1.6	Concrete Lime Stabilized Subgrade Compacted Subgrade				
		0% ≤ Avg. Swell < 2%			
2.6	Concrete Nonwoven Geotextile Cement-Treated Base Lime Stabilized Compacted Subgrade				
		0% ≤ Avg. Swell < 2%			

Table 8.16 – Pavement Design Inputs

Input	Thoroughfare Classification			
	Type A	Type B	Type C	Types D-E Alley, Fire Lane
Design Period	20 years	20 years	20 years	20 years
Initial Serviceability	4.5	4.5	4.5	4.5
Terminal Serviceability	2.5	2.3	2.3	2.0
Concrete MOR @ 28 days	620 psi	620 psi	620 psi	620 psi
Concrete E @ 28 days	5,000,000 psi	5,000,000 psi	5,000,000 psi	5,000,000 psi
Modulus of Subgrade Reaction (Eagle Ford Shale Formation)	300 psi/in	300 psi/in	300 psi/in	270 psi/in
Modulus of Subgrade Reaction (Austin Chalk Formation)	420 psi/in	420 psi/in	420 psi/in	420 psi/in
Reliability	95%	92%	90%	85%
Standard Deviation	0.35	0.35	0.35	0.35
Load Transfer Coefficient	2.9	2.9	2.9	2.9
Drainage Coefficient	1.0	1.0	1.0	1.0
Design Average Daily Traffic (ADT)	60,000	30,000	20,000	12,000
Traffic Growth Rate	3%	3%	3%	3%
Percent Trucks	3%	3%	2%	2%
Lanes	6	4	2	2
Lane Distribution Factor	0.7	1	1	1

9. Alley pavement thickness shall be 8”–5”–8” with pavement strength and reinforcement as shown in the Standard Details.

10. Sidewalk thickness shall be as shown in Table 8.17.

Table 8.17 – Sidewalk Thickness

Sidewalk Width	Thickness of Concrete	Reinforcing
up to 8’	5”	#3 bars @ 18” o.c.e.w.
8’ or greater	6”	#3 bars @ 18” o.c.e.w.

11. Fire lane paving shall be designed with the same design inputs as Types D-E streets.

SECTION 9

LANDSCAPE REQUIREMENTS

Section 9 – Index

Section 9 – Landscape Requirements

SCREENING AND LANDSCAPE STANDARDS

9.1 Intent

The requirements established herein for the installation and maintenance of landscaping and screening are deemed necessary by the City Council to protect and enhance the community's environmental, economic and aesthetic quality, thereby contributing to the overall objective of promoting the public health, safety and general welfare.

More specifically, it is the purpose of this section to:

A. Aid in stabilizing the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, ground water recharge and retardation of stormwater runoff;

B. Aid in abatement of noise, glare, heat and dust;

C. Promote energy conservation and personal comfort by maximizing the cooling effects of vegetation;

D. Help delineate separation of spaces and activities, thereby reducing visual and functional conflicts between land uses and activity areas associated with a site;

E. Enhance community appearance, identity and unique natural beauty;

F. Create visual interest, variety and harmony and provide contrast and relief from the built-up environment;

G. Protect and enhance property values;

H. Establish the minimum landscaping and screening standards and criteria that are necessary to achieve the desired quality of life described by the purposes set forth above.

9.2 Definitions

Terms not defined herein shall have the meaning assigned to them in the Zoning Ordinance, Building Code, or other codes and ordinances of the City of Van Alstyne. Terms not defined herein or in the Code of Ordinances shall have the meaning assigned to them by the latest edition of a recognized dictionary.

A. "Adjacent to Residential District" means located in such a manner as to be adjoining, contiguous with, or abutting a residential district boundary line; even when separated by alley rights-of-way, easements, or street rights-of-way.

B. "Building Site" means:

1. One or more lots as identified by a subdivision plat filed in the plat records of the County of Grayson or Collin, Texas.

2. An area within the platted lot or lots that is delineated by the applicant and approved by the City Manager for the sole purpose of fulfilling the requirements of this section.

C. "Caliper" means the diameter of the trunk measured six (6) inches above ground level up to and including four (4) inch caliper size, and measured twelve (12) inches above ground level if the measurement at six (6) inches above ground level exceeds four (4) inches. If a tree is of a multi-trunk variety, the caliper of the tree is the sum of the largest trunk plus one-half the total of all other trunks, measured at twelve (12) inches above the root ball.

D. "District" means a zoning district as provided by the City of Van Alstyne Zoning Ordinance, as amended.

E. "Evergreen Shrub" means a shrub of a variety identified in Section 9.5.G.3 as an evergreen shrub.

F. "Groundcover" means plants of species which normally reach a height of less than three (3) feet upon maturity, installed in such a manner so as to form a continuous cover over the ground.

G. "Heavy Vehicle Loading Area" means a paved area designed to accommodate the maneuvering, loading and unloading, and parking of commercial vehicles having a length of twenty-seven (27) feet or greater.

H. "Landscape Architect" means a person licensed to practice or teach landscape architecture in the State of Texas pursuant to state law.

I. "Large Tree" means a tree of a variety identified in Section 9.5.G.1 as a large tree.

J. "Light Vehicle Loading Area" means a paved area designed to accommodate the maneuvering, loading and unloading, and parking of commercial vehicles having a length of less than twenty- seven (27) feet.

K. "Masonry Wall" means an exterior wall composed of stone, brick, concrete, gypsum, hollow clay tile, concrete block or tile or other similar building units or materials or combination of these materials laid up unit by unit and set in mortar, or precast panels.

L. "Mow Edge" means a projected concrete footing which is perpendicular to the base of the wall or fence and is contiguous with the ground for the purpose of restricting the growth of weeds and grasses.

M. "Outdoor Storage Area" means the storage of equipment, materials, goods, and supplies including the keeping of automobiles, trucks, boats, trailers, buses, and lawn and garden equipment which are not entirely enclosed within a building and which are not on temporary display for the purpose of being immediately for sale to the public at large (where permitted by the Zoning Ordinance).

N. "Rear Yard" means an open space extending the full width of the lot between the rear lot line and the rear of a main building.

O. "Side Yard" means an open space extending from the front yard to the rear yard between the side lot line and the side of the main building.

P. "Small/Ornamental Tree" means a tree of a variety identified in Section 9.5.G.2 as a small/ornamental tree.

9.3 Application

A. The Screening and Landscape Standards shall apply to all building sites located in the City of Van Alstyne except for the following:

1. Property governed by screening and landscape requirements approved by City Council as part of a Planned Development District unless the Planned Development Ordinance specifies compliance with the regulations set forth herein. In the event that a Planned Development Ordinance does not contain screening and landscape requirements, then these standards shall apply.

    a. The City Council may impose screening and landscape requirements consistent with the purposes and standards set forth herein as a part of all ordinances establishing or amending Planned Development districts.

2. Property included as part of a master plan for a public park facility.

B. Except as otherwise provided in Section 9.3.A, these standards shall apply to a building site at such time as an application for a building permit on such site is made, unless the application is for:

1. A single-family or duplex residence;

2. Restoration, within 12 months, of a building that has been damaged or destroyed by fire, explosion, flood, tornado, riot, act of public enemy, or accident of any kind;

3. Restoration of a building having a City, County, State or national historic designation if it can be demonstrated that compliance with these landscape and screening standards will detract from the historic or architectural significance of the structure, site or existing landscaping.

4. Expansion or renovation of an existing structure that does not:

    a. Increase the area of any surface parking lot on the site by forty (40) percent or greater.

        1. Where the area of any surface parking lot on the site is increased by forty (40) percent or greater, compliance with Section 9.4 shall be required for the affected parking lot.

b. Increase any loading and related maneuvering area on the site by twenty (20) percent or greater.

1. Where the size of any loading and related maneuvering area on the site is increased by twenty (20) percent or greater, compliance with Sections 9.1 and 9.2 shall be required for the affected area.

c. Increase the size or alter the layout of any outdoor storage area on the site.

1. Where the layout of any outdoor storage area on the site is altered or its size increased, compliance with Section 9.3 shall be required for the affected area.

d. Provide additional refuse storage containers or alter the locations of existing containers on the site.

1. Where additional refuse storage containers are provided or the location of existing containers is altered, compliance with Section 9.5 shall be required for the affected containers.

5. New construction on a developed site which does not exceed the percentage of total floor area of all existing structures on the site indicated by the following chart:

Total Floor Area of Existing Structures	Percentage of Total Floor Area
Less than 20,000 ft^2	40%
20,000 to 100,000 ft^2	30%
Greater than 100,000 ft^2	20%

Such construction shall, however, comply with the requirements of Section 9.5.

9.4 Administration and Procedures

The City Manager or his designee is responsible for review of screening and landscape plans and for interpretation of these standards.

A. The City Engineer is responsible for enforcement of these standards.

B. A site plan showing the proposed screening and landscaping shall be submitted as follows:

1. To the Plan Commission when a Detail Development Plan is required for Planned Development zoning or at the time of preliminary platting of single-family or duplex subdivisions, or:

2. To the City Clerk prior to receiving a Building Permit.

C. The site plan(s) shall be prepared by a Landscape Architect, Professional Engineer or Architect registered and licensed to practice in the State of Texas. Plans shall be prepared on a standard size drawing sheet and contain the following information:

1. Project title, address, name of owner, date, north arrow and scale.

2. Boundary lines of the site, physical features of the site, including but not limited to buildings, other structures, parking areas, loading areas, refuse containment areas, outdoor storage areas, walls and fences, adjacent paving such as streets, sidewalks, and alleys, utilities and related easements, drainage courses, existing and proposed grades, and existing trees six (6) inches in diameter or larger at four and one-half (4 ½) feet above the adjacent grade.

3. The location of required screening and plant materials by type, size and quantity.

4. The location of required landscape irrigation system. This is required only prior to receiving a Building Permit.

5. Site drainage information necessary to verify that the proposed screening and landscaping is compatible with, and does not adversely affect, site drainage as shown on the plan.

D. Design of masonry walls greater than four (4) feet in height shall be sealed by a Professional Engineer.

E. The required screening and landscaping shall be in place prior to the issuance of a Certificate of Occupancy.

F. The City may inspect each site periodically after issuance of the certificate of Occupancy to ensure compliance with requirements of this ordinance.

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DESIGN STANDARDS: SECTIONS 9.5 – 9.13

9.5 Methods and Materials

The following shall be accepted methods and materials for required screening and landscaping:

A. Screening Height:

Except where other heights are specified within this or other sections, all required screening shall have a minimum height of six (6) feet from the highest grade immediately adjacent to that portion of the screen.

B. Masonry Walls:

1. Shall be treated on both sides with a finish compatible with the materials, textures, and colors of the architecture of the use being screened.

2. Shall have no greater than ten (10) percent of their surface area composed of openings or of non-masonry materials such as wrought iron, steel or anodized aluminum tubing, pickets or filigree panels. Wood products and chain link fencing are prohibited as components of masonry walls. No opening, including spacing between non-masonry elements, shall allow a sphere six (6) inches or greater in diameter to pass through it.

3. Shall have a continuous landscaped area possessing a minimum width of three (3) feet to allow for required landscaping as specified. Such area shall be located on the side of the wall which faces the activity being screened.

   a. Landscaping shall be required adjacent to masonry walls and shall consist of a minimum of one (1) small/ornamental tree for each ten (10) linear feet, or one (1) large tree for each thirty (30) linear feet, evenly distributed and placed no closer than twenty-five (25) feet on center. This requirement is in addition to other required landscaping.

4. Where such masonry wall faces a street right of way line, a continuous reinforced concrete mow edge possessing a minimum width of twelve (12) inches shall be installed on the side adjacent to the street right of way. Such mow edge shall meet compression strength as required by Section 8.13.D as adopted by the City of Van Alstyne. Mow edges shall have a minimum thickness of four (4) inches and shall be reinforced with a minimum of two (2) steel reinforcing bars three-eighths (3/8) inches in diameter, 24” on center each way, running continuously through such mow edge.

5. Where masonry walls are used to screen the rear and sides of residential lots in conformance with the Subdivision Ordinance, sidewalks shall be placed contiguously with such wall in fulfillment of the requirements of this section or they shall be placed such that no point along the sidewalk is closer than three (3) feet to the mow edge required by Section 9.5.B.4.

C. Earthen Berms:

1. Shall have a maximum side slope of four feet to one foot (4:1).

2. Shall be entirely vegetated with lawn grass or groundcover within two (2) years of the date of planting.

D. Live Screening:

1. Shall consist of a hedgerow of evergreen shrubs which will normally grow to or exceed the minimum height specified in this section. A minimum three (3) foot wide bed shall be provided for the planting of such shrubs.

2. Shall be contained within the site being screened by a wrought iron fence possessing a minimum continuous height of five (5) feet.

   a. Where such wrought iron fence abuts or is within three (3) feet of a street right of way line as measured from the face of the fence, a continuous reinforced concrete mow edge shall be installed in such a manner as to both project twelve (12) inches toward the street right of way as measured from the exterior of the fence post line and project a minimum of two (2) inches toward the site being screened as measured from the interior fence post line. The minimum width of the mow edge shall be sufficient to accommodate required projections and the installation of the fence. Construction standards shall meet the requirements specified in Section 9.5.B.5.

   b. A wrought iron fence shall not be required where live screening is used to fulfill the requirements of the Subdivision Ordinance unless otherwise allowed by City Council.

E. Where evergreen shrubs are used to fulfill the requirements of Section 9.5.D, the frequency of plantings shall accomplish the formation of a solid visual screen within three (3) years of the date of planting. The spacing of such shrubs shall not exceed thirty-six (36) inches on center.

1. Where it can be demonstrated that the plant variety employed will form a solid visual screen with spacing greater than thirty-six (36) inches on center, the City Engineer may vary the requirement of the Landscape Ordinance to allow for greater distances between plantings.

F. Allowed Combinations:

1. A combination of evergreen shrubs, at least thirty-six (36) inches in height, and earthen berms may be used to accomplish the required screening height. The berms shall have an average height of three (3) feet.

2. A combination of masonry walls with required landscaping and earthen berms may be used to accomplish the required screening height.

G. Plant List:

This list specifies acceptable trees to meet minimum tree planting requirements and acceptable evergreen shrubs to meet screening requirements for six (6) foot high screens. Additional non-required trees and shrubs used on a site may be other than those listed herein.

1. Large Trees

Acceptable large trees, as specified herein, shall be at least four (4) inches in caliper at time of planting.

Red Oak	(Quercus shumardi)
Live Oak	(Quercus virginiana)
Cedar Elm	(Ulmus crassifolia)
Pecan	(Carya illinoensis)
Sweetgum	(Liquidambar styraciflua)
Magnolia	(Magnolia grandiflora)
Bald Cypress	(Taxodium distichum)
Burr Oak	(Quercus macrocarpa)
Chinkapin Oak	(Quercus muehlenbergi)
Southern Red Oak	(Quercus falcata)
Texas Red Oak	(Quercus texana)
American Elm	(Ulmus americana)
Chinese Elm	(Ulmus parvifolia)
	Note: The Siberian Elm (Ulmus pumilia) is often confused with the true Chinese Elm, but is not recommended
Green Ash	(Fraxinus Pennsylvania var.Lanceolata)
White Ash	(Fraxinus americana)
Chinese Pistache	(Pisticia chiensis)
Texas Pistache	(Pisticia texana)
Chinese Tallowtree	(Sapium sebiferum)
Ginkgo	(Ginkgo biloba)

American Plane –Tree (Sycamore) (Plantanus occidentalis)

2. Smaller/Ornamental Trees

Acceptable small/ornamental trees, as specified herein, shall be at least eight (8) feet in height at time of planting.

Crape Myrtle	(Lagerstroemia indica)
Yaupon Holly	(Ilex vomitoria)
Bradford Pear	(Pyrus calleryana)
Red Cedar	(Juniperus virginiana)
Crabapple	(Malus floribunda)
Redbud	(Cercis canadensis)
Texas Sophora	(Sophora affinis)
Golden Rain Tree	(Koelreuteria paniculata)
Dogwood	(Cornus florida)
Mexican Plum	(Prunus mexicana)

3. Evergreen Shrubs

Acceptable evergreen shrubs for six (6) foot high screens, as specified herein, shall be at least thirty-six (36) inches in height at time of planting and meet or exceed required screening heights and density within three (3) years of the date of planting.

Red Cedar	(Juniperus virginiana)
Fraser's Photinia	(Photinia fraseri)
Nellie R. Stevens Holly	(Ilex "Nellie R. Stevens")
Buford Holly	(Ilex cornut a "Bufordii")
Waxleaf Ligustrum	(Ligustrum japonicum)
Japanese Ligustrum	(Ligustrum ludicum)
Eleagnus	(Eleagnus ebbing) or (Eleagnus angustifolia)

Automatic irrigation shall be required and in place at the time of installation of all required landscaping and live screening.

9.6 Screening and Landscaping of Non-Residential Yards from Residential Districts

A. Side and Rear Yards:

1. Side and rear yards of non-residential uses adjacent to residential districts and not separated from the district by a street right of way shall be screened in accordance with Section 9.5.

    a. All such screening shall be installed along the entire property line adjacent to the residential district boundary.

2. Side and rear yards of non-residential uses adjacent to residential districts which are separated from the district by a street right of way shall be subject to the provisions of Section 9.5.

9.7 Screening and Landscaping of Non-Residential Yards Adjacent to Public Streets

A. All Yards:

A minimum ten (10) foot wide landscape buffer independent of right of way shall be provided adjacent to all street rights-of-way and shall be maintained as permanent green space. Drives, alleys and sidewalks shall not be contained within the required buffer except that they may cross the buffer to provide access to the site.

1. One (1) large tree or three (3) small/ornamental trees, varieties as specified in Section 9.5.G, shall be provided for each five hundred (500) square feet (or any fraction thereof) of landscape buffer, and shall be planted within the landscape buffer.

2. No screening or fencing other than earthen berms may be located within the required landscape buffer unless otherwise specified herein.

3. Where a pedestrian easement is required, such easement shall be allowed to overlap the landscape buffer provided that a total width of ten (10) feet of permanent, irrigated green space is provided between the property line and the placement of site features including, but not limited to, buildings, parking areas, loading and maneuvering areas and outdoor storage. The ten (10) foot width may be divided into two segments to allow for sidewalk placement. In no case, however, shall the width of either segment be less than three (3) feet, nor the total width of both segments be less than ten (10) feet, not including the width of the sidewalk.

4. If the area contained within the required landscape buffer(s) on a site, excluding sidewalks, crossing drives and alleys, exceeds fifteen (15) percent of the total area of the site, a screening and landscape plan shall be submitted to the City Engineer.

B. Side and Rear Yards:

Where the side or rear yard of a non-residential use contains no site feature requiring screening, no further screening shall be required in addition to the ten (10) foot landscape buffer.

9.8 Screening and Landscaping of Multi-Family Residential Uses from Single Family Residential and Duplex Districts

A. Side and rear yards of multi-family residential uses adjacent to single-family residential and duplex districts shall be screened in accordance with Section 9.5.

9.9 Screening and Landscaping of Site Features

This section shall not waive the requirements of Sections 9.5, 9.6, 9.7, and 9.8. Where a conflict exists between this and Sections 9.5, 9.6, 9.7, and 9.8, the more restrictive shall apply.

Heavy Vehicle Loading Areas:

A. Vehicle Loading Areas:

Shall be screened from Type A, B, C, & D thoroughfares as designated on the City of Van Alstyne Thoroughfare Plan and adjacent residential districts where required by the following provisions.

1. Where the yard containing the loading area is adjacent to a thoroughfare and the loading dock openings are so positioned as to be within forty-five (45) degrees of being parallel to a thoroughfare, screening for the loading area shall meet the following requirements:

    a. Screening shall meet the requirements of Section 9.5. In addition, one large tree shall be planted and evenly distributed for each thirty (30) linear feet comprising the side of the loading area within forty-five (45) degrees of being parallel to the thoroughfare. Where the planting of trees is required under screening options of Section 9.5.D, this provision shall be used in substitution for those requirements. Where the planting of trees in a landscape buffer is required and such landscape buffer is contiguous with the loading area, such trees as required by this section may be planted and evenly distributed in the landscape buffer in fulfillment of these requirements and those of Section 9.7.

    b. Such screening (excluding required trees when placed within the landscape buffer) shall be located a distance not greater than ten (10) feet from the pavement edge of the loading area.

2. Where the loading area is located on property adjacent to a thoroughfare and the loading dock openings are positioned such that they are not within forty-five (45) degrees of being parallel to a thoroughfare, screening of the loading area shall consist of wing walls, evergreen shrubs, earthen berms, or a combination thereof, and in conjunction with one (1) large tree or two

(2) small/ornamental trees per thirty (30) linear feet of the required screening. Such materials shall be placed so as to screen the view of the loading area from an angle of ninety (90) degrees in relation to the thoroughfare.

a. Such screening shall have a minimum height of eight (8) feet. Where evergreen shrubs are used to meet this requirement, they shall have a minimum height of thirty-six (36) inches at time of planting and shall meet or exceed the required height within three (3) years of the time of planting. The spacing of such shrubbery shall otherwise be subject to the provisions of Section

b. The minimum length of the screen, beginning at the building wall containing the loading dock openings, shall be six (6) feet less than the distance from this wall to the interior line of the driveway or fifty (50) feet, whichever is less.

3. Screening of loading areas adjacent to residential districts shall meet the following requirements:

a. Where loading areas are contained within a side or rear yard adjacent to a residential district and such yard is not separated from the district by a street right of way, screening shall meet the requirements of Section 9.5. In addition, one (1) large tree shall be planted and evenly distributed for each thirty (30) linear feet of property line adjacent to the residential district. Where the planting of trees is required under the screening options of Section 9.5.D, this provision shall be used in substitution for those requirements.

b. Where loading areas are contained within a yard adjacent to a residential district, and such yard is separated from the district by a street right of way (regardless of thoroughfare type), the loading area shall be screened in accordance with Section 9.5.

4. Where the City Engineer determines that setback or topographical features accomplish the intent of this section, the City Engineer may lower or waive requirements. However, in no case may the requirements of Section 9.6 be lowered or waived.

B. Light Vehicle Loading Areas:

1. Shall be subject to the requirements of Section 9.5 with the following exceptions:

a. The planting of large trees as required in Section 9.9.A.1.a shall not be required in addition to the provisions of Section 9.5.

b. The placement of screening as required by 9.9.A.2 shall not be required.

C. Non-Residential Outdoor Storage Areas:

Where outdoor storage areas are located within a yard which is adjacent to a residential district or public street, screening of such storage areas shall meet the requirements of Section 9.5, except that the planting of trees as required in Section 9.5.B.3 shall not be required.

D. Non-Residential And Multi-Family Residential Surface Parking Areas:

1. A minimum of five (5) percent of the total parking area shall be landscaped. Such landscaping shall be distributed within the parking area, occurring within medians, islands, or peninsulas.

    a. One (1) large tree or three (3) small/ornamental trees shall be provided for each ten (10) parking spaces and shall be located in such a manner that no parking space is further than one hundred (100) feet from a required tree.
    b. All such landscape areas shall be protected by concrete curbing or other acceptable devices which prohibit vehicular access to these areas.
    c. Bumper overhang shall not be included as part of required landscaping.
    d. A permeable area no less than four (4) feet by four (4) feet shall be provided surrounding each tree located in a surface parking area.

2. Parking areas other than those described for heavy vehicles shall be screened from public streets and adjacent residential districts. Screening shall consist of one or a combination of the following alternatives. In each case, screening shall have a continuous minimum height of twenty-four (24) inches above the top of the adjacent parking area curb.

    a. Masonry walls
    b. Landscaped earthen berms
    c. Evergreen shrubs
    d. Any combination of the above
    e. Landscaping installed to meet the requirements of Section 9.9.D.2 shall be in addition to any landscaping installed to meet the requirements of Section 9.9.D.1.
    f. Where slope, grade differential, or setback between parking areas and surrounding properties accomplish the intent of this section, the City Engineer may waive requirements.

E. Non-Residential And Multi-Family Refuse Storage Areas:

Refuse storage containers shall be screened from public streets and adjacent residential districts. Where they are not entirely screened from these areas by meeting the requirements of other sections, they shall be screened on three (3) sides by the construction of masonry walls. An opening shall be provided on the fourth side for access by refuse collectors. However, the opening shall be situated so that the container is not visible at an angle greater than forty-five (45) degrees from adjacent public streets. Such openings shall have a minimum width of twelve (12) feet to accommodate refuse collection.

9.10 Screening and Landscaping of Single-Family and Duplex Residential Subdivisions

A. Where subdivisions are platted so that the rear or side yards of single-family or duplex lots are adjacent to a Type A, B, C or D thoroughfare (as designated on the City of Van Alstyne Thoroughfare Plan) or are separated from a thoroughfare by an alley, screening shall be provided in compliance with all provisions of Section 9.5 with exception of the following:

1. The three (3) foot landscape area and trees adjacent to masonry walls as provided in Section 9.5.B.3 shall not be required.

2. The five (5) foot chain link or wrought iron fence in addition to evergreen shrubs as provided in Section 9.5.D shall not be required.

3. Where earthen berms are employed, easements in addition to pedestrian easements may be required when the berm is not contained within existing right of way or easement.

B. Where masonry walls as provided in Section 9.5.B are employed to screen residential subdivisions, the developer shall ensure the perpetual maintenance of such screening walls through one of the following methods:

1. Where maintenance of common areas is required in addition to maintenance of required screening, the developer shall form a Homeowner's Association responsible for maintenance of the screening as required in Section 9.14. The Homeowner's Association shall be approved by the City Attorney and the City Manager. The Homeowner's Association shall include in the bylaws a provision allowing the City to assess the Homeowner's Association for maintenance in the event the Homeowner's Association defaults. A maintenance bond shall be provided by the developer issued to the Homeowner's Association for a period of two (2) years. The maintenance bond shall be in the amount of one hundred (100) percent of the total cost of initial construction of the screening. The establishment of the Homeowners' Association and provision of the maintenance bond shall occur prior to acceptance of the subdivision by the City.

2. Where no other common areas exist, the developer shall provide the following maintenance options for masonry walls:

   a. Form a Homeowner's Association to maintain the required screening. The Homeowners Association shall be approved by the City Attorney and the City Manager. The Homeowner's Association shall include in the bylaws a provision allowing the City to assess the Homeowner's Association for maintenance in the event the Homeowner's Association defaults. A maintenance bond shall be provided by the developer issued to the Homeowner's Association for a period of two (2) years. The maintenance bond shall be in the amount of one hundred (100) percent of the total cost of initial construction of the screening. The establishment of the Homeowner's Association and provision of the maintenance bond shall occur prior to acceptance of the subdivision by the City.

C. Where live screening or earthen berms as provided in Sections 9.5.C and 9.5.D are employed to screen residential subdivisions, the developer shall ensure the perpetual maintenance of such live screening or earthen berms by forming a Homeowner's Association. The Homeowner's Association shall be approved by the City Attorney and the City Manager. The Homeowner's Association shall include in the bylaws a provision allowing the City to assess the Homeowner's Association for maintenance in the event the Homeowner's Association defaults. A maintenance bond shall be provided by the developer issued to the Homeowner's Association for a period of two (2) years. The maintenance bond shall be in the amount of one hundred (100) percent of the total cost of initial construction of the screening. 'The establishment of the Homeowner's Association and provision of the maintenance bond shall occur prior to acceptance of the subdivision by the City.

D. If residential development occurs in a non-residential district where such development is permitted but is not expected to be the dominant land use, as required, of the adjoining non-residential use. Such screening shall be installed in accordance with the provisions of Section 9.10.

9.11 Preservation of Existing Trees and Natural Landscape

Preservation of existing trees and natural landscape features shall be encouraged.

A. When the location of existing trees in a healthy and growing condition or significant natural landscape features impedes strict compliance with the standards set forth herein, then the submittal of an alternative landscape and screening plan which incorporates such existing features into the overall site design is encouraged.

B. Existing trees may be used to fulfill tree planting requirements if such trees are in a healthy and growing condition and if they are included on the Plant List set forth in Section 9.5.G. The City Engineer may approve existing trees which are not included on the Plant List as part of the landscape and screening plan upon determining that the tree is of an appropriate size and variety.

C. Existing trees used to fulfill tree planting requirements shall be protected by barricades or other acceptable methods during site preparation and construction to provide an area having one foot of radius for each one (1) inch of caliper, measured at four and one- half (4 1/2) feet above the ground.

1. A minimum of seventy-five (75) percent of the protected area shall be maintained as a permanent permeable landscape area at grades existing prior to site development.

9.12 Visibility

Where rigid enforcement of these landscaping and screening standards creates a conflict with the provisions of Section 8.7 shall take precedence and the landscaping and screening standards shall be reduced to the extent necessary to alleviate the conflict.

9.13 Alternative Compliance

Where unique natural features such as soil characteristics, topography, geological characteristics, water features, and significant vegetation; or peculiarly-shaped building sites; or location of existing structures and other built features on the site inhibit creative site design or pose unnecessary constraints to appropriate development as a result of strict compliance with the requirements set forth herein, the City Engineer may approve an alternative landscape and screening plan upon determining that such plan meets the intent of these standards and meets or exceeds a plan in strict compliance. Prior to submitting an alternative plan under this section, the applicant shall secure the written approval of the City Engineer.

9.14 Maintenance

A. Masonry Walls and Wrought Iron Fences:
All masonry walls and wrought iron fences shall be erected and maintained in conformance with the Fence Ordinance of the City of Van Alstyne and the Uniform Building Code as adopted by the City of Van Alstyne.

B. Landscaping:
The owner, tenant, and their respective agents, if any, shall jointly and severally be responsible for the maintenance of all landscaping. This shall include, but not be limited to, pruning, fertilizing, watering, mowing, weeding, and other such activities necessary to the proper maintenance of landscaping. No plant material shall be allowed to encroach on rights-of-way and easements to the extent that motorists' vision or vehicular traffic is impeded. Automatic irrigation facilities for watering required plant materials shall be required and in place at time of planting, and shall be maintained in proper operating condition. Landscaped areas shall be kept free of trash, litter, weeds, and other such materials that are not a part of the landscaping. All plant material shall be maintained in a healthy and growing condition as is appropriate for the season of the year. All plant material which dies shall be replaced with plant material of required variety and size, within thirty days written notice by the City of Van Alstyne. This time period may be extended if weather conditions inhibit installation of new plant materials.

C. Mow Edges:
The structural integrity of concrete mow edges shall be maintained. Maintenance shall be provided by the owner of the property being screened. Where mow edges are installed on City right of way the mow edge shall be maintained by the owner of the property being screened.

9.15 Appeals

A. The Planning and Zoning Commission shall hear and decide appeals which allege error in any order, requirement, decision, or determination made by the City Engineer in the interpretation and enforcement of these standards.

B. When the Planning and Zoning Commission denies an appeal, a hearing before the City Council shall be set only when an appeal is filed by the applicant with the City Manager within fifteen (15) days of the date of denial.

SECTION 10

LIGHTING REQUIREMENTS

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Section 10 – Lighting Requirements

Section 10 – Lighting Requirements

10.1 General

Standards for controlling lighting and glare are set forth to reduce the annoyance and inconvenience to property owners and traffic hazards to motorists. These standards are intended to allow reasonable enjoyment of adjacent and nearby property by owners and occupants while requiring adequate levels of lighting of parking areas.

10.2 Definitions

The following words, terms and phrases, when used in this chapter, shall have the meanings ascribed to them in this section except where the context clearly indicates a different meaning:

A. Building official means the City Manager for the city, or his designee, having responsibility to enforce and administer this chapter.

B. Bulb or lamp means the source of electric light. To be distinguished from the whole assembly, lamp is used to denote the bulb and its housing.

C. Candela means the unit of luminous intensity in a given direction. It is commonly called one candlepower.

D. Class I lighting means all outdoor lighting used for, but not limited to, outdoor sales areas, recreational facilities and assembly areas, eating areas, repair areas, advertising displays, billboards and other signs and similar applications when color rendition is important.

E. Class II lighting means all other outdoor lighting including, but not limited to, illumination for walkways, roadways, equipment yards, parking areas, outdoor security and similar application when color rendition is not important.

F. Cutoff means a luminaire light distribution where the candela per 1,000 lamp lumens does not numerically exceed 25 (2.5 percent) at an angle of 90 degrees above nadir, and 100 (ten percent) at a vertical angle of 80 degrees above nadir. This applies to all lateral angles around the luminaire.

G. Diffusing luminaire means one that scatters light substantially in all directions as contrasted with a directional luminaire which confines its tight principally in an angle of less than 180 degrees.

H. Fixture means the assembly that holds the lamp in a lighting system. !t includes the elements designed to give light output control, such as a reflector (mirror) or detractor (lens), the ballast, housing and the attachment parts.

I. Floodlight means a luminaire designed to project its light in a well-defined area. It is directional in character.

J. Floodlight beam means the angular spread of light between two orthogonal planes each of which equal ten percent of the maximum candlepower within the beam.

K. Footcandle means the amount of illumination provided by one lumen uniformly distributed on one square foot of surface.

L. Footlambert means the luminance of a surface uniformly emitting, transmitting, or reflecting one lumen per square foot of surface.

M. Full cutoff means a luminaire light distribution where zero candela intensity occurs at an angle of 90 degrees above nadir, and at all greater angles from nadir. Additionally, the candela per 1,000 lamp lumens does not numerically exceed 100 (ten percent) at a vertical angle of 80 degrees above nadir. This applies to all lateral angles around the luminaire.

N. Glare means direct lighting emitted from a luminaire that causes reduced vision or temporary blindness.

O. High pressure sodium (HPS) means a high intensity discharge lamp where radiation is produced from sodium vapor at relatively high partial pressures {100 torr). HPS is essentially point source light.

P. Horizontal plane means a line horizontal to the lowest point on the fixture from which light is emitted.

Q. Illumination means the density of the luminous flux (lumens) incident on a surface. !t is the quotient of the luminous flux divided by the area of the surface, expressed in footcand!es.

R. Incandescent lamp means any lamp that produces light by heating a filament through use of an electric current.

S. Installed means the attachment, or assembly fixed in place, whether or not connected to a power source, or any outdoor light fixture.

T. Kilowatt hour (kwh) means a unit of energy equal to the work done by one kilowatt (1,000 watts) of power acting for one hour.

U. Light source means a device {such as a lamp) which produces visible energy as distinguished from devices or bodies which reflect or transmit light such as a luminaire.

V. Light trespass means light falling outside the boundary of property for which it was originally intended or needed. Also referred to as spillover light or obtrusive light.

W. Low pressure sodium (LPS) means a discharge lamp where the light ls produced by radiation from sodium vapor at a relatively low partial pressure (about 0.001 torr). LPS is a "tube source" monochromatic light.

X. Lumen means the quantity of luminous flux intercepted by a surface of one square foot, all points of which are one foot from a uniform source of one candela. A one candela source provides 12.57 lumens.

Y. Luminaire means a device or fixture containing a light source and means for directing and controlling the distribution of light from the source.

Z. Luminance means the luminous intensity per unit projected area of a given surface viewed from a given direction for purposes of this chapter expressed in candelas divided by distance squared.

AA. Mercury lamp means a high intensity discharge lamp where light is produced by radiation from mercury vapor.

BB. Metal halide lamp means a high intensity discharge lamp where light is produced by radiation from metal halide vapor.

CC. Mounting height means the maximum height of the pole from ground level. The lighting fixture shall not exceed the height of the pole. Refer to section 146-129 of the zoning ordinance for maximum pole height.

DD. Noncutoff means a !uminaire light distribution where there is no candela limitation in the zone above maximum candela.

EE. Outdoor lighting fixture means an outdoor artificial illumination device, whether permanent or portable, used for illumination outdoors and shall include, but not be limited to, devices used for search, spot, flood and area lighting for buildings and structures, recreational facilities, parking areas, landscape lighting, outdoor advertising displays, billboards, signs, public and private street lighting and walkway lighting.

FF. Photometric means quantitative measurements of light levels and distribution.

GG. Semicutoff means a luminaire light distribution where the candela per 1,000 lamp lumens does not numerically exceed 50 (five percent) at an angle of 90 degrees above nadir, and 200 (20 percent) at a vertical angle of 80 degrees above nadir. This applies to aH lateral angles around the luminaire.

10.3 Applicability and Exemptions

This chapter shall apply to all new construction except as follows:

Commercial sites for which lighting was approved as part of a site plan prior to the ordinance from which this chapter is derived shall conform to the provisions of this chapter as was in effect prior to the effective date of the ordinance from which this chapter is derived. As of the date of adoption of this manual, all new submittals must comply with the provisions of this chapter. Any substantial change or addition to the existing lighting system shalt, as determined by the City Manager, however, comply with the provisions of this section.

A. For sites used as single-family residential uses, two-family residential uses and townhome residential uses, residential lighting for security and night recreation use is permitted in all residential districts; provided the following requirements are met:

1. Direct lighting over ten feet in height is shielded from adjacent property in accordance with section 10.6. Luminaries that are directed toward a viewer shall be aimed in such a manner that the viewer's eye, at least five feet above ground at or beyond the property line, shall not be exposed to fixture luminance within the floodlight beam of the luminaire;
2. No light source or luminaire shall exceed a 30-foot mounting height; and
3. Lighting shall not shine directly onto any dwelling beyond the property line.

B. Exceptions and exemptions shall include the following:

1. Lighting installed by a governmental agency for public benefit on public rights-of-way, parks, and public recreation areas;
2. Navigation and airport lighting required by the FAA for operation of airplanes;
3. Emergency lighting by police, fire and/or other municipal, state or federal government authorities;
4. Temporary special effects of holiday lighting if in compliance with the limitations at property lines as outlined in section 10.5. Other temporary lighting effects may be used lf approved by city council in accordance with section 10.8; and
5. The city council may approve exceptions to this chapter for private recreational uses such as ball fields and golf courses if this exception will have minimal impact, if any, on the surrounding land uses, and no adverse impact on the public health, safety, and general welfare.

10.4 Submittal requirements.

As part of any building permit application or prior to altering any existing lighting the applicant shall submit evidence that the proposed work will comply with this chapter. The submission shall contain, but shall not necessarily be limited to, the following, all or part of which may be part or, in addition to, the information required elsewhere in the laws of the city upon application for the required permit:

A. Plans indicating the location on the premises, and the type of illuminating devices, fixtures, lamps, supports, reflectors and other devices, and the mounting height of the light;

B. Description of the illuminating devices, fixtures, lamps, supports, reflectors and other devices may include, but is not limited to, catalog cuts by manufacturers and drawings (including sections where required); and

C. Photometric plans showing illumination levels on the property, at the property line and just beyond the property line, as well as other data such as that furnished by manufacturers or similar data showing the angle of cutoff for light emissions.

D. The required plans, description, and data provided in subsection (A) of this section shall be sufficiently complete to enable the plans examiner to readily determine whether compliance with the requirements of this chapter will be secured. If such plans, description and data cannot enable this ready determination, by reason of the nature of configuration of the devices, fixtures or lamps proposed, the applicant shall additionally submit as evidence of compliance to enable such determination such certified reports of tests as will do so; provided that these tests shall have been performed and certified by a recognized testing laboratory. Prior to issuance of a certificate of occupancy, the applicant shall submit to the building inspections department an as-built photometric plan, stamped by a certified testing laboratory or engineering firm that the installed lighting is in compliance with this chapter.

E. Should any outdoor lighting fixture or type of light source be changed therein after the building permit has been issued, a change request must be submitted to the building official for approval together with the adequate information to ensure compliance with this section, which must be received and approved prior to substitution.

10.5 Illumination

A. **Metering equipment.** Lighting levels of outdoor lighting shall be measured in footcandles with a direct reading portable light meter with a color and cosine corrected sensor with multiple scales. The meter shall read within an accuracy of plus or minus five percent. It shall have been tested and calibrated by an independent commercial photometric laboratory or the manufacturer within one year of date of use as attested to by a certificate issued by such laboratory.

B. **Horizontal method of measurement.** The meter sensor shall be mounted or held not more than six inches above ground level in a horizontal position. Readings shall be taken only after the cell has been exposed to provide a constant reading. Measurements shall be made when the National Weather Service indicates visibility is six miles or greater such that measurements will not be adversely affected by atmospheric scatter. Measurements shall be made at least one hour after sunset or one hour prior to sunrise, with sunset and sunrise being established by the U.S. Naval Observatory, with the existing questioned light sources on, then with the same sources off. The difference between the two readings shall be compared to the

footcandle ratings listed in subsection (d) of this section. This procedure eliminates the effects of moonlight and other ambient tight. However, if lighting levels comply with the light sources on then no further reading is needed with the light sources off to demonstrate compliance.

C. **Vertical method of measurement.** The meter sensor shall be mounted or held at least five feet above ground level in a vertical position, perpendicular to the property line and facing the outdoor lighting in question. Readings shall be taken only after the cell has been exposed to provide a constant reading. Measurements shall be made when the National Weather Service indicates visibility is six miles or greater such that measurements will not be adversely affected by atmospheric scatter. Measurements shall be made at least one hour after sunset or one hour prior to sunrise, with sunset and sunrise being established by the U.S. Naval Observatory, with the existing questioned light sources on, then with the same sources off. The difference between the two readings shall be compared to the footcandle ratings listed in subsection (d) of this section. This procedure eliminates the effects of moonlight and other ambient light. However, if lighting levels comply with the light sources on then no further reading is needed with the light sources off to demonstrate compliance.

D. Limitations.

1. Limitations on neighboring property. The limit of illumination on neighboring property from one establishment shall be based on the zoning of the neighboring property. Maximum computed maintained and maximum measured footcandles at the neighboring property line shall not exceed:

Zoning of neighboring property	**Footcandles Horizontal / Vertical**
Single family and two-family residential district	0.25 / 0.25
Multi-family residential district	0.50 / 0.50
Agricultural	1.00 / 1.00
Non-residential districts except Industrial	3.00 / 3.00
Industrial District	5.00 / 5.00

Exception: Illumination at interior property lines on contiguous lots in a multitenant, nonresidential development may exceed the above criteria when necessary to provide constant lighting levels of adjoining parking areas, fire lanes and interior access roadways as determined by the building official.

2. Limitations on subject property. The maximum outdoor maintained computed and measured illuminance level on the subject property shall not exceed 20 footcandles outdoors at any point, with the following exceptions:

a. Lighting under canopies {such as service stations) shall not exceed 30 footcandles. All other lighting on the site shall comply with the provisions of this section; and

b. Lighting for car dealerships shall not exceed 30 footcandles within the front yard. The front yard being the area on a lot facing a street extending across the front of a lot between the side lot lines and from the main

building to the front lot or street line. The remainder of the property cannot exceed 20 footcandles.

3. Computation of illumination. Illumination at a point may be computed in lieu of measurement. Computation methods shall consist of an Illuminating Engineering Society of North America accepted method, using certified photometric data furnished by the fixture manufacturer, lamp manufacturer, photometric laboratory, or other reliable authority satisfactory to the city. Computations shall be based on new, properly seasoned lamps, new and clean fixtures, and at rated voltage and wattage, with ballasts, lenses, shields, diffusers, and other appurtenances in place, and with proper regard taken for mounting height, relative elevation, natural and manmade objects and industry standard maintenance factors.

10.6 Luminance.

A. Calculations generally. If the City Manager determines that the illumination measurements are not practical and no other means of measuring fixture luminance is immediately available, a computational method as defined in subsection (b) of this section for measuring luminance may be used to determine compliance with this chapter.

B. Luminance calculations using luminaire photometric data. For the purpose of this chapter, the luminance shall be computed by the formula:

$$L = \frac{I}{(d^2 + h^2)}$$

Where I is the fixture candlepower in candelas in the direction of the point from which the calculations are to be made, d is the shortest distance in feet measured horizontally from the property line to a point directly under the luminaire, and h is the height of the luminaire at five feet above the ground as explained in Figure 10.1 below.

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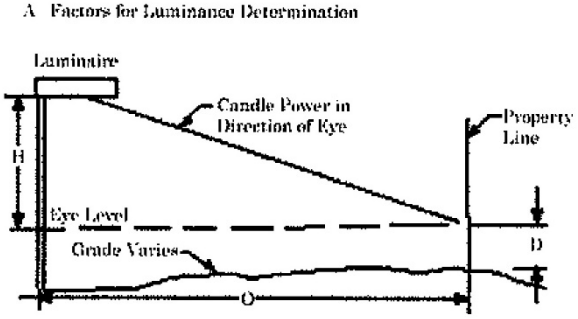
Figure 10.1



C. Luminance limitations. The luminance on neighboring property from one establishment shall be by zoning of the neighboring property. The luminance as calculated in subsection (b) of this section shall not exceed the value by zoning as follows:

Zoning of Neighboring Property	Luminance
Single-Family and Two-Family Residential Districts	0.02
Multi-Family Residential Districts	0.05
Agricultural	0.10
Non-Residential Districts (excluding industrial districts), rights-of-way, and private streets	0.30
Industrial Districts (includes the ML, MH, and BC Districts and PD ordiance with a base district of one of the above districts)	0.50

10.7 Effective outdoor lighting

The purpose of the effective outdoor lighting section is to minimize glare, sky glow, light trespass and excessive energy consumption through the use of appropriate lighting fixtures, practices and systems, while maintaining safety, security and productivity and curtailing degradation of the nighttime visual environment. The following are requirements for effective outdoor lighting:

A. Full cutoff luminaries shall be required in all outdoor lighting installations unless permitted below. Lamp types shall be permitted:

Lamp Type	Class I Lighting	Class II Lighting
Low pressure sodium (LPS)	Prohibited	Prohibited
High pressure sodium (HPS)	Permitted	Permitted
Metal halide	Permitted	Permitted
Mercury Vapor	Permitted	Permitted
Fluorescent	Permitted	Permitted
Any light source 15 watts and under	Non-cutoff permitted	Non-cutoff permitted
Low intensity neon, krypton, or argon discharge tubes	Non-cutoff permitted	Non-cutoff permitted

B. The quality of the light source shall be a minimum of 65 CRI (color rendering index) as indicated by the lamp manufacturer's data;

C. Outdoor lighting for signs shall be as outlined in the Sign Ordinance.

D. Outdoor lighting shall be constructed and installed in a manner consistent with this section and shall be located so as not to produce glare or direct illumination across the building property line or onto rights-of-way and private streets;

E. Outdoor lighting shall be constructed and installed in a manner so as to conform with requirements in section 10.5 so as to not produce light trespass;

F. Searchlights are prohibited except as permitted in the Sign Ordinance.

G. Outdoor light fixtures used to illuminate flags, statues, or any other objects mounted on a pole, pedestal, or platform shall use a very narrow cone of light for the purpose of confining the light to the object of interest and minimize spill-fight and glare. Compliance with this provision shall be subject to approval by the chief building official; and

H. Building facades and architectural features of buildings may be floodlighted when the following conditions are met:

1. Floodlight fixtures are equipped with shields and are located so as to limit the fixture's direct light distribution to the facade or feature being illuminated;

2. The configuration of the floodlight installation shall block all view to the floodlight fixture's lamps from adjacent properties; and

3. The maximum luminance of any floodlighted surface does not exceed the footcandles specified in the Illuminating Engineering Society of North America Lighting Handbook for floodlighting surfaces.

10.8 Exemptions; meritorious exceptions and variances.

A. Temporary exemptions.

1. The City Manager, or designee, may approve temporary exemptions from the requirements of this chapter; provided the duration of the approval is not more than 14 days from the date of approval. Temporary exemptions may be granted for two, two-week periods each calendar year per legal business. A two-week period will commence on the day the exemption is approved. The two, two-week periods shall not occur in the same or consecutive months. A legal business shall include any commercial, industrial, or institutional use for which a certificate of occupancy is issued.

2. Any person may submit a written request, on a form prepared by the city, to the City Manager for a temporary exemption request. The request shall contain the following information:

3. Specific exemptions requested;

4. Type/use of outdoor lighting fixture involved;

5. Duration of time requested;

6. Type of lamp and calculated footcandles;

7. Total wattage of lamps;

8. Proposed location of fixtures;

9. Previous temporary exemption requests;

10. Physical size of fixtures and type of cutoff provided; and

11. Such other data or information as may be required by the chief building official.

B. Requests for renewal or exemptions shall be processed in the same way as the original request. Each renewal shall be valid for not more than 14 days.

C. Approval for temporary exemptions will be based on the effect of location and use of outdoor lighting fixtures.

D. Meritorious exceptions. In the development of this chapter, a primary objective has been ensuring against lighting that creates harmful or negative impacts. On the other hand, an equally primary objective has been to provide adequate lighting for safety and reasonable use of property. The provisions of this chapter are not intended to discourage innovation. It is entirely conceivable that lighting plans could be developed that, while nonconforming to this chapter and thus not allowable, have obvious merit and not only being appropriate to a particular site or location but provide for lighting more in keeping with the spirit of this chapter to balance the above mentioned objectives. Meritorious exception proposals shall be considered at a public hearing by city council after the posting of zoning notification signs and a property owner notice.

E. Variances. The city council may hear appeals from the denial of a permit due to lack of conformance with this chapter. Criteria for granting such a variance is as stated in the state statute, V.T.C.A., Local Government Code et seq., as it may be amended.