

LORENA DESIGN CRITERIA & IMPROVEMENTS

Approved March 20, 2017

“Exhibit A”

CHAPTER 1

DESIGN CRITERIA

SECTION 101 GENERAL

101.1 Intended Use. The following Design Criteria are primarily intended for use by the Developer's Engineer. There may be special circumstances which would dictate requirements in excess of those outlined; however, in most cases, these exceptions will be apparent to the Developer's Engineer while preparing the Construction Plans and Specifications for the subdivision.

101.2 Maintenance. These criteria and related standards shall be maintained, modified and kept current by the City Engineer and/or City Manager.

101.3 Related Standards. The latest version of *Standard Specifications for Construction, City of Waco*, with all amendments thereto, shall govern and shall constitute the technical specifications.

101.4 Compliance Required. All subdivision, development and new construction shall comply with all related City Ordinances, including, but not limited to, the *Subdivision Ordinance* and *Zoning Ordinance*.

101.5 Conformance Required. The City Council and the City or its representatives shall approve no final plat, shall accept no completed improvements, shall issue no permits or rights to

occupy unless and until such improvements conform to these standards herein listed and all other applicable standards as prescribed by the City of Lorena.

All improvements, including, but not limited to, streets, alleys, sidewalks, drainage ways, water and sanitary sewer lines, shall be designed, placed and constructed in accordance with the following *Design Criteria and Construction Standards*.

101.6 Flood Areas. Any land which in its natural state is subject to a 100-year flood or which cannot be properly drained shall not be subdivided, re-subdivided or developed until receipt of evidence that the construction of specific improvements proposed by the Developer can be expected to yield a usable building site. Thereafter, the Planning and Zoning Commission may recommend approval of the plat; however, construction upon such land shall be prohibited until the specific improvements have been planned and completed.

101.7 Variances. Where specific topographic or other conditions make variance from these standards necessary in order to achieve the best overall design, the City Manager upon recommendation from the City Engineer may modify these standards.

101.8 Special Exceptions. Where the appropriate use of the neighboring property will not be substantially injured, the City Manager, after consultation with the City Engineer, may in specific cases, and subject to appropriate conditions and safeguards, authorize special exceptions to the Design Criteria items in order to permit reasonable development and improvement of property where literal enforcement of these values would result in an unnecessary hardship.

SECTION 102 BLOCKS

102.1 Length. The length of a block shall be considered to be the distance from property corner to property corner measured along the property line of the block face (1) of greatest distance, or (2) on which the greatest number of lots face.

Where no existing subdivision controls, the block length should not be less than five hundred (500) feet in length nor greater than one thousand (1,000) feet in length. However, in cases where physical barriers, property ownership, or individual usage creates conditions where it is appropriate that these standards be varied, the length may be increased or decreased to meet existing conditions, having due regard for connecting streets, circulation of traffic and public safety.

102.2 Width. The width of a block shall be considered to be the distance from property corner to property corner measured along the property line of the block face (1) of least dimension, or (2) on which the fewest number of lots face.

102.3 Shape Criteria. The length, width and shapes of blocks shall be determined with due

regard to: provision of adequate building sites, zoning requirements as to lot sizes and dimensions, needs for convenient access and circulation, limitations of topography.

102.4 Streets. Intersecting streets should be provided at such intervals as to serve traffic adequately and to meet existing streets in a safe manner as determined by the City.

102.5 Walkway Required. Where blocks in the vicinity of a school, park or shopping center are platted, the City Manager or his designee shall require a public walkway near the middle of long blocks or opposite a street that terminates between the streets at the ends of the block. If required, the concrete walkway shall not be less than four (4) feet nor more than eight (8) feet in width, through the block from sidewalk to sidewalk, or curb to curb, or if no street, to the property line adjacent to the school, park, or shopping center.

SECTION 103 LOTS

103.1 Design. Lot design shall provide adequate width, depth, and shape to provide open area, to eliminate overcrowding and to be appropriate for the location of the subdivision for the type of development and use contemplated and in accordance with the *Zoning Ordinance* of the City of Lorena.

103.2 Width. No lot shall have less width at the building line than is required by the Zoning Ordinance.

103.3 Building Lines. Building lines shall be shown on all lots in the subdivision but shall not be less restrictive than the *Zoning Ordinance*.

103.4 Front Yard. The shorter dimension across a residential lot, adjacent to a street, shall designate the front yard orientation of the lot, unless otherwise specified on the face of the plat.

103.5 Adequate Size. Depth and width of properties reserved or laid out for commercial and industrial purposes shall be adequate to provide for the off-street service and parking facilities required by the type of use and development contemplated.

103.6 Frontage. Every lot shall have frontage on, and access to, a public street.

103.7 Double Frontage. Double frontage and reverse frontage lots should be avoided except where essential to provide separation of residential development from traffic arteries or to overcome specific disadvantages of topography and orientation.

103.8 Access Limits. Residential lots shall not have direct access onto thoroughfare streets, and direct access from residential lots shall be permitted on collector streets only where design conditions do not permit any other possibility.

103.9 Large Lots. Where the area is divided into larger lots than for normal urban building sites, and in the opinion of the City, any or all of the tracts are susceptible of being re-subdivided, the original subdivision shall be such that the alignment of future street dedications may conform to the general street layout in the surrounding area so that the larger tracts may be later subdivided in conformance with the requirements of this Ordinance and the minimum standards specified by the *Zoning Ordinance*.

103.10 Markers. Lot markers shall be iron pins not less than one half inch (1/2") in diameter and

no less than eighteen inches (18") long and shall be set flush with the ground at each lot corner.

103.11 Corners. All lot corners shall be set prior to the acceptance of the public improvements and shall be marked in a way that is traceable to the responsible registrant or associated employer. See **Section 107.2. Lot and Block Corners.**

SECTION 104 EASEMENTS

104.1 Utility Easements. Utility easements shall be provided on subdivision plats when the following criteria indicate that an easement is required:

1. Where not adjacent to a public right-of-way, easements at least fifteen (15) feet wide for utility construction, service and maintenance shall be provided where necessary in locations approved by the City, and
2. Easements at least fifteen (15) feet wide for utility construction, service and maintenance shall be provided for lots which have frontage along state highways, and
3. Easements of at least ten (10) feet in width shall be provided on each side of all rear lot lines and along side lot lines, where necessary, for utilities such as electric, telephone and gas, and
4. Easements having greater width dimensions may also be required where engineering design or special conditions make it necessary for the installation of utilities outside public right-of-ways.

The following statement of restrictions shall be placed in the dedication instrument:

UTILITY EASEMENT RESTRICTION:

Any public utility, including the City of Lorena, shall have the right to remove all or part of any building, fences, trees, shrubs, other growths or improvements which in any way endanger or interfere with the construction, maintenance, or efficiency of its respective systems on any of the easements shown on the plat; and any public utility, including the City of Lorena, shall have the right at all times of ingress and egress to and from and upon said easements for the purpose of construction, reconstruction, inspection, patrolling, maintaining and adding to or removing all or part of its respective systems without the necessity at any time of procuring the permission of anyone.

104.2 Public Open Space Easement. A 15' x 15' triangular public "open space" easement is required on corner lots at the intersection of an alley and a street.

A 20' x 20' triangular public "open space" easement is required on corner lots at the intersection of two streets.

The following full statement of restrictions shall be placed in the dedication instrument or on the face of the plat:

PUBLIC OPEN SPACE EASEMENT RESTRICTION:

No structure, object or plant of any type may obstruct vision from a height of thirty (30) inches to a height of ten (10) feet above the top of the curb, including, but not limited to buildings, fences, walks, signs, trees, shrubs, cars, trucks, etc., in the public open space easement as shown on the plat.

The preceding Public Open Space Easement restrictions may be altered to permit, on

commercially zoned lots, the placement within the easement area of:

One single pole sign with said pole not to exceed fourteen (14) inches in diameter and with every portion of said sign allowing a minimum height clearance between it and the ground of ten (10) feet.

104.3 Drainage Easement. Drainage easement requirements are as follows:

1. Easements for storm drainage facilities shall be provided at locations containing proposed or existing drainageways.
2. Storm drainage easements of fifteen (15) feet minimum width shall be provided for existing and proposed enclosed drainage systems. Easements shall be centered on the systems. Larger easements, where necessary, shall be provided as directed by the City Engineer.
3. Storm drainage easements shall be provided for emergency overflow drainageways of sufficient width to contain within the easement storm water resulting from a 100-year frequency storm less the amount of storm water carried in an enclosed system of a capacity required by the City of Lorena.
4. No construction or filling without the written approval of the City of Lorena shall be allowed within a drainage easement, and then only after detailed engineering plans and studies show that no flooding will result, that no obstruction to the natural flow of water will result and subject to all owners of the property affected by such construction becoming a party to the request. Where construction is permitted, all finished floor

elevations shall be a minimum of one (1) foot above the 100-year flood elevation.

The following statement of restriction shall be placed in the dedication instrument of the subdivision plat:

DRAINAGE EASEMENT RESTRICTION:

No construction or filling, without the written approval of the City of Lorena, shall be allowed within a drainage easement, and then only after detailed engineering plans and studies show that no flooding will result, that no obstruction to the natural flow of water will result; and subject to all owners of the property affected by such construction becoming a party to the request. Where construction is permitted, all finished floor elevations shall be a minimum of one (1) foot above the 100-year flood elevation.

104.4 Floodway Easement. Floodway easement requirements are as follows:

1. Floodway easements shall be provided along natural drainageways and lakes or reservoirs. Floodway easements shall encompass all areas beneath the water surface elevation of the base flood, plus such additional width as may be required to provide ingress and egress to allow maintenance of the banks and for the protection of adjacent property as determined and required by the City Engineer.
2. Existing creeks, lakes, reservoirs or drainage channels traversing along or across portions of this addition will remain as an open channel at all times and will be maintained by the individual owners of the lot or lots that are traversed by or adjacent to the drainage courses along or across said lots.

3. The City of Lorena will not be responsible for the maintenance and operation of said drainageways or for the control of erosion.

4. Each property owner shall keep the natural drainage channels traversing or adjacent to his property clean and free of debris, silt or any substance which would result in unsanitary conditions, and the City shall have the right of ingress and egress for the purpose of inspection and supervision of maintenance work by the property owner to alleviate any undesirable conditions which may occur.

The natural drainage channel, as is the case of all natural drainage channels, are subject to storm water overflow and natural bank erosion to an extent that cannot be definitely defined. The City of Lorena shall not be liable for damages of any nature resulting from the occurrence of these natural phenomena, nor resulting from a failure of any structure(s) within the natural drainage channels. The natural drainage channel crossing each lot is shown by the floodway easement line as shown on the plat.

The following statement of restrictions shall be placed in the dedication instrument of the subdivision plat:

FLOODWAY EASEMENT RESTRICTION:

No construction, without the written approval of the City of Lorena, shall be allowed within a floodway easement, and then only after detailed engineering plans and studies show that no flooding will result, that no obstruction to the natural flow of water will result; and subject to all owners of the property affected by such construction becoming a party to the request. Where construction is permitted, all finished

floor elevations shall be a minimum of one (1) foot above the 100-year flood elevation.

SECTION 105 ALLEYS

No alleys shall be allowed in any new residential development unless an existing adjacent subdivision has an alley that would be closed or shut off so as to deny said existing alleys of separate ingress and egress. Alleys may be provided in blocks to be used for commercial purposes. The minimum commercial alley width shall be thirty (30) feet of dedicated right-of-way having a minimum of twenty-six (26) feet of pavement.

SECTION 106 SIDEWALKS

Sidewalks shall be required in new subdivisions and wherever deemed necessary for public benefit and safety as determined by the City Manager or the City Engineer, and as follows:

1. Sidewalks shall be constructed for lots adjoining dedicated streets, along major thoroughfares where lots do not adjoin the street, across power line easements and in other areas where pedestrian walkways are necessary.
2. Sidewalks shall be constructed in parking areas to assure safe pedestrian access from parking spaces to structures.
3. Sidewalks shall be constructed so as to assure uninterrupted connections between existing pedestrian walkways.
4. Sidewalks shall be constructed to minimize pedestrian and automobile conflicts.

5. Sidewalks shall be constructed either one foot (1) from the property line within the street right-of-way or within a dedicated sidewalk easement and shall extend along the street frontage including the side of corner lots and block ends.
6. Sidewalk construction may be delayed until development of lots, but in locations not adjacent to lots and across bridges and culverts, the sidewalk shall be constructed with the other improvements to the subdivision.
7. Routing to clear poles, trees or other obstacles shall be subject to approval by City staff.
8. The plat or construction plans shall show the location of all proposed sidewalks and shall state at what stage of the project they will be constructed.
9. All sidewalks and barrier free ramps shall conform to the latest ADA and Texas Accessibility Standards (TAS) requirements. City of Waco Standard Details and Specifications shall apply.

SECTION 107 MISCELLANEOUS

107.1 Private Streets. All streets as defined by the *Zoning Ordinance*, not dedicated to the public shall be paved in accordance with the these *Design Standards* and shall be maintained by means of the property owner or other means as approved by the Commission.

Any request to dedicate a private street as a public street shall be approved only if arrangements are made to bring the street into

conformity with all City standards and regulations in effect at the time of dedication at the cost of affected property owners.

All private streets that intersect with public streets shall be constructed with standard drive approaches. In such cases where an unusual condition exists, the City Engineer may approve standard intersection approaches if the approval is requested prior to the preparation of the plans. Private streets will be named and shown on the plat. Street signs for said private streets shall be erected and maintained by the property owner.

107.2 Lot and Block Corners.

The description and location of all lot and block corners and permanent survey monuments shall be shown on the plat. Such corners and monuments shall meet the following standards:

1. Lot corners shall be one-half (1/2) inch iron rods, embedded in a six (6) inch cylinder of concrete, flush with the ground, with a minimum depth in ground of twenty-four (24) inches.
2. Block corners shall be one-half (1/2) inch iron rods, embedded flush with the ground with a six (6) inch cylinder of concrete, with a minimum depth in ground of eighteen (18) inches. The top of the concrete cylinder must be flush with the ground and of an elevation equal to the top of existing curb or proposed curbs.
3. Permanent type bench mark elevation to sea level datum at block corner of each street intersection and in no case more than eight hundred (800) feet from any other bench mark. These elevations shall be clearly shown on the plat. They top nut on fire hydrants may also be used as permanent bench marks and so indicated on the plat.

107.3 Trench Safety. In conformance with House Bills 662 and 665 as passed by the Seventieth Legislature Regular Session of the State of Texas, all construction projects within the City of Lorena or its extraterritorial jurisdiction as provided by the Municipal Annexation Act (Article 970a, Vernon's Texas Civil Statutes) shall contain provisions for trench safety.

On construction projects in which trench excavation will exceed a depth of five (5) feet, the uniform set of general conditions must require that the bid documents and the contract include detailed plans and specifications for adequate safety systems that meet Occupational Safety and Health Administration standards and that these plans and specifications include a pay item for these same safety systems.

107.4 Underground Utilities. All distribution lines, cables, etc. for utilities shall be installed below ground within the subdivision. Transmission lines or major cables to provide utilities such as electric, telephone and cable television to the area as a whole may be located above ground on the perimeter of the subdivision being served. The installation of these utilities shall conform to commonly accepted construction standards and be subject to review by the City Engineer.

107.5 Revegetation of Disturbed Areas. Revegetation shall occur to all area disturbed by construction prior to acceptance of the project. As a minimum revegetation shall consist of grass sowing, straw mulching, fertilizing and watering. Revegetation shall be acceptable when vegetation growth achieves one (1) inch in height, with 85% coverage, and no greater than 10 square feet bare.

107.6 Off-Street Parking. All parking shall be off-street, meaning that all vehicle maneuvering is done on the subject parcel and not on the street or right-of-way. The following minimum dimensions apply for off-street parking:

Parking Angle	Stall Width	Stall Length	Maneuvering Space
90 degrees	9 feet	18 feet	24 feet
60 degrees	9 feet	18 feet	20 feet
45 degrees	9 feet	18 feet	18 feet

107.7 Driveway Approaches. All driveway approaches connecting to City streets shall be composed of concrete and shall meet the construction requirements as specified in the City of Waco Standard Street Improvement Details. (Note: Driveway spacing and width details are given in Section 201.8, Tables E & F).

CHAPTER 2

IMPROVEMENTS

SECTION 201 STREET IMPROVEMENTS

201.1 Street Classification Definitions. Streets shall be classified according to the following:

1. **Arterial:** The main function of an arterial is to carry traffic from one urban area to another. The arterial system serves the major activity centers of urbanized areas. An arterial is used for longer urban trips and carries a high portion of the total traffic with a minimum of mileage.
2. **Collector:** Carries traffic from local streets to thoroughfare. Also may serve local facilities such as schools, churches. Uses served would include medium and high density residential, limited commercial facilities, elementary schools, some small offices and as direct access within industrial parks. Collector streets also carry heavy traffic to major commercial and industrial facilities from thoroughfare. Uses would include office parks, industrial parks, and community level commercial facilities.

3. **Local or Residential:** Carries traffic from residential and commercial areas to collector streets and interconnects individual sites. Local streets carry light traffic volumes and trips are of a short duration.

201.2 General Requirements. Any roadway design criteria not addressed in these documents shall conform with the latest edition of *ASSHTO's Geometric Design of Highways and Streets* and the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). The following general requirements apply to street improvements:

1. Adequate streets shall be provided by the subdivider. Each street shall be considered in its relation to existing and planned streets, topographical conditions, significant natural features such as mature trees or water courses, public safety and convenience, and its relationship to the proposed uses of land to be served by such street.
2. Whenever a tract to be subdivided abuts any part of any street, such part of the proposed

public street shall be platted. The right-of-way shall be dedicated, and the street shall be constructed by the subdivider consistent with the requirements of the *Subdivision Ordinance*.

3. Whenever a subdivision, development or new construction occurs adjacent to an existing street, the street shall be curbed and guttered according to the specifications given herein. Rural sections (non curb and gutter) will not be approved in subdivisions.
4. Mountable curb sections may be constructed in subdivisions where it is deemed feasible by the City Engineer.
5. All streets shall be designed to coordinate with existing streets in adjoining subdivisions.
6. Streets shall be named to provide continuity with existing streets. Names of new streets shall not duplicate or cause confusion with the names of existing streets. All street names shall be approved by the Planning and Zoning Commission upon recommendation of the City Manager or the City Engineer.
7. Where adjoining areas are not subdivided, the arrangement of streets in the subdivision shall make provision for the proper projection of streets into such un-subdivided area.
8. Streets should be platted to allow two tiers of lots back to back between streets when possible. Exceptions may be made where topography would work substantive hardships on the subdivider.
9. The reservation in private ownership of strips of land at the end of proposed or existing

streets and intended solely or primarily for the purpose of controlling access to property not included in the subdivision shall be prohibited.

10. Half streets (constructing only half the street width) shall be prohibited, except divided thoroughfare streets where essential to the reasonable development of the subdivision in conformity with the other requirements of these regulations, and where the Commission finds it will be reasonable to require the dedication of the other half when the adjoining land is subdivided. The other half of the street shall be platted within the adjacent tract at the time it is platted.
11. Partial cul-de-sacs (more than one entrance and exit) are not permitted on arterial or collector streets.

201.3 Cul-de-sacs. The following shall apply to cul-de-sacs:

1. Streets designated to be dead-ended permanently shall be platted and constructed with a paved cul-de-sac. Any dead-end street of a temporary nature, if longer than two hundred (200) feet, shall have a surfaced turning area eighty (80) feet in diameter and a street property line diameter of at least one hundred (100) feet for a cul-de-sac. Temporary dead-end streets shall have provisions for future extension of the street and utilities and, if the temporary cul-de-sac is utilized, a reversionary right to the land abutting the turnaround for excess right-of-way shall be provided.
2. A street ending permanently in a cul-de-sac should not be longer than six hundred (600) feet and shall be provided at the closed end with a turnaround having an outside roadway

diameter of at least eight (80) feet, and a street property line diameter of at least one hundred (100) feet.

201.4 Street Class Requirements. The following street class requirements shall apply:

1. Street layout shall provide for continuation of collector streets in areas between thoroughfares.
2. Those local streets designated by the Planning and Zoning Commission shall be extended through the tract to the tract boundary to provide future connection with adjoining unplatted lands. In general, these extensions should be at such intervals as necessary to facilitate internal vehicular circulation with adjoining unplatted lands.
3. Where single family or duplex uses abut an existing or proposed thoroughfare or collector street, the plat or dedication instrument will provide:
 - i) Lots to side onto the arterial with a non-access restriction on the thoroughfare or collector side, or
 - ii) Reverse frontage with screening and containing a non-access restriction along the rear property line, or
 - iii) Other treatment as may be necessary or required for adequate protection of adjoining properties, and as approved by the City Council after taking into consideration the proposed method of off-street parking and maneuvering which will prevent the necessity of backing into the thoroughfare or collector street.

201.5 Street Design General Provisions. The following general provisions shall apply:

1. All dedicated streets shall conform to the criteria set forth. Additional right-of-way may be required at intersections and at high-volume driveways to provide for left and right turn lanes to maintain traffic volume capacities through the intersections. Additional utility easements may also be required beyond the right-of-way in some locations.
2. The dedicated streets shall conform to the minimal design parameters as shown in Table A in section 201.8.
3. Streets shall be designed in accordance with The Texas Department of Transportation's Highway Design Division Operations and Procedures Manual.
4. No street intersections of an arterial street with another arterial street shall intersect at an angle of less than seventy-five (75) degrees. Intersections of collector streets shall not intersect at an angle less than seventy-five (75) degrees. Intersections of local streets shall not intersect at an angle less than sixty (60) degrees.
5. All intersections shall have:
 - i) A tangent section at least 50 feet long that meets the angle of intersection requirements, and
 - ii) A centerline curve radius of at least 400 feet.

201.6 Pavement Types. The developer or contractor will be required to furnish soil tests to the City Engineer on the subgrade soils at four hundred foot (400') intervals or more frequently

if material changes are encountered. Such data will include, but is not necessarily limited to: Liquid Limit, Plasticity Index (P.I.), and Percent Passing No. 200 sieve. Tests will be performed by an independent testing laboratory, approved by the City of Lorena at the developer's or contractor's expense.

Subgrades will be stabilized with lime or cement treated base material to at least one foot beyond the limits of the proposed roadway, regardless of the type of soil encountered. The amount and type of stabilization will be in accordance with the geotechnical investigation recommendation. Cement Stabilized Base shall be placed only on subgrade properly compacted at or near optimum moisture content. All bases shall be Plant Run. The percentage of cement to be added to the soil shall be determined by data furnished by a commercial laboratory or from a previously approved mix design that can be substantiated from a similar recent project.

The minimum pavement thicknesses are provided below:

1. For Local Streets serving primarily residential areas, the developer shall construct 6 inches of Portland Cement Stabilized Base and 1 1/2 inches of Type "D" asphalt on a minimum of 6 inches of stabilized subgrade.
2. For Collector Streets and alleys, the developer shall construct 8 inches of Portland Cement Stabilized Base and 2 inches of Type "D" on a minimum of 6 inches of stabilized subgrade or as approved by the City Engineer.
3. For Arterial Streets, the developer shall provide a geotechnical report with a recommended pavement thickness as approved by the City Engineer.

With approval by the City, Flexible Base may be used in lieu of Portland Cement Stabilized Base.

No street surface or pavement shall be constructed until all planned underground facilities affecting the portions of streets intended for vehicular traffic have been installed and properly backfilled.

During construction, density tests shall be taken every five hundred (500) feet. Density reports shall be submitted daily to the City's Staff. Tests shall be performed by a Registered Professional Engineer and /or a commercial testing laboratory, and shall be in accordance with common engineering practice.

201.7 Street Signs. The following requirements shall apply:

1. Street signs shall be furnished and installed by the Subdivider for all intersections within or abutting the subdivision.
2. Street signs shall be 6 inches extruded, match existing street signs and include the block numbers along with the street name.
3. Stop signs shall be 24 inch by 24 inch in size and shall conform to the standards as set forth in the *Texas Manual on Uniform Traffic Control Devices*.
4. All signs shall be of engineer grade reflective material and be located in accordance with the *Texas Manual on Uniform Traffic Control Devices*.
5. The sign pole shall be buried to a minimum depth of 2 feet and placed in 12 inches diameter concrete filled posthole. The pole shall be tall enough to accommodate all applicable signs. The bottom of the stop sign shall be located 7 feet above the

finished grade of the surrounding ground. Poles shall adhere to State sign mounting detail standards for break away support.

201.8 Street Design Tables. The following tables provide design information.

Table A – Street Design Criteria

Street Classification	Min Design Speed (MPH)	Max % Grade	Min % Grade	Area Free from Storm Water, Using a 100-Year Frequency Storm
Arterial	60	6	0.5	One lane in each direction
Collector	50	8	0.5	One lane or center 12'
Local	30	10	0.5	-

Table B – ROW and Street Widths

Functional Class	No. Lanes	Min ROW	Recommended ROW	Street Width (Back of curb to Back of curb)
Arterial	4	64'	80'	55'
	3	64'	70'	43'
	2	64'	65'	43'
Collector	2	64'	65'	40'
Local	3	56'	70'	43'
	2	50'	60'	31'

Table C – Lane Widths

Location	Functional Classification	Min	Recommended
Urban	Arterial	12'	12'
	Collector	10'	12'
	Local	10'	12'
Rural	Arterial	12'	12'
	Collector	12'	15'
	Local	12'	15'

Table D – Design Speeds

Location	Functional Classification	Recommended Range (mph)
Urban	Arterial	45-70
	Collector	40-50
	Local	35-40
Rural	Arterial	50-70
	Collector	40-60
	Local	40-50

Table E – Access Management Minimum Spacing

Functional Classification	Driveway Spacing	Median Openings	
		Directional	Full
Arterial	440'	2640'	5280'
Collector	100'	N/A	330'
Local	One Per Lot	N/A	N/A

Table F – Driveway Widths

Area	Minimum	Maximum
Residential	8'	24'
Commercial	10' – One Way	24'
Industrial	10' – One Way	26'

201.9. Horizontal Curves and Super-elevation

Curves should be at least 500 ft long for a central angle of five degrees, and the minimum length should be increased 100 ft for each one degree decrease in the central angle.

201.10 Vertical Curves

When two (2) longitudinal street grades intersect at a point of vertical intersection (PVI) and the

algebraic difference in the grades is on percent (1.0%) or greater, a vertical curve is required. Crest and sag vertical curves shall be designed based upon design speed of the roadway. Vertical curves shall conform with the latest edition of *ASSHTO's Geometric Design of Highways and Streets*.

SECTION 202 WATER SYSTEM IMPROVEMENTS

202.1 General. This section pertains to general design requirements for water distribution system construction in the City of Lorena.

1. The developer shall furnish, install, construct, or extend at his own expense, water distribution facilities necessary for the proper development of the subdivision. The water system shall provide individual service to every lot in the subdivision. All water mains constructed within a proposed subdivision to allow for future extension of the water system into adjacent properties. The water system shall be designed and constructed in accordance with the specifications contained in these Standards. Where considered necessary by City Staff, the facilities shall be sized in excess of that dictated by these Standards to provide for the future growth and expansion of the City's water distribution system.
2. All water lines shall be sized and designed in accordance with City of Lorena recommendations or as determined by the City Engineer. In the absence of specific standards, all water supply, distribution, pumping, and storage improvements shall be designed in accordance with the most current standards of the American Water Works Association, *Standard Specifications for Construction of the City of Waco*, and criteria

adopted by the Texas Administrative Code, Chapter 290, "Water Hygiene".

3. Water lines for multi-family, commercial and industrial fire protection lines shall be dedicated to the public, unless the system is isolated from the public system by a detector check.
4. All components of the water system must comply with ANSI/NSF Standard 61.

202.2 Water Line Sizing

1. Standard water line sizes are 6 inch, 8 inch, 12 inch, and 16 inch diameter. Other sizes must be approved by the City Engineer.
2. All water lines shall be a minimum of 6 inches in diameter. All water lines shall be looped except in cul-de-sacs. Dead end lines shall not exceed 50 feet on multi-family, commercial, or industrial sites.

202.3 Water Line Location

1. Along State Highways, water lines are required to be constructed on both sides of roadway. New water lines crossing existing streets shall be placed by boring. A casing shall be required under arterial and collector roadways. Open cut excavation will not be allowed to cross existing streets, unless approved in advance and in writing by City Manager.
2. All public water lines located on private property shall be centered in an easement. Water lines shall not be located under paved surfaces where possible. Easements for water line construction shall meet the requirements in **Section 104.1 Utility Easements**:

3. All piping with mechanical couplings, push-on, or similar joints subject to internal pressure shall be designed with blocking, anchors, and restraining harnesses to preclude separation of joints.

202.4 Water Line Materials

1. Polyvinyl Chloride (PVC) Pipe / Fittings shall meet requirements of *Standard Specifications for Construction City of Waco*.
2. Polyvinyl Chloride (PVC) Pipe used for potable water is to be pigmented blue.

202.5 Installation

1. General
 - i) All installations shall conform to the latest *Standard Specifications For Construction City of Waco*, as amended by these standards.
 - ii) All water pipes shall be installed with a minimum of 42 inches of cover over top of pipe or in special cases as required by the design shown on the plans.
 - iii) At the end of each workday, all trench excavation shall be backfilled to the end of the pipe laying operation. Barricades and lights will be required around any open trench left overnight.
 - iv) All connections to existing water mains shall be made under pressure unless dry connections will not cause any loss of service. Under special conditions connections that cause an interruption of service may be performed with approval of the City Engineer.
 - v) Density tests shall be taken every two hundred (200) feet at the Contractor's expense. Density reports shall be submitted daily to the City's Staff.
- vi) All density reports shall be completed and delivered to the City's Staff before paving is allowed to begin.
- vii.) PVC Water Pipe and appurtenances shall be installed as specified in AWWA Manual M-23 and in accordance with the pipe manufacturer's recommendations. Fittings shall be installed in accordance with AWWA C-600.

202.6. Fire Hydrants

1. Fire hydrants in commercial areas shall generally be at street intersections and so located that there will be a fire hydrant every three hundred (300) feet. Fire hydrants in a residential area shall be generally located on street intersections and not over five hundred (500) feet apart. Fire hydrants in a multi-family complex shall be generally located on street intersections and not over three hundred (300) feet apart.
2. Materials
 - i) Fire hydrants shall comply with *Standard Specifications for Construction City of Waco* or as otherwise required by the City of Lorena.
 - ii) Shut off
 - a) The valve action shall provide positive shut-off at minimum closing torque.
 - b) Wedge action closing gates shall not be used.
 - c) All hydrants shall open by turning the operating-stem nut to the LEFT

(COUNTER CLOCKWISE). A clearly visible CURVED ARROW and the word "OPEN" shall be cast in relief on the top of the hydrant to indicate the direction of opening.

d) All hydrants shall have an isolation valve for maintenance and repair purposes.

iii) Bury Length - The standard fire hydrant bury length from ground to bottom of the connecting pipe shall be 3 feet 6 inches. The hydrant shall be of a design that will permit extensions without disturbing the bottom section of the hydrant.

iv) Hydrant Body - The body of the hydrant between the elbow and the top cap must be made in two parts connected by a swivel flange, or breakable flange which will permit facing of the nozzles in any desired direction in increments of 45 degrees or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the bottom section of the hydrant. Gradelok or approved equal may be used to accommodate site conditions. Extension sections will not be allowed unless approved by the water department manager.

v) The fire hydrant body shall be painted a high gloss alkyd fire hydrant red.

vi) Ballards shall be placed around fire hydrants in high traffic areas. The ballards shall be placed at 45 degree angles to the fire hydrant with a minimum spacing of 30 inches.

3. Location Markers - A location marker shall be placed in the center of the roadway opposite the fire hydrant. If the fire hydrant is located near the intersection of at least two streets, a marker shall be placed on all streets. The installation of this reflector shall be in accordance with the manufacturer's recommendation. Location markers shall be Stemsonite 1-88-55A or approved equal.

4. Manufacturers - Approved fire hydrants manufacturers are Clow Medallion and Mueller Centurion and shall comply with the requirements of *Standard Specifications for Construction City of Waco* or as otherwise required by the City of Lorena.

202.7 Valves

1. Resilient seated gate valves shall be used for 6 inch through 16 inch water lines.
2. Valves of approved design shall be installed at the intersections of all water mains so as to provide for proper maintenance and operation of the system and to provide a means of shutting off the supply to portions of the system for repairs. Valves shall be spaced such that only two fire hydrants are out of service at any one time. Three (3) valves shall be used on a four-way water line intersection and a minimum of two (2) valves shall be used on a three-way intersection.
3. Gate Valves / Butterfly Valves
 - i. Resilient seated gate valves and butterfly valves shall comply with the requirements of *Standard Specifications for Construction City of Waco* or as otherwise required by the City of Lorena.
4. Installation

- i) Valves shall be furnished with extensions, such that the working nut is a maximum of 48 inches below grade.
- ii) Adjustable valve boxes shall be furnished and set on each valve in accordance with these standards. Valves that are deeper than 48 inches, AWWA C900 PVC pipe shall be used for stacks, as long as the adjustable valve box is used at the top.
- iii) After the final clean-up and alignment has been complete, the contractor shall cast in place a concrete block, 24 inches by 24 inches around all valve box tops at the finish grade.
- iv) Valves located within a right-of-way shall be indicated on the face of the curb, or where curbs do not exist, on a conspicuous location adjacent to the valve location. Markings are to be the stamping of a four (4) inch high letter "V" with the point of the "V" pointing towards the valve location.
- v) Valve markers shall be provided in rural areas.

5. Manufacturers

- i) Approved manufacturers of 3 inch through 12 inch resilient seated gate valves shall be Clow R/W F6100 and Mueller A2360 and shall comply with the requirements of *Standard Specifications for Construction City of Waco* or as otherwise required by the City of Lorena.
- ii) Approved manufacturers of 16 inch and larger butterfly valves shall comply with the requirements of *Standard Specifications for Construction City of*

Waco or as otherwise required by the City of Lorena.

202.8 Air Release and Flushing Valves

1. Adequate air relief and flushing valves shall be provided for flushing, disinfection, daily operation requirements and repairs when required by the City Manager or the City Engineer. Air release valves shall be required on 12 inches and larger water lines. Water lines shall be designed so that each section of the water line can be flushed at its lowest and highest points.
2. All dead end lines shall have a fire hydrant installed for flushing purposes. If installation of a fire hydrant is not possible, a flushing valve is required.
3. A fire hydrant shall be required at high points on water lines smaller than 12 inches for air relief and flushing.

202.9 Tapping Sleeve

A tapping sleeve and valve shall **not** be used when connecting a new water line to an existing line, unless it has been approved in writing by the water department manager. If approved a resilient seated gate valve shall be flanged to the tapping sleeve. The tapping sleeve shall be stainless steel and shall comply with the requirements of *Standard Specifications for Construction City of Waco*.

202.10 Water Service

1. The water meter box shall be placed a minimum of 6 inches behind the back of curb, and the water service shall be no more than 24 inches deep, covered with a meter box in place at grade. If no curb is present, the water service shall be located at the

property line, no more than 24 inches deep, covered with a meter box in place at grade. Along roadways without a curb the water service line shall be constructed at a minimum of 18 inches below the ditch flow line. All water services crossing beneath streets must be encased in 4 inch diameter PVC casing sealed with neoprene end seals or grout if approved by the Public Works Director.

2. Meter and service sizes will be determined by the developer prior to requesting service from the City. The minimum water service size between the water main and the meter shall be 3/4 inches and the minimum meter size shall be 5/8 inches. Jumbo or oversized meter boxes must be used for residential meters.
3. Water services on undeveloped lots shall be located at the property line and shall be a minimum of 1 inch in diameter.

4. Materials

- i) Service saddles shall comply with the requirements of *Standard Specifications for Construction City of Waco*.
- ii) Service lines shall be 3/4 inch minimum diameter, Type K copper as specified in ASTM B88.

5. Installation

- i) General
 - a) All water service shall be installed in accordance with these standards.
 - b) Each individual service location shall be saw cut into the face of the curb with a four (4) inch high blue "W" painted by the Contractor. If no curb

exists, a similar mark should be placed in the pavement near the edge of the roadway.

- ii) Residential Meters – All residential meters shall be manufactured by Census or other manufacturer as required by the City of Lorena.
- iii) Commercial or Institutional Meters (2 inches and larger) – The developer shall purchase from the manufacturer a master compound meter that is approved for use by the City of Lorena. The meter shall be installed by a utility contractor or licensed plumber. All meters in this size class are required to have a strainer prior to the meter. The City may require specialized meter vaults for Commercial or Institutional applications.

202.11 Water Line Bore

1. Minimum casing thickness shall be 1/4 inch. Casings shall be required under collectors and thoroughfares, highway crossings, and railroad crossings. Casings may also be required where deemed necessary by the City Engineer. The construction bore pit shall be located at a minimum distance of four (4) feet behind the back of curb or edge of pavement where no curb is present.
2. The design engineer shall design the water line pipe casing.
3. Materials
 - i) Steel Casing Pipe – Steel casing pipe shall be new (or used if approved by the City Engineer) and suitable for the purpose intended and shall have a minimum yield strength of 35,000 psi. Casing shall meet

ASTM A-36, ASTM A-570, ASTM A-135, ASTM A-139, or approved equal.

- ii) Minimum nominal size of casing shall be large enough to accommodate the outside diameter of the bells of the carrier pipe plus 2 inches. Casing ends shall be sealed with neoprene end seals or grout if approved by the Public Works Director.

- iii) Carrier pipe shall be Certa-loc C-900/RJ.

4. Installation

- i) Excavations within the right-of-way and not under surfacing shall be backfilled and consolidated by mechanical methods as specified in these standards for compaction of trenches under roadways. Surplus material shall be removed from the right-of-way and the excavation finished to original grades. Backfill pits immediately after the installation of the carrier pipe is completed. If carrier pipe is not installed immediately after casing pipe installation, the City may require the access pits be temporarily backfilled until installation of carrier pipe.
- ii) Where seeding or sodding is disturbed by excavation or backfilling operations, such areas shall be replaced by seeding or sodding as specified elsewhere.
- iii) Carrier pipe bells must maintain a minimum of one inch clearance from the casing wall. The carrier pipe must be braced and anchored in a manner that prevents movement in any direction. The carrier pipe must be installed in a manner that will permit its removal with reasonable ease. Spacers must be placed on the carrier pipe at no more than 2 feet

from each joint and maximum spacing as per manufacturer's recommendations. Spacers on the carrier pipe must be a maximum of one inch from the casing wall. All casings exposed to the atmosphere must be painted an approved color and thickness to prevent oxidation and corrosion.

SECTION 203

WASTEWATER SYSTEM IMPROVEMENTS

203.1 General. This section pertains to general design requirements for wastewater collection system construction in the City of Lorena. All sewer lines shall be sized and designed in accordance with City of Lorena recommendations or as determined by the City Engineer. In the absence of specific standards, all collection, treatment, and disposal systems shall be designed in accordance with the most current criteria adopted by the Texas Administrative Code, Chapter 317, *Design Criteria for Sewerage Systems*.

- 1. All sewers shall be designed with consideration for serving the full drainage area subject to collection by the sewer in question; the drainage area may be modified with the concurrence of the City Engineer because of the projected rate of development or the financial feasibility of the proposed extension.
- 2. Sewers should be designed with straight alignment whenever possible. When horizontal curvatures must be used, the maximum joint deflection should be in accordance with the pipe manufacturer's recommendations.
- 3. The developer shall furnish, install, construct, or extend, at his own expense, wastewater collection facilities necessary for the proper

development of the subdivision. The wastewater collection system shall provide individual service to every lot in the subdivision. All sewer mains constructed within a proposed subdivision shall be extended to the perimeter of the proposed subdivision to allow for future extension of the wastewater collection system into adjacent properties. The wastewater collection system shall be designed and constructed in accordance with the specifications contained in these Standards. Where considered necessary by City Staff, the facilities shall be sized in excess of that dictated by these Standards to provide for the future growth and expansion of the City's wastewater collection system.

4. All sewers shall be designed with hydraulic slopes sufficient to give mean velocities, when flowing full or half full, of no less than two (2) feet per second on Kutter's or Manning's formulas using an "n" value of 0.013. Slopes shall also conform to TAC Chapter 317, *Sewage Collection System*.
5. When a 150 psi rated sewer line is required due to its proximity to a water line, the 150 psi rated pipe shall terminate at a manhole on each end. The pipe shall be extended to the interior wall of the manhole. No external boot connection will be allowed.

203.2 Sanitary Sewer Line Sizing

1. Standard sewer line sizes are 6 inches, 8 inches, 12 inches, and 15 inches in diameter; other sizes must be approved by the City Engineer.
2. Sewer lines shall be a minimum of 6 inches in diameter.

203.3 Location

1. Sewer lines shall be constructed at a minimum depth of four (4) feet. They shall be located on both sides of a state highway.

Easements for sewer line construction shall meet the following requirements in **Section 104.1 Utility Easements**:

203.4 Materials

1. All sanitary sewer pipes shall be PVC pipe type SDR-26 pigmented green. PVC pipe will not be allowed for depths greater than twenty-four (24) feet unless approved by City Engineer. If service connections are needed on sewer pipe constructed below fifteen (10) feet in depth, a parallel line shall be constructed at a shallower depth, specifically for service connections.
2. PVC sewer pipe and fittings shall comply with the requirements of *Standard Specifications for Construction City of Waco* or as otherwise required by the City of Lorena.

203.5 Installation

1. General
 - i) All installations shall conform to ASTM Designation D2321, and the latest *Standard Specifications for Construction City of Waco* as amended by these standards.
 - ii) Sewer lines shall not be installed within nine (9) feet horizontally of any water main or fire hydrant.
 - iii) Construction shall begin at the downstream end of project and continue upstream with the bell facing upstream. No upstream piping shall be installed

before downstream piping unless approved by the City Engineer.

2. Excavation and Backfill

- i) At the end of each workday, all trench excavation shall be backfilled to the end of the pipe laying operation. Barricades and lights will be required around any open trench left overnight.
- ii) Density tests shall be taken every two hundred (200) feet at the Contractor's expense. Density reports shall be submitted daily to the City's Staff.
- iii) All density reports shall be completed and delivered to the City's Staff before paving is allowed to begin.

203.6 Inspection

1. All sanitary sewer lines shall be inspected prior to acceptance by the City.
 - i) The Contractor is responsible for cleaning the sewer pipe. If the inspection shows debris or evidence that the line has not been properly cleaned, the line will not be accepted.
 - ii) The line must pass both air and mandrel tests.
2. Criteria for Repair
 - i) The Contractor shall make repairs if the inspection reveals any deficiency in the sewer line. If repairs are required, a television inspection shall be made after the repairs are complete from manhole to manhole at the Contractor's expense.
 - ii) Repairs shall be made to the satisfaction of the City Staff and City Engineer.

203.7 Manholes

1. Manholes shall be located at all intersections of sewer lines and at intermediate spacing along the line. Generally the maximum spacing should not exceed five hundred (500) feet. Manholes should be located at all changes in grade and at the ends of all sewer lines that will be extended.
2. A manhole is required at the junction of sewer lines with different inside pipe diameters.
3. A drop of at least 0.1 feet is required through the manhole when a change in flow direction occurs.
4. The flow line into a manhole should not be greater than 6 inches above the flow line out of the manhole. Where the flow line in is greater than two (2) feet above the flow line out, a drop manhole is required.
5. Minimum manhole inside diameter is four (4) feet.
6. Drop-connection manholes shall have a minimum inside diameter of five (5) feet, with an interior drop connection if line size is greater than eight (8) inches.
7. Minimum pre-cast wall thickness is five (5) inches.
8. A manhole is required where a sanitary sewer line enters and exits private property.
9. All manholes shall be constructed of concrete per the City of Waco Manhole Details.

10. Installation

- i) Use the following table to determine sanitary sewer manhole sizes:

Pipe Sizes	Depth of Cover	Maximum Diameter of Manhole	Number of Pipe Connections Allowed in Manhole
Under 12"	<12'	4'	3
	12' - 20'	5'	3
12" to 18"	<12'	5'	3
	12' - 20'	6'	4

NOTE: *If the proposed design requires the sewer line to be placed at depths greater than shown above, the design will require approval by the City Engineer.*

ii) Cast-in-place

- a) The inlet and outlet pipes shall be poured into the foundation of the manhole. The pipe shall extend one and one half (1½) inches into the manhole. When straight through flow occurs, the pipe shall not be laid continuously through the manhole.
- b) The invert shall be shaped and smoothed so that no projections will exist and the invert shall be self cleaning. The invert floor shall have a minimum slope of one (1) inch per foot.
- c) Concrete work shall conform to all requirements of ACI 301, Standard Specification for Structural Concrete, published by the American Concrete Institute, except as modified herein.
- d) Portland Cement shall be Type II, low-alkali and conform to ASTM Designation C-150.
- e) The manhole shall not be backfilled within twelve (12) hours after the concrete placement.

- f) The face of curb shall be sawed with an "MH" to mark the location of all manholes. The location of the stamp shall be a line that intersects the center of the manhole cover and the curb perpendicular to the centerline of the street. For manholes located in intersections, the curb shall be stamped at the closest location to the manhole. If no curb exists, a similar mark should be placed in the pavement near the edge of the roadway.

iii) Precast Manhole

- a) Precast manholes shall be constructed in accordance to City of Waco Manhole Details.
- 11. Approved precast manhole manufacturers shall comply with the requirements of *Standard Specifications for Construction City of Waco*.

203.8 Manhole Frame and Cover

1. Cover

- i) All manhole covers shall be forty-eight (48) inches in diameter.
- ii) All manhole covers shall have two (2) integrally cast pick bars.
- iii) Manholes shall have the words "Sanitary Sewer", "City of Lorena"
- iv) Acceptable manufacturers shall comply with the requirements of *Standard Specifications for Construction City of Waco*.

2. Frames

- i) All manhole frames shall conform to the Standard Specifications for Grey Iron Castings, ASTM A-48, Class 30 B.
- ii) All manhole frames shall provide a 48 by $\frac{1}{4}$ inch opening to assure proper fit of the manhole cover.
- iii) Acceptable manufacturers shall comply with the requirements of *Standard Specifications for Construction City of Waco*.

3. Extension Ring

- i) All precast reinforced concrete extension rings shall conform to ASTM C-478.
- ii) The number of extension ring sections shall be kept to a minimum (i.e. use 1-12 inch extension ring instead of 2-6 inch extension rings).
- iii) A 1 inch by 3 1/2 inch bitumastic gasket shall be used to seal the extension ring at both joints.

203.9 Sewer Service

1. No sewer service line (lateral) shall be less than four (4) inches in nominal diameter. Commercial sewer laterals shall be six (6) inches minimum diameter.
2. Sewer laterals shall be located at the center of the lot and extended to the property line and be a minimum of ten (10) feet downstream of the water service.
3. Sewer service laterals shall have no more than six (6) feet of cover at the property line.
4. A cleanout shall be located on the service lateral at the time of connection to the building.

5. All lateral sewer service lines shall be PVC pipe type SDR-35.
6. All service laterals shall be installed in accordance with the sanitary sewer embedment and backfill standards.
7. Each individual service location shall be saw-cut into the face of the curb with a 4-inch green "S" painted by the contractor. If no curb exists, a similar mark should be placed in the pavement near the edge of the roadway.

203.10 Cleanouts

1. All cleanouts are to be constructed of PVC pipe type SDR-35.
2. PVC sewer pipe and fittings shall conform to the current ASTM Designation D 3034 for four (4) inches through fifteen (15) inches and ASTM Designation F 679 for greater than fifteen (15) inches.

203.11 Main Line Cleanouts. Main line cleanouts shall be located on dead end sewer mains at a distance no greater than 25 feet from the preceding manhole. If the distance is greater than 25 feet, a manhole shall be installed at the end of the line.

203.12 Aerial Sewer

1. The City Engineer will give approval if an aerial crossing will be allowed.
2. The piers for the aerial crossing shall be designed in accordance with the guidelines of the Ductile Iron Pipe Research Association.
3. Aerial sewer crossings shall be located in areas where the sewer line cannot be constructed with the appropriate minimum cover. The design engineer shall design the

aerial crossing in accordance with these standards and as approved by the City Engineer.

4. Pier placement and spacing shall be determined according to soils analysis performed by a geotechnical engineer. Piers shall be placed at a maximum span distance as indicated by the design engineer's calculations.
5. Pier placement and spacing along with a soils report shall be submitted to the City Engineer.
6. All above ground sewer installations shall be ductile iron, minimum Class 150, utilizing restrained joints and shall have a wall thickness required for the size and span as designed. The pipe shall have an internal polyurethane coating.
7. The aerial pipe shall be connected to the sanitary sewer pipe by means of a manhole on each side of the aerial crossing.
8. Piers are to be constructed with a minimum of Class A 3,500 psi reinforced concrete.
9. The design engineer shall submit both a pipe design and pier design for approval by the City Engineer.

203.13 Sewer Line Boring

1. The design engineer shall design the sewer line pipe casing.
2. Steel casing pipe shall be new (or used if approved by the City Engineer) and suitable for the purpose intended and shall have a minimum yield strength of 35,000 psi. Casing shall meet ASTM A-36, ASTM A-570, ASTM A-135, ASTM A-139, or approved equal. All bores shall be installed at a grade

no less than the minimum indicated by TAC, Chapter 317 for the desired pipe size.

3. All bores shall maintain grade enough to ensure desired clearance distances between existing utilities and bore.
4. Excavations within the right-of-way and not under surfacing shall be backfilled and consolidated by mechanical methods as specified in these standards for compaction of trenches under roadways. Surplus material shall be removed from the right-of-way and the excavation finished to original grades. Backfill pits immediately after the installation of the carrier pipe is completed. If carrier pipe is not installed immediately after casing pipe installation, the right-of-way Owner may require the access pits be temporarily backfilled until installation of carrier pipe.
5. Where seeding or sodding is disturbed by excavation or backfilling operations, such areas shall be replaced by seeding or sodding as specified elsewhere.
6. Minimum size of casing shall be large enough to accommodate the outside diameter of the bells of the carrier pipe plus 2 inches. Casing ends shall be sealed with neoprene end seals or grout if approved by the Public Works Director. Carrier pipe shall be Certa-loc Yellowmine or other pipe approved by the Public Works Director. Carrier pipe bells must maintain a minimum of one inch clearance from the casing wall. The carrier pipe must be braced and anchored in a manner that prevents movement in any direction. The carrier pipe must be installed in a manner that will permit its removal with reasonable ease. Spacers must be placed on the carrier pipe at no more than 2 feet from each joint and maximum spacing as per manufacturer's

recommendations. Spacers on the carrier pipe must be a maximum of one inch from the casing wall. All casings exposed to the atmosphere must be painted an approved color and thickness to prevent oxidation and corrosion.

203.14 Lift Stations

1. Lift stations must be designed in accordance with 30 TAC, 317.3.

2. Instrumentation and Control

i) The voltage supplied for pump operation shall be 3 phase, 480 volts. Converting single phase power to 3 phase power using additional mechanical equipment shall not be allowed.

ii) Wet-well level control shall be achieved through the use of an ultrasonic level indicating transmitter.

iii) Submersible pumps shall be provided with moisture and motor over-temperature sensors.

3. Site Requirements

i) A concrete pad will be required at the front of the control cabinet. The pad shall provide a three (3) foot working area away from the face of the cabinet and extend the width of the enclosure mounting structure. Pad depth shall be a typical four (4) inches.

ii) A one (1) inch minimum potable water service is required. The water service may be set in a standard eighteen (18) inch galvanized water meter box with a one (1) inch brass angle stop. A reduced pressure backflow assembly of

appropriate size and capacity will be required.

iii) The site shall be graded to drain away from the station to prevent stormwater inflow or infiltration into the wet-well.

iv) The site shall be located outside of the 100-year flood plain.

v) The site shall not be located within one hundred (100) feet of an existing or proposed residence, if possible.

vi) If applicable the lift station site driveway shall include driveway area for maintenance vehicles to park off public roadway while performing maintenance. The minimum driveway length shall be fifteen (15) feet.

vii) A concrete driveway turning area is required where access drives extend more than twenty (20) feet from main roads. The driveway area shall be "T" shaped with the applicable turning radius. The minimum driveway width shall be fifteen (15) feet.

SECTION 204

DRAINAGE AND STORM SEWER IMPROVEMENTS

204.1 General. Drainage facilities shall be provided and constructed by the developer in accordance with all City standards and the following basic requirements:

The developer or owner is required to meet all FEMA regulations. When submittal to FEMA is required, the submittal must be submitted to and approved by the City Engineer prior to submitting to FEMA. Conditional Letter of Map Revisions (CLOMRs) and Letter of Map Revisions

(LOMRs) are required for any modifications to a floodplain or floodway.

A Certificate of Occupancy will not be issued by the City until a copy of the FEMA approval letter for the LOMR is sent to the City (if required for the site). In the typical development of a site, a CLOMR precedes site development, and a LOMR follows site development and is based on as-built conditions.

204.2 Runoff Calculations

1. The selection of which method to use for calculating runoff depends upon the size of the contributing drainage area at the most downstream point of the project. The "Rational Method" is acceptable for designing projects in which the drainage area is less than two hundred (200) acres. A unit hydrograph method is required for projects with larger drainage areas.
2. No matter which method is used to calculate runoff, a developer or builder of property greater than one (1) acre in size, or any property that was platted as a part of an overall tract which was greater than one (1) acre in size (including churches and schools), shall develop the property so that the rate of runoff created by the development as it leaves the property does not exceed the rate of runoff that would have been created if the property had developed as a single-family residential property.
3. Runoff computations shall be based upon fully developed watershed conditions in accordance with current land use projections. The design engineer shall size drainage facilities by disregarding the detention effects of upstream property and calculating the runoff as if the off-site property was

developed without any detention. If an approved regional detention/retention facility is in operation, the design engineer may size downstream drainage facilities based on consideration of the detention effects of the regional facility.

4. Procedure for drainage areas less than two hundred (200) acres.
 - i) Computation of Storm Water Runoff for by the "Rational Method."

The following Coefficient of Runoff shall be used during design:

C = Coefficient of Runoff.

Park areas - No developed land	0.30
Developed Park sites	0.40
Single Family Residential	0.55
Duplex	0.60
Multiple Family	0.70
Schools	0.70
Churches	0.70
Neighborhood	
Commercial	0.70
Office Commercial	0.70
Commercial	0.85
Industrial	0.85

- ii) When designing inlets and laterals, the time of concentration is equal to the inlet time. The design engineer will compare the above specified inlet times to the actual calculated inlet time by computing the flow time overland and along the gutter to the first inlet. Manning's equation shall be used to determine flow time to the inlet. The design engineer may use the actual calculated or specified inlet time.
 - a) The inlet time shall be ten (10) minutes for property zoned multiple family, churches, schools, local

business, central business, commercial, or industrial.

- b) An inlet time of fifteen (15) minutes shall be used for property zoned for parks, cemeteries, agricultural, and single family residential.

5. Procedures for Drainage Areas greater than two hundred (200) acres:

- i) For drainage areas in excess of two hundred (200) acres the use of a unit hydrograph method shall be made. The use of a unit hydrograph calculation will be based upon standard and accepted engineering principles subject to the approval of the City Engineer. Acceptable methods include the Soil Conservation Service (SCS) Technical Release Number 55 or the Corps of Engineers HEC-1 models for drainage areas 200 acres or more.
- ii) The unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from the small on-site detention facilities for maintaining the rate of runoff as if the property was developed as single-family residential use.
- iii) Designers should be aware that the requirement of designing for fully developed watershed conditions will mean that they will have to calculate these fully developed flows instead of using the flows calculated in the Federal Emergency Management Agency's (FEMA) flood insurance studies for Lorena or McLennan County.

204.3 Design Storm Frequencies

The approved drainage system shall provide for positive overflow at all low points. The term "positive overflow" means that when the inlets do not function properly or when the design capacity of the conduit is exceeded, the excess flow can be conveyed overland along a grassed or paved course. Normally, this would mean along a street or alley, or shall require the dedications of special drainage easements on private property.

DRAINAGE FACILITY	DESIGN RECURRENCE INTERVAL
Closed Storm Sewer Systems	10-year with 100-year positive overflow in streets such that the depth of flow in the street does not exceed the top of curb.
Closed Storm Sewer Systems and Inlets at Street Low Point or Sag	100-year with positive overflow
Culverts and Bridges	100-year
Concrete-lined Channels	100-year
Earthen Channels	100-year

204.4 Street Capacity

1. The depth of flow in the streets shall not exceed the top of curb for the 100-year storm.
2. The first floor elevations of all residential and other structures shall be set at a minimum elevation of one foot above the top of the street curb elevation, and with positive drainage provided away from the structure. Positive overflow sections shall provide a minimum of 1 foot of freeboard from the overflow invert adjacent to structures and the corresponding first floor elevation of all residential and other structures.

204.5 Inlet Placement and Capacity

1. Storm sewer inlets shall be built along paved streets at such intervals that the depth of flow, based upon the 100-year storm, does not exceed the top of curb. Inlets shall be located as necessary to remove the flow based on a 10-year storm. If in the opinion of the City Engineer the flow in the gutters would be excessive using the above design criteria, the storm sewers or inlet locations could be altered to relieve adverse conditions.
2. Inlets shall be placed upstream from an intersection whenever possible. At any intersection, only one street shall be crossed with surface drainage and this street shall be the lower classified street. When an alley intersects a street, inlets shall be placed in the alley whenever flow down that alley would cause the capacity of the intersecting street to be exceeded.
3. The minimum inlet size shall be five (5) feet. No more than twenty (20) feet of inlet shall be placed along one gutter at any given location. Minimum sizes of laterals shall be 24 inches for use with all inlets. Where laterals tie into trunk lines, place the laterals on a 60 degree angle with the trunk line and connect them so that the longitudinal centers intersect.

204.6 Pipe Design Standards

1. Storm sewer conduit shall be sized to flow full. Manning's Equation shall be used to determine the conduit size.
2. Minimum and Maximum Velocities in Pipes

- i) The minimum velocities in conduit shall be 2.5 feet per second.
- ii) Maximum velocity in the pipe shall not exceed 12 feet per second.
- iii) The maximum discharge velocities in the pipe shall also not exceed the permitted velocity of the receiving channel or conduit at the outfall to prevent erosive conditions. The maximum outfall velocity of a conduit in partial flow shall be computed for partial depth and shall not exceed the maximum permissible velocity of the receiving channel unless controlled by an appropriate energy dissipater (e.g. stilling basins, impact basins, riprap protection).

3. In general, storm water shall be carried in concrete pipe conduit, but other types of conduit can be used to carry stormwater. However, prior permission to use other conduit materials must be obtained from the City Engineer.
4. Hydraulic Gradient
 - i) Conduits must be sized, and slopes must be set such that runoff flows smoothly down the drainage system. To insure this smooth passage, the hydraulic gradient must be at the proper elevations. The hydraulic grade line shall be established and shown on the plans for all storm sewer design.
 - ii) The hydraulic grade line shall in no case be closer to the surface of the ground or street than one (1) foot.
 - iii) Hydraulic gradient calculations shall account for all head losses that may occur

in the storm sewer line. Friction head loss shall be determined by direct application of Manning's Equation.

204.7 Culvert Design

1. Culverts must be designed using standard methods and engineering judgement. Culverts shall be designed in accordance with the latest edition of the Texas Department of Transportation (TxDOT) Hydraulic Design Manual.
2. Culvert hydraulic grade line calculations shall consider both inlet and outlet control.
3. Stream stability shall be assessed when determining the number of barrels, height and width and culvert skew. Potential for scour shall be accounted for in the design.

204.8 Channels

1. Open channel design criteria:
 - i) Channels may be left in their natural state at the discretion of the City Manager or the City Engineer, provided that the channel velocities are 6.0 feet per second or less and that one (1) foot of freeboard is available during the design storm event.
 - ii) If the natural channel is to be replaced by an improved channel, the flow from the 100-year design flood must be contained within the improved channel while allowing for one (1) foot of freeboard.
 - iii) Improved channels shall be trapezoidal shaped and include a lined section if the design velocity is greater than six (6) feet
- iv) Unless shown to be feasible in a soils report sealed by a licensed professional engineer in the State of Texas and approved by the City Engineer, improved channels shall have minimum side slopes of:
 - a) Four (4) feet horizontal to one (1) foot vertical for earthen, grassed-lined side slopes.
 - b) 1.5 feet horizontal to one (1) foot vertical for concrete-lined side slopes in rock.
- v) Where practicable, all unpaved channels should have sufficient grade to avoid ponding during backwater flow conditions. A minimum slope of 0.40% is required for earthen channels and swales, except those used as part of a wetlands area.
- vi) The developer or owner shall use low maintenance vegetation for vegetative cover, as approved by the City Manager or City Engineer prior to planting. The selection of materials shall comply with *Standard Specifications for Construction City of Waco*.
2. Manning's equation can be used to design channels and determine water surface elevations and velocities when backwater effects are negligible. Channels where

per second. Lining types such as concrete, rock walls and gabions may be used upon approval of the City Engineer. The maximum velocity allowed in concrete lined channels is fifteen (15) feet per second.

backwater effects occur must be designed using models accepted by FEMA.

3. All channel sections must consider and account for channel stabilization in their design. This requirement pertains to all sections whether they are left in their natural condition or are modified in any manner. The design of all drainage channels and swales shall assure adequate capacity and minimum maintenance to overcome the result of erosion, silting, sloughing of bends or similar occurrences.

204.9 Detention Design. Detention/retention facilities shall be designed for the 100-year design flood according to the following criteria:

1. Dedicated detention/retention basins shall also include an additional one (1) foot of freeboard and two (2) feet of sediment storage. The volume of runoff storage for drainage areas greater than two hundred (200) acres shall be computed using unit hydrograph procedures. Acceptable unit hydrograph procedures are provided in section 204.2.5 of this document.

For drainage areas less than two hundred (200) acres, the above methods are recommended; however, an approximate routing method based on the rational formula is allowable.

2. All detention facilities designed shall consider the timing of the flood peak in the main channel into which the detention facility drains. Delaying the peak from a site in lower portions of a watershed may result in a higher peak on the main channel.
3. A detention facility shall have enough gradient to ensure positive drainage to the

outlet structures so as to avoid nuisance conditions such as standing water, odors, insects, and weeds. A minimum slope of 0.40% towards the outlet structure is required for all detention facilities.

4. Drainage easements shall be provided for all detention/retention facilities and for other detention/retention facilities where two (2) or more owners are involved.
5. Detention facilities shall be designed to empty in less than 24 hours, unless it is also serving as an erosion control facility.
6. The owner shall maintain detention/retention facilities and channels unless the facilities are specifically dedicated to and accepted by the City of Lorena. Detention facilities must be properly maintained if they are to function as intended over a long period of time. The following measures are required to ensure the facility functions properly.
 - i) Facilities should be mowed at least three times a year to control weeds and discourage woody growth.
 - ii) Debris, litter and accumulated sediment should be removed from detention facilities at least three times a year. Particular attention should be given to removal of debris, litter and sediment around outlet structures.
 - iii) Detention basins designed for sediment removal shall be maintained as specified in the maintenance plan and approved by the City with construction plan submittal.

2204.10 Offsite Drainage. Detention/retention facilities shall be designed for the 100-year design flood according to the following criteria:

1. The owner or developer of property to be developed shall be responsible for all storm drainage flowing on his property. This responsibility includes the drainage directed to that property by prior development as well as drainage naturally flowing through the property by reason of topography.
2. Adequate consideration shall be given by the owner in the development of property to determine how the discharge leaving the proposed development will affect downstream property.
3. When any proposed development requires the need for offsite grading or includes areas of two (2) or more where stormwater runoff has been collected or concentrated, whether it be by permanent drainage systems or streets, it shall not be permitted to drain onto adjacent property except in existing creeks, storm sewers or streets unless the following is provided:
 - a. Notarized letter of permission from the affected property owner; or
 - b. Proper drainage easements are obtained; or
 - c. If the owner is unable to acquire the necessary offsite easements, he shall provide the City with documentation of his efforts, including evidence of a reasonable offer made to the adjacent property owner. Upon such a written

request for assistance, the City shall attempt to acquire these easements through negotiations. If the negotiations are unsuccessful, the request may, at the developer's option, be submitted to Council for consideration of acquisition through condemnation. In either case, the total cost of the acquisition and the cost of the easements shall be paid by the owner (developer): or

- d. If the developer is unable to obtain either (1) or (2) above and chooses not to pursue City assistance as outlined in (3) above, he shall provide the City with documentation of his efforts. The developer will then execute a notarized letter. Said letter shall be in a form approved by the City Attorney and shall provide that the developer shall agree to save and hold harmless the City of Lorena from any and all claims or suits for damage arising out of the required grading and/or concentrations of flow. The City reserves the right to require the notarized letter of permission or easement from the affected property owner prior to construction.
4. The subdivider shall pay for the cost of all drainage improvements required for the development of his subdivision, including any necessary offsite channels or storm sewers and acquisition of the required easements, in which only (2) or (3) above shall apply.

In areas where the proposed offsite improvement are to be made within existing City rights-of-way, an estimate of these offsite costs shall be prepared and submitted along with the plans. Subject to City Council approval, cost for such offsite

improvements shall be prorated to the extent that the owner pays for a percentage of the offsite cost based on the increase of the discharge originating within the limits of his addition.

5. Where it is anticipated that additional runoff incident to the development of the subdivision will overload an existing downstream drainage facility, whether natural or manmade, and result in hazardous conditions, the Planning Commission and/or the City Council may withhold approval of the subdivision until appropriate provision has been made to accommodate the problem, and plans shall be provided which include all necessary improvements, including storm sewer systems, channel grading, driveway adjustments, and culvert improvements, etc.