### Article Five – Subdivision Design and Improvement Requirements

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Section 5.01 - Adequate Public Facilities and Services

A. An applicant for development review, including rezoning and specific use permit reviews, shall submit proof of having reviewed the development proposal with applicable street, access, water, sewer, fire protection, drainage, and private utility services. The applicant is responsible for researching the existing and future availability and timing of services needed for the subject property.

B. No development plan shall be approved unless the City of Keller determines that public facilities will be adequate to support and service the area of the proposed development. The applicant shall, at the request of the City, submit sufficient information and data on the proposed development to demonstrate the expected impact on and use of public facilities. Public facilities and services to be examined for adequacy will include roads and public transportation facilities, water, sanitary sewer, and drainage services.

1. Comprehensive Plan Consistency Required
   Proposed public improvements shall conform to and be properly related to the City of Keller’s Comprehensive Plan and all applicable capital improvements plans.

2. Water
   All habitable buildings and buildable lots shall be connected to a public water system capable of providing water for health and emergency purposes, including adequate fire protection.

3. Wastewater
   All habitable buildings and buildable lots shall be served by an approved means of wastewater collection and treatment.

4. Subsurface Stability
   Developer shall provide a geotechnical report providing specific information on subsurface soil, rock, and water conditions. While the geotechnical report content and format will vary by project size, all geotechnical reports should contain certain basic essential information, including:
   a. Summary of all subsurface exploration data, including subsurface soil profile, exploration logs, laboratory or in situ test results, and ground water information;
   b. Interpretation and analysis of the subsurface data;
   c. Specific engineering recommendations for design;
   d. Discussion of conditions for solution of anticipated problems; and
   e. Recommended geotechnical special provisions.

   The Scope of the geotechnical investigation, including the number and types of borings or soundings, the equipment used to drill or sample, the in situ testing equipment and the laboratory testing program, shall be determined by a registered design professional. However, there shall be at least one exploratory boring to adequate depth below the disturbed area for every 10,890 square feet of disturbed area for building, infrastructure, detention, etc, and such additional tests as the city engineer requires. Adequate depth is defined as subsurface disturbance.

5. Stormwater Management
   Drainage improvements shall accommodate potential runoff from the entire upstream drainage area and shall be designed to prevent increases in downstream flooding. The City
may require the use of control methods such as retention or detention, and/or the construction of off-site drainage improvements to mitigate the impacts of the proposed developments.

6. Roads

Proposed roads shall provide a safe, convenient, and functional system for vehicular, pedestrian, and bicycle circulation and shall be appropriate for the particular traffic characteristics of each proposed development. The developer is responsible for providing the appropriate means of access to the development.

7. Extension Policies

All public improvements and required easements shall be extended through the parcel on which new development is proposed. Streets, water lines, wastewater systems, drainage facilities, and utility lines shall be constructed through new development to the next property line to promote the logical extension of public infrastructure. The City may require the applicant of a development to extend off-site improvements to reach adjacent development or oversize required public facilities to serve anticipated future development as a condition of plat approval.

At the time of submittal of a site plan or final plat application, the applicant shall submit proof that adequate water, sanitary sewer, fire protection, gas, and electric services are presently available to the subject property. If adequate public facilities and services are not presently available at the time of submittal of application for site plans or final plats, or are not planned to be provided by the developer/applicant to appropriately serve the proposed development as determined by the City, the site plan or final plat may be denied.
Section 5.02 - Grading, Excavating, and Land Clearing Permit

A permit (see Article Nine - Application Forms) shall be obtained from the Director of Public Works prior to commencement of any of the following:

A. Grading, excavation, land clearing, or any activity precedent to development of open, vacant, or unimproved land.

B. Dredging, filling, grading, excavation, or clearing of land within any Federal Emergency Management Agency (FEMA) designated floodplain areas.

C. Tree Preservation requirements, as outlined in Article Eight, shall be met.

D. Grading Permit Criteria shall be reviewed by the City Engineer, the Planning Manager and the Director of Public Works for completeness and conformance with this UDC and best professional practices:
   1. Developer Agreement in Process with the City of Keller
   2. Construction Plans are substantially complete
   3. Final Plat has been submitted to and approved by the City
   4. Full Application Includes the Following:
      5. Cover Sheet
      6. Grading Plan
      7. Erosion Control Plan and Details
      8. Geotechnical Report
      9. Tree Survey
      10. Tree Protection Plan and Details
Section 5.03 - Streets and Thoroughfares

A. General Policy

1. Every subdivision or development shall be served by streets and thoroughfares adequate to accommodate the vehicular traffic to be generated by the development. Proposed streets shall provide a safe, convenient, and functional system for traffic access and circulation, shall be properly related to the City’s Comprehensive Plan and Thoroughfare Plan, and shall be appropriately designed and sized for the traffic characteristics of each development.

2. The arrangement, character, extent, width, grade, and location of all streets shall conform to the City of Keller Thoroughfare Plan, the Design Standards, and the Technical Construction Standards of this UDC; and shall be considered in their relation to existing and planned streets or driveways, topographical conditions, public safety, and in their appropriate relation to the proposed uses of the land to be served by such streets. A traffic Impact Analysis (TIA) may be required to determine if additional measures must be taken to adequately serve both the development and the public circulation system. Reserve strips of land controlling access to or egress from other property, or to or from any street or alley, or having the effect of restricting or damaging the adjoining property for subdivision purposes or which will not be taxable or accessible for special improvements shall not be permitted in any subdivision. All streets shall be designed and constructed in accordance with the Design Standards and Technical Construction Standards of this UDC.

3. Minor residential streets shall be so laid out that their use by through traffic will be discouraged, and access is provided to adjacent subdivisions.

4. Direct residential driveway access onto all thoroughfares as shown on the Thoroughfare Plan is prohibited unless specifically approved by a Planned Development Zoning District. Where a subdivision contains an existing or proposed thoroughfare, or where a thoroughfare is the only access point to a residential lot, the City may require marginal access streets, reverse frontage, deep lots, rear service alleys, or such treatment as may be necessary for adequate protection to residential properties and to afford separation of through and local traffic.

B. Responsibility for Adequacy of Streets and Thoroughfares, Right-of-Way Dedication and Construction

1. The developer is responsible for the dedication of the right-of-way and construction of all street(s) within the development including all thoroughfares as shown on the Thoroughfare Plan, additional lanes as determined by a TIA, and one-half of the street(s) that abuts the development or the proportionate cost of constructing one-half (1/2) of the street that abuts the development. Any off-site street required, by the platting process, to provide adequate access to the development shall be the entire responsibility of the developer. These provisions shall apply in all cases including where there is an existing sub-standard street.

2. When the owner or subdivider is responsible for one-half (1/2) of the street construction, the owner or subdivider may escrow the amount of the construction cost of the facility unless the City participates in the construction of the facility. Whenever a partial street previously has been platted along a common property line, the other portion of the street right-of-way shall be dedicated at the time of Final Plat approval.

3. Roadway impact fee credit for road construction shall be given in accordance with the Impact Fee Ordinance. The developer shall be responsible for constructing the thoroughfare(s) that is within or adjacent to the development. When appropriate, impact fee credits will be applied based on the assessment rate (Schedule 1) as shown in the Impact Fee Ordinance and in no case shall exceed the actual cost of construction. The City may elect to participate in any road construction at a ratio approved by the City Council.
C. Deviation From Thoroughfare Plan

1. A developer/applicant desiring to deviate from the Thoroughfare Plan must make application to amend the Plan prior to proceeding with the development. All expenses related to a request for the Thoroughfare Plan amendment will be the responsibility of the developer/applicant. This includes a Traffic Study to support the change in the plan. Failure to provide for such approval prior to submission of a plan shall be grounds for automatic denial.

2. When such a street is not on the Thoroughfare Plan, the arrangement of streets in a subdivision shall:
   
   a. Provide for the continuation or appropriate projection of existing streets into surrounding areas.
   
   b. Conform to a plan for the neighborhood approved or adopted by the City to meet a particular situation where topographical or other conditions make continuance or conformity to existing streets impracticable.
   
   c. Provide for future access to adjacent vacant areas that will likely develop under a similar zoning classification.
   
   d. Not conflict in any way to existing or proposed driveway openings.

D. Street Dedications

Dedication of Rights-of-way - The property owner shall provide all rights-of-way required for existing or future streets and on-site streets including perimeter streets and approach roads as shown in the Thoroughfare Plan or other valid detailed development plans. Prior to submittal of a Traffic Impact Analysis (TIA), a completed Trip Generation Form shall be submitted for review.

E. Road Network

1. New subdivisions and developments shall be supported by a road network having adequate capacity and safe and efficient traffic circulation. The adequacy of the road network for developments of more than five hundred (500) trips per day for residential traffic and more than two thousand (2,000) trips per day for commercial traffic, or for developments involving collector or arterial streets not appearing on the City’s approved Thoroughfare Plan, shall be demonstrated by preparation of a Traffic Impact Analysis. Developer shall be responsible for mitigation if traffic impact exceeds five percent (5%) of current traffic counts or causes level of service (LOS) to drop below a LOS “C”.

2. If a property to be developed is intended as a phase in a larger development project, or constitutes a portion of the land to be ultimately developed, the City may require a demonstration of adequacy pursuant to this section, for additional phases or portions of the property, as a condition of approval for the proposed plat.

F. Approach Roads and Access

All subdivisions or developments must be connected to the City’s approved thoroughfare and street system by one or more approach roads of such dimensions and approved to such standards as are hereinafter set forth. Requirements for dedication of rights-of-way and improvement of approach roads may be increased depending on the density or intensity of the proposed development if the need is demonstrated by a Traffic Impact Analysis.

G. Points of Access

Subdivisions generally may provide one point of access in each direction (north, east, south and west) to a public street and/or future connection, which is adequately designed and sized
to handle the traffic adjacent to the development. For a development of over fifty (50) lots, a
minimum of two (2) functional access points shall be required. Developments of fifty (50) lots
or less but more than twenty (20) lots may be served with one point of access and one point
of future connection. Developments of twenty (20) lots or less may be served with one point
of access. Single points of access, including cul-de-sac streets, may exceed six hundred feet
(600') if a residential fire sprinkler system is provided and a recommendation from the Fire
Marshal and approval of the City Council.

H. Intersection Improvements

Intersection improvements and traffic control devices shall be installed by the developer as
warranted in accordance with the traffic impact analysis. The signals shall be installed in
accordance with procedures specified in the state Manual of Uniform Traffic Control Devices.

I. Street Dimensions

1. Street right-of-way widths shall be as shown on the Thoroughfare Plan.

2. The classification and widths of rights-of-way listed within this section are subject to
changes per the City's Thoroughfare Plan and can be revised in accordance with the
Thoroughfare Plan without an amendment to this Code.

J. Half Streets

Construction of half streets shall be prohibited, except when essential to the reasonable
development of the subdivision in conforming with the other requirements of these regulations
and the Thoroughfare Plan, and where the City finds it will be practical to require the
dedication of the other one-half when the adjoining property is subdivided. When the owner
or subdivider is responsible for one-half (1/2) of the street construction, the owner or
subdivider shall escrow the amount of the construction cost of the facility unless the City
participates in the construction of the facility. Whenever a partial street previously has been
platted along a common property line, the other portion of the street shall be dedicated at the
time of Final Plat approval.

K. Cul-De-Sac Streets

A cul-de-sac street is a street with only one inlet/outlet and may be used with a suitable
turnaround provided for, with an outside right-of-way diameter of one hundred twenty feet
(120') and pavement diameter of one hundred feet (100'). The cul-de-sac shall be measured
from the centerline of the intersecting street to the center of cul-de-sac turnaround. Cul-de-
sacs greater than six hundred feet (600') in length may be allowed for developments of less
than twenty (20) lots with a recommendation from the Fire Marshal and approval of the City
Council.

L. Dead End or Stub Streets

1. Dead end or stub streets are not allowed except as required to provide future access to
adjacent vacant land areas that will likely develop under a similar zoning classification and
in no case shall be more than one hundred fifty feet (150') in length or equal to one lot
depth, whichever is greater.

2. A sign shall be placed at the beginning of a dead end street stating "No Outlet" and
barricades will be placed at the dead end. Such sign and barricades shall be installed at
the expense of the developer.

M. Street Pavement Design and Standards

1. All new streets shall be constructed in accordance with paving widths and specifications as
set forth in the Design Standards and Technical Construction Standards of this UDC.
2. Pavement widths shall be thirty feet (30’) from face-of-curb to face-of-curb on local residential streets with curbs. All streets with curbs shall be considered local residential for width design unless one of the following conditions exists:

   a. Designated as a collector or thoroughfare by the City's Thoroughfare Plan.

   b. Adjacent to commercial, multi-family, industrial, or public land uses or in a residential subdivision where, in the opinion of the City, additional street width is indicated for proper access and circulation.

   c. Where, in the opinion of the City or in the opinion of the developer with the concurrence of the City, the aesthetic value is achieved if extra width is dedicated.

   d. Residential subdivision street connections to the thoroughfares, at the entrance to the subdivision, shall provide for a ten-foot (10’) extra right-of-way and five-foot (5’) of additional pavement to accommodate for easier turning movement. These entrances to residential additions shall provide a divided entry with a landscaped island. The landscaping and irrigation for the islands shall be shown on the landscaping plans for the development. All raised islands within developments and/or medians that have no landscaping shall be paved with brick/concrete pavers or stamped concrete as approved by the City.

3. In the case of 2.a above, the section to be constructed shall be in accordance with the Thoroughfare Plan or a revision thereof based on updated conditions. In the case of 2.b and 2.c, each condition shall be studied individually and approved by the City prior to approval of the subdivision in question.

N. Street Construction

All streets shall be constructed in accordance with current City standards and specifications before the street(s) are accepted for maintenance by the City.
Section 5.04 - Private Street Developments

Subdivisions may be developed with private streets instead of public streets if the development complies with the requirements of this section and the subdivision has received zoning approval for a private street development (see Article Eight – Planned Developments (PD) for procedures). Variances to these requirements shall not be considered.

A. Private Street Development Requirements

1. Private Street Developments shall be designated on the plat as a separate lot(s) owned by an approved Public Improvement District (PID) or a property owners association. The street lots shall conform to the City’s Standards for public streets and rights-of-way. An access, utility, and drainage easement covering the street lots shall be granted to the City allowing unrestricted access and use of the property by the City and all other utility providers for the purpose of maintaining the utility services. The easement shall provide the City with the right of access for any purpose related to the exercise of a governmental service or function, including but not limited to fire and police protection, inspection, utility repair, and code enforcement. The easement shall permit the City to remove any vehicle or obstacle within the street lot that impairs emergency access.

2. The developer shall install all necessary appurtenances for the access gates and provide to the City all equipment necessary to operate the access control devices as determined by the City at no cost to the City.

3. It shall be the responsibility of the residential development to install and maintain all necessary preemptive access control system (i.e. Opticom) devices at all entrances (accesses) to said residential development in accordance with the City’s requirements therefore.

4. A fee of one hundred dollars ($100.00) per each platted private street single-family residential lot shall be paid by the development at the time of execution of the Development Agreement.

5. A fee of one hundred dollars ($100.00) per each residential building within a multi-family development at the time of issuance of a building permit for the development.

6. Each residential development shall be solely responsible for the operation and maintenance of the preemptive access control system installed at all entrances (accesses) to their respective residential development.

B. General Design and Construction Standards for Private Streets

Private streets shall conform to the same standards regulating the design and construction of public streets. These standards shall include, but are not limited to, the following:

1. Developments proposed with private streets must submit to the City the same plans and engineering information required to construct public streets and utilities. Requirements pertaining to inspection and approval of improvements prior to final plat approval and acceptance of the subdivision shall be the same as public streets. The City may periodically inspect private streets and require repairs necessary to insure safe emergency access. All standard requirements and fees will be applicable.

2. Water, sewer and drainage facilities, landscaping, screening walls, street lights, and signs placed within the private street right-of-way or public utility easement shall be built to City standards. Unless otherwise stated on the plat or within the development agreements, all maintenance and operation costs of landscaping, street lights, screening walls, and signage shall be the responsibility of the PID, homeowners association, or homeowners, whichever is applicable. The City of Keller will maintain the public water, sanitary sewer, and storm drainage infrastructure.
3. The City shall not participate in the payment for any portion of the cost of constructing and maintaining a private street.

4. There shall be a two (2) year maintenance bond provided to the developer for every private street. There shall be a two (2) year maintenance bond provided to the City of Keller for public water, sanitary sewer, and storm drainage infrastructure.

C. Property Owners Association Required

A mandatory property owners association shall be established for all subdivisions developed with private streets. The association shall own the private streets and be responsible for maintaining the streets and all applicable appurtenances to City maintenance standards. The association documents shall reflect that the City may use the reserve funds or assess the lot owners for street repair if the streets are not continually maintained to City standards. The association documents shall be reviewed and approved by the City and City Attorney at the time of submittal of the preliminary site evaluation and be filed concurrently with the final plat.

D. Access Restrictions

1. The entrances to all private streets shall be marked with a sign stating that it is a private street. An access control gate, guardhouse or other means of restricting access to private streets may be constructed. Gates must be located on private property a minimum of fifty feet (50') from the right-of-way line with entrance gates that swing in, away from the right-of-way of the intersecting street, or side-to-side on a pulley, but cannot swing out toward the right-of-way. All gates and drives shall accommodate government and utility personnel, U.S. Postal Service, solid waste collection, residents, guests, deliveries, etc., without impeding traffic movement on public thoroughfares. If the PID or HOA fails to maintain reliable access as required to provide city services, the City may enter the subdivision and remove any gate or device that is a barrier to access at the sole expense of the PID or association. The PID or HOA documents shall contain provisions in conformity with this paragraph that may not be amended without the written consent of the City.

2. The location and design of each entrance or exit shall accommodate peak travel times. Adequate stacking distance, not less than a total of a hundred feet (100'), shall be provided to allow for any delay in gate(s) opening. The gate(s) must setback from the public right-of-way for a minimum distance of fifty feet (50') with a turn-around provided for vehicles denied access to be able to exit onto a public street in a forward manner before getting to the gate. If an overhead barrier is used, it must have a minimum vertical clearance of sixteen feet (16') in height above the road surface. A construction detail in accordance with the above parameters shall be provided with construction plans, prior to submission of the final plat, for review and approval by the City.

3. All gates shall comply with the Keller Fire Department regulations for emergency access. The developer shall install all necessary appurtenances for the access gates and provide to the City all equipment necessary to operate the access control devices as determined by the City at no cost to the City.

E. Waiver of Services

1. The subdivision final plat and the PID or property owners association documents shall reflect that the streets are private and certain City services shall not be provided on private streets. Among the services that will not be provided are routine police patrol, enforcement of traffic and parking ordinances, and preparation of accident reports. All private traffic regulatory signs shall conform to the Texas Manual of Uniform Traffic Control Devices. Depending on the characteristic of the development, other city services may not be provided.

2. The subdivision final plat and the PID or property owners association documents shall contain language that the PID or association and the residents as the owner of the streets,
agree to release, indemnify, defend and hold harmless the City, any government or public utility for damages to the private streets occasioned by the reasonable use of the private street by the City, government, or public utility; for damages or injury (including death) arising out of the condition of said private street; for damages or injury (including death) arising out of the use by the City, government, or public utility of any restricted access gate or entrance; and for damages and injury (including death) arising out of the use of the subdivision by the City, government, or public utility. The indemnifications contained in this paragraph apply whether or not such damages and injury (including death) are caused by the negligent act of omission of the City, government, or public utility, or their representative officers, employees or agents. Those portions of the PID or homeowners association’s documents pertaining to the subject matter contained in this paragraph shall not be amended without the approval of the City Council.

F. Petition to Convert to Private Streets

Existing public street subdivisions may request a Specific Use Permit (SUP) for a private street subdivision subject to the approval criteria for Planned Development (PD) as listed in Article Eight.

G. Petition to Convert to Public Street(s)

The City shall not be obligated to accept private streets as public streets at a later time. However, a private street subdivision may be converted to a public street subdivision with the following conditions:

1. A petition containing the signatures of one hundred percent (100%) of property owners within the subdivision must be submitted to the City. The PID or property owner association documents shall allow the association to request the City to accept private streets and associated property as public streets and rights-of-way upon written notice to all association members and the favorable vote of a majority of the membership, in accordance with the voting rights and procedures of the PID or association.

2. The property must be replatted to dedicate the streets to the City on the revised Final Plat.

3. Should the City elect to accept the streets as public, the City shall inspect the private streets and either:
   a. Assess the lot owners for the expenses needed to repair the streets to current public street maintenance standards; or
   b. Require that the streets be repaired to city standards in lieu of payment.
   c. Either method must be completed prior to acceptance by the city. In the event that option b. (above) is selected, engineered plans shall be submitted for review and approval, a permit shall be obtained, and the city shall inspect each phase of the construction process in the same manner all public street construction projects are inspected. The City may require, at the lot owner’s expense, the removal of guardhouses, access control devices, landscaping, or other appurtenances located within the street lot.
Section 5.05 - Alleys

A. Alleys shall be optional in all zoning districts. Service alleys in commercial and industrial districts shall be a minimum right-of-way of twenty-five feet (25’) and pavement width of fifteen feet (15’). Construction details for proposed alleys shall be provided with development construction plans.

B. Residential alleys shall not be required except to connect to a subdivision with existing alleys for the purpose of providing continuity. If alleys are required, the following standards shall be met:

1. In residential districts, alleys shall be parallel, or approximately parallel, to the frontage of the street. Alleys in residential districts shall provide a minimum of twenty feet (20’) of right-of-way and fifteen feet (15’) of pavement.

2. Alleys shall be paved in accordance with the design and construction details within the Design Standards and Technical Construction Standards of this UDC at the time of subdivision construction.

3. Where the deflection of alley alignment occurs, the design of the paving and property line shall be as established by the Design Standards and Technical Construction Standards of this UDC.

4. Dead end alleys shall be avoided where possible, but, if unavoidable, shall be provided with adequate turnaround facilities at the dead end as recommended by the City.

5. Alleys may not exceed the roadway length to which it is parallel to, unless otherwise approved by the City Council.

6. Alleys shall not be obstructed in any way.

7. The City shall provide pavement maintenance of all accepted alleys. Right-of-way areas outside of pavement boundaries shall be maintained by the adjacent property owner.

8. All alley intersections must meet line-of-sight requirements for streets (see Design Standards and Technical Construction Standards of this UDC).
Section 5.06 - Sidewalks and Trails

Sidewalks

A. The purpose of the public sidewalk and curb ramps is to provide a safe area for all pedestrians. Sidewalks and curb ramps are required on all streets to be constructed with the paving of streets or when building construction occurs. All sidewalks shall conform to state laws for barrier free construction.

B. Sidewalks not less than four feet (4') wide shall be constructed adjacent to all residential streets. A five feet (5') wide sidewalk is required for all thoroughfares as shown on the Thoroughfare Plan. Sidewalks shall be constructed within the street right-of-way one foot from the property line. If sidewalks are constructed adjacent to the curb on a thoroughfare, a six-foot (6') wide sidewalk shall be provided. Other locations may be approved by the City at the time of plat or site plan approval. If sidewalks are to be constructed on private property, a sidewalk easement shall be granted to the City.

C. Sidewalks and curb ramps shall conform to the Design Standards and Technical Construction Standards of this UDC and shall be constructed by the builder and/or developer as applicable. A Certificate of Occupancy shall not be issued until the required sidewalk is in place or a sidewalk fee in lieu of construction is paid to the City as determined by the Director of Public Works.

D. The construction of sidewalks along thoroughfares, as shown on the Thoroughfare Plan, may be delayed if approved by the City. In such cases, the developer/builder shall pay a fee in lieu of sidewalk construction to be used by the City in the future construction of sidewalks (see Article Nine - Fees). This provision applies to all lots and developments adjacent to the thoroughfares.

E. If a sidewalk and a hike/bike trail are located in the same location, the hike/bike trail shall replace the sidewalk and be constructed in accordance with the Parks and Trails Master Plan within the trail right-of-way. Minor adjustments to the trail location may be approved by the Development Review Committee (DRC). Park Development Fees will be credited for the difference in the required width (see Design Standards and Technical Construction Standards of this UDC).

Trails

A. The purpose of the public trail is to provide a safe area for recreational walking, jogging, biking, etc. and in some cases, equestrian use. All trails shall conform to state laws for barrier free construction.

B. Trails not less than ten feet (10') wide shall be constructed according to the Parks and Trails Master Plan. Trails shall be constructed within the easement or right-of-way dedicated for trails. Other locations may be approved by the City at the time of plat or site plan approval. If trails are to be constructed on private property, easement or right-of-way dedicated shall be granted to the City.

C. Trails and curb ramps shall conform to the Design Standards and Technical Construction Standards of this UDC and shall be constructed by the builder and/or developer as applicable. A Certificate of Occupancy shall not be issued until the required trail is in place or a fee in lieu of construction is paid to the City as determined by the City Manager or designee.

D. If a hike/bike trail and a sidewalk are located in the same location, the hike/bike trail shall replace the sidewalk and be constructed in accordance with the Parks and Trails Master Plan within the trail right-of-way. Minor adjustments to the trail location may be approved by the Development Review Committee (DRC). Park Development Fees may be credited for the difference in the required width (see Design Standards and Technical Construction Standards of this UDC).
Section 5.07 - Driveways

All driveways in the City of Keller shall be constructed with a permit from the Public Works Department. A permit will be granted by the City Engineer only after due consideration of safety, traffic flow, and conflicts with existing and proposed facilities. In addition to the above, access to State controlled highways shall require State and City permits.

A. Residential Driveway Approaches

1. Residential driveway approaches shall follow these guidelines:

   Residential driveways shall be permitted onto residential streets only, unless an access from a residential street is not available. Driveways (either individual or the entry drive of a subdivision) shall be located a minimum of seventy-five feet (75') from any intersection of residential streets and a minimum of two hundred fifty feet (250') from any intersection of arterial or collector streets. This may be waived by the DRC on a case-by-case basis for reasons of hardship not created by the applicant, nor solely financial in nature. Driveways shall not be located within the entry drive of a subdivision.

2. Width shall be twelve feet (12') minimum and twenty-four feet (24') maximum, plus a five-foot (5') radii (if access is onto street) or a five-foot (5') flare (if access is onto alley).

3. The radius or flare point at the street or alley of any driveway shall not extend beyond the intersection of the side property line(s) with the street or alley when projected.

4. All residential driveway approaches shall be constructed in accordance with the City Standard Driveway Construction Details and be maintained by the property owners or property associations.

5. Maximum slope of a residential driveway shall not exceed eight percent (8%) up to the right-of-way line. Sidewalk cross slopes shall not exceed two percent (2%) when crossing a driveway.

B. Non-Residential and Multi-Family Driveway Approaches

Non-Residential and Multi-Family driveway approaches shall follow these guidelines:

1. Required widths:

   a. One-Way Driveway: Fifteen feet (15') plus ten-foot (10') radii.

   b. Two-Way Driveway: Thirty feet (30') plus fifteen-foot (15') radii.

   c. A maximum width of forty-five feet (45') plus twenty-foot (20') radii will be allowed where significant traffic is projected for two-way access as determined by the Director of Public Works.

2. Maximum slope of a commercial driveway shall not exceed six percent (6%) up to the right-of-way line and ten percent (10%) beyond the right-of-way line on a case-by-case basis (as determined by the Fire Department), except in areas required for accessibility purposes. Sidewalk cross slopes shall not exceed two percent (2%) when crossing a driveway.

3. The minimum spacing (measured at inside edge of driveway to inside edge of driveway at the right-of-way line) between driveways along:

   a. Principal arterial streets (A6D) (A4D) (C4U) shall be two hundred fifty feet (250') on the same platted lot, and two hundred feet (200') between adjacent lots. Joint access shall be strongly considered for adjacent properties. All properties shall extend access points to the adjacent property for future connection.
b. Collector streets (C2U) (C3U) shall be one hundred fifty feet (150’).

c. Driveways shall be located a minimum of two hundred fifty feet (250’) from arterial street intersections and two hundred feet (200’) from collector street intersections.

4. All two-way driveways shall intersect at ninety degrees (90°).

5. Parking lots shall be designed with adequate internal circulation. There shall be a minimum of sixty feet (60’) driveway (throat length) between the street and the internal traffic lane at driveway locations. Adequate site distances and on-site maneuvering shall be available from every driveway. The parking lot and driveways shall be so designed to allow vehicles to exit the street in a forward manner, to park, load and unload totally within the site, and to enter onto the street in a forward manner. In no instance shall vehicles use street right-of-way to travel in reverse unless approved by a Planned Development or in the Old Town/Town Center Zoning Districts.

6. All non-residential driveway approaches shall be constructed in accordance with the City Standard Driveway Construction Details and be maintained by the property owners or property associations.

7. All driveways for non-residential uses shall have a minimum ten-foot (10’) wide band of brick/concrete pavers or stamped concrete at the entry drives and crosswalks. The color and materials shall be consistent with the existing or proposed pattern of the non-residential use(s). The band of brick/concrete pavers or stamped concrete shall be centered with the sidewalk.

C. Modifications

Modifications or alternatives to the standards in this section may be considered by the Director of Public Works. If he/she determines that the requested changes will not create a serious detriment to the safety or operation of traffic on the street or roadway, he/she may forward to the City Council for final approval. The Director of Public Works may require that the applicant submit a traffic analysis if it is determined that such an analysis is necessary in order to render a decision on the request.

D. Right-of-Way Work Permit

No construction, grading, excavation, repair or reconstruction of any street, curb or gutter, or any sidewalk or driveway between the street and the property line shall be commenced without first obtaining a Right-of-Way Work Permit from the Director of Public Works. A permit is not required for the utility companies in case of an emergency to restore service or to perform minor repair and maintenance operations.
Section 5.08 - Turning Lanes

A. Turning lanes are provided at intersections to accommodate left and right-turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in advance of the intersection or to a safe speed for the turn in case a stop is unnecessary.

B. Left-turn lanes shall be provided on all approaches to existing or proposed intersections when four or six-lane streets cross. Left-turn lanes shall also be provided for all divided streets where median openings provide access to streets, alleys or driveways, when required by the City.

C. Right-turn/deceleration lanes shall be provided on all approaches at intersections of arterial and collector streets (as shown on the Thoroughfare Plan). Right-turn/deceleration lanes shall also be provided at driveways to all commercial developments of five (5) acres or more (includes overall development with pad sites). The DRC may approve modifications to this requirement at one or more driveways when multiple entries from different streets are proposed for a commercial development of five (5) acres or more and based on a Traffic Impact Analysis demonstrating adequate traffic safety.

D. The minimum length of left-turn lanes, right-turn lanes, and deceleration lanes shall be one hundred feet (100’) stacking and one hundred feet (100’) transition except at locations specifically identified by the City as needing less than one hundred feet (100’).

E. In the event that the City staff, based on the TIA, determines that the developer must install a turn lane, the developer will be wholly responsible for the dedication of all rights-of-way and the construction of all turning lanes.
Section 5.09 - Residential Subdivisions Entry Features and Signage

All subdivisions in excess of ten (10) platted lots shall provide a landscaped entryway feature at the primary access point from an arterial or collector street as designated on the City of Keller Thoroughfare Plan.

A. The entryway feature shall be placed in an easement a minimum of five feet (5’) in width or open space lot identified for such use adjacent to the street right-of-way. All site visibility requirements shall be observed.

B. The entryway feature shall include living landscape materials as specified in Article Nine - Recommended List for Required Landscape Areas. Wall materials shall be the same as those specified in Section 5.10. The design of the entryway feature shall also include an irrigation system and subdivision identification signage located on the wall. All plants shall be living and in a sound, healthy, and vigorous growing condition. The subdivision shall provide for the maintenance of the entry feature and landscaping.

C. Materials for identification signage shall consist of cast stone, brick, or metal. Wood and plastic are not acceptable signage materials. Signage color shall be limited to earth-tone colors or natural metal colors. All identification signage shall be externally illuminated.

D. The design of the entryway feature and signage shall be reflected on the Landscaping and Screening Wall Plans submitted for any existing or new residential subdivision (see Section 4.14 - Landscaping and Screening Wall Plans for requirements).

E. The subdivision entry feature and landscaping shall be maintained by the Public Improvement District (PID), the homeowners or Homeowners Association.
ARTICLE FIVE
Unified Development Code

Adopted: July 7, 2015

Section 5.10 - Residential Subdivisions Thoroughfare Screening and Landscaping

A. Screening Walls

1. Screening walls shall be required in all residential subdivisions platted with rear or side yards adjacent to arterial or collector streets identified on the City of Keller Thoroughfare Plan. Any changes or modifications to these standards shall be approved through a Planned Development (PD) zoning request.

2. The screening wall shall be located on the lot side or back side of a minimum ten-foot (10’) wide landscape/screening wall easement or a separate open space lot adjacent to the street right-of-way.

3. The screening wall shall be constructed of double wall brick or thin wall brick. Thin wall columns are to be spaced no greater than twelve feet (12’) on center. The brick shall be clay-fired brick of natural colors. Concrete poured in place, concrete panel, wood, and stucco shall not be allowed.

4. A combination brick masonry and decorative metal/iron wall with brick detailing may be used to create a change in plane or texture at locations adjacent to the side yards in front of the building line. Columns shall be constructed of brick and centered no more than twelve feet (12’) on center. The tubing or pickets shall be a minimum of one inch by one inch (1” X 1”) and spaced a maximum of four inches (4”) on center. Tubing may be painted with epoxy paint, the color of which to be approved by the City.

5. For residential subdivisions within the SF-36 (Single Family Residential-Low Density-36,000 square foot lots) zoning district, the screening wall may be constructed of a combination brick or stone masonry columns and decorative metal/iron wall. Masonry columns are to be spaced no less than twenty-five feet (25’) and no greater than thirty-five feet (35’) on center. The tubing or pickets shall be a minimum of one inch by one inch (1” X 1”) and spaced a maximum of six inches (6”) on center. Wood fencing shall not be allowed behind the open screening.

6. Required wall heights, measured at the spans between columns, shall be a minimum of six feet (6’) in height and a maximum of eight feet (8’) in height from natural grade.

7. All screening wall plans and details shall be approved and sealed by a licensed civil or structural engineer or a landscape architect (see Section 4.14 - Landscaping and Screening Wall Plans for requirements).

8. The screening wall should be constructed and completed prior to the release of any building permits within the subdivision. If screening wall construction is under way at the time of final acceptance of the infrastructure by the Public Works Department, then ten percent (10%) of the building permits may be released by the Building Official. The remaining permits will not be released until all screening walls, entry features, landscaping, and irrigation is complete and a letter, signed and sealed by the licensed, Texas registered, professional engineer has been received by the City of Keller stating that the construction of the screening wall has been constructed properly and matches the approved construction plans for the screening wall. The Building Official may release additional permits if progress is being made toward completion of this improvement.

B. Landscaping

1. Large canopy trees a minimum of three inches (3”) in caliper, spaced a distance to accommodate mature tree canopy (on center), and shall be planted within the minimum ten foot (10’) wide landscape/screening wall easement or open space lot between the screening wall and the right-of-way line. Tree planting shall also comply with the requirements of Section 8.19 (M).

2. Grass or other permanent, living groundcover shall be installed in all areas between the back of curb and screening wall.
3. A permanent automatic irrigation system, equipped with a rain sensor and anti-freeze device, shall be installed for all landscaped and grass areas. Each irrigation head shall be of an approved water conservation type. A licensed irrigation designer must design the system. Irrigation plans and details in front of screening walls and within entry features shall accompany the landscape and screening wall plans.

4. The irrigation system shall be installed by a licensed irrigator who will provide a two (2) year maintenance bond to assure that the irrigation system remains in good condition. The irrigation will be metered in the name of the developer, PID, or Homeowners Association.

5. All plants (trees, shrubs, ground cover) shall be living and maintained in a sound, healthy, and vigorous growing condition. The contractor installing the landscaping shall provide a two (2) year maintenance bond to assure that plant materials remain in good condition.

6. The landscaping and irrigation should be completely installed prior to the release of any building permits within the subdivision. If landscaping and irrigation installation is under way at the time of final acceptance of the infrastructure by the Public Works Department, then ten percent (10%) of the building permits may be released by the Building Official. The remaining permits will not be released until all screening walls, entry features, landscaping, and irrigation is complete. The Building Official may release additional permits if progress is being made toward completion of this improvement.

C. Maintenance

The maintenance of the screening wall, landscaping, and entry features shall be the responsibility of the developer, PID, or Homeowners Association. If a PID or HOA has not been established for the subdivision, maintenance of the screening wall, landscaping and entry feature will become the responsibility of the property owners within the entire subdivision.
Section 5.11 - Easements

A. The property owner shall be required to furnish all easements and rights-of-way required to serve the development with both public and private utilities and shall be shown on the Preliminary Site Evaluation or Final Plat and accompanying construction plans. Utility easements shall be considered part of the right-of-way and subject to all ordinance requirements for right-of-way.

B. Easements shall be provided for both municipal and private utilities. Municipal or other public easements for water, wastewater and storm sewer shall be a minimum fifteen (15') in width. All municipal easements may be wider as determined by the Director of Public Works depending on the depth and size of the utility. Easements for the private utility companies shall be established based on the utility company’s guidelines. Proper coordination shall be established between the property owner, developer, and the applicable utility companies for the establishment of utility easements as needed to serve the development.

C. Location of utility easements. When topographical or other conditions are such as to make impractical the inclusion of utilities within public rights-of-way, perpetual unobstructed easements at least fifteen feet (15') in width shall be provided along selected side lot lines for satisfactory access to the street or rear lot lines. Easements shall be indicated on the plat.

D. Water, sanitary sewer, or drainage easements shall be allowed to straddle an internal lot line or be placed with one half of the easement width on each adjacent lot except for those easements that are placed along the boundary of a subdivision shall not straddle the lot line but be contained with the boundary of the lot for that subdivision.

E. Electric, gas, telephone, and cable TV easements shall meet the requirements of the respective utility company and shall not conflict with or be coincident with water, sanitary sewer, or drainage easements.

F. The contractor and owner shall be responsible for locating existing utilities and is responsible for all damage to existing public improvements caused during construction of new public improvements.

G. Electric, cable, traffic, water and sanitary sewer metering, low-watt lighting, telephone, internet provider, and smart house facilities serving the subdivision may be located with a Utility Duct Bank Facility. If a Utility Duct Bank is proposed for a development, easements shall be provided and utilities shall be installed to adequately serve the subdivision. All easement locations and utility installations shall be in accordance with industry standards. All provisions and responsibilities regarding dedication, construction, installation and maintenance shall be incorporated into the Development Agreement for the addition.

H. Easements across lots or centered on rear or side lot lines shall be provided for utilities where necessary and shall be of such widths as may be reasonably necessary for the utility or utilities using same. It shall be the subdivider’s responsibility to determine appropriate easement widths as required by utility companies.

I. Where a subdivision is traversed by a watercourse, drainageway, or channel, there shall be provided a storm water easement or drainage right-of-way conforming substantially with such course and of such additional width as may be designated by the Director of Public Works, subject to determination according to proper engineering considerations. The required width shall conform to the requirements set forth by the Federal Emergency Management Agency (FEMA). Parallel streets or parkways may be required adjacent to creek or drainageways to provide maintenance access or access to recreation areas. City approved utilities are permitted within the drainage easement.

J. A lot area shall be computed inclusive of all easements.

K. Accessory buildings, swimming pools and its appurtenances are not allowed in any rights-of-way, easements, floodway or 100-year flood plains.
L. All construction within easements shall comply with the requirements outlined in Design Standards and Technical Construction Standards of this UDC.
Section 5.12 - Blocks

A. The length, width, and shapes of blocks shall be determined with due regard to:

1. Provision of adequate building sites suitable to the special needs of the type of use contemplated.
2. Zoning requirements as to lot sizes, setbacks, and dimensions.
3. Needs for convenient access, circulation, control, and safety of street traffic.

B. In general, intersecting streets, determining the blocks, lengths and widths, shall be provided at such intervals as to serve cross-traffic adequately, and to meet existing streets or customary subdivision practices. Where no existing subdivision controls, the block lengths shall not exceed one thousand six hundred feet (1,600') and shall generally be one thousand (1,000) to one thousand two hundred feet (1,200') in length. Where no existing subdivision controls, the blocks shall not be less than five hundred feet (500') in length; however, in cases where physical barriers or property ownership creates conditions where it is appropriate that these standards be varied, the length may be increased or decreased to meet the existing conditions having due regard for connecting streets, circulation of traffic and public safety.

C. Where blocks are adjacent to a school or public park, or are platted one thousand feet (1,000') or longer, the City may require a walkway near the middle of the block or at a street that terminates between the streets at the ends of the block. The walkway shall be concrete and shall not be less than four feet (4') or more than eight feet (8') in width, and shall extend through the block from sidewalk to sidewalk, or to the rear property line of the lots that front the street, if a double row of lots do not exist. The walkway shall not cross streets.
ARTICLE FIVE
Unified Development Code
Adopted: July 7, 2015

Section 5.13 - Lots

A. Lots shall comply with the minimum requirements of the established zoning district and with the minimum standards of this Code.

B. Each residential lot shall front on a dedicated public street right-of-way or an approved recorded paved public access easement. Lots shall have a minimum of fifty feet (50') frontage along a dedicated street right-of-way or public access easement. The minimum width of access easements for all platted/replatted lots, from the date of the adoption of this Code shall be sixty feet (60'). All access easements shall be listed as a private access/public drainage/utility easement. The paving standards for the access easements shall be in accordance with the Design Standards and Technical Construction Standards of this UDC. Fire Department access shall be provided to all lots as required per the adopted Fire Code. The minimum width of pavement for an access easement shall be twenty-four feet (24'). Access easements that serve more than three (3) lots shall comply with the requirements established in Section 5.04 - Private Street Developments. Access easements shall be owned and maintained by the homeowners, PID or Home Owners Association (HOA) when applicable.

C. Irregular-shaped lots shall have sufficient width at the building line to meet frontage requirements of the appropriate zoning district. Also, the rear width shall be sufficient to provide access for all necessary utilities.

D. No lot shall be platted less than one hundred feet (100') in depth except as approved as part of a Planned Development (PD) ordinance or in cases where an irregular-shaped tract is platted into lots and a remnant piece of property has sufficient area to plat one or more lots. In this case, the Planning and Zoning Commission may approve a waiver of the width and depth requirement, if needed, to prevent a hardship.

E. Side lot lines shall be at right angles to street lines (or radial to curving street lines) unless a variation from this rule will give a better street or lot plan.

F. Double frontage and reversed frontage lots shall be avoided except where necessary to provide separation of residential development from traffic arterials (Thoroughfare Types A6D, A4D, C4U, C2U, or C3) or to overcome specific disadvantage to topography and orientation. Where lots have double frontage, a front building line shall be established for each street (see Section 8.18 - Figure 6). Double frontage lots in subdivisions will not be allowed without providing screening walls in accordance with this Code. Lot depths adjacent to thoroughfares shall exceed normal standards and shall not be less than one hundred forty feet (140'). Additional rear yard setback of a minimum forty feet (40') also shall be provided if the lot backs up to a 4-lane thoroughfare or larger and a solid masonry screening wall is not provided as a buffer.

G. The lot arrangement shall be such that there will be no foreseeable difficulties, for reasons of topography or other conditions, in securing building permits to build on all lots in compliance with this Code, Building Code and other applicable ordinances, laws, and regulations. Driveway access shall be provided to buildings on the lots from a street, alley, or public access easement as approved for a development.

H. Dimensions of corner lots shall be large enough to allow for erection of buildings. Depth and width of properties reserved or laid out for business, commercial, or industrial purposes shall be adequate to provide for the off-street parking, landscaping, and loading facilities required for the type of use and development contemplated, as established in this Code.
Section 5.14 - Water

A. Adequate Water Facilities

All development(s) are required to connect to the City’s water distribution system. Water systems serving the subdivision, development or addition shall connect with the City’s water supply and distribution system in accordance with the City’s Water Master Plan. Water facilities shall be installed to adequately serve the development and each lot or tract therein and shall be located and sized to conform to City engineering standards and specifications, in accordance with the City’s Water Master Plan. The City may require owners to provide a water study, including adequate engineering data to support water demand projections, before final plans will be approved.

B. Design and Construction Requirements.

No water system will be constructed unless all plans have been reviewed and released for construction by the City to assure compliance with these requirements. All water facilities shall be designed and constructed under the inspection of the City and in accordance with the City’s Water Master Plan and Design Standards and Technical Construction Standards of this UDC. All water facilities designated as transmission shall be placed in a dedicated waterline easement.

C. Extension Policy

The developer shall extend all water mains and appurtenances necessary to connect the development with the City’s water supply and distribution system and shall extend such mains and appurtenances to all property lines of the subdivision to allow connection to these facilities by adjoining property owners in accordance with the City’s Water Master Plan. Authority to extend water mains to serve newly subdivided or platted land shall be granted by the City only upon a determination by the Director of Public Works that all facilities necessary to adequately serve the development are in place or will be in place prior to the issuance of occupancy permits for structures developed on such land.

D. Water Wells Provisions

All water wells shall be considered private and shall be owned and maintained by its property owner. All water wells shall meet all regulations and requirements of the City of Keller, The Northern Trinity Groundwater Conservation District, and the State of Texas. Permit for new or replacement water well system shall be obtained from the City of Keller and The Northern Trinity Groundwater Conservation District.
Section 5.15 - Sanitary Sewer

A. Adequate Sewage Wastewater Facilities

All development(s) are required to connect to the City’s wastewater collection system. Wastewater systems serving the subdivision, development or addition shall connect with the city’s wastewater distribution system in accordance with City’s Wastewater Master Plan. Wastewater facilities shall be installed to adequately serve the development and each lot or tract therein and shall be located and sized to conform to City engineering standards and specifications and be in accordance with the City’s Wastewater Master Plan. The City may require owners to provide a wastewater study, including adequate engineering data to support projected wastewater discharge before final plans will be approved. The projected wastewater discharge of a proposed development shall not exceed the capacity of the wastewater system based upon required studies.

1. Connection to Public Sanitary Sewer System Required for New Construction

   a. Single-Family and Two-Family Residential Developments

      All new single-family and two-family residential subdivisions of five (5) or more lots, at the owner’s or occupant’s expense, are required to extend sanitary sewer lines necessary to serve the subdivision as shown on the City’s Sanitary Sewer Master Plan. The extension of the sanitary sewer lines shall be in accordance with this Code and all other applicable regulations. Single-family residential developments containing five (5) lots or fewer may be exempted from wastewater requirements if approved by the City. In cases of five (5) lot developments without sanitary sewer, the entire property under one ownership shall be Final platted. The developer/builder is responsible for providing the necessary permits for an on-site sanitary sewer disposal facility. The permit shall be submitted to the Building Inspections Division prior to the issuance of a building permit.

   b. Non-Residential and Multi-Family Developments

      All new non-residential and multi-family developments, at the owner’s or occupant’s expense, are required to extend sanitary sewer services to the development and connect to the public sanitary sewer prior to the occupancy of the building(s). This provision also applies to building expansions and additions of existing non-residential developments. The extension of the sanitary sewer lines shall be in accordance with this Code and all other applicable regulations.

B. On-Site Sewage Systems for Single-Family and Two-Family Residential Uses

   Installation

   1. Installation of an approved on-site sewage system is allowed for new residential developments of five (5) lots or less if a public sanitary sewer line is not adjacent to the development. An on-site sewage system shall be approved by the Tarrant County Health Department and the City of Keller prior to its installation. Property owners with on-site sewage systems are required to have the system inspected by the Tarrant County Health Department at the property owner’s expense upon installation, alteration, or as a response to complaint(s) related to system malfunction. A copy of the report must be provided to the city of Keller.

   2. Existing, properly functioning septic systems may continue to be utilized until public sanitary system is available to the property. The Tarrant County Commissioners Court Order Number 42703 (Sewer Regulation) shall be the regulatory authority determining if a septic system is functioning properly. All abandoned septic tanks shall be properly filled with sand.
3. If a new or replacement on-site sewage system is needed, and the public sewer is either contained within street rights-of-way or an easement adjacent to the property, the property shall be required to connect to the City's sanitary system.

4. Permit for new or replacement on-site sewage system shall be obtained from the Tarrant County Health Department.

C. Design and Construction Requirements.

All design and construction shall be done under the inspection of the City and in accordance with Design Standards and Technical Construction Standards of this UDC. No wastewater system shall be constructed unless all plans have been reviewed and released for construction by the City to ensure compliance with these requirements.

D. Easements

All wastewater facilities designated as interceptors shall be placed in a dedicated sanitary sewer easement on all developments.
Section 5.16 - Fire Protection

A. General Provisions

1. The Fire Marshal of the City of Keller will review all plans and specifications of all proposed commercial and residential development in the City and will determine whether or not adequate fire protection may be afforded the building or buildings situated or proposed to be situated on such property with existing or proposed fire hydrants and water lines.

2. If, in the opinion of the Fire Chief, adequate fire protection requires additional fire hydrants and water lines to serve proposed developments, he will direct the owner of the property, in writing, to locate at pre-designated positions on the property a fire hydrant or hydrants and adequate water lines to provide adequate fire protection at the owner’s expense. The location and number of fire hydrants and water lines shall be situated as to afford adequate fire protection to all buildings located or proposed to be located on the property. Such installation to be completed in such reasonable period of time as the Fire Chief may direct.

B. Fire Hydrant Location and Coverage Requirements

1. Commercial and Industrial Areas
   a. Fire hydrants shall be located no more than a five hundred foot (500’) truck hose lay distance to all points of any structure or combustible storage area on the lot.
   b. Fire hydrants located on the opposite side of a street, designated as four lanes or larger on the current City Thoroughfare Plan, shall not be considered acceptable for meeting hydrant coverage requirements.
   c. Fire hydrants shall be positioned to allow truck hose lays to follow normal traffic access to the site.
   d. Fire hydrants shall be spaced at no more than three hundred feet (300’) intervals.

2. Residential Areas
   a. Fire hydrants shall be placed on block corners or near the center of the block to place every structure within a five hundred foot (500’) truck hose lay distance from fire hydrant coverage.
   b. Fire hydrants located on the opposite side of a street, designated as four lanes or larger on the current City Thoroughfare Plan, shall not be considered acceptable for meeting hydrant coverage requirements.
   c. Fire hydrants shall be positioned to allow truck hose lays to follow normal traffic access to the site.
   d. Fire hydrants shall be spaced at no more than five hundred feet (500’) intervals.

C. Fire Hydrants Specifications

All fire hydrants must meet required City of Keller Standard Fire Hydrant Specifications.

1. All fire hydrants shall have one (1) 5” Hydra-Storz pumper connection and two (2) 2.5” hose outlets with the National Standard hose threads; shall have a main barrel valve opening of not less than 5.25”; shall be placed on mains of not less than six inches (6”) in diameter. Six-inch (6”) gate valves shall be placed on all fire hydrant leads. All fire hydrants shall have a valve at the main with flange-to-flange fittings.

2. All fire hydrants shall be of a “break-away” design in accordance with City of Keller Standard Fire Hydrant Specifications.
3. Each hydrant shall have a minimum of two primer coats. The final coat of paint on the body of all hydrants shall be a silver color of an approved aluminum paint.

D. Fire Protection Distribution Systems

Water distribution systems shall be of sufficient size to provide adequate water for fire protection to the development and shall conform to the City’s Master Water Distribution Plan.

1. Residential Areas
   a. Sizes and Allowable Dead End Lengths

      In residential areas the minimum water line size shall be eight inches (8”). Dead end lines over three hundred feet (300’) and up to six hundred feet (600’) in length shall be ten inches (10”) minimum. Dead end lines over six hundred feet (600’) in length will not be allowed. Dead end lines shall terminate at a fire hydrant that shall be installed for maintenance purposes and may not necessarily be considered for fire hydrant density as required. Flush hydrants may be installed in lieu of hydrants at terminating points of dead end lines for maintenance purposes only.

   b. Valves

      Additional isolation valves may be required to be installed depending upon the configuration of the system as determined by the City.

   c. Construction Standards

      All water line construction shall conform to construction standards located in Design Standards and Technical Construction Standards of this UDC.

2. Commercial Areas
   a. Sizes and Allowable Dead End Lengths

      In commercial areas the minimum water line size shall be eight inches (8”). Dead end lines over three hundred feet (300’) and up to six hundred feet (600’) in length shall be ten inches (10”) minimum. Dead end lines over six hundred feet (600’) in length will not be allowed. Dead end lines shall terminate at a fire hydrant that shall be installed for maintenance purposes and may not necessarily be considered for fire hydrant density as required. Flush hydrants may be installed in lieu of hydrants at terminating points of dead end lines for maintenance purposes only.

   b. Valves

      Additional isolation valves may be required to be installed depending upon the configuration of the system as determined by the City.

   c. Construction Standards

      All water line construction shall conform to construction standards located in Design Standards and Technical Construction Standards of this UDC.
ARTICLE FIVE
Unified Development Code  
Adopted: July 7, 2015

Section 5.17 - Drainage

Developers and builders must refer to the most current Flood Insurance Rate Maps (FIRM) and Flood Boundary-Floodway Maps prepared by the Federal Emergency Management Agency (FEMA) for the City of Keller to determine whether their property is within the boundaries of a designated Flood Hazard Area. Keller’s Flood Plain Administrator is the Director of Public Works. Plats are reviewed by the Director of Public Works to determine that the potential for flooding in the area will not increase due to the proposed development, and that the proposed development is sufficiently protected from a 100-year frequency storm runoff from a fully developed upstream watershed. If the development area is within a Flood Hazard Area, construction cannot begin until the developer or builder has received an approved Flood Plain Development Permit from the Director of Public Works (see Article Nine for permit form).

A. General Requirements

1. Drainage Facilities

   Drainage facilities shall be designed and constructed according to Design Standards and Technical Construction Standards of this UDC so that adequate facilities are provided to serve the development and the entire developed watershed. The developer is responsible for construction of all drainage facilities as identified in the drainage study and, in the event that underground water is encountered, a subsurface drainage system shall be installed with discharge of said system being carried to the nearest storm drain system or natural water shed system. The developer shall provide all necessary easements and rights-of-way for drainage facilities.

2. Natural Drainage Pathway

   The developer shall insure that the Post-Development runoff follows the Pre-Development drainage pathway and that the natural water-course is of adequate size to convey peak runoff.

3. No Adverse Effects on Other Properties

   The developer shall be responsible for the necessary facilities to provide drainage controls such that properties within the drainage area, whether upstream or downstream of the development, are not adversely affected by runoff from the development.

4. Developer and Engineer Responsible For Design

   The requirements set forth in Design Standards and Technical Construction Standards of this UDC are considered minimum requirements. The developer and his engineer shall bear the total responsibility for the adequacy of the design. The review of the drainage design plans by the Director of Public Works in no way relieves the developer of this responsibility.

B. Design of Facilities

1. Standards

   Design and construction of storm sewer systems shall be in accordance with Design Standards and Technical Construction Standards of this UDC. Natural drainage courses, curbs, inlets, manholes, etc., shall be designed and constructed in accordance with these standards.

2. Drainage Study

   A drainage study shall be provided for each development in accordance with Design Standards and Technical Construction Standards of this UDC. The study shall be provided to insure that all upstream and downstream watershed components are accounted for and will not be adversely impacted. Adverse impact is considered a tenth of a foot (0.1’).
maximum increase for one (1), ten (10), and one hundred (100) year water surface elevation (WSEL) and four thousandths of a foot (0.004\textquoteleft) if the building is impacted. The study shall include a pre-development versus post development runoff analysis and a storm water runoff routing analysis designed to predict the post development runoff rate and the downstream drainage system ability to accommodate post development runoff.

C. Dedication of Drainage Easements

1. General Requirements

When a subdivision or addition is traversed by a flood plain as referenced by the current panel number(s) on the FEMA Flood Insurance Rate Maps (FIRM), or other watercourse, drainage way, channel or stream, a drainage easement shall be required. The easement shall substantially conform to the natural alignment of the watercourse, and should be of such width and construction as will be adequate for the purpose (i.e., the easement shall be adequate for an open channel of natural appearance with landscaped banks and sufficient width for maximum potential volume of flow, unless otherwise approved by the City Engineer). Any increased velocity, depth, or flow rate shall be mitigated to predevelopment rates. An improved open drainage system or closed drainage system may be allowed if approved by the Director of Public Works as part of a master drainage study.

2. Access Easements

The property owner must provide sufficient access on each side of and parallel to all flood ways and open drainage ways for drainage maintenance purposes by the City. The access shall be above the base flood elevation and have a slope of 6:1 or less and be accessible by vehicles and equipment. Minimum access width and location shall be determined by the Director of Public Works.

3. Drainage Easements

Where topography or other conditions are such as to make impractical the inclusion of drainage facilities within street rights-of-way, perpetual, unobstructed easements at least fifteen feet (15\textquoteleft) in width, depending on slopes, for drainage facilities shall be provided across property outside the street rights-of-way and with satisfactory access to the street. Easements shall be indicated on the plat. Drainage easements shall extend from the street to a natural watercourse or to other drainage facilities. When a proposed drainage system will carry water across private land outside the proposed subdivision, an agreement from the property owner shall be secured by the developer.

4. Private Drainage Easements

Private Drainage Easements are to be maintained by the owner of each lot. The maintenance of a private drainage easement shall not be the obligation or liability of the City of Keller.

D. Flood Plain Dedication Requirement

1. All areas within any subdivision located in a flood plain as referenced by FEMA FIRM maps or the City’s Master Drainage Plan, shall be dedicated to the City, approved property owners association, foundation or conservancy if designated as open space in accordance with the City’s Comprehensive Plan or under terms and conditions in an approved open space plan.

2. The flood plain and floodway shall remain in their natural state unless improvements are permitted by the City due to the pending development of properties adjacent to or upstream of the required improvements.
ARTICLE FIVE
Unified Development Code

3. Prior to acceptance of any flood plain by the City, the area shall be cleared of all trash and debris. Flood plains dedicated to the City shall be left in a natural state except those areas designated for recreational purposes.

4. Flood plains to be dedicated to the City shall meet the recommendation of City’s Drainage Master Plan for drainage facilities.

E. Grading

1. Site, street, lot or development grading shall conform to Design Standards and Technical Construction Standards of this UDC.

2. A permit for grading is required and issued by the Director of Public Works (see Article Nine for Grading Permit application).

F. Plans, Specifications, and Design Calculations

1. The developer shall provide engineered plans, specifications, and design calculations for all drainage facilities.

2. All open drainage courses shall be designed in a natural landscaped manner to prevent erosion.

3. The types of methods used for erosion prevention shall be shown on the construction plans and Released for Construction by the Director of Public Works or City Engineer.

4. Any site graded and not actively worked on for five (5) or more days must have seeded erosion mat installed in the interim time between grading and construction activities.
Section 5.18 - Erosion Control

A. The National Pollutant Discharge Elimination System (NPDES) requirements of the Clean Water Act (CWA) prohibit construction activities that cause erosion that may pollute adjacent rivers and streams. The developer/applicant shall indicate the extent to which the construction activities of a project will disturb soil and cause the movement of soil particles off the site. Construction shall meet all requirements established by the Texas Commission on Environmental Quality (TCEQ).

B. The subdivider/developer shall prepare an erosion control plan to minimize the transportation of soil from the site due to storm water runoff during development and to control erosion as part of a Storm Water Pollution Prevention Plan as provided in Design Standards and Technical Construction Standards of this UDC.

C. Such plans shall include current best management practices for the prevention and control of erosion. The plan also shall include the subdivider/developer’s proposed measures to deter movement of sediment onto adjacent property or street.

D. Any site graded and not actively worked on for five (5) or more days must have seeded erosion mat installed in the interim time between grading and construction activities.
Section 5.19 - Street Lights

A. Before final acceptance of streets, alleys, sewers and other utilities, street light locations and installations shall be coordinated by the developer with the power company and the City of Keller. It shall be the subdivider's responsibility to install street lights with metal poles (or approved similar material) at all intersections not to exceed a maximum distance of six hundred feet (600') apart. The design of all street lights shall conform to Design Standards and Technical Construction Standards of this UDC. The developer shall pay for the electricity for the subdivision for a period of twenty-four (24) months, after which the City shall pay for the electricity.

B. If a developer desires to install designer street lights, the design and installation shall be approved by the City. The total cost of designer street lights shall be furnished to the City by the subdivider for all intersections within the subdivision. Designer street lights shall be owned and maintained by that subdivision’s PID or Homeowners Association.

C. Street Lighting in Public Right-of-Way

1. Street lights in all subdivisions shall be installed on approved poles.
   a. Poles must be approved by a public electric utility holding a City franchise and the Director of Public Works.
   b. Poles and their installation shall be contracted and paid for by the Developer during the construction phase of a subdivision and before building permits are issued.
   c. Poles shall be purchased through a public electric utility holding a City franchise to serve the area the subdivision is located in.

2. The location of street lights shall be as follows:
   a. At all intersections.
   b. Where a new street intersects an existing street.
   c. Where a block is six hundred (600') feet or longer, a street light shall be installed every six hundred (600') feet or mid-block, whichever is the shortest distance.
   d. If more than one mid-block light is required, they shall be installed to create an equal balance of light throughout the entire length of the block.
   e. If a cul-de-sac block is four hundred (400') feet or longer, a street light shall be installed in the end of the cul-de-sac.
   f. Street lights shall be installed at any other location as may be directed by the Public Works Director for the welfare and safety of the community.
Section 5.20 - Street Names and Signs

A. Street Names

The developer shall name streets in conformance with the following considerations. City staff may deny or recommend alternative street names and reserves the right for final determination.

1. Names of new streets shall not duplicate or cause confusion with the names of existing streets, unless the new streets are a continuation of or in alignment with existing streets. New streets that are an extension of existing streets shall bear the names of existing streets and shall be dedicated at equal or greater widths than the existing streets. Where the streets will not be extended or end in a cul-de-sac, new names may be assigned.

2. Street names that are spelled differently but sound the same shall be avoided.

3. Street name suffixes such as “Place” or “Court” shall be designated on streets that are cul-de-sac streets, and shall take their prefix from the streets from which they originate. Suffixes such as “Boulevard” or “Parkway” shall be confined to designated arterial or collector streets.

4. Street name prefixes such as “North”, “South”, “East”, and “West” may be used to clarify the general location of the street, however the prefixes shall be consistent with the existing and established street naming and address numbering system of the general area in which the street is located.

5. All street names shall contain only one (1) street suffix. The following are valid street suffixes:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLEY</td>
<td>Alley</td>
</tr>
<tr>
<td>AVE</td>
<td>Avenue</td>
</tr>
<tr>
<td>BLVD</td>
<td>Boulevard</td>
</tr>
<tr>
<td>CIR</td>
<td>Circle</td>
</tr>
<tr>
<td>CO ROAD</td>
<td>County Road</td>
</tr>
<tr>
<td>COVE</td>
<td>Cove</td>
</tr>
<tr>
<td>CR</td>
<td>Creek</td>
</tr>
<tr>
<td>CT</td>
<td>Court</td>
</tr>
<tr>
<td>DR</td>
<td>Drive</td>
</tr>
<tr>
<td>EXPWY</td>
<td>Expressway</td>
</tr>
<tr>
<td>FWY</td>
<td>Freeway</td>
</tr>
<tr>
<td>HWY</td>
<td>Highway</td>
</tr>
<tr>
<td>LN</td>
<td>Lane</td>
</tr>
<tr>
<td>LOOP</td>
<td>Loop</td>
</tr>
<tr>
<td>MNR</td>
<td>Manor</td>
</tr>
<tr>
<td>PASS</td>
<td>Pass</td>
</tr>
<tr>
<td>PK</td>
<td>Park</td>
</tr>
<tr>
<td>PKWY</td>
<td>Parkway</td>
</tr>
<tr>
<td>PL</td>
<td>Place</td>
</tr>
<tr>
<td>PLZ</td>
<td>Plaza</td>
</tr>
<tr>
<td>PNT</td>
<td>Point</td>
</tr>
<tr>
<td>RD</td>
<td>Road</td>
</tr>
<tr>
<td>RDG</td>
<td>Ridge</td>
</tr>
<tr>
<td>ROW</td>
<td>Row</td>
</tr>
<tr>
<td>SQ</td>
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<td>Trace</td>
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<td>TERR</td>
<td>Terrace</td>
</tr>
<tr>
<td>TR</td>
<td>Trail</td>
</tr>
<tr>
<td>WAY</td>
<td>Way</td>
</tr>
<tr>
<td>WLK</td>
<td>Walk</td>
</tr>
</tbody>
</table>
B. Street Signs

1. The total cost of street signs and posts shall be furnished to the City by the subdivider for all intersections within or abutting the subdivision. Such signs shall be of a type approved by the City, and shall be installed by the City as per City of Keller standards. If a developer desires to install designer street signs, the design and installation shall be approved by the City and installed by the developer.

2. Street signs shall be installed at all intersections providing access to development on a block prior to the issuance of a Certificate of Occupancy on that block. Block numbers are required on all street signs unless otherwise approved by the City.

3. Street name signs for “Private” streets shall be distinguished from “Public” street name signs by including the phrase “Private Street” on the sign and using a white background with black letters to construct the street name sign.
Section 5.21 - Lot Addressing Procedures

A. Addressing shall be performed by the designated City Staff in accordance with the adopted addressing procedures as followed. No address shall be issued prior to approval of and submission of final documents for recording of subdivisions.

B. Upon recording of a final plat, replat, or amending plat, addresses shall be assigned to each lot created by such plat. Whenever possible, a current or previous address of an unplatted parcel of land shall be assigned if the address meets the following criteria:

1. The address is in accordance with Tarrant County 9·1·1 recommended guidelines.
2. Address sequencing is not affected.

C. Addresses will be assigned in the following manner:

1. Even address will be assigned to south and west sides of streets. Where the opposite has occurred for previous addresses, addresses will be continued to provide consistency.
2. Odd addresses will be assigned to north and east sides of streets. Where the opposite has occurred for previous addresses, addresses will be continued to provide consistency.

D. The Community Development Department is responsible for assigning and distributing assigned addresses to all government offices, including Tarrant County 9·1·1, utility companies both public and private, and the developer or his designee.

1. A property owner may request an address change in writing to the Community Development Department stating the purpose of the request. A new address will be considered and assigned if the assigned address is out of sequence or if it is determined that public safety services and delivery services are compromised with the assigned address.
2. Notifications for address changes are supplied to all government offices, including Tarrant County 9·1·1, utility companies both public and private, and the owner/developer or his designee.
Section 5.22 - Private Utility Services

A. Utility companies shall submit plans, showing the extent and location of construction, to the City and receive a construction permit when constructing new overhead lines, underground lines, and upgrading existing lines within the rights-of-way. Non-emergency utility work shall be coordinated with the city’s capital improvement plan to reduce disruption due to construction to the community. Utility companies are not required to obtain a permit in the event of an emergency in order to restore service.

B. From and after the effective date of this Code, all subdivision plats, site plans and construction plans filed and submitted to the City for approval shall provide for utility services such as electrical, gas, telephone, and cable TV utility (lateral and/or service distribution) lines and wires including, but not limited to, street lighting, to be placed underground. Existing feeder and other major transmission lines that could not practically be placed underground may remain overhead. However, a subdivider shall endeavor, and whenever practical (as determined by the Development Review Committee), the City may require that feeder lines are placed away from traffic arteries (Thoroughfare Types A6D, A4D, C4U, C2U, and C3) and/or be placed underground. Overhead feeder lines shall not be placed along both sides of the street rights-of-way. The developer shall be responsible for obtaining verification from the utility companies for easement locations and widths prior to the final approval of construction plans by the City. Any changes during construction shall be approved by the utility companies and the City of Keller.

C. Where existing overhead service or lateral/distribution utilities lines are located within the land proposed for development and the lines must be relocated to accommodate the development, the developer is responsible for relocation and placement of the lines underground.

D. All new service lines shall be placed underground.

E. In special or unique circumstances or to avoid severe hardships that are not strictly financial, the City may authorize exceptions from this requirement and permit the construction and maintenance of overhead electric utility lateral or service lines and of overhead telephone or cable TV lines and may approve any plat or site plan with such approved exceptions.

F. Where electrical service is to be placed underground, all other utilities, including circuits for street and site lighting, except street lighting standards, shall also be placed underground.

G. All electrical and telephone support equipment (transformers, amplifiers, switching devices, etc.,) necessary for underground installations shall be pad mounted and screened with live screening to block its view from public streets. Installation and maintenance of screening for electrical pad transformers and switching equipment shall be the responsibility and at the cost of the Developer/Owner. The location and depth of the screening material must be coordinated with the utility companies to ensure that safe and efficient access is maintained to the equipment. The location of all new equipment shall be shown on all Site Plans and Construction Plans.

H. Each of the utility companies shall be responsible for developing administrative policies and cost reimbursement procedures for the installation and extension of their underground utilities. Each utility company shall have the right to charge or recover costs associated with installing underground utilities in accordance with the respective utility’s Tariff for Service and/or Line Extension Policy. No utility company shall be required to begin construction of underground facilities unless and until the owner or developer of the subdivision has made arrangements with the respective utility company for payment in accordance with that respective utility’s Tariff for Service and/or Line Extension Policy governing utility installations and their cost.

I. Temporary construction service may be provided by overhead electric lines and facilities without obtaining a variance or exception, provided that when the underground utility service to any portion of a subdivision is completed, such overhead electric lines and facilities are promptly removed.
J. All installations regulated by this section shall also conform to the standards for utility construction as per Design Standards and Technical Construction Standards of this UDC.
Section 5.23 - Design and Technical Construction Standards (DTCS)

A. Introduction and Purpose

The contents within Sections 5.23, 5.24, 5.25, the Design and Technical Construction Standards, are minimums and due to health, welfare or safety considerations, the Director of Public Works may subject property to additional requirements.

1. The following rules and regulations are hereby adopted by the City Council as the Design and Technical Construction Standards of the City of Keller, Texas, and shall be applicable to the filing of plats and the subdivision of land, as that term is defined in the Keller Unified Development Code and in Chapter 212 of Texas Local Government Code, within the corporate City Limits and the Extraterritorial Jurisdiction (ETJ) of the City of Keller as they may be from time to time as provided by Chapter 42, Texas Local Government Code.

2. The latest version of “Public Works Construction Standards” of the North Central Texas Council of Governments, with all amendments thereto, shall govern and shall constitute the technical specifications for all improvements to be dedicated to the City of Keller except as amended by the Keller Design and Technical Construction Standards and is made a part thereof, but is not physically bound within this document.

3. It is the responsibility of the Developer and his Project Engineer to comply with all applicable standards, ordinances, and regulations. In the interpretation and application of the provisions of these standards, it is the intention of the City Council that the principles, standards, and requirements provided for herein shall be minimum requirements for (the developing of subdivisions in) the City of Keller (exceeding these requirements is encouraged). Where other ordinances of the City are more restrictive in their requirements, such other ordinances shall control.

All deviations from the provisions presented herein shall be submitted by the Project Engineer in writing and approved in writing by the Director of Public Works or City Engineer.

4. Where specific topographic or other conditions make special requirements in addition to these standards necessary in order to achieve the best overall design, these standards may be modified by the Director of Public Works and/or City Engineer.

The City of Keller reviews construction plans to ensure compliance with the Design and Technical Construction Standards, Unified Development Code, and all other applicable documents. The proper design of all construction plans is the responsibility of the Project Engineer.
Section 5.24 - Design Standards

A. Design Standards

1. Construction Plans

   a. Plan Order

A civil construction plan submittal shall meet the following general sheet requirements and order:

   1) Cover Sheet with Vicinity Map (to include project title, legal description, city’s project number, and date)

   2) Final Plat (copy of the executed, approved, and filed final plat)

   3) Site Plan (copy of approved site plan for non-residential projects)

   4) Dimensional Control Plan

   5) Paving Plan and Profile

   6) Grading Plan

   7) Drainage Area Map

   8) Storm Sewer Layout

   9) Storm Sewer Plan and Profile

   10) Water Layout

   11) Water Plan and Profile

   12) Sanitary Sewer Layout

   13) Sanitary Sewer Plan and Profile

   14) Storm Water Pollution Prevention Plan (Erosion Control Plan)

   15) Tree Protection Plan

   16) Street Sign and Street Light Plan (plan view of development showing the location for all permanent street signs, traffic control signs, and street lights)

   17) Traffic Control Plan (to be included for all proposed temporary street closures, existing street connections, and open cut utility crossings of existing streets)

   18) Standard Construction Details

Additional plan sheets may be required per the City of Keller Unified Development Code.

Three (3) copies of complete Construction Plans shall be submitted with the Final Plat. Construction plans must be 100% complete at the time of submittal. Any incomplete sets of construction plans may be returned without City review comments.

b. Plan Layout

   1) The Construction Plans shall be submitted on standard 22” x 34” sheets.
2) Each sheet of the Construction Plans shall include north arrow, scale, date, and benchmark description to sea level datum. Scales shall be 1 inch equal 20, 40, or 50 feet horizontally and 1 inch equal 2, 4, or 5, feet vertically.

3) Each sheet shall bear the seal and signature of the Professional Engineer licensed in the State of Texas who prepared the plans (Project Engineer).

4) Each sheet of the Construction Plans shall contain a title block, including space for the notation of revisions. This space is to be completed with each revision to the plan sheet and shall clearly note the nature of the revision and the date that the revision was made.

5) Include a signature block for a representative of the City of Keller on each plan sheet in the lower right hand portion of the sheet. The signature block should read "Reviewed by the City of Keller and Released for Construction" with a separate line for "Date: __________" and another line for a signature by "Director of Public Works / City Engineer".

6) On the Cover Sheet, the project title, legal description, and City’s project number shall be placed vertically along the right border in small print.

2. Street System Improvements
   a. General

   The purpose of this section is to provide a set of minimum design standards to be used in the designing of roadways in the City of Keller. These guidelines will be used by consulting engineers employed by the City and engineers for private developments in the City. Each sheet of the plans and profiles will bear the seal, date, and signature of the licensed professional civil engineer who prepared them. Unusual circumstances or special designs requiring a variance from the standards in this manual may be approved by the Director of Public Works or City Engineer. The project engineer shall also refer to the City of Keller Master Thoroughfare Plan and Unified Development Code for additional roadway design criteria not covered in this document. Additionally, any roadway design criteria not addressed in these documents shall conform with the latest edition of AASHTO’s Geometric Design of Highways and Streets and the Manual on Uniform Traffic Control Devices (MUTCD) published by the Texas Department of Transportation.

   b. Streets

   The scope of this section includes the various design elements, criteria, standards and instructions required to prepare paving plans for the City of Keller Department of Public Works. These guidelines should result in the construction of safe, economical streets and thoroughfares.

   1) Classification of Streets

      As described in the Master Thoroughfare Plan, the classifications of roadways in the City of Keller are as follows:

      a) Arterial 6-Lane Divided (A6D)
      b) Arterial 4-Lane Divided (A4D)
      c) Collector 4-Lane Undivided (C4U)
      d) Collector 3-Lane Undivided (C3U)
      e) Collector 2-Lane Undivided (C2U)
f) Local /Residential Streets

g) Rural Road

Each street is made up of elements which are related to the use of that particular facility. These elements include right-of-way, pavement width, median width if required, arrangement of traffic lanes and parking lanes, curb radii at intersections and other characteristics. Table No. 1 is to be used in the design of the various classifications of streets in Keller.
### Table No. 1

**MINIMUM DESIGN STREET STANDARDS**

<table>
<thead>
<tr>
<th>DESIGN ELEMENT</th>
<th>A4D</th>
<th>A6D</th>
<th>C4U</th>
<th>C3U</th>
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<tbody>
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<td>Design Speed (mph)</td>
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<td>Grade (percent)</td>
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<td>Right-in-Way Width (ft)</td>
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<td>Median Opening Distance (ft)</td>
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<td>Capacity (CBS-C/D) (week/day)</td>
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<td>Two-way Left Turn Lane</td>
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<td>Parking Area</td>
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<td><strong>Removal Criteria</strong></td>
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<td></td>
<td></td>
<td></td>
<td>23,000</td>
</tr>
<tr>
<td>N/A (residential)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17,000</td>
</tr>
<tr>
<td>N/A (industrial)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12,500</td>
</tr>
<tr>
<td>N/A (government)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8,500</td>
</tr>
</tbody>
</table>

* Two-way Left Turn Lane

**Removal Criteria:** The minimum design criteria for proposed future Roadway Type.
2) Geometric Design

a) General

Geometrics of city streets may be defined as the geometry of the curbs or pavement areas which govern the movement of traffic within the confines of the rights-of-way. Included in the geometrics are the pavement, width, degree of curvature, width of traffic lanes, parking lanes, or turning lanes, median width separating opposing traffic lanes, median nose radii, curb radii at street intersections, crown height, cross fall, geometric shapes of islands separating traffic movements and other features. Since city streets are differentiated by their functions and location, there is also a variance in the geometry which describes the path vehicular traffic should follow.

b) Design Speed

The design speed is a primary factor in the horizontal and vertical alignment on city streets and thoroughfares. Design features such as curvature, super-elevation, radii for turning movements and sight distance are directly related to the design speed. The design speed also affects features such as lane widths, pavement width, pavement cross-fall, pavement crown, and clearances.

The design speed is defined as the approximate maximum speed that can be maintained safely by a vehicle over a given section of road when conditions are so favorable that the design features of the roadway govern. The speed limit or posted speed is the maximum legal speed set by local authorities for a certain roadway or area. The design speed should never be less than the likely legal speed limit for arterials and collectors.

The various street and thoroughfare classifications, which make up the system within the City of Keller, require different design speeds according to their use and location. Refer to Table No. 1 for design speeds for each roadway classification. Lower design speeds will be permitted for all classifications for unusual conditions, terrain or alignment.

c) Horizontal Alignment

The horizontal geometrics of the streets and thoroughfares include the segment of geometric design associated with the alignment, intersections, pavement widths, and related geometric elements. The various classifications, utilizing the design speed as a control, must have certain horizontal and vertical geometrics to provide a safe economical facility for use by the public.

i) Horizontal Curves and Super-elevation

The alignment of the streets and thoroughfares is usually determined by the alignment of the existing right-of-way or structures which cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing a simple curve having a radius which is compatible with the speed of vehicular traffic. To increase the safety and reduce discomfort to drivers traversing a curved portion of a street or thoroughfare, the pavement may be super-elevated.

Curvature in the alignment of arterials is allowed under certain conditions, but the greater traffic volume and the higher vehicle speeds which accompany these thoroughfares tend to increase the number of accidents when curving of alignment occurs. Curves in the alignment of minor streets usually provide aesthetic value to residential neighborhoods without affecting the orderly flow of traffic or safety.
A recommended minimum radius of horizontal curvature for different street types is shown in Table No. 1. These standards are based on traffic consisting of typical present day automobiles operating under optimum weather conditions. There are other important considerations in the design of curves on thoroughfares including the location of intersecting streets, drives, bridges, and other topographic features.

Minor residential streets intersecting a collector street or major street will have a tangent section of centerline at least fifty feet (50') in length measured from the right-of-way line of the collector or major street; however, no such tangent is required when the minor street curve has a centerline radius greater than four hundred feet (400') with the center located on the collector street or major street right-of-way line. Within a reverse curve, there will be a tangent section of centerline not less than one hundred feet (100') long.

ii) Turning Lanes

Turning lanes shall conform to the standards outlined in Section 5.08 of this Unified Development Code.

iii) Street Intersections

The intersection at grade of all thoroughfares will be at or near an angle of ninety degrees (90°). Streets shall intersect at no less than an eighty degree (80°) angle.

Curb radii required for intersections at ninety degrees (90°) are specified in Table No. 1. The radii required for intersections at less than ninety degrees (90°) will be determined using the design data for various vehicles as shown in Table No. 2.

The location of any median nose will be so located that traffic will clear it while making a left turn. Other considerations include adequate clearance between the median nose and through traffic on the intersecting thoroughfare and location of the median nose to properly clear the pedestrian crosswalks. Reference the City of Keller Standard Construction Details.

<table>
<thead>
<tr>
<th>INTERSECTING STREETS</th>
<th>PASSENGER (P)</th>
<th>SINGLE UNIT TRUCK (SU)</th>
<th>TRACTOR SEMI-TRAILER COMBINATION (WB-50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local with Local</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local with Collector</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Local with Arterial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector with Collector</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Arterial with Collector</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Arterial with Arterial</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Fire Lane and Alley Alignment</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Refer to AASHTO’s *Geometric Design of Highways and Street* for design vehicle information and figures.

d) Vertical Alignment
The vertical alignment of all thoroughfares should be designed to insure the safe operation of vehicles by the traveling public and should allow easy access to adjacent property.

i) Street Grades

The intersection design of two (2) thoroughfares will include grades which will result in a plane surface or at least a surface which approximates a plane surface. A vehicle traveling on either thoroughfare should be able to traverse the intersection at the design speed without discomfort to accomplish a smooth transition, crossfall toward the median of one lane of each thoroughfare may be required. A storm drainage inlet may also be required in the median.

In presenting the grades of intersecting thoroughfares in the paving plans, profiles of all four (4) curbs of a thoroughfare will be shown as a continuous grade through the intersection of the other thoroughfare.

- Minimum Grades

Minimum longitudinal grades for streets and thoroughfares are required to ensure proper flow of surface drainage toward inlets. The minimum grade required for all roadways shall be 0.65 percent. All valley gutters should be a minimum of eight feet (8') wide and constructed of reinforced concrete and will have a minimum grades of 0.65 percent

- Maximum Grades

Maximum longitudinal grades will be compatible with the type of facility and the accompanying characteristics including the design speed, traffic conditions and sight distance.

Collectors and arterials must move large volumes of traffic at faster speeds, and flatter grades will better accommodate these characteristics. Truck and bus traffic on these type facilities often controls traffic movement, particularly if steep grades prevent normal speeds. The normal maximum street grades allowed for Keller streets are specified in Table No. 1. Steeper grades may be permitted for short lengths where required by topographical features or restricted alignment if approved by the Director of Public Works or City Engineer.

- Cross Fall

On undivided streets, the maximum difference in curb elevations will not exceed five-tenths of a foot (0.5'). On divided streets, cross slope of the traffic lanes will be ¼-inch per foot minimum and ½-inch per foot maximum.

ii) Vertical Curves

When two (2) longitudinal street grades intersect at a point of vertical intersection (PVI) and the algebraic difference in the grades is one percent (1.0%) or greater, a vertical curve is required. Vertical curves are utilized in roadway design to affect a gradual change between tangent grades and should result in a design which is safe, comfortable in operation, pleasing in appearance, and adequate for drainage. The vertical curve will be formed by a simple parabola and may be a crest vertical curve or a sag vertical curve.
iii) Stopping Sight Distance

- Crest Vertical Curve

When a vertical curve is required, it must not interfere with the ability of drivers to see a length of street ahead, should they be required to suddenly stop. This length of street, called the stopping sight distance, should be of sufficient length to enable a person in a vehicle having a height of eye of three and three quarters feet (3.75’) above the pavement and traveling at or near design speed to stop, before reaching an object in his path five tenths foot (0.5’) in height.

The minimum stopping sight distance is the sum of two (2) distances; one, the distance traversed by a vehicle from the instant the driver sights an object for which a stop is necessary, to the instant the brakes are applied; and the other, the distance required to stop the vehicle after the brake application begins.

The minimum safe stopping sight distances for the City of Keller street types are shown in Table No. 3. These sight distances are based on each design speed shown and on wet pavement. The minimum length of crest vertical curve required for the safe stopping sight distance of each street type may be calculated using the formula $L = KA$ and the values of $K$ for a crest vertical curve are also shown in Table No.3.

<table>
<thead>
<tr>
<th>STREET CLASSIFICATION</th>
<th>DESIGN SPEED (MPH)</th>
<th>SAFE STOPPING SIGHT DISTANCE (FT)</th>
<th>NORMAL CREST VERTICAL CURVE K (FT)</th>
<th>NORMAL SAG VERTICAL CURVE K (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial (A6D)</td>
<td>50</td>
<td>425</td>
<td>84</td>
<td>96</td>
</tr>
<tr>
<td>Arterial (A4D)</td>
<td>50</td>
<td>425</td>
<td>84</td>
<td>96</td>
</tr>
<tr>
<td>Collector (C4U)</td>
<td>40</td>
<td>305</td>
<td>44</td>
<td>64</td>
</tr>
<tr>
<td>Collector (C3U)</td>
<td>35</td>
<td>250</td>
<td>29</td>
<td>49</td>
</tr>
<tr>
<td>Collector (C2U)</td>
<td>35</td>
<td>250</td>
<td>29</td>
<td>49</td>
</tr>
<tr>
<td>Local/Residential</td>
<td>30</td>
<td>200</td>
<td>19</td>
<td>37</td>
</tr>
</tbody>
</table>

Based on Geometric Design of Highways and Streets (2001) by AASHTO
• Sag Vertical Curve

When a sag vertical curve is required, the vertical curve will be of sufficient length to provide a comfortable ride during the change in vertical direction. The minimum length of sag vertical curve required to provide a comfortable ride may be calculated using the formula \( L = KA \) and the values of \( K \) for a sag vertical curve are shown in Table No. 3.

• Sight Distance at Intersections

An important consideration in the design of thoroughfares is the vehicle attempting to cross the thoroughfare from the side street or drive. The operator of the vehicle attempting to cross should have an unobstructed view of the whole intersection and a length of the thoroughfare to be crossed sufficient to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception and reaction time and during braking. This sight distance, which is termed intersection sight distance, can be calculated for different thoroughfares and for various grades upwards and downward. Intersection sight distances are shown in Table No. 4. Figure No. 1 shows the method for measuring the intersection sight distance.

Table No. 4
SIGHT DISTANCES
(see Figure No. 1)

<table>
<thead>
<tr>
<th>DESIGN SPEED (MPH)</th>
<th>STOPPING SIGHT DISTANCE (FT)</th>
<th>THOROUGHFARE CLASSIFICATION</th>
<th>INTERSECTING SIGHT DISTANCE (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NEAR SIDE</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>Local/Residential</td>
<td>290</td>
</tr>
<tr>
<td>35</td>
<td>250</td>
<td>Collector - (C2U)</td>
<td>335</td>
</tr>
<tr>
<td>35</td>
<td>250</td>
<td>Collector - (C3U)</td>
<td>335</td>
</tr>
<tr>
<td>40</td>
<td>305</td>
<td>Collector - (C4U)</td>
<td>385</td>
</tr>
<tr>
<td>50</td>
<td>425</td>
<td>Arterial - (A4D)</td>
<td>480</td>
</tr>
<tr>
<td>50</td>
<td>425</td>
<td>Arterial - (A6D)</td>
<td>480</td>
</tr>
</tbody>
</table>

Based on Geometric Design of Highways and Streets (2001), by AASHTO

Table No. 4 (Continued):

<table>
<thead>
<tr>
<th>DESIGN SPEED (MPH)</th>
<th>UPGRADES (DECREASE FEET)</th>
<th>DOWNGRADES (INCREASE FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 6 10</td>
<td>3 6 10</td>
</tr>
<tr>
<td>25</td>
<td>5 10 15</td>
<td>5 15 25</td>
</tr>
<tr>
<td>30</td>
<td>10 15 20</td>
<td>10 20 30</td>
</tr>
<tr>
<td>35</td>
<td>15 20 ---</td>
<td>15 25 ---</td>
</tr>
<tr>
<td>40</td>
<td>20 25 ---</td>
<td>20 35 ---</td>
</tr>
<tr>
<td>45</td>
<td>25 30 ---</td>
<td>25 50 ---</td>
</tr>
</tbody>
</table>
iv) Intersection Grades

The grade of an intersecting street with the principal street gutter should not be generally more than four percent (4%) either up or down within the first twenty feet (20') beyond the curb line of the principal street except that in very hilly terrain a maximum intersecting grade of six percent (6%) can be considered. Grade changes of one percent (1%) or more require vertical curves.

e) Openings

The following standards for median and curb openings are established to facilitate traffic movement and promote traffic safety. Additional standards are found in the Master Thoroughfare Plan, Unified Development Code and Standard Construction Details. Figure No. 2 shows typical values for distances and angles required for openings.

i) Median Openings

Median openings will normally be permitted at all intersections with dedicated City of Keller Streets. Exceptions would be at certain minor streets where, due to unusual conditions, a hazardous situation would result. Normal spacing between median openings should be no more than 1,200 feet.

Mid-block median openings or other openings with left turns permitted into adjacent property will not normally be permitted unless all the following conditions exist:

- The property to be served is a significant traffic generator with demonstrated or projected trip generation of not less than two hundred fifty (250) vehicles in a twelve (12)-hour period.
- The edge of the median opening is not less than four hundred feet (400') from the edge of an intersection with a collector or arterial thoroughfare.
- The median width is sufficient to permit the construction of a left turn storage lane.

Median openings will not be permitted in left turn storage lanes. Wherever possible, median openings should serve both sides of a thoroughfare.

ii) Driveway and Curb Openings

Design of driveway and curb openings shall be as specified in Section 5.07 of this Unified Development Code.

Driveway return radii shall meet the design vehicle requirements as specified in Table No. 2 or as shown in Table No. 1, whichever is more restrictive.

In all cases, driveway locations must conform to minimum safe sight distance and stopping sight distance standards.

Driveway approaches shall not be located in street intersections or at established pedestrian crossings.

Driveways shall be kept at a minimum of five feet (5') away from obstructions such as street light posts, fire hydrants, traffic signals, etc.

Driveway approaches shall not occupy more than forty percent (40%) of the frontage of a lot or tract.
Minimum distances of driveways from intersections shall be as specified in Figure No. 3 or Section 5.07 of this Unified Development Code, whichever is more restrictive.

All driveway approaches shall be constructed six inches (6”) thick with No. 4 rebar on eighteen-inch (18”) centers each way. Concrete for approaches to have three thousand six hundred (3,600) p.s.i compressive strength at twenty-eight (28) days (minimum).

iii) Drive Approach on Rural Roads

- Culvert Size – The developer/property owner shall provide a drainage study by a Professional Engineer licensed in the State of Texas that determines the size of culvert needed. The minimum culvert pipe size shall be 18” diameter. The ends of all culvert pipes shall be cut at a 6:1 slope and require a reinforced concrete sloping headwall.

- Radius – Driveways shall be constructed with the return curbs joining the edge of pavement at the street with a minimum ten-foot (10’) radius.

- Slope – The maximum slope from the edge of driveway to the top of the culvert pipe shall be 4:1. The sloped area around the end of the culvert pipe headwall shall be sodded or hydro-mulched to resist erosion.

- Cross Slope – The minimum cross slope on the drive shall be 1/8 inch per foot. The minimum longitudinal slope between the existing pavement edge at the street and the valley over the culvert pipe shall be ¼ inch per foot down and away from the street.

- Maintenance – Future maintenance of the drive approach and culvert pipe is the responsibility of the property owner.

- Grading – During the drive approach installation, all ditch grading upstream and downstream of the proposed driveway culvert is the responsibility of the property owner.

f) Driveway and Alley Grades

i) Driveway Grades

The normal driveway grade within the street right-of-way is set at one-quarter inch per foot rise above the top of curb to the property line. The minimum elevation of a driveway at the right-of-way line is two and one half inches (2.5”) above the top of curb. Barrier free sidewalk construction requires a maximum driveway grade as grade measured from the gutter of eight percent (8%).

Where driveway construction or reconstruction must occur off the street right-of-way, the usual maximum grade is fourteen percent (14%). The maximum change in grade without vertical curve is twelve percent (12%) for any ten feet (10’) in distance. Driveways should be profiled for a distance of at least twenty-five feet (25’) outside the right-of-way to ensure adequate replacement design.

Due to state laws requiring barrier free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveways.

ii) Alley Grades
The minimum width of residential alleys in the City of Keller is fifteen feet (15′) of pavement with a right-of-way of twenty feet (20′). Alleys are constructed with a 5-inch inverted crown for drainage. The maximum grades for alleys are eight percent (8%) within thirty feet (30′) of an intersection with a street and fourteen percent (14%) elsewhere, unless otherwise approved by the Director of Public Works or City Engineer. The minimum grade for alleys is six and one-half tenths percent (0.65%). Changes in grade, including intersections with streets, may not exceed three percent (3%) without providing vertical curves.

**g) Pavement Design**

All streets will be constructed of reinforced Class 'C' concrete with the minimum strength and thickness as shown in Table No. 6 of this section. Table No. 6 also calls for a minimum amount of lime or cement to be mixed with the subgrade soils for stabilization. A geotechnical investigation to determine the level of lime or cement to be added for soil stabilization may be required if deemed necessary by the Director of Public Works. The Developer or Contractor will be responsible for all costs associated with this geotechnical investigation and tests.

Standard pavement sections are established and are included in this manual in Table No. 6, "Minimum Standard Street Pavement Design." Unusual design conditions may be encountered which will preclude the use of Table No. 6. The proposed pavement will be designed in accordance with the geotechnical investigation or Table No. 6, whichever is more restrictive.

**Table No. 5**

**MINIMUM STANDARD STREET PAVEMENT DESIGN**

<table>
<thead>
<tr>
<th>TYPE OF STREET</th>
<th>CONCRETE THICKNESS (IN)</th>
<th>COMPRESSIVE PAVEMENT STRENGTH AT 28 DAYS (PSI)</th>
<th>REBAR SIZE AND SPACING</th>
<th>MINIMUM SUBGRADE TREATMENT *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alley</td>
<td>6</td>
<td>3,600</td>
<td>No. 3 18&quot; longitudinal 12&quot; traverse</td>
<td>6&quot; lime or cement treated material</td>
</tr>
<tr>
<td>Driveway (Commercial Drive and Residential Approaches)</td>
<td>6</td>
<td>3,600</td>
<td>No. 3 18&quot; longitudinal 18&quot; traverse</td>
<td>6&quot; lime or cement treated material</td>
</tr>
<tr>
<td>Fire Lanes</td>
<td>7</td>
<td>3,600</td>
<td>No. 4 18&quot; longitudinal 18&quot; traverse</td>
<td>8&quot; lime or cement treated material</td>
</tr>
<tr>
<td>Residential (local)</td>
<td>6</td>
<td>3,600</td>
<td>No. 3 18&quot; longitudinal 18&quot; traverse</td>
<td>6&quot; lime or cement treated material</td>
</tr>
<tr>
<td>Collector</td>
<td>7</td>
<td>3,600</td>
<td>No. 4 18&quot; longitudinal 18&quot; traverse</td>
<td>8&quot; lime or cement treated material</td>
</tr>
<tr>
<td>Arterial</td>
<td>8</td>
<td>3,600</td>
<td>No. 4 18&quot; longitudinal 18&quot; traverse</td>
<td>9&quot; lime or cement treated material</td>
</tr>
</tbody>
</table>

* Site specific per geotechnical report, subject of review and approval by the Public Works Director.

The developer or contractor will be required to furnish a geotechnical report indicating soil tests on the subgrade soils at four hundred foot (400′) intervals, or more frequently if material changes are encountered. Such data will
ARTICLE FIVE
Unified Development Code

Adopted: July 7, 2015

5-52 Section 5.24 – Design Standards

include, but is not necessarily limited to Liquid Limit, Plasticity Index (P.I.), and Percent Passing No. 200 sieve. All soil tests will be performed by an independent testing laboratory, approved by the City of Keller, at the developer's or contractor's expense.

All subgrade soils will be stabilized with lime or cement treated base material to at least one foot behind the proposed curb, regardless of the type of soil encountered. The amount and type of stabilization will be in accordance with the geotechnical investigation recommendation or as shown in Table No. 6, whichever is more restrictive. Subgrade stabilization of residential driveways is recommended but shall be considered optional and the decision to comply with this recommendation shall be at the discretion of the builder or developer.

The street curb will not be more than six inches (6") wide at the top and seven and one-half inches (7-1/2") wide at the base and six inches (6") high. The gutter will be a minimum of twenty-four inches (24") wide. Mountable curbs do not create an acceptable side roadway barrier and will not be allowed.

h) Sidewalks

i) The purpose of the public sidewalk is to provide a safe area for pedestrians to walk. The City of Keller requires that sidewalks be constructed with the paving of streets or when building construction occurs, in all residential areas and wherever pedestrian traffic may be generated and that all sidewalks conform to state laws for barrier free construction. Refer to Section 5.06 of this Unified Development Code and the Standard Construction Details for design requirements not covered in this section.

ii) Concrete sidewalks will have a thickness of not less than four inches (4") and will be constructed of three thousand six hundred pounds per square inch (3,600 psi) compressive strength concrete on both sides of all streets and thoroughfares. Sidewalks will be constructed within the right-of-way and will extend along the street frontage including the side corner lots and block ends.

All concrete for sidewalks will be placed on a two-inch (2") sand cushion and will be reinforced with a minimum of No. 3 rebar on eighteen-inch (18") centers each way.

iii) All sidewalk intersections with street curbs shall be constructed so as to provide a curb ramp that complies with the Architectural Barriers Act. Barrier free curb ramps shall be provided for access to the street. The following specifications shall apply:

- Ramp to be a minimum four feet (4’) in width.
- Ramp to be constructed with Class “C” concrete.
- Minimum ramp concrete thickness shall be six inches (6”).
- #3 bars shall be used for reinforcement on eighteen-inch (18”) centers both ways.
- Curb return shall match existing curb height of the street and taper to the connecting walk with a 1-foot radius.
- Street shall be blocked out (max. twelve (12") inches) and dowels installed.
- Saw joints shall be made one and a half (1 ½”) inch minimum depth and sealed with silicone joint sealant material.
iv) Surface of walk shall be coarse and ribbed to provide extra traction.

Where the above specifications do not apply or do not have jurisdiction, refer to the specifications in the American Disabilities Act (ADA).

i) Trails

i) The purpose of the public trail is to provide a safe area for recreational walking, jogging, biking, and in some cases, equestrian use. The City of Keller requires that trails be constructed when building construction occurs on sites that have trails in accordance with the Parks and Trails Master Plan. Refer to Section 5.06 of this Unified Development Code and the Standard Construction Details for design requirements not covered in this section.

ii) Concrete trails will have a thickness of not less than six inches (6”) and will be constructed of three thousand six hundred pounds per square inch (3,600 psi) compressive strength concrete. Trails will be constructed within dedicated right-of-way and will extend the length of the property, in accordance with the Parks and Trails Master Plan.

All concrete for trails will be placed on a two-inch (2”) sand cushion and will be reinforced with a minimum of No. 3 rebar on eighteen-inch (18”) centers each way.

iii) All trail intersections with street curbs shall be constructed so as to provide a curb ramp that complies with the Architectural Barriers Act. Barrier free curb ramps shall be provided for access to the street. The following specifications shall apply:

- Ramp shall match the width of the trail.
- Ramp to be constructed with Class “C” concrete.
- Minimum ramp concrete thickness shall be six inches (6”).
- #3 bars shall be used for reinforcement on eighteen-inch (18”) centers both ways.
- Curb return shall match existing curb height of the street and taper to the connecting trail with a one (1)-foot radius.
- Street shall be blocked out (max. twelve (12”) inches) and dowels installed.
- Saw joints shall be made one and a half (1-½”) inch minimum depth and sealed with silicone joint sealant material.

iv) Surface of trail shall be coarse and ribbed to provide extra traction.

Where the above specifications do not apply or do not have jurisdiction, refer to the specifications in the American Disabilities Act (ADA).

3. Drainage System Improvements

a. General

The following contains minimum storm drainage design criteria and outlines the design procedures to be employed on drainage projects in the City of Keller.
Plans, profiles, and specifications will be prepared for storm sewer improvements to be constructed. The plans will show the appropriate watershed areas, drainage through the site and/or discharge point, storage volume calculations, run-off coefficient calculations, hydraulic gradients, flow arrows, and other details for the proposed pipe, inlets, manholes, culverts, outlet structures, and other appurtenances for the one (1), ten (10) and one hundred (100) year events. The plans will also show any proposed low impact design (LID) system plans including pervious pavement, bioretention areas, bioswales, etc. Each sheet of the plans and profiles will bear the seal and signature of the licensed professional civil engineer who is responsible for the design.

The developer will pay for the cost of all drainage improvements connected with development of the subdivision, including any necessary off-site channels or storm sewers and acquisition of any required easements.

Discharge of storm drainage will be at a point of adequate capacity or no adverse impact (as previously defined). This will require the developer to provide off-site drainage improvements if an adequate discharge point (defined an outlet of storm water, acceptable to the City Engineer, which does not create adverse impact) does not exist on-site as determined by the provisions provided herein.

b. Residential Grading and Drainage

1) Surface runoff from residential lots shall cross no more than one additional lot before being discharged to an adequate discharge point in a public right-of-way (R.O.W.) or drainage easement. When the flow reaches the second lot, side lot swales shall be in place to direct the flow to the street or to a drainage system within a public easement in the rear yard.

2) Three types of residential lot grading and drainage design plans are allowed within the City of Keller, as shown in Appendix Part B, Figure No. 1.a. Specific deviations from these three plans will be considered on an individual basis.

3) Individual lot grading plans are required to be submitted with the building permit application for all platted lots. An example of a Lot Grading Plan and a checklist of items required on the plan are shown on Appendix Part B Figures 1.02 and 1.03.

c. Buildings

When adjacent to the floodplain, the finished floor (FF) elevation of commercial and residential buildings shall be a minimum of 2 feet above the 100-year frequency storm water surface elevation based on runoff from a fully developed (based on the Future Land Use Plan or Zoning Map, whichever is more restrictive) upstream watershed.

d. Detention

1) The developer or builder 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 currently generated by the undeveloped site during one (1), ten (10), and one hundred (100) year frequency storm events. The runoff coefficient for the existing site will be based on the existing surface cover and land use, not the zoning designation.

2) Runoff computations shall be based upon fully developed watershed conditions in accordance with the land use projections in the latest comprehensive land use plan for the City of Keller and upstream cities. 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.
3) Detention calculations for single basins shall be designed with HEC-1, HEC-HMS, XPSWM, or the Modified Rational Method for contributing basins up to one hundred (100) acres. All basins with contributing areas greater than one hundred (100) acres or with multiple detention basins (in series or parallel) shall be designed with HEC_HMS or XPSWM.

4) Detention outflow hydraulics shall be designed as broadcrested weirs, orifices, or closed conduit systems.

5) Weir calculations will be based on the following equation if the weir is trapezoidal with side slopes of three (3) horizontal with one (1) vertical or milder: 
   \[ H = \left( \frac{Q}{2.9(BW)} \right)^{2/3} \]
   If the side slopes are steeper, it shall be considered a contracted weir and the effective bottom width (BW) shall be reduced by two-tenths (0.2) H.

6) Orifice calculations will be based on the following orifice equation: 
   \[ H = \left( \frac{Q}{64.4(A)} \right)^{2} \]

7) Culvert or closed conduit calculations shall be as customary or as described in this Unified Development Code.

8) Storage calculations will begin at the discharge invert on the basin side of the control structure; or at the hydraulic grade line (created from the downstream surcharge) at the same location, whichever is greater. Volume below this elevation will not be used for the detention volume necessary.

9) All detention facilities shall include landscaping corresponding to that of the development.

e. Hydrology

1) Construction plans shall include a topographic layout of pre-development conditions and a layout of the proposed site grading. Each sheet shall clearly indicate points where runoff exits the site and include detailed calculations.

2) Rational Method

The design of storm drainage improvements for watersheds less than one hundred (100) acres may be based on flood discharges determined from the Rational Formula. The Rational Formula for calculating storm flow is:

\[ Q = CIA \]

Where:

- \( Q \) = the maximum storm flow rate at a given point in c.f.s.;
- \( C \) = runoff coefficient which varies with the topography, land use and moisture content of the soil at the time. The runoff coefficient will be based on the ultimate use of the land. If weighted \( C \) is used for non-residential use, a CAD file shall be submitted;
- \( I \) = the average intensity of rainfall in inches per hour for a period equal to the time of concentration of flow from the farthest point of the drainage area to the point under consideration; and,
- \( A \) = the drainage area, in acres, tributary to the point under design calculated from the drainage map of the area. This drainage map will be submitted with any drainage plans submitted for consideration by the City of Keller.

a) Runoff Coefficients

The runoff coefficient, which considers the slope of the terrain, the character of the land use, the length of overland flow, and the imperviousness of the drainage area, will be determined from the ultimate land development plan of
the City of Keller. The runoff coefficient for the appropriate land uses will be as follows:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Areas (Commercial and Retail)</td>
<td>0.90</td>
</tr>
<tr>
<td>Industrial &amp; Institutional areas</td>
<td>0.70</td>
</tr>
<tr>
<td>Residential areas</td>
<td></td>
</tr>
<tr>
<td>Single Family (Lots &gt; 0.5 acres)</td>
<td>0.50</td>
</tr>
<tr>
<td>Single Family (Lots &lt; 0.5 acre)</td>
<td>0.55</td>
</tr>
<tr>
<td>Apartments/Multi-Family</td>
<td>0.70</td>
</tr>
<tr>
<td>Parks and open space</td>
<td>0.30</td>
</tr>
<tr>
<td>Razed for redevelopment and left to vegetate</td>
<td>0.20</td>
</tr>
<tr>
<td>Razed and covered with impervious material</td>
<td>0.95</td>
</tr>
</tbody>
</table>

b) Rainfall Intensity

The rainfall intensity duration frequency curves, (IDF) shall be those included for Tarrant County in the 2010 ISWM Hydrology Technical Manual (See Figure 10).

The intensity, I, in the formula Q = CIA, is determined from these curves by arriving at a time of concentration and adapting a storm frequency upon which to base the drainage improvements.

i) Time of Concentration

The time concentration is the time required for a drop of water to flow from the upper limits of a drainage area to the point of concentration. The time of concentration includes the time required to flow overland plus the time required to flow in the gutter to the inlet, plus the time of flow in the storm sewer.

When designing inlets and laterals, the time of concentration is equal to the inlet time. The design engineer will compare the below 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. In no case shall a longer inlet time be used than ten (10) minutes for multi-family, commercial, churches, schools, industrial and business areas and fifteen (15) minutes for parks, cemeteries, agricultural, and single-family areas. A nomograph, shown on Figure No. 3 of Part 8, is attached for estimating the time of concentration. The design engineer will consider overland flow channelized at such time as the distance traveled exceeds one hundred (100’) feet.

ii) Storm Frequency

The design storm frequencies for storm drainage improvements in Keller are shown in Table No. 1.
Table No. 1
DESIGN STORM FREQUENCY

<table>
<thead>
<tr>
<th>TYPE OF FACILITY</th>
<th>DESCRIPTION OF AREA TO BE DRAINED</th>
<th>MAXIMUM TIME OF CONCENTRATION (MIN)</th>
<th>DESIGN FREQUENCY (YEARS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel Storm Sewers</td>
<td>Residential, Commercial and Industrial</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Street Right-of-Way</td>
<td>Including parallel underground drainage system</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Culverts, Channels, and Creeks</td>
<td>Any type of area less than 100 acres</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Culverts, Channels, and Creeks</td>
<td>Any type of area greater than 100 acres but less than 1,000 acres</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>Culverts, Channels, and Creeks</td>
<td>Any type of area greater than 1,000 acres</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

All bridges are to be designed for the one hundred (100)-year frequency regardless of drainage area.

- When an inlet is located in a sump and runoff in excess of the inlet capacity is designed to flow between houses, a reinforced concrete flume will be required to be installed above the storm sewer. The flume will be a minimum of four (4') foot wide with six (6") inch curbs.
- The underground storm drain and sump inlet will be designed to carry the 100-year frequency storm runoff.
- All sump inlets will have a path for overland relief to flow across in case the sump clogs. The overland relief path will be lined with reinforced four-foot (4") concrete flume with curb, gabions, or rock riprap to control erosion.
- Whenever storm sewer is to be installed under an arterial or collector street, the parallel storm sewer shall be sized to carry the combined one hundred (100)-year storm (above and below ground).

c) Area

The area used in determining flows by the Rational Method will be calculated by subdividing a map into drainage areas within the basin contributing storm water runoff to the system.

d) The plans shall include a table that shows the following:
   i) Drainage area designation (name) for each delineated basin.
   ii) Basin area, A.
   iii) Runoff coefficient, C (current and post-project conditions).
iv) Time of Concentration, \( T_c \).

v) Rainfall Intensity, \( I \).

vi) Discharge at each concentration/design point, \( Q \) (current and post-project conditions).

3) Unit Hydrograph Method

Method: For hydrology performed by the Unit Hydrograph Method, use HEC-1, HEC-HMS or XPSWM computer models and the Soil Conservation Service (SCS) Method. If XPSWM is used for the models, a triangular hydrograph (such as those used with the Rational Method) will not be allowed. The models will be constructed by defining the watershed areas as noted above for the Rational Method and as further defined herein.

Sub-areas used for determining the runoff at a specific design point should not exceed a ratio of 6:1. In some cases the area ratio may not effectively define the parameters of the existing or proposed watershed. In those cases, the ratio may be increased but will not exceed 10:1. In both cases, the intent is to limit the size of the largest sub-area in the analysis to be no larger than 10 times the smallest sub-area. In cases where flow timing is a concern which might otherwise increase the ratio, the larger sub-areas will be further subdivided so as not to exceed the 10:1 ratio.

Lag Time: The model Lag Times will be 60% of the composite Time of Concentration (\( T_c \)). The composite \( T_c \) will be composed of three (3) elements:

Sheet Flow: This element is calculated using the following equation:
\[
T_c = 1.8 \times (1.1 - C) \times L^{1.5} / S^{0.33}
\]

Where:
- \( T_c \) = Time of Concentration (min)
- \( C \) = surface runoff coefficient
  - Paved Surface = 0.016
  - Grass = 0.24
  - Woods = 0.60
  - Additional values may be approved by City Engineer
- \( L \) = distance traveled (ft.)
- \( S \) = slope (%)

Shallow Concentrated Flow: This element will use the following equations:
\[
T_c = \frac{L}{(V \times 60)} \quad \text{and;}
\]
for paved areas \( V = 20.3282 \times S^{0.5} \)
for unpaved areas \( V = 16.1345 \times S^{0.5} \)

Where:
- \( T_c \) = Time of Concentration (min)
- \( V \) = velocity (fps)
- \( L \) = distance traveled (ft.)
- \( S \) = slope (%)

Channelized Flow: This element will use Manning’s equation to calculate the approximate velocity or a hydraulic model as noted below to calculate actual flow time.
Soil Type: The soil types for the pervious areas will be determined from the USDA Natural Resources Conservation Service Soil Survey. The data will be used to determine the hydrologic soil group for each of the sub-areas. The following Curve Numbers (CN) will be assigned for each group to determine a weighted CN for the sub-area.

- Group A  CN = 39
- Group B  CN = 61
- Group C  CN = 74
- Group D  CN = 80

*Areas containing water year round will be included with the Percent Impervious.

Percent Impervious: This factor will be calculated assuming that all impervious areas are ultimately connected to the drainage system. The actual percent impervious may be calculated using a Geographical Information System (GIS) or vector based drawing file such as AutoCAD. Alternately the percent impervious may be selected from the table:

- Residential > 2 ac.  12%
- SF-LD & SF-30  20%
- SF-25 & SF-20  25%
- SF-15  30%
- SF-12, 10 & 8.4  38%
- 2F & MF  65%
- NS, O, R, TC & C  85%
- IP & LI  72%

All others will be calculated from drawing files as noted above.

Precipitation: The meteorological data will be input as "Frequency Storms" from the Rainfall-Intensity-Duration data described with the Rational Method noted above. The initial loss rate will be set to zero to represent a saturated watershed.

All storms will be modeled for a 24-hour occurrence.

f. Hydraulics

4) Spread of Water

During the design storm, the quantity of storm water that is allowed to collect in the streets before being intercepted by a storm drainage system is referred to as the "spread of water". In determining the limitations for carrying the storm water in the street, the ultimate development of the street will be considered. The portion of the street for carrying storm water will be limited as shown in Table No. 2.

<table>
<thead>
<tr>
<th>SPREAD OF WATER</th>
<th>MAJOR THOROUGHFARES (DIVIDED)</th>
<th>MAJOR THOROUGHFARES (UNDIVIDED)</th>
<th>COLLECTOR STREETS</th>
<th>MINOR RESIDENTIAL STREETS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One (1) traffic lane each way on each side to remain clear.</td>
<td>Two (2) traffic lanes each way to remain clear.</td>
<td>One (1) traffic lane each way to remain clear.</td>
<td>Depth of flow to top of curb, or no lanes completely clear.</td>
</tr>
</tbody>
</table>

a) Flow in Gutters

The City of Keller requires a storm drain conduit to begin at a point where the depth of flow based on the 10-year storm frequency reaches the top of curb. Inlets are then located as necessary to remove the flow based on a 10-year
storm frequency, as well as contain the 100-year storm within the street right-of-way. If, in the judgment of the engineer, the flow in the gutter would be excessive under either of these conditions, then the storm sewer should be extended upgrade to a more appropriate point for the inlet locations. Multiple inlets at a single location are permitted in extenuating circumstances. Where possible, inlets should be placed upstream from an intersection to prevent large amounts of water running through intersections. Inlets should also be located on the approach street to an intersection and in alleys where necessary to prevent water from entering these intersections in amounts which would cause the allowed street capacity to be exceeded.

b) Capacity of Street

Curves are provided on Part B, Figure No. 4 for determining the spread of water for certain gutter slopes, gutter discharge, and pavement crown. Also provided is Part B, Figure No. 5 for determining the capacity of parabolic gutters for various width of streets.

5) Valley Gutters

The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:

a) Valley gutters will not be allowed on arterial thoroughfares.

b) Wherever feasible, a collector street will not be crossed with a valley gutter.

c) At any cross intersection between a collector street and a residential street, perpendicular valley gutters on a collector street will not be permitted, and parallel valley gutters should cross only the lower classified street.

6) Sizing and Locating Inlets

a) Inlets in sumps are inlets in low points of surface drainage to relieve ponding. The capacity of inlets in sumps will be based on the following weir equation:

\[ Q = 3.0LH^{3/2}; Q/L \text{ or } Q/P = 3.0H^{3/2} \]

Where:

- \( Q \) = Capacity in c.f.s. of curb opening or capacity in c.f.s. of drop inlet;
- \( H \) = Head at the inlet in feet;
- \( L \) = Length of curb opening inlet in feet; and,
- \( P \) = Length of portion of perimeter of opening which water enters the drop inlet in feet.

Maximum allowable capacity for sump inlets is 2.0 cfs/foot.

Inlets should be placed such that the inlet openings do not become submerged. In cases where this is not possible and the inlet is completely submerged, the following orifice equation shall be utilized to determine capacity:

\[ Q = 4.84A H^{1/2} \]

Where:

- \( A \) = Area of Inlet Opening

The Curves shown in Figure Part B, No. 6 provide for a direct solution to the above equations.
b) Curb inlets may be depressed, recessed or nonrecessed. Depressed inlets should be used on continuous grades that exceed one percent (1%). For roadways with high traffic volumes, depressed inlets should also be recessed. Undepressed curb inlets will not be used when the street grade exceeds one percent (1%) without the approval of the Director of Public Works or City Engineer. The capacity of curb inlets will be based on the following equation:

\[
\frac{Q}{L} = 0.7 \left[ (H)^{5/2} - (a)^{5/2} \right] \div y
\]

Where:

- \( Q \) = the discharge into inlet in c.f.s
- \( L \) = the length of inlet opening in feet
- \( a \) = the gutter depression in feet (0 for undepressed)
- \( y \) = the depth of flow in approach gutter in feet
- \( H \) = the sum of gutter depression and flow depth \((a + y)\) in feet

The curve shown in Part B, Figure No. 7 provides for the direct solution of the above equation when the value of \( y \) is known.

The curve shown in Part B, Figure No. 8 provides for the determination of the ratio of the intercepted flow by the inlet to the total flow in the gutter.

7) Design of Closed Conduits

Storm water runoff in excess of that allowed to collect in the streets will be intercepted in inlets and carried away in a storm sewer system. Storm sewer capacity will be calculated by Manning’s Formula:

\[
Q = \frac{1.486}{n} AR^{\frac{2}{3}} S^{\frac{1}{2}}
\]

Where:

- \( Q \) = the discharge in c.f.s;
- \( A \) = the cross-sectional area of flow in square feet;
- \( R \) = the hydraulic radius in feet;
- \( S \) = the slope of the hydraulic gradient in feet per foot; and,
- \( n \) = the coefficient of roughness \((n = 0.013\) for concrete pipe and 0.015 for poured culverts).

In the design of the storm sewer system where the design is for the ten (10)-year flood event, the elevation of the hydraulic gradient of the storm sewer will be a minimum of one and one half feet (1.5’) below the elevation of the adjacent street gutter. Where the system is designed for the one hundred (100)-year flood event, this may be reduced to half foot (0.5’) below the elevation of the adjacent street gutter.

Storm sewer pipe will be a minimum of eighteen inches (18”) in diameter. Storm sewer pipe material shall be reinforced concrete tongue and groove pipe meeting specifications for ASTM C-76, Class III.

a) Hydraulic Gradient

After the computation of the quantity of storm runoff entering each inlet, the size and gradient of pipe required to carry off the design storm are to be determined. The City of Keller requires the hydraulic gradient for all drainage design to be shown and tabulated. All hydraulic gradient calculations shall begin at the outfall of the system. The following is the criteria for the starting elevation of the hydraulic gradient:
i) The 100-year water surface elevation in a creek, stream or other open channels will be calculated for the time of peak pipe discharge in the same storm and that elevation used for beginning the hydraulic gradient.

ii) In lieu of separate calculations for the difference in time to crest on the creek compared to the closed conduit time of concentration, Table 1.10 Frequencies For Coincidental Occurrences from the 2010 iSWM Hydraulics Technical Manual may be used.

iii) For pipes that flow into storm water storage areas, the design flood elevation for that storage area will be based on the 100-year storm.

iv) When a proposed storm sewer is to be connected to an existing storm sewer system that has a design flow less than the proposed, the hydraulic gradient for the proposed storm sewer will start at the elevation of the existing storm sewers’ hydraulic gradient or the top inside elevation of the pipe, whichever is greater.

b) Velocity in Closed Conduits

Table No. 3 is a tabulation of minimum pipe grades which will produce a velocity of not less than 2.5 f.p.s. when flowing full. Grades less than those shown will not be allowed. Only those pipe sizes shown in Table No. 3 should be used in designing pipe storm sewer systems.

<table>
<thead>
<tr>
<th>PIPE DIAMETER (INCHES)</th>
<th>SLOPE (FEET/100 FEET)</th>
<th>PIPE DIAMETER (INCHES)</th>
<th>SLOPE (FEET/100 FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.180</td>
<td>54</td>
<td>0.041</td>
</tr>
<tr>
<td>21</td>
<td>0.150</td>
<td>60</td>
<td>0.036</td>
</tr>
<tr>
<td>24</td>
<td>0.120</td>
<td>66</td>
<td>0.032</td>
</tr>
<tr>
<td>27</td>
<td>0.110</td>
<td>72</td>
<td>0.028</td>
</tr>
<tr>
<td>30</td>
<td>0.090</td>
<td>78</td>
<td>0.025</td>
</tr>
<tr>
<td>33</td>
<td>0.080</td>
<td>84</td>
<td>0.023</td>
</tr>
<tr>
<td>36</td>
<td>0.070</td>
<td>90</td>
<td>0.021</td>
</tr>
<tr>
<td>42</td>
<td>0.056</td>
<td>96</td>
<td>0.019</td>
</tr>
<tr>
<td>48</td>
<td>0.048</td>
<td>102</td>
<td>0.018</td>
</tr>
</tbody>
</table>

Table No. 4 shows the maximum allowable velocities in closed conduits:

<table>
<thead>
<tr>
<th>Type of Conduit</th>
<th>Maximum Velocity (f.p.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culverts and Storm Sewers</td>
<td>15.0</td>
</tr>
<tr>
<td>Inlet Laterals</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Discharge velocities cannot exceed the maximum velocity of the channel or conduit at the outfall. Velocity dissipaters shall be used at all outfall points to prevent erosion.

c) Roughness Coefficients for Closed Conduits
Values for the roughness coefficient "n" are tabulated in Table No. 5. Where engineering judgment indicates values other than those shown should be used, the appropriate adjustments should be made in the calculations and the variance noted and approved by the Public Works Director or City Engineer.

Table No. 5
ROUGHNESS COEFFICIENTS FOR CLOSED CONDUITS

<table>
<thead>
<tr>
<th>Materials of Construction</th>
<th>Roughness Coefficient &quot;n&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Monolithic Concrete Conduit</td>
<td>0.013</td>
</tr>
<tr>
<td>Concrete Pipe Storm Sewer</td>
<td></td>
</tr>
<tr>
<td>Good Alignment, Smooth Joints</td>
<td>0.013</td>
</tr>
<tr>
<td>Concrete Pipe Culverts</td>
<td>0.013</td>
</tr>
<tr>
<td>Monolithic Concrete Culverts</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**d) Head Losses in Closed Conduits**

Head losses for wyes will be calculated by the formula:

\[ \frac{V_2^2 - 0.75V_1^2}{2g} = H_L \]

Head losses for pipe size changes will be calculated by the formula:

\[ \left( \frac{d_1}{2d_2} - 0.5 \right) \frac{V_1^2}{2g} = H_L \]

and,

- \( V_1 \) = upstream velocity (f.p.s.);
- \( V_2 \) = downstream velocity; and,
- \( g \) = acceleration due to gravity
- \( d_1 \) = upstream diameter
- \( d_2 \) = downstream diameter

Head losses and gains for manholes, bends, and junction boxes will be calculated by the formulas shown below.

**Manholes on Main Line with Laterals:**

- 90° Lateral \( h_j = \frac{(V_2^2 - 0.25V_1^2)}{2g}; \)
- 60° Lateral \( h_j = \frac{(V_2^2 - 0.35V_1^2)}{2g} \); and,
- 45° Lateral \( h_j = \frac{(V_2^2 - 0.50V_1^2)}{2g} \).

**no Lateral \( h_j = \frac{(V_2^2 - 0.75V_1^2)}{2g} \).**

**Bends where Radius = Diameter of Pipe:**

- 90° Bend \( h_j = 0.50 \frac{V_2^2}{2g}; \)
- 60° Bend \( h_j = 0.43 \frac{V_2^2}{2g}; \)
- 45° Bend \( h_j = 0.35 \frac{V_2^2}{2g} \); and
- 22.5° Bend \( h_j = 0.20 \frac{V_2^2}{2g} \).
Bends are not to be used without the approval of the Director of Public Works or City Engineer.

The head loss due to friction in the closed conduit will be the product of the hydraulic gradient and the length of conduit. The hydraulic gradient is the slope of the frictional gradient such that the pipe, when flowing full, will carry an amount of flow equal to or greater than the necessary discharge.

e) Junction Boxes

i) A junction box will be installed on all storm sewers whenever two (2) or more laterals join the main line at the same location or every 500 feet, whichever is less.

ii) Maximum spacing between junction boxes shall be 500 feet. Junction boxes may be required at shorter intervals to meet maintenance requirements.

8) Design of Open Channels

All open channel design will be in accordance with all federal and state laws.

Open Channels will be allowed only if the design flow is greater than 200 cfs or cannot be contained in a 72-inch circular conduit.

Storm water runoff in excess of that allowed to collect in the streets in developed areas and runoff in undeveloped areas may be carried in open channels (not in the street right-of-way).

Open channel capacity will be calculated by Manning's Formula, and roughness coefficients will be as follows:

<table>
<thead>
<tr>
<th>TYPE OF LINING</th>
<th>ROUGHNESS COEFFICIENT</th>
<th>MAXIMUM PERMISSIBLE MEAN VELOCITY (feet per second)</th>
<th>Minimum Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth (Bermuda Grass)</td>
<td>0.035</td>
<td>8</td>
<td>1.25</td>
</tr>
<tr>
<td>Earth (Non-Vegetated)</td>
<td>0.020</td>
<td>5</td>
<td>Must be vegetated</td>
</tr>
<tr>
<td>Concrete Lined</td>
<td>0.015</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>Weathered Rock</td>
<td>0.030</td>
<td>15</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Where federal and state laws allow, open channels will be constructed with a trapezoidal cross-section and will have sides sloped no steeper than 4:1.

All open channels having a design quantity of runoff less than four hundred (400) c.f.s will be lined with reinforced concrete. Open channels having a quantity greater than four hundred (400) c.f.s. may be either earthen channel or concrete-lined. Earthen channels will not be allowed without channel armoring for erosion control as well as concrete pilot channels and two feet (2') of gabion rip-rap along each side of the pilot channel. The width of the pilot channel shall be no less than one-half of the total bottom width of the channel.

Where the grade of the open channel must be sixteen hundredths percent (0.16%) or less, the channel will be concrete-lined, regardless of the amount of runoff.

Concrete lining in channels will have a minimum thickness of six inches (6”) of NCTCOG Class C concrete and will be reinforced with #4 bars at eighteen inches (18”) on center each way.
The ends of concrete-lined channels will have a reinforced concrete toe wall constructed along the base and side slopes of the lined channel and will have a minimum vertical depth of three feet (3’) and two feet (2’), respectively. A horizontal concrete section, one-foot (1’) in width, will be constructed between the top of the channel lining and the top toe wall.

The design water surface in an open channel is to include one-foot (1’) of freeboard to the top of bank. Water surface elevations for all channels shall be provided by submitting a Hec-RAS or XPSWM model for review and acceptance by the Public Works Director.

Special care must be taken at entrances to closed conduits and culverts to provide for the headwater requirements. The water surface elevation, which is coincident with the hydraulic gradient, will be calculated and shown on the construction plans for all channels.

9) Design of Driveway Culverts

Design of driveway culverts will include the determination of upstream backwater conditions as well as downstream velocities and flooding conditions for the 100-year storm. Consideration will be given to the discharge velocity from culverts, and the following limitations are allowed.
Table 7
DRIVEWAY CULVERT DISCHARGE - VELOCITY LIMITATIONS

<table>
<thead>
<tr>
<th>Culvert Discharging Onto</th>
<th>Maximum Allowable Velocity (f.p.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>5</td>
</tr>
<tr>
<td>Sod earth</td>
<td>8</td>
</tr>
<tr>
<td>Paved or rip rap apron</td>
<td>15</td>
</tr>
<tr>
<td>Shale</td>
<td>10</td>
</tr>
<tr>
<td>Rock</td>
<td>15</td>
</tr>
</tbody>
</table>

Generally, all culverts will be designed with a free outfall, and the following head losses will govern the design of the culvert.

a) Frictional Head Loss

\[ h_f = S_f L \]

Where:

- \( S_f \) = Slope of frictional gradient in feet per foot; and,
- \( L \) = Length of culvert in feet

b) Head Loss Due to Change in Velocity

\[ h_v = \frac{(V_2^2 - V_1^2)}{2g} \]

Where:

- \( V_2 \) = Velocity in culvert (f.p.s.);
- \( V_1 \) = Velocity in channel upstream from culvert (f.p.s.); and,
- \( g \) = acceleration due to gravity

c) Head Loss at Upstream Entrance to Culvert Due to Entrance and Change in Section

\[ h_e = \frac{V_2^2}{2g} \]

Where \( V_1 \) is equal to or less than six (6) f.p.s.

\[ h_e = \frac{(V_2^2 - K_e V_1^2)}{2g} \]

Where \( V_1 \) is greater than six (6) f.p.s.

Headwalls are used to protect the embankment from erosion and the culvert from displacement. The headwalls, with wingwalls and aprons, will be constructed in accordance with the standard drawings as required by the physical conditions of the particular installation. Special headwalls and wingwalls may be required where approach velocities are in excess of twelve (12) to fifteen (15) f.p.s. This requirement varies according to the axis of the approach velocity with respect to the culvert entrance.

Velocity dissipaters shall be installed at culvert outfalls where the outlet velocity exceeds ten (10) f.p.s.
A table of culvert entrance data is shown on Table No. 8. The values of the entrance coefficient, \( K_e \), are a combination of the effects of entrance and approach conditions. It is recognized that all possible conditions may not be tabulated, but an interpolation of values should be possible from the information shown. Where the term "round" entrance edge is used, it means a 6-inch radius on the exposed edge of the entrance.

<table>
<thead>
<tr>
<th>ENTRANCE</th>
<th>( K_e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box culvert with Flare Angles</td>
<td></td>
</tr>
<tr>
<td>0° – Square</td>
<td>0.7</td>
</tr>
<tr>
<td>0° – Round</td>
<td>0.5</td>
</tr>
<tr>
<td>15° – 30° – Square</td>
<td>0.5</td>
</tr>
<tr>
<td>15° – 30° – Round</td>
<td>0.3</td>
</tr>
<tr>
<td>30° – 75° – Square</td>
<td>0.4</td>
</tr>
<tr>
<td>30° – 75° – Round</td>
<td>0.3</td>
</tr>
<tr>
<td>Pipe with Headwall</td>
<td></td>
</tr>
<tr>
<td>Spigot End</td>
<td>0.5</td>
</tr>
<tr>
<td>Bell End</td>
<td>0.2</td>
</tr>
<tr>
<td>Pipe without Headwall</td>
<td></td>
</tr>
<tr>
<td>Spigot End</td>
<td>0.6</td>
</tr>
<tr>
<td>Bell End</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Velocities in culverts are limited to the maximum allowed in the downstream channel or protection for erosion control will be provided.

10) Design of Bridge Hydraulics

All span bridges and culverts under roadways, or pedestrian bridges shall be analyzed using Hec-RAS or XPSWM.

a) In general, excavation of the natural channel is not allowed as compensation for loss of cross sectional area due to the bridge structure.

b) Channelization upstream or downstream of the proposed bridge will normally not be permitted.

c) A two-foot (2') freeboard is required between the 100-year water surface elevation and the lowest chord for a span bridge. The freeboard for a culvert is two feet (2') from the top of the roadway of the top of the bank, whichever is more restrictive.

f. FEMA Criteria for Flood Plain and Floodway Development

The developer or owner who wants to develop or build in the floodplain is required to meet all FEMA regulations, all requirements of the City’s Flood Hazard Prevention Ordinance, and all sections of the Unified Development Code. When submittal to FEMA is required, the submittal must be submitted to and accepted by the City Engineer or Director of Public Works 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. FEMA written approval of a CLOMR is required prior to beginning construction of the development within the floodplain.

Submittal of the CLOMR to FEMA for their approval is not required for work in the floodway fringe if an appropriate detailed drainage study (reviewed and approved by the Director of Public Works) determines that the proposed development construction in the floodway fringe will not cause any rise in the stream’s water surface elevation.
for the 100-year frequency storm runoff from a fully-developed watershed. All construction on the project will be done by the developer and owner at their own risk pending FEMA's approval of the LOMR submittal. If any modifications are required by FEMA as part of their approval of the LOMR, the developer and owner will be responsible for all costs associated with making these modifications.

A building permit will not be issued by the City for lots in the existing 100-year floodplain until a copy of the FEMA approval letter for the required LOMR is received by the City. 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.

4. Water System Improvements
   a. General

   1) This section pertains to general design requirements for water distribution system construction in the City of Keller. All water lines shall be sized and designed in accordance with the City of Keller Water Distribution System Master Plan or as determined by the City Engineer or Public Works Director. 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, the Public Works Construction Standards of the North Central Texas Council of Governments, and criteria adopted by the Texas Administrative Code, Chapter 290, "Water Hygiene".

   2) All components of the water system must comply with ANSI/NSF Standard 61.

   3) Refer to Section 5.14 of this Unified Development Code and Standard Construction Details for additional water system requirements not covered in this document.

   b. Water Lines

   1) Standard water line sizes to be used for design purposes are 8-inch, 12-inch, and 16-inch diameter. Use of pipe sizes other than these must be approved by the City Engineer or Public Works Director.

   2) All water lines shall be a minimum of eight (8") inches in diameter. All water lines shall be looped where possible. Dead end lines shall have an automatic flushing valve and shall not exceed 600 feet, unless approved by the City Engineer or Director of Public Works.

   3) Water lines shall be located in the parkway behind the back of curb. Along State Highways and divided streets, water lines are required to be constructed on both sides of the roadway. New water lines crossing existing streets shall be installed by the boring method. A casing pipe shall be required under all arterial and collector roadways. Open cut excavation will not be allowed to cross existing streets unless approved by the City Engineer or Director of Public Works.

   4) All water lines located down lot lines between proposed houses shall be installed in casing pipe from ten (10') feet in front of the front building line to ten (10') feet past the back building line.

   5) Easements for water line construction shall meet the following requirements:

   a) The minimum width of water line easements shall be in accordance with Section 5.11 of this Unified Development Code. Greater widths may be required based on site conditions.

   b) If the water line is less than 12 feet deep, the outside diameter of the water line shall be located a minimum distance of 6 feet from the edge of the easement, and if other utilities are located in the same easement, the outside
diameter of the water line shall be located a minimum distance of 3 feet from the outside diameter of the other utilities.

c) If the water line is greater than 12 feet deep, the outside diameter of the water line shall be located a minimum distance of 9 feet from the edge of the easement, and if other utilities are located in the same easement, the outside diameter of the water line shall be located a minimum distance of 6 feet from the outside diameter of the other utilities.

d) Transmission lines shall be within a dedicated water line easement.

6) Water lines for multi-family, commercial and industrial fire protection lines shall be private and isolated from the public system by a double detector check placed at the property line. All water lines shall be 8 inches minimum diameter and looped when possible. Dead end lines shall not exceed 50 feet on multi-family, commercial, or industrial sites. All public water lines located on private property shall be centered in a minimum 15-foot wide easement. Larger easements may be required by the City Engineer to provide adequate space for maintenance. Public water lines shall not be located under paved surfaces unless approved by the City Engineer or Director of Public Works.

Multi-family developments may be supplied fire protection and domestic service by the same water line provided that a fire-rated master meter is used along with a double detector check.

If residential developments require fire suppression systems, the developer is responsible for the design and specifications for said fire suppression system.

7) The developer shall furnish, install, construct, or extend, at his own expense, water distribution facilities necessary for the proper development of the subdivision. All water mains constructed within a proposed subdivision shall be extended to the perimeter of the 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.

8) All water line 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. All fittings will be restrained with anchoring couplings or restraining harnesses.

9) Pipeline markers shall be used to locate water line road crossings and water line alignments across undeveloped property.

10) Materials

a) Polyvinyl Chloride (PVC) Pipe

   i) PVC pipe shall be designed, manufactured, and tested in accordance with the applicable requirements of AWWA C-900 (6-inch through 12-inch diameter water pipe), AWWA C-905 (16-inch diameter and larger water pipe), and AWWA C-605.

   ii) All PVC water pipe shall be blue in color.

   iii) Water pipe with diameters of 6 inches through 12 inches shall be pressure Class 150, DR 18. Pressure Class 200, DR 14 pipe may be required by the City Engineer in areas to high distribution system pressures induced by booster pump operations.
b) Ductile iron, HDPE (high density polyethylene pipe), or CSCP (concrete steel cylinder pipe) may be used only if initially approved by the Director of Public Works or City Engineer.

c) Fittings

i) Fittings shall be made from ductile iron in accordance with AWWA C110 or AWWA C153.

ii) Gasketed joints shall be in accordance with ANSI/AWWA C111/A21.11, except gaskets shall be neoprene or other synthetic rubber and factory installed. Natural rubber will not be acceptable.

iii) All buried metal shall be wrapped in 8-mil thick polyethylene film as specified in ANSI/AWWA C105/A21.5

11) Installation

a) General

i) All installations shall conform to the latest NCTCOG Specifications, as amended by these standards.

ii) Separation of Water and Wastewater Line installations shall conform with the criteria outlined in the Texas Administrative Code, Chapter 290.44, “Water Distribution”, (e) “Location of Water Lines.”

iii) All 8-inch diameter water pipe shall be installed with a minimum of 42 inches of cover over the top of pipe, 12-inch diameter water pipe shall be installed with a minimum of 48 inches cover, and pipe 16 inches in diameter and larger shall be installed with a minimum of 60 inches of cover over the top of pipe.

iv) Where dead end lines occur, sampling taps terminating with a ¾-inch hose bib at least 3 feet above grade shall be located at the end of the line. The sampling lines and corporation stops will be removed after bacteriological testing has been completed and the line accepted by the City.

v) All backflow installations shall conform with the backflow regulations outlined in the Texas Administrative Code, Chapter 290.44 “Water Distribution” (h), “Backflow, Siphonage” as well as the City ordinances.

vi) The amount of trench excavation per pipeline crew shall not exceed two hundred (200’) feet from the end of the pipe laying operations, and no more than three hundred (300’) feet of total open trench per crew will be allowed. At the end of each work day, all trench excavation shall be backfilled to the end of the pipe laying operation. Barricades with lights will be required around any open trench left overnight.

vii) 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 Director of Public Works.

viii) Coated tracer wire shall be installed in the embedment material above the PVC pipe with the tracer wire terminating in in-line gate valve boxes accessible by City Staff. Blue underground water line tape of a minimum 4-inch width shall be installed above the embedment material.
ix) Density tests shall be taken one every two hundred (200') feet per twelve (12") inch lift. The density reports shall be submitted daily to the City's inspector.

x) All field density reports shall be completed and delivered to the City's inspector before paving is allowed to begin.

b) PVC Water Pipe

PVC water pipe and appurtenances shall be installed as specified in AWWA C605 and in accordance with the pipe manufacturer's recommendations.

c) Fittings

i) Fittings shall be installed in accordance with AWWA C-600.

ii) All mechanical joint valves, bends, crosses, tees, and reducers which require blocking shall be additionally restrained with EBAA mega-lug retainer gland or approved equal.

iii) All fittings must be wrapped with 8 mil thick polyethylene film as specified in ANSI/AWWA C105/A21.5.

c. Fire Hydrants

1) Fire hydrants in commercial and industrial areas shall generally be at street intersections and so located that there will be a fire hydrant every three hundred (300) feet and within a five hundred foot (500’) truck hose lay distance from all points of any structure or combustible storage area on the property. Fire hydrants in residential areas shall generally be at street intersections and so located that there will be a fire hydrant every five hundred (500’) feet and within a five hundred foot (500’) truck hose lay distance from all points of any structure or combustible storage area on the property. Fire hydrants in a multi-family complex shall be generally located on street intersections and meet the same requirements noted for commercial areas. Refer to the Section 5.16 of this Unified Development Code for additional requirements.

2) Materials

a) Fire hydrants shall be manufactured in accordance with AWWA C-502, Dry-Barrel Fire Hydrants.

b) Hydrants shall be manufactured such that all maintenance and adjustments can be performed without excavation and such that hydrants may be faced in any direction in relation to the base.

c) Threads on hose and pumper nozzles shall meet the requirements of National Fire Protection Association, NFPA 1963, "Standard for Screw Threads and Gaskets for Fire Hose Couplings" as follows:

<table>
<thead>
<tr>
<th>HOSE NOZZLE</th>
<th>PUMPER NOZZLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Size of Coupling Waterway</td>
<td>2 1/2”</td>
</tr>
<tr>
<td>Number of Threads per inch</td>
<td>7 1/2</td>
</tr>
<tr>
<td>Nominal Size of Coupling Waterway</td>
<td>2.5 - 7.5 NH</td>
</tr>
<tr>
<td>Approximate Outside Diameter of External Thread</td>
<td>3 1/16”</td>
</tr>
<tr>
<td>Length of Nipple</td>
<td>1”</td>
</tr>
<tr>
<td>Length of Pilot to Start of Second Thread</td>
<td>1/4”</td>
</tr>
</tbody>
</table>
ARTICLE FIVE
Unified Development Code

Depth of Coupling 15/16” 1 3/16”
Diameter of Gasket Seat in Coupling 3 3/16” 5 1/8”
Length of Coupling Internal Thread 11/16” 7/8”
From Face of Coupling to Start of Second Thread 3/16” 3/8”

Refer to the Standard Construction Details for additional requirements.

d) Outlet nozzles shall be fastened into the nozzle section by threads or mechanical means and secured in place by a pin, a set screw or other acceptable method to prevent the nozzle from turning or backing out. Connecting the nozzle to hydrant by leading is not acceptable. All fire hydrants shall be equipped with a 5” Hydra-Storz® Quick Connect Hydrant System or approved equal.

e) Nozzle cap harnessing and gaskets shall be furnished.

f) Shut off:
   
   i) The hydrants shall be of the compression type, with the main valve opening against the pressure and closing with the pressure.

   ii) The valve action shall provide positive shut-off at minimum closing torque.

   iii) Wedge action closing gates shall be 5” Hydra-Storz® Quick Connect Hydrant System or approval equal.

   iv) The fire hydrant operating nut shall be pentagon-shaped.

g) 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.

h) Hub Type: Inlet connection shall be mechanical joint unless otherwise specified, and shall be for 6-inch diameter ductile iron pipe. The nominal diameter of the fire hydrant main valve opening is to be 5¼ inches.

i) 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. Extension sections, where required, shall include barrel extension section, extension rod with connectors provided for lengthening the complete unit. These units shall be available in increments of six inches (6”) in length.

j) Bollards shall be placed around fire hydrants in high traffic areas. The bollards shall be placed at 45-degree angles to the fire hydrant with a minimum spacing of thirty inches (30”).

3) Installation

a) Fire hydrants will be located a minimum of three (3’) foot behind the curb to a maximum of eight (8’) behind the curb.

b) 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 Mueller, CLOW, American Darling, and M&H.

d. Valves

1) Resilient seated gate valves shall be used for 6-inch through 16-inch diameter water lines. Butterfly valves shall be allowed for 16-inch and larger water lines when approved by the City Engineer.

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 one fire hydrant is out of service at any one time. Three (3) valves shall be used on a water line cross intersection and a minimum of two (2) valves shall be used on a tee intersection.

3) Materials

a) Resilient Seated Gate Valves

i) Resilient seated gate valves shall meet or exceed the latest revisions of AWWA C509 and these standards.

ii) Resilient seated gate valves for buried service shall be furnished with a square 2 inch operating nut. The valve box shall be as shown and described in the Standard Construction Details. The valve box lid shall be painted safety blue. The paint shall be Glidden or approved equal.

b) Butterfly Valves

Butterfly valves shall meet or exceed the latest revision of AWWA C504 for Class 150B butterfly valves and these standards.

4) Installation

a) Refer to the Standard Construction Details for valve installation requirements.

b) 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.

c) Valve markers shall be provided in rural areas or as directed by the Director of Public Works.

5) Manufacturers

a) Approved manufacturers of resilient seated gate valves are Mueller, CLOW, and M&H.

e. Air Release and Flushing Valves

1) Adequate number of combination air valves and flushing valves shall be provided for flushing, disinfection, daily operation requirements, and repairs where required by the City Engineer. Combination air release/vacuum valves shall be required on
12 inch diameter 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 an automatic flushing valve installed for flushing purposes.

3) A fire hydrant shall be required at high points on water lines smaller than 12 inches for air relief and flushing.

4) Materials

Air release valves and air/vacuum valves shall meet or exceed the latest revision of AWWA C512.

f. Tapping Sleeve

A tapping sleeve and valve shall be used when connecting a new water line to an existing line. A resilient seated gate valve shall be flanged to the tapping sleeve. Approved manufacturers of tapping sleeves are Romac Industries (only Stainless Steel sleeves) or approved equal.

g. Water Service

1) Meter and service sizes will be determined by the developer prior to requesting service from the City. The minimum water service and meter size shall be in accordance with the Standard Construction Details.

2) Materials

Size and materials for service lines, service saddles, corporation and curb stops and meter boxes shall be as shown in the Standard Construction Details.

3) Installation

a) General

i) All water service shall be installed in accordance with these standards.

ii) Each individual service location shall be sawed or stamped into the face of the curb with a four (4) inch high blue "W" painted by the Contractor. If no curb exist, a similar mark should be placed in the pavement near the edge of the roadway.

b) Meters

Residential and commercial meters shall be supplied by the City.

4) Acceptable Manufacturers for Corporation Stops, Curb Stops, and Service Saddles shall be in accordance with the Standard Construction Details.

h. Water Line Bore

1) All water line bores under collector or arterial streets will be cased. All casings will be pressure grouted in place. Both ends of the casing will be grouted shut. Minimum casing thickness shall be 1/4 inch. Casings shall be required under collector and arterial streets, highway crossings, and railroad crossings. Casings may also be required were deemed necessary by the City Engineer. The construction bore pit shall be located at a minimum distance of four feet (4’) 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 for the following loading conditions and applicable combinations thereof:

   a) Cooper's E-80 Railway loading or AASHTO HS20 loading as applicable.
   b) Earth loading with the height of fill above the casing as shown on the plans.
   c) Loads applied during jacking, including axial load from jacking.
   d) All other applicable loading conditions, including loads applied during transportation and handling.

3) Materials

   a) 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. Pipe shall be coated with coal tar epoxy (15 mils min.) in accordance with AWWA C-210. Pipe joints shall be welded in accordance with AWWA C-206. After pipe is welded, coating shall be repaired.

   b) Cement Mortar

      Cement mortar shall consist of one (1) part cement to two (2) parts clean sand with sufficient water to make a thick, workable mix.

   c) Pressure Grout Mix

      Grout shall be comprised of 1 cubic foot of cement and 3.5 cubic feet of clean fine sand with sufficient water added to provide a free flowing thick slurry. If desired to maintain solids in the mixture in suspension, one cubic foot of commercial grade bentonite may be added to each twelve to fifteen cubic feet of the slurry.

   d) Casing Insulators (Spacers)

      Use casing insulators on all carrier pipe. Insulators shall be high density polyethylene. Insulators shall fit snug over the carrier pipe and position the carrier pipe approximately in the center of the casing pipe to provide adequate clearance between the carrier pipe bell and the casing pipe. Acceptable manufacturers are RACI Spacers or as noted in the Standard Construction Details.

4) Installation

   a) Excavation and Backfill of Access Pits

      i) No excavation over the limits of the bore or tunnel as specified will be permitted. Trench walls of access pits adjacent to the bore or tunnel face shall be truly vertical. Shore the trench walls as necessary to protect workmen, the public, structures, roadways, and other improvements.

      ii) 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.
iii) Where seeding or sodding is disturbed by excavation or backfilling operations, such areas shall be restored to as near original condition as possible.

5. Wastewater System Improvements

a. General

1) This section pertains to general design requirements for wastewater collection system construction in the City of Keller. All sanitary sewer lines shall be sized and designed in accordance with the City of Keller Waste Water System Master Plan 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".

2) Refer to Section 5.15 of this Unified Development Code and the Standard Construction Details for additional sanitary sewer requirements.

b. Sanitary Sewer Lines

1) All sanitary sewer lines shall be a minimum of eight (8") inches in diameter. Standard sanitary sewer line sizes are 8-inches, 12-inches, 15-inches, and 18-inches in diameter. Other sizes of sewer lines must be approved by the City Engineer.

2) Sanitary sewer lines shall be located in the parkway and are required to be constructed on both sides of a State Highway or Farm to Market Road. No sewer service lines will be allowed to cross a State highway unless approved by the Director of Public Works.

3) Easements for sanitary sewer line construction shall meet the following requirements:

   a) The minimum width of sanitary sewer easements shall be in accordance with the Sections 5.11 and 5.15 of this Unified Development Code. Greater widths may be required based on site conditions.

   b) If the sanitary sewer line is less than 12 feet deep, the outside diameter of the sanitary sewer line shall be located a minimum distance of 6 feet from the edge of the easement, and if other utilities are located in the same easement, the outside diameter of the sanitary sewer line shall be located a minimum distance of 3 feet from the outside diameter of the other utilities.

   c) If the sanitary sewer line is greater than 12 feet deep, the outside diameter of the sanitary sewer line shall be located a minimum distance of nine feet (9') from the edge of the easement, and if other utilities are located in the same easement, the outside diameter of the sanitary sewer line shall be located a minimum distance of 6 feet from the outside diameter of the other utilities.

   d) Interceptor lines shall be within a dedicated sanitary sewer line easement with a minimum width of twenty feet (20').

4) All sanitary sewers shall be designed with consideration for serving the full upstream service area. The service area may be modified only with written permission from the Director of Public Works.

5) Sanitary Sewers should be designed with straight alignment whenever possible. When horizontal curvatures must be used, the pipe should be laid on a curve with a minimum radius of eight hundred feet (800'). No vertical curves will be allowed.
6) 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 current City Wastewater System Master Plan and 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.

7) 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. Minimum grades for sewer pipe shall conform to that noted in the Texas Administrative Code, Chapter 317, Sewage Collection System.

8) When a pressure rated sanitary sewer line is required due to its proximity to a water line, the pipe will be pressure rated for one hundred fifty pounds per square inch (150 psi) and 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.

9) Materials
   a) Polyvinyl Chloride (PVC) Pipe
      i) All sanitary sewer pipes shall be PVC pipe type SDR-35 for sewer lines constructed less than fifteen (15') feet deep. SDR-26 shall be provided where sewer lines exceed fifteen (15) feet. 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 (15') feet in depth, a parallel line shall be constructed at a shallower depth, specifically for service connections.
      ii) All PVC sanitary sewer pipe shall be green in color.
      iii) PVC sewer pipe and fittings shall conform to the current ASTM Designation D 3034 for four inches (4") through fifteen inches (15") and ASTM Designation F 679 for greater than fifteen inches (15").
   b) High-Density Polyethylene (HDPE) pipe may be used only if approved prior to the initial construction plan submittal by the Director of Public Works or City Engineer in writing.

10) Installation
   a) General
      i) All installations shall conform to ASTM Designation D2321, and the latest NCTCOG Specifications as amended by these standards.
      ii) Sanitary sewer lines shall not be installed within nine feet (9') horizontally of any water main or fire hydrant. Reference Texas Administrative Code, Chapter 317.13 (Appendix E – Separation Distances).
      iii) Construction shall begin at the downstream end of the project and continue upstream with the bell facing upstream. No upstream piping
shall be installed before downstream piping unless approved in writing by the City Engineer.

iv) Minimum cover on a sanitary sewer line will be five (5') feet or as approved by the City Engineer.

b) Excavation and Backfill

i) When PVC pipe is used, green marker tape with the wording "Buried Sanitary Sewer" shall be installed in the backfill material no more than twelve (12") inches above the top of the pipe.

ii) The amount of trench excavation per pipeline crew shall not exceed two hundred (200') feet from the end of the pipe laying operations, and no more than three hundred (300') feet of total open trench per crew will be allowed. 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.

iii) Density tests shall be taken every two hundred (200') feet for each twelve (12") inch lift. The density reports shall be submitted daily to the City's inspector.

iv) All density reports shall be completed and delivered to the City's inspector before paving is allowed to begin.

c) Inspection

All sanitary sewer lines shall be inspected using television inspection methods prior to acceptance by the City.

i) The Contractor is responsible for cleaning the sanitary sewer pipe. If the inspection shows debris or evidence that the line has not been properly cleaned, the review will cease and the tape will be returned to the Contractor.

ii) The City may have an inspector present during the television inspection process. In the event that the City cannot have an inspector present, the company performing the television inspection and the builder or developer will be required to provide a written statement certifying that a television inspection in accordance with the City's Televised Inspection Criteria was performed on all sanitary sewer line sections within the development or improvement area.

iii) The televised inspection shall commence only after the line has passed both air and mandrel test.

d) Televised Inspection Criteria

i) All sanitary sewer mains must be flushed with water just prior to televised inspection. Water is to be provided at the Contractor’s expense. A City representative shall be present during the flushing of the main.

ii) All television equipment used shall have a minimum of 220 lines of horizontal resolution. The picture shall be in color.

iii) Camera shall be capable of pan and tilt functions.

iv) All video information on tape must have good picture quality.
v) As a title heading on the tape and during the televising, the operator must:

- Note the project name and Contractor name.
- Note the name of the company and the operator performing the video inspection.
- Note line size and material, joint type and length.
- Line segment to be televised including beginning and ending station numbers.
- Note page of plans used and year plans were stamped.
- Note date and time of inspection.
- A footage counter must be displayed on the tape during the filming.
- Show the above title block before and after each line segment. Show the title block at 100 foot intervals while filming the line segment.
- All defects should be shown on film for a minimum of 10 seconds before proceeding with the televising.

vi) The Contractor shall provide a certified inspection log, supplied by the camera contractor, and used in conjunction with the videotape for written documentation. All written information gathered must be legible and clearly understandable.

- The certified inspection log shall indicate that the inspection is accurate and has followed the inspection guidelines of the City. Each inspection log shall contain a cover sheet that indicates the location of each defect found during the inspection process, including sags, open joints, debris, damaged pipe, inappropriate pipe material and misalignment. The Camera Contractor is to be registered with the City.
- Note the project name, Contractor name, and contract number.
- Note the name of the company and the operator performing the video inspection.
- Note pipe size and material, joint type and length between joints.
- Note the VCR tape footage counter, start to end.
- Note line segment to be televised, station numbers from and station numbers to length of line segment as indicated on plans.
- Note page of plans used and year plans were stamped.
- Note date and time of inspection.
- Indicate by sketch the line segment to be televised in relation to surrounding road intersections and street addresses. Identify manhole station numbers. Show direction of flow with arrows and direction the camera is going. Indicate direction of north on the sketch.
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- Note the water depth at the beginning, every 50 foot station, every change in grade, and at the end of the line segment.

- Identify the clock location, direction, size and type of laterals entering the main. Indicate laterals as saddles, punched, or glued fittings.

- Indicate final footage televised at end of the log sheet.

vii) One tape per visual televised inspection project shall be furnished to the Director of Public Works.

viii) Tapes must be at minimum VHS format, 1” wide T-120, high quality tape. Tapes are to be recorded on SP (2 hours) play.

ix) All tapes and run sheets shall be submitted to the City. All tapes and log sheets shall become the property of the City.

e) Criteria for Repair

The Contractor shall make repairs if the inspection reveals any deficiency in the sanitary sewer line. If repairs are required, another television inspection shall be made after the repairs are complete on a new tape from manhole to manhole at the Contractor’s expense. Repairs shall be made to the satisfaction of the City Engineer and Director of Public Works.

11) No connection will be made to any sanitary sewerage system within the City which will permit the entrance of surface water or waste of other than domestic sewage characteristics without specific authorization by the City Council.

c. Manholes

1) Manholes shall be located at all intersections of sanitary sewer lines and at intermediate spacing along the line. Generally the maximum spacing should not exceed five hundred feet (500’). Manholes should be located at all changes in grade and at the ends of all sanitary sewer lines that will be extended.

2) A manhole is required at the junction of sanitary 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 six inches (6”) above the flow line out of the manhole. Where the flow line in is greater than two feet (2’) above the flow line out, a drop manhole is required.

5) Minimum manhole inside diameter is four feet (4’). Manholes greater in depth than ten feet (10’) shall be a minimum of five feet (5’) in diameter.

6) Drop-manholes shall have a minimum inside diameter of five (5) feet.

7) Minimum cast-in-place manhole wall thickness is eight (8) inches. For depth’s greater than twelve feet (12’) add an extra four inches (4”) of thickness for each additional six feet (6’) of depth.

8) Minimum pre-cast wall thickness is five inches (5”).

9) A manhole is required where a sanitary sewer line enters and exits private property.
10) All manholes shall be constructed of concrete.

11) Manholes located in all flood-prone areas will be constructed with water-tight covers or with the elevation of the top manhole cover a minimum of one foot (1’) above the 100-Year Flood Plain water surface elevation, whichever is the most reasonable for maintenance purposes.

12) Installation

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

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Depth of Cover</th>
<th>Maximum Diameter of Manhole</th>
<th>Number of Pipe Connections Allowed in Manhole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 12&quot;</td>
<td>&lt;12'</td>
<td>4'</td>
<td>3</td>
</tr>
<tr>
<td>&gt;12' - 20'</td>
<td>5'</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>&lt;12&quot;</td>
<td>&gt;12' - 20'</td>
<td>6'</td>
<td>4</td>
</tr>
<tr>
<td>(See Note #1)</td>
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<td></td>
</tr>
</tbody>
</table>

Note: If the proposed design requires the sanitary sewer line to be placed at depths greater than shown above, the design will require approval in writing by the Director of Public Works.

b) Cast-in-place

i) The manhole foundation shall be poured on undisturbed soil and shall have a minimum thickness of twelve (12”) inches. The concrete used for the cast-in-place manhole will be a minimum of Class C (3,600 psi compressive strength).

ii) 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.

iii) 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.

iv) 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.

v) Detailing of concrete reinforcement and accessories shall be in accordance with ACI Publication 315.

vi) Portland Cement shall be Type II, low-alkali and conform to ASTM Designation C-150.

vii) The manhole can be backfilled only after 12 hours has elapsed since the concrete placement.

viii) The face of curb shall be sawed or stamped 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
exist, a similar mark should be placed in the pavement near the edge of the roadway.

c) Precast Manhole

i) Precast manholes shall be constructed in accordance to ASTM Designation C-478. The concrete used for the precast manhole will be a minimum of Class F (4,200 psi compressive strength).

ii) Manhole base shall have a spread footing and be placed on a minimum of twenty-four (24”) inches of compacted crushed rock.

d. Manhole Frame and Cover

1) Cover

a) Materials

All manhole covers shall conform to the Standard Specifications for Grey Iron Castings, ASTM A-48, Class 30 B.

b) Installation

Installation shall be in accordance with the Standard Construction Details and the latest NCTCOG Specifications.

c) Manufacturers

Approved manhole cover manufacturers are Certain-Teed, Bass & Hayes, or City approved equal.

2) Frames

a) Materials

All manhole frames shall conform to the Standard Specifications for Grey Iron Castings, ASTM A-48, Class 30 B.

b) Installation

All manhole frames shall provide 24-1/4 inch opening to assure proper fit of the manhole cover.

c) Manufacturers

Approved manhole frame manufacturers are Certain-Teed, Bass & Hayes, or City approved equal.

3) Extension Ring

a) Materials

Concrete extension rings shall conform to ASTM C-478.

b) Installation

i) 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) and shall not exceed 24 inches.
ii) A 1-inch by 3-1/2-inch bitumastic gasket shall be used to seal the extension ring at both joints.

4) Rain Pan

Rain pans shall be installed in every manhole unless manhole cover is sealable with a gasket and latch and approved by the Director of Public Works to not require a rain pan.

a) Materials

Rain pans shall be high density polyethylene plastic with a synthetic strap handle for removal by hand or pick.

e. Sanitary Sewer Service

1) No sanitary sewer service line (lateral) shall be less than 4 inches in nominal diameter. Commercial sanitary sewer laterals shall be 6 inches minimum diameter.

2) Sanitary sewer laterals shall be located at the center of the lot extend to the property line, and be a minimum of 10 feet downstream of the water service.

3) Sanitary sewer service laterals shall be designed to have no more than 6 feet of cover at the property line unless noted otherwise on the construction plans.

4) A cleanout shall be installed on the service lateral at the property line on the city side prior to the time of connection to the home.

5) Materials

a) All lateral sanitary sewer service lines shall be PVC pipe type SDR-35.

b) All PVC sanitary sewer pipe used for lateral services shall be green in color.

6) Installation

All service laterals shall be installed in accordance with the Standard Construction Details and the latest NCTCOG Specifications.

g. Main Line Cleanouts

Main line permanent cleanouts will not be allowed. Consideration will be given to the installation of temporary cleanouts on short sewer mains (200 feet or less) stubbed out to provide service for future phases of the same subdivision development.

g. Aerial Crossing

1) The piers for the aerial crossing shall be designed in accordance with the guidelines of the Ductile Iron Pipe Research Association and submitted for approval by the City Engineer.

2) Aerial sanitary sewer crossings shall be located in areas where the sanitary sewer line cannot be constructed with the appropriate minimum cover. The design engineer shall design the aerial crossing in accordance with these standards.

3) 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.
4) Pier placement and spacing along with a soils report shall be submitted to the City Engineer with the proposed construction plans.

5) Materials

a) Pipe

i) All above ground sanitary 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. The exterior of all ductile iron piping shall be painted as directed by the City Engineer.

ii) The aerial pipe shall be connected to the underground sanitary sewer pipe by means of a manhole on each side of the aerial crossing.

b) Piers

Piers to be constructed with a minimum of Class C (3,600 psi compressive strength) reinforced concrete.

6) Installation

a) Pipe

The design engineer shall submit an aerial pipe installation design for approval by the City Engineer.

h. Piers

The design engineer shall submit a pier design for approval by the City Engineer.

i. Sanitary Sewer Line Boring

1) All sanitary sewer line bores requiring casing pipe will be pressure grouted in place. Both ends of casing will be grouted shut.

2) The design engineer shall design the sanitary sewer line pipe casing for the following loading conditions and applicable combinations thereof:

a) Cooper’s E-80 Railway loading or AASHTO HS20 loading as applicable.

b) Earth loading with the height of fill above the casing as shown on the plans.

c) Loads applied during jacking, including axial load from jacking.

d) All other applicable loading conditions, including loads applied during transportation and handling.

3) Materials

a) 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. Pipe shall be coated with coal tar epoxy (15 mils min.) in accordance with AWWA C-210. Pipe joints shall be welded in accordance with AWWA C-206. After pipe is welded, coating shall be repaired.
b) Cement Mortar

Cement mortar shall consist of one (1) part cement to two (2) parts clean sand with sufficient water to make a thick, workable mix.

c) Pressure Grout Mix

Grout shall be comprised of 1 cubic foot of cement and 3.5 cubic feet of clean fine sand with sufficient water added to provide a free flowing thick slurry. If desired to maintain solids in the mixture in suspension, one cubic foot of commercial grade bentonite may be added to each twelve to fifteen cubic feet of the slurry.

d) Casing Insulators (Spacers)

Use casing insulators for any type of carrier pipe. Insulators shall be high density polyethylene. Insulators shall fit snug over the carrier pipe and position the carrier pipe approximately in the center of the casing pipe to provide adequate clearance between the carrier pipe bell and the casing pipe. Approved manufacturers are RACI Spacers or as noted in the Standard Construction Details.

4) Installation

a) Tolerances

i) All bores shall be installed at a grade no less that the minimum indicated by Texas Administrative Code, Chapter 317 for the required pipe size.

ii) All bores shall maintain grade enough to ensure desired clearance distances between existing utilities and bore.

b) Excavation and Backfill of Access Pits

i) Bore pits must be a minimum of four (4) feet from the back of curb when located for boring under roadways.

ii) Do not allow excavation over the limits of the bore or tunnel as specified. Trench walls of access pits adjacent to the bore or tunnel face shall be truly vertical. The trench walls shall be shored as necessary to protect workmen, the public, structures, roadways, and other improvements.

iii) Excavations within the right-of-way whether under pavement or not 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. The bore pits shall be backfilled 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 is ready to begin.

Where seeding or sodding is disturbed by excavation or backfilling operations, such areas shall be restored to as near original condition as possible.

j. Lift Stations

1) Lift stations shall be installed only if approved by the Director of Public Works.
2) Lift stations shall be designed by a professional engineer licensed in the State of Texas. Construction plans submitted for the lift station shall include: wet well design, vault designs, pump specifications, pipe design and applicable instrumentation including approved telemetry equipment.

3) Lift stations must be designed in accordance with 30 Texas Administrative Code, 317.3.

4) Instrumentation and Control
   a) The voltage supplied for pump operation shall be 3 phase, 480 volts. Converting single phase power to three phase power using additional mechanical equipment shall not be allowed.
   b) Wet-well level control shall be achieved through the use of an ultrasonic level indicating transmitter.
   c) All lift stations dedicated to the City shall have SCADA telemetry equipment installed, at the expense of the developer, that interfaces with the City's SCADA system and meets the City's protocol and specifications.
   d) Submersible pumps shall be provided with moisture and motor over-temperature sensors.

5) Site Requirements
   a) A reinforced concrete pad will be required at the front of the control cabinet. The pad shall provide a 3-foot working area away from the face of the cabinet and extend the width of the enclosure mounting structure. The reinforced concrete pad will be a minimum of four inches (4”) thick.
   b) A 1-inch minimum potable water service is required. The water service may be set in a standard 18-inch galvanized water meter box with a 1-inch brass angle stop.
   c) The site shall be graded to drain away from the station to prevent storm water inflow or infiltration into the wet-well.
   d) The site shall be located outside of the 100-year flood plain.
   e) The site shall not be located within 100 feet of an existing or proposed residence, unless approved by the Director of Public Works.
   f) 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 15 feet off the back of curb line of the proposed street per the City's Master Thoroughfare Plan.
   g) A concrete driveway turning area is required where access drives extend more than twenty feet (20’) from main roads. The driveway area shall be "T" shaped with the applicable turning radius. The minimum driveway width shall be fifteen feet (15’).

6. Miscellaneous (Erosion Control, Tree Protection, and Retaining Walls)
   a. Erosion Control
      1) An erosion control plan or Storm Water Pollution Prevention Plan (SWPPP) shall be provided with each construction plan submittal for review by the City Engineer.
      2) Each erosion control plan shall clearly identify all erosion and sediment control measures to be installed and maintained throughout the duration of the project.
3) The erosion control plan or SWPPP shall meet the requirements outlined in the most recent version of NCTCOG's *Storm Water Quality Best Management Practices for Construction Activities* as well as the EPA's *Storm Water Phase II Rule*.

b. Tree Protection

Design of construction projects shall conform to the guidelines stated in Article Eight-“Tree Preservation” in this Unified Development Code.

c. Retaining Walls

Retaining walls three feet (3’) or greater in height shall be designed and sealed by a professional structural engineer licensed in the State of Texas. The retaining wall design engineer will be required to issue an approval letter with his seal stating the wall was installed in strict accordance with the plans. This signed and sealed approval letter from the engineer must be submitted to the City Engineer prior to final acceptance of the development. Retaining wall height is the dimension from the bottom of the footing to the top of the wall.
Section 5.25 – Technical Construction Standards

A. Construction Standards

1. City Inspection

   The City inspects construction projects to ensure compliance with the Design and Technical Construction Standards, Unified Development Code, and all other applicable documents. The proper design of all construction plans is the responsibility of the Project Engineer.

2. Material Testing

   All material testing services shall be provided during construction on City or Developer projects by an independent testing laboratory company approved by the City Engineer or Director of Public Works. The company shall have been in business under its current name for at least five years and have at least one full-time Professional Engineer on staff licensed in the State of Texas and experienced in this type of material testing for construction operations. All cost for the material testing will be the developer's or contractor's responsibility to pay.

3. Traffic Control

   A Traffic Control Plan shall be submitted with the Construction Plans whenever traffic is expected to be disrupted as defined in the latest version of the Texas Manual for Uniform Traffic Control Devices for Streets and Highways by the Texas Department of Transportation. If a traffic plan is submitted after construction begins, it shall be submitted at least seventy-two (72) hours prior to any activities affecting traffic.

4. Erosion control

   a. Prior to the start of construction, the contractor shall submit for acceptance to the City schedules for accomplishment of the storm water pollution control measures in accordance with the erosion control plan or the Storm Water Pollution Prevention Plan (SWPPP). Work on the project shall not begin until the schedules for implementation of the controls and methods of operations have been reviewed and accepted, in writing, by the City.

   b. The contractor shall provide all control measures necessary to prevent and control soil erosion, sedimentation, and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, groundwater, and wetland. These control measures shall be installed and maintained throughout construction as specified on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction periods. The controls may include silt fences, straw bale dikes, rock berms, diversion dikes, interceptor swales, sediment traps and basins, pipe slope drains, inlet protection, stabilized construction entrances, seeding, sodding, mulching, soil retention blankets, or other structural or non-structural storm water pollution controls. Additional information regarding these controls can be found in NCTCOG's guidance manual entitled Storm Water Quality Best Management Practices for Construction Activities-North Central Texas.

   c. Proper erosion control shall be the responsibility of the developer. The builder shall assume responsibility after the property is sold.

5. Utility Service Interruption

   In the event that existing utility service is to be interrupted during construction, official notice as well as a meeting with the City and all other applicable parties shall be held seventy-two (72) hours prior to interruption.
6. Right-of-Way Restoration

a. Prior to construction or re-construction of any roadway or other public facility whose right-of-way or easement abuts or is on private property, all public right-of-way and/or easements shall be televised or photographically documented as to condition, type, placement of existing materials (mailboxes, grass, fences, irrigation systems, etc.). Documentation shall be used to determine the extent and type of right-of-way/easement restoration required.

b. The City or its Contractor shall restore the right-of-way or easement as follows:

1) Urban Streets (Curb & Gutter) – Right-of-way shall be restored to its original or as near to its original condition as possible including the matching of the type of grass. All irrigation systems shall be restored to their original operating condition. If existing flora is subject to dying without an operating irrigation system to supply water, the City or its contractor shall ensure that the existing irrigation system is modified to provide a reliable source of water for this flora during the construction period.

2) Rural (County Road Cross-section) – Right-of-way shall be restored to its original or as near to its original condition as possible. If the abutting property owner has developed the roadway ditch line to a condition conducive to reasonably easy mowing and maintenance, the ditch line shape and type of sod or grass shall be used to restore the ditch line and right-of-way. However, all ditch lines that are not easily mowed and regularly maintained by the abutting property owner shall be restored to a safe cross-section capable of reasonably easy mowing by the abutting property owner. These ditch lines shall be hydro-mulched with common Bermuda or a common Bermuda and Winter Rye mix depending on the season of the year.

c. Prior to Final Acceptance of the construction project, the video and/or photographically documented right-of-way shall be reviewed to assure its restoration has met the above standards.

7. Development and Construction Sequence

a. Pre-Construction Sequence

1) City Council reviews and releases the Final Plat

2) City Engineer reviews and releases the construction plans

3) Developer submits cost of all public improvements

4) Development agreement executed and fees paid

5) Plat recorded

b. Construction Operations Sequence

1) Pre-construction meeting

a) Prior to the meeting, submit two (2) full size (22” x 34”) sets and three (3) half size (11” x 17”) sets of approved Construction Plans

b) Submit Trench Safety Plan sealed by a licensed professional engineer

c) Submit copy of Contract Documents may be electronic or hard copy

d) Receive Authorization to Proceed from City
2) Begin cut/fill procedures
3) Install utilities
4) Install streets and curb inlets
5) Install street lights
6) Install street signs
7) Install screens and irrigation
   a) Screening wall
   b) Irrigation system
   c) Landscaping (seasonal)
8) Acceptance of subdivision
9) Issuance of Building Permits
**Part A – Street System Improvements**

**FIGURE 1 – Sight Distance at Intersections**
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Adopted: July 7, 2015

Part A – Street System Improvements

FIGURE 2 – Required Distances and Radii for Openings

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*Unified Development Code*  
Adopted: July 7, 2015

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**Section 5.26 – Appendix 5-93**

**Part A – Street System Improvements**

**FIGURE 3 – Minimum Distance of Driveways from Intersections**

**CASE I - RESIDENTIAL (SINGLE AND TWO FAMILY) DRIVEWAYS**

**CASE II - NON-RESIDENTIAL AND MULTIFAMILY DRIVEWAYS**

**FOR RESIDENTIAL, COLLECTOR, AND ARTERIAL INTERSECTIONS**

**DRIVEWAY LOCATIONS PER THE CITY OF KELLER UNIFIED DEVELOPMENT CODE**
### Trip Generation Data Form (Part 1)

#### FIGURE 4.01 – Trip Generation Data Form (Part 1)

<table>
<thead>
<tr>
<th>Source</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITE Land Use Code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day of Week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metropolitan Area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Part A – Street System Improvements

Transportation Demand Management (TDM) Information:
- No. of Employees
- Parking, including employer parking facilities
- Number of Employees
- Parking by Transit
- Employees (No.)
- Employees (Full)
- Employees (Part)
- Parking by Transit
- Parking by Carpool
- Parking by Vanpool
- Parking by Bike
- Parking by Transit
- Parking by Carpool
- Parking by Vanpool
- Parking by Bike

#### Section 5.26 – Appendix

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Unified Development Code
Adopted: July 7, 2015
City of Keller
### ARTICLE FIVE
Unified Development Code

**Section 5.26 – Appendix 5-95**

**Part A – Street System Improvements**

**FIGURE 4.02 – Trip Generation Data Form (Part 2)**

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<th>Total</th>
<th>Enter</th>
<th>Exit</th>
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</tr>
</thead>
<tbody>
<tr>
<td>6:20-6:30</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td>15</td>
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**Summary of Demand Volume**

- A.M. Period: 6:20-6:30
- No. of Flows Counted: 10
- Total: 12
- Enter: 8
- Exit: 4
- Total: 15

**Note:**

- Provide additional site-specific information, including special traffic conditions or extreme weather events.

**Signatory:**

- Date: [Signature Date]
- City of Keller

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**Section 5.26 – Appendix**

5-95
**ARTICLE FIVE**
Unified Development Code

Adopted: July 7, 2015

5-96 Section 5.26 – Appendix

Part B – Drainage System Improvements

**FIGURE 1.01 – Allowable Lot Grading Designs**
Part B – Drainage System Improvements

FIGURE 1.02 – Example of Lot Grading Plan
Site specific grading plan submittal: These requirements are used when: An engineered grading plan has been “released for construction” or approved by the Public Works Director or City Engineer with the subdivision construction drawings. The labeled grading plan submitted with the building permit application shall comply with the as-built Engineered drainage and grading plans previously provided to the City by the developers engineer, otherwise provide an engineered drainage study and grading plan. These guidelines DO NOT apply if an engineered grading plan has not been previously provided and accepted by the City of Keller Public Works Department.

The following information shall be included on the plan submitted by the builder:
1. Boundary of lot including dimensions
2. Right-of-way (ROW) line clearly labeled with street name(s) indicated
3. All easements shown and labeled with size and type (i.e. 5’-0 drainage easement)
4. Building line labeled and dimensioned
5. Finished floor elevation (FF); FP is acceptable
6. Elevations at the property corners – these should be PROPOSED elevations per the developer’s engineered grading plan. ALSO, if there is a change in flow direction, provide proposed elevation at change
7. Location of swales-if swales have been designed by the developers engineer include depth, slope, side slope and top width; otherwise add note such as: swale to be graded per plans prepared by Design Engineer Jane Doe, dated 05-05-05.
8. Flow arrows indicating direction of flow for ALL areas on lot. Arrows need to be pointing in direction of flow as indicated by the elevations.
9. Retaining or landscaping walls of all heights–include length of wall, distance from property line, height at each end and at bends. Include T/W (top of wall), B/W (bottom of footing) elevations on walls requiring permits.
10. Location of floodplain, if applicable
11. Footprint of house with dimensions from the property line and driveway width at the property line
12. Proposed culvert size (minimum 18”), type of material and safety end treatment shown if bar ditch road and/or culvert required in ROW
13. North arrow & scale (minimum 1”=20’)
14. Lot, block, subdivision name and address
15. Any other structures, including fences, telephone pedestal, power poles, power company boxes, flumes, channel, manholes, inlets, fire hydrants, city side cleanout or water meters that may conflict with the driveway or drainage.
16. Tree survey and wall permit application (wall 4’-0 or greater from foundation to top of wall) shall be provided separately. Include engineered retaining wall plans and proposed grading plan with wall permit application.
17. **Optional information: Indicate if adjacent homes are finalized. This MAY assist in releasing grading plan if grades at property corners cannot be changed.**

Submitted grading plan with elevations and/or flow directions other than shown on the developers engineered plan MAY be released for construction with the signature of permittee on the special condition form completed by Public Works. NO dirt work, stock piles, grading and/or earth or tree disturbance of any kind may occur BEFORE obtaining permit.

**Part B – Drainage System Improvements**

**FIGURE 1.03 – Lot Grading Plan Checklist**
**Part B – Drainage System Improvements**

**FIGURE 2 – IDF Curve**
Part B – Drainage System Improvements

FIGURE 3 – Time of Concentration Nomograph
Part B – Drainage System Improvements

FIGURE 4 – Triangle Channel Nomograph
ARTICLE FIVE
Unified Development Code
Adopted: July 7, 2015

Part B – Drainage System Improvements

FIGURE 5.01 – Gutter Flow Curves – 24’ Street, No Curb Split
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Unified Development Code
Adopted: July 7, 2015

Section 5.26 – Appendix

CUTTER FLOW
24’ STREET – 6” PARABOLIC CROWN
6” CURB – 0.25’ CURB SPLIT (n=.016)

Part B – Drainage System Improvements

FIGURE 5.02 – Gutter Flow Curves – 24’ Street, 0.25’ Curb Split
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Adopted: July 7, 2015

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Part B – Drainage System Improvements

FIGURE 5.03 – Gutter Flow Curves – 24’ Street, 0.50’ Curb Split
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Unified Development Code

Adopted: July 7, 2015

Section 5.26 – Appendix

Part B – Drainage System Improvements

FIGURE 5.04 – Gutter Flow Curves – 30’ Street, No Curb Split
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Unified Development Code

Adopted: July 7, 2015

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Part B – Drainage System Improvements

FIGURE 5.05 – Gutter Flow Curves – 40’ Street, No Curb Split
**Part B – Drainage System Improvements**

**FIGURE 5.06 – Gutter Flow Curves – 44’ Street, No Curb Split**
**ARTICLE FIVE**  
*Unified Development Code*  
Adopted: July 7, 2015

**5-108 Section 5.26 – Appendix**  
**Part B – Drainage System Improvements**

**FIGURE 5.07 – Gutter Flow Curves – 60’ Street, No Curb Split**
**Part B – Drainage System Improvements**

**FIGURE 6 – Capacity of Inlets in Sumps**

Section 5.26 – Appendix
Part B – Drainage System Improvements

FIGURE 7 – Capacity of Curb Inlet on Grade
Part B – Drainage System Improvements

**FIGURE 8 – Ratio of Intercepted to Total Flow**
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Unified Development Code

Adopted: July 7, 2015

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Part

B – Drainage System Improvements

FIGURE 9 – Manning’s Full Pipe Flow Chart (n=0.013)
FIGURE 10 – Storm Frequency Chart

(ISWM™ Technical Manual Hydraulics TxDOT, 2002)

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TRAFFIC IMPACT ANALYSIS AND MITIGATION

A. Purpose

The purpose of a traffic impact analysis is to assess the effects of specific development activity on the existing and planned roadway system.

A Traffic Impact Analysis (TIA) is intended to adequately assess the traffic-related impacts of a zoning and/or development proposal on the existing and planned thoroughfare system. The purpose of this Section is to:

1. Provide the safest and most efficient transportation system in conjunction with the development review process;
2. Inform the applicant of the City’s requirements and expectations;
3. Provide standard guidelines for the preparation and review of a TIA; and
4. Establish equitable mitigation measures for the accommodation of identified impacts.

B. Applicability of Requirements

Initial analysis to determine if TIA is required for all zoning requests. Prior to a traffic impact analysis, a Trip Generation Form must be completed on all projects.

1. Zoning

   a. These TIA requirements shall apply to all zoning requests for land uses, which will generate five hundred (500) or more vehicle trips per day for residential traffic and, more than two thousand (2,000) or more vehicle trips per day for commercial traffic or arterial streets not appearing on the City’s approved Thoroughfare Plan.

   b. 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’s Director of Public Works and/or the Planning Manager 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, the internal street or access is not anticipated to accommodate the expected traffic generation.

   c. The analysis periods for a zoning TIA shall be the opening year of development, two (2) years after development opening, and five (5) years after opening with full build out of the site. The analysis shall include all adjacent signalized and/or unsignalized intersections within one and a half (1½) miles of the site boundary.

   d. Depending upon specific site development characteristics of the proposed development, as determined by the Director of Public Works, one or more of the following elements may also be required as part of the TIA: an accident analysis, sight distance survey, traffic simulation, queuing analysis and/or turn lane analysis.

C. Responsibility of TIA Preparation and Review

1. A TIA must be prepared in accordance with all the guidelines of this code and submitted in accordance with the Development Review Schedule set by the City of Keller. The responsibility for TIA preparation shall rest with the applicant, and must be performed by a licensed Professional Engineer (PE) in the State of Texas with experience in traffic and transportation engineering. The final TIA report must be signed and sealed by the PE.
responsible for the analysis to be considered for review by the City. City staff shall serve primarily in a review and advisory capacity, and will only provide data to the applicant when available. If the City does not have the data, it is not grounds for omission, but will necessitate that the applicant’s traffic engineer must perform additional tests to acquire the data.

2. It shall be the responsibility of the applicant to submit four (4) draft TIA reports, final reports, and executive summaries with the zoning and/or development 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. Applications submitted with incomplete TIAs (or failure to submit a TIA with the application) shall be deemed incomplete and delay consideration of zoning and development requests. Should it be determined during the review of the 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. An initial review of the TIA by the City shall be available to the applicant fifteen (15) working days from the submittal date. Should additional analysis be required of the applicant, re-submission shall be within five (5) working days from when the initial review is available. Longer review periods may be needed if the Texas Department of Transportation (TXDOT) is involved in the review process.

D. Traffic Impact Assessment Standards

It is the objective of the City to determine whether the existing and planned thoroughfare system can accommodate the impact of the proposed development. To achieve uniformity in the evaluation process, the following standards shall apply:

1. Design Level of Service

The minimum acceptable level of service (LOS) within the City shall be defined as LOS “C” in peak hours 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. A written request for acceptance of alternative trip generation rates must be submitted to the City’s Director of Public Works or designated representative in advance of the TIA submission.

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’s Director of Public Works or designated representative, on a case-by-case basis. Assumptions relative to auto 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.

3. 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) of two (2) years after initial phase opening and five (5) years with full build out conditions.
E. Methodology

The TIA for zoning and development applications shall comply with the following methodology and be formatted as outlined in this section.

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, square footage the number of 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, square footage and number of dwelling units (as appropriate); identify other adjacent land uses that have similar peaking characteristics as the proposed land use and the most impactful use allowed in the requested zoning category; 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 – horizon year(s) background traffic projections for the planned thoroughfare system within the study area;

8. 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 Staff);

9. 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 Staff);

10. Net Change in Trip Generation (zoning) – possible trip generation (based on most impactful use) minus existing trip generation (if applicable) and proposed trip generation minus existing trip generation (if applicable); the net increase in trips to be added to base volumes for the design year to produce a range of net change;

11. 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;

12. 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;

13. Traffic Signal Evaluations – the need for new signals based on warrants, the impact on transportation system performance;
14. 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;

15. Conclusions – identification of all thoroughfares, driveways, intersections, and individual movements that exceed LOS D, degrade by one or more LOS, the percentage of roadway volume change produced by the proposed development, and any operational problems likely to occur;

16. Recommendations – proposed impact mitigation measures consistent with this section; and

17. Other information required for proper review – as requested by the City’s Director of Public Works or designated representative.

F. Report Format

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 a computerized and published format compatible with Microsoft Word and ArcView GIS (geographic information system).

The various sections of the report should be categorized according to the subject areas 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. Traffic Mitigation
VII. Conclusions
VIII. Recommendations
APPENDICES
G. Mitigation

Mitigation of impacts shall be required if the proposed development would cause a facility or traffic movement to exceed LOS C, or where it already exceeds LOS C and the development would contribute 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. Acceptable mitigation measures shall include:

1. Staging of development in order to relate site development to the construction of the required thoroughfare system;

2. Off-site improvements, including the provision of right-of-way and/or the participation in funding for needed thoroughfare and intersection improvement projects; and

3. On-site improvements, including access controls and site circulation adjustments.