

CITY OF CELINA, TEXAS ENGINEERING STANDARDS



RECORDS OF REVISIONS

- 1) **Addition of fire hydrant spacing along major and high-volume thoroughfares – section 2.1.9j (added on 5/9/2016)**
- 2) **Temporary turn around requirements- Section 4.02B7 (revised on 5/9/2016)**
- 3) **Addition of Design details for barrier free ramp- Sheet ST- 7 (added on 5/9/2016)**
- 4) **Added curbs on residential streets shall be mountable and place monolithically with street (added on 7/21/2016)**
- 5) **Mountable curb details revised - Sheet ST- 4 (revised on 7/21/2016)**
- 6) **Thoroughfare details revised- Sheet ST-1 (revised on 9/26/2016)**
- 7) **Section 4.06 (B) revised (revised on 9/26/2016)**
- 8) **Construction general notes (CN-1) revised (revised on 9/26/2016)**

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DS

DESIGN STANDARDS



SECTION 1- GENERAL REQUIREMENT



1.01 Short Title

These are hereby adopted as a part of the “Engineering Standards”, Sections 1 – 10 and Appendices including Technical Specifications, Approved Material List and Standard Construction Details which shall be in full force and effect from and after the effective date of adoption of the Engineering Standards.

1.02 Interpretation

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

The City has adopted various ordinances and master plans, which address various requirements not explicitly included in the Engineering Standards, including, but not limited to the following. The Engineer is responsible for understanding and complying with the City’s various ordinances and master plans.

- [City of Celina Code of Ordinances](#)
- Master Plans

1.03 Enforcement

The City’s Engineering Standards are issued by the Engineering Services and Public Works Departments, and are hereby authorized to enforce the provisions of these Engineering Standards. The standards and any updates will be available on the City’s website.

These Engineering Standards shall be in full force and effect immediately upon adoption by the City Council. Projects will be required to comply with all requirements. The standards include the various design criteria, technical specifications, and standard construction details which are considered minimum requirements for the design and construction of adequate public facilities within the City. **The Engineer of record shall bear the sole responsibility for meeting the Engineering standard of care for all aspects of the design and providing a design that’s required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City’s design and construction requirements.**

1.04 Amendment

- A. The City may amend the Engineering Standards. In order to ensure that the Engineer has the City’s latest design standards, they are directed to the City’s website to acquire the City’s most current design standards. The Engineering Standards will include a Record of Revisions to identify any revisions to the Engineering Standards.
- B. A formal request to modify current design criteria or add new design criteria can be submitted to the City for consideration in writing to the City Engineer or designee.

1.05 Deviation Requests

- A. All deviations from the requirements included in the Engineering Standards shall be approved by the City Engineer or designee. **A grant of an alternative material, design, or method of construction shall not affect nor relieve the Engineer of the obligation and responsibility of such material, design, or method of construction for the intended purposes.**
- B. In the event that specific circumstances dictate requirements not already included in the Engineering Standards, it shall be the responsibility of the Engineer to provide the additional information as deemed necessary by the City Engineer or designee in writing for review

1.06 Applicability

The Engineer shall be responsible for the applicability of the information contained in the Engineering Standards to the design of their particular project. The Engineer shall also be responsible for the applicability and accuracy of the information furnished in their design.

Acceptance by the City of the plans for construction shall not be construed to relieve the Engineer of any responsibility.

1.07 Other Local, State and Federal Environmental Regulations (this is not intended to be a complete list and is provided for informational purposes only)

- [Section 404 of the Clean Water Act \(33 USC 1344\)](#)
- [Water Rights](#)
- [Migratory Bird Treaty Act](#)
- [Water Well Drilling](#)
- [Threatened and Endangered Species](#)
- [The Antiquities Code of Texas](#)
- [Air Quality](#)
- [TCEQ Dam Requirements](#)

1.07 Texas Accessibility Standards (TAS)

- A. All plans and specifications for the construction or alteration of public buildings and facilities, privately owned buildings and facilities leased or occupied by state agencies, places of public accommodation, pedestrian facilities within public right-of-way, and commercial facilities must be in compliance with the [Texas Accessibility Standards \(TAS\)](#) for individuals with disabilities and must conform to the standards required by regulations issued by the [Texas Department of Licensing and Regulation \(TDLR\)](#) under the Architectural Barriers Act, codified as Article 9102. Texas Civil Statutes (see [Architectural Barriers Administrative Rules – Section 68.30](#) for exemptions).
- B. Projects with a total estimated construction cost of \$50,000 or more are required to submit a full set of construction documents in accordance with Administrative Rule 68.20 to TDLR for registration and review. For Public Right-of-Way projects, the estimated cost for the project shall be based on pedestrian elements only in accordance with Administrative Rule 68.102. If a project's total estimated construction cost is less than \$50,000, it is not required to be submitted to TDLR for registration and review; however, the project is still required to comply with TAS.

An architect, engineer, interior designer, or landscape architect with overall responsibility for the design of a building or facility subject to subsection 5(j) of the Architectural Barriers Act, shall mail, ship, or hand-deliver the project registration form, review and inspection fees, and construction documents to the TDLR, a registered accessibility specialist, or a contract provider not later than thirty (30) business days after the design professional seals and signs the construction documents. An [Architectural Barriers Project Registration form](#) must be completed for each subject building or facility.

1.08 Engineering Criteria – Section Descriptions

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

- A. Section 1 – General Requirements

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

B. Section 2 –Water and Wastewater Design Requirements

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

C. Section 3- Drainage Design Requirements

This section includes minimum storm drainage design requirements to be followed in the design of storm drainage facilities, and demonstrates the design procedures to be used on drainage projects within the City. This section also addresses floodplains, bridge hydraulics, erosion control and sustainable development.

D. Section 4- Thoroughfare Design Requirements

This section includes minimum requirements associated with the City’s thoroughfares, including roadway geometry, street lighting, signage and markings, and traffic signals, etc.

E. Section 5 –Pavement and Subgrade Design Requirements

This section includes minimum requirements associated with pavement and subgrade design requirements (including geotechnical requirements) for roadways within the City,

F. Section 6 – Landscaping Design Requirement

This section provides additional requirements and standards to address landscaping requirements within roadway right-of-way, specifically in the medians of arterial roadways.

G. Section 7– Irrigation Design Requirements

This section provides additional requirements and standards to address irrigation requirements within roadway right-of-way.

H. Section 8 – Environmental Requirements

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

I. Section 9 – Structural Design Requirements

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

J. Section 10 – Survey Requirements

This section is to address survey requirements.

K. Appendix

- General Notes – The latest version of general notes shall be included in the Construction Plans for all projects.
- Standard Details - All projects shall be constructed in accordance with the City’s standard details which are available through the City’s web site. It is the responsibility of the engineer to use the most current detail, as the details are subject to change. If a necessary standard detail is not available from the City, TxDOT details are generally acceptable except for utility construction. For utility work, a standard detail may be selected from the most recent version of Public Works Construction Standards as issued by the North Central Texas Council of Governments (NCTCOG). It is the responsibility of the Design Engineer to provide plans details if a standard detail is not available.

- Approved Materials List – Products that have been pre-approved for use on projects are available in this listing on the City web site. Products not shown on this list must be approved prior to installation.
- Technical Specifications – All projects shall be constructed in accordance with the most recent version of the City specifications which are available through the City web site or TxDOT specifications. It is the responsibility of the Design Engineer to use the most current specification, as the specifications are subject to change. If a necessary specification is not available from the City or TxDOT, then one may be selected from the most recent version of NCTCOG Public Works Construction Standards with approval from the City.
- Plan Checklists – common elements necessary on most plans that should be verified by designer prior to submittal of plans. These elements are routinely reviewed by staff and if missing can delay issuance of construction permits. Various checklists will be made available on the website as developed over time.

1.09 Submittal Requirements for Construction Plans

- A. All improvements shall be designed in accordance with the City design criteria, specifications, and standard details referenced as part of the Engineering Standards.
- B. Up to five (5) copies of complete construction plans, technical specifications, construction details, requested calculations, construction cost projection, geotechnical report, and certified plan submittal checklist are required to be submitted to the City for review and approval. All submitted items shall be 100% complete at the time of the submittal. **Any incomplete components of a submittal shall result in the entire submittal being considered incomplete and shall be returned to the Engineer not reviewed.**
- C. Two (2) full size and three (3) half size of the construction plans shall be submitted as well as a CD with a PDF copy. 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. If the submittal is for a private project, the City will notify the Engineer and Developer of the incomplete submittal.
- D. Record Drawings shall be submitted on Mylar print and electronic CAD files for public infrastructure projects. The CAD file shall include line-work for property boundaries, right-of-way, easements, roadway, signals, lighting, drainage, water, and sewer facilities. Refer to Survey Requirements for additional electronic submittal requirements.
- E. Each construction plan sheet shall bear the seal and signature of the Licensed Professional Engineer in the State of Texas who prepared the plans. If standard details are included in the construction plan submittal, the Engineer shall provide the following certification on the title sheet of the plans:
 - The standard [City, TxDOT, etc.] details specifically identified in this set of construction plans [or specifically included in these bidding/contract documents] have been selected by me or under my direct responsible supervision as being applicable to this project.

_____, P.E., Firm Registration # _____

F. The Engineer shall provide the following certification on the title sheet of the plans: title sheet of the construction plans shall bear a signature block for approval for construction which shall read as follows:

- These construction plans have been reviewed by the City of Celina. The City has determined that they are in general compliance with the City's Master Plans and Engineering Standards. The City's review and release of these plans does not represent that the City has reengineered or verified the engineering of the proposed improvements. The Design Engineer is responsible for all engineering and recognizes that specific site circumstances or conditions may require improvements constructed to exceed minimum standards contained in the City's Engineering Standards. The Design Engineer is responsible for the applicability and accuracy of the plans and specifications contained herein.

_____, P.E., Firm Registration # _____

G. Specific information required for submittals can be found within this document and in the plan checklists located on the City's website. The City reserves the right to specify additional requirements as necessary to facilitate the review.

Submittals	Responsible Reviewing Department
Preliminary Site Plan - Private	Development Services
Overall Concept	Engineering
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Engineering
Utilities	
Preliminary Plans (30/60%) - Public	
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Engineering
Traffic	Engineering
Landscaping and Irrigation (Public)	Parks
Construction Plans (Final) - Public and Private	
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Engineering
Utilities	Engineering
Landscaping and Irrigation (Public)	Parks
Landscaping and Irrigation (Private)	Development Services
Project Manual (Public)	Engineering
Technical Specifications (Private)	Engineering

H. Any projects requiring permits from agencies other than the City (such as railroad, TxDOT, NTTA, etc.) shall submit the required permit documents to the City for approval. City staff will review and submit permit requests to the agencies.

I. A separate checklist is available for construction plan sets to be submitted at the pre-construction conference.

1.10 Easements

- A. General - Easements shall be provided for public facilities including water, wastewater, drainage features, and traffic signal or lighting equipment that are located outside the public right of way. Storm drains lines are also considered public if they cross property lines and collect runoff from adjacent properties. For single-family residential developments, water, wastewater and storm drain lines shall not cross-residential lots unless specifically approved by the City Engineer or designee. Additional easement width may be required to accommodate future maintenance of the facilities.
- B. Acquisition of Easements - Easements that have not been dedicated on a plat may be acquired by separate instrument. The acquisition of any easement is the owner's responsibility. If the owner cannot obtain a required offsite easement, the owner may request assistance from the City. Prior to requesting assistance, the owner shall provide a written offer to the property owner based on fair market value. The City's assistance does not relieve the owner of the cost of purchasing the easement. In addition, the owner shall reimburse the City for all costs associated with the acquisition.
- C. The process for acquiring an easement by separate instrument is as follows:
- Submit a metes and bounds description, a drawing of the easement sealed, signed and dated by a licensed surveyor, and ownership information to Engineering Services.
 - Engineering Services will prepare the easement documents on city forms.
 - Person requesting the easement shall pay any document preparation and filing fees required by the city.
 - After fee is paid to City, the easement documents will be sent to the person requesting the easement to obtain all necessary signatures (other than City's).
 - Return all signed documents to the city for filing with the county.
 - City will send a copy of the filed easement to the person requesting the easement and the easement grantor, if needed.
- D. Abandonment of Right of Way and Easements - Right of way and easements that have not been abandoned by plat may be abandoned by separate instrument. Signatures are required from all the public utility companies, including franchise utilities and the adjacent affected property owners indicating either agreement or disagreement to the proposed abandonment. Proposed Right of way and easements to be abandoned that do not contain improvements may be processed administratively. If improvements are present, the abandonment request will be forwarded to City Council for approval. Abandonments opposed by the affected property owners will also be forwarded to City Council for approval. Right of way and easements granted to entities other than the City shall be abandoned by that entity.
- E. The following describes the process for abandoning right of way or easements:
- The applicant shall notify all property owners abutting the proposed abandonment by certified letter. The City prior to staff review must receive a written response from each abutting property owner.
 - All public utilities including franchise utilities must consent to the abandonment.
 - The applicant shall provide a description as to how the city originally acquired the right of way or easement (i.e., by plat, by separate instrument, etc.).
 - For right of way, the applicant shall provide a certified appraisal stating the value. In addition, the applicant shall provide an explanation that identifies why the proposed use of the right of way will benefit the community under private ownership, versus retention of

the property as public right of way.

- For easements, the applicant shall describe why the easement is no longer needed.

F. The right of way/easement abandonment application shall be submitted along with the supporting documentation to the Engineering Services Department for coordination and processing. The application form is available from the Engineering Department or the City's website.

G. Easement Use Agreements - The City may allow permitting of certain improvements within easements with the execution of an Easement Use Agreement, which is in addition to a building permit. The agreement states that the City is not responsible for the maintenance or reconstruction of any improvements located in the easement or right of way and that the owner must remove the improvement at the request of the City. Forms and instructions are available from the Planning and Development department, or on the City's [website](#).

H. The Easement Use Agreement is processed by the Planning and Development department with concurrence and review by Engineering Services. The following items will require an Easement Use Agreement:

- Driveways/flatwork
- Brick, stone fences
- Retaining walls (less than 4 feet that support a structure, or greater than 4 feet)
- Private storm systems/area drains
- Swimming pools decks
- Wood decks, gazebos and patios (covered/uncovered)
- Buildings and other permanent improvement

Items listed below may be allowed without the execution of an Easement Use Agreement and with approval from the City Engineer or designee:

- Paving or flatwork
- Wooden or chain-link fences (where allowed)
- Retaining walls less than three feet in height that do not support a structure or infringe on the required visibility triangles.

1.11 Fees

In accordance with Article A6.008 subsection (a) of the City's Ordinance, the city secretary shall require a deposit in the amount of \$5,000.00 for the service at the time the initial development application is filed. The actual costs will be determined prior to final approval and either an additional sum will be due from the applicant or a reimbursement made if the actual cost is less than the deposit.

SECTION 2 – WATER & WASTEWATER DESIGN REQUIREMENTS

2.01 Water System - General

- A. The intent of the water system design requirements is to list minimum requirements for public water distribution and transmission system facilities and appurtenances. Private fire service mains shall also be designed according to these water system design requirements, the City's Fire Code and the National Fire Protection Association (NFPA) 24: Standard for the Installation of Private Fire Service Mains and Appurtenances, latest revision.
- B. Design criteria for all water systems shall comply with [Texas Commission on Environmental Quality \(TCEQ\) Chapter 290, Subchapter D](#) (Rules and Regulations for Public Water Systems); latest revision. Chapter 290 is included in Part I of Title 30 of the Texas Administrative Code.
- C. Line sizes shall comply with the [Water Distribution System Capital Improvement Plan](#).
- D. Water mains shall be sized and extended through the limits of a development to serve adjacent properties.
- E. Dead end water mains are not allowed unless approved in writing by the City Engineer or designee; however, if approved, an automatic flushing device shall be provided (See 2.1.12). Automatic flushing devices shall drain via a pipe system to the storm sewer system.

2.1.1 Water Main Location

- A. Water mains shall be installed a minimum of one foot (1') from the back of the curb, as measured to the centerline of pipe unless approved otherwise by the City.
- B. The water main locations can be adjusted based on existing field conditions with approval from the City (reference utility layout details).
- C. Water mains shall be designed to minimize bends and fittings and follow right-of-way or centerline alignment curves at a uniform distance from the right-of-way or centerline.
- D. Dead end water mains shall extend a minimum of five feet (5') beyond the edge of the pavement. If adjacent to a fitting, extend a minimum of twenty feet (20') or one pipe joint beyond fitting.

2.1.2 Horizontal and Vertical Alignment

- A. A clearance of eighteen inches (18") shall be maintained when crossing storm drain systems. Where minimum clearance cannot be achieved, water mains shall be encased in six inches (6") of concrete in accordance with the standard detail.
- B. Lines less than twelve inches (12") within developed areas shall have a minimum cover of four feet (4'), otherwise a six feet (6') cover shall be required.
- C. Lines between twelve inches (12") and twenty inches (20") within developed areas shall have a minimum cover of five feet (5'), otherwise a six feet (6') cover shall be required.
- D. Lines greater than twenty inches (20") shall have a minimum cover of six feet (6') if it is within a developed area otherwise seven feet (7') cover shall be required.
- E. Water mains shall be designed as straight as possible following the existing or proposed grade at the minimum depth of cover. Bends shall be provided where vertical slope changes exceed eighty percent (80%) of the manufacturer's recommended joint deflection.
- F. Excessive high points that trap air and restrict water flow shall be avoided.

2.1.3 Separation Distance between Water and Wastewater

- A. The separation distance between water mains and wastewater mains, manholes or other appurtenances is governed by [Title 30 of the Texas Administrative Code, Part 1, Chapter 290, Subchapter D, Rule 290.44\(e\) and Chapter 217, Subchapter C, Rule 217.53\(d\)](#).
- B. Water mains shall have a minimum separation distance of nine feet (9') in all directions from wastewater collection facilities. Separation distances shall be measured from the outside surface of each of the respective facilities.
- C. If the minimum separation distances cannot be achieved for parallel water and wastewater mains, the separation distances may be reduced if the material of the wastewater main has a minimum pressure rating of 150 psi. In these cases, the water main shall be placed above the wastewater main with minimum separation distances of four feet (4') horizontally and two feet (2') vertically.
- D. If the minimum separation distances cannot be achieved for crossing water and wastewater mains, the separation distances may be reduced under two scenarios:
1. The wastewater main has a minimum pressure rating of 150 psi.
 2. The water or wastewater main is cased for a minimum of eighteen feet (18') with a casing pipe having a minimum pressure rating of 150 psi.
- Under each scenario, the water main shall be centered on the wastewater main crossing with a minimum separation distance of twelve inches (12").
- E. When water mains are designed to be closer than nine feet (9') to wastewater manholes the water main shall be cased as described in section 2.1.3D above.
- F. Residential water and sewer lines shall be ten feet (10') apart and centered in the lot.

2.1.4 Average Daily Water Demands

Apart from project specific water demand and/or actual flow measurements, the following values shall be used when calculating the average daily water demands:

Table 2.1 – Average Daily Water Demands

Land Use	Design	Calculation
Apartment	3.0 persons/unit 230 gallons per person per day	690 gpd/unit
Residential/ Town Home/ Patio Home	3.5 persons/unit 230 gallons per person per day	805 gpd/unit
Hospital (Beds)	720 gallons per day per bed	720 gpd/bed
Nursing Home or Other Institution (Beds)	240 gallons per day per bed	240 gpd/bed
Commercial/ Industrial/Office	1 person per parking space, or 1 person per 400 SF of building	50 gpd/person
School	30 gallons per student/day	30 gpd/student

2.1.5 Water Main Sizing

- A. Water mains shall be sized in accordance with the Water Distribution System Master Plan.
- B. The following criteria shall be used to size water mains.
 1. Average daily water demands less than 80,000 gallons per day:
 - a. Single Family Residential
 - i. Water mains shall be a minimum of eight inches (8”).
 - ii. Twelve inches (12”) water mains are required to serve the development and shall be located along collector streets.
 - b. Multi-Family Residential
 - i. Water mains shall be a minimum of eight inches (8”) and shall be extended to provide service to adjacent properties.
 - ii. Water mains greater than six hundred feet (600’) in length or supplying more than one fire hydrant/fire service line shall be twelve inches (12”).
 - c. Commercial, Schools and Manufacturing
 - i. Looped eight inches (8”) water mains may be used for fire hydrants located in parking lots and not adjacent to buildings.
 - ii. Water mains greater than a thousand feet (1,000’) in length or supplying more than two fire hydrants/fire service lines shall be a minimum of twelve inches (12”).
 2. For average daily water demands greater than 80,000 gallons per day the following information shall be submitted:
 - a. Zoning
 - b. Area in acres
 - c. Type of Development
 - d. Number of units and/or building square footage
 - e. Exhibit with connection locations and proposed water main schematic
 - f. Projected Average Daily Water Demands

2.1.6 Water Main Materials

A. Polyvinyl Chloride (PVC) Pipe

1. PVC water mains from four inches (4”) to eight inches (8”) in diameter shall be AWWA C900 DR14.
2. PVC water mains twelve inches (12”) in diameter shall be AWWA C900 DR18.
3. PVC water mains sixteen inches (16”) in diameter and greater shall be AWWA C905 DR18.
4. Water mains crossing other utilities such as gas lines shall be PVC, otherwise pipe shall have a cathode protection.

B. Ductile Iron Pipe

Ductile iron water mains sixteen inches (16”) in diameter and larger shall be in accordance with ANSI/AWWA C151/A21.50 with a minimum pressure class of 150 psi. It shall be the Engineer’s responsibility to determine whether a higher pressure class is required. All ductile iron pipes shall be epoxy coated inside and out. Coatings must conform to [American National Standards Institute/National Sanitation Foundation \(ANSI/NSF\) Standard 61](#) and must be certified by an organization accredited by ANSI.

C. Fittings

1. All fittings shall be ductile iron complete with epoxy coating conforming to [American National Standards Institute/National Sanitation Foundation \(ANSI/NSF\) Standard 61](#) or stainless steel, having mechanical restraints and thrust blocking as approved by the City.
2. All fittings shall be Mechanical Joint (MJ) unless specified otherwise. PVC fittings are not allowed.
3. Fittings at crosses and tee junctions with valves and fire hydrant leads shall be flanged and not MJ.

D. Embedment

Embedment for water mains shall be as per the embedment detail:

1. For pipe sizes twenty four inches (24") and smaller, the embedment shall be cushion sand with the following dimensions; six inches (6") beneath, a minimum of nine inches (9") on the sides of the pipe and twelve inches (12") above the pipe for cushioning preferably using stabilized sand free of clay and other objectionable materials with a tracer wire attached to the top.
2. For pipe sizes larger than twenty four inches (24") the embedment shall also be cushion sand with the following dimensions; a quarter of the pipe outer diameter ($1/4 * OD$) beneath the pipe, a minimum of nine inches (9") on the sides and twelve inches (12") above for cushioning preferably using stabilized sand free of clay and other objectionable materials with a tracer wire attached to the top.

E. Storage

1. PVC water pipes shall not be stored on site without approval from the City.
2. Pipes shall not be laid in water or placed where it can be flooded with water or sewage during its storage or installation.

F. Installation

1. Blue PVC water pipe is acceptable for installation. Pipes shall be installed in such a way that the writing on the pipe is installed on the side up and is readable from the top of the ditch.
2. Maximum pipe deflection shall be as recommended by the manufacturer.
3. Newly installed pipelines shall be cleaned by pigging if possible.

G. Casing

When PVC water pipe is installed in casing, skids must be used to prevent damage to the pipe and bell during installation. PVC pipe should not rest on the bells. Plastic spacers shall be used.

H. Water main marker

All offsite city of Celina mains with valves, air release valves etc. shall be marked with a marking tape.

I. Material

All material incorporated in the construction shall be new.

2.1.7 Water Services

Minimum requirements for water services are as follows:

- A. Minimum one inch (1") meter and service lines are required for all residential and commercial services. The size necessary shall be selected based on design calculations of actual demands.

Meters shall be set using re-setters with height of ten inches (10"). Twin meters in parallel are not permitted as meter size shall correlate to the line size. Bullhead connections are not permitted.

- B. Meters three inches (3") and bigger are required to be in vaults. There will be no rising stem valves in vaults and blocking on valves shall be concrete. Metallic blockings are not allowed.
- C. Domestic or irrigation services connections shall not be allowed on a fire hydrant lead or fire service line.
- D. A domestic or irrigation service connection shall not exceed fifty feet (50') in length.
- E. A fire service line shall be a minimum of eight inches (8"). Provided that the City Engineer or designee may approve installation of six-inch mains for lines no longer than six hundred feet (600') between intersecting mains which complete a desirable gridiron.
- F. The water meter size shall be the same size as the service line.
- G. Water meter and electronic read device will be furnished by the City's meters department.
- H. Water pipe, valves and fittings (excluding water meter) are to be assembled inside meter box by contractors.
- I. Sand backfill around exterior walls of meter box is to be carefully placed and compacted.
- J. Bottom inlet and outlet connections are to accommodate flared /compressive brass fittings with restrained union.
- K. Lid is to be HDPE with a brass lock, sized to fit meter box with hole and plug for electronic meter read module.
- L. For a water service requiring a vault, a minimum six inches (6") water line shall be required off the water main with a minimum six inches (6") gate valve prior to reducing in size.
- M. Meter box shall be located out of all flat work, sidewalks and approaches.
- N. Residential water line shall run to the center of the lot with its meter within the right of way (R.O.W) or easement.
- O. Refer to Approved Material List for acceptable products.
- P. Water services are to be marked with "W" stamped or cut in the curb

2.1.8 Valves

Valves are to be marked with "V" stamped or cut in the curb for easy identification

A. Isolation Valves

1. Isolation valves shall be placed on or near street property lines.
2. Isolation valves shall not be over six hundred feet (600') apart in residential and multi-family areas.
3. Isolation valves shall not be over five hundred feet (500') apart in all other non-residential areas on lines twelve inches (12") and smaller. For lines sixteen inches (16") and larger, valves shall not be over a thousand feet (1000') apart.
4. Two isolation valves shall be placed such that only one fire hydrant/firefighting apparatus and one fire sprinkler private service system is shut down at a time. No more than three isolation valves shall be used to shut down the combined fire hydrant/firefighting apparatus and fire sprinkler system on the private service main.
5. Water mains supplying an automatic fire sprinkler system shall include isolation valves on the private fire service main.

6. Isolation valves shall not be located in parking spaces.
7. In undeveloped areas, main line isolation valves shall be spaced every twelve hundred feet (1,200') and adjacent to fire hydrants.

B. Air Release Valves

1. The Engineer shall be responsible for locating and sizing air release valves in accordance with AWWA Manual M51: Air-Release, Air/Vacuum & Combination Air Valve.
2. Air release valves shall be installed on water mains larger than twelve inches (12"). Vent pipes shall discharge air above grade and above 100-year floodplain elevation if applicable.
3. Air valves are not required on water distribution mains smaller than twelve inches (12") where fire hydrants and service connections provide a means for venting trapped air.
4. Air valve boxes shall not be located in parking spaces.

2.1.9 Fire Hydrants

Fire hydrants shall be provided as recommended by the "[Guide for Determination of Required Fire Flow](#)" published by the Insurance Service Office. The following minimum guidelines shall be met:

- A. Fire hydrants shall be installed at a minimum of ten feet (10') from the curb return for all streets and fire lanes.
- B. Fire hydrants shall be installed at a minimum of three feet (3') from the back of curb on all streets and fire lanes. The fire hydrant shall be centered on a six-inch (6") thick thirty- inch by thirty- inch (30" x 30") concrete pad extended all the way to the back of curb.
- C. Fire hydrants shall be located at all main entrances and intersecting streets and fire lanes.
- D. Fire hydrants shall be spaced every twelve hundred feet (1200') along undeveloped roadways.
- E. Fire hydrant leads exceeding one hundred feet (100') shall be looped with a minimum eight inches (8") line.
- F. Fire hydrants shall be provided every five hundred feet (500') within residential developments as measured along the route that a fire hose is laid by a fire apparatus.
- G. The fire hydrant shall not be located in the sidewalk.
- H. Fire hydrant valves shall be positioned to one side of the fire hydrant pumper nozzle.
- I. Fire hydrants required to supplement water supply for automatic fire protection systems shall be located within one hundred feet (100') of the Fire Department connection for such system.
- J. Major thoroughfares with built-up or walled medians can prevent ready access to hydrants if they are on the opposite side of the street from a fire incident. Accordingly, fire hydrants are required to be installed on both sides of the thoroughfare's right-of-way. Similarly arterial thoroughfares with high traffic flows are also problematic with respect to accessing hydrants on the opposite side of the street because of the physical danger to fire fighters and apparatus of leading out or manually dragging supply hoses across such busy thoroughfares. These hydrants are typically intended for use only with thoroughfare hazards and may be spaced every five hundred feet (500') on each side in alternating positions; resulting in a hydrant every two hundred and fifty feet (250'). See figure 2.1 below.

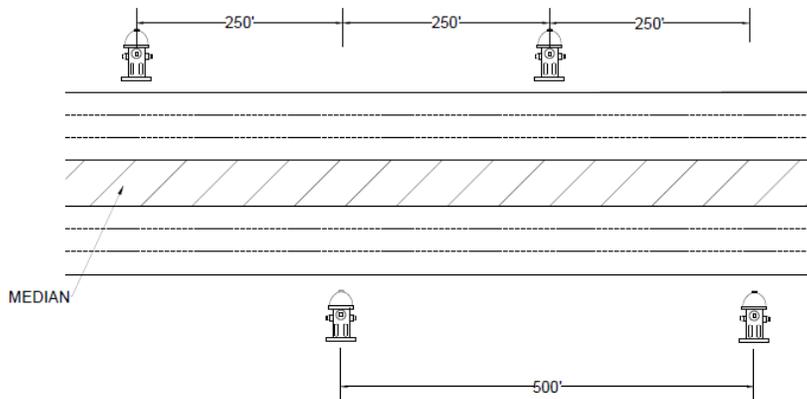


Figure 2.1: Fire hydrant spacing along major and high volume thoroughfares

- K. Additional requirements for fire hydrant installation adjacent to and along fire lanes are as follows:
1. Multi-family
 - a. Fire hydrants shall be located every three hundred feet (300') as measured along the route that a fire hose is laid by a fire apparatus.
 - b. Fire hydrants shall be located outside the radius of the fire lane and at least thirty five feet (35') from all buildings.
 - c. A minimum of two fire hydrants shall be located within five hundred feet (500') of the front of any building as measured along the route that a fire hose is laid by a fire apparatus.
 2. Commercial
 - a. Fire hydrants shall be located within one hundred and fifty feet (150') of the main entrance.
 - b. Fire hydrants shall be located outside the radius of the fire lane and at least thirty-five feet (35') from all buildings.
 - c. A minimum of two fire hydrants shall be located within three hundred feet (300') from the front of any building as measured along the route that a fire hose is laid by a fire apparatus.
- L. Eight inches (8") water mains shall be installed such that not more than two fire hydrants will be between intersecting lines.
- M. Fire hydrants on private property shall be located within easements and protected by parking curb stops or bollards, the maintenance of which shall be the responsibility of the property owner. The property owner is responsible for keeping the parking curb stops or bollards in place.
- N. All fire hydrants shall be adequately protected against vehicular damage in a manner prescribed by the Fire Chief.
- O. All fire hydrant installations on dead-end mains or temporarily dead-end mains shall include provisions for looping, together with minimum easement of sixteen feet (16'), unless a different installation design is approved by the Director of Public Works.
- P. Fire hydrants on private property shall be accessible to the Fire Department at all times.
- Q. Fire hydrant locations shall be subjected to approval by the Fire Department.
- R. Minimum pipe size leading to the Storz FDC shall be determined by hydraulic calculations, but shall be a minimum of four inches (4") for all systems. A six inches (6") minimum is required for

all systems with a total demand exceeding 750 GPM. Four and half national standard thread (4.5 NST) by Five-inch (5”) Knox Storz Guard fitting with no locking caps are required on all fire hydrants. All exposed piping and fittings are to be galvanized with the exception of the Storz fitting.

- S. All fire hydrants must be anchored to the main by use of anchor fittings.
- T. Fire hydrants located in the City and its Extra Territorial Jurisdiction shall be painted silver. The bonnet of the fire hydrant shall be painted in the color code indicated below.

Color	Flow rate (gpm)	Evaluation
Light blue	>1500	Very good flow
Green	1000-1500	Good for residential area
Orange	500-999	Marginally adequate
Red	Less than 500	Inadequate
Black	Less than 300	Out of service/flushing hydrant

2.1.10 Connections to Existing Water Mains

- A. Tapping Sleeves and Valves – Size on size tapping sleeves are not allowed. The largest allowable tapping sleeve shall be the main line size less one standard pipe size (Example: 16 inch x 12 inch, 8 inch x 6 inch, etc.). If a size on size connection is required then a cut-in connection shall be used. Connections to an existing line shall be made with full body stainless steel tapping sleeve and valve. A resilient wedge gate valve shall be flanged to the tapping sleeve.
- B. Cut-In Connection – When connecting to an existing main, it may be required to provide a cut-in connection with a tee and valve being installed into the existing main in lieu of a tapping sleeve and valve as directed by the Director of Engineering. A test shut down of the existing water main(s) shall be conducted by the City of Celina Public Works Department, prior to preparation of the final design plan. The requirement for a test shut-down may be waived with approvals of the Director of Engineering and the Water Superintendent.
- C. Four-Way Connections – When two water mains cross and one of the mains is 16 inches or larger, the connection shall be made by means of a Type “D” connection. The connecting “D” section of water line shall be, at a minimum, equal to the size of the smaller of the two crossing water lines. A valve shall be provided in the “D” section of pipe to isolate the two crossing mains. The installation of a cross fitting shall not be allowed unless approved by the Director of Engineering.
- D. Requirements for Abandoning Water Lines – The engineer of record is to note the limits and appropriate conditions for abandoning existing water lines that are being replaced. The engineer of record shall make allowances to permit the existing and proposed mains to remain in service simultaneously thereby providing a means for transferring customer’s services from the old main to the new main with minimum interruption. If the construction of a proposed main necessitates the abandoning of the existing main prior to the new main’s placement into service, then provisions for a temporary water main with services must be addressed with the design. Existing fire hydrants located on mains being abandoned are to be removed and delivered to the City of Celina Public Works Department.
- E. Replacement Lines – To replace an existing line, the new line should be designed parallel to the line being replaced. The engineer of record shall perform a field investigation to determine pavement condition over the existing main. Based on this field investigation, the engineer of record shall include additional quantities for pavement replacement, if needed. Also, locate the proposed main at least 5 feet away from the existing curb to avoid damaging the curb or undercutting the pavement during installation of the proposed line. On lines being abandoned, the engineer of record should note and locate points of cut and plug at the junction with the line that remains in service.

2.1.11 Backflow Prevention

Backflow prevention devices shall be required at the following locations in order to protect the public water system from cross contamination:

- A. Commercial property water service lines
- B. Dedicated irrigation lines
- C. Private fire service main supplying fire sprinkler systems
- D. Multi-family residential water service lines

2.1.12 Automatic Flushing Valve

- A. Automatic Flush Valves shall be placed on dead-end water mains. Water mains anticipated to be extended in the future may be required to install an automatic flush valve, depending on the timing of future work and the specific location.
- B. Automatic Flush Valves shall drain via pipe to storm drain system.
- C. Automatic flushing valve shall have a two-inch (2") brass FIP inlet leading vertically into a two-inch (2") automatic solenoid valve. Automatic solenoid valve shall have an internal, self-cleaning debris screen and have a 220 psi rating. Each unit shall be furnished with a stand-alone controller. Valve controller will not require a second hand-held device for programming. Controller must have a minimum of nine (9) possible flushing cycles per day. Shall be submersible to twelve feet (12'). Operate with a 9 volt battery and have resin-sealed electrical components. Solenoid shall have no loose parts when removed from valve. Each unit shall have a double valve all brass sampling point. Removal of two-inch (2") solenoid valve shall be possible via a quick disconnect below the valve. All above-ground components shall be contained within a UV-resistant locking cover.
- D. Tubing shall be embedded in sand from corporation stop to curb stop.
- E. The automatic flushing device system shall be installed parallel to the curb line.
- F. Unit shall not be installed front of a residential lot.
- G. Irrigation box shall be no less than seventeen inches wide, thirty inches long and eighteen inches deep bolted down on each side (17" wide x 30" long x 18" deep x 2 bolt down).
- H. Contractor to obtain permit from the city and request two-inch (2") turbine meter set at the public works department.
- I. Refer to approved materials list for acceptable products.

2.1.13 Water Meter Vault

- A. Unit shall be concrete precast from the approved material list.
- B. Reinforcement: grade 60 reinforced. Steel bar conforming to ASTM 1615 on required centers or equal.
- C. Hatchway: three feet by five feet (3' x 5') galvanized steel double leaf spring assisted hatchway-with slam lock (traffic rated if within paving).
- D. Minimum of six inches (6") water line off the water main with minimum six inches (6") gate valve prior to reducing in size
- E. Thickness of vault walls top and base may vary and are specified by the precast vault manufacturing company.
- F. No high rising valve stems shall be allowed in the vault.
- G. All blocking shall be concrete.

2.1.14 Double Detector Check Fire Vaults and FDC

- A. The assembly shall meet the basic requirements of ASCE 1048 for double check valves and meet requirements of AWWA, CSA, UL classified, FM approved. Assembly shall also be approved by

the foundation for cross-connection control and hydraulic research at the university of southern California

- B. The vault shall be located on the owner's property and not within city right-of-way or easement.
- C. The owner at his option and the approval of the city of Celina may be permitted to install the double check detector back-flow preventer assembly inside the building. The installation would be required to be permitted with the building inspection department and will be inspected by the city's construction inspectors and the building inspection department. The fire department connection is to be located at the street. Fire department connection shall be within six feet (6') of curb, unobstructed and in clear view. Water utility personnel shall have access during normal business hours.
- D. The fire department connection may be installed outside the vault with the approval of the engineering department.
- E. The valve vault shall be precast and from the approved material list
- F. The vault shall be placed on a six inches (6") crushed rock bed and the vault shall have a sump with a minimum twelve inches by twelve inches (12" x 12") grate in the bottom of the vault for draining purposes. Concrete shall be minimum 4200 psi at 28 days
- G. Hatchway shall be a quarter inch (1/4") aluminum diamond plate cover with extruded aluminum frame. Hatch to be furnished with 316 stainless steel snap lock and brass hinges.
- H. The installation of the check valves and vault shall be permitted and inspected by the public works department. The applicant will be required to pay a permit fee and obtain a two (2) year maintenance bond from date of acceptance of installation.
- I. The pipe line from the check valve vault to the building shall be permitted and inspected by the water division of the city of Celina public works department.
- J. The double check detector backflow preventer assembly shall consist of single complete assembly containing two independent acting check valves and four properly placed resilient test cocks for test of the assembly.
- K. Assembly shall also include two (2) U.L listed resilient seated OS & Y shutoff valves and test cocks.
- L. Unit shall be UL/FM approved with UL/FM approved OS & Y shutoff valves.
- M. The auxiliary line shall consist of an approved backflow preventer (double check assembly completed with test cocks) and a three quarter - inch (3/4") water meter.
- N. The bypass auxiliary line shall have a double check assembly.
- O. The backflow preventer shall have an epoxy coated cast iron body or stainless steel body with replacement brass seats and/or a unitized stainless and plastic check assembly.
- P. The uniform plumbing code requires that this assembly must be tested immediately upon installation. Copies of the test report must be forwarded to the City's construction inspectors.
- Q. Upon installation and approval of fire sprinkler line/fire department connection, the owner shall be required to submit a yearly test report from a reputable testing company stating that the check valves are in good working condition. These test reports shall be submitted to the City's engineering department and the fire department once a year as required by the TNRCC rules and regulations

and the city of Celina code of ordinances. The testing of backflow preventer assemblies which are installed to provide protection against health hazards are to be completed by certified fire-line testers that are qualified to test and repair backflow preventer assemblies on fire lines only.

- T. The maintenance of the double check detector backflow assembly shall be by the property owner.
- U. All material incorporated in the construction shall be new.

2.1.15 Testing

- A. Water Quality and Testing: Water mains shall be designed to provide adequate circulation by looping water mains to prevent odor, taste and color problems associated with stagnant water. Disinfection must be performed in accordance with American Water Works Association (AWWA) requirements. Water samples shall be collected and submitted to a City approved laboratory by the City Inspector. The water main will remain out of service until the water mains have been tested and approved for public consumption. In general, bacteriological tests are performed with passing results after conducting a pressure test. One water sample per each street name or as approved by the City Engineer.
- B. The contractor shall be responsible for the following:
 - 1. Cleaning pipes by purging using the poly-pig method to enter and exit at approved strategic locations if possible or by flushing as per NCTCOG item 506.7 specifications, to include all equipment, materials, fittings and labor.
 - 2. Hydrostatic test as per NCTCOG item 506.5 specifications.
 - 3. All temporary test points are to have corporation stops at the main.
 - 4. All temporary testing and chlorination points shall be removed at the corporation prior to final acceptance.
 - 5. De-chlorinating the chlorinated water before discharging either to the environment or City's storm sewer system.
- C. The contractor shall provide backfill, density and concrete testing for all projects unless specified otherwise. All reports shall be turned in to the Inspector within five (5) working days.

2.02 Wastewater System - General

- A. Design criteria for all wastewater systems shall comply with [TCEQ Chapter 217 \(Design Criteria for Domestic Wastewater Systems\)](#), latest revision. Chapter 217 is included in Part 1 of [Title 30 of the Texas Administrative Code](#).
- B. Wastewater main sizes shall comply with the [Wastewater System Capital Improvement Plan](#).
- C. Wastewater mains shall be sized and extended through the limits of a development to serve adjacent properties.

2.2.1 Wastewater Main Location

- A. Wastewater mains serving subdivisions and commercial developments shall be located under street paving along the center of the street.
- B. Wastewater mains shall not be located in alleys.
- C. Wastewater mains located near open waterways shall follow the alignment of the waterway along the high bank and be located a minimum of fifteen feet (15') beyond the top of bank. Wastewater manholes shall not be located in the flow line of an existing waterway.
- D. No wastewater main shall be located inside the storm sewer system.

2.2.2 Horizontal and Vertical Alignment

- A. Wastewater mains shall be designed as straight as possible between manholes.
- B. Wastewater mains running parallel with public right-of-ways shall match change in street direction. When streets have horizontal curvature, curved sewers are acceptable to maintain parallel alignment.
- C. Minimum cover for wastewater main shall be four feet (4').
- D. In general, the minimum depth for a wastewater main to serve a given residential property with a four inch (4") lateral shall be three feet (3') plus 2% times the length of the house lateral (the distance from the wastewater main to the center of the house). Thus, for a house one hundred and thirty five feet (135') from the wastewater main, the depth would be ***three feet (3') plus 2% x 135' = 3.0 + 2.7 = 5.7'***. The depth of the flow line of the wastewater main should then be at least ***5.7 feet*** below the elevation of the ground at the point where the service enters the house. Profiles of the ground line twenty feet (20') past the building line will be required to verify that this criterion is met.
- E. No vertical bends or vertical curves shall be allowed between manholes.
- F. A parallel wastewater main shall be required for wastewater lateral connections on wastewater mains deeper than twelve feet (12').
- G. Wastewater mains shall be placed on such a grade that the velocity is not less than two feet per second (2 fps) or more than ten feet per second (10 fps) at design peak flow. The following table of values may be used.

Table 2.3: Minimum and Maximum Grades for Wastewater Mains*

Size of Pipe (inches)	Minimum Slope in (Percent)	Maximum Slope in (Percent)
6	0.5	12.35
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65
30	0.055	1.43
33	0.05	1.26
36	0.045	1.12
39	0.04	1.01
>39	**	**

*The slopes were calculated using Manning's Equation and a roughness coefficient of 0.013.

**For lines larger than 39" in diameter, the slope shall be determined using the following equation.

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

Where:

V = velocity of flow in wastewater main (fps)

n = roughness coefficient of the wastewater main

R = hydraulic radius of the wastewater main (ft.), which is equal to the area of the flow divided by the wetted perimeter (R=A/P)

S = Slope of the hydraulic gradient (ft. /ft.)

2.2.3 Separation Distance between Wastewater and Water Mains

- A. The separation distance between wastewater and water mains or other appurtenances is governed by Title 30 of the Texas Administrative Code, Part 1, Chapter 217, Subchapter C ; Rule 217.53(d).
- B. Wastewater mains shall be installed in trenches separate from water mains.
- C. Wastewater mains shall have a minimum separation distance of nine feet (9') in all directions from water mains. All separation distances shall be measured from the outside surface of each of the respective facilities.
- D. If the minimum separation distances cannot be achieved for crossing water and wastewater mains, the separation distances may be reduced under two scenarios:
 1. The wastewater main material has a minimum pressure rating of 150 psi.
 2. The water or wastewater main is cased for a minimum of eighteen feet (18') with a casing pipe having a minimum pressure rating of 150 psi.

Under each scenario, the water main shall be centered on the wastewater main crossing with a minimum separation distance of twelve inches (12"). If the minimum separation distances cannot be achieved for crossing wastewater and water mains, the separation distances may be reduced if the wastewater main has

a pressure rating of 150 psi. In these cases the wastewater main shall be cased for a minimum of 18". The casing pipe shall be centered on the water main crossing, be a minimum of two nominal pipe sizes larger than the wastewater main and be sealed at each end with watertight non-shrink cement grout, or a manufactured watertight seal. The minimum separation distance is 6".

2.2.4 Wastewater Flows

If project specific wastewater flow projections or actual flow measurements are not available for a development, the criteria in Table 2.4 shall be used to calculate average daily wastewater flows. This criteria meets or exceeds the minimum requirements as set by TCEQ in Title 30 of the Texas Administrative Code, Part 1, Chapter 217, Subchapter C, Rule 217.32(a)(3).

Ideally, flow monitoring should be used to determine the relationship between the peak flows and the average daily flow for each area of a wastewater system. In the absence of flow monitoring data a standard peaking factor relationship can be utilized. The Dallas Water Utilities (DWU) method will be used (see Table 2.5) unless specified otherwise by the City's Engineer. This method applies a peaking factor based on pipe size that varies from 3.0 to 4.0. The peaking factor is applied to the average daily flows and considers infiltration and inflow. Table 2.5 below is from the DWU Design Manual.

Table 2.4 – Wastewater Flow Projections

Land Use	Design Factors	Average Daily Wastewater Flows
Apartment	<ul style="list-style-type: none"> 3.0 persons/unit 102 gallons per person per day 	306gpd/unit
Residential/ Town Home/ Patio Home	<ul style="list-style-type: none"> 3.5 persons/unit 102 gallons per person per day 	357gpd/unit
Hospital (Beds)	<ul style="list-style-type: none"> 200 gallons per bed per day 	200gpd/unit
Nursing Home or Other Institution (Beds)	<ul style="list-style-type: none"> 100 gallons per day per bed 	100gpd/bed
Commercial/ Industrial/Office	<ul style="list-style-type: none"> 1 person per parking space, or 1 person per 400 s.f. of building 20 gallons per day/person 	20gpd/unit
School	<ul style="list-style-type: none"> 20 gallons per student/day 	20gpd/unit

Table 2.5: Dallas Water Utilities Wastewater Peaking Factors

Pipe Size	Peak Factor	Depth of flow
Less than 18"	4	Full
18" through 30"	3.5	Full
Larger than 30"	3.0	Full

2.2.5 Wastewater Main Materials

A. Polyvinyl Chloride (PVC) Wastewater Pipe

1. PVC non-pressure rated gravity wastewater mains from six inches (6") to fifteen inches (15") in diameter shall be SDR 35 (if less than fifteen feet (15') deep) or SDR 26 (if fifteen feet (15') or deeper) (ASTM D3034).
2. PVC non-pressure rated gravity wastewater mains eighteen inches (18") in diameter and greater shall have a minimum pipe stiffness of 46 psi or 115 psi and be manufactured in accordance with ASTM F679 (solid wall).
3. PVC pressure rated gravity wastewater mains and force mains from six inches (6") to twelve inches (12") in diameter shall be SDR 26 (ASTM D2241) with a minimum pressure rating of 160 psi.
4. PVC pressure rated gravity wastewater mains and force mains greater than twelve inches (12") in diameter shall be AWWA C900-16 DR25 with a minimum pressure rating of 165 psi.
5. PVC profile wall pipe will not be allowed.

B. Vitrified clay pipe and Fiberglass pipe shall not be allowed.

C. Fittings

1. All fittings shall be rubber gasket push on type.
2. All fittings shall be blocked as per the details
3. All pipe connections fittings such as adaptors and couplings shall be compatible with the same pipe material. Flexible adaptors and couplings shall not be permitted unless pre-approved by the Engineer.

D. Embedment

Wastewater mains embedment shall be as per the embedment detail;

1. For pipe sizes twenty four inches (24") or less embedment shall be six inches (6") of crushed stone (size as approved by the City) compacted to at least 90% standard proctor density beneath the pipe, a minimum of nine inches (9") of the same material on the sides and six inches (6") above. For cushioning, a minimum of twelve inches (12") of the selected native material shall be used to backfill with twelve inches (12") loosed lifts and mechanically compacted with approved vibratory methods with a tracer wire taped on top of it.
2. For pipe sizes greater than twenty four inches (>24") embedment shall be a quarter of the pipe outer diameter ($1/4 * OD$) of crushed stone (size as approved by the City), compacted to at least 90% standard proctor density beneath the pipe, a minimum of nine inches (9") of the same material on the sides and six inches (6") above. For cushioning, a minimum of a twelve inches (12") of the selected native material shall be used to backfill with twelve inches (12") loosed lifts and mechanically compacted with approved vibratory methods with a tracer wire taped on top of it.

E. Storage

No PVC pipes shall be stored on site without approval from the City.

F. Installation

1. Green PVC sewer pipe is acceptable for installation. Pipes should be installed in such a way writing on the pipe is installed on the side up and is readable from the top of the ditch.
2. Maximum pipe deflection shall be as recommended by the manufacturer.

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3. Wastewater services are to be marked with “S” stamped or cut in the curb.

G. Casing

When PVC wastewater pipe is installed in casing, skids must be used to prevent damage to the pipe and bell during installation. PVC pipe should not rest on the bells. Plastic spacers such as shall be used.

H. Material

All material incorporated in the construction shall be new.

2.2.6 Wastewater Main Sizing

- A. Although the Wastewater Master Plan may be used as a guide for sizing wastewater mains, sizing should be based on an engineering analysis of initial and future flow of the total drainage area to be served.
- B. Wastewater mains shall be sized to carry the ultimate peak flow at 100% of the full flow capacity of the pipe. Pipe capacity shall be calculated using Manning’s equation. A roughness coefficient of 0.013 shall be used.

2.2.7 Wastewater Service Laterals

The sizes and locations of laterals shall be designated as follows:

- A. Wastewater service laterals for single-family residential shall be a minimum of four inches (4”) in diameter. Laterals shall be installed ten feet (10’) downstream from the center of the lot and have a minimum distance of ten feet (10’) separation from the water service.
- B. Wastewater service laterals for multiple units, apartments, local retail and commercial developments shall be a minimum of six inches (6”) in diameter.
- C. Wastewater service laterals for manufacturing and industrial shall be a minimum of eight inches (8”).
- D. Manholes are required on six inches (6”) and larger wastewater service laterals where they connect to the main line.
- E. Wastewater service laterals shall not be attached to wastewater mains that are deeper than twelve feet (12’). Deep cut or drop connections are not to be permitted.
- F. Each building shall have only one wastewater service lateral with a clean-out on the owner’s side, except duplexes which shall have two wastewater service laterals independently attached to the main.
- G. All mains installed for future developments shall include wastewater service laterals; the use of cleanout boots will not be permitted.
- H. All wastewater service laterals crossing water mains shall conform to the requirements of the [TCEQ Chapter 217, Subchapter C, Rule 217.53\(d\), latest revision](#), or Section 2.2.3 of this standard.

2.2.8 Wastewater Service Clean-out

- A. For new development extend PVC clean-out above finished grade with plug.
- B. At the time of service connection the clean-out extension shall be adjusted and the lateral clean-out cover installed at the finished ground elevation.
- C. All fittings shall be solvent weld
- D. All fittings shall be PVC SDR 35 or schedule 40

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- E. Center line of clean-outs to be placed 6 inches inside city right-of-way line unless specified otherwise.
 - F. All new service laterals shall have clean-outs as per standard wastewater service connection.
 - G. Cleanouts for new construction shall be furnished and placed in areas with no vehicular traffic
 - H. Slope of lateral to be two percent (2%) minimum
 - I. The wastewater lateral shall be connected to building lateral and constructed in such a way as to clear existing and proposed utilities.
 - J. The mainline lateral connection to the private building lateral shall be as close to the property line as possible.
 - K. Install four inches (4") stopper or cap at property line if building lateral does not exist.

2.2.9 Manholes

- A. Manholes shall be installed at all changes in grade and direction, and have a maximum spacing of five hundred feet (500').
- B. Clean outs shall be provided on service laterals on the private side but shall not be provided at dead ends of sewer mains. Rather a manhole shall be located at the end of a wastewater main and the last two service lines shall be directed into the manhole.
- C. Manholes on curved wastewater mains shall be located at the point of curvature (P.C.) or point of tangent (P.T.) of the curve and have a maximum spacing of three hundred feet (300') along the curve.
- D. Only precast concrete manholes are approved for use. Cast in place manholes may be used with approval from the City Engineer.
- E. Concrete for all precast and cast in place shall have a biocide admixture (see approved material list) and be a minimum 6 sack 4000 p.s.i. sulfate resistant concrete.
- F. Manholes shall be concentric type conforming to ASTM C478 and C76 unless otherwise approved by the Director of Public works.
- G. Drop manholes shall be required when the inlet pipe flow line elevation is more than twenty four inches (24") above the outlet pipe flow line elevation. Drops shall be outside the manhole unless approved otherwise by the Director of Public works.
- H. Manholes shall be sized as follows:
 - Four feet (4') feet in diameter for eight, ten and twelve inches (8", 10", and 12") pipes.
 - Five feet (5') in diameter for fifteen, eighteen, twenty one, twenty four and twenty seven inches (15", 18", 21", 24" and 27") pipes.
 - Six feet (6') in diameter for thirty and thirty six inches (30" and 36") pipes.
 - Five feet (5') in diameter minimum for manholes deeper than fifteen feet (15').
- I. Where more than three manholes in sequence are to be bolted and sealed, every third manhole shall be vented two feet (2') above the 100-year floodplain elevation or ten feet (10') above the adjacent ground line, whichever is higher. The Engineer shall provide the elevation of the 100-year floodplain on the profile.
- J. Construct manholes within thirty feet (30') of each end of wastewater mains that are installed by other than open cut and within thirty feet (30') of each end of aerial crossings.
- K. Each manhole shall be furnished with an inflow and infiltration barrier apparatus (see approved material list) between the cone and support frame of the manhole system. The apparatus includes a

barrier, cap, and seal that restricts the inflow and infiltration of water or other debris into the interior of the manhole system.

- L. All manhole joints shall be sealed with an external rubber sleeve (see approved material list). The seal shall be made of a stretchable, self-shrinking, intra-curing halogenated based rubber with a minimum thickness of 30mils. The back side of each unit shall be coated with a cross-linked reinforced butyl adhesive. The butyl adhesive shall be non-hardening sealant with a minimum thickness of 30mils. The seal shall be designed to stretch around the joint and then overlapped creating a cross-link and fused bond between the rubber seal and butyl adhesive. This is to prevent water and soil from infiltrating through the manhole.
- M. Manhole walls shall be core drilled for sewer connections.
- N. All new manholes shall be marked with "MH" stamped or cut in the curb.
- O. Manholes shall not be located in parking spaces or areas with vehicular traffic.
- P. A manhole with pipes of different sizes must have the tops of the pipes at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe.
- Q. False manhole bottom shall be furnished and installed in all manholes constructed in advance of paving. These false manhole bottoms will be installed at a time directed by the City but will usually be after all work is completed on the wastewater system including the air test, but prior to the final inspection
- R. False manhole bottom shall be removed after the final appurtenance adjustment inspection, the paving contractor and city inspector will coordinate the removal of the false manhole bottoms.
- S. Manhole lids shall have pick slots only unless specified otherwise with city approval.
- T. Manholes in low points, undeveloped areas or near floodways shall be bolted down, gasketed, and water tight.

2.2.10 Manhole Abandonment

- A. Remove frame, lid and cone.
- B. Cut and plug all abandoned sewer mains at manhole.
- C. Fill bottom (twelve inches (12")) of manhole with 2000 psi concrete.
- D. Backfill and compact manhole cavity with sand and/or gravel.
- E. Repair surface to match existing as per city standards.

2.2.11 Inverted Siphons

The use of an inverted siphon to avoid obstructions along the alignment of the wastewater main requires approval by the City Engineer or designee. Should an inverted siphon be necessary the design shall include:

- A. Two or more barrels (pipes).
- B. A minimum pipe diameter of six inches (6").
- C. The necessary appurtenances for convenient flushing and maintenance.
- D. One upstream and one downstream manhole for cleaning equipment, inspection and flushing.
- E. The siphon must be sized with sufficient head to achieve velocity of at least three feet per second (3fps) at initial and design flows.
- F. The inlet and outlet shall divert the normal flow to one barrel.
- G. The system shall be designed to allow any barrel to be taken out of service for cleaning.
- H. The system shall be designed to minimize nuisance odors.

2.2.12 Wastewater Lift Stations

Lift stations are hydraulic structures that are designed to move wastewater from a lower elevation up to a higher one, so that it can be transported through municipal sewer lines for eventual processing and cleaning

at a treatment plant. Subdivisions shall be laid out so that all wastewater mains will be gravity flow. The use of a wastewater lift station must be approved by the City Engineer or designee and the Director of Public Works.

These lift station design guidelines are to be used in conjunction with the latest revision of the Texas Commission on Environmental Quality's (TCEQ) [TAC 30 Chapter 217, subchapter C rules](#). Where conflicts exist, the more stringent requirements will be used.

Preliminary Design Submittal

A preliminary design submittal will be required for each lift station proposed. The submittal shall include a typed report, plans and a basin map prepared by a registered professional engineer.

1. Report-The typed report shall include the following information at a minimum.

A brief summary of project scope that includes:

- General description of proposed development
- General explanation on circumstances that warrant a lift station including other options considered.
- Description of any potential phasing of lift station until sewer basin is built-out.
- Influent hydraulic calculations showing:
 - a. Area in acres of the sewer basin and the development.
 - b. The area of each proposed use for the development and the ultimate projected use for the basin.
 - c. The average design flow and the maximum peak flow for the basin and the development.
- Elevation of the proposed lift station site.
- The elevation of the proposed discharge point of the force main.
- Preliminary wet well volume calculations
- Preliminary force main size with proposed velocities in pipe.
- Power outage records on Electric provider letterhead for power outages in area for the past 24 months.
- Opinion of probable costs for lift station, force main, and annual operating and maintenance costs.
- Ground water levels in proposed site area.
- Proposed system's effect on existing system's capacity.
- Odor control methods shall be submitted to the Director of Engineering for review and approval. The potential odor determination must include the estimated flows immediately following construction and throughout a system's 50-year expected life cycle.

2. Plans- The plan or plans submitted shall contain the following information:

- Scale
- North arrow
- Vicinity map
- Delineation of the boundary of the proposed development and offsite areas of the sewer basin (service area) in which the development lies. Basin delineation shall

be provided using NCTCOG, LIDAR or surveyed contours. Contours shall be provided on 2 foot or less intervals. USGS topo is not permissible.

- Area in acres of the development and of the sewer basin contributing to the Lift Station.
- Proposed use or uses for the development and service area.
- The proposed lift station location.
- The proposed force main routing.
- Delineation of the 100-year Fully Developed flood plain, FEMA 100-year flood plain and Erosion Hazard setbacks.
- The location and size of the existing collection system at the tie-in point.
- Property lines.

- 3. Site Selection-** The following are the minimum criteria that shall be met for a lift station site. The station should be located as remotely as possible from populated areas. The lift station site shall not be located within one hundred and fifty feet (150') of an existing or proposed residential dwelling and one hundred feet (100') from a residential lot. The station shall be protected from the 100-year flood and shall be accessible during a 100-year flood. The elevation of the site shall be a minimum of two feet (2') above both the Fully Developed 100-year flood plain and FEMA 100-year flood plain. The station site and its access shall be dedicated to the City as a wastewater easement. The fencing set back shall be 20 feet from the easement line to allow for a landscape and drainage buffer. The station site shall be located so it may serve as much of the entire sewer drainage basin as possible. This may require that the station be located off-site of the development. When a station serves a larger area than the proposed development, the developer may enter into a pro-rata agreement with the City to be reimbursed the cost of excess capacity as other developments connect to the system.

4. Site Requirements

a. Access

Access will be provided by a concrete surface from a public street and/or dedicated access easement. Concrete shall be a minimum six inches (6") thick, 4,000 psi reinforced concrete pavement with a minimum of fifteen feet (15') in width and twenty feet (20') in length to allow maintenance vehicles to park fully outside of the City right-of-way designed in accordance with the City of Celina Street Design Standards. Access drives shall be "T" shaped with applicable turning radii when located on existing and future thoroughfares and all other locations where egress becomes a safety hazard. The alignment of the drive shall allow maintenance vehicles the ability to back up straight to the wet well. Access shall be functional during a 100-year flood. The access surface shall be a minimum of 2 feet above the water level caused by a 100-year return period storm.

5. Security

At a minimum, security of the lift station site shall be provided by an intruder-resistant fence (IRF) to restrict access by an unauthorized person(s). The IRF shall be placed around the perimeter of the site encompassing all interior structures and apparatuses and shall maintain a three-foot (3') clearance from all lift station components. The IRF shall be a minimum of eight feet (8') high brick fence with a sixteen foot (16') wide minimum slide gate for access.

6. Site Interior

- a. Site pavement shall be a minimum six inches (6") thick reinforced concrete pavement designed in accordance with The City of Celina's Street Design Standards. Site shall be graded to drain away from the station to prevent storm water inflow or infiltration into the wet well. The wet well top elevation shall be a minimum of six inches (6") higher than interior concrete to provide wheel stop for maintenance vehicles.
- b. Control panel shall have a three foot (3') minimum clear working area away from face of cabinet. Electrical and Instrumentation Panels shall be located where they do not obstruct vehicle access to the wet well or the dry well. They shall be placed at an elevation so that they are easily accessible.
- c. A fifteen foot (15') high halogen area light with photometric cell on an aluminum pole shall be placed within ten feet (10') of wet well and control panel without obstructing daily operations. Hoisting equipment shall be provided when the ultimate sized pump weight exceeds twenty five hundred (2,500 lbs.). Hoisting equipment shall be electric and capable of lifting selected pumps onto a fifty four inch (54") high truck bed or trailer with minimal manual assistance.
- d. One inch (1") potable freeze-proof water service with one inch (1") angle stop and double check valve shall be installed in an appropriately sized meter box.

2.2.13 Wet Well Design

Wet well shall be cast in place or pre-cast watertight and gas tight walls with watertight joint meeting ASTM C478-90. Steel, fiberglass, HDPE and RCP are not acceptable materials. The tops may be pre-cast with the hatches built in. All wall penetrations through the wet well wall shall be gas tight. The wet well shall be hydrostatically tested to the top of the wet well for 48 hours prior to putting the lift station into service. Only losses due to evaporation will be tolerated. Additional design requirements are as follows:

A. Orientation

Orientation shall consider the routing of incoming sewer and force main for ease of maintenance and to minimize effluent turbulence. Orientation shall allow a 5 ton vehicle to pull in forwards or backwards directly to the wet well or the dry well. All influent gravity lines discharging into the wet well shall be located so that the invert/flow line is above the "on" setting liquid level of the pumps. Lift stations with two or more wet wells shall include a sluice gate between each wet well.

B. Level Sensors

Liquid level sensors shall be level regulators switch. Sensors shall be provided for "All Pumps Off", "Lead Pump On", "Lag Pump On" and "High Level Alarm" levels as well as additional "Lag-Lag Pump On" for lift stations with more than two pumps. Level Sensors shall be placed in a stilling well.

C. Wet Well and Valve Vault Separation

Wet wells and valve vaults shall be separated by at least one foot (1') and have separate entrances.

D. Liner and Coatings

Wet wells shall have a minimum of 10% sloped bottoms to the pump intakes and shall have a smooth finish to avoid excess sludge deposits. Wet well interiors shall be coated with 2 coats of epoxoline. Application shall be per manufacturer recommendation. Wet well exteriors shall be coated with tar and its application shall also be by manufacturer's recommendation.

E. Hatches

The wet well shall have a lockable odor suppressing aluminum door with an aluminum frame and safety grate. The minimum opening size shall be 4 feet x 6 feet with 2 doors large enough to adequately maintain the wet well.

F. Ventilation

The design of a wet well must reduce odor potential in a populated area or as directed by the Director of a Public Works. Passive ventilation structures shall be provided and must include screening to prevent the entry of birds and insects to the wet well. An air vent pipe shall have a minimum diameter of four inches (4") with outlet located one foot (1') above wet well top. Continuous mechanical ventilation structures shall be provided with ventilation equipment providing a minimum capacity of 12 air exchanges per hour and be constructed of corrosion resistant material.

G. Wet Well Volume

Wet well volume for a submersible pump station is the volume contained above the top of the motor, or as specified by the pump manufacturer. High level alarm elevation shall be a minimum of sixty inches (60") below the top of the wet well or forty eight inches (48") below the flow line elevation of the lowest service tap, whichever elevation is lower. Wet well volume shall be calculated by the following method:

$$V = \frac{Q_p t}{4}$$

Where:

V = required capacity, gal

t = minimum time of one pumping cycle or time between successive starts or speed increases of a pump operating over the control range (min.)

Q_p = pump capacity, gpm

The pump capacity, Q_p is the largest pump in alternation. This capacity is to be the actual flow rate of one pump pumping alone against a system head generated with new pipe friction factors (C=150 for PVC and C=140 for Ductile Iron Pipe).

Pump cycle time, based on **Peak flow**, must equal or exceed the following:

<u>Pump Horsepower</u>	<u>Minimum Cycle Times (minutes)</u>
less than 50	6
50 – 100	10
Over 100	15

The operation cycle "t" shall not be less than 10 minutes minimum for Average flow and not more than 60 minutes for minimum flow conditions. The operation cycle time must exceed the manufacturer's requirements.

H. Valve Vault

Valve vaults shall have sloped bottoms towards a floor drain to remove liquid build up. The floor drain line from the valve vault connecting to the wet well must prevent gas and liquids from entering valve vault. The valve vault shall have a lockable aluminum door with an aluminum frame. The minimum opening size shall be 2 feet x 3 feet or large enough to adequately maintain the valve vault.

2.2.14 Pumps, Lift Station Piping and Valves

A. Pumps

Stations shall contain a minimum of two pumps and shall be capable of handling peak flows with one pump out of service. All pumps shall be explosion proof, non-clog, submersible type capable of passing a 2-1/2 inch diameter sphere or greater unless approved by the Director of Public Works. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point will be 60%. The minimum required horsepower for the motor must be capable of handling the entire range as shown in the pump curve. Where necessary, a higher horsepower pump will be required to prevent any damage to the motor as a result of loss of hydraulic head situation. All submersible pumps shall be equipped with an automatic flush valve attached to the pump volute using the hydraulic energy created by the pump operation to temporarily suspend settled materials. Each pump shall have two guide rails. For triplex pump stations, all three pumps are required to have swinging check valves, breakers, starters and floats for emergency situations.

B. Pump Capacity

The firm pumping capacity shall be greater than the peak flow for the entire drainage basin. If the drainage basin is significantly larger than the proposed development and it is not feasible to design for this flow, the firm capacity may be designed to handle a portion of the basin with the ability to expand for the ultimate basin capacity with approval from the Director of Engineering. The pump curves shall be selected so that during normal operating conditions the pumps will run near the best efficiency point. The curves shall not approach shut off head when the pumps are running together. System head curves, pump curves and head calculations shall be submitted. Calculations and pump curves at both minimum (all pumps off) and maximum (last normal operating pump on) static heads, and for a C value of both 100 and 140 must be provided for each pump and for the combination of pumps with modified pump curves. Head calculations shall be the sum of static head, friction head in force main and lift station piping, and fittings head. Flow calculations, system curves and head calculations shall be shown in the construction drawings as well as in a final design report. Final design report shall include all of the preliminary design submittal requirements with the exception of the replacement of final design information.

C. Lift Station Piping

Piping inside the lift station shall be PVC. All fittings shall be stainless steel.

D. Valves

Isolation valves, check valves and air release/vacuum valves shall be located in the valve vault.

1. Isolation Valves

Each pump shall have one isolation valve downstream of the pump and a check valve. Isolation valves shall be resilient wedge gate valves or plug valves meeting the City of Celina standard specification.

2. Check Valves

Check valves shall be a controlled closing swing check valve with a lever arm or a ball check. There must be at least fifteen feet (15') of vertical head downstream in order to use a ball check valve. Check valves shall be located upstream of the isolation valve. All external nuts and bolts shall be ASTM 316 stainless steel.

3. Air Release/Vacuum Valves

Air release valves of a type suitable for wastewater service shall be installed along the force main where the force main would be prone to trapped air. The type of valve shall be air release or a combination of air release and vacuum breaker. Valves shall be fitted with blow off valves, quick disconnect coupling and hose to permit back flushing after installation without dismantling the valve.

The engineer of record shall determine the valve type and location. The calculations for valve type and valve sizing shall be provided to the Director of Engineering. Isolation valves for three inch (3") and smaller air release valves shall be all bronze or brass. Isolation valves 4 inch and larger shall meet Celina standard specification for resilient wedge gate valve. Locations of the air release/vacuum valves shall be shown on the plan and profile sheets for the force main.

E. Force Main

1. Force main capacity shall be sized to meet the pump capacity. The force main may be designed to handle a portion of the basin with the ability to expand for the ultimate basin capacity with the approval from the Director of Engineering. The minimum force main size shall be four-inch (4") diameter. The minimum recommended velocity is 3 feet per second, and the velocity shall not be less than 2.5 feet per second when only the smallest pump is in operation. Force main sewer pipe shall be designed to meet the working pressure requirements of the particular application. Design calculations and pipe selection shall be submitted to the Director of Engineering.
2. Plug valves shall be installed every one thousand feet (1,000') of force main
3. The force main must terminate at a manhole with the top of the pipe matching the water level in the manhole at design flow. A force main must be designed to abate any anticipated odor.

Table 2.6: Pipe Materials

Internal Diameter Pipe Size	Pipe Material
4 inch through 12 inch	<ul style="list-style-type: none"> • PVC AWWA C900, minimum DR 18, minimum working pressure of 200 psi. • Ductile Iron AWWA C151 Pressure Class 350 (Lining shall consist of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified Fusabond Polyethylene and the exterior shall be polyethylene encased).
12 inch and larger	<ul style="list-style-type: none"> • PVC AWWA C900-16, minimum DR 18, 235 psi pressure class. • Ductile Iron AWWA C151 Pressure Class 350 (Lining shall consist of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified Fusabond Polyethylene and the exterior shall be polyethylene encased)

Note: For trench depths greater than 12 feet or other dead and/or live loading considerations, the engineer of record shall provide a pipe with the appropriate DR rating which shall exceed the minimum requirements. All fittings shall be stainless steel/brass. All valves and fittings shall be restrained. Joint material for PVC shall conform to ASTM F477.

Plans shall include plan and profile for the force main. Force main shall have a minimum of four feet (4") of cover and be laid to standard specifications in relation to potable waterline.

Force main separation and design criteria from water lines and all other utility lines shall meet the minimum requirements from TCEQ chapter 217 (Design Criteria for Sewerage Systems) and Chapter 290 (Rules and Regulations for Public Water Systems).

All force main contractors shall furnish and install metallic pipe detector tape. The detector tape must be located above and parallel to the force-main and bear the label “PRESSURIZED WASTEWATER” continuously repeated in at least 1-1/2 inch letters.

F. Embedment

The type of embedment for force mains less than 24 inches shall be as per the embedment detail; six inches (6”) of crushed rocks (3/4” diameter) below, eight inches (8”) of same material on the sides and six inches (6”) above. For cushioning, a minimum of twelve inches (12”) of the selected native material shall be used to backfill with twelve inches (12”) loose lifts and mechanically compacted with approved vibratory methods with a marking tape/ tracer tape installed on top of it. For pipe sizes twenty four inches (24”) and greater the embedment class (from NCTCOG embedment Classes) shall be a function of the pipe material selected including dead and live load considerations provided by the engineer of record. The engineer of record shall submit calculations on the embedment selected for the particular pipe type.

G. Electrical Requirements for New Lift Stations

1. Code Information

The engineer of record shall consult with the City of Celina Building Inspections Department for the latest NEC code requirements. Allow a minimum of 3 feet in front of all enclosures to wet well openings for workmen standing space. Observe NEC Article 110 rules for working clearances around the electrical panels.

2. Electrical Supply

Electrical services shall be 240 volt 3 phase or 480 volt 3 phase. Where a single-phase power transformer is required, install a minimum 3 KVA transformer, fused on both the primary and secondary side. Install a power phase monitor capable of protecting against phase loss, phase reversal, low voltage, and high voltage. Power phase monitor shall have 2 sets of control or alarm contacts. One set used to disable the pump control circuit. The second set used to alarm the RTU of a power failure. Install current transformer between the service disconnect and the rest of the electrical equipment to provide a means to monitor the complete station load. Terminate secondary leads on a terminal strip for connection to a future power usage monitor. Install potential transformer to provide a 120 volt secondary voltage on all 3 phases. Terminate the secondary leads on a terminal strip for connection to a future power usage monitor. All electrical power circuits to be protected by circuit breakers (versus fuses) where applicable. As a guide for single-phase circuits use; RTU 15 amp, Flow meter/record 15 amp, pump control circuit 15 amp, convenience outlet/flood light 20 amp.

3. Pumps

Thermal protection and moisture sending devices in submersible pumps are to be wired to disable pumps and/or control circuits. Hand position on H-O-A switch shall be provided and will be capable of operating pump in the event of a complete failure of the level controller. The required remote start/stop capability is to be provided by using RTU control module. Install interface relay between RTU contacts pump control circuit. RTU contact operating may be momentary action only.

Motor starters shall have a normally open auxiliary contact to be used for a pump run contact connected to the RTU. Where submersible pump cords are to be installed in conduits, the conduits should be sized and installed to facilitate removal and re-installation of the pump cords.

4. Level

Liquid level sensors shall be provided for “All Pumps Off”, “Lead Pump On”, “Lag Pump On” and “High Level Alarm” levels as well as additional “Lag-Lag Pump On” for lift stations with more than 2 pumps.

Mercury float switch is to be installed and wired as a low level emergency shut off in the event of a continuous pump run due to a level controller failure; pump control switch left in hand position, etc.

5. Site

Install a weatherproof 20 amp rated 120 volt convenience receptacle outside of the electrical control panel wired to a 20 amp circuit breaker. A switch-operated floodlight shall be installed to illuminate control panel area at night.

6. Generator

Install a manual transfer switch between electrical service and electrical equipment along with an emergency generator receptacle.

7. Controls

All control relays are to be octal 8 pin or 11 pin plug-in types where feasible. Three laminated control drawings are to be provided. All conduit between wet well and control panel shall be sealed airtight to prevent wet well gases from entering control panel. Enclosures shall be mounted on an appropriately sized mounting structure. Mounting structure shall be constructed of 6 inches x 2 inches x 0.25 inches hot dip galvanized steel channel stock. Intersections shall be bolted, not welded with stainless steel fasteners. Aluminum or epoxy coated steel unistrut may be attached to the mounting structure to facilitate placement of enclosures. The legs of the mounting structure shall be set at 24 inch minimum below grade and be encased in concrete.

Control panels shall have heaters and exhaust fans, CT for reading amperage, HOA switch, and an amp overload reset button on the outside of the panel.

8. Monitoring

A spare conduit shall be installed between the pump control panel and the RTU enclosure for power usage monitor wiring (1 inch minimum).

9. SCADA

The lift station shall be connected to the City’s Supervisory Control and Data Acquisition (SCADA) system. The Owner shall pay all costs associated with the SCADA including all labor, equipment, materials, and programming of the City’s computer and testing. The SCADA equipment installed shall conform to the City’s standard specifications for Computerized Monitoring and Control Specifications for Wastewater Lift Stations.

H. Emergency Provisions for Lift Stations

Minimum emergency provisions shall comply with TCEQ chapter 217.63 “Emergency Provisions for Lift Stations”.

2.2.15 Dumpster Enclosure Drains

- A. Dumpster enclosures serving commercial sites that will need to have the enclosure washed out shall provide a connection to the sanitary sewer system.
- B. Connection shall provide a water-tight sealed cover that can be removed to drain enclosure during periodic cleaning.

-
- C. Dumpster enclosure shall be constructed to prevent parking lot storm water runoff from entering enclosure area.

2.03 Reclaimed Water System

Reserved

2.04 Easements

- A. In single-family residential developments, water and wastewater mains shall not cross residential lots unless specifically approved by the City Engineer or designee, in which case the easement shall be located within a single lot and be a minimum of fifteen feet (15') in width.
- B. Water mains twenty four inches (24") and larger shall be located in an easement parallel and adjacent to the right-of-way.
- C. All easements required by the City shall be dedicated by plat if within the platted boundary. If outside the platted boundary, provide easement by separate instrument.
- D. Site paving, such as, parking, fire lanes and access drives are allowed over utility easements with an easement use agreement.
- E. The following minimum width exclusive utility easements are required when facilities are not located within public rights-of-way:
1. Water mains twelve inches (12") and smaller are to be located within the center of a minimum fifteen-foot (15') utility easement.
 2. Easement widths for water mains sixteen inches (16") and larger shall be a minimum of twenty feet (20') subject to the approval of the City Engineer or designee.
 3. Wastewater mains with a depth up to ten feet (10') are to be located in the center of a fifteen-foot (15') utility easement.
 4. Wastewater mains with a depth between ten and twenty feet (10' and 20') are to be located in the center of a twenty-foot (20') utility easement.
 5. Wastewater mains with a depth greater than twenty feet (20') are to be located in the center of a thirty-foot (30') utility easement.
- F. Fire hydrants and automatic flushing valve located outside of public rights-of-way shall be located within a ten by ten feet (10' x 10') utility easement.
- G. Two inches (2") and smaller meters serving multi-family residential and non-residential developments shall be located within the right-of-way or in a minimum five by five feet (5' x 5') utility easement or in the right-of-way.
- H. Three inches (3") and larger meters shall be located within a minimum ten by ten feet (10' x 10') utility easement outside the right-of-way.
- I. All water main appurtenances such as air release valves with vents must be contained within utility easements with a minimum three feet (3') clearance from the edge of the easement.

2.05 Thrust Restraint

- A. All pressurized water and wastewater mains shall be restrained against thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.
- B. Thrust restraint shall be accomplished by concrete thrust blocks and restrained joints
- C. All valves, fittings and changes in elevation shall have concrete thrust blocks and restrained joints installed.

-
- D. Thrust blocking shall be Class “B” concrete and sulfate resistant. It shall be able to withstand a minimum 200 psi test pressure with a minimum safety factor of 1.5 without exceeding the soil bearing capacity.
 - E. Restrained joints lengths shall be calculated to withstand a minimum 200 psi test pressure with a minimum factor of safety of 2.0.
 - F. All calculations are based on internal pressure of 200 psi for ductile iron and P.V.C
 - G. Volumes of thrust blocks are net volumes of concrete to be furnished. The corresponding weight of the concrete is equal to or greater than the vertical components of the thrust on the vertical bend.
 - H. Pour concrete for block against undisturbed earth
 - I. Dimensions may be varied as required by field conditions where and as directed by the Engineer.
 - J. The soil bearing pressure are based on 1000 lbs/s.f in soil and 2000 lbs./s.f in rock.
 - K. Use polyethylene wrap or equal between concrete and bend, tee or plug to prevent the concrete from sticking to it.
 - L. For standard fittings, concrete shall not extend beyond joints.
 - M. The following technical references are available for calculating thrust restraint systems:
 1. AWWA Manual M9: Concrete Pressure Pipe by AWWA, Latest Edition.
 2. AWWA Manual M11: Steel Pipe – A Guide for Design and Installation by AWWA, Latest Edition.
 3. AWWA Manual M23: PVC Pipe – Design and Installation by AWWA, Latest Edition.
 4. Thrust Restraint for Ductile Iron Pipe by Ductile Iron Pipe Research Association (DIPRA), 2006, or Latest Edition.
 5. Thrust Blocking, [National Fire Protection Association Standard 24](#), Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2007 Edition

2.06 Pavement Cut and Repair

- A. Water and wastewater main improvements shall be designed to minimize the impact to existing pavement, where feasible.
- B. No pavement shall be cut unless approved in writing by the Director of Public Works. Existing pavement cut, excavation and repair shall be in accordance with NCTCOG Item 402 and NCTCOG Standard Drawings 3070A through 3070D.
- C. Full panel concrete pavement replacement will be required if pavement must be cut.

2.07 Trenchless Construction

- A. Launching and receiving pits for trenchless construction shall be a minimum of five feet (5’) from the edge of pavement.
- B. The location, size and depth of the launching and receiving pits for trenchless construction shall be evaluated during construction plan review.
- C. Approved Methods
 1. Horizontal Boring - Horizontal boring shall require a steel casing pipe with minimum yield strength of 35,000 psi and minimum wall thickness of a quarter of an inch (1/4”). Actual wall thickness shall be designed based on a highway loading of HS-20, a maximum deflection of 5% and a minimum factor of safety of 2.0.
 2. Pipe Jacking - Pipe shall be designed to withstand all jacking forces with a factor of safety of 2.0 during construction.
 3. Tunneling

2.08 Crossings

A. Highway Crossings

1. The design of water and wastewater mains within a state highway must be in compliance with all applicable requirements of the Texas Department of Transportation (TxDOT), unless a variance is approved by TxDOT. The following reference applies: Title 43 of the Texas Administrative Code, Part 1, Chapter 21, Subchapter C – Utilities Accommodation
2. Water and wastewater mains shall be located so as to avoid or minimize the impact to future highway projects and improvements, to allow other utilities in the right-of-way, and to permit access to water and wastewater mains and other utility facilities for their maintenance with minimum interference to highway traffic
3. New water and wastewater mains crossing a highway shall be installed at approximately 90° to the centerline of the highway,
4. New water and wastewater mains located longitudinally along a highway shall be designed parallel to the right-of-way.
5. All water and wastewater crossings shall be encased with steel casing pipe in accordance with Section 2.07C (1) Horizontal Boring, or approved equal. Casing pipe shall be extended to the right-of-way line
6. Water valves, manholes and other appurtenances shall not be placed in the pavement or shoulder of highway.
7. Water main crossings shall include a valve on each side of the highway crossing.
8. Individual service meters shall be placed outside the limits of the right-of-way.

B. Railroad Crossings

1. The design of water and wastewater mains within railroad right-of-way must be in compliance with the requirements of the appropriate railroad authority. The designer should determine which railroad company right-of-way is being crossed and obtain their utility accommodation policies prior to beginning the design. The following references may be applicable:
 - a. [Utility Accommodation Policy by Burlington Northern Santa Fe \(BNSF\), Latest Edition.](#)
 - b. American Railway Engineering & Maintenance Association (AREMA), Latest Edition.
2. New water and wastewater mains crossing a railroad shall be installed at approximately 90° to the centerline of the railroad.
3. New water and wastewater mains located longitudinally along a railroad shall be designed parallel to the right-of-way. No main shall be located closer than twenty five feet (25') from the centerline of the track.
4. All water and wastewater crossings shall be encased with steel casing pipe in accordance with Section 2.07C (1) Horizontal Boring, or approved equal. Casing pipe crossing railroad tracks shall be designed to withstand E80 railroad loadings and shall extend to the right-of-way lines.
5. Water valves, manholes, meters and other appurtenances shall be placed outside the limits of the right-of-way.
6. Water main crossings shall include a valve on each side of the railroad crossing.

C. Creek Crossings

1. All water and wastewater mains crossing under a flowing stream or semi-permanent body of water such as a marsh or pond shall be encased with concrete or steel casing pipe in accordance with Section 2.07C(1) Horizontal Boring, or approved equal.
2. Wastewater main crossings shall include a manhole on each side of the creek crossing beyond the top of creek bank.
3. Water main crossings shall include a valve beyond the top of creek bank on each side.
4. Water mains installed under and across creeks or ditches shall be designed according to the following:
 - a. Water mains with less than 4' of cover shall be protected by Class PC concrete encasement a minimum of ten feet (10') past the top of the embankment on each side.
 - b. Trench backfill under creeks and ditches shall consist of flow-able backfill in accordance with NCTCOG Item 504.2.3.4.
 - c. Rock bottom creeks and ditches shall include a six-inch (6") concrete cap at the surface in accordance with NCTCOG Item 504.5.2.14.
 - d. Bank stabilization shall be required at all crossings and shall consist of a pervious armored surface to resist scour and shear forces on all disturbed areas.

D. Elevated Crossings

Elevated crossings for water and wastewater mains should be avoided.

2.09 Corrosion Protection

- A. Corrosion protection should be considered on all metal water and wastewater mains.
- B. Corrosion investigation of metal pipeline sites shall include

Conditions Requiring Corrosion Protection System

Soil Characteristics	Conditions Requiring Corrosion Protection System
Chloride	>500
Sulfate	>2,000
Soil pH	≤ 5.5 or >8.5
Soil/Water Resistivity	<2,000 ohm-

- C. External and internal protective coating shall be required.
- D. To prevent galvanic corrosion for all metal pipes, provide isolating joints by using insulating kits or other means in the following locations:
 1. Changes in pipeline materials
 2. Connections to existing piping, i.e. old and new piping, including taps
 3. Laterals from transmission mains
 4. Valve to metal pipe
 5. Metallic casing spacer to RCCP, PCCP, DI or Steel pipe
- E. All metal pipes that are sixteen inches (16") and larger shall be designed to be electrically continuous through joint bonding wires, or welded joints and shall install corrosion test stations at a maximum spacing of one thousand feet (1,000').

-
- F. All water and wastewater mains requiring a corrosion protection system shall be designed by a NACE certified professional engineer.

2.10 Pipe Bollard

- A. Bollards shall be used where curbs are not possible or as specified by the city.
- B. Guard posts shall be six linear feet (6') of six inches (6") diameter steel pipe (3 feet above and below ground level). Post shall be encased in sixteen inches (16") diameter concrete pier to a depth of twelve inches (12") below post bottom. Reinforced concrete pier with two #6 bars (12 inches long) through post into pier. Post above ground shall be painted safety yellow.

SECTION 3 – DRAINAGE DESIGN REQUIREMENTS

3.01 General

- A. This section contains the minimum storm drainage design criteria to be followed in the design of storm drainage facilities and demonstrates the design procedures to be used on drainage projects in the City of Celina.
- B. The design factors, formulas, graphs and procedures described are intended to serve as guidelines. Responsibility for the actual design remains with the Engineer. Deviation from the requirements of these standards shall be approved by the City Engineer or designee.
- C. It is the responsibility of the Engineer to provide all necessary calculations and designs described herein. The Engineer shall provide the City with the data, calculations, and designs necessary to demonstrate the design does not adversely impact the surrounding or downstream property and meet local, state, and federal rules, regulations, and requirements.
- D. The Engineer shall use the city's base models for development along floodplain areas. If a model is not available, the Engineer shall be required to provide a floodplain model in accordance with city standards and guidelines.

3.02 Determining Design Discharge

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

- A. Rational Formula (Drainage Areas < 200 acres)

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

$$Q = C * I * A$$

Q = runoff rate (cfs)

C = runoff coefficient (dimensionless)

I = rainfall intensity (in/hr.)

A = drainage area (ac)

- B. Runoff Coefficient (C)

1. Runoff coefficients shall be based on the future land use plan, which is included in the City's Comprehensive Plan. Runoff coefficients reflecting other conditions may be used based on the guidelines set forth in Section 3.02.F.
2. Table 3.1 provides guidelines for runoff coefficients for typical land use within the city; however, a weighted runoff coefficient may be used for the design if it is more representative of the site conditions.
3. A lower runoff coefficient may be used if sustainable elements are included in the design. The Engineer shall notify Engineering Services of the design intent and provide the necessary data, calculations and design to support the desired runoff coefficient. All sustainable designs are subject to approval by Engineering Services (refer to Section 3.18 for sustainable design options).

Table 3.1 Runoff Coefficients and Inlet Time Guidelines

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

C. Time of Concentration (Tc)

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

1. Sheet Flow: The maximum allowable length for sheet flow is three hundred feet (300') for undeveloped drainage areas and one hundred feet (100') for developed areas. When selecting the Manning's roughness coefficient (n) for sheet flow, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow. The travel time (Tt) in minutes for sheet flow is determined using the following equation:

$$T_t = \frac{0.07(nL)^{0.8}}{(P_2)^{0.5}(S)^{0.4}}$$

Tt = travel time (hr.)

n = Manning's roughness coefficient (Table 3.2)

L = flow length (ft.)

P2 = 2-year, 24-hour rainfall, 3.6in

S = slope of hydraulic grade line (land slope, ft/ft)

Table 3.2 Sheet Flow 'n' Values

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

2. Shallow Concentrated Flow

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

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

T_t = travel time (hr)

L = flow length (ft.)

V = velocity (fps)

Unpaved = 16.1345*(S)^{0.5}

Paved = 20.3282*(S)^{0.5}

3. Open Channel Flow

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

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

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

T_t = travel time (hr)

V = average velocity (ft/s)

r = hydraulic radius (ft.)

A = cross sectional flow (ft²)

P = wetted perimeter (ft.)

s = slope of the hydraulic grade line (channel slope, ft/ft)

n = Manning's roughness coefficient

The Engineer shall compare the calculated time to the time listed in Table 3.1. If the calculated time of concentration (T_c) differs from the value in Table 3.1, the Engineer shall provide information to justify the time of concentration (T_c) calculations.

D. Rainfall Intensity (I)

The rainfall intensity (I), shall be based on the National Weather Service Rainfall Frequency Data presented in Technical Memorandum NWS Hydro-35, dated June 1977 (2 to 100 year) and U.S. Geologic Survey Frequency Data presented in Water Resources Investigations Report 98-4044, dated 1998 (500 year). The intensity for a particular duration can be obtained using the coefficients from Table 3.3. If the calculated inlet time differs from the value in Table 3.1, the Engineer shall provide information to justify the inlet time calculations. The equation used to determine the intensity values for various storm events and durations is provided below.

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

Refer to Table 3.3 values for b, d, and e.

Table 3.3 Intensity Coefficient Table

	2-year	5-year	25 year	100- year
b	81.319	82.686	106.665	112.783
d	15.788	15.497	18.069	17.572
e	0.864	0.820	0.806	0.771

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

1. The use of a unit hydrograph method shall be based upon standard and accepted engineering principles normally used in the profession subjected to the approval of Engineering Services. Acceptable methods include the Soil Conservation Services (SCS) Technical Release Number 55 (TR-55) for drainage areas 200 acres to 2,000 acres and SCS's Technical Release Number 20 (TR-20), or the United States Army Corps of Engineers HEC-HMS models for drainage areas 200 acres or more.
2. The post development unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from upstream or on-site detention facilities, unless the requirements set forth in Section 3.03.b are met, or as directed by Engineering Services. The Engineer should discuss the approach method with Engineering Services prior to design.
3. Circumstances that may require the use of a unit hydrograph method include open channels, reclaiming floodplains, creating lakes, regional detention/retention facilities or building other types of drainage related facilities on major drainage courses. The city requires fully developed watershed conditions be used for all modeling. Federal Emergency Management Agency's (FEMA) flows shall not be used as the flows are generally based upon existing watershed conditions.
4. Coincident peak flows can also be considered using Table 3.4.

Table 3.4: Frequencies for Coincidental Occurrences

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

5. Modeling Requirements

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

- a. 24-hour storm duration using a SCS Type II distribution.
- b. Rainfall values calculated using coefficients provided in Table 3.3.
- c. The SCS Curve Number (CN) method shall be used to determine the loss rate. CN values shall be taken from TR-55.
- d. Tc values shall be calculated as shown in Section 3.02.C.
- e. Muskingum Cunge method shall be used for routing of the Unit Hydrograph through the drainage system. Engineering Services may request for other routing methods, such as the

Modified Puls Routing Method to be used in the design if the method is more characteristic of the hydrologic and hydraulic conditions of the watershed.

F. Runoff from Off-Site Developments

a. Off-site Flows for Developed Upstream Watershed

The Engineer may take the effects of upstream detention into account if the hydrologic and hydraulic information for the existing upstream ponds are shown on the construction plans and the information can be verified by record drawings or a record survey. An emergency overflow path between the existing detention ponds and the proposed site shall be identified and clearly indicated on the construction plans. The Engineer shall confirm the hydrologic and hydraulic effects of upstream facilities in accordance with Section 3.09.

b. Off-site Flows for Undeveloped Upstream Watershed

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

3.03 Downstream Assessment

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

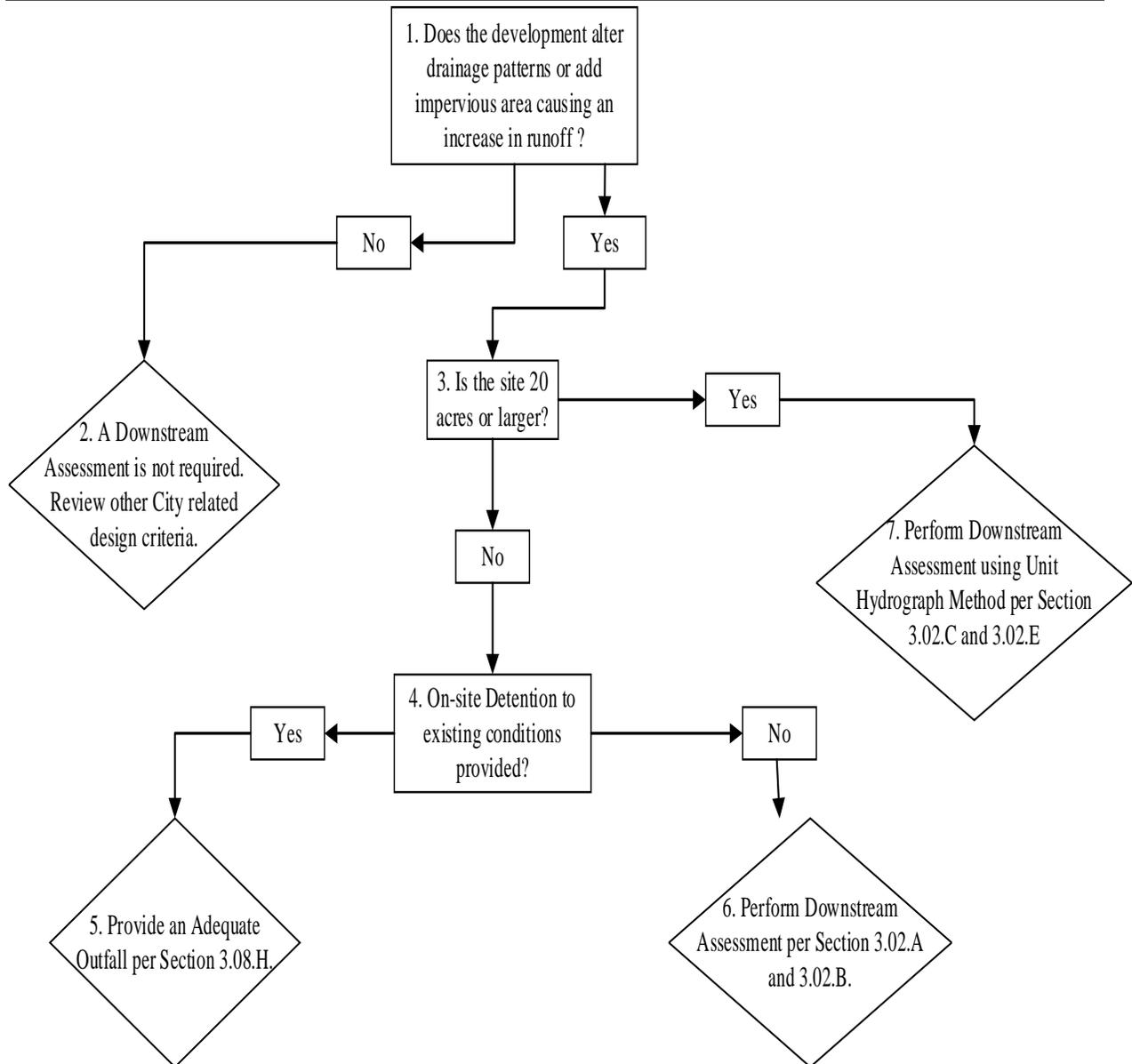


Figure 3.1: Downstream Assessment Flow Chart

Downstream Assessments shall be prepared and submitted to the City with the construction plans. The study shall demonstrate that the development will produce no adverse impacts. No adverse impacts may include, but are not limited to:

- a. No new or increased flooding of existing insurable (FEMA) structures (habitable buildings).
- b. No increases in water surface elevations for the 2, 5, 25, and 100 year storm events unless contained in existing channel (with freeboard), roadway, drainage easement and ROW. Dry lane and gutter capacity requirements set forth in Section 3.04.A shall also be met.
- c. Post-development channel velocities shall not be increased by more than five percent (5%) above predevelopment velocities. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion.

- d. No increases in downstream discharges caused by the proposed development that, in combination with existing discharges, exceeds the existing capacity of the downstream storm drainage system.
- e. The Downstream Assessment shall extend to a point downstream where the proposed development creates no adverse impacts. The downstream point is known as the Zone of Influence. The Engineer shall determine how far downstream the analysis for the Downstream Assessment shall extend. For properties less than 20 acres, the Downstream Assessment may use the ten percent (10%) rule to determine the Zone of Influence. For all other properties, the Zone of Influence will be defined by a detailed hydrologic and hydraulic modeling analysis.
- f. The ten percent (10%) rule states the Zone of Influence can be considered to be the point where the drainage area controlled by the drainage facility comprises ten percent (10%) of the total drainage area. As an example, if a structural control drains 10 acres, the Zone of Influence ends at a point where the total drainage area is at least 100 acres.
- g. If a portion of a larger property is being developed, the Zone of Influence shall be determined based on the entire property.

3.04 Street Capacity

A. Straight Crown Streets:

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

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

Q = Gutter flow (cfs)

n = Manning's roughness coefficient, (0.0175 for concrete street)

A = Cross section flow area (ft²)

R = Hydraulic radius of the conduit in feet, which is the area of the flow divided by the wetted perimeter (R=A/P)

P = Wetted perimeter (ft.)

S = Slope of the hydraulic gradient (ft/ft)

2. The City requires a minimum of nine feet (9') of pavement in each direction during the 100-year event for Type 6LD and 4LD thoroughfares.
3. The dry lane criteria shall be met in both the interim and future conditions.

B. Parabolic Crown Streets

1. All parabolic crown street capacities shall be hydraulically designed using Manning's equation.
2. During a 100 year storm event, the gutter depth on Type 2LC, 2LCB, 2L, 2LN and 2LRN thoroughfares are required by the City not to exceed six inches (6") or top of curb, whichever is less.
3. During a 100-year storm event, the City requires a minimum of nine feet (9') of pavement in each direction for Type 2LC and 2LCB thoroughfares.

3.05 Alley Capacity

- A. All alley capacities shall be hydraulically designed using Manning's equation.
- B. The 100 year storm event shall be contained within the edge of pavement.
- C. In residential areas where the standard alley section capacity is exceeded, storm sewer systems with inlets shall be provided.
- D. Grate combination inlets shall be located in alleys upstream from an intersection and where necessary to prevent water from entering intersections in amounts exceeding allowed street capacity.

3.06 Valley Gutters

- A. The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:
1. Valley gutters shall not cross Type 6LD, 4LD, 2LC, and 2LCB thoroughfares.
 2. At any intersection, valley gutters perpendicular to the main street will not be permitted; and valley gutters parallel to the main street may only cross a lower classified street.

3.07 Inlet Location and Capacity

A. Gutter Flow

Curb inlets shall be placed to ensure that the 100 year flow in a street does not exceed the dry lane requirements for straight crown streets and top-of-curb elevation for parabolic crown streets as per Sections 3.04. The following form of the Manning's equation should be used to evaluate gutter flow hydraulics:

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

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

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

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

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

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

B. Capacity of Curb Inlet on Grade

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

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

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

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

$$S_e = S_x + \frac{a}{W} E_o$$

S_e = Equivalent cross slope (ft/ft)

S_x = Roadway cross slope (ft/ft)

a = Gutter Depression Depth (ft.)

W = Width of depressed gutter section (ft.)

E_o = Ratio of flow in the depressed gutter to the total flow

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

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

L_T = Required length of inlet (ft.)

Q = Total flow in the roadway (cfs)

S = Roadway longitudinal slope (ft/ft)

n = Manning's roughness coefficient

S_e = Equivalent cross slope (ft/ft)

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

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

E = Inlet efficiency

L = Length of the curb inlet opening (ft.)

L_T = Required length of inlet to capture 100% of the roadway flow (ft.)

The total flow captured by the curb inlet is:

$$Q_i = EQ$$

Q_i = Flow capture by inlet (cfs)

E = Inlet efficiency

Q = Total flow in the roadway (cfs)

C. Capacity of Curb Inlets in Sag

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

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

$$Q = C_w(L + 1.8w)d^{1.5}$$

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

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

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

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

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

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

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

Q = total flow reaching inlet (cfs)
 C_o = orifice coefficient = 0.70
 h = depth of opening (ft.) (this depth will vary slightly with the inlet detail used)
 L = length of curb opening inlet (ft.)
 g = acceleration due to gravity = 32.2 ft/s²
 d_e = effective head at the centroid of the orifice (ft.) d_e = d - h/2

Rearranging equation allows a direct solution for required length:

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

4. If both steps 1 and 2 were performed (i.e., h<d≤1.4h), choose the larger of the two computed lengths as being the required length.
 5. Select a standard inlet length that is greater than the required length.

D. Capacity of Wye Inlets

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

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

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

E. Curb Inlet Placement

1. Placing several curb inlets at a single location is only permitted in areas with steep grades (4% or greater) to prevent flooding and avoid exceeding street capacity in flatter reaches downstream.
2. No more than twenty feet (20') of inlet shall be constructed at one location along one curb line.
3. Curb inlets shall be placed upstream from right angle turns and street intersections.
4. An emergency overflow path shall be provided on the plans for sag locations. An emergency overflow path is the path the storm water will take if the drainage facility becomes clogged or ceases to function as designed. The emergency overflow path must be located within public right-of-way or within a drainage easement.
5. Curb inlet depth shall not be less than four and half feet (4.5') from top of curb for all public improvements.
6. Inlets are required at the low point of a super elevation to prevent flow across the roadway.
7. Multiple sag inlets shall be located no closer than three hundred feet (300').



Microsoft Excel
Worksheet

[FIGURE 3.2: Inlet Spreadsheet \(http://www.celina.tx.gov/DocumentCenter/View/1294\)](http://www.celina.tx.gov/DocumentCenter/View/1294)

F. The Inlet capacity calculation Spreadsheet provided in Figure 3.2 shall be provided with the construction plans for review by the City. A description of each of the columns shown in the inlet spreadsheet is provided below:

- Column 1: Design Point for Inlet
- Column 2: Inlet number
- Column 3: Location of inlet by storm drain station number
- Column 4: Drainage area designation for incremental area
- Column 5: Drainage area size (acres)
- Column 6: Runoff coefficient (C)
- Column 7: Time of concentration (minutes)
- Column 8: 100-year intensity (in/hr)
- Column 9: 100-year runoff, $Q=CIA$ (cfs)
- Column 10: 100-year carryover flow from upstream inlet (cfs)
- Column 11: 100-year total gutter flow (Column 9 + Column 10) (cfs)
- Column 12: Percentage of flow traveling from lower station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- Column 13: Percentage of flow traveling from higher station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- Column 14: 100-year total gutter flow reaching the lower station side of the sag in (Column 11 times Column 12) (cfs)
- Column 15: 100-year total gutter flow reaching the higher station side of the sag inlet (Column 11 times Column 13) (cfs)

- Column 16: Longitudinal slope of the approach gutter. For sag inlets, half the longitudinal slope of the approach gutter on the lower station side of the inlet (S0) (ft/ft)
- Column 17: Not used for on-grade inlets. For sag inlets, half the longitudinal slope of the approach gutter on the higher station side of the inlet (S0) (ft/ft)
- Column 18: Street crown section type (straight crown [“rooftop”] or parabolic)
- Column 19: Roadway cross slope “Sx” (%)
- Column 20: Manning’s roughness coefficient (n) for pavement (0.0175 for concrete pavement)
- Column 21: Street capacity based on Manning’s equation. For sag inlets calculate the street capacity for both the lower and higher station sides of the inlet and use the greater of the two(cfs)
- Column 22: Total right-of-way capacity as a function of the cross-sectional area of the right of- way at the inlet. For sag inlets, the total right of way capacity on the lower station side of the inlet. (cfs)
- Column 23: Not used for on-grade inlets. For sag inlets, the total right of way capacity on the higher station side of the inlet. (cfs)
- Column 24: Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the lower station side of the inlet. (ft.)
- Column 25: Not used for on-grade inlets. Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the higher station side of the inlet. (ft.)
- Column 26: Spread of water (T) or width of ponding in the gutter measured from the face of curb. Column 19 times column 24, or the distance from the gutter to the crown, if the crown height is exceeded. For sag inlets, the spread of flow on the lower station side of the inlet. (ft.)
- Column 27: Not used for on-grade inlets. Spread of water (T) or width of ponding in the gutter measured from the face of curb. Column 19 times column 25, or the distance from the gutter to the crown, if the crown height is exceeded. For sag inlets, the spread of flow on the higher station side of the inlet. (ft.)
- Column 28: Gutter cross slope (Sw) (%)
- Column 29: Width of depressed gutter section (ft.)
- Column 30: 100-year ratio of flow in the depressed gutter to the total flow (E0)
- Column 31: Gutter depression depth (a) (ft.)
- Column 32: Equivalent cross slope (Se) (%)
- Column 33: 100-year inlet length required to capture 100% of the gutter flow (LT) (ft.)
- Column 34: Actual length (L) in feet of inlet which is to be provided (10’, 15’ or 20’). For wye inlets the length provided is equal to the perimeter of the opening intercepting flow. The length for wye inlets may be less than the total perimeter if the wye is not located in a sag location.
- Column 35: Efficiency of a curb inlet where the length provided is shorter than the length required. (E)
- Column 36: Discharge (Q) in cubic feet per second which the inlet in question actually intercepts
- Column 37: Discharge capacity of the inlet (Q) (cfs)
- Column 38: Carryover flow (q) is the amount of water which passes the inlet in a 100-year storm. A substantial portion of the 100-year flow should be picked up by the inlet. The carry-over flow should be accounted for in further downstream inlets and should be

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

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

G. Recessed / standard curb inlet

1. Recessed curb inlets shall be installed on major thoroughfares and standard curb inlets on residential thoroughfares unless approved otherwise by the City.
2. Top of inlet to slope two percent (2%) towards street or per plan
3. Center support beam required for fifteen feet (15') and twenty feet (20') recessed and standard curb inlets.
4. Additional reinforcing steel to be placed around manhole opening.
5. All concrete shall be class A
6. All reinforcing steel shall be new billet steel conforming to ASTM A-615
7. Chamfer all exposed corners three quarters of an inch (3/4") except where otherwise noted.
8. Dimensions relating to reinforcing steel are to centers of bars
9. Field cut and bend bars are necessary to accommodate storm sewer pipe
10. All reinforcing steel shall have a minimum cover of two inches (2")
11. Rock foundation shall be used during prefabricated inlet box installation. Six inches (6") for backfill with flowable fill to fill voids or compact with select surplus excavation compacted in eight inches (8") lifts to 95% standard proctor density.
12. Standard curb inlet sizes shall be ten feet (10')
13. Grate inlets are not allowed unless approved otherwise by the City.

H. Curb inlet manhole

1. Manhole shall be placed at the low end of the inlet.
2. Two manholes are required on fifteen feet (15') and twenty feet (20') inlets only if the inside height of the inlets is less than four feet (4').

I. Drop inlet

1. Reinforcing steel shall be #4 bars on eighteen inches (18") centers both ways for bottom slab. Additional reinforcing steel shall be placed around manholes as shown in details.
2. All reinforcing steel shall be grade 60
3. All concrete shall be class "A" 4000 psi at 28 days
4. All exposed corners shall be chamfered three quarters of an inch (3/4")
5. All reinforcing steel shall have a minimum cover of two inches (2") on inside face wall.
6. All backfilling shall be performed by mechanical tamping to ninety five percent (95%) standard proctor density.
7. All drop inlets shall have one opening on each side unless otherwise shown on plans
8. Light broom finish on all surfaces.

J. Curbed flume

1. If flume is seven feet (7') or wider, install seven feet by six inches (7' x 6") diameter steel bollards (filled with concrete) buried to four feet (4') depth at both start and end of flume.
2. Slopes shall be stabilized with vegetation or other approved methods.

K. Storm drain manholes

1. All manholes shall be poured in place. Precast junction boxes or manholes are not allowed unless shop drawings are pre-approved by the city engineer.
2. Concrete shall be made with a minimum of 5 1/2 sacks of cement and have a minimum compressive strength of 4,000 psi at 28 days.
3. All reinforcing steel shall be new, neat, billet-steel per ASTM designation A-615, grade 60, and shall be detailed and placed per ACI manuals SP-88 and 318, latest additions. All reinforcing steel shall have minimum fifteen-inch (15") lap splices, unless noted otherwise on the plans.
4. Light broom finish required on all exposed manhole tops.

5. Stacked manhole extension shall be installed, where specified on the plans.
6. Soil testing technician must provide written proof of eighteen to twenty four (18 - 24) months of related field experience.
7. Prefabricated round manholes shall conform to ASTM C478 specifications.
8. Prefabricated square manholes shall conform TO ASTM C890 and ASTM C913 specifications.
9. All material incorporated in the construction shall be new.
10. Contractor shall contact the streets department for the removal of city signs in right-of-way.
11. Manhole cover and frame shall be selected from approved material list.

3.08 Design of Enclosed Storm Sewer System

A. Design Flow

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

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

Q = Runoff rate (cfs)

A = Cross sectional area of the conduit (ft²)

n = Manning's roughness coefficient (0.013 for concrete)

R = Hydraulic radius (ft.) (Area of conduit divided by wetted perimeter (R=A/P))

S = Slope of the hydraulic gradient (ft/ft)

B. Hydraulic Gradient

1. The City requires that all hydraulic gradient calculations begin at the outfall of the system.
2. The starting hydraulic grade line (HGL) shall be based upon the results of the Downstream Assessment per Section 3.03.b if a downstream assessment is conducted. The results of the Downstream Assessment will provide the Engineer with the capacity and resulting design storm of the downstream facilities.
3. The starting HGL at an outfall into a creek or channel shall be the 100-year fully developed water surface unless an approved flood hydrograph is available to provide a coincident flow elevation for the system's peak.
4. When a proposed storm sewer is to connect to an undersized existing storm sewer system, calculation of the hydraulic gradient for the proposed storm sewer shall start at the outfall of the existing storm sewer system.

C. Hydraulic Design

1. The hydraulic grade line (HGL) must be calculated for all storm drain mains and laterals using appropriate head loss equations. In all cases, the storm drain HGL must remain below lime treated subgrade and must be at least one foot (1') below top of curb at each inlet.
2. In partial flow conditions, the HGL represents the actual water surface within the pipe. The velocity of the flow should be calculated based on actual area of flow, not the full flow area of the pipe or box.
3. Unless partial flow conditions exist, the beginning hydraulic gradient shall begin at either the top of pipe or at the hydraulic gradient of the receiving stream at the coincident frequency, whichever is higher.

D. Lateral Design

1. The HGL shall be calculated for all proposed laterals and inlets, and for the existing laterals being connected into a proposed drainage system.
 2. Laterals shall intersect the storm drain at standard angles.
- E. Velocity Head Losses (HL)
1. Adjustments are made in the HGL whenever the velocity in the main changes due to conduit size changes or discharge changes. Laterals in partial flow must be designed appropriately and the partial flow velocity shall be used in the calculations.
 2. In determining the HGL for the lateral, begin with the hydraulic grade of the trunk line at the junction plus the H_L due to the velocity change. Where the lateral is in full flow, the hydraulic grade is projected along the friction slope calculated using Manning's Equation.
 3. H_L losses or gains for wyes, pipe size changes, and other velocity changes will be calculated by the following formulas:

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

HL = Head loss or gain (ft.)
 V1 = Upstream velocity (fps)
 V2 = Downstream velocity (fps)
 g = Gravity constant (32.2 ft/s²)

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

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

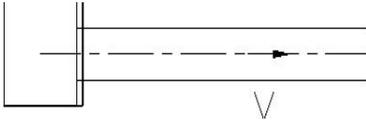
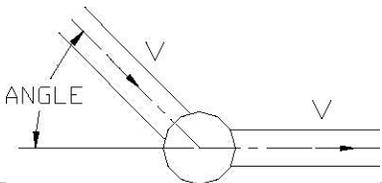
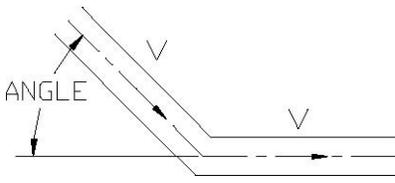
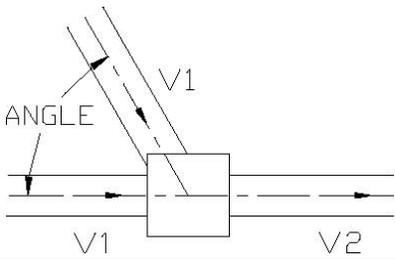
HL = Head loss or gain (ft.)
 v = Velocity in the lateral (fps)
 g = Gravity constant (32.2 ft/s²)
 K_j = Coefficient of loss per Table 3.5

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

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

HL = Head loss or gain (ft.)
 V1 = Upstream velocity (fps)
 V2 = Downstream velocity (fps)
 g = Gravity constant (32.2 ft/s²)
 K_j = Coefficient of loss per Table 3.5

Table 3.5 Velocity Head Loss in Closed Conduits

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



Microsoft Excel
Worksheet

FIGURE 3.3: Storm Drain Calculations Spreadsheet

<http://www.celinatx.gov/DocumentCenter/View/1293>

The Engineer shall include a completed Storm Drain Calculations Spreadsheet (see Figure 3.3) in the construction plans. A description of the runoff calculations is provided below followed by a description of the hydraulic design calculations:

- Column 1: Enter the downstream storm drain station number.
- Column 2: Enter the upstream storm drain station number. This is the design point. Design should start at the farthest upstream point.
- Column 3: Enter the distance (in feet) between the storm drain stations.
- Column 4: Enter the designation of the drainage area(s) at the design point in Column 2 corresponding to the designations shown on the drainage area map.
- Column 5: Enter the area in acres for the drainage area identified in Column 4.
- Column 6: Enter the total drainage area in acres within the system corresponding to storm drain station shown in Column 2.
- Column 7: Enter the runoff coefficient “C” for the drainage area shown in Column 5.
- Column 8: Multiply Column 5 by Column 7 for each area.
- Column 9: Determine the total “CA” for the drainage system corresponding to the inlet or manhole shown in Column 2.
- Column 10: Determine inlet time of concentration.
- Column 11: Determine flow time in the storm drain in minutes. The flow time is equal to the distance in Column 3 divided by 60 times the velocity of flow through the storm drain in ft/sec.
- Column 12: Total time of concentration in minutes. Column 10 plus Column 11. Note that time of concentration only changes at a downstream junction with another drainage area(s). It remains the same from an inlet or junction to the next inlet or junction picking up additional drainage areas. The junction of two paired inlets with each other is not a downstream junction.
- Column 13: The intensity of rainfall in inches per hour for the 100-year storm frequency.
- Column 14: The 100-year storm runoff in cfs. Column 9 times Column 13.
- Column 15: The proposed inlet carryover from upstream inlets during a 100-year storm. This should generally correspond to the carryover flow in Column 10 of the Inlet Spreadsheet (minor variances may occur due to travel time routing in the Hydraulics Table).
- Column 16: The proposed inlet carryover during a 100-year storm. This should generally correspond to the carryover flow “q” in Column 38 of the Inlet Spreadsheet (minor variances may occur due to travel time routing in the Hydraulics Table).
- Column 17: Design Discharge for the storm drain system (“ Q_{pipe} ”) in cfs
- Column 18: Enter the selected pipe size for circular pipe.
- Column 19: Enter the selected width for box pipe.
- Column 20: Enter the selected height for box pipe.
- Column 21: Enter the appropriate Manning’s roughness coefficient “n” (0.013 for concrete pipe and box culverts).
- Column 22: Enter the slope of the frictional gradient (hydraulic gradient) determined by Manning’s equation. In a partial flow condition, the friction slope is the slope of the water surface and should follow the slope of the pipe.

- Column 23: This is the upstream HGL before the structure and is calculated as Column 24 plus the friction loss (Column 3 times Column 22).
- Column 24: This is the beginning hydraulic gradient of the line. It is equal to the Design HGL (Column 32) for the next downstream segment, or the beginning HGL of the system as described above.
- Column 25: Velocity of flow in incoming pipe at the junction, inlet or manhole at the design point identified in Column 2.
- Column 26: Velocity of flow in outgoing pipe (i.e. the pipe segment being analyzed) at junction, inlet or manhole at design point identified in Column 2.
- Column 27: Velocity head of the velocity in Column 25.
- Column 28: Velocity head of the velocity in Column 26.
- Column 29: Head loss coefficient “Kj”, at junction, inlet or manhole at design point from Table 3.5.
- Column 30: Multiply Column 27 by Column 29.
- Column 31: Head Loss at Structure. At a junction or change in pipe size, this is Column 28 minus Column 30. At a bend or inlet, this is Column 26 times Column 29. In all cases this is 0.10’ minimum.
- Column 32: Design HGL at the design point identified in Column 2. Column 24 plus Column 31. This is the beginning HGL (Column 24) for any upstream pipe discharging into that junction.
- Column 33: Invert elevation for the pipe being analyzed at the downstream storm drain station in Column 1.
- Column 34: Invert elevation for the pipe being analyzed at the design point (upstream storm drain station) in Column 2.
- Column 35: Top of curb elevation at the design point in Column 2.
- Column 36: Comments regarding pipe being analyzed.

F. Storm Drain

1. Alignments of proposed storm drain systems shall use existing easements and rights-of-way. If located within an easement, the storm sewer shall be centered within the easement. If located within rights-of-way, the centerline of the storm sewer shall be located under paving seven feet (7’) from the back of curb. No part of the storm sewer is to be designed within the lime-treated subgrade of a proposed pavement.
2. Horizontal and vertical curve design for storm sewers shall take into account joint closure.
3. A minimum full flow velocity of 2.5fps and a minimum slope of 0.5% shall be maintained in the pipe unless otherwise approved by the City Engineer or designee.
4. Only standard sizes shall be used. The minimum allowable pipe size is eighteen inches (18”). Pipe sizes shall not be decreased in the downstream direction, unless otherwise approved by the City Engineer or designee.
5. In situations where only the lower portion of an enclosed storm sewer system is being built, stub-outs for future connections must be included.
6. The required storm drain capacity to meet existing and future needs, if applicable, shall be provided.

G. Manhole Placement

The following is a list of guidelines governing the placement of storm sewer manholes to ensure adequate accessibility of storm drainage system:

1. Storm sewer lines shall have points of access no more than five hundred feet (500’) apart. A manhole shall be provided where this condition is not met.
2. A manhole shall be required where two or more pipes connect into a main at the same joint.
3. A manhole shall be located where pipe sizes or slopes change unless otherwise approved by the City Engineer or designee.

H. Outfall Design

The Engineer shall demonstrate that the drainage from the site is conveyed to an adequate outfall. An adequate outfall is a structure or location that is adequately designed as to not cause adverse flooding conditions, erosion, or any other adverse impacts. An adequate outfall shall also have capacity to convey the increased runoff.

3.09 Detention/Retention Facility Design

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

1. Detention shall be provided for the 2, 5, 25, and 100 year design storms based on the results of a downstream assessment. Sites without a downstream assessment will be required to provide detention to undeveloped runoff rates.
2. Pilot channels may be required for detention facilities for maintenance purposes if the bottom slope is less than 2%. The Engineer shall provide a maintenance plan for the detention facility as part of the design. The maintenance plan shall indicate the ingress and egress locations to enter and maintain the pond, maintenance roles and responsibilities, contact information for the party responsible for the maintenance, and a maintenance schedule.
3. Criteria established by the State of Texas for dam safety ([TAC Title 30, Part 1, Chapter 299](#)) and impoundment of state waters ([Texas Water Code Chapter 11](#)) shall apply where required by the state, and where, in the Engineer's judgment, the potential hazard requires these more stringent criteria.

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

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

D. Detention Storage Calculation

1. Detention facilities without upstream detention areas and with drainage areas of 20 acres or less can be designed using the Modified Rational Method otherwise the Unit Hydrograph Method shall be used.
2. If the Unit Hydrograph Method is used, the model shall extend through the Zone of Influence (see Section 3.03) and include existing detention facilities within the Zone of Influence watershed.
3. No required parking space or fire lane may be located within a surface drainage pond. A maximum depth of six inches (6") of ponded water is allowed in the parking lot.

E. Pond and Spillway Geometry

1. Detention structures shall have a minimum of one foot (1') of freeboard above the 100-year water surface elevation.
2. Where embankments are used to temporarily impound detention, the effective crest of the embankment will be a minimum of two feet (2') above the 100-year water surface elevation.
3. The steepest side slope permitted for a vegetated embankment is 4:1.
4. Earth embankments used to temporarily or permanently impound surface water must be constructed according to specifications as required based on geotechnical investigations of the site and all regulatory requirements.
5. Detention facilities shall be designed with an emergency spillway in case the primary outfall ceases to function as designed. The spillway shall be designed to pass a minimum of the 100-year flood event.
6. The detention facility bottom must be designed to provide positive drainage.

7. Access shall be provided to the banks and bottom of a detention facility for maintenance.
 - a. The Engineer shall provide an operations and maintenance plan that will detail access.
 - b. Facilities with permanent pools shall address dewatering procedures.
 8. It is the responsibility of the Engineer to consider pedestrian and vehicular safety in the design of detention facilities. Perimeter rails or fencing may be required.
 9. Underground detention facilities shall be designed with reinforced concrete if located under fire lane or within city right of way.
- F. Texas Commission Environmental Quality Requirements for Dams
- The Texas Commission on Environmental Quality (TCEQ) provides design and review criteria for construction plans and specifications, construction, operation and maintenance, inspection, repair, removal, emergency management, site security, and enforcement of dams. As of the date of these design standards, dams that fall under TCEQ dam safety regulations meet the following criteria:
1. Have a height greater than or equal to twenty five feet (25') and a maximum storage capacity greater than or equal to fifteen acre-feet (15 acre-feet)
 2. Have a height greater than six feet (6') and a maximum storage capacity greater than or equal to fifty acre-feet (50 acre-feet)

Figure: 30 TAC §299.1(a)(2)

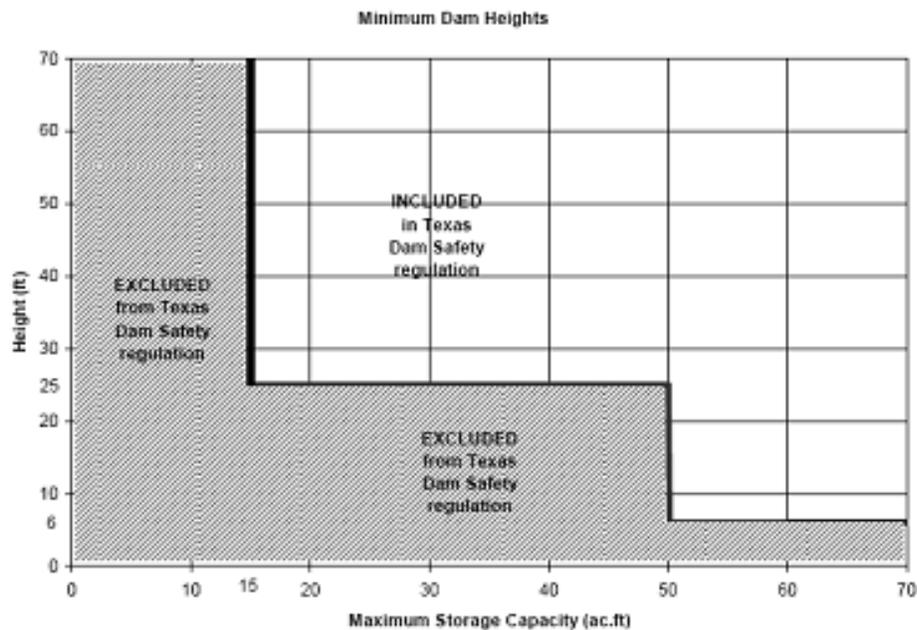


Figure 3.4a: Dam height and required capacities

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

Water features and detention facilities with permanent pools must obtain a TCEQ water rights permit if applicable. [Refer to TCEQ for water rights regulations](#). For permanent pool ponds without a water rights permit, the Engineer shall provide a signed statement to the City stating the water rights permit is not required.

3.10 Miscellaneous Drainage Requirements

- A. Lot Drainage - Lot to lot surface drainage is prohibited. Pad elevations shall be no less than twelve inches (12") above curb elevation. Figure 3.4b is provided below for reference when performing lot grading designs. Lot grading type and finished floor elevations shall be shown on the construction plans. Type B and Type C Lot Grading must back to alleys, open space, or drainage easement. Type C Lot Grading may only be used with approval of Engineering Service. Refer to the International Residential Building Code (IRC) Section 401.3 (latest version) <[International Residential Building Code \(IRC\)](#)> for additional requirements.

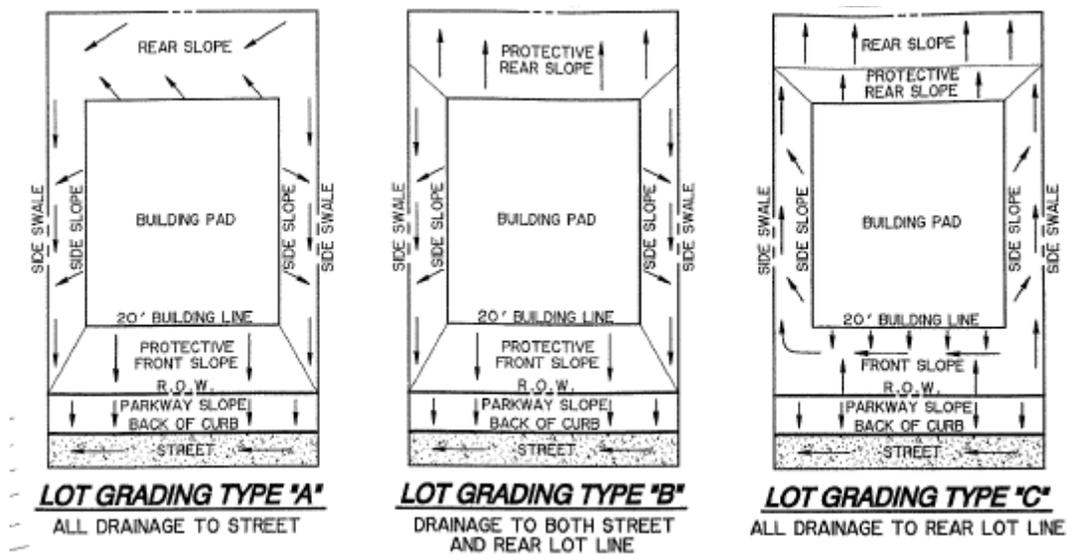


Figure 3.4b: Typical Lot Grading Pattern

- B. Storm Drain Materials
1. All public storm sewers shall be reinforced concrete.
 2. All storm sewers under a fire lane or roadway and within a drainage easement shall be reinforced concrete. Any structure under a fire lane must be designed to withstand applicable loadings, including loading of a fire apparatus.
- C. The minimum finished floor elevation for any lot adjacent to a drainage feature shall be two feet (2') above the adjacent 100 year fully developed lot water surface elevation and shall be shown on the final plat.
- D. Should mitigation be required under Section 404 of the Clean Water Act, the areas shall be identified on the engineering construction plans.
- E. Refer to Section 3.15 for floodplain reclamation requirements.

3.11 Open Channel Design

Excavated open channels may be used to convey storm waters where the construction costs and/or long term maintenance cost involved with a closed storm sewer system is not justified economically. Open channels shall be designed to convey the full design discharge. The allowable excavated channel cross section is shown on Figure 3.5. The maximum velocities allowed for various types of excavated channel

cover are shown in Table 3.6. These maximum velocities do not apply for drainage facilities discharging off-site. A downstream assessment in accordance with Section 3.03.b shall be performed to determine maximum discharge velocities.

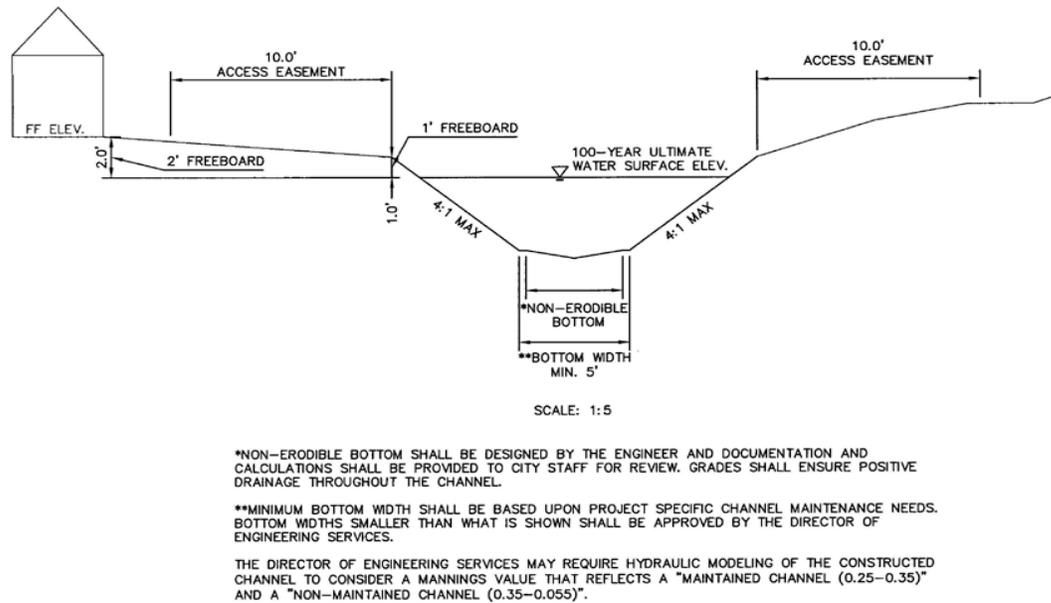


Figure 3.5: Excavated Open Channels

- A. Unlined un-vegetated excavated channels are not allowed. Construction of excavated channels will not be considered complete until the channel banks are stabilized. Vegetation selected for channel cover must conform to allowable vegetation from the Approved Material List.
- B. Supercritical flow shall not be allowed in channels except at drop structures and other energy dissipaters.
- C. At transitions in channel characteristics, velocities must be reduced to the maximum velocity per the downstream assessment in accordance with Section 3.03.b. Velocities must be reduced before the flow reaches the natural channel using either energy dissipaters and/or wider and less steep channel.
- D. Channel armoring for erosion control shall be provided where deemed necessary by the City Engineer or designee.
- E. If the channel cannot be maintained from the top of the bank, a maintenance access ramp shall be provided and included within the drainage easement.
- F. Minimum channel bottom widths are recommended to be equal to twice the depth of the channel. Any permanent open channel shall have a minimum bottom width of five feet (5').
- G. All open channels require a minimum freeboard of one foot (1').
- H. The minimum slope for an excavated improved channel is 1% unless a pilot channel is constructed, or otherwise approved by the City Engineer or designee.

Table 3.6 provides allowable ranges for roughness coefficients of open channels.

Table 3.6 Channel Roughness Coefficients

Channel Description	Roughness Coefficient			Maximum Velocity (fps)
	Minimum	Normal	Maximum	
Minor Natural Streams				
Moderately Well Defined Channel				
-grass and weeds, little brush	0.025	0.030	0.033	8
-dense weeds, little brush	0.030	0.035	0.040	8
-weeds, light brush on banks	0.030	0.035	0.040	8
-weeds, heavy brush on banks	0.035	0.050	0.060	8
-weeds, dense willows on banks	0.040	0.060	0.080	8
Irregular Channel with Pools and Meanders				
-grass and weeds, little brush	0.030	0.036	0.042	8
-dense weeds, little brush	0.036	0.042	0.048	8
-weeds, light brush on banks	0.036	0.042	0.048	8
-weeds, heavy brush on banks	0.042	0.060	0.072	8
-weeds, dense willows on banks	0.048	0.072	0.096	8
Flood Plain, Pasture				
-short grass, no brush	0.025	0.030	0.035	8
-tall grass, no brush	0.030	0.035	0.050	8
Flood Plain, Cultivated				
-no crops	0.025	0.030	0.035	8
-mature crops	0.030	0.040	0.050	8
Flood Plain, Un-cleared				
-heavy weeds, light brush	0.035	0.050	0.070	8
-medium to dense brush	0.070	0.100	0.160	8
-trees with flood stage below branches	0.080	0.100	0.120	8
Major Natural Streams				
Moderately Well Defined Channel	0.025	-----	0.060	8
Irregular Channel	0.035	-----	0.100	8
Unlined Vegetated Channels				
Mowed Grass, Clay Soil	0.025	0.030	0.035	8
Mowed Grass, Sandy Soil	0.025	0.030	0.035	6
Unlined Un-vegetated Channels				
Clean Gravel Section	0.022	0.025	0.030	8
Shale	0.025	0.030	0.035	10
Smooth Rock	0.025	0.030	0.035	15
Lined Channels				
Smooth Finished Concrete	0.013	0.015	0.020	15
Riprap (Rubble)	0.30	0.40	0.50	10

- I. Water surface elevations and flow velocities in channels are impacted by the maintenance condition in the channel. Calculations shall be performed assuming maintained and unmaintained vegetative conditions. Lower (maintained) Manning's values shall be used to determine maximum velocities, while higher (unmaintained) Manning's values shall be used to determine water surface elevations per Figure 3.5.
- J. Any channel modification must meet the applicable requirements of all Local, State and Federal Regulatory Agencies.

-
- K. An erosion hazard setback shall be included within the Drainage Easement for the channel. The purpose of this setback is to reduce the potential for any damage to a private lot or street right-of-way caused by the erosion of the bank. The erosion hazard setback shall be determined as follows, and is provided in Figure 3.6:
1. For stream banks composed of material other than rock, locate the toe of the natural stream bank. Project a 4:1 line sloping away from the bank until it intersects finished grade. From this intersection add fifteen feet (15') away from the bank. This shall be the limit of the erosion hazard setback.
 2. Figure 3.6 is intended to illustrate various scenarios under which the erosion hazard setback can be applied and how it interacts with the floodplain access easement. Scenario 1 shows a situation where the setback may be located outside the 100-year floodplain and access easement boundaries. Scenarios 2 and 3 show locations where the erosion hazard setback will be located inside the 100-year floodplain and access easement boundaries.
- L. Any modifications within the area designated as erosion hazard setback, will require a geotechnical and geomorphological stability analysis, and a grading permit (two separate items).

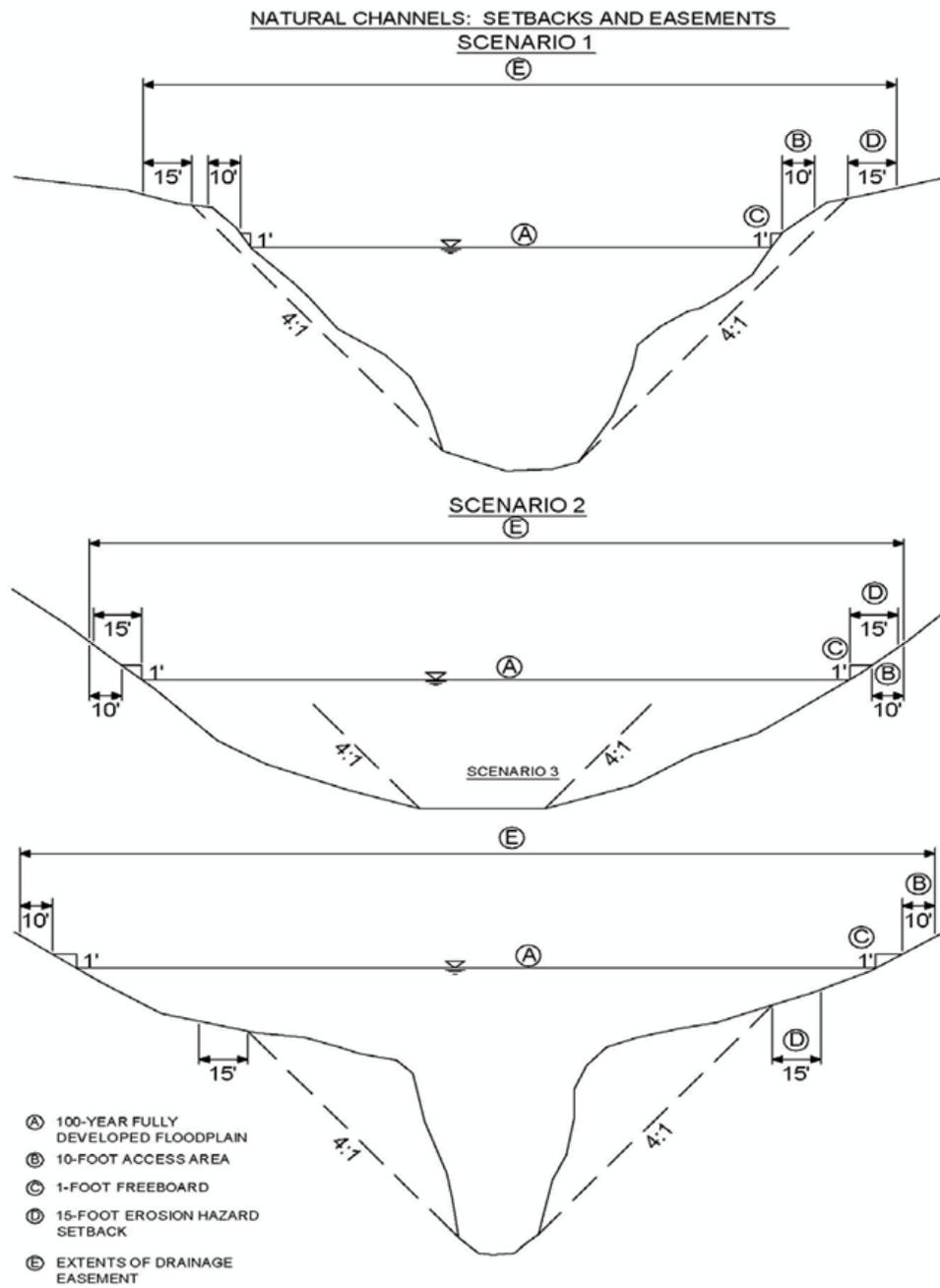


Figure 3.6: Natural Open Channels

3.12 Hydraulic Design of Culverts

- A. All culverts, headwalls, wing-walls, and aprons shall be designed in conformance with the City Standard Details. The Engineer is responsible for selecting the applicable detail.
- B. Culvert calculations shall be provided to the City for review. Calculations may include, but are not limited to, headwall, tail-water, and flow-line elevations, lowest adjacent grade and structure elevations, inlet and outlet control calculations and velocity calculations.
- C. There is no minimum freeboard requirement for culvert crossings; however, an emergency overflow path shall be identified and provided on the construction plans. An emergency overflow path is the path the storm water will take when the drainage facilities becomes clogged or does not function in the manner as to which it was designed. The emergency overflow path shall be limited to public right-of-way or drainage easements.
- D. Culverts should always be aligned to follow the natural stream channel. The engineer shall provide sufficient information to analyze the upstream and downstream impacts of the culvert and illustrate the interaction of the channel and culvert alignment.
- E. Headwalls and Entrance Conditions:
 1. The Engineer shall be responsible for the headwall and wing-wall designs. Headwalls and end-walls refer to the entrances and exits of structures, respectively, and are usually formed of cast-in-place concrete and located at either end of the drainage system. Wing-walls are vertical walls, which project out from the sides of a headwall or end-wall.
 2. The culvert entrance losses are provided in Table 3.7. The values of the entrance coefficient K_e represent a combination of the effects of entrance and approach conditions. Losses shall be completed using the
 3. following formula:

$$H_e = K_e \left[\frac{V^2}{2g} \right]$$

H_e = Entrance head loss (ft.)
 K_e = Entrance loss coefficient
 v = Velocity (fps)
 g = Gravity constant (32.2 ft/s²)

- F. Concrete culvert headwalls and wing-walls shall use form-liner surface finish unless otherwise approved by City Engineer or designee.

Table 3.7 Culvert Entrance Losses

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

3.13 Bridge Design Hydraulics

- A. The City requires that head losses and depth of flow through bridges be determined with a HECRAS program or other approved program. The following guidelines pertain to the hydraulic design of bridges:
1. Fully developed 100 year water surface must not be increased upstream of the bridge.
 2. Excavation of the natural channel is not allowed as compensation for loss of conveyance.
 3. Channelization upstream or downstream of the proposed bridge will normally only be permitted when necessary to realign the flow to a more efficient angle of approach.
 4. Side swales may be used to provide additional conveyance downstream of and through bridges.
 5. Bridges are to be designed with the lowest point (low beam) low chord at least two feet (2') above the water surface elevation of the design storm.
- B. A scour analysis shall be submitted with design plans.

3.14 Energy Dissipaters

- A. The Engineer shall be responsible for all energy dissipation designs.
- B. A Downstream Assessment shall be performed to ensure modifications to the storm drainage system, through development or construction of storm drainage facilities, do not have an adverse impact on downstream conditions.
- C. Grouted rock rip-rap or gabion baskets or mattresses are required for energy dissipation. Other designs may be considered.

-
- D. All energy dissipation designs shall include supporting calculations showing the design is adequate. The City may require the Engineer to provide a hydraulic model as supporting documentation.
 - E. All energy dissipaters should be designed to facilitate future maintenance. The design of outlet structures in or near parks or residential areas shall give special consideration to appearance and shall be approved by the City Engineer or designee.

3.15 Floodplain Alterations

- A. No new construction is allowed in floodplain areas, but construction is allowed in those areas that have been reclaimed from the floodplain.
- B. Floodplain alteration shall be allowed only if all the following criteria are met:
 1. Flood studies shall include flows generated for existing conditions and fully-developed conditions for the 2, 5, 10, 25, and 100 year storm events.
 2. Alterations of the floodplain shall not increase the water surface elevation of the design flood of the creek on other properties.
 3. Alterations shall be in compliance with FEMA guidelines.
 4. Alterations of the floodplain shall meet the requirements of Section 4.03.
 5. Alterations shall result in no loss of valley storage for a [Major Creek \(pdf\)](http://www.celina-tx.gov/DocumentCenter/View/1416) (<http://www.celina-tx.gov/DocumentCenter/View/1416>) and a 15% maximum loss of valley storage for any other tributary for any reach, except at bridge and culvert crossings where it can be proven that there are no detrimental effects downstream.
 6. Any alteration of floodplain areas shall not cause any additional expense in any current or projected public improvements, including maintenance.
 7. The floodplain shall be altered only to the extent permitted by equal conveyance on both sides of the natural channel, as defined by the United States Army Corps of Engineers in a HEC-RAS analysis. The right of equal conveyance applies to all owners and uses, including greenbelt, park areas, and recreational areas. Owners may relinquish their right to equal conveyance by providing a written agreement to the City Engineer or designee.
 8. A grading permit shall be required to perform any grading activities on site.
 9. The toe of any fill shall parallel the natural direction of the flow.
 10. Grading activities in the floodplain shall incorporate and consider other City planning documents and ordinances.
- C. The above criteria shall be met before any floodplain alteration may occur. Typical projects requiring a floodplain alteration include placing fill, (whether or not it actually raises the property out of the floodplain) constructing a dam, straightening channel sections, making improvements (substantial or otherwise) to existing structures in a floodplain in which the existing outside dimensions of the structure are increased, and temporary storage of fill materials, supplies and equipment.
- D. In general, the information needed for the application shall be performed by running a backwater model, such as HEC-2 or HEC-RAS, and a flood routing model, such as TR-20, HEC-1, or HEC-HMS. Unless a pre-existing model is in place, HEC-HMS and HEC-RAS shall be used. The backwater information shall be used to determine that upstream water surface elevations and erosive velocities have not increased. Flood routing information shall be used to insure that the cumulative effects of the reduction in floodplain storage of floodwater will not cause downstream increases in water surface elevations and erosive velocities.
- E. The Engineer is responsible for providing documentation of the relevant USACE approved permits prior to beginning modification to the floodplain, or for providing a signed and sealed statement detailing why such permits are unnecessary.
- F. Verification of Floodplain Alterations:
 1. Prior to final acceptance by the City, a certified statement shall be prepared by a Licensed Professional Engineer showing that all lot elevations, as developed within the subject

- project, meet the required minimum finished floor elevations shown on the construction plans. This certification shall be filed with the City Engineer or designee.
2. In addition, at any time in the future when a building permit is desired for existing platted property which is subject to flooding or carries a specified or recorded minimum finished floor elevation, a Registered Professional Land Surveyor shall survey the property prior to obtaining a building permit. The certified survey data showing the property to be at or above the specified elevation shall be furnished to the City Engineer or designee for approval. Certification of compliance with the provisions of this ordinance pertaining to specified finished floor elevations shall be required.
 3. The owner/developer shall furnish, at his expense, to the City Engineer or designee sufficient engineering information to confirm that the minimum finished floor elevations proposed are as required by this ordinance. Construction permits will not be issued until a Conditional Letter of Map Revision (CLOMR) or amendment has been accepted by the City Engineer or designee for submittal to FEMA. Letters of Map Revision shall be submitted to the City Engineer or designee for submittal to FEMA prior to final acceptance of the project. The contractor shall supply to the City Engineer or designee all necessary documentation and fees to be forwarded to FEMA for application for a Letter of Map Amendment if the Letter of Map Revision has not yet become effective.
 4. All submittals to FEMA shall be made through the Engineering Services Department. The owner/developer will provide the City with an additional copy of the CLOMR or LOMR submittal as well as the required FEMA submittal and shipping fees. Upon City approval, receipt of the fees, and receipt of the FEMA review copy, the City will forward the submittal to FEMA.
 5. All response to FEMA comments shall be submitted to the City prior to submittal to FEMA. The City will review the response to comments in a timely manner.

3.16 Erosion and Sedimentation Control

- A. See Section 8 for requirements for Storm water Best Management Practices and Storm water Management Plan.

3.17 Drainage Easements

- A. The following minimum width exclusive drainage easements are required when facilities are not located within public rights-of-way or easements:
 1. Storm sewers are to be located within the center of a fifteen-foot (15') drainage easement or 1.5 times the depth plus the width of the structure rounded up to the nearest five feet (5'), whichever is greater.
 2. Overflow flumes are to be located with the edge being a minimum of one foot (1') off the property line within a ten-foot (10') drainage easement.
- B. Storm drains lines are considered public if they cross property lines and collect runoff from adjacent properties. Drainage easements shall be dedicated to the City when a drainage system crosses a property line. For single-family residential developments, storm drain lines shall not cross residential lots unless approved by the City Engineer or designee.
- C. Drainage Easements shall be dedicated for all floodplains and shall include an erosion hazard setback to reduce the potential for damage due to erosion of the bank.
- D. Drainage Easements shall be dedicated for all detention facilities.

3.18 Sustainable Development

The City encourages developments to implement sustainable designs, concepts, and practices on site. The Engineer shall notify the City of the design intent and provide the necessary information, data, and calculations on the construction plans. The following items are potential concepts and designs that may be

considered in a sustainable design. Concepts and designs not included on this list may be proposed by the Engineer.

- Rainwater Harvesting
- Green Roofs
- Modular Porous Paver Systems
- Porous Concrete
- Extended Detention
- Bio Retention
- Reduction of impervious surfaces
- Preservation of natural drainage paths

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

Detention/Retention Pond Example

GIVEN: A 10 acre site is currently undeveloped and will be developed as a non-residential use. The entire site is the drainage area for the proposed detention basin.

EXAMPLE

DETERMINE: Maximum release rate and required detention storage.

SOLUTION:

- 1) Determine 100-year peak runoff rate for single family runoff ($Q=C*I*A$). This is the maximum release rate from the site after development. (Any area within the drainage area not being conveyed to the detention basin shall be accounted for in the calculation for the maximum release rate.)

Existing Conditions: $C = 0.3$

$T_c = 20$ minutes

$I_{100} = 6.88'' / \text{hour}$

$A = 10$ acres

$Q_{100} = (0.3) (6.88)10 = 20.64$ cfs

- 2) Determine inflow Hydrograph for storms of various durations in order to determine maximum volume required with maximum release rate calculated in step 1. (Incrementally increase durations by 10 minutes until the duration of peak inflow is less than the maximum release rate or where the required storage is less than the storage for the prior duration. The prior duration storage shall be used for the required detention storage.)

Proposed Conditions: $C = 0.90$

$T_c = 10$ minutes

$I_{100} = 8.74'' / \text{hour}$

$A = 10$ acres

$Q_{100} = (0.90) (8.74)10 = 78.66$ cfs

Check various duration storms:

10 minutes $I=8.74$; $Q=0.9(8.74)10 = 78.66$ cfs

20 minutes $I=6.88$; $Q=0.9(6.88)10 = 61.96$ cfs

30 minutes $I=5.74$; $Q=0.9(5.74)10 = 51.65$ cfs

40 minutes $I=4.95$; $Q=0.9(4.95)10 = 45.59$ cfs

50 minutes $I=4.38$; $Q=0.9(4.38)10 = 39.41$ cfs

60 minutes $I=3.94$; $Q=0.9(3.94)10 = 35.43$ cfs

70 minutes $I=3.59$; $Q=0.9(3.59)10 = 32.27$ cfs

80 minutes $I=3.30$; $Q=0.9(3.30)10 = 29.68$ cfs

90 minutes $I=3.06$; $Q=0.9(3.06)10 = 27.53$ cfs

Maximum Detention Storage Volume is determined by deducting the volume of runoff released during the time of inflow from the total inflows for each storm duration:

10 minute storm

INFLOW = $10(78.66)60$ sec/min = 47,196 cf

OUTFLOW = $(0.5)20(20.64)60$ sec/min = 12,392 cf

STORAGE = INFLOW - OUTFLOW = 34,804 cf

20 minute storm

INFLOW = $20(61.96)60$ sec/min = 74,354 cf

OUTFLOW = $(0.5)30(20.64)60$ sec/min = 18,588 cf

STORAGE = INFLOW - OUTFLOW = 55,765 cf

30 minute storm

INFLOW = $30(51.65)60$ sec/min = 92,975 cf

OUTFLOW = $(0.5)40(20.64)60$ sec/min = 24,785 cf

STORAGE = INFLOW - OUTFLOW = 68,190 cf

40 minute storm

INFLOW = $40(44.59)60$ sec/min = 107,006 cf

OUTFLOW = $(0.5)50(20.64)60$ sec/min = 30,981 cf

STORAGE = INFLOW - OUTFLOW = 76,026 cf

50 minute storm

INFLOW = $50(39.41)60$ sec/min = 118,219 cf

OUTFLOW = $(0.5)60(20.64)60$ sec/min = 37,177 cf

STORAGE = INFLOW - OUTFLOW = 81,042 cf

60 minute storm

INFLOW = $60(35.43)60$ sec/min = 127,541 cf

OUTFLOW = $(0.5)70(20.64)60$ sec/min = 43,373 cf

STORAGE = INFLOW - OUTFLOW = 84,168 cf

70 minute storm

INFLOW = $70(32.27)60$ sec/min = 135,516 cf

OUTFLOW = $(0.5)80(20.64)60$ sec/min = 49,569 cf

STORAGE = INFLOW - OUTFLOW = 85,947 cf

80 minute storm

INFLOW = $80(29.68)60$ sec/min = 142,485 cf

OUTFLOW = $(0.5)90(20.64)60$ sec/min = 55,765 cf

STORAGE = INFLOW - OUTFLOW = 86,720 cf

90 minute storm

INFLOW = $90(27.53)60$ sec/min = 148,679 cf

OUTFLOW = $(0.5)100(20.64)60$ sec/min = 61,961 cf

STORAGE = INFLOW - OUTFLOW = 86,717 cf

Required detention storage is 86,720 cf at the 80 minute storm duration.

SECTION 4 - THOROUGHFARE DESIGN REQUIREMENTS



4.01 General

- A. The arrangement, character, extent, width, alignment, and location of all streets, public ways, alleys, and driveways shall be in conformity with the City's Thoroughfare Plan and Comprehensive Plan and should be considered in their relation to existing and planned streets, alleys and driveways, topographical and environmental features, scenic views, and the land uses proposed to be served by such streets.
- B. All thoroughfare designs shall meet the guidelines in AASHTO's current *A Policy on Geometric Design of Highways and Streets*.

4.02 Street Design

- A. **Thoroughfare Definitions** – The City recognizes five basic classifications of public roadways that include highways (freeway/toll-ways), major and minor thoroughfares and major and minor collectors as identified in the transportation element of the Comprehensive Plan. Each class provides a certain degree of continuity, capacity, and accessibility to adjacent land uses. While differentiated by function, there is also a variance in geometric design. Table 4.1 summarizes the general design criteria of roadways within the City. The typical cross sections are depicted in Figure 4.2.
 - i. Major Thoroughfares, 6LD – Six-lane divided roadways defined herein as 6LD thoroughfares. 6LD thoroughfares are typically initially constructed as four-lane divided roadways with a wider median and then widened to six lanes at a later date. Frontage roads are also considered major thoroughfares.
 - ii. Minor Thoroughfares, 4LD – Four-lane divided roadways defined herein as Type 4LD thoroughfares.
 - iii. Collectors (Commercial and Residential- 2LC)) – Commercial collectors (major) provide access from a 6LD or 4LD thoroughfare to non- residential properties and are defined herein as 2LC. Residential collectors (minor) connect to a 6LD or 4LD thoroughfare, extend more than six hundred feet (600') into a residential neighborhood, and have no homes fronting on them. Residential collectors can be built with the cross section of a Type 2LC, 2LN, 2LRN or 2LCB thoroughfare. Collectors with bicycle lanes; 2LCB shall be provided in school, park and residential areas.
 - iv. Local Streets – Residential (Neighborhood) streets with homes fronting on them are defined herein as Type 2L, 2LN, 2LRN, and 2LCB thoroughfares, each with different design characteristics depending on whether the homes are front entry or alley served and whether or not the street is adjacent to a school or park.
 - v. Private Streets – Private streets shall be designed and constructed to the same standards as public streets. Any gated entrances shall also meet the requirements of Section 4.05.K.
 - vi. Public Ways – Public ways shall be designed and constructed to the same standards as public streets and shall meet the design criteria of a commercial collector (Type 2LC thoroughfare) unless otherwise allowed under Subsection 'a' below. Public ways shall be privately maintained, shall be dedicated to public use, and shall not be gated.
 - a. A public way can be reduced to the design criteria of a 2LN thoroughfare

if the owner agrees to prohibit parking on the public way and to actively enforce such prohibition. The parking prohibition shall be recorded on the plat and shall be clearly posted along the public way.

B. Roadway Geometrics – Geometrics of City streets shall be defined as the geometry of the pavement and curb areas that govern the movement of traffic within the confines of the right-of-way (ROW). Included in the geometrics are pavement width, horizontal curvature, width of traffic lanes, median nose radii, curb radii at street intersections, pavement cross-slope, crown height, pavement thickness, and geometric shapes of islands separating traffic movements and other features.

1. Design Speed – The design speed is a primary factor in the horizontal and vertical alignment of roadways. Design features such as curvature, super-elevation, turning movement radii, and sight distance affects roadway lane width, pavement width, pavement cross-slope, pavement crown, and clearances. Refer to Table 4.1.
2. Grades – Roadway grades shall be a minimum of six-tenths percent (0.6%) in order to insure proper flow of surface drainage toward inlets and a maximum of six percent (6%). Steeper grades may be permitted on local residential streets and where required by topographical and/or natural features, as approved by the City Engineer or designee.
3. Roadway Centerline
 - a. Roadways shall be placed in the center of the ROW. The centerline of curves shall be tangent to the centerline of street at each end of curve.
 - b. If offset, roadway centerlines for Type 2LC, 2LCB, 2L, 2LN and 2LRN thoroughfares shall be offset a minimum of one hundred and twenty five feet (125'). If offset: Type 6LD and 4LD thoroughfares shall be offset to meet the median requirements in Section 4.03.B.
4. Cross-Slope – 6LD or 4LD thoroughfares shall have a two-percent (2%) cross-slope. The cross-slope can vary where there is a transition into or out of a maximum two percent (2%) super elevation.
5. Pavement Thickness and Reinforcement – See Section 5 of the Engineering Standards for subgrade and pavement design requirements
6. Transitions – A concrete transition shall be constructed where four (4) lanes of a thoroughfare connect to a two (2)-lane thoroughfare. The transition occurs only in the direction in which traffic needs to be shifted laterally to join the thoroughfare with a different cross section.
 - a. Transitions from a four (4) lane to a two (2) lane thoroughfare shall be a minimum of sixteen feet (16') wide, a minimum of three hundred feet (300') long and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.
 - b. A transition from a two (2) lane to a four (4) lane thoroughfare that occurs less than one thousand feet (1,000') from a traffic signal, or from an intersecting 6LD or 4LD thoroughfare, shall be a two (2) lane transition twenty-four feet (24') wide, a minimum of three hundred feet (300') long, and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.
 - c. A transition from a two (2) lane thoroughfare to a four (4) lane thoroughfare that occurs more than one thousand feet (1,000') from a traffic signal, and from an

intersecting 6LD or 4LD thoroughfare, shall be a one (1) lane transition sixteen feet (16') wide, a minimum of three hundred feet (300') long, and meet AASHTO's current minimum design requirements based on a design speed of 25 mph.

7. Dead-End Streets/Cul-de-Sacs/Stub Streets

- a. All dead-end streets shall have a turn-around unless otherwise allowed in Subsection (g) below.
- b. The maximum length of a dead-end street with a turn-around (cul-de-sac) shall be six hundred feet (600'), measured from the right-of-way line of the intersecting street to the center point of the cul-de-sac or T-shaped (hammer head) turn around except in conditions of unusual topography.
- c. Residential cul-de-sac turnarounds shall have a minimum ROW width (diameter) of one hundred feet (100') and a minimum pavement width of eighty feet (80') for single family and two-family uses.
- d. If any residential lot fronts onto the dead-end portion of a street that will be extended in the future, a temporary turn-around that meets the standards described above shall be constructed at the end of the dead-end street within a temporary street easement. The following note shall be placed on the plat: "Cross-hatched area is temporary street easement for turn-around until street is extended (give direction) with future development of abutting property".
- e. Commercial cul-de-sac turnarounds shall have a minimum right-of-way of one hundred and twenty feet (120') and a minimum pavement width of one hundred feet (100') for all other uses.
- f. Hammer head turnarounds shall have a minimum pavement width of sixty feet (60') and a minimum depth of twenty feet (20').
- g. Temporary turnarounds shall be provided at ends of streets more than one hundred and fifty feet (150') long that will be extended in the future. No buildings shall be constructed in these sections without approval from the City Engineer or designee. For a temporary turnarounds thirty feet (30') widths and twenty feet (20') radii may be substituted for the twenty four feet (24') widths and thirty feet (30') radii for hammer head turnarounds. A stub street is an undivided dead-end street that will be extended in the future that does not have a turn-around, which is only allowed under the following conditions: No residential lots shall front onto a stub street. Non-residential lots adjacent to a stub street shall have access to another street. If the length of a residential stub street exceeds the depth of the adjacent residential lots, it shall be temporarily blocked at the rear edge of the lots (or alley) with barrel-mounted barricade. If a non-residential stub street extends more than one hundred feet (100') beyond the last driveway on the street, it shall be temporarily blocked at the last driveway with barrel-mounted barricade.
- h. A stub street shall have a permanent Type III barricade installed at its terminus. A residential stub street shall also have a twenty four by thirty inches (24"x30") sign prominently posted at its terminus with black letters on a white background that state, "NOTICE – This street will be extended as part of a future development." The installation and cost of these barricades and signs shall be the

responsibility of the developer.

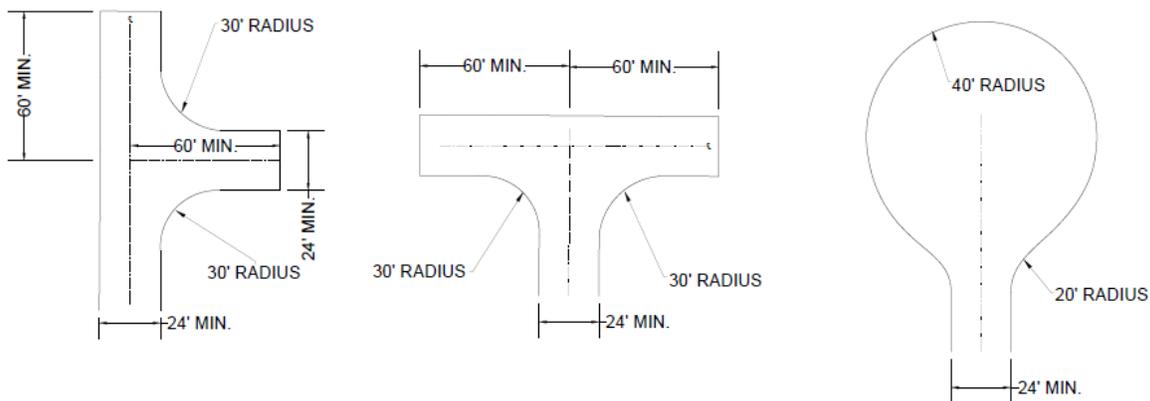


Figure 4.1- Temporary Turnarounds

C. Minimum Horizontal Design Radius

1. The minimum centerline radius is a function of design speed, super-elevation, and the vehicle side friction factor. Side friction is the force that keeps a vehicle from sliding off the roadway.
2. The minimum horizontal radii are shown in Table 4.2 and are in accordance with the guidelines in AASHTO's 2011 edition of *A Policy on Geometric Design of Highways and streets*.

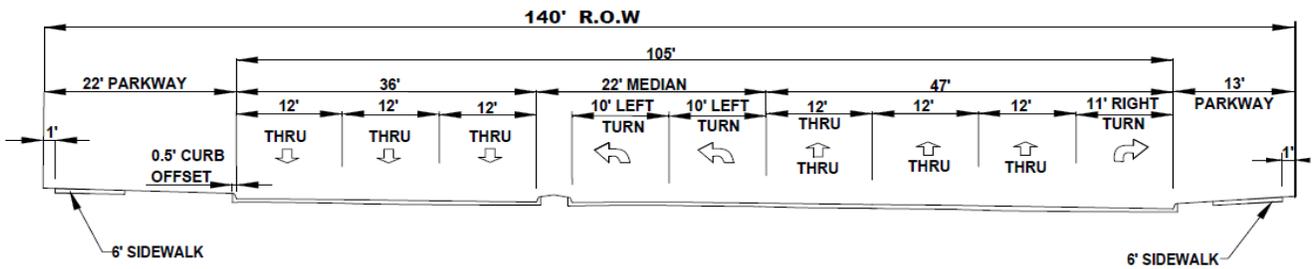
Table 4.1: General Roadway Design Criteria

Criteria	Thoroughfare Class						
	Major Thoroughfare (6LD)	Minor Thoroughfare (4LD)	Collector Com/Res (2LC)	Collector used as Neighborhood street (2L)	Collector Com/Res with Bike lane (2LCB)	Neighborhood street (2LN)	Rural Neighborhood street (2LRN)
Right-of-Way (ROW)	120' ⁽¹⁾	90' ⁽²⁾	60'	60'	80'	50'	50'
Pavement Width (face to face)	36' in each direction	24' in each direction	36'	36'	41'	30'	(26'*)30
Traffic Lanes	6	4	2	2	2	2	2
Bicycle lanes	N.A.	N.A.	N.A.	N.A.	2	N.A.	N.A.
Left Turn-lane Width	2@10'	1@11'	N.A.	N.A.	N.A.	N.A.	N.A.
Right Turn-lane Width	11'	11'	N.A.	N.A.	N.A.	N.A.	N.A.
Median Width	22'	16'	N.A.	N.A.	13'	N.A.	N.A.
Parkway Width	13'	13'	12'	12'	13'	10'	N.A.
Ditch width	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	10' ^(*)
Shoulder width	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2'
Design Speed, V (MPH)	45	45	30	30	25	25	25
Minimum Grade	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Maximum Grade	6%	6%	6%	6%	6%	6%	6%
Min. Horizontal Radii	See Table 4.2						
Min. Tangent Between Curves	100'	100'	100'	100'	100'	N.A.	N.A.
Min Length of Vertical Curve	See Tables 4.3 and 4.4						
Stopping Sight Distance	425'	360'	200'	200'	200'	155'	155'
Parking	Prohibited	Prohibited	Prohibited	Allowed	Prohibited	Allowed	Allowed
Volume Range (VPD)	36-45,000	20-28,000	12-18,000	6-12,000	6-12,000	N.A.	N.A.

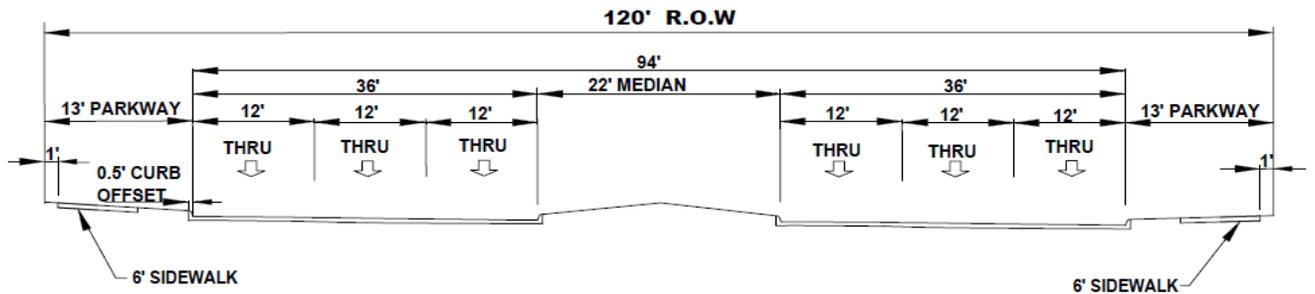
(1) 140' or 160' ROW at intersections (See Figures 4.2 and 4.4)

(2) 110' or 120' ROW at intersections (See Figures 4.3 and 4.5)

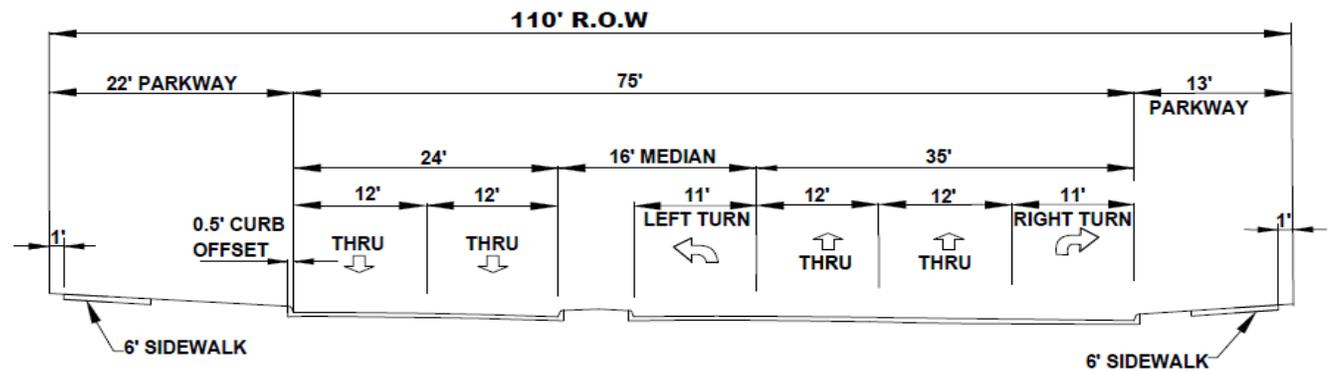
(*) Varies depending on drainage area calculations



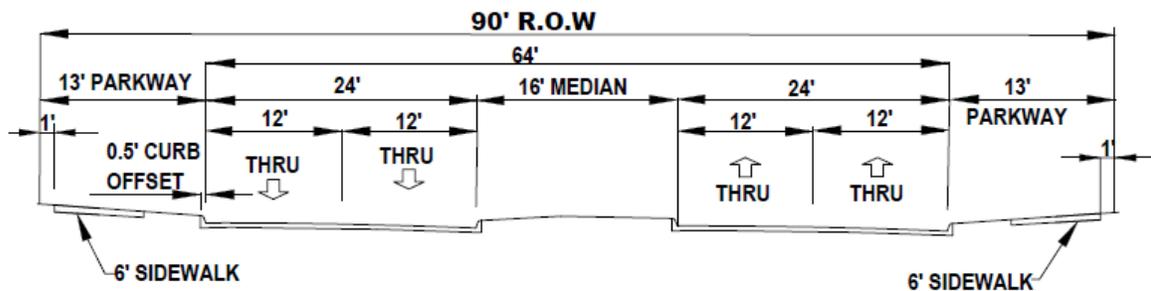
Major thoroughfare 6LD (at intersection)



Major thoroughfare 6LD (at midblock)

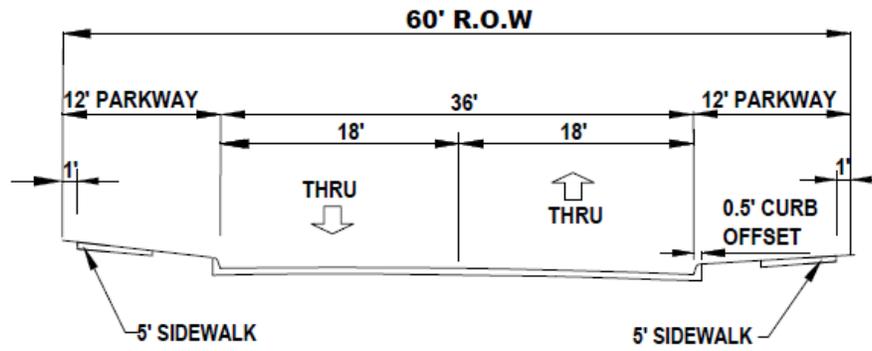


Minor thoroughfare 4LD (at intersection)

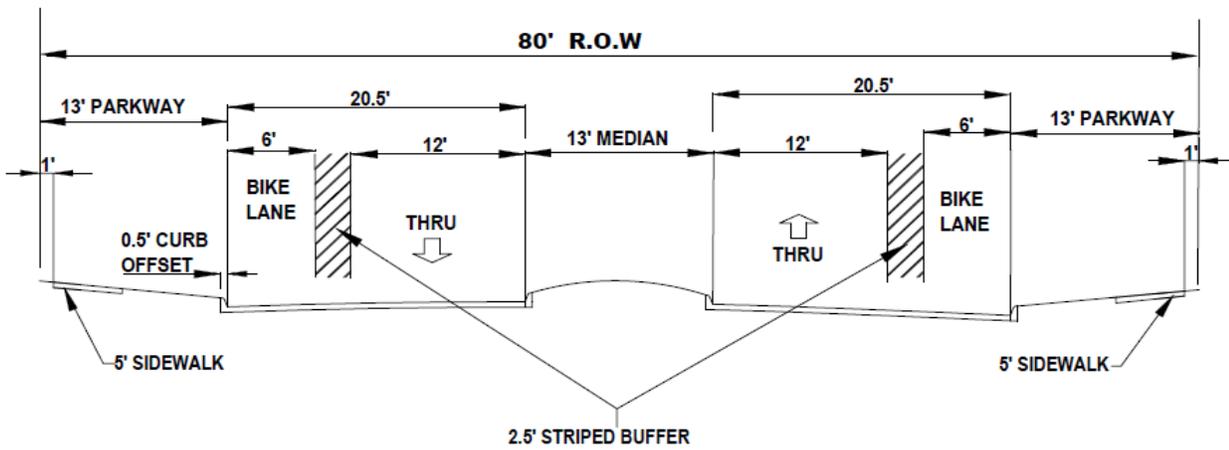


Minor thoroughfare 4LD (at midblock)

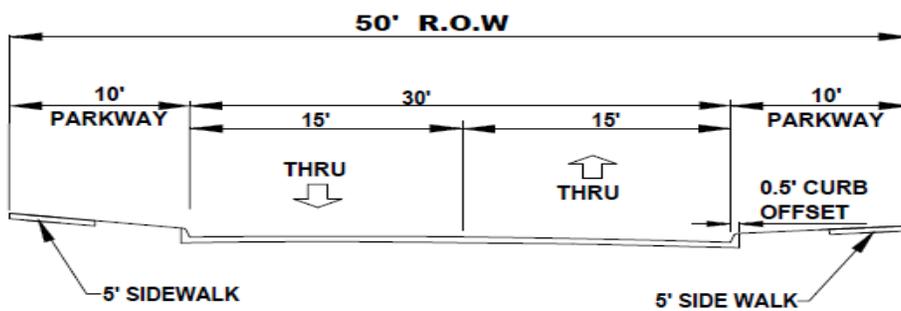
FIGURE 4.2: Typical Cross Sections for 6LD and 4LD



Collector street 2LC (commercial and residential) and neighborhood street 2L

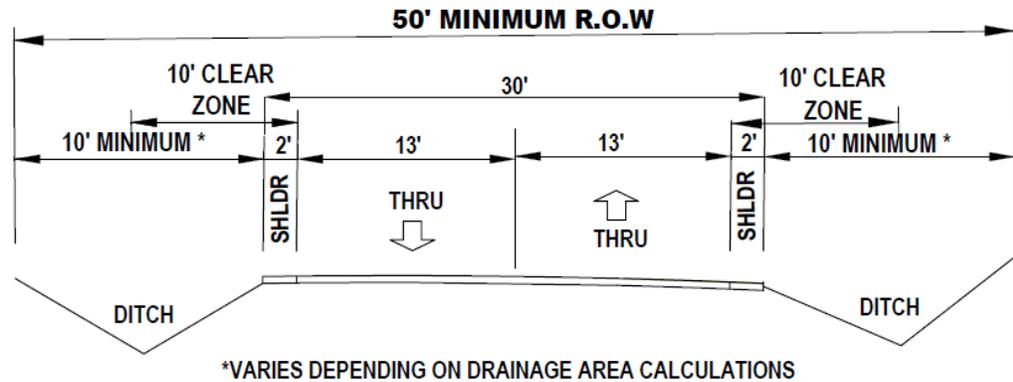


Collector street with bike lanes; 2LCB

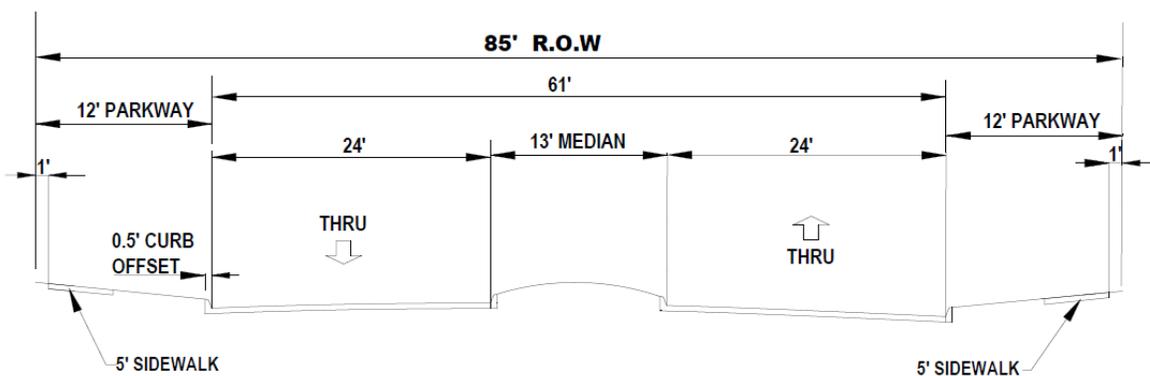


Neighborhood Street; 2LN

FIGURE 4.2 (Cont.): Typical Cross Section for 2LC, 2L, 2LCB and 2LN



Rural Neighborhood Street; 2LRN



Divided Residential Subdivision Entrance

For residential Collector use the cross-section of Type 2L, 2LN, 2LRN or 2LCB

FIGURE 4.2 (Cont.): Typical Cross Section of 2LRN and subdivision entrance

TABLE 4.2: Minimum Horizontal Centerline Radius

<u>Design Speed,</u> <u>V (MPH)</u>	<u>Friction Factor,</u> <u>F</u>	<u>Super elevation,</u> <u>e (ft./ft.)</u>	<u>Radius, R (ft.)</u> <u>(Rounded for</u> <u>Design)</u>
25	0.23	-0.02	250 ⁽¹⁾
30	0.20	-0.02	350
35	0.18	-0.02	525
40	0.16	-0.02	775
45	0.15	-0.02	1100
50	0.14	-0.02	1400

(1) May be reduced to two hundred feet (200') radius at mid-block locations provided that it is shown that the general public safety is not compromised (e.g., stopping sight distance). A curve with a radius less than two hundred fifty feet (250') must be a minimum of three hundred feet (300') from a street or alley intersection.

D. Minimum Vertical Alignment

- Vertical curves are utilized in roadway design to affect gradual change between tangent grades and will result in a design, which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide Stopping Sight Distance (SSD) in all cases. SSD is a function of design speed, perception-reaction time, and deceleration rate. The perception-reaction time is assumed to be 2.5 seconds and is in accordance with the guidelines in AASHTO's 2011 edition of *A Policy on Geometric Design of Highways and Streets*. The equation for SSD appears below:

$$SSD = 1.47Vt + 1.075 \frac{V^2}{a}$$

SSD = stopping Sight Distance (ft.)

t = brake reaction time (2.5 sec.);

V = vehicle design speed (MPH)

a = deceleration rate, (11.2 ft./s²)

- To determine the minimum acceptable length of Crest and Sag curves shown in Tables 4.3 and 4.4, it is assumed that approach grades are between -3% and 3% in the SSD calculation. The SSD for grades steeper than -3 % or 3% shall be in accordance with the guidelines in AASHTO's current *A Policy on Geometric Design of Highways and Streets*. Tables 4.3 and 4.4 also show values of K. K is defined as the rate of vertical curvature and is equivalent to the horizontal distance in feet required to make a one percent (1%) change in grade. The values of A are equivalent to the algebraic difference in grade between the two grades that are being joined together by the vertical curve.

TABLE 4.3: Minimum Acceptable Crest Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft.)	K	Length of Vertical Curve (L=KA)									
			A=1.6	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	12	50	50	50	50	60	80	90	100	110	120
30	200	19	50	50	60	80	100	120	140	160	180	190
35	250	29	50	60	90	120	150	180	210	240	270	290
40	305	44	70	90	140	180	220	270	310	360	400	440
45	360	61	100	130	190	250	310	370	430	490	550	610
50	425	84	140	170	260	340	420	510	590	680	760	840

TABLE 4.4: Minimum Acceptable Sag Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft.)	K	Length of Vertical Curve (L=KA)									
			A=1.6	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	26	50	60	80	110	130	160	190	210	240	260
30	200	37	60	80	120	150	190	230	260	300	340	370
35	250	49	80	100	150	200	250	300	350	400	450	490
40	305	60	110	140	200	260	320	390	450	520	580	640
45	360	79	130	160	240	320	400	480	560	640	720	790
50	425	96	160	200	290	390	480	580	680	770	870	960

E. Standard Intersection Layout

1. Street intersections shall intersect at ninety-degree (90°) angles. Intersection approaches for Type 6LD and 4LD thoroughfares shall remain perpendicular for a minimum distance equal to the corresponding design speed Stopping Sight Distance (SSD) identified in Table 4.1. For residential collector and/or local street intersections, up to a five degree (5°) tolerance is allowable.
2. When the classification of a thoroughfare changes as it crosses an intersecting street, the design of both thoroughfare approaches shall maintain the characteristics of the higher-class thoroughfare for a minimum distance specified by the City Engineer or designee.
3. The through lane(s) on one approach shall align with the receiving lane(s) on the other side of the intersection. If pre-existing physical encroachments make an offset necessary, a through lane can be offset no more than six feet (6') from its receiving lane when crossing a Type 4LD or smaller thoroughfare and offset no more than eight feet (8') when crossing a Type 6LD thoroughfare. These requirements apply to both public street and private driveway approaches to an intersection.
4. The curb radii shall be a minimum of twenty feet (20') where Type 2L, 2LN and 2LRN thoroughfares intersect with Type 2L, 2LN and 2LRN thoroughfares. The curb radii shall be a minimum of forty feet (40') where Type 6LD, 4LD, 2LC and 2LCB thoroughfares intersect with Type 6LD and 4LD thoroughfares. The curb radii at all other intersecting streets shall be a minimum of thirty feet (30'). Larger curb radii may be required to accommodate fire trucks and/or commercial trucks.
5. Type 6LD-6LD, 6LD-4LD, and 4LD-4LD intersections shall maintain a maximum slope of two percent (2%) a minimum distance of two hundred feet (200') upstream and downstream of the intersection.
6. Roadway connections to a Type 6LD or 4LD thoroughfare shall maintain a maximum slope of two percent (2%) a minimum distance of one hundred feet (100') upstream and downstream of the intersection.
7. A separate grading plan shall be provided for Type 6LD-6LD, 6LD-4LD, and 4LD-4LD intersections. Grading plans shall account for future extensions of Type 6LD and Type 4LD thoroughfares for a minimum distance of six hundred feet (600') beyond the curb return of the intersection in all directions.
8. At four-way intersections of parabolic streets, the reduction of the crown height shall occur on the thoroughfare with the through gutter.
 - a. For Type 2LC, 2LCB and 2L thoroughfares, the crown height reduction from six inches (6") to three inches (3") shall occur through the intersection and transition from the curb return to a point fifty feet (50') past the curb return.
 - b. For Type 2LN thoroughfares, the crown height reduction from four inches (4") to two inches (2") shall occur through the intersection and transition from curb return to a point thirty feet (30') past the curb return.
 - c. For Type 2LRN thoroughfare, the crown height reduction from five inches (5") to three inches (3") shall occur through the intersection and transition from curb return to a point thirty feet (30') past the curb return.
9. A minimum of nine and a half feet (9.5') of parkway shall be maintained from the back of

the curb along the curb's radius.

10. ROW width for a Type 6LD thoroughfare that intersects a Type 6LD or Type 4LD thoroughfare shall be one hundred forty feet (140') for a distance of two hundred feet (200') and then taper at a 15:1 ratio to the standard ROW width. See Figure 4.3.

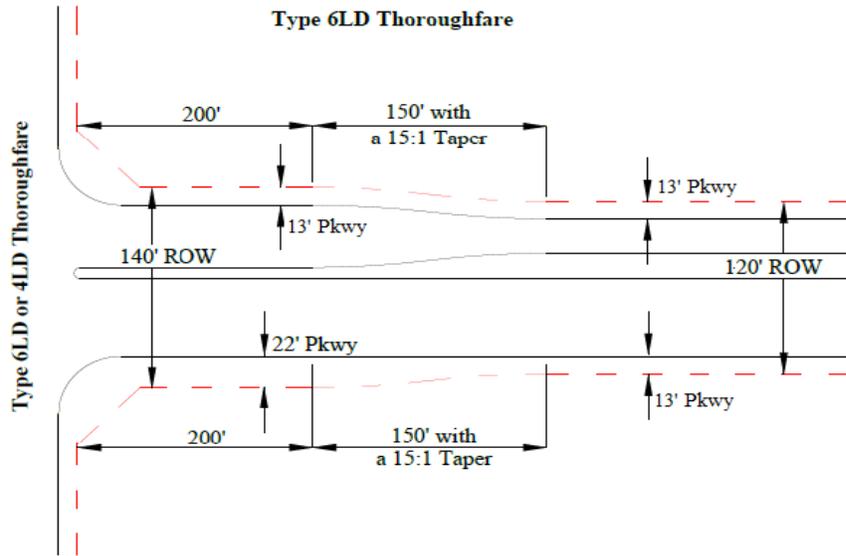


FIGURE 4.3: Type 6LD Thoroughfare Intersection Detail

11. ROW width for a Type 4LD thoroughfare that intersects a Type 6LD or Type 4LD thoroughfare shall be one hundred ten feet (110') for a distance of one hundred fifty feet (150') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figure 4.4.

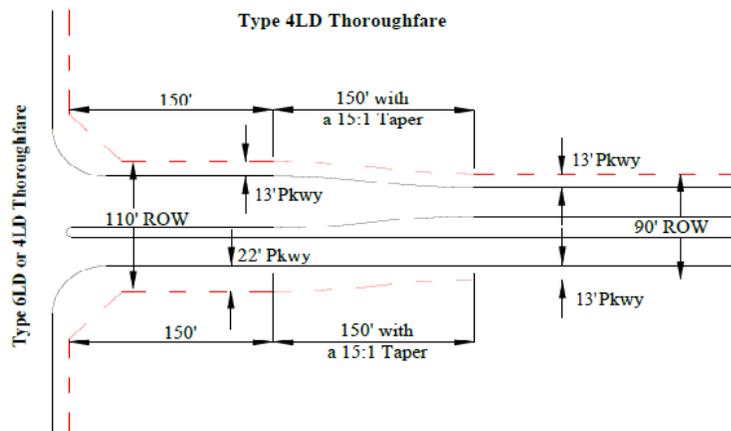


FIGURE 4.4: Type 4LD Thoroughfare Intersection Detail

- The ROW width for a Type 6LD thoroughfare that intersects with a pair of highway frontage roads shall be one hundred sixty feet (160') for a distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. The ROW width for a Type 4LD thoroughfare that intersects with a pair of highway frontage roads shall be one hundred twenty feet (120') for a distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figures 4.5 and 4.6.

Type 6LD Thoroughfare

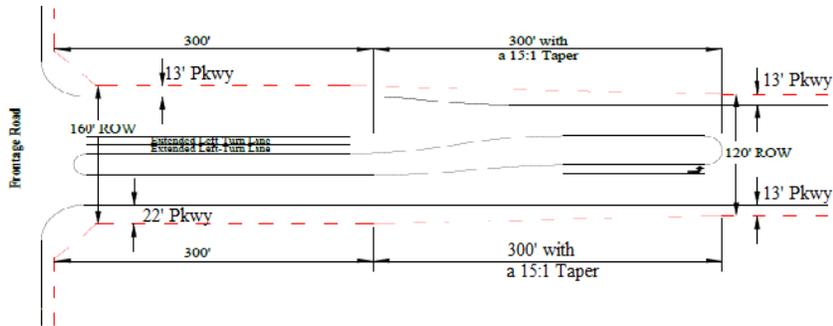


FIGURE 4.5: Type 6LD Thoroughfare Intersection with Frontage Road

Type 4LD Thoroughfare

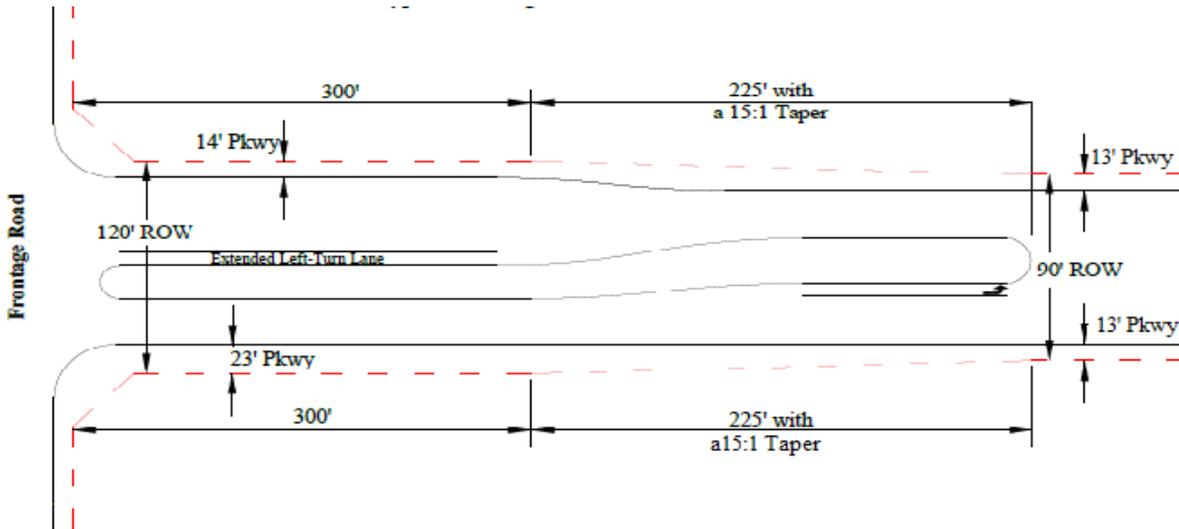


FIGURE 4.6: Type 4LD Thoroughfare Intersection with Frontage Road

F. Residential Frontage

- Residential lots shall not front onto a Type 6LD, 4LD or 2LC thoroughfare or a residential collector unless parallel access roads are provided. The minimum distance between adjacent curbs of the thoroughfare and the access road shall be twenty feet (20'). Access

road ROW shall be in addition to the thoroughfare ROW and access roads shall not connect to the adjacent thoroughfare.

2. Residential lots shall not front onto a Type 2L, 2LN, 2LCB or 2LRN thoroughfare within one hundred feet (100') of the ROW line of the nearest 6LD or 4LD thoroughfare.
3. Residential lots shall not front onto any portion of a Type 2L, 2LN, 2LCB or 2LRN thoroughfare that is part of a residential collector, which is a street that connects to a Type 6LD or 4LD thoroughfare and extends into a neighborhood for more than six hundred feet (600') without changing direction (see Section 4.02.H.5).
4. Residential lots shall not front onto a roundabout. Residential lots adjacent to roundabouts shall be oriented so that their houses do not face the roundabout and their driveways do not intersect with the roundabout or along any section of street with a splitter island.

G. Partial Streets

Longitudinal partial dedications of Type 6LD and 4LD thoroughfares shall be permitted when only one side of a future thoroughfare is being developed. In such a case, one-half of the total right-of-way shall be dedicated and a minimum of twenty four feet (24') of pavement, face- to-face, shall be constructed.

1. Longitudinal partial dedications of Type 2LC, 2L, 2LN, 2LRN, or 2LCB thoroughfares shall be prohibited, except when essential to the reasonable development of a property in conforming with the requirements of the Subdivision Ordinance, and where the Planning & Zoning Commission finds that it will be practical to require the dedication of the other portion of the street when the adjoining property is developed. Whenever a partial street exists along a common property line, the other portion of the street shall be dedicated when the adjoining property is subdivided or developed. Where a partial street is being dedicated along a common property line and the ultimate planned ROW width is sixty feet (60'), the first ROW dedication will be thirty-five feet (35').
 - a. The developer shall construct a minimum of twenty four feet (24') of pavement, face-to- face, for all Type 2LC or 2L thoroughfares that are partial streets at the time of development.
 - b. The developer shall construct the full width of pavement face-to-face for all Type 2LN or 2LRN thoroughfares that are partial street dedications at the time of development.

H. Street Lengths

1. Type 6LD, 4LD, and 2LC thoroughfares have no street length restrictions. Residential streets (Type 2L, 2LN, 2LRN and 2LCB) thoroughfares in a single-family, duplex, or townhome neighborhood) shall have street length restrictions to discourage speeding and cut-through traffic.
2. A residential street that intersects with a 6LD or 4LD thoroughfare and has residential lots fronting any portion of the street shall not exceed a maximum length of six hundred feet (600') measured from the Type 6LD or Type 4LD thoroughfare ROW line. Such an entrance street shall be a minimum of thirty feet (30') wide, face to face, or be divided according to Section 4.03.B.7. On each side of the entrance street, at least one cross street shall have a minimum width of thirty feet (30'), face to face, between the entrance street and the first intersection that provides access deeper into the subdivision. See Figure 4.7 for an example.

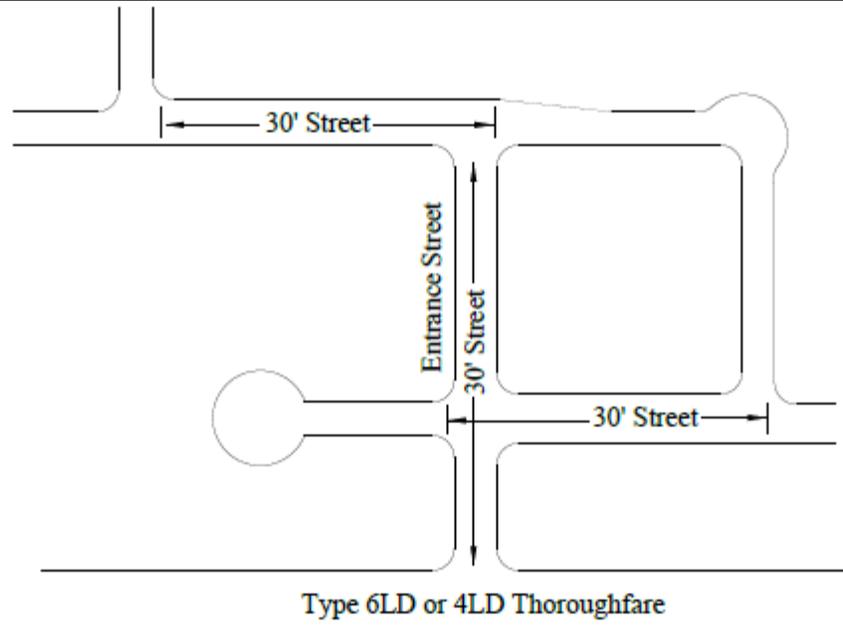


FIGURE 4.7: Example of 30' Entrance Street Requirements

3. Residential streets that do not intersect with a Type 6LD or Type 4LD thoroughfare shall not exceed one thousand two hundred feet (1,200') in length before changing direction. A change in direction occurs when one of the following elements is used:
 - a. A horizontal curve radius of three hundred and fifty feet (350') for a Type 2L or 2LCB thoroughfare or of two hundred and fifty feet (250') for a Type 2LN or 2LRN thoroughfare that changes the course of the street between ninety (90°) and one hundred and twenty degrees (120°) (see Figure 4.8). A tangent that is a minimum of one hundred feet (100') long shall be provided between reverse curves.
 - b. A street offset using two elbow intersections, each between ninety (90°) and one hundred twenty degrees (120°). The minimum distance between reverse elbows shall be one hundred fifty feet (150'). See Figure 4.9.

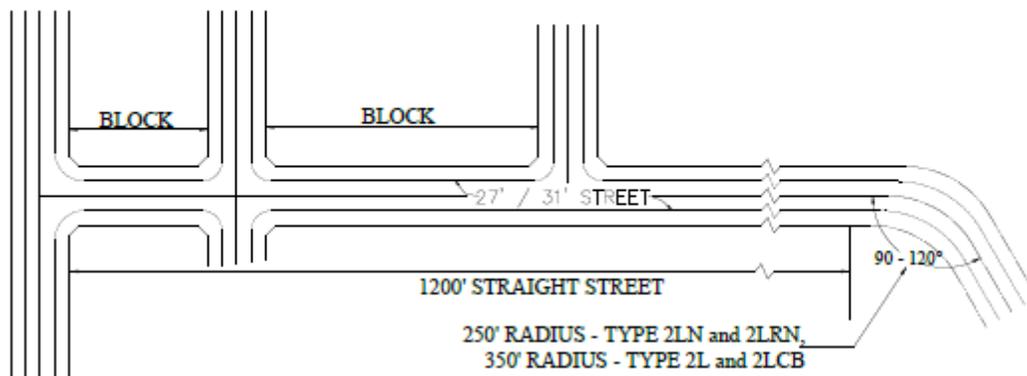


FIGURE 4.8: Change in Street Direction Curve

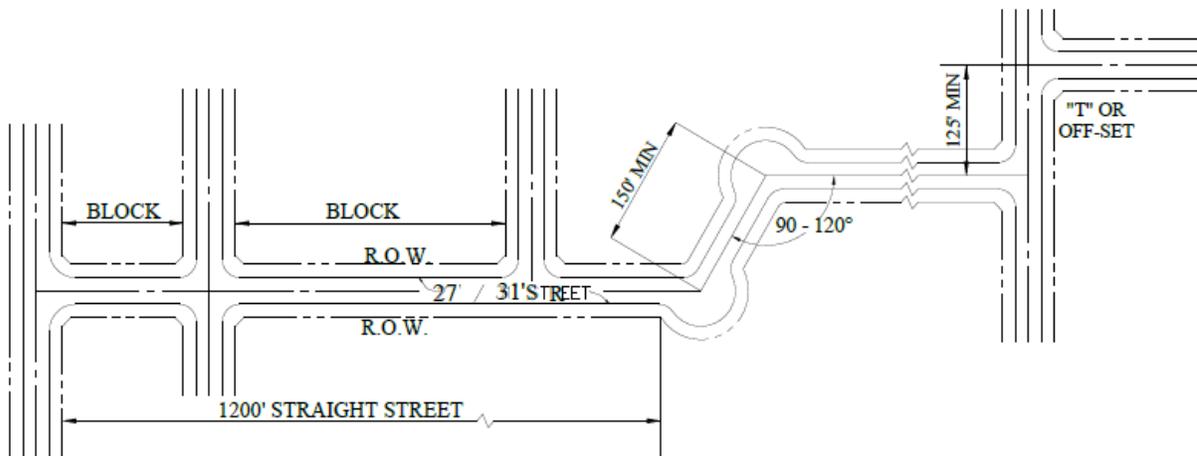


FIGURE 4.9: Change in Street Direction: Offset

4. Residential streets that do not intersect with a Type 6LD or 4LD thoroughfare may extend to a length of one thousand eight hundred feet (1,800') without a change in direction when one of the following is provided:
 - a. A zipper street with a twenty two foot (22') wide travel section with parking cut-outs that are nine feet (9') wide and forty-four feet (44') to eighty-eight feet (88') long and a tree island between the parking cut-outs that is a minimum of thirty feet (30') long and nine feet (9') wide. Parking cut-outs shall be offset from parking cut-outs on the opposite side of the street. A tree shall be planted in each tree island per the requirements in the Zoning Ordinance. Front entry homes are prohibited on this type of street. See Figure 4.10.
 - b. A Type 2LN residential street with street trees, block lengths that do not exceed seven hundred feet (700'), and at least one four-leg intersection. See Figure 4.11.
 - c. A roundabout installed at one or more of the intersections along the street, not counting a roundabout installed at the start or end point of the street.
5. A residential collector shall have no street length restriction provided that, no residential lots front onto any part of the collector and the collector shall not have any straight sections exceeding one thousand feet (1,000'). A residential collector is a street that connects to a Type 6LD or 4LD thoroughfare and extends into a neighborhood for more than six hundred feet (600') without changing direction. A residential collector shall be constructed with the cross section of a Type 2LC, 2L, or 2LCB thoroughfare.

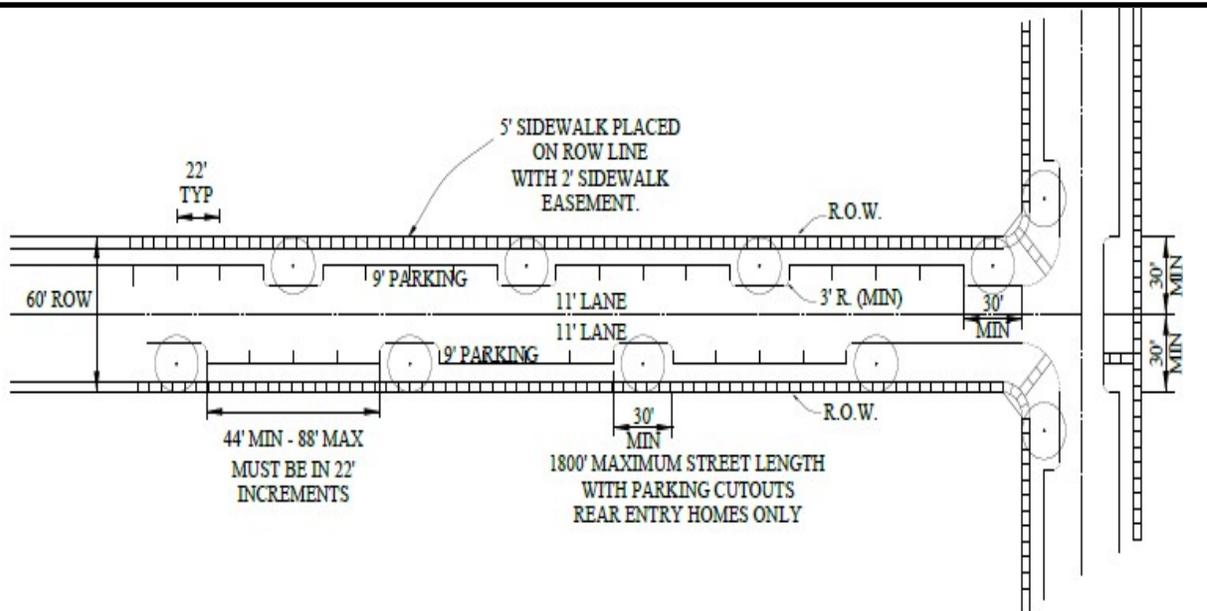


FIGURE 4.10 Maximum Street Length: Zipper Street

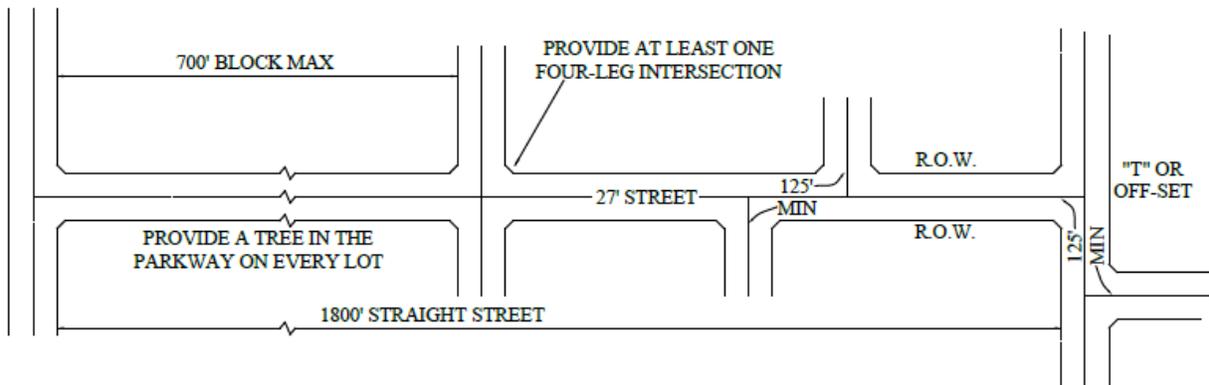


FIGURE 4.11 Maximum Street Length: Short Blocks, Trees and a four leg Intersection

I. Block Requirements

1. **Block Length** – Blocks shall not exceed one thousand two hundred feet (1,200') in length, measured from street ROW line to street ROW line. In the case of non-rectangular blocks, each side of the block with lots fronting it shall not exceed one thousand two hundred feet (1,200'), measured between the vertices formed by the extension of ROW lines at each corner of the block. Blocks shall be further restricted so that they shall contain no more than twenty (20) lots on one side. Blocks with a continuous series of lots longer than one thousand two hundred feet (1,200'), measured along one or more sides, may be required to be bisected by a pedestrian easement and a sidewalk (see Section 4.06.B.14).
2. **Block Width** – Blocks shall be wide enough to allow two (2) tiers of lots and shall have a block width no less than two hundred feet (200'), except when only one tier of lots is

possible due to the size of the property or the need to back up to a Type 6LD or 4LD thoroughfare.

J. Roundabouts

1. Roundabout is a form of circular intersection with the following characteristics and design features:
 - Yield control on entering traffic to circulating traffic
 - Counterclockwise circulation of traffic around a central island and
 - Appropriate geometric curvature to include slow and consistent speeds through the intersection.

Requiring entering traffic to wait for gaps in the circulating traffic flow prevents the intersection from locking up. Adequate horizontal curvature of entering and exiting vehicle paths reduces the entry and circulating speeds, which improves safety by reducing the severity of crashes. In general, the roundabout is optimally located when the centerlines of all approach legs pass through the center of the inscribed circle. This location usually allows the geometry to be adequately designed so that vehicles will maintain slow speeds through both the entries and the exits. The radial alignment also makes the central island more conspicuous to approaching drivers. If it is not possible to align the legs through the center point, a slight offset to the left (i.e., the centerline passes to the left of the roundabout's center point) is acceptable. This alignment will still allow sufficient curvature to be achieved at the entry, which is of supreme importance. It is almost never acceptable for an approach alignment to be offset to the right of the roundabout's center point. This alignment brings the approach in at a more tangential angle and reduces the opportunity to provide sufficient entry curvature. Vehicles will be able to enter the roundabout too fast, resulting in more loss-of control crashes and higher crash rates between entering and circulating vehicles. See Figure 4.12 below. Figure 4.13 identifies the predominant design features of a roundabout.

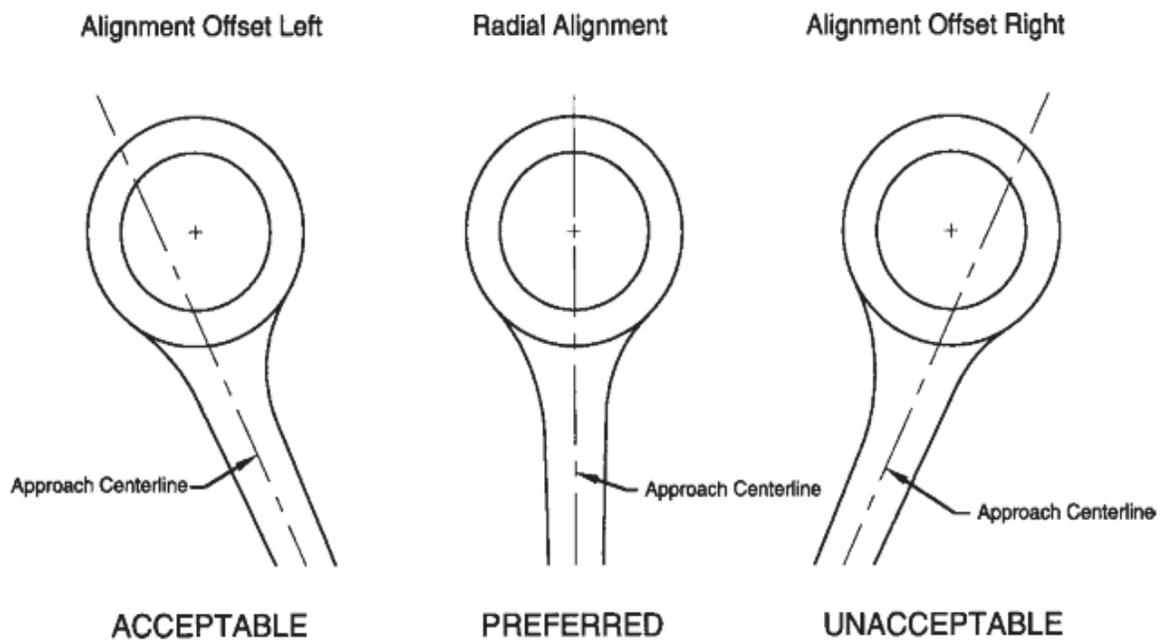


Figure 4.12: Radial Alignment of Entries

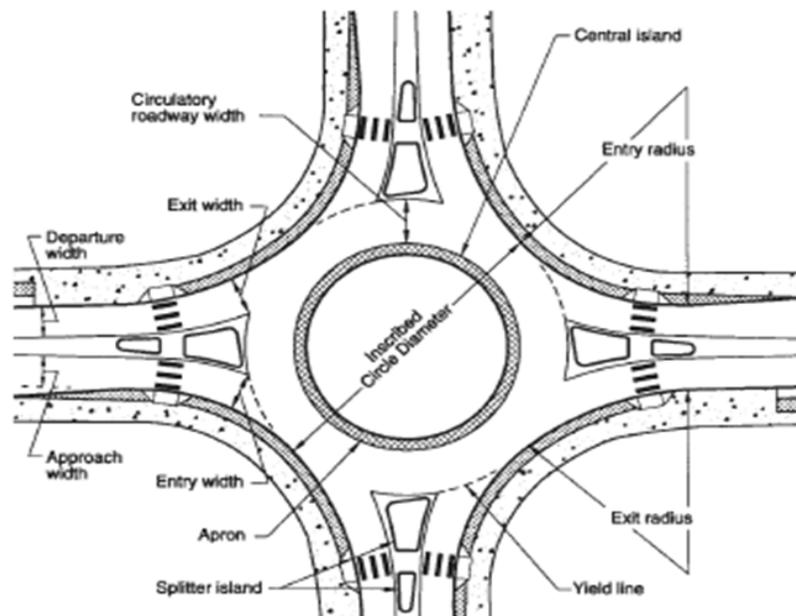


Figure 4.13: Roundabout Design Features

In a modern roundabout, the curvature of the splitter islands, the location of the splitter islands in relation to the central island and the width of the circulatory roadway create an environment for low and consistent operating vehicle speeds. Small and medium roundabout use truck aprons around the central island to accommodate larger vehicles such as tractor-trailers and emergency vehicles. Larger vehicles are able to track on the truck apron without running over the central island. Table 4.5 provides a description of each of the design features.

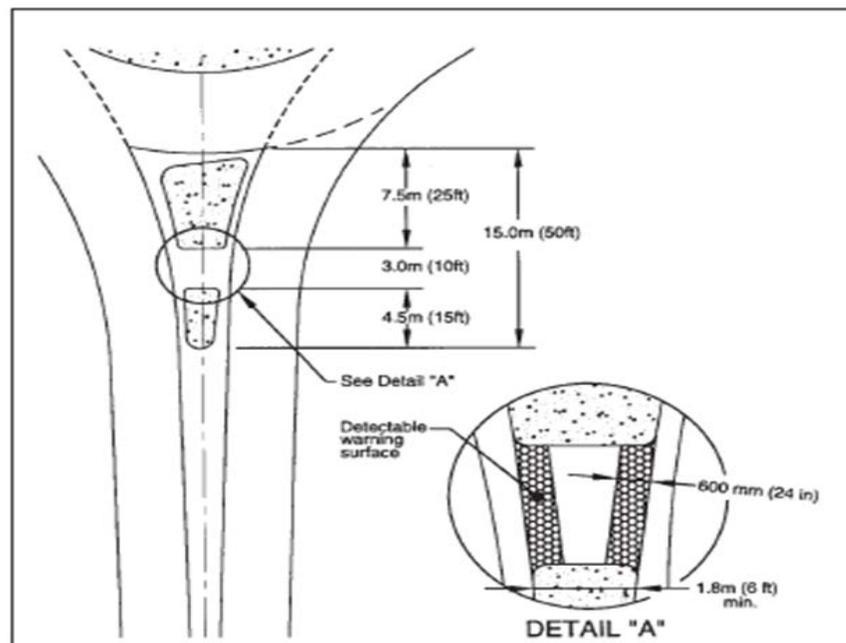


Figure 4.14: Minimum Splitter Island Dimension

Table 4.5: Description of key roundabout features

Feature	Description
Central Island	The central island is the raised area in the center of a roundabout around which traffic circulates. The central island does not necessarily need to be circular in shape. In the case of mini-roundabouts the central island is traversable.
Splitter Island	The splitter island is the raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic and allow pedestrians to cross the road in two stages.
Circulatory roadway	The circulatory roadway is the curved path used by vehicles to travel in a counterclockwise fashion around the central island.
Truck apron	The truck apron is the traversable portion of the central island adjacent to the circulatory roadway that may be needed to accommodate the wheel tracking of large vehicles. An apron is sometimes provided on the outside of the circulatory roadway.
Entrance Line	The entrance line marks the point of entry into the circulatory roadway. This line is physically an extension of the circulatory roadway edge line but functions as a yield or give-way line in the absence of a separate yield line. Entering vehicles must yield to any circulating traffic coming from the left before crossing this line into the circulatory roadway.
Accessible Pedestrian Crossings	For roundabouts designed with pedestrian pathways, the crossing location is typically set back from the entrance line, and the splitter island is typically cut to allow pedestrians, wheelchairs, strollers and bicycles to pass through. The pedestrians' crossings must be accessible with detectable warnings and appropriate slopes in accordance to ADA requirements.
Landscape strip	Landscape strips separate vehicular and pedestrian traffic and assist with guiding pedestrians to the designated crossing locations. This feature is particularly important as a way-finding cue for individuals who are visually impaired. Landscape strips can also significantly improve the aesthetics of the intersection.

2. Categories of Roundabouts

Roundabouts are categorized according to size and number of lanes. The following are the categories:

- Mini-roundabouts
- Single-lane roundabouts and
- Multi-lane roundabouts

The three main roundabout categories can be further subdivided by their location (example, rural, urban and suburban).

I. Mini-Roundabout

Mini-roundabouts have relatively small inscribed circle diameter (typically 45 to 90ft.) and fully traversable central islands, allowing larger vehicles to cross over the central island when turning. However, they are designed to accommodate passenger vehicles without requiring them to drive over the central island. Mini-roundabouts are useful in locations with limited right-of-way or other restrictions. They are most commonly implemented in low-speed urban environments with average operating speeds of 30mph or less. Typical entry speeds for a mini-roundabout are 15 to 20mph. a mini-roundabout controls speed through the geometric design of the entry and exit legs and the design that requires most vehicles to travel around the central island.

Mini-roundabouts are moderately inexpensive because they do not require extensive additional pavement at an intersection. They are perceived as pedestrian-friendly because they are small, have short crossing distances and very low vehicle speeds at the entry and exist of the intersection.

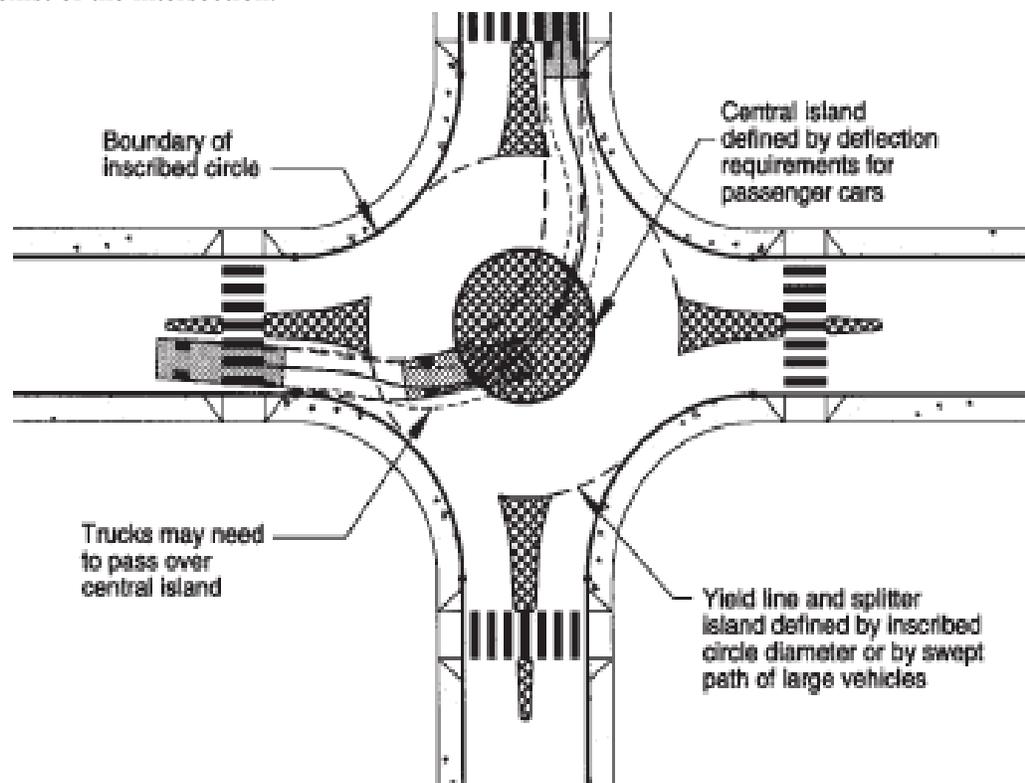


Figure 4.15: Example of Mini-Roundabout

II. Single-Lane Roundabout

Single-lane roundabout have one lane entries at all legs and one circulatory lane. They are distinguished from the mini-roundabout by their larger inscribed circle diameters (typically 90 to 180ft.), more tangential entries and exits and non-traversable central islands. Their design, focused on achieving consistent entering and circulating vehicle speeds, allows slightly higher speeds than a mini-roundabout at the entry, on the circulatory roadway and at the exit. Typical entry speeds for a single-lane roundabout are 20 to 25 mph. the geometric design features of a single lane roundabout include raised splitter islands, a non-traversable central island, cross walks and a truck apron. Figure 4.16 shows the features of a typical single-lane roundabout.

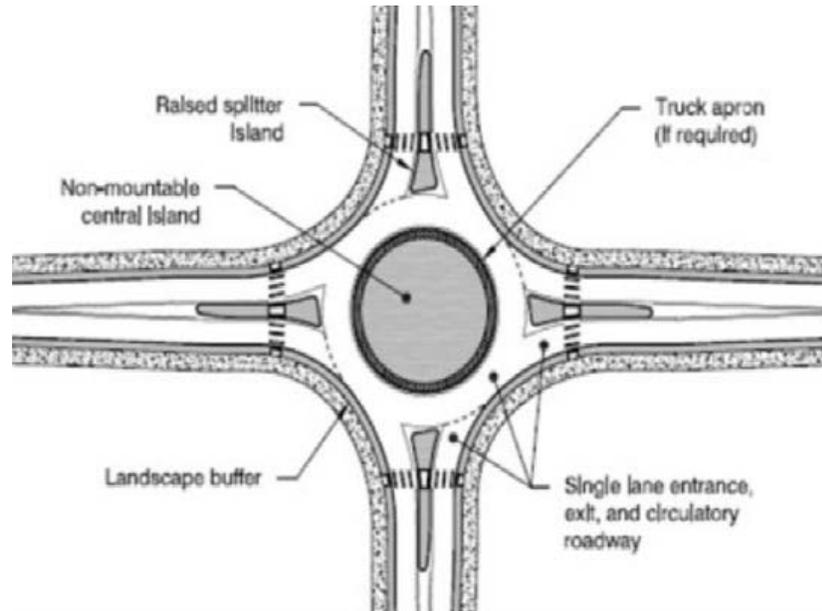


Figure 4.16: Features of a single-lane roundabout

III. Multi-lane Roundabouts

Multi-lane roundabouts have a minimum of one entry with more than one lane. Entry lanes can flare from a single –lane approach to two lanes to accommodate traffic patterns (e.g. heavy turn movement). The circulatory roadway is wider for a multi-lane roundabout to accommodate vehicles traveling side-by-side. The design allows speeds at the entry, on the circulatory roadway, and at the exit similar to or slightly higher than those for the single-lane roundabouts. Typical entry speeds for a multilane roundabout are 25 to 30mph. The geometric design features of a multi-lane roundabout included raised splitter islands, a non-traversable central island and possibly apron. Figure 4.17 shows features of a typical multi-lane roundabout.

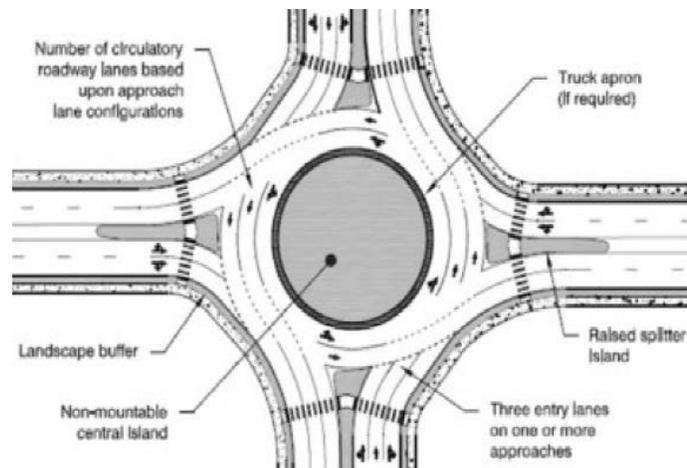


Figure 4.17: Features of a multi-lane roundabout

Table 4.6: Roundabout category comparison

Design Element	Mini-Roundabout	Single-lane Roundabout	Multilane Roundabout
Desirable maximum entry design speed	15-20 mph (25 to 30 km/h)	20-25mph (30 to 40 km/h)	25 – 30 mph (40 to 50 km/h)
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45- 90 ft. (13 to 27m)	90-180 ft. (27 to 55m)	150- 300 ft. (46 to 91m)
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh./day)*	Up to approximately 15,000	Up to approximately 25,000	Up to approximately 45,000 for two-lane roundabout
* Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs			

IV. Difference between Roundabout and Other Circular Intersections

Roundabout is a type of circular intersection. Other distinct types are Rotaries, signalized traffic circles and neighborhood traffic circles. Table 4.7 presents five key elements that distinguish roundabouts from other types of circular intersections.

Table 4.7: Difference between roundabout and other types of circular intersections

Key Element	Roundabout	Traffic Circle
Control on entry	YIELD control on entry	Some use a signal, stop control or no control on one or more entries
Priority to circulating vehicles	Circulating vehicles have the right of way	Some require circulating traffic to yield to entering traffic
Pedestrian access and crossing	Allowed only across the approaches to the roundabout behind the entrance line	Some allow pedestrian to cross to the central island
Parking	No parking allowed within the circulatory roadway or at the entries.	Some allow parking within the circulatory roadway
Direction of circulation	Counterclockwise direction to the right of the central island	Some allow left-turning vehicles to pass to the left of the central island

1. Roundabouts may be considered for the intersection of Type 4LD, 2LC, 2L, 2LN, 2LCB, or 2LRN thoroughfares with Type 2LC, 2L, 2LN, 2LCB, or 2LRN thoroughfares. Roundabouts shall not be installed at a Type 6LD - 6LD, 6LD - 4LD, or 4LD - 4LD intersection without a detailed traffic simulation and cost-benefit analysis approved by the City Engineer or designee. Roundabouts shall not be installed along a six-lane (6LD) thoroughfare.
2. Roundabouts on private property that connect to a private street or to a fire lane shall be designed to the standards in these design requirements.
3. Roundabouts shall be designed to accommodate a City fire truck making all possible entry and exit movements. A fire truck shall be able to make the “through” movement without traveling on a truck apron.
4. Roundabouts shall include the typical features of a modern roundabout shown in Figure 4.13 and described in these design requirements.
5. The curb surrounding the central island shall be six- inch (6”) mountable curb if a truck apron is provided and six- inch (6”) vertical curb if no truck apron is provided. The curb surrounding a truck apron shall be three-inch (3”) mountable curb. The curb surrounding all faces of each splitter island shall be four- inch (4”) mountable curb.
6. The inscribed circle radius shall be a minimum of fifty-five feet (55’) and a maximum of eighty feet (80’) for a single lane roundabout, and a minimum of seventy-five feet (75’) and a maximum of a hundred feet (100’) for a two-lane roundabout.
7. The circulatory roadway shall have a minimum width of sixteen feet (16’), face-to-face. The circulatory roadway shall be at least as wide as the maximum entry width at the roundabout. If the circulatory roadway is less than twenty- nine feet (29’) wide, face-to-face, a truck apron shall be provided. The combined width of the circulatory roadway and the truck apron shall be a minimum of twenty- nine feet (29’). Truck aprons shall provide a solid surface of concrete pavers that are a contrasting color compared to the pavement of the circulatory roadway and shall not give the appearance of being a sidewalk.
8. Single lane entries and exits shall be a minimum of sixteen feet (16’) wide, face to face. Two-lane entries and exits shall be a minimum of twenty- four feet (24’) wide, face to face.
9. Splitter islands shall provide a solid surface of concrete pavers unless the entry and exit on the same leg of the roundabout are both at least twenty- four feet (24’) wide, face-to-face. The pavers shall be a contrasting color compared to the street pavement and no signs shall be installed in the splitter island. If pavers are not required, the splitter island can contain landscaping provided it does not interfere with the necessary sight distance.
10. Crosswalks shall pass through or in advance of each splitter island.
11. All streets, fire lanes, and approved driveways shall intersect radially with a roundabout. Residential driveways shall not intersect with a roundabout.
12. Landscaping and/or monuments within the central island are encouraged, but shall be limited so that the minimum sight distances described in FHWA’s *Roundabouts: An Informational Guide* are provided at the roundabout. For vehicles approaching the roundabout, this includes the approach stopping sight distance to the crosswalk or the yield line, the stopping sight distance to the crosswalk on the next exit, and the intersection sight distance to circulating vehicles and vehicles entering at the immediate upstream entry. For circulating vehicles, this includes the stopping sight distance on the circulatory roadway.

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13. Parking is prohibited within a roundabout.
 14. On any approach to roundabout, driveways, alley connections, and on-street parking shall not be permitted between the crosswalk and the yield line or along any portion of street that contains a splitter island.
 15. The ROW for a roundabout shall extend a minimum of twelve feet (12') beyond the back of its outer curb. The ROW for any street entering the roundabout will flare out as the street flares so that a minimum of twelve feet (12') is provided beyond the back of curb on each side of the street.
 16. The roundabout entries and exits and the pavement contained within the inscribed circle radius shall be constructed on a uniform plane of the same grade, which shall not exceed two percent (2%). Roadway approaches to the roundabout shall have a maximum slope of two percent (2%) for a distance of at least two hundred feet (200') for Type 4LD thoroughfares and at least one hundred feet (100') for Type 2LC, 2LCB, 2L, 2LRN, and 2LN thoroughfares.
 17. Roundabouts shall be illuminated by streetlights as described in FHWA's *Roundabouts: An Informational Guide*.

4.03 Median, Left-Turn Lane, Right-Turn Lane, Deceleration Lane, and Island Design

A. Required Median Openings and Left-Turn Lanes

1. Median openings on divided thoroughfares shall be required at all street intersections. Median openings may be constructed to serve non-residential drives provided that the minimum spacing requirements herein are met. Left-turn lanes are required for each street or driveway that connects to a median opening. The design of median openings and left-turn lanes shall accommodate potential future left-turn lanes that might serve undeveloped land.
2. All non-residential lots on a divided thoroughfare shall have direct or indirect access to a median opening. Indirect access shall be provided through a series of fire lane and access easements.
3. Multi-family developments on a divided thoroughfare shall have direct access to a median opening.
4. The City can modify, relocate, or remove any existing or planned median opening to facilitate traffic flow and/or preserve the health, safety and welfare of the Public, as reasonably determined by the City Engineer or designee utilizing recognized industry standards as they exist or amended.

B. Minimum Left-Turn Storage, Taper Length, and Median Opening Width, Location, and Spacing Requirements

1. Left-Turn Lane Storage
 - a. All single left-turn lanes constructed on divided thoroughfares of ultimate cross section width shall be a minimum of eleven feet (11') wide. Where double left-turn lanes are provided, each left-turn lane shall be a minimum of ten feet (10') wide.
 - b. All left-turn lanes constructed as future through lanes on divided thoroughfares shall be twelve feet (12') wide for the entire storage and taper length requirements as listed in Table 4.5.

- c. Minimum storage requirements are listed in Table 4.5. Storage requirements may be increased by the City based upon actual and projected traffic demands of the properties that will be served by the left-turn lane.
 - d. Left-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
 - e. Concrete pavers shall be required in the median where the median width is six feet (6') or less, back of curb to back of curb. If the median width is greater than six feet (6'), then concrete pavers shall be required for a minimum distance of ten feet (10') from the median nose. See Figure 4.18.
2. Taper Length – The taper specifications for left-turn lane entrance areas are specified in Table 4.5. The variables used for the specifications are shown in Figure 4.18.

TABLE 4.5: Minimum Left-Turn Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width(s) (ft)	Length of Full-Width Storage(ft)	Taper Specifications		
				Length(ft)	R1(ft)	R2(ft)
6LD	6LD, 4LD	10 ⁽¹⁾⁽⁴⁾	150,250 ⁽²⁾	200	505	505
4LD	6LD, 4LD	11	150	100	250	250
6LD, 4LD	2LC, 2LCB, Residential Collector	11 ⁽⁴⁾	150	100	250	250
6LD, 4LD	2L, 2LN, 2LRN	11 ⁽⁴⁾	100 ⁽³⁾	100	250	250
TxDOT Road	6LD, 4LD, 2LC, 2L, 2LN, 2LCB, 2LRN and Non-Residential Driveway	See TxDOT's Roadway Design Guide and Specifications ⁽⁵⁾				
Frontage Road	6LD, 4LD, 2LC, 2L, 2LN, 2LCB, 2LRN and Non-Residential Driveway	Apply Type 6LD Thoroughfare specifications to Dallas Pkwy Apply TxDOT specifications US 380				

- (1) Double left-turn lanes
- (2) 150 feet for the inside left-turn lane; 250 feet for the outside left-turn lane
- (3) 150 feet of storage shall be required for gated communities.
- (4) Left-turn lanes that will become a future through lane shall be twelve feet (12') in width and be square at the end and incorporate a street header.
- (5) Turn lane designs on Preston Road (SH 289) shall also meet the requirements set forth in the Preston Corridor Access Management Plan.

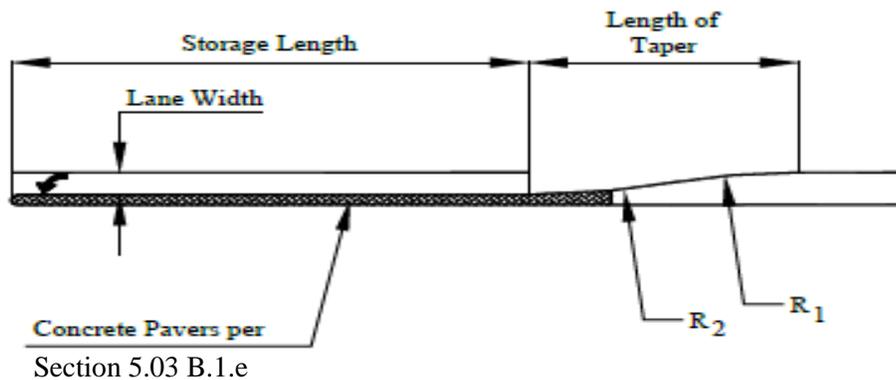


FIGURE 4.18: Typical Left Turn Lane Dimensions

3. Median Openings
 - a. Median openings shall accommodate all turning paths and crosswalks.
 - b. The width of mid-block median openings shall not be less than sixty feet (60'). They may be greater than sixty feet (60') where necessary to accommodate turning paths and crosswalks subject to approval by the City Engineer or designee.
 - c. Median openings shall not be less than seventy feet (70') wide at divided high capacity driveways (see Section 4.05.B.5).
4. The minimum distance to the first mid-block median opening along a Type 6LD or 4LD thoroughfare that is immediately downstream from a Type 6LD or 4LD thoroughfare is shown in Figure 4.19. This distance varies from three hundred and fifty feet (350') to six hundred feet (600'), measured nose to nose, depending on the thoroughfare type and the type of mid-block opening.
5. The minimum distance between median openings on a Type 6LD or 4LD thoroughfare where left turn storage is provided in both directions for Types 2LC, 2L, 2LCB, 2LN, and 2LRN intersecting thoroughfares and driveways is shown in Figure 4.20. The distances shown are measured nose to nose. Refer to Table 4.11 for driveway design requirements.
6. Medians without Left-Turn Lanes in Both Directions
 - a. If a left-turn lane is required in only one direction, the minimum length of the median shall be the sum of the required left-turn storage, taper length, fifty foot (50') tangent, and length of median nose. This requirement is reflected in Figure 4.20. This median design is only allowed if access is not compromised for vacant property on the opposite side of the thoroughfare.
 - b. If the left-turn storage is not required in either direction, but the median is simply a spacer between two median openings, the minimum length of the spacer must be one hundred feet (100') (see Figure 4.21). A minimum spacing of one hundred feet (100') from the median opening to the first non-residential driveway shall be maintained.
 - c. If a driveway is not served by a left-turn lane, then seventy-five feet (75') of separation shall be provided from edge of driveway to the median opening.

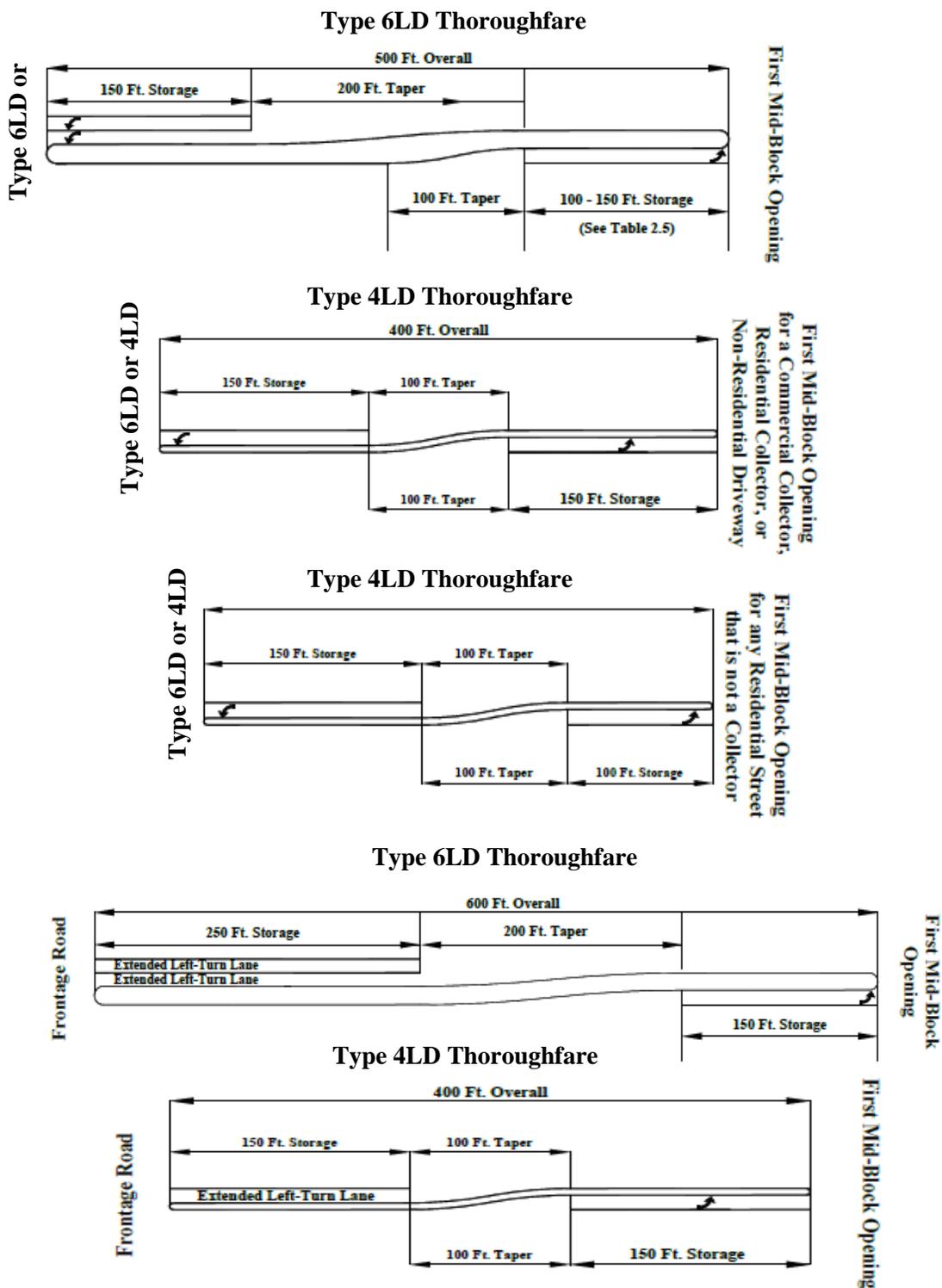
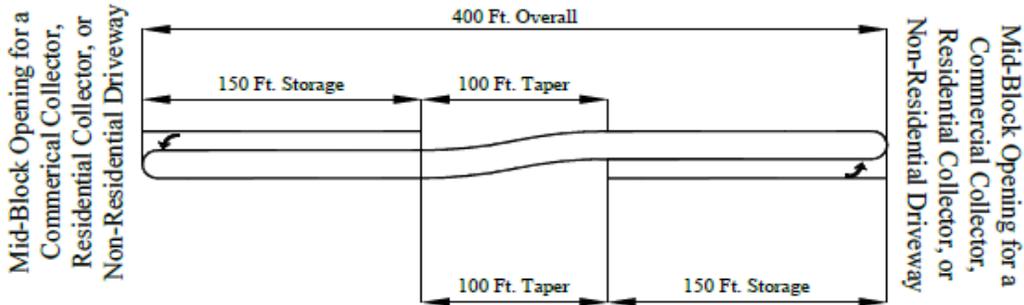
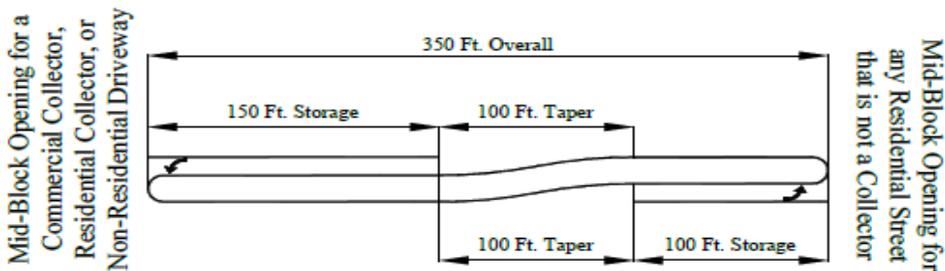


FIGURE 4.19: Minimum Spacing between Type 6LD or 4LD Thoroughfare and First Mid-Block Median Opening on a Type 6LD or 4LD Thoroughfare

Type 6LD or 4LD Thoroughfare



Type 6LD or 4LD Thoroughfare



Type 6LD or 4LD Thoroughfare

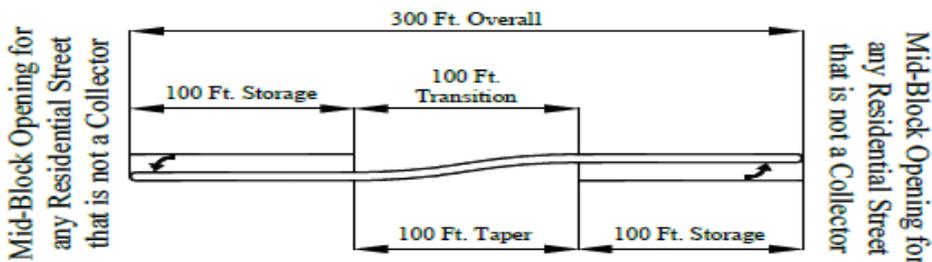


FIGURE 4.20: Minimum Spacing between Mid-Block Median Openings on a Type 6LD or 4LD Thoroughfare

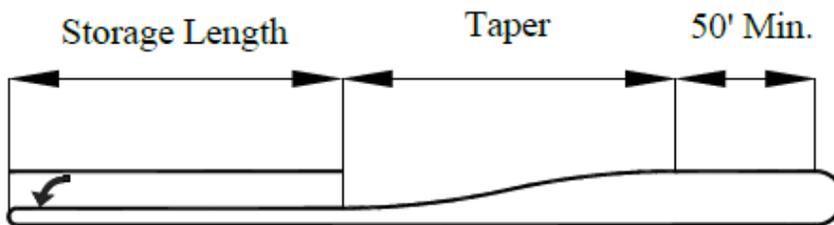


FIGURE 4.21: Minimum Length of Median Where a Left-Turn Lane is needed in Only One Direction

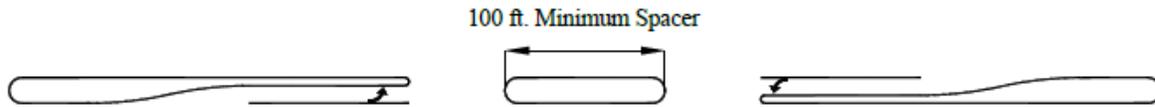


FIGURE 4.22: Minimum Spacer Length

7. Medians on Public Street Entrances to Developments

- a. Medians installed on undivided thoroughfares at entrances to subdivisions for aesthetics or any other purpose shall be a minimum of thirteen feet (13') wide and one hundred feet (100') long (see Figure 4.2 for Divided Residential Subdivision Entrance cross section).
- b. A divided residential subdivision entrance shall transition to the normal residential street width upstream or downstream of the first street intersection. No part of the transition shall occur within an intersection.
- c. If specified by zoning, alternative design standards may be required for these types of subdivision entrances.

C. Minimum Right-Turn Storage and Taper Length

1. Right-Turn Lane Storage

- a. At all intersections on Type 6LD and B thoroughfares, right-turn lanes shall be constructed at the time of development.
- b. All right-turn storage areas shall be eleven feet (11') wide.
- c. Additional ROW shall be required adjacent to right-turn lanes so that there is a minimum of ten feet (10') of ROW from the back of curb.
- d. Right-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
- e. Minimum storage requirements are listed in Table 4.6. Storage requirements may increase based upon actual and projected traffic demands.
- f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveways or cross street curb return and the taper of a right-turn lane.

2. Taper Length – The taper specifications for right-turn lane entrance areas are specified in Table 4.6. The variables used for the specification are shown in Figure 4.23

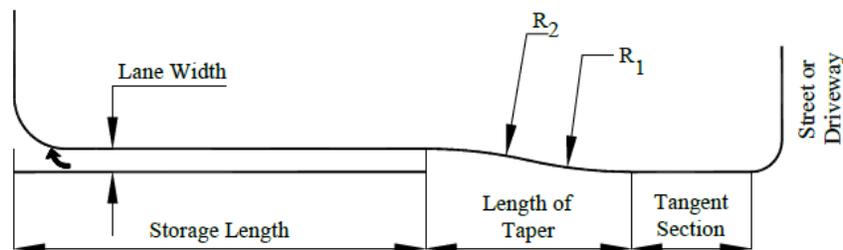


FIGURE 4.23: Typical Right-Turn / Deceleration Lane Dimensions

TABLE 4.6: Minimum Right-Turn Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width(s) (ft.)	Length of Full-Width Storage(ft.) ⁽¹⁾	Taper Specifications ⁽²⁾		
				Length(ft.)	R1(ft.)	R2(ft.)
6LD	6LD, 4LD	11	225	150	515	515
4LD	6LD, 4LD	11	175	150	515	515
6LD, 4LD	2LC, 2LCB, Residential Collector	11	150	110	280	280
6LD, 4LD	2L, 2LN	11	100	110	280	280
TxDOT Road	6LD, 4LD, 2LC, 2L, 2LN AND 2LCB	See TxDOT's Roadway Design Guide and Specifications				
Frontage Road	6LD, 4LD, 2LC, 2L, 2LN AND 2LCB	Apply Type 6LD Thoroughfare specifications to Dallas Pkwy Apply TxDOT specifications to SH 121 and US 380				

1. Measured from the edge of the driveway.
2. When a deceleration lane is immediately downstream from an intersecting Type 6LD or 4LD thoroughfare, its storage can be reduced to 100 feet and its taper can be reduced to 70 feet (see Figure 4.28)

D. Minimum Deceleration Lane Storage and Taper Length

1. Deceleration Lane Storage

- a. Deceleration lanes are required on Type 6LD and 4LD thoroughfares at all non-residential and multi-family driveways.
- b. All deceleration lane storage areas shall be eleven feet (11') wide.
- c. In locations where there will be less than ten feet (10') of ROW adjacent to the deceleration lane, a street easement shall be dedicated such that the combination of ROW and street easement extends at least ten feet (10') from the back of curb of the deceleration lane. Street easements shall extend along the street a minimum of forty feet (40') beyond the far edge of the driveway to allow for utility connections.
- d. Deceleration lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
- e. Minimum storage requirements are listed in Table 4.7. Storage requirements may increase based upon actual and projected traffic demands.
- f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveways or cross street curb return and the taper of a deceleration lane.
- g. A tangent section is not required when a deceleration lane is immediately downstream from an intersecting Type 6LD or Type 4LD thoroughfare.

2. Taper Length – The taper specifications for deceleration lane entrance areas are specified in Table 4.7. The variables used for the specification are shown in Figure 4.22.

TABLE 4.7: Minimum Deceleration Lane Design Requirements

Type of Thoroughfare On	Type of Thoroughfare At	Turn Lane Width (s)(ft)	Length of Full Width Storage (ft) ⁽¹⁾	Taper Specifications		
				Length (ft)	R1 (ft)	R2 (ft)
6LD	Non-Residential Driveway	11	110 ⁽²⁾	110 ⁽²⁾	280	280
4LD	Non-Residential Driveway	11	90	110 ⁽²⁾	280	280
TxDOT Road	Non-Residential Driveway	See TxDOT's Roadway Design Guide and Specifications				
Frontage Road	Non-Residential Driveway	Apply Type 6LD Thoroughfare specification.				

1. Measured from the edge of the driveway
2. When a deceleration lane is immediately downstream from an intersecting Type 6LD or 4LD thoroughfare, its storage can be reduced to 100feet and its taper can be reduced to 70 feet (see figure 4.28)

E. Cost of Median Openings and Turn Lanes

1. Median openings, left-turn lanes, and right-turn lanes constructed for residential streets and/or subdivision entrances not referenced on the Thoroughfare Plan shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.
2. Median openings, left-turn lanes and deceleration lanes for multi-family and non-residential developments shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.
3. If median openings, left-turn lanes, deceleration lanes or right-turn lanes are not constructed at the time of development, the developer shall escrow funds for such future improvements prior to final acceptance. The escrow amount shall include all costs for engineering, inspection, and construction.

4.04 Alley Design

A. Alley Intersections

1. Alleys shall not intersect any Type 6LD, 4LD, or 2LC thoroughfare or any residential collector.
2. Alleys that are parallel to and share a common ROW line with a Type 6LD, 4LD, or 2LC thoroughfare or a residential collector shall turn away from that thoroughfare not less than forty feet (40') or one subdivision lot width (whichever is greater) from the cross street ROW as shown in Figure 4.23.
3. Alleys shall intersect with a residential street so that the alley ROW line is not less than forty feet (40') or one subdivision lot width (whichever is greater) from the ROW of the nearest cross street as shown in Figure 4.23.

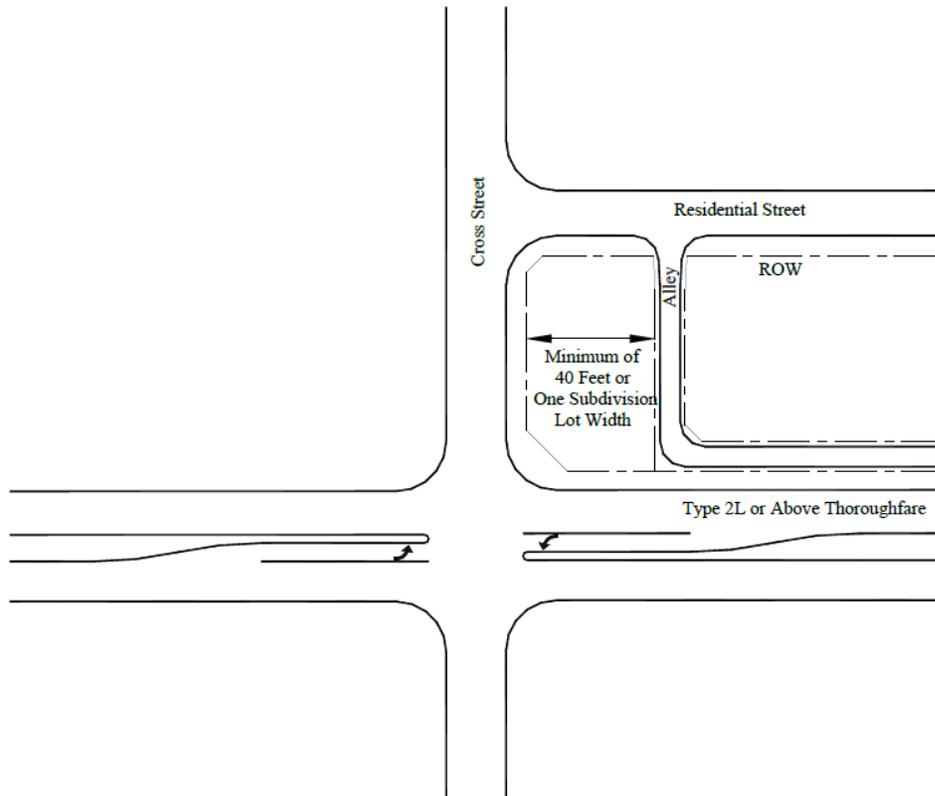


FIGURE 4.24: Minimum Distance from Intersection for Parallel Alley

4. All alley intersections with streets shall be perpendicular or radial, within a five degree (5°) tolerance, at the intersection of the ROW lines.
5. The offset between alleys on opposite sides of a residential street shall be less than three feet (3') or greater than seventy-five feet (75') measured from edge of alley to edge of alley.
6. Alleys shall not align with existing or future streets or driveways on the opposite side of a street. Alleys shall be offset from such a street or driveway by a minimum of seventy-five feet (75') measured from edge of alley to edge of street or driveway.
7. Alleys that intersect at "elbow" street intersections shall not intersect within thirty (30°) degrees of the centerline of the adjacent streets. See Figure 4.25.
8. Alleys shall not intersect with a roundabout.

TABLE 4.8: Alley Intersecting Alley Radius

Alley ROW Intersection	Angle Minimum Required ROW Radius (ft)
1°-40°	70
41° -70°	50
71° -90°	40
> 90°	50

- B. Alley ROW Width – Alley ROW shall be eighteen feet (18') wide.
- C. Alley Pavement Width – Alley pavement shall be twelve feet (12') wide except near alley intersections, as shown in Figure 4.26, and except near street intersections as shown in Figure 4.27.

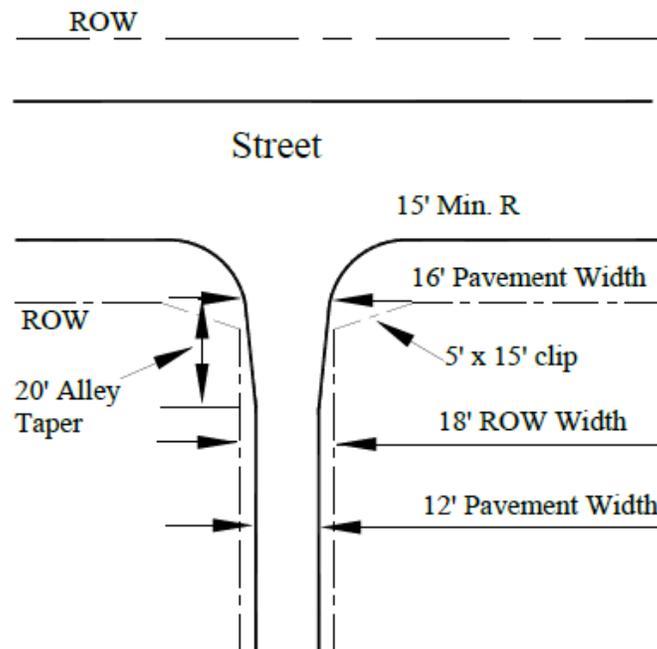


FIGURE 4.27: Alley to Street Intersection

- D. Alley Length – Alleys shall not exceed eight hundred feet (800') in length without an intermediate connection to a residential street.
- E. Alley Pavement Thickness – See Section 5 of the Engineering Standards for alley subgrade and pavement design requirements.
- F. Alley as Fire Lane – An alley that also serves the purpose of a fire lane shall be constructed to the standards of a fire lane as required by the Fire Department. These standards include, but are not limited to, a minimum pavement width of twenty four feet (24') and a minimum radius of alley pavement of twenty feet (20') at street intersections.
- G. Rear Alley Frontage – The minimum alley rear frontage shall be twenty feet (20').
- H. Alley Visibility Obstructions
1. No fence, wall, screen, sign, structure, landscaping rock greater than four inches (4") in height, or foliage of hedges, trees, bushes, or shrubs shall be erected, planted or maintained in any alley ROW.
 2. Foliage of hedges, trees, bushes, and shrubs planted adjacent to the alley ROW shall be maintained by the property owner such that the overhang or encroachment shall be no less than fourteen feet (14') above the alley surface and no less than one foot (1') outside the edge of the pavement.

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- I. Alley Grade
 - 1. Alleys shall have a maximum grade of six percent (6%). Steeper grades may be permitted where required by topographical and/or natural features, as approved by the City Engineer or designee.
 - 2. Alleys shall maintain a maximum cross-slope of two percent (2%) at the intersection of the adjacent sidewalk.
 - J. Vertical Curves in Alleys – Vertical curves in alleys shall be used in order to provide a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide stopping sight distance in all cases based on a design speed of 20 mph.
 - K. Alley Screening Walls – The area between screening walls and alleys shall be paved and graded to drain to the invert.

4.05 Driveway Design

- A. Introduction – Driveway design standards are needed to provide safe and efficient vehicular access to and from the public street system, to provide public street capacity for accommodating peak traffic volumes of public streets, to maintain smooth traffic flow, and to maintain street ROW and drainage. The intent of driveway design standards is to achieve the following:
 - 1. Prohibit the indiscriminate location and spacing of driveways while maintaining reasonable vehicular access to and from the public street system.
 - 2. Reduce conflicting turning movements and congestion thereby reducing vehicular crashes.
- B. Definition of Driveway Types
 - 1. Residential Driveway – Provides access to a single-family residence, duplex, or multi-family building containing four or fewer dwelling units. Residential driveways shall intersect Type 2L, 2LN, 2LCB and 2LRN thoroughfares only (according to the restrictions described below).
 - 2. Non-Residential Driveway
 - a. Commercial Driveway – Provides direct access to an office, retail or institutional building, or multi-family building having more than four dwelling units. It is anticipated that such buildings will have incidental truck service. Commercial driveways shall typically access Type 6LD, 4LD or 2LC thoroughfares only, with a maximum of one (1) driveway accessing a residential collector. In the case of multi-family developments, the primary driveway shall access a Type 6LD or 4LD thoroughfare.
 - b. Industrial Driveway – Serves truck movements to and from loading areas of an industrial facility, manufacturing, warehouse, or truck terminal. A retail development may have one or more driveways specially designed, signed, and located to provide access for trucks, which shall be considered industrial driveways. Industrial plant driveways whose principle function is to serve administrative or employee parking lots shall be considered commercial driveways. Industrial drives shall access Type 6LD, 4LD, and 2LC thoroughfares only.
 - 3. Standard Driveway – Provides two-way access at a single, undivided curb opening. The minimum width of a standard driveway depends on land use and is shown in Table 4.9.
 - 4. One-Way Driveway – Provides only inbound or outbound access and can only be permitted when the orientation of on-site circulation and parking layout clearly utilize the driveway for one-way movements. The minimum width for a one-way driveway depends on land use and is shown in Table 4.9.
 - 5. High Capacity Driveways – Intended to provide two-way access with geometric provisions which more adequately respond to greater driveway volumes and/or access

limitations than standard driveways. These provisions include increased width, increased internal storage and a median divider.

- a. Divided high capacity driveways are required at the first median opening downstream of a Type 6LD-6LD, 6LD-4LD, or 4LD-4LD intersection.
- b. The primary multi-family driveway shall be a divided high capacity driveway at a median opening.
- c. Divided high capacity driveways are required on Type 6LD or Type 4LD thoroughfares when the number of parking spaces per driveway exceeds two hundred (200), except along a frontage road.

C. Driveway General Design Parameters

1. The centerline angle for a driveway approach shall be ninety degrees (90°) to the street curb line for all driveways.
2. Driveways shall not be permitted in the taper area of any right-turn lane or deceleration lane.
3. Driveways that intersect at a mid-block median opening shall have the driveway centerline intersect with the midpoint of the median opening (measured nose-to-nose).
4. Driveway connections can be required by the City Engineer or designee to ensure adequate circulation.
5. Driveway elevations at the ROW line of a public street shall be a minimum of six inches (6") above the street gutter. A residential driveway that intersects an alley shall be a minimum of three inches (3") above the edge of the alley pavement at the ROW line and shall be high enough to maintain gutter capacity.
6. Cross access is required between adjacent non-residential properties so that each property can share the use of the driveway(s) on the adjacent property. A shared driveway that is centered on the common property line is also encouraged. When one non-residential property develops before the adjacent property develops, the full width of the shared driveway shall be constructed at that time.
7. Driveway grades in a fire lane shall not exceed six percent (6%). Steeper grades may be permitted in areas where buildings are not present, as approved by the City Engineer or designee and the Fire Department.
8. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.
9. Differential grades on driveways shall not exceed ten percent (10%).
10. Any sidewalk access across a driveway shall meet all state and federal ADA requirements for accessibility.
11. Residential driveways shall be prohibited:
 - a. Along a Type 2L, 2LN, 2LCB, or 2LRN thoroughfare within one hundred feet (100') of an intersection with a Type 6LD or Type 4LD thoroughfare measured from the ROW line.
 - b. Along any part of a Type 6LD, 4LD, 2LC or 2LCB thoroughfare or a residential collector.
12. Residential driveways shall provide access to an alley or an eligible public street according to the following restrictions:
 - a. A residential lot shall be allowed a maximum of one (1) driveway onto a public street, except in the case of a circular driveway approved by the City Engineer or designee.
 - b. A residential driveway that provides access to a garage shall connect to an alley or shall connect to a residential street that is at least thirty feet (30') wide, face-to-face.
 - c. A residential lot bordered by an alley and a residential street that is at least thirty feet (30') wide shall provide a driveway to the alley if trash pick-up services cannot be easily provided on the residential street, as determined by the Public Works

Department. Factors that will be considered include, but are not limited to, trash truck routing and whether existing or planned homes on the block already connect to the alley.

- d. A residential lot shall be prohibited from having multiple driveway connections in a configuration that would create the possibility of a cut-through route between a public street and an alley that do not intersect or between two public streets that do not intersect, as determined by the City Engineer or designee.
- e. If a residential driveway is shared between two properties, the driveway shall be centered on the common property line unless otherwise approved by the City Engineer or designee. A residential driveway connecting to an alley shall not be located within twenty feet (20') of the ROW line of a public street so as to prevent the driveway from being located in the alley taper
- f. A residential driveway connecting to a public street shall be located so its upstream edge is no closer than fifteen feet (15') from the curb return of an upstream intersection and its downstream edge is no closer than five feet (5') from the curb return of a downstream intersection.
- g. A residential driveway that changes in width as it extends onto the property shall do so with an angled transition that does not exceed a taper of one to one (1:1) within ten feet (10') of the property line.
- h. Side walk section through driveway shall be poured same thickness as driveway approach (existing sidewalk if any shall be removed).
- i. Driveway thickness shall match street pavement thickness (six inches (6'') minimum

13. Driveways shall be located so that they meet the required spacing from other driveways and streets, as described in Subsections F, G, and H below. The spacing and location of driveways shall be related to existing driveways and streets and to future driveways and streets that are shown on approved preliminary site plans and/or site plans that have not expired.

D. Driveway Width – The width of a driveway refers to the width of pavement at the property line and is measured where the curb return radii ends perpendicular to the street curb or edge of pavement. The minimum and maximum widths of driveways are listed in Table 4.9. A driveway may transition to a different width as it extends onto the property, but its width shall not change abruptly at the property line.

TABLE 4.9: Minimum and Maximum Driveway Widths⁽¹⁾

Driveway Type	Land Use	Width in feet (face-to-face) ⁽²⁾	
		Minimum (ft.)	Maximum (ft.)
Standard Driveway	Residential	10	24 to a street 32 to an alley ⁽³⁾
	Commercial	30	36 (40 at a gas station)
	Industrial	30	40
One-Way Driveway	Residential (circular)	10	16
	Commercial	24	24
	Industrial	24	24
Divided High Capacity Driveway	Entrance	24	24
	Exit: Two Lanes	24	24
	Three Lanes	30	36
Driveway Medians		4	11

1. Driveway width at the property line. A driveway may transition to a different width as it extends onto the property.
2. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.
3. A residential driveway connecting to an alley may have a width up to a maximum of thirty-two feet (32') if the garage faces onto the alley; otherwise, its width is limited to twenty-four feet (24').

E. Driveway Spacing

1. Spacing between driveways is measured along the property line from the edge of one driveway to the closest edge of the next driveway.
2. Table 4.10 defines minimum driveway spacing as a function of thoroughfare classification.
3. In the vicinity of a railroad crossing, the closest edge of a driveway shall be a minimum of one hundred feet (100') from the railroad ROW line.
4. Non-residential and multi-family driveways on opposite sides of an undivided street shall align with each other or be spaced a minimum of seventy-five feet (75') apart, measured edge to edge, to ensure that conflicting movements do not overlap. This spacing shall also apply to a driveway that is on the opposite side of an undivided street from an intersecting street. See Figure 4.28

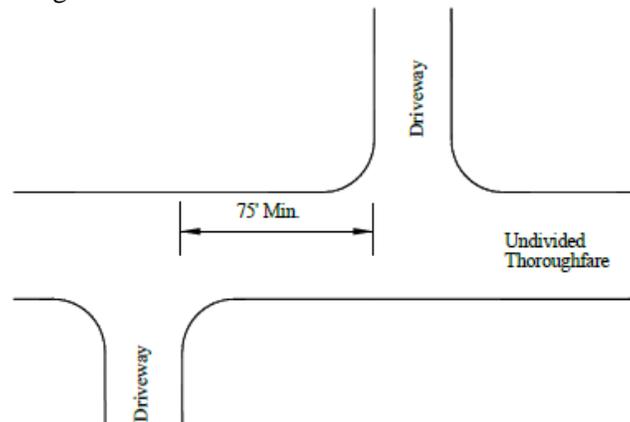


FIGURE 4.28: Driveway Spacing on Opposite Sides of an Undivided Street

Table 4.10: Driveway Design Requirements

Criteria	Thoroughfare Classification	Residential Driveway (ft.)	Commercial or Multi-family driveway (ft.)	Industrial Driveway (ft.)
Driveway Curb Radius	Type 6LD	N.A	30	40
	Type 4LD	N.A	30	40
	Commercial Collector Types 2LC and 2LCB	N.A	30	40
	Residential Collector	N.A	30	N.A
	Local 2L, 2LN, 2LRN	5-10	N.A	N.A
Minimum Driveway Spacing along roadway (edge to edge)	Type 6LD	N.A	280	280
	Type 4LD	N.A	260	260
	Commercial Collector Type 2LC and 2LCB	N.A	90	90
	Residential Collector	N.A	Max. of 1 drive	N.A
	Local 2L, 2LN, 2LRN	20 (10 when enclosing both mailboxes) ⁽²⁾	N.A	N.A
Minimum Distance to intersection along roadway (edge to ROW line of intersecting street) ⁽¹⁾	Type 6LD	N.A	75/200	
	Type 4LD	N.A	75/200	
	Commercial Collector Type 2LC and 2LCB	N.A	100/100	
	Residential Collector	N.A	100/100	N.A
	Local 2L, 2LN, 2LRN	15/5 from curb return to edge of drive	N.A	N.A

1. Upstream/downstream distance to intersection. See figure 4.28

2. If both mailboxes are located between two driveways, those driveways can be exactly ten feet (10') apart. If they are more than 10 feet apart, they must be 20 feet apart or more.

F. Driveway Radius

- All driveways intersecting dedicated streets shall be built with a circular curb radius connecting the six-inch (6") raised curb of the roadway to the design width pavement of the driveway.
- Driveway radii shall fall entirely within the subject property so as to begin at the street curb at the extension of the property line.
- Table 4.10 presents the minimum and/or maximum standards to be applied in designing and locating driveways on public streets.
- High capacity driveways shall meet the same standards as those defined in Table 4.10.

G. Distance between Driveway and Intersection

- Adequate distance between cross street intersections and access driveways shall be provided to ensure intersection/driveway conflict areas are minimized.
- Table 4.10 defines the upstream and downstream distance from an intersection as a function of thoroughfare classification. The distances required from an intersection along a Type 6LD or 4LD thoroughfares are shown in Figure 4.29.

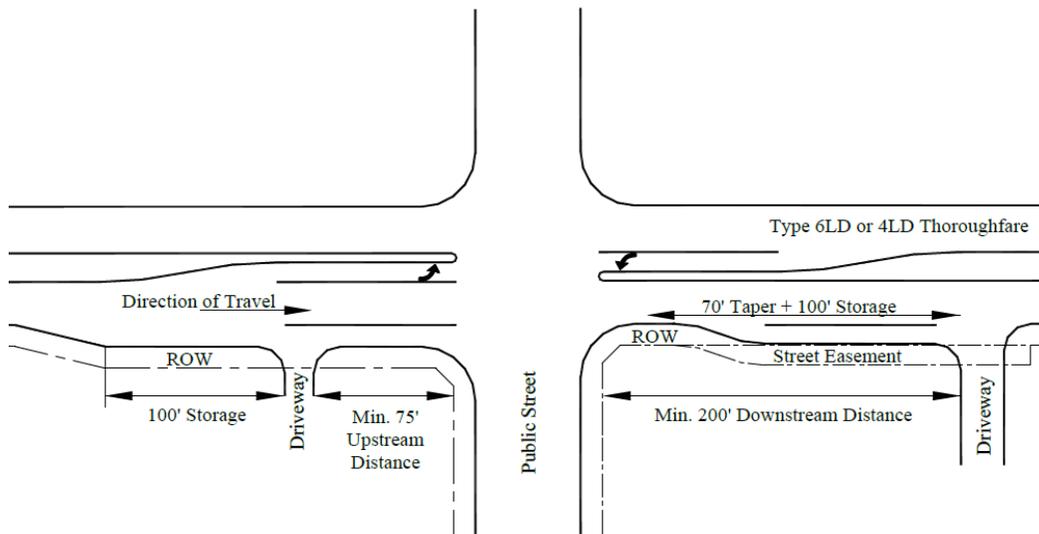


FIGURE 4.29: Distance between Driveway and Intersection

H. Driveways Located in Right-Turn Lanes

1. A driveway located within the right-turn lane of a public street intersection shall be spaced so that its closest edge will be a minimum of seventy-five feet (75') in advance of the ROW line of the intersecting street. See Figure 4.29.
2. If a driveway is located within the right-turn lane of a public street intersection, the storage length of the right-turn lane shall extend a minimum of one hundred feet (100') beyond the upstream edge of the driveway (see Figure 4.8). No driveway shall be permitted within the taper area of a right-turn or deceleration lane.

I. Driveway Deceleration Lanes - Deceleration lanes are required on Type 6LD and 4LD thoroughfares at all non-residential and multi-family driveways and shall meet the requirements of Section 4.03.D.

J. Driveway Storage Lengths

1. On-site internal storage shall be provided at all non-residential and multi-family driveways for queuing of vehicles off-street, to minimize congestion, and increase safety both on the public street and within the driveway.
2. Internal storage requirements shall be based on the number of parking spaces accessible by the affected driveway. Divide the total number of parking spaces by the number of driveways and then use Table 4.11 to determine the amount of internal storage required. This calculation shall be based on the preliminary site plan for an overall development or the site plan for a specific lot, whichever produces the largest ratio of parking spaces per driveway.
3. Internal storage length shall be measured from the ROW line to the first intersecting aisle, internal driveway, or parking stall.
4. A circulation study will be required for all multi-story parking structures. Driveway storage requirements will be determined as a result of the study.

TABLE 4.11: Minimum Driveway Storage Lengths

Parking Spaces per Driveway	Storage Required (ft.)			
	Multi-family or Commercial Uses		Industrial Land Uses	
	Non Median opening ⁽¹⁾	Median Opening ⁽²⁾	Non Median opening ⁽¹⁾	Median Opening ⁽²⁾
Less than 25	25	25	25	25
25-50	25	40	25	40
51-100	25	40	40	40
101-200	40	80	40	60
More than 200	100	150	40	100

1. Includes driveways that connect to one-way frontage roads.
2. Includes any driveway where a left-turn exit can be made, including driveways that connect to undivided roadways.

K. Entrance Streets and Driveways for Gated Developments

1. To ensure that the minimum dimensions are adequate, a traffic study is required with the submission of a Specific Use Permit application for all gated communities.
2. Residential/Multi-family Developments
 - a. Gated developments shall have a median divided street or driveway that will allow for a vehicular turn-around prior to the gate in the event that access is denied.
 - b. The turn-around shall be a minimum of eighteen feet (18') in width.
 - c. Entry gates shall be set back from the ROW line a minimum of one hundred thirty five feet (135') or as indicated in the traffic study. The card reader, or first stop, shall be set back from the ROW line a minimum of one hundred feet (100'), or as indicated in the traffic study, to provide storage for the longest queue of vehicles expected to access the gate. See Figure 4.30.
 - d. Each direction of the divided street or driveway shall be a minimum of twenty-four feet (24') in width with curb radii of thirty feet (30'). See Figure 4.30.
 - e. The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb. The gate shall open to twenty-four inches (24") behind back of curb.
 - f. Gates shall open sideways or swing open in the direction of travel on each side of the divided street.
 - g. Gates shall be equipped with emergency access devices as required by the Fire Department
 - h. All gates shall provide pedestrian access. The movement of the gates shall not encroach on sidewalks.
 - i. Gates shall remain open between 7:00 a.m. and 7:00 p.m. whenever a guard is not on duty during that time.
 - j. Any alternative designs shall require the approval of the City Engineer or designee
3. Non-Residential Developments
 - a. Gated developments shall have a median separating ingress and egress traffic flow allowing for a vehicular turn-around prior to the gate in the event that access is denied.
 - b. The turn-around shall be a minimum of eighteen feet (18') in width.
 - c. Entry gates shall be set back from the ROW line, or fire lane, a minimum of seventy-five feet (75'), or as indicated in the traffic study. The card reader, or first stop, shall be set back from the ROW line a minimum of forty feet (40'), or as indicated in the traffic study, to provide storage for the longest queue of vehicles expected to access the gate.

- d. Each direction of the driveway shall be a minimum of twenty-four feet (24') in width with curb radii of thirty feet (30'). See Figure 4.30.

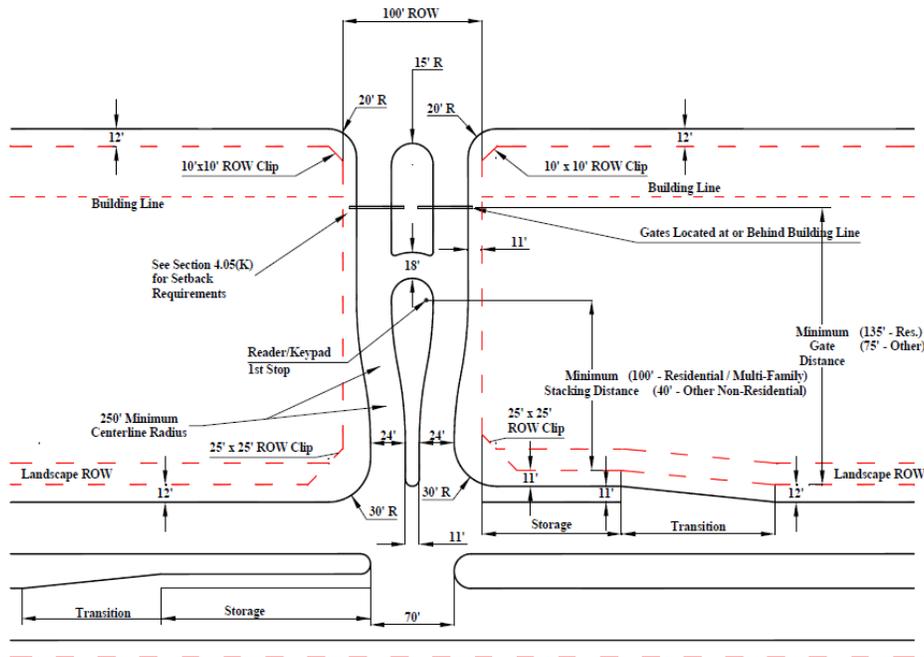


FIGURE 4.30: Gated Entrance Detail

- e. The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb. The gate shall open to twenty-four inches (24") behind back of curb.
- f. Gates shall open sideways or swing open in the direction of travel on each side of the divided entrance.
- g. Gates shall be equipped with emergency access devices as required by the Fire Department.
- h. All gates shall provide pedestrian access. The movement of the gates shall not encroach on sidewalks.
4. Individual gated single-family residences shall have a minimum setback of twenty feet (20') from the property line. The movement of the gate(s) shall not encroach on a sidewalk, alley, or street.
- L. Non-Conforming Driveways
1. All nonconforming driveways on a lot, tract, parcel or site shall be allowed to remain in use until the occurrence of one or more of the following events:
 - a. A change in use, or an increase in intensity of use, occurs such that the site requires a ten percent (10%) increase in required parking spaces.
 - b. Addition or expansion of required stacking spaces.
 - c. Any modification that changes the design or function of the existing driveway.
 - d. The addition of a median opening on the public street by a developer. All driveways that are served by the new median opening shall comply with the requirements of these standards.
 2. Upon the occurrence of the events described above, the nonconforming driveway shall either be reconstructed in accordance with these design requirements, or eliminated.

4.06 Sidewalk Location and Design

- A. Definition of Sidewalk – A sidewalk is defined as the paved area designated for pedestrian use which is generally located between the curb of the roadway and the adjacent property line. The inside edge of the sidewalk is the edge closest to the street while the outside edge of the sidewalk is farthest from the street.
- B. Sidewalk Design – Sidewalks shall conform to the most current federal, state, and local ADA requirements and to the following standards:
1. Sidewalk Grade – The maximum grade of the sidewalk shall be five percent (5%) or the grade of the adjacent street, whichever is greater. The maximum cross-slope of the sidewalk shall be two percent (2%).
 2. Zoning Classification Requiring Sidewalks – Concrete sidewalks designed and located according to City standards shall be constructed along all streets in all zoning classifications except agriculture uses in agricultural zoned areas. Prior to developing any single-family, duplex, or townhome residential lots, residential developers shall build sidewalks along all streets adjacent to the subdivision and along the portions of any street within the subdivision where residential lots do not front or side onto the street. Sidewalks along residential lots shall be constructed by the homebuilder at the time each lot develops. Sidewalks adjacent to non-residential and multi-family land uses shall be built at the time of lot development.
 3. Type 6LD and 4LD Thoroughfares – A concrete sidewalk, a minimum six feet (6') in width, shall be located along all Type 6LD and 4LD thoroughfares. The sidewalk should typically be located within the street ROW, but may extend into a sidewalk easement. The inside edge of the sidewalk shall be no closer than five feet (5') from the back-of-curb.
 4. Type 2LC, 2LCB, 2L and 2LN Thoroughfares – A concrete sidewalk, a minimum five feet (5') in width, shall be located along all Type 2LC, 2L, 2LCB, 2LN thoroughfares. The sidewalk shall be located within the street ROW unless pre-existing physical encroachments (e.g., utility infrastructure or trees) dictate otherwise. The outside edge of the sidewalk shall be located one foot (1') inside the ROW line on Type 2LC, 2L, and 2LCB thoroughfares. On Type 2LN thoroughfare, the outside edge of the sidewalk shall be on the ROW line and a two-foot (2') sidewalk easement may be provided adjacent to the ROW line.
 5. All sidewalks shall be class A concrete unless approved otherwise by the City.
 6. See Section 5 of the Engineering Standards for sidewalk thickness requirements.
 7. Sidewalk Easements – A minimum of two feet (2') of ROW or sidewalk easement shall be provided adjacent to the outside edge of the sidewalk. Any portion of sidewalk extending outside the ROW shall be contained within a sidewalk easement, the inside edge of which extends to the ROW line and the outside edge of which extends a minimum of two feet (2') beyond the outside edge of the sidewalk.
 8. All honeycomb in back of curb shall be trowel-plastered before pouring sidewalk.
 9. Parkways – The area between the curb and ROW line shall be graded at two percent (2%) above the top of street curb. If the area between the curb and the sidewalk is at least three feet (3') wide, it shall contain grass that is maintained by the adjacent property owner. If the area between the curb and sidewalk is less than three feet (3') wide, it shall be paved with concrete for a minimum length of fifteen feet (15'). If a parkway is adjacent to a nonresidential or multi-family land use, the area between the curb and the sidewalk may be paved with concrete or concrete pavers in lieu of grass.
 10. Meandering Sidewalks – Sidewalks along Type 6LD, 4LD, and 2LC thoroughfares and residential collectors may meander for aesthetics and/or to avoid pre-existing physical encroachments. Sidewalk easements adjacent to the standard ROW line will be required to contain any portion of the meandering sidewalk that extends beyond the ROW. Sidewalk easements shall provide a minimum clearance of two feet (2') beyond the outside edge of

the sidewalk. The inside edge of a meandering sidewalk shall never be less than five feet (5') from the back-of curb. A tangent calculated at any point along the centerline of a meandering sidewalk shall not be less than thirty degrees (30°) from perpendicular to the street. These requirements are shown in Figure 4.31.

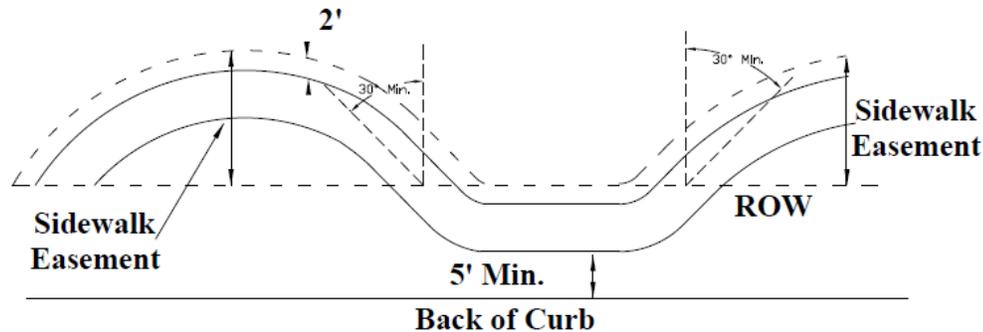


FIGURE 4.31: Meandering Sidewalk Detail

11. Sidewalks Adjacent to Screening Walls – In areas where a screening wall is provided along a thoroughfare, the outside edge of the sidewalk shall either remain a minimum of two feet (2') from the wall or the sidewalk shall be paved up to the wall.
12. Access Ramps – Barrier-free ADA access ramps shall be provided at all street intersection corners, at all crosswalks, and across any non-residential or multi-family driveway.
13. Sidewalks on Bridges
 - a. All street bridges shall have a sidewalk constructed on each side of the bridge. The sidewalk shall have a minimum width of six feet (6') with a parapet wall that is separated from the travel lane by an eighteen inch (18") shoulder. See Figure 4.32.
 - b. A standard pedestrian bridge rail protecting the sidewalk shall be provided on the outside edge of the bridge. See Figure 4.32.
 - c. When an eight foot (8') sidewalk is required on the bridge as part of a hike and bike trail, the center lane may be reduced to eleven feet (11') and the shoulders may be reduced to twelve inches (12").
14. Sidewalks Under Bridges – When new bridges are built as a part of the construction of a roadway or the reconstruction of a roadway and a pedestrian crossing is needed beneath the bridge, a sidewalk shall be built as a part of the embankment design underneath the structure for future hike and bike trails. The Hike and Bike Master Plan will designate whether a sidewalk is built on one or both sides of the waterway and whether the sidewalk shall be ten feet (10') or twelve feet (12') wide.
15. Sidewalks on Culverts – All culvert crossings shall have a sidewalk, a minimum of six feet (6') wide, constructed on each side of the culvert. A standard pedestrian hand rail as shown in Figure 4.33 shall be provided on the outside edge of the culvert. A parapet wall may be required by the City Engineer or designee.

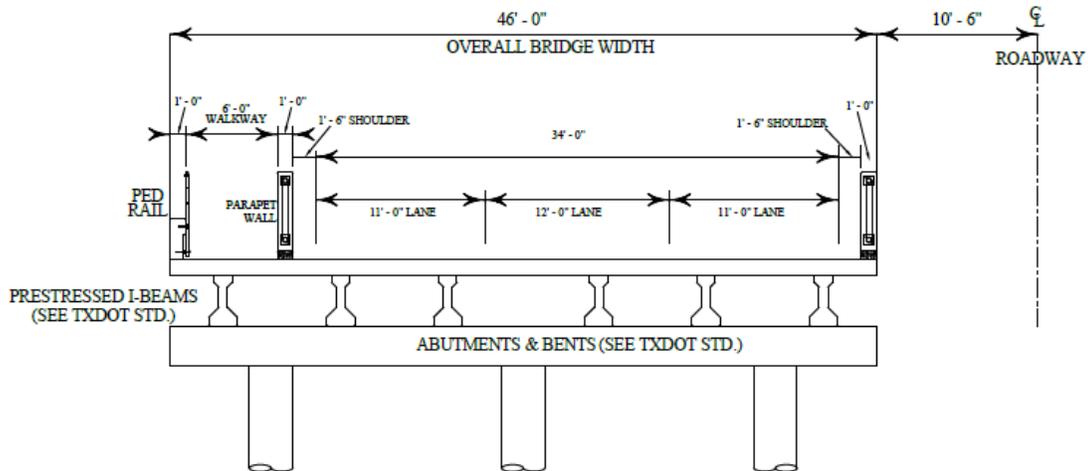


FIGURE 4.32: Typical Sidewalk on Bridge Section

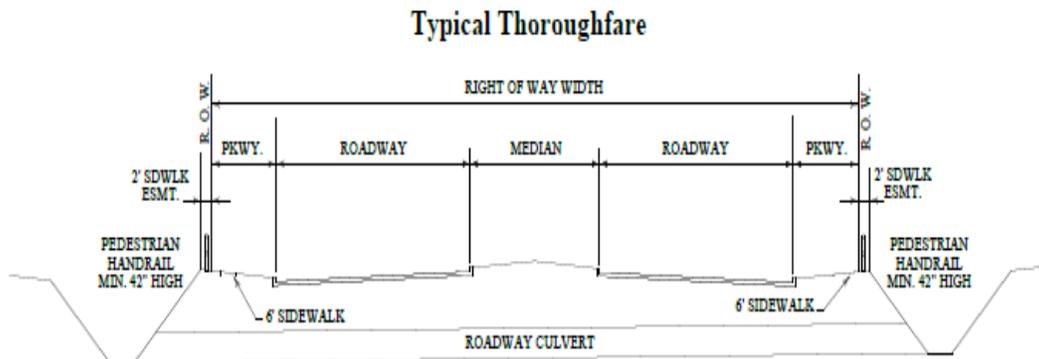


FIGURE 4.33: Typical Pedestrian Handrail over Culvert

16. Sidewalks between Residential Lots
 - a. Where deemed necessary by the City Engineer or designee, a block with a continuous series of lots longer than one thousand two hundred feet (1,200'), measured along one or more sides, shall be bisected by a fifty foot (50') wide pedestrian easement containing a sidewalk that is a minimum of five feet (5') wide. Such a mid-block pedestrian connection will be necessary where it would be beneficial to create a short-cut to walk to a school, park, trail, or group of homes on the other side of the long block.
 - b. Pedestrian easements and sidewalk connections shall be provided between cul-de-sacs and adjacent streets as required by the Subdivision Ordinance.
17. Sidewalk Escrow – When the delay of sidewalk construction is deemed appropriate by the City due to future right-of-way improvements, escrow funds in lieu of the construction of sidewalks may be approved by the City Engineer or designee. Such funds shall be escrowed with the City prior to final acceptance of the development. The escrow amount shall be determined by the square footage of sidewalk to be constructed, as estimated by the developer, and approved by the City Engineer or designee.

18. Sidewalk Reimbursement – If the City constructs the sidewalk along any street before the adjacent property develops, the owner of that property shall reimburse the City for its construction costs when the property is to be subdivided or developed. This amount shall be determined by multiplying the City’s square foot cost of constructing the sidewalk by the square footage of sidewalk that is required along the property, subtracting out the square footage of sidewalk the developer will remove or replace while developing the site, and adding any cost associated with City-installed ADA access ramps, retaining walls, and protective railing. The reimbursement shall be paid before any plat may be filed for the property. If the property has already been platted or a plat is not required, the reimbursement shall be paid prior to final acceptance or Certificate of Occupancy, whichever occurs first.
- C. Sidewalks within Non-Residential and Multi-family Developments – All sidewalks within nonresidential and multi-family developments shall be a minimum of four feet (4’) in width with a five feet by five feet (5’x5’) passing spaces provided no more than two hundred feet (200’) apart. At least one ADA accessible sidewalk connection shall be made between each building and the public sidewalk.

4.07 Public Right-of-Way Visibility Requirements

- A. Adequate sight distance at the intersection of a thoroughfare and a proposed thoroughfare, driveway, or alley must be ensured. This sight distance is provided through the use of Corner Visibility Triangles and/or Sight Line Triangles. Corner Visibility Triangles are also known as ROW Corner Clips and Sight Line Triangles are also known as Visibility, Access and Maintenance Easements (VAMs). All intersection visibility requirements shall meet the guidelines for sight triangles in AASHTO’s current *A Policy on Geometric Design of Highways and Streets*.
1. Corner Visibility Triangles shall be provided on all corners of an intersection between two thoroughfares or an intersection between an alley and a thoroughfare.
 2. Sight Line Triangles shall be provided where a driveway, an alley, or a stop-controlled thoroughfare intersects an uncontrolled thoroughfare and on any signalized intersection approach where right turn on red operation is permitted.
 3. No fence, wall, screen, sign, structure, foliage, hedge, tree, bush, shrub, berm, driveways, parking, drive aisles, or any other item, either man-made or natural shall be erected, planted, or maintained in a position that will obstruct or interfere with a driver’s clear line of sight within a corner visibility triangle or a sight line triangle (i.e., a VAM).
 4. The City has the right to prune or remove any vegetation within City right-of-way, including within the corner visibility triangle, and within sight line triangle easements (including VAMs), to abate a safety hazard and/or a nuisance
- B. Corner Visibility Triangles
1. The corner visibility triangle is defined at an intersection of two thoroughfares by extending the two ROW lines from their point of intersection to a distance as shown on Table 4.12. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 4.34. This corner visibility triangle shall be dedicated as ROW.

TABLE 4.12: Corner Visibility Triangle Distances

Type of Thoroughfare on	Type of Thoroughfare At	Distance ⁽¹⁾ (X)
6LD,4LD, 2LC, 2LCB	6LD ,4LD,2LC,2LCB, 2L or any residential street that potentially will be signalized	40’
6LD,4LD,2LC,2LCB	2L,2LN,2LRN that will remain un-signalized	25’
2L,2LN,2LRN	2L,2LN,2LRN	10’
TxDOT Road, Frontage Road	Use the specifications for a Type 6LD thoroughfare	
Unimproved Road	2L,2LN,2LRN	30’

(1)The corner visibility triangle shall have the same dimension on all corners of the intersection.

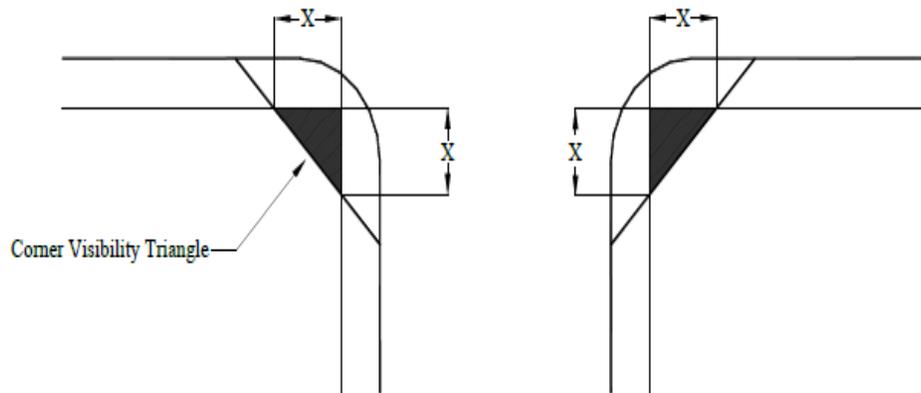


FIGURE 4.34: Corner Visibility Triangle for an Intersection

2. Vision at all intersections of thoroughfares shall be clear at elevations between thirty inches (30") and nine feet (9') above the average gutter elevation within the corner visibility triangle and meet AASHTO's current minimum requirements.
3. Where alleys intersect residential Type 2L, 2LN, and 2LRN thoroughfares, the corner visibility triangle is measured as fifteen feet (15') along the residential street ROW and five feet (5') along the alley ROW from the point of intersection. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 4.35. The alley corner visibility triangle shall be dedicated as ROW.

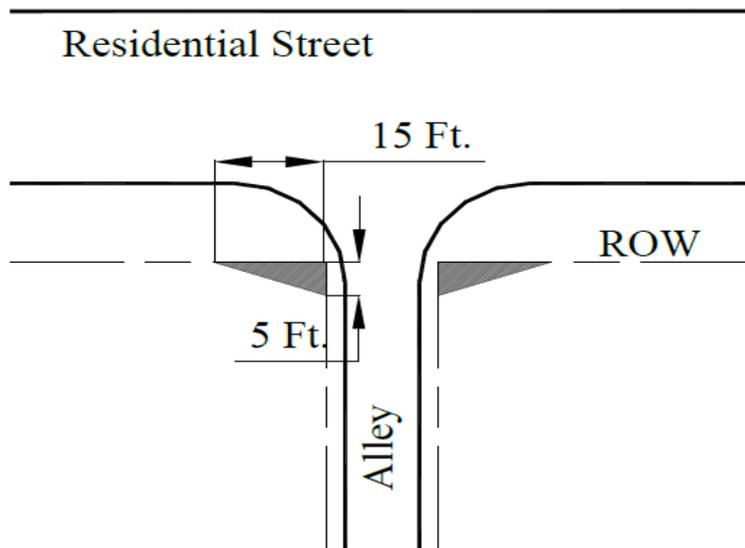


FIGURE 4.35: Corner Visibility Triangle for an Alley

C. Sight Line Triangles

1. The sight line triangle is formed by first extending a line along the center line of the proposed thoroughfare or driveway that begins at the tangent curb of the intersecting thoroughfare and extends to its endpoint fifteen feet (15') into the proposed thoroughfare or driveway. For the sight line triangle to the left, construct a second imaginary line that is parallel to and five feet (5') out from the intersecting thoroughfare's curb that begins at the centerline of the side street and continues to the left for a distance L (see Table 4.13) to its endpoint. To complete the sight line triangle, connect the endpoints of the first two lines as shown in Figures 4.36 and 4.37. In the case of the sight line triangle to the right, the second imaginary line is parallel and five feet (5') out from the nearest edge of the conflicting traffic flow (or adjacent median in the event of a divided thoroughfare). It begins at the centerline of the side street and continues to the right for a distance R (see Table 4.13) to its endpoint. See Figures 4.36 and 4.37.
 2. Distance to driver's eye for driveways that intersect a street is fifteen feet (15') from the intersecting curb line as shown in Figures 4.36 and 4.37.
 3. In the case where the thoroughfare contains existing horizontal curvature, the distances L and R must be measured along the horizontal curve.
 4. Sight Line Triangles that extend outside of the ROW shall be identified and dedicated as Visibility, Access and Maintenance Easements (VAMs) on the plat using City-approved VAM language.
- D. Traffic Control Devices – Any landscape requirements in the Engineering Standards, the Subdivision Ordinance, the Zoning Ordinance, or any other City ordinance shall not interfere with the placement, visibility or maintenance of traffic control devices under governmental authority and control.

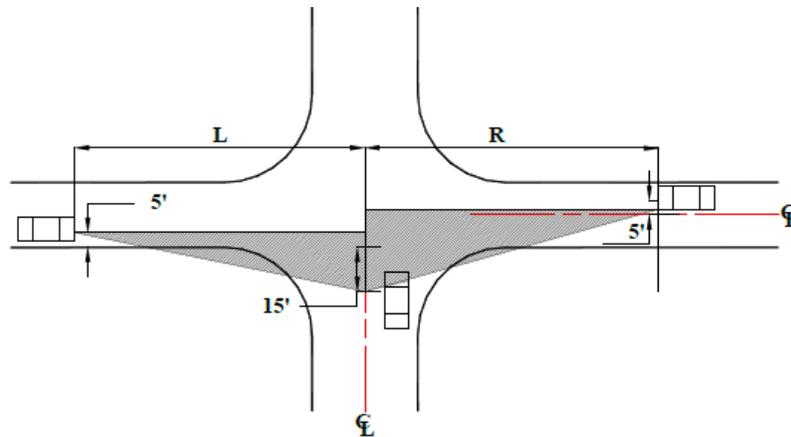


FIGURE 4.36: Sight Line Triangle for Undivided Thoroughfare

4.09 Traffic Signal Installation

- A. Introduction – According to the *Texas Manual of Uniform Traffic Control Devices* (TMUTCD), traffic control signals should not be installed unless one or more of the signal warrants in the manual are met. The satisfaction of a warrant or warrants is not in itself justification for a signal. Information should be obtained by means of engineering studies and compared with the requirements set forth in the warrants. The engineering study should indicate the installation of a traffic signal will improve the overall safety and/or operation of the intersection. If these requirements are not met, a traffic signal should neither be put into operation nor continued in operation (if already installed).
- B. Warrant Criteria
1. To justify the installation of a traffic signal, Part IV in the TMUTCD shall be followed. Part IV describes the warrants for a traffic signal installation and provides guidelines and requirements for the actual design and operation of a traffic signal.
 2. Engineering studies must be conducted in order to assess whether a particular location satisfies the warrant criteria listed in the TMUTCD. These studies may include one or more of the following:
 - a. Traffic volume counts
 - b. Pedestrian volume counts
 - c. Delay studies
 - d. Speed studies
 - e. Gap studies
 - f. Diagram of physical conditions
 - g. Accident studies
- C. Traffic Signal Spacing – Signal spacing is an important factor in being able to provide progressive flow for a platoon of traffic. Traffic signal spacing shall be determined by the City Engineer or designee.
- D. Traffic Signal Design and Installation – The design and installation of traffic signals shall follow the City’s Technical Specifications.
- E. Cost of Traffic Signal Installation
1. Traffic signals where a private driveway or a residential street intersects with a Type 6LD or 4LD thoroughfare – The developer is responsible for the total cost of designing and constructing a traffic signal that would only be warranted based on the traffic generated by the development. The developer shall escrow funds for the cost of the traffic signal and the City shall construct the traffic signal at the time of development or when the development reaches a certain level of activity, as determined by the City Engineer or designee. If a future traffic signal will equally serve a development on each side of the thoroughfare, each development shall be responsible for half the cost of the traffic signal.
 2. Traffic signals at Type 6LD-6LD, 6LD-4LD, and 4LD-4LD intersections – The developer on each corner of a Type 6LD-6LD, 6LD-4LD, or 4LD-4LD intersection is responsible for a portion of the cost of designing and constructing a future traffic signal at the intersection and shall escrow such funds with the City at the time of development. Seventy-five percent (75%) of the total cost of designing and constructing the traffic signal shall be divided equally among each of the four corners of the intersection and then proportionally assessed to each lot within a fifteen (15) acre area at each corner, measured eight hundred and eight feet (808’) in each direction from the corner. In the case of a three-leg intersection, an imaginary fourth leg shall be assumed for the purposes of creating four corners. As each lot develops as a portion of each corner, the trips generated by that land use shall be calculated and compared to the trips that would be generated by the total fifteen (15) acre area, the ratio of which determines the proportion of the traffic signal escrow that shall be assessed to that lot. If a preliminary site plan has not been approved for the whole fifteen (15) acre area, the land uses of a typical shopping center shall be assumed. If there are less

than fifteen (15) acres that can be developed on a corner, the trips generated by a developing lot will be compared to a hypothetical fifteen (15) acre shopping center.

4.10 Street Lighting

- A. The following standards shall apply to all Type 6LD and Type 4LD Thoroughfares:
1. Street lighting shall be placed in the medians, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred fifty feet (150') depending on median breaks and intersections.
 2. Unless a photometric analysis suggests the use of a different type of luminaire, street lighting shall use Full Cutoff, Type 3 luminaires on thoroughfares with one hundred twenty feet (120') of ROW and Full Cutoff, Type 2 luminaires on thoroughfares with one hundred feet (100') of ROW.
 3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt Metal Halide single or double head with davit arm(s) traffic black (RAL9017-traffic black) in color, or the equivalent approved by the City Engineer or designee shall be used.
 4. Street lighting shall be installed prior to final acceptance of the construction of a thoroughfare. When partial thoroughfares are constructed, the City Engineer or designee may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect thoroughfares, each Owner (Developer) is responsible for one-half the total cost of fully developed street lighting along that segment of the thoroughfare.
 5. When development occurs along a Type 6LD or Type 4LD thoroughfare, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the thoroughfare.
 6. Poles are to be round and tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details and specifications.
 7. Type A ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.
 8. Street lighting foundations shall be thirty inches by ninety six inches (30" x 96") in accordance with the City's Standard Details and specifications.
 9. Street lighting conduit shall be two inch (2") Schedule 40 PVC.
 10. Street lighting shall use #12 AWG wiring inside the poles.
 11. Electrical service pedestals shall be 240V/480V and meet the local service provider's specifications.
 12. Conduit shall be installed as shown in Section 6.02, Landscape Requirements in the Median.
- B. The following standards shall apply to all Type 2LC and Type 2LCB commercial collectors:
1. Street lighting shall be placed in the parkway between the curb and the sidewalk, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred fifty feet (150').
 2. Street lighting shall use Full Cutoff, Type 2 luminaires.
 3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt Metal Halide single head with davit arm traffic black (RAL-9017 traffic black) in color, or equivalent approved by the Director of Engineering Services shall be used.
 4. Street lighting shall be installed prior to final acceptance of the construction of a commercial collector. When the delay of installing street lighting is deemed appropriate by the City Engineer or designee, the City Engineer or designee may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect

collectors, each owner (Developer) is responsible for one-half of the total cost of fully developed street lighting along that segment of the collector.

5. When development occurs along a Type 2LC commercial collector, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the collector.
 6. Poles are to be round tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details and specifications.
 7. Type "A" ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.
 8. Street lighting foundations shall be thirty inches by ninety six inches (30" x 96") in accordance with the City's Standard Details and specifications.
 9. Street lighting conduit shall be two inch (2") Schedule 40 PVC.
 10. Street lighting shall use #12 AWG wiring inside the poles.
 11. Electrical service pedestals shall be 240V/480V and meet the local service provider's specifications.
- C. The following standards shall apply to all Type 2L, 2LCB, 2LN, and 2LRN Residential Streets:
1. Poles are to be four inches diameter fluted with anchor base, black in color. Pole height shall be twelve feet (12') for Type 2L, 2LCB, 2LN, and 2LRN local streets and fourteen feet (14') for residential collectors.
 2. Lamp wattages shall be 100 watts High Pressure Sodium.
 3. Luminaires shall be Acorn with refractive globes (see approved material list).
 4. The Developer may install additional banding and/or medallions with prior approval from the City Engineer or designee. The cost for maintenance and/or replacement of the banding and/or medallions shall be the responsibility of the developer or Homeowners' Association.
 5. Street lights shall be installed without multiple luminaires.
 6. Street lights shall typically be located at intersections and at mid-block locations if the block length is greater than six hundred feet (600'). Cul-de-sacs over two hundred twenty five feet (225') in length, measured from centerline of cross street to center point of cul-de-sac, shall have a street light installed at the street intersection and at the beginning of the bulb. Other locations may be required as deemed necessary by the City Engineer or designee. Street lights shall not be closer than one hundred fifty feet (150') nor greater than six hundred feet (600') apart.
 7. Subdivisions bounded by Type 6LD or Type 4LD thoroughfares shall have a common type of luminaire throughout. Street lighting shall be installed prior to acceptance by the City Engineer or designee
- D. A lighting plan shall be required anytime street lighting is proposed, or modified. The lighting plan shall be submitted to the City Engineer or designee for a construction permit. A certified engineer, architect, landscape architect, lighting engineer or designer shall prepare the plan. The plan shall also contain a certification by the property owner or agent and the preparer of the plan that the street lighting depicted on the plan complies with these requirements. The submission shall contain but shall not necessarily be limited to the following:

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1. Plans indicating the location of the lighting, and the type of illuminating devices, fixtures, lamps, supports, reflectors, and other devices;
 2. Description of the illuminating devices, fixtures, lamps, supports, reflectors, and other devices and the description may include, but is not limited to, catalog cuts by manufacturers and drawings (including sections where required) and height of the luminaires;
 3. Photometric plan and data sheets, such as that furnished by manufacturers, or similar to that furnished by manufacturers or the lighting designer, showing the angle of cut off or light emissions; and
 4. Water and sewer locations along with any other existing utilities lightly shaded on plans showing any possible location conflicts with proposed lighting.
- E. The following are exempt from these requirements:
1. “Cobra head” type lighting fixtures having dished or “drop” lenses or refractors which house other than incandescent light sources in undeveloped areas.
 2. Temporary lighting approved in writing by the City Engineer or designee.
 3. Where existing or phased subdivisions are currently under construction, the continued use of previously approved street lighting will be permitted. When a new phase of a subdivision is divided by a residential collector, the street lighting standards contained in these requirements shall be required.
 4. City Council may vary from these requirements as part of the approval of public street and sidewalk projects in overlay districts and Planned Developments.
 5. Lighting luminaires in existence on the effective date of these requirements shall be exempt from these standards and shall be considered legally non-conforming. Such fixtures may be repaired, maintained and/or replaced. If an identical replacement of non-conforming luminaires is not available, then luminaires shall comply with these requirements.

4.11 Street Name Signs

- A. Street name signs shall be installed at all intersections of public streets, private streets, and public ways in accordance with the City’s Standard Details, Technical Specifications and requirements.
- B. Street name blades shall be nine inch (9”) tall aluminum.
- C. The street name shall be centered, with block numbers located in the lower right-hand and lower left-hand corners. Abbreviated street designations shall be located in the upper right-hand corner and right-justified. Where applicable, the abbreviation for the street direction (N, S, E and W) shall be at the upper left – hand corner.
- D. The lettering of the street name shall be Highway Series B, six inches (6”) tall and upper/lower case. Letters of abbreviated street designations shall be three inches (3”) tall upper/lower case (i.e., Ln, Pkwy, Dr, Ct, etc.). Block numbers and abbreviation for direction shall be 3” tall.
- E. A street name shall be limited to sixteen (16) characters, not including the street designation. A street name shall either consist of one word no longer than sixteen (16) letters or two words separated by one space where the two words have no more than fifteen (15) letters combined.
- F. Sign sheeting shall be diamond grade intensity. The background shall be green and the legend shall be white.
- G. For a street with only one cul-de-sac end, a standard W 14-2a shall be mounted over the street name blade. In the case of a street with two cul-de-sac ends, two standard W 14-2a signs shall be mounted over the street name blade in the appropriate directions.

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- H. Owners, developers, and/or contractors should contact Planning and Development Department at 972.382.2682 to obtain block numbers. Block numbers are required on all street name blades, even if no homes or buildings front onto the street.

4.12 Traffic Signs

- A. Signage shall conform to the "Texas Manual on Uniform Traffic Control Devices."
- B. Bottom of sign shall be a minimum of seven feet (7') above finished grade.
- C. A foundation minimum of three feet (3') below finished surface and anchored with concrete shall be used for all city traffic sign assembly
- D. Refer to the approved material list for materials and installation shall be as directed by the manufacturer.
- E. The stop sign shall be an octagon with a white legend and border on a red background (TMUTCD 2B.05 (R1-1))

4.13 Pavement Markings and Markers

- A. All striping, arrows and words on pavement shall be thermoplastic unless otherwise noted in plans.
- A. Refer to technical specification 321723
- B. Refer to TXDOT PM (4) - 03 DETAIL "A" for dimension between pavement markings and markers.

4.14 Road Dead End Barricade

- A. All barricades shall be in accordance with the latest revision of the Texas Manual On Uniform Traffic Control Devices (TMUTCD)
- B. Barricade must cover entire width of paved roadway or fire-lane surface.
- C. All one by eight inches and four by four inches (1" x 8" and 4" x 4") wood posts shall be painted white.
- D. Barricades shall be designed and constructed to the standards of the Compliant Work Zone Traffic Control Device List.
- E. Barricade striping material shall be red and white high intensity reflective sheeting.
- F. Diagonal striping shall be placed in a manner that directs traffic in the appropriate direction of travel.
- G. Proposed barricade striping shall be approved by the city prior to placement of the barricade.

4.15 Traffic Impact Analysis and Mitigation

- A. Purpose – The purpose of a Traffic Impact Analysis (TIA) is to assess the effects of specific development activity on the existing and planned thoroughfare system. Development activity may include but is not limited to rezoning, preliminary site plans, site plans, preliminary plats, driveway permits, certificates of occupancy, and Thoroughfare Plan amendments.
- B. Pre-submission Meeting – Prior to the commencement of a TIA, an initial or pre-submission meeting with City staff is required to establish a base of communication between the City and the applicant. This meeting will define the requirements and scope relative to conducting a TIA and ensure that any questions by the applicant are addressed.
- C. Applicability of TIA Requirements
 1. Zoning – These TIA requirements shall apply to all zoning requests for land uses which will generate 2,500 or more vehicle trips per day or contain a density of 0.75 Floor Area

Ratio (FAR) or greater. Applicable requests include zoning requests and Thoroughfare Plan amendments, if no previous traffic assessment was performed. Special circumstances, including but not limited to development with no case history, which do not meet the daily trip generation threshold, may also require a TIA. Such circumstances, as determined by the City Engineer or designee may include, but not limited to, impacts to residential neighborhoods from non-residential development, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the proposed land use differs significantly from that contemplated in the Comprehensive Plan, or the internal street or access is not anticipated to accommodate the expected traffic generation.

2. Development – These TIA requirements shall apply to all development requests for land uses, except single-family residential development, which will generate over 100 total trips during the AM or PM peak hour. Applicable development requests include concept plans, preliminary site plans, site plans and preliminary plats. Special cases, in which site generated peak hour trip activity is different from that of the adjacent street (weekdays 7:00-9:00a.m. and 4:00-6:00 p.m.), may require an additional separate analysis as determined by the City Engineer or designee. Such circumstances may include, but are not limited to, commercial/retail, entertainment or institutional activity. The City Engineer or designee may waive the TIA for a development request if a TIA was performed previously with the Zoning request and conditions listed in the report are still current.
3. Single-Family Residential Exception – A TIA for single-family residential development will not be required if the development contains fewer than six dwelling units unless special circumstances exist, as determined by the City Engineer or designee. These special circumstances may include, but are not limited to, impacts to other residential development from cut-through traffic, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the internal street or access system is not anticipated to accommodate the expected traffic generation, or the development is outside the urban core of the community.
4. Daycares and Schools – All development requests and/or specific use permit requests for a daycare, Montessori school, private school, charter school, or public school shall include, at a minimum, a traffic circulation study. This study shall include the estimated maximum peak hour trip generation of the facility, the planned circulation of inbound and outbound traffic during drop-off and pick-up operations, and the estimated length of the queue of cars waiting to pick up students. The design of the site and the circulation plan shall ensure that school traffic does back up onto any public street. The traffic circulation study shall include a statement that the owner and/or operator of the daycare or school agree to operate the facility in accordance with the approved circulation plan. The circulation plan must be approved by the City Engineer or designee before the development request or the specific use permit can be approved.
5. Determination of Applicability – The need for a TIA shall be determined by the City Engineer or designee based upon the results and recommendation from a pre-submission meeting. It shall be the responsibility of the applicant to demonstrate that a TIA should not be required. If a TIA is required, the level of effort for a TIA submission shall be

determined based on the criteria set forth in Table 4.14. Depending upon the specific site characteristics of the proposed development, one or more of the following elements may also be required as part of the TIA: an accident analysis, sight distance survey, traffic simulation, traffic signal warrant analysis, queuing analysis, turn lane analysis, and/or traffic circulation plan.

TABLE 4.14: Criteria for Determining TIA Study Requirements

Analysis Category	Site Trips Generated at Full Build-Out	TIA Analysis Periods ⁽¹⁾	Minimum Study Area ⁽³⁾
I	>50 peak hour driveway trips; or 100-500 total peak hour trips	1. Existing year 2. Opening year ⁽²⁾ 3. Five years after opening	1. All site access drives 2. All signalized intersections and/or major un-signalized intersections within 0.5 mile to 1 mile of site boundary
II	>500 total peak hour trips	1. Existing year 2. Opening year of each phase 3. Five years after initial opening 4. Ten years after final opening with full build-out	1. All site access drives 2. All signalized intersections and/or major un-signalized intersections within 1.5 miles of site boundary

(1) Analysis periods shall include build and no-build scenarios. Assume full occupancy when each phase opens.

(2) Assume full build-out.

(3) For certain projects, the City may require an enlarged study area. Land uses within the study area should include recently approved or pending development adjacent to the site.

- D. Requirements for TIA Updates – A TIA shall be updated when time or circumstances of the original study fall within the parameters presented in Table 4.15. The applicant is responsible for preparation and submittal of appropriate documentation in order for City staff to process the zoning or development application. A TIA for site development requests must be updated if two years have passed since the original submittal, or if existing or assumed conditions have changed within the defined study area. The City Engineer or designee shall make the final determination as to the extent of a TIA update.

TABLE 4.15: Criteria for Determining TIA Update Requirements

Original TIA Report was based on:	Changes to the Originally Proposed Development:	
		Access Changed ⁽¹⁾ or Trip Generation Increased by more than 10%
Zoning; or Preliminary Site Plan or Site Plan that is less than 2 years old	Prepare New Study. Must meet all current TIA requirements	Letter Documenting Change (No analysis is required)
Preliminary Site Plan or Site Plan that is more than 2 years old	Prepare New Study. Must meet all current TIA requirements	Prepare New Study. Must meet all current TIA requirements.

(1) Changed access includes proposed new access or refinement of general access locations not specifically addressed in original proposed development.

- E. Responsibility of TIA Preparation and Review

1. A TIA shall be prepared in accordance with all of the guidelines in this section and submitted in accordance with the Development Review Schedule set by the City. The responsibility for TIA preparation shall rest with the applicant and must be performed by a Professional Engineer (P.E.) licensed in the State of Texas with experience in traffic and transportation engineering. The final TIA report must be signed and sealed by the P.E. responsible for the analysis to be considered for review by the City. Application and review fees are due at the time of each submittal. City staff shall serve primarily in a review and advisory capacity and will only provide data to the applicant when available.
2. It shall be the responsibility of the applicant to submit four (4) draft TIA reports and executive summaries with the zoning and/or development request submission. The proper number of reports, the timing for submission, and the review of these reports shall be based on standard City development review procedures. Incomplete TIAs or failure to submit a TIA with the submission shall delay consideration of zoning and development requests. Should it be determined during the review of any zoning and/or development plans that a TIA is required; consideration shall be deferred until the applicant submits a completed TIA and the City has reviewed the assessment.
3. The City shall review the TIA and provide comments to the applicant. It shall be the responsibility of the applicant to submit four (4) finalized TIA reports and executive summaries once all review comments have been addressed.

F. TIA Standards

1. Design Level of Service – The minimum acceptable level of service (LOS) within the City shall be defined as LOS “D” in the peak hour for all critical movements and links. All development impacts on both thoroughfare and intersection operations must be measured against this standard.
2. Trip Generation Resources – The City’s standard for trip generation rates for various land use categories shall be those found in the latest edition of Trip Generation published by the Institute of Transportation Engineers (ITE) or other published or recognized sources applicable to the region. Alternate trip generation rates may be accepted on a case-by-case basis if the applicant can provide current supporting data substantiating that their development significantly differs from the ITE rates. The City Engineer or designee must approve alternative trip generation rates in writing in advance of the TIA submission.
3. Trip Reductions – Trip reductions for passer-by trips and mixed-use developments will be permitted, subject to analytical support provided by the applicant and approval by the City Engineer or designee on a case-by-case basis. Assumptions relative to automobile occupancy, transit mode share, or percentage of daily traffic to occur in the peak hour must be documented and will be considered subject to analytical support provided by the applicant.
4. Study Horizon Years – The TIA must evaluate the impact of the proposed development on both existing traffic conditions and future traffic conditions for the horizon year(s) as specified in Table 4.14. However, applications for densities of 0.75 Floor Area Ratio (FAR) or greater within the Dallas North Tollway, US 380 or Preston Road corridors (throughout the City Limits) shall require that the horizon year land use assumptions be updated to reflect full development based on all proposed zoning. These applications should also assume full development of the Master Thoroughfare Plan or pending amendments.

G. TIA Methodology

1. Site Location/Study Area – A brief description of the size, general features, and location of the site, including a map of the site in relation to the study area and surrounding vicinity.
2. Existing Zoning – A description of the existing zoning for the site and adjacent property, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate);

3. Existing Development – A description of any existing development on the site and adjacent to the site and how it would be affected by the development proposal;
4. Proposed Zoning / Site Development – A description of the proposed zoning/development for the site, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate); identify other adjacent land uses that have similar peaking characteristics as the proposed land use; identify recently approved or pending land uses within the area;
5. Thoroughfare System – A description and map of existing planned or proposed thoroughfares and traffic signals for horizon year(s) within the study area;
6. Existing Traffic Volumes – Recent traffic counts for existing thoroughfares and major intersections within the study area;
7. Projected Traffic Volumes – Background traffic projections for the planned thoroughfare system within the study area for the horizon year(s);
8. Density of Development – A table displaying the amount of development assumed for existing zoning and/or the proposed development (using gross floor area, dwelling units, occupied beds, etc., as required by the trip generation methodology);
9. Existing Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy based on existing zoning (if applicable), and including all appropriate trip reductions (as approved by the Director of Engineering Services);
10. Proposed Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy for the proposed development, and including all appropriate trip reductions (as approved by the Director of Engineering Services);
11. Net Change in Trip Generation (for rezoning cases) – Proposed trip generation minus existing trip generation (if applicable); the net increase in trips to be added to base volumes for the design year;
12. Trip Distribution and Traffic Assignment – Tables and figures of trips generated by the proposed development (or net change in trips, if applicable) added to the existing and projected volumes, as appropriate, with distribution and assignment assumptions, unless computer modeling has been performed;
13. Level of Service Evaluations – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for both existing conditions and horizon year projections for intersections, thoroughfare links, median openings and turn lanes associated with the site, as applicable;
14. Traffic Signal Evaluations – The need for new traffic signals based on warrants and their impact on the performance of the transportation system;
15. Evaluation of Proposed/Necessary Mitigation – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for intersections, thoroughfare links, median openings and turn lanes associated with the site under proposed/necessary traffic mitigation measures;
16. Conclusions – Identification of all thoroughfares, driveways, intersections, and individual movements that exceed LOS D or degrade by one or more LOS, the percentage of roadway volume change produced by the proposed development, and any operational problems likely to occur;
17. Recommendations – Proposed impact mitigation measures consistent with Subsection I below; and
18. Other information required for proper review – As requested by the Director of Engineering Services.

H. TIA Report Format



1. The TIA report must be prepared on 8½" x 11" sheets of paper. However, it may contain figures on larger sheets, provided they are folded to this size. All text and map products shall be computer-based and provided in both published format and computer file format (PDF). In addition, all electronic files used as part of the traffic analysis (i.e. Synchro, HCS, Passer II/III, CORSIM, VISSIM, etc.) shall be provided.
2. The sections of the TIA report should be categorized according to the outline shown below:

Executive Summary

- I. Introduction
 - a) Purpose
 - b) Methodology
 - II. Existing And Proposed Land Use
 - a) Site Location/Study Area
 - b) Existing Zoning
 - c) Existing Development
 - d) Proposed Zoning (if applicable)
 - III. Existing And Proposed Transportation System
 - a) Thoroughfare System
 - b) Existing Traffic Volumes
 - c) Projected Traffic Volumes
 - IV. Site Traffic Characteristics
 - a) Existing Site Trip Generation (if applicable)
 - b) Proposed Site Trip Generation
 - c) Net Change in Trip Generation (if applicable)
 - d) Trip Distribution and Traffic Assignment
 - V. Traffic Analysis
 - a) Level of Service Evaluations
 - b) Traffic Signal Evaluations
 - VI. Mitigation
 - VII. Conclusions
 - VIII. Recommendations
- Appendices

I. Traffic Impact Mitigation

1. Mitigation of traffic impacts shall be required if the proposed development would cause a facility or traffic movement to exceed LOS D, or where it already exceeds LOS D and the development would contribute five percent (5%) or more of the total traffic during any projected horizon year. If mitigation is required, the applicant must only mitigate the impact of the proposed development, and would not be responsible for alleviating any deficiencies in the thoroughfare system that may occur without the proposed development.
2. Acceptable mitigation measures shall include:
 - a. Staging of development in order to relate site development to the construction of the required thoroughfare system;
 - b. Staging of development so that the site contributes less than five percent (5%) of the total traffic to the affected facility or traffic movement during the projected horizon year;
 - c. Off-site improvements, including the provision of right-of-way and/or the participation in funding for needed thoroughfare and intersection improvement projects (including, but not limited to, through lanes, turn lanes and traffic signals); and
 - d. On-site improvements, including access controls and site circulation adjustments.

-
3. Mitigation is not required if it can be shown that the traffic impacts of the project are fully mitigated ten (10) years after the final opening with any improvements that are already programmed to be implemented within five (5) years of the initial opening.
- J. Administration of the TIA – Based on the results of the TIA and actions recommended by the City Engineer or designee, the Planning & Zoning Commission and/or the City Council, as appropriate, shall take one or more of the following actions:
1. Approve the zoning or development request, if the project has been determined to have no significant impact or where the impacts can be adequately mitigated;
 2. Approve the development request, subject to a phasing plan;
 3. Recommend study of the City Thoroughfare Plan to determine amendments required to increase capacity;
 4. Recommend amendment of the Capital Improvement Program (CIP) to expedite construction of needed improvements; or
 5. Deny the zoning or development request, where the impacts cannot be adequately mitigated.
- K. In accordance with Article A6.008 subsection (a) of the City’s Ordinance, the city secretary shall require a deposit in the amount of \$5,000.00 for the service at the time the initial development application is filed. The actual costs will be determined prior to final approval and either an additional sum will be due from the applicant or a reimbursement made if the actual cost is less than the deposit.

SECTION 5 – PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS



5.01 General

- A. All new City Streets, alleys and rehabilitation of existing streets shall be constructed in accordance with the latest editions of the City of Celina Construction Standards and Specifications and the North Central Texas Council of Governments (NCTCOG) Public Works Construction Standards. The following standards are minimum design criteria only. A geotechnical evaluation and design shall be conducted to determine an adequate pavement section based on a minimum 20 year design life for all paving projects.
- B. The following specifies minimum standards required for the design of pavement and subgrade for roadways within the City. These minimum standards are not intended to replace the professional judgment of the Engineer for any specific pavement project. The standards may need to be expanded or modified on a case by case basis as determined necessary and appropriate by the Engineer, and as approved by the City Engineer or designee.
- C. All roadway, alley, and fire lane pavements shall have a subgrade investigation and pavement design.
- D. Pavement and subgrade designs shall be submitted to the City for review in accordance with these requirements. However, any such review shall be conducted as a means to verify if the design has been performed in general conformance to the City's requirements, and shall not be considered a detailed technical review of the design for adequacy, accuracy, or completeness. The Engineer performing the pavement design shall remain responsible for the technical adequacy, accuracy, and completeness of the pavement and subgrade design and shall not be relieved of any responsibility for such as a result of the City's review.
- E. When performing the pavement and subgrade designs and providing submittals of such to the City, the Engineer shall specifically document in writing any intended deviations from the City's minimum standards, and shall provide adequate justifications as deemed necessary by the City Engineer or designee.
- F. Refer to Engineering Standards Appendices (Standard Details, Technical Specifications) for additional specific requirements.

5.02 Concrete Design

- A. Unless otherwise approved by the City Engineer or designee, all new pavements shall be Portland Cement Concrete.
- B. The minimum compressive strength shall meet or exceed 4,000 psi at 28 days for all concrete placed within the ROW and all fire lanes.
- C. Up to a maximum of 20% cement may be replaced with fly ash at a ratio of 1 lb. of cement to 1lb of fly ash.
- D. The slump for all machine placed concrete may have a minimum slump of 1 inch and a maximum of 3 inches. The slump for all hand placed concrete may have a minimum slump of 3 inches and a maximum of 5 inches.
- E. All mix designs shall be generated by a certified laboratory, sealed by a Professional Engineer and submitted to the City of Celina for review and approval in a minimum of 10 days prior to the scheduled placement of the concrete. Design Engineer shall request from City the most current traffic count data for the specific area of a given project. If no data is available, the ADT amount listed in Table 5.1 shall be used.

5.03 Pavement Thickness Requirements

- A. All Type 6LD and 4LD thoroughfares shall be a minimum of 8 inches thick.
- B. Types 2LC, 2L, 2LCB, 2LN, 2LRN and alleys shall be a minimum of 6 inches thick.
- C. When turn lanes and median openings are added to existing streets, the pavement thickness may be increased by one (1) inch and a minimum of 6 inch flexible base course in lieu of treating the sub-grade with lime or cement. Written approval required prior to placement of pavement modification.
- D. Fire lanes shall be 6 inches thick, but may be increased by one (1) inches and a minimum of 6 inch flexible base course in lieu of treating the subgrade with lime or cement.

Streets and alleys serving only single family and duplex uses shall be a minimum of 6 inches in thickness with mountable curbs placed monolithically with the Street except where there is a retention/detention pond in their vicinity (twenty feet or less) then a standard six inch (6") curbs shall be installed. Commercial streets and commercial alleys shall be a minimum of 8 inches in thickness. Street and alleys serving both residential and commercial areas shall be a minimum of 8 inches in thickness. All alleys shall be considered commercial except those serving only single family and two family zoning classifications and uses. Modifications or deviations from these paving requirements may be approved at the discretion of the City Engineer or designee.

5.04 Base Course

All street alley and fire lane paving shall be placed on a stabilized base course/sub-grade compacted to a minimum of 95% Standard Proctor. The base course thickness shall be a minimum of 6 inches in thickness and shall consist of lime or cement stabilization as recommended in the Geotechnical Report. The lime used to stabilize the subgrade shall meet the requirements of ASTM C977 / AASHTO M 216; contain at least ninety-two percent (92%) calcium and magnesium oxide, and the rate of slaking test for moderate reactivity shall be per ASTM C110 / AASHTO T 232.

The minimum lime content shall be determined with a project specific lime series or as outlined in the Geotechnical Report. In small areas where stabilization is not practical, the base course shall consist of a minimum six- inch (6") flexible base course compacted to a 95% Standard Proctor or 6 inches of asphalt base as directed by the City. The standard pavement thickness may be increased by one (1) inch combined with a minimum of six inches (6") flexible base course in lieu of treating the sub-grade with lime or cement. The Plasticity Index of the base course shall not exceed 12. Where the Geotechnical Report identifies an area having high sulfates, the base course shall be stabilized as outlined in the Geotechnical Report, subject to City Engineer's or designee's approval. Modifications or deviations from these base course requirements shall be supported with a Geotechnical Report and be approved at the discretion of the City Engineer or designee.

5.05 Reinforcement

- A. All public roads and fire lanes within the City of Celina shall be reinforced with steel. The minimum steel reinforcing shall be no less than #4 deformed bars conforming to ASTM A615 (grade 60) on 18inch centers in each direction. All reinforcing shall be supported on bar chairs or supports designed for the specific purpose of reinforcement support. Bar laps shall be 30 inches.
- B. Sidewalk thickness shall be as shown in Table 5.2.
- C. Fire lane paving shall be designed with the same design inputs as Types 2L, 2LN or 2LRNstreets.

Table 5.1: Pavement Design Inputs

Input	Thoroughfare Classification				
	Type 6LD	Type 4LD	Type 2LC or 2LCB Residential	Types 2L,2LN, 2LRN, Alley, Fire Lane	Type 2LC or 2LCB Commercial
Design Period	20 years	20 years	20 years	20 years	20 years
Initial Serviceability	4.5	4.5	4.5	4.5	4.5
Terminal Serviceability	2.5	2.3	2.3	2.0	2.3
Concrete MOR @ 28 days	620 psi	620 psi	620 psi	620 psi	620 psi
Concrete E @ 28 days	5,000,000 psi	5,000,000 psi	5,000,000 psi	5,000,000 psi	5,000,000 psi
Concrete Strength @ 28days	4000psi	4000psi	4000psi	4000psi	4000psi
Reliability	95%	92%	90%	85%	90%
Standard Deviation	0.35	0.35	0.35	0.35	0.35
Load Transfer Coefficient	2.9	2.9	2.9	2.9	2.9
Drainage Coefficient	1.0	1.0	1.0	1.0	1.0
Design Average Daily Traffic (ADT)	60,000	30,000	20,000	12,000	20,000
Traffic Growth Rate	3%	3%	3%	3%	3%
Percent Trucks	3%	3%	2%	2%	2%
Lanes	6	4	2	2	2
Lane Distribution Factor	0.7	1	1	1	1
Reinforcement*	#4@18" centers	#4@18" centers	#4@18" centers	#4@18" centers	#4@18" centers
Minimum Thickness*	8"	8"	6"	6"	8"
Minimum Subgrade Thickness*	8"	8"	6"	6"	6"
Minimum Side walk Width	6'	6'	5'	5'	5'

* Minimum allowed. The required geotechnical evaluation shall determine a more substantial pavement section to be used but in no case will a lesser pavement section be allowed.

Table 5.2: Sidewalk Thickness

Sidewalk Width	Thickness of Concrete	Reinforcing
up to 6'	4"	#3 bars @ 18" o.c.e.w. or fiberglass mesh
6'-1" to 7'-11"	5"	#3 bars @ 18" o.c.e.w. or fiberglass mesh
8' or greater	6"	#3 bars @ 18" o.c.e.w. or fiberglass mesh

5.06 Concrete Placement

A. Forming of Pavement

All city streets are required to be slipped formed and shall be vibrated by machine. Hand pours are allowed for intersections and other miscellaneous areas as approved by the City Inspector. Hand pours shall be vibrated by hand vibrators.

B. Temperature

a. Warm Weather Concrete Placement

The maximum time interval between the addition of cement to the batch, and the placing of concrete in the forms shall not exceed the following:

Table 5.3: Temperature-Time Requirements

Air and Concrete Temperature (whichever is higher at point of placement)	Maximum time- minutes (no retarding agent)	Maximum time- minutes (with retarding agent) ⁽¹⁾
Non-Agitated Concrete		
All Temperatures	30	40
Agitated Concrete		
Above 90 °F ⁽²⁾	45	75
Above 75°F through 90° F	60	90
75° F and below	90	120

(1) Normal dosage of retarder

(2) The temperature for all concrete shall not exceed 95°F. Any concrete exceeding this condition will be rejected.

b. Cold Weather Concrete Placement

- i. 35°F and Rising- okay to place (if the projected high is 40°F or less, no concrete shall be poured)
- ii. 40°F and Falling- Concrete pours shall stop

5.07 Concrete Pavement Jointing Layout

- A. All pavement joints shall either be sawed contraction or construction joints unless noted otherwise
- B. The maximum transverse joint spacing shall be fifteen feet (15').
- C. Longitudinal joint spacing shall match lane lines unless noted otherwise

-
- D. All saw-cuts shall be one eighth or three sixteenth of an inch (1/8" to 3/16") wide and one-fourth the depth of the actual slab thickness.
 - E. All pavement joints shall be sealed. Joint sealant shall be provided in accordance to technical Specification 321373.

5.08 Concrete Pavement Construction Joints

- A. Dowels shall be installed in the pavement parallel to the pavement surface.
- B. Dowels in transverse joints shall be installed in the pavement parallel to the pavement centerline.
- C. Dowels in longitudinal joints shall be installed in the pavement normal to the pavement centerline.
- D. Backer rod material may be used in conjunction with sealant if the joint sealant reservoir maintains at least 1:1 width / depth ratio, but in no case shall the ratio be greater than 1:15. The backer rod diameter shall be one-eighth of an inch (1/8") greater than the joint width.

5.09 Concrete Pavement Expansion Joints

- A. Dowels must be installed in the pavement parallel to the pavement surface and to the centerline.
- B. The entire length of the dowel shall be lubricated and the capped and uncapped dowel ends shall alternate.
- C. Dowel support materials and layout shall be submitted to the city for review and approval prior to ordering materials for construction.
- D. Expansion joints in pavements shall be redwood boards only with a maximum spacing of six hundred feet (600').

SECTION 6 – LANDSCAPING DESIGN REQUIREMENTS

6.01 General

- A. The purpose of this section is to provide additional requirements and standards to address landscaping requirements only **within the medians of major and minor thoroughfares**. Refer to the following ordinances and documents:
1. [Zoning Ordinance, Section 14.03](#) - Special Zoning Districts
 2. [Zoning Ordinance, Section 14.05.090](#)– Tree Preservation Requirements
 3. [Zoning Ordinance, Section 14.05.081 through Section 14.05.089](#) – Landscape Requirements
- B. Landscape construction plans shall be prepared and sealed by a Landscape Architect licensed to practice Landscape Architecture within the State of Texas.
- C. Requirements for landscaping within the parkways are contained in the Zoning Ordinance, Section 4.02.

6.02 Landscape Requirements within the Median

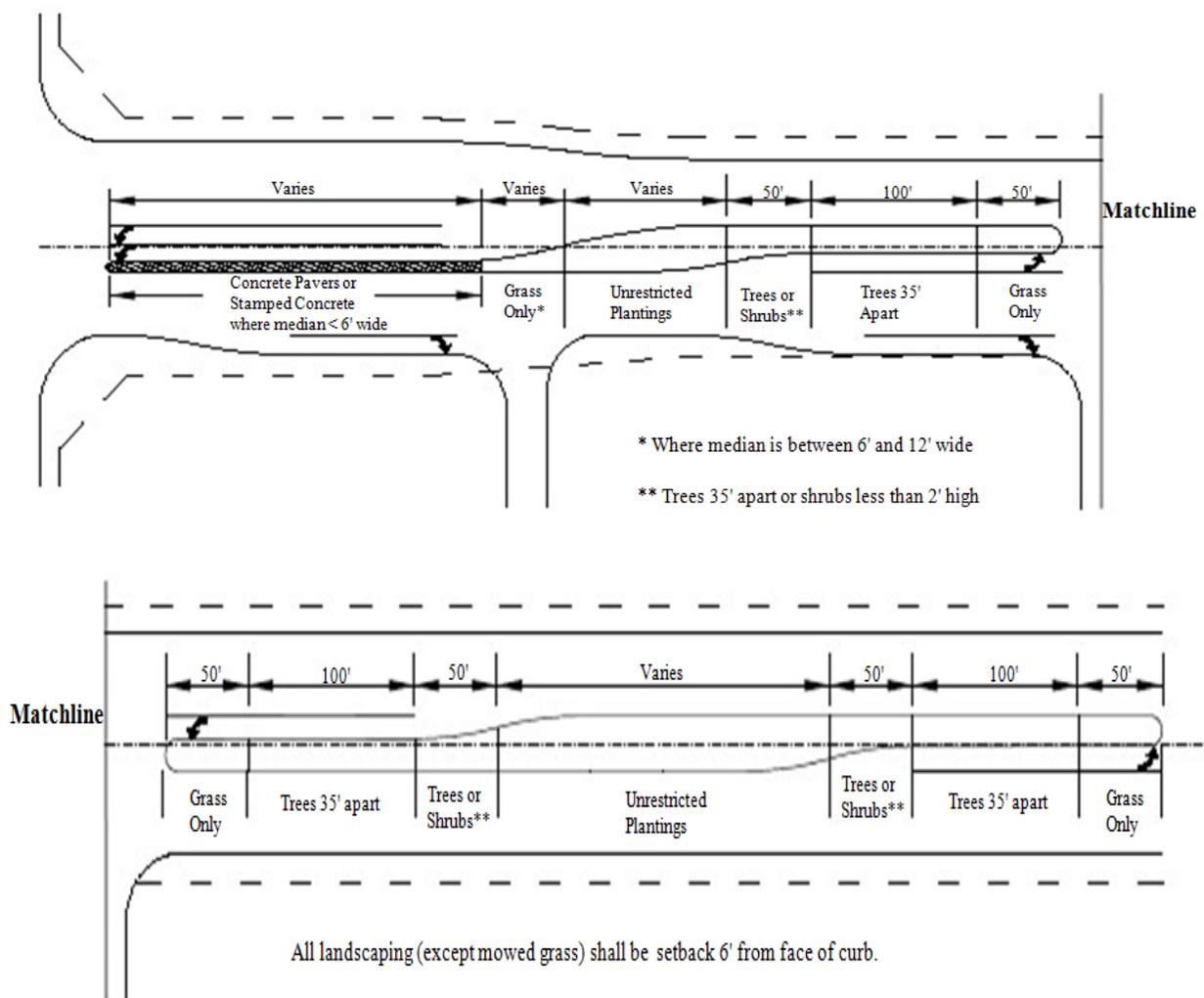


FIGURE 6.1: Typical Median Landscaping

- A. Landscaping that is located within the median of a thoroughfare shall meet the requirements shown in Figure 6.1.
- B. Refer to Section 4.07 of the Thoroughfare Design Requirements for corner visibility and sight line triangles with regards to landscaping and other obstructions.
- C. A minimum of four inches (4") or (six inches (6") in rock) suitable loam topsoil shall be furnished and installed in the areas behind the curbs.
- D. Only mowed grasses are permitted within six feet (6') of the existing or future face of curb unless approved by the City Engineer or designee and Director of Parks and Recreation.
- E. Irrigation shall be provided in accordance with the Irrigation Design Standards (Section 7 of the Engineering Standards).
- F. Median tree spacing shall be thirty five feet (35') (typical) apart center-to-center of tree trunk generally located in the center of the ultimate median.
- G. Trees shall be planted at least four feet (4') from the outside edge of a pipeline.
- H. The City has final approval for all tree placements.
- I. Trees overhanging walks and parking shall have a minimum clear trunk height of seven feet (7'). Trees overhanging public street pavement, drive aisles and fire lanes shall have a minimum clear trunk height of fourteen feet (14').
- J. Trees and planting areas shall not be installed on slopes steeper than 3:1.
- K. Landscaping shall be located so that pedestrians can walk along the parkway whether a paved sidewalk is provided or not.
- L. Sod shall be placed to cover the first four feet (4') behind the curbs of the median area and two feet (2') behind the curb along the parkway along all public roadways in accordance with the City Technical Specifications.
- M. Areas not required to be sodded shall be seeded after properly preparing the ground as designated on the plans and in accordance with City Technical Specifications.
- N. Conduit for street lighting and irrigation shall be generally located as shown in Figure 6.2 to accommodate trees, street lights and irrigation within the roadway median.

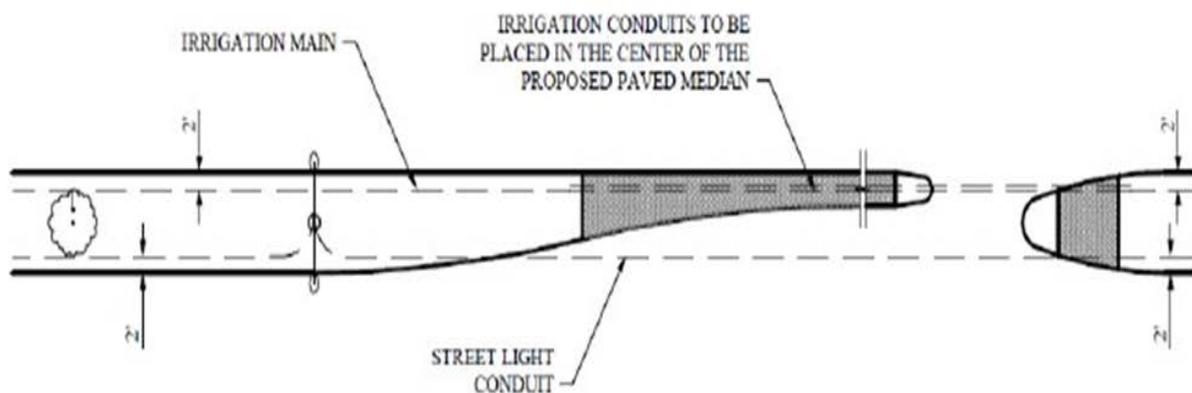


FIGURE 6.2: Conduit for Street Lighting and Irrigation

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- O. Trees within two hundred feet (200') from the nose of a median shall have foliage trimmed to at least ten feet (10') above the ground.
 - P. Beyond a point two hundred feet (200') from the nose of the median, tree foliage should be trimmed to at least six feet (6') from ground.

6.03 Approved Plant Materials

A. Refer to the online Approved Material List for approved plant materials for median planting.

Other species may be utilized with approval from the City's Parks and Recreation Department.

Artificial plants are prohibited.

SECTION 7 – IRRIGATION DESIGN REQUIREMENTS



7.01 General

- A. The purpose of this section is to provide additional requirements and standards to address irrigation requirements **within the medians of major and minor thoroughfares**. Refer to the following ordinances and documents:
1. [Irrigation Ordinance](#) (HB 1656)
 2. [Zoning Ordinance, Section 14.05.081 through Section 14.05.089](#) – Landscape Requirements

7.02 Roadway Irrigation Requirements

- A. Irrigation system shall be designed and installed to minimize runoff onto paved surfaces. Overspray on streets and walks are prohibited.
- B. Private irrigation system mainlines, valves, or control wires located within the City’s right-of-way shall be maintained by the adjacent property owner.
- C. The bore depth under streets, drive aisles, and fire lanes shall allow two feet (2’) minimum from the bottom of paving to the top of the sleeve, or greater if required to clear other utilities
- D. All irrigation piping and boxes shall be purple in color.
- E. A separate water meter is required for irrigation.
- F. ET controllers shall be installed on AC power.
- G. A ball valve is required on the upstream side of control valve and shall be located in a jumbo box.
- H. Backflow prevention devices are required for all irrigation systems.
- I. Provide a section valve to regulate pressure in the irrigation system.
- J. Check valves are required where elevation differences will cause low-head drainage.
- K. PVC water lines shall be Pressure Rated Class 200, DR 21.
- L. Minimum main line pipe size shall be 1-1/4”.
- M. Minimum lateral line pipe size shall be 3/4”.
- N. System shall deliver a minimum residual pressure of 30 pswi at the spray head and 50 pswi for rotors.
- O. Each valve shall irrigate a landscape zone containing plant materials with similar water requirements and similar site, slope and soil conditions.
- P. Where drip systems are to be used, they shall be designed to provide water uniformly from subgrade PVC piping.
- Q. Trees shall be irrigated with one bubbler each with a separate valve
- R. Irrigation heads shall comply with the following:
1. Multi-stream multi-trajectory rotor heads
 2. Low precipitation with 0.7DU or greater
 3. Selected and spaced for maximum distribution and uniformity.
 4. Matched precipitation rates on each zone.
 5. Have spring retracted pop-up operation.
 6. Installed on green 6” cut off riser.
 7. Adjust heads to ensure uniform coverage and to prevent overspray.
 8. Shall be installed a minimum of six inches (6”) from back of curb and in accordance with current TCEQ regulations.
 9. Connect all MSMTR or equivalent heads with bull head connection.
- S. Feeder laterals and mainlines shall be located as close to the center of median as feasible.
- T. Refer to the Approved Materials List for Median Right-of-Way Irrigation Equipment

7.03 Additional Irrigation Design Requirements within Roadway

- A. Two four-inch (4”) PVC conduits shall run from two feet (2’) behind the back of curb from median nose to median nose, extending beyond the limits of hardscape (concrete median nose, pavers, etc.).

Two four-inch (4") PVC conduits shall also run from median to parkway as needed to provide water and power to the median. The end of the conduits shall be clearly marked with a saw-cut.

- B. No swing pipe or flex pipe allowed in medians.
- C. Wiring shall include six 14 gauge (minimum) wires.
- D. Refer to Section 6.02, Landscape Requirements within the Median for additional information on location of conduits for street lighting and irrigation in relation to tree planting.

SECTION 8 – ENVIRONMENTAL REQUIREMENTS



8.01 General

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

8.02 Storm Water Management Plan (SWMP) – Permanent Controls

A. General Requirements

A Storm Water Management Plan (SWMP) shall be prepared for all developments in accordance with the Subdivision Ordinance. The SWMP shall be developed and coordinated with the site drainage plan and may be shown on the same sheet. The SWMP shall identify permanent site features and controls that will be constructed with the project to minimize and mitigate the project's long-term effects on storm water quality and quantity. The SWMP should also be coordinated with the landscaping plan to prevent conflicts and ensure compatible land use.

B. Site Development Controls (Permanent)

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

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

The following are some examples of permanent controls:

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

8.03 Texas Construction General Permit (CGP)

Construction activities that discharge storm water runoff into or adjacent to any surface water of the state are regulated by the state of Texas under the Construction General Permit (CGP) (TXR150000). The governing agency is the Texas Commission on Environmental Quality (TCEQ). Construction activities are regulated according to the area of land disturbed. For sites that disturb five or more acres, or are part of a larger common plan of development that will disturb five or more acres, and meet the definition of an operator, the following applies:

Large construction activities

- Prepare and implement a Storm Water Pollution Prevention Plan (SW3P)
- Post a Site Notice
- Submit a copy of the Site Notice to the Municipal Separate Storm Sewer System (MS4) Operator

For sites that disturb five or more acres, and meet the definition of a primary operator, the following applies:

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

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

Small construction activities

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

Sites that disturb less than one acre and that are not part of a larger common plan of development that would disturb one or more acres, are not required to have coverage under the general permit. Refer to the General Permit definitions for Operator and Primary Operator. Additional information on the Texas Construction General Permit can be found at the following link:

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

8.04 Storm Water Pollution Prevention Plan (SW3P)

One of the requirements of the Construction General Permit is to develop an SW3P. The purpose of the SW3P is to provide guidelines for minimizing sediment and other pollutants that may originate on the site, from flowing into municipal storm systems, or jurisdictional waters during construction. The plan must also address the principal activities known to disturb significant amounts of ground surface during construction. The storm water management controls included in the SW3P should focus on providing control of pollutant discharges with practical approaches that use readily available techniques, expertise, materials, and equipment. The SW3P must be implemented prior to the start of construction activity.

A. Construction Controls

Structural and non-structural controls may be used for controlling pollutants for storm water discharges from small and large sites. Structural controls shall comply with details and specifications in the latest edition of the NCTCOG iSWM Technical Manual and these standards. When the NCTCOG Manual and these standards are in conflict, these standards shall govern. The following are acceptable temporary controls for use during construction:

a. Non-Structural

- Minimizing the area of disturbance
- Preserving existing vegetation

b. Structural**1. Silt fence**

- i. Steel posts which support the silt fence shall be installed on a slight angle toward the anticipated runoff source. Post shall be embedded a minimum of one foot (1').
- ii. The toe of the silt fence shall be trenched-in with spade or mechanical trencher so that the down slope face of the trench is flat and perpendicular to the line of flow. Where silt fence cannot be trenched-in (e.g. Pavement or rock surface) weight fabric flap with rock on uphill side to prevent flow from seeping under fence.
- iii. The trench must be minimum of six inches (6") deep and six inches (6") wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.
- iv. Silt fence shall be securely fastened to each steel support post or to woven wire which in turn shall be attached to the steel fence post. There shall be a three foot (3') overlap. Securely fastened where ends of fabric meet.
- v. Accumulated silt shall be removed when it reaches a depth of one foot (1'). This silt shall be disposed of at an approved site and in such a manner as to not contribute to additional siltation.
- vi. Silt fence shall be removed when the site is completely stabilized.
- vii. Rock filter dams shall be used at concentrated high flow discharge areas in lieu of silt fence.

2. Rock filter dams

- i. Rock filter dams shall be constructed downstream from disturbed areas to intercept sediments from overland runoff and/or concentrated flow. The dams shall be sized to filter a maximum flow through rate of sixty gallons per minute (60 gpm) per square foot of cross sectional area. A two (2) year storm frequency may be used to calculate the flow rate.
- ii. Type 1 (eighteen inches (18") high with no wire mesh): may be used at the toe of slopes, around inlets, in small ditches and at dike or swales outlet. This type of dam is recommended to control erosion from a drainage area of five (5) acres or less. Type 1 may not be used in concentrated high velocity flows (approx. eight feet per second (8 ft. /sec) or more) in which aggregate wash out may occur. Sandbags may be used at the embedded foundation (four inches (4") deep min.) for better filtering efficiency of low flows if called for on the plans or directed by city engineer.
- iii. Type 2 (eighteen inches (18") high with wire mesh): may be used in ditches and at dike or swales outlets.
- iv. Type 3 (thirty six inches (36") high with wire mesh): may be used in stream flow and should be secured to the stream bed.
- v. Type 4 (sack gabions): may be used in ditches and smaller channels to form an erosion control dam.
- vi. Materials (aggregate, wire mesh, sandbags, etc.) Shall be as indicated by the specification for "rock filter dams for erosion and sedimentation control".
- vii. The rock filter dam dimensions shall be as indicated on the SWPPP or erosion control plans.
- viii. Stone side slopes should be 2:1 or flatter. Dams within the safety zone shall have side slopes of 6:1 or flatter.
- ix. A minimum of one foot (1') shall be maintained between top of rock filter dam weir and top of embankment for filter dams at sediment traps.
- x. Filter dams shall be embedded a minimum of four inches (4") into existing ground.
- xi. The sediment trap for ponding of sediment laden runoff shall be of the dimensions shown on the plans.
- xii. Rock filter dam types 2 & 3 (see design detail) shall be secured with twenty (20) gauge galvanized woven wire mesh with one inch (1") diameter hexagonal openings. The aggregate shall be placed on the mesh to the height and slopes specified. The mesh shall be folded at the upstream side over the aggregate and tightly secured to itself on the downstream side using wire ties or hog rings. In stream use the mesh should be secured or staked to the stream bed prior to aggregate placement.
- xiii. Sack gabions should be staked down with three quarters of an inch (3/4") dia. Rebar stakes.
- xiv. Flow outlet should be onto a stabilized area (vegetation, rock, etc.).
- xv. The guidelines shown are suggestions only and may be modified by the engineer.
- xvi. All material incorporated in the construction shall be new.
- xvii. Max temporary earth slope is 3:1 with 4:1 recommended if practical

3. Inlet protection

- i. A section of filter fabric shall be removed as shown on the detail to provide a four inches (4") minimum clear opening. Fabric shall be secured to wire backing with clips or hog rings at this location

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- ii. Inspection shall be made by the contractor and silt accumulation must be removed when depth reaches two inches (2")
 - iii. Contractor shall monitor the performance of inlet protection during each rainfall even and immediately remove the inlet protections if the storm-water begins to overtop the curb.
 - iv. Inlet protections shall be removed as soon as the source of sediment is stabilized.
4. Erosion Control Mats
- i. Erosion control mats may be used in place of or in addition to silt fence for sheet flow filtering applications.
 - ii. Mats shall be installed and anchored securely to the ground in compliance with the manufacturer's recommendations.
 - iii. The width requirements of the erosion control mats shall be comparable to the width of the disturbed surface to be filtered. The minimum width shall be ten feet (10') for single family lots and twenty feet (20') for commercial applications unless approved otherwise by the city.
 - iv. The width of erosion control mats can be reduced when used in conjunction with silt fence and block sod vegetative buffer strips. In no applications will erosion control mats be less than four feet (4') wide.
- 5. Stabilized construction entrances
 - 6. Sediment traps
 - 7. Vegetated buffer strips
 - 8. Temporary detention structure
 - 9. Rock check dams
 - 10. Hydro-mulch

Suggested construction controls can be found on the NCTCOG iSWM website. It is the responsibility of the design engineer to select and design appropriate construction controls for each site. If the most appropriate control is not shown in the iSWM Technical Manual, the design engineer shall submit calculations and references for design of the control to the City Engineer or designee for review and approval.

B. Waste and Hazardous Material Controls

Covered containers shall be provided for waste construction materials and daily trash. Hazardous materials shall be stored in a manner that prevents contact with rainfall and runoff. Onsite fuel tanks and other containers of motor vehicle fluids shall be placed in a bermed area with a liquid-tight liner or be provided with other secondary containment with spill prevention controls. The SW3P shall require federal, state and local reporting of any spills and releases of hazardous materials greater than the regulated Reportable Quantity (RQ) and reporting to the Engineering and Public works department of all spills and releases to the storm drainage system.

C. Temporary Stabilization

Portions of a site that have been disturbed, but where no work will occur for more than twenty (21) days shall be temporarily stabilized as soon as practicable, and no later than fourteen (14) days, except when precluded by seasonal arid conditions, or prolonged drought. Temporary stabilization shall consist of providing a protective cover, designed to reduce erosion on disturbed areas. Temporary stabilization may be achieved using temporary seeding, soil retention blankets, hydro-mulches and other techniques that cover one hundred (100) percent of the disturbed areas until either final stabilization can be achieved or until further construction activities take place. Perimeter controls such as silt fence, vegetated buffer strips or other similar perimeter controls are intended to act as controls when stabilization has not occurred. Perimeter controls may remain in place during temporary stabilization.

D. Final Stabilization

Final stabilization consists of soil cover such as vegetation, geo-textiles, mulch, rock, or placement of pavement. For stabilizing vegetated drainage ways, sod or seeded soil retention blankets shall be used. Hydro-mulch will not be allowed in vegetated swales, channels or other drainage ways. The plan for final stabilization shall be coordinated with permanent controls in the SWMP and with the landscaping plan, if applicable.

E. Notice of Intent (NOI)

If applicable, copies of the NOI shall be sent to the Engineering and Public works department at least 2 days prior to construction.

F. TCEQ Site Notice

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

G. Notice of Termination (NOT)

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

H. Inspection and Maintenance during Construction

The owner shall construct all controls required by the SW3P. The owner shall have qualified personnel inspect the controls at least every two weeks during construction and within twenty four (24) hours after a storm event of half (0.5) inch, or greater. Alternately, inspections may be performed every seven (7) days with no additional inspections after rain events. Certified inspection reports shall be retained as part of the SW3P. Within seven days of the inspection, controls identified as damaged or deteriorated shall be repaired or replaced, as appropriate. Controls shall also be routinely cleaned to maintain adequate capacity. Changes or additions shall be made to the controls within seven (7) days to prevent discharges from the site. The owner shall implement procedures to remove discharged soil from all portions of the storm drainage system including streets, gutters, inlets, storm drain, channels, creeks, ponds, etc. Notes requiring the inspection and maintenance shall be placed on SW3P drawings. The SW3P shall identify the responsible party for inspecting and maintaining each control. If no party is identified, each owner and operator that submitted a NOI for the site shall be fully responsible for implementing all requirements of the SW3P.

I. Construction and Maintenance

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

SECTION 9 – STRUCTURAL DESIGN REQUIREMENTS

9.01 General

- A. The Design Engineer of record shall bear the sole responsibility for meeting the engineering standard of care for all aspects of the design and providing a design that's required by the site specific-conditions and intended use of the facilities.
- B. For the purposes of this section of the Engineering Standards, the following items shall be considered structures: bridges, foundations, retaining walls (structural and gravity), headwalls and wing-walls, culverts, slopes and embankments, and screening walls.
- C. The City's review of any structural design is limited to determining whether the construction plans are in general compliance with the City's Master Plans and Engineering Standards. The City's review and release of the construction plans does not represent that the City has reengineered or verified the engineering of the proposed improvements.
- D. The structural design must be signed and sealed by a structural engineer or civil engineer competent in structural engineering licensed in the State of Texas. The Design Engineer is responsible for all engineering and recognizes that specific site circumstances or conditions may require improvements constructed to exceed minimum standards contained in the City's Engineering Standards. The Design Engineer is responsible for the applicability and accuracy of the construction plans and specifications.
- E. Walls shall be permitted and constructed in accordance with all requirements of these Engineering Standards. Third-party inspections shall be performed during construction, and reports provided to the City. A third-party shall certify wall was constructed in general compliance with the City-approved plans and specifications, and a certification shall be provided to the City.

9.02 Code Requirements

- A. All structural design shall comply with the City's currently adopted version of the *International Building Code*.
- B. The design and construction of structural concrete for buildings and where applicable in non-building structures shall be provided in accordance with the requirements of the current version of "Building Code Requirements for Structural Concrete (ACI 318)" as published by the American Concrete Institute.
- C. Placing reinforcing steel in reinforced concrete structures shall be provided in accordance with the requirements of the current version of the "ACI Detailing Manual (ACI 315)" as published by the American Concrete Institute.
- D. The design and construction of concrete tanks, reservoirs, and other structures commonly used in water and wastewater treatment works where dense, impermeable concrete with high resistance to chemical attack is required shall be provided in accordance with the requirements of the current version of "Environmental Engineering Concrete Structures (ACI 350)" as published by the American Concrete Institute. This code places special emphasis on structural design that minimizes the possibility of cracking and accommodates vibrating equipment and other special loads. ACI 350's minimum requirements for proportioning of concrete, placement, curing, and protection against chemicals shall be met or exceeded. The design and spacing of joints shall also meet or exceed the minimum requirements of ACI 350.
- E. The design and construction of roadway bridges shall be provided in accordance with the requirements of the current version of the "Standard Specifications for Highway Bridges" as published by the American Association of State and Highway Transportation Officials (AASHTO).
- F. Concrete exposed to sulfate-containing solutions or soils shall be made with sulfate-resisting cement. The concrete shall be provided in accordance with the requirements of ACI 318 Section 4.3. Table 9.1 lists the appropriate types of cement, the maximum water-cementitious material ratios, and the minimum specified compressive strengths for various exposure conditions.
- G. ASTM test method C 1012 can be used to evaluate the sulfate resistance of mixtures using combinations of cementitious materials.

1. In addition to the proper selection of cement, other requirements for durable concrete exposed to concentrations of sulfate are essential, such as, low water-cementitious material ratio, strength, adequate air entrainment, low slump, adequate consolidation, uniformity, adequate cover of reinforcement, and sufficient moist curing to develop the potential properties of the concrete.
- H. More stringent requirements may be required for unusual designs or specific site conditions. The codes cannot replace sound engineering knowledge, experience, and judgment.
- I. For any structure, the City or the structural engineer may require the quality of materials and construction to be higher than the minimum requirements as stated in the codes.

Table 9.1 - ACI 318 Section 4.3

Sulfate exposure	Water soluble sulfate(SO ₄) in soil, percent by weight	Sulfate (SO ₄) in water, ppm	Cement Type	Maximum water-cementitious materials ratio, by weight, normal weight aggregate concrete*	Minimum f_c' , Normal-weight and lightweight aggregate concrete, psi*
Negligible	$0.00 \leq SO_4 < 0.10$	$0 \leq SO_4 < 150$	-	-	-
Moderate ⁺	$0.10 \leq SO_4 < 0.20$	$150 \leq SO_4 < 1500$	II, IP(MS), P(MS), I(PM)(MS), I (SM)(MS)	0.50	4000
Severe	$0.20 \leq SO_4 \leq 2.00$	$1500 \leq SO_4 \leq 10,000$	V	0.45	4500
Very severe	$SO_4 > 2.00$	$SO_4 > 10,000$	V plus pozzolan [‡]	0.45	4500

*When both Table 9.1 and Table 9.2 are considered, the lowest applicable maximum w/cm and highest applicable minimum f_c' shall be used.

+ Seawater

‡Pozzolan that has been determined by test or service record to improve sulfate resistance when used in concrete Type V cement.

9.03 Geotechnical Performance Specifications

- A. Field investigation, geotechnical testing, and geotechnical engineering shall be performed in accordance with the standard of care taking into account local experience and conditions. The geotechnical recommendations shall establish the minimum design criteria upon which the Design Engineer can rely. However, based on the Design Engineer's experience and engineering judgment, if the Design Engineer is compelled to use more conservative geotechnical design criteria for his/her structural design, that is the Design Engineer's prerogative. In no case shall the Design Engineer use geotechnical design criteria less conservative than the geotechnical engineer's recommendations.
- B. ROW Permit must be obtained prior to performing any boring within the City's right-of-way.
- C. The complexity of geological conditions and the type, length, and width of structure will determine the number and locations of test holes required. The following should be considered by the Design Engineer in coordination with the geotechnical engineer: Depth of test hole, location of proposed grade relative to existing grade, channel relocations and/or channel widening, scour, foundation loads and foundation types.
- D. Locate the test holes in an accessible area. Avoiding overhead power lines and underground utilities where possible, avoid steep slopes and standing or flowing water. Identify test-hole locations on the plans.

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- E. Provide a complete soil and bedrock classification and log record for each test hole, including all pertinent information to complete the standard log. Location and surface elevation shall be shown on the boring logs.
 - F. Perform the appropriate field and laboratory tests necessary to determine the soil shear strength for proper soil evaluation and geotechnical design criteria. The geotechnical engineer shall consider the short-term and long-term conditions. In addition, special attention is required when testing highly plastic clays. Tests of these soil types shall be performed at a slow enough rate such that any excess pore water pressure is dissipated, or in a manner that measures pore water pressure.
 - G. Ground water elevations shall be included as part of the data acquisition. Site conditions may require the installation of piezometers to establish a true groundwater surface elevation and method of monitoring water surface fluctuations.
 - H. Minimum boring requirements are as follows:
 - 1. **Slopes and Embankments including Bridge Approaches.** Obtain soil borings for cuts greater than ten feet (10') or embankments taller than ten feet (10'). The exploration shall include the following:
 - a. The soil under future embankments. Advance borings to a depth at least equal to the embankment height or twenty feet (20'), whichever is greater, unless a greater depth is recommended by the geotechnical engineer.
 - b. Soil in proposed cuts. Advance borings to a depth of at least 15' below the bottom of the proposed cut, unless a greater depth is recommended by the geotechnical engineer.
 - 2. **Bridges**
 - a. In general, drill test holes ten to fifteen feet (10' to 15') deeper than the probable top elevation of the bridge foundation.
 - b. Test holes near each abutment of the proposed structure plus a sufficient number of intermediate holes to determine depth and location of all significant soil and rock strata.
 - c. Major stream crossings (over channels more than 200 feet wide) require borings in the channel. A site inspection by the driller or logger is necessary to evaluate site accessibility and special equipment needs.
 - d. Minor stream crossings over channels less than 200 feet wide shall provide a boring on each bank as close to the water's edge as possible. If boring information varies significantly from one side of the channel to the other, a boring in the channel may be required by the City Engineer or designee.
 - e. Grade Separations. If the borings indicate soft surface soils (fewer than 10 blows per foot), additional borings and testing shall be required for the design of the bridge approach embankments.
 - 3. **Retaining Walls:** Obtain soil borings for **walls taller than 4-ft.**
 - a. Obtain soil borings at two hundred feet (200') spacing unless site conditions or the design engineer requires closer spacing. A greater spacing may be allowed by the City Engineer or designee only if recommended in writing by the geotechnical engineer of record.
 - b. Fill Walls. For spread footing walls and MSE walls, the depth of the boring shall be a minimum of the wall height depending on the wall type and existing and proposed ground lines. The minimum boring depth is 10' below the bottom of the proposed wall unless rock is encountered (see Section 9.03.H.4). Extend borings at least 5' into rock for fill walls unless additional depth is recommended by the geotechnical engineer.
 - c. Cut Walls. For drilled shaft walls, tied-back walls, and soil and rock nail walls, the depth of the boring is based on the proposed ground line. Cantilever drilled shaft walls require the depth of boring to extend the anticipated depth of the shaft

below the cut, which is typically between one and two times the wall height unless additional depth is recommended by the geotechnical engineer of record. Borings for soil nail and rock nailed walls need to be advanced through the material that is to be nailed. The minimum boring depth is 15' below the bottom of the proposed wall. Borings for proposed cut walls may need to penetrate rock significant distances depending on the depth of the cut and wall height.

- d. Provide additional testing for taller walls, walls on slopes, or walls on soft founding strata as necessary, or recommended by the geotechnical engineer of record, to completely evaluate wall stability.
4. **Borings Encountering Rock**
- a. Based on the geotechnical engineer's experience and engineering judgment, if rock is encountered the minimum boring depths specified above may be reduced but only at the direction of the geotechnical engineer.

9.04 Bridge Design

- A. The structural engineer shall be responsible for selecting the appropriate bridge foundation. The engineer shall consider the following factors in that selection:
 - 1. Design load. The magnitude of the design load dictates the required size of the foundation.
 - 2. Geotechnical engineering recommendations. The strength and depth of subsurface formations determine the type of foundation chosen. In general, drilled shafts are well suited to areas with competent soil and rock, and are the preferred foundation type subject to concurrence of the geotechnical and structural engineers' concurrence. Alternative foundation types require approval in writing by the Director of Engineering Services.
 - 3. Corrosive conditions. Salts, chlorides, and sulfates are detrimental to foundations. Where these conditions exist, the Design Engineer shall take preventative measures. Use sulfate resistant concrete as defined in these Engineering Standards as required.
- B. The structural engineer shall use the geotechnical investigation recommendations as minimum design criteria. If in the structural engineer's judgment, the structural design needs to be based upon more conservative geotechnical design criteria, the structural engineer shall provide the more conservative design.
- C. Disregard surface soil in the design of drilled shaft foundations. The disregarded depth is the amount of surface soil that is not included in the design of the foundation due to potential erosion from scour, future excavation, seasonal moisture variation (shrinkage and swelling), lateral migration of waterways, and recommendations of the geotechnical investigation.
- D. Drilled shaft capacity relies upon penetrating a specific stratum at specified depth. The plans shall provide a note instructing the contractor and field personnel of the penetration requirement. The plans shall identify the specific type of material to be penetrated and the minimum penetration depth. The plan may allow for the drilled shaft to be shortened if the founding stratum is encountered at a shallower depth, and it requires the shaft to be lengthened if the founding stratum is not encountered at the expected elevation.

When the founding stratum is present at or near the surface, the structural engineer shall consider the load-carrying capacity along with the stability of the superstructure on the foundation. For these conditions, a minimum drilled shaft length shall be specified on the plans and the drilled shaft will not be allowed to be shortened from plan length, but it may be lengthened if the founding stratum is not encountered at the expected elevation.

- E. Bridge foundations for new bridges over waterways require a scour analysis. A scour analysis shall be conducted in accordance with the following:
 - 1. TxDOT guidelines in "Evaluating Scour at Bridges" (HEC-18).

2. Abutment scour does not need to be calculated. However, abutments shall be protected against potential scour through use of flexible revetment, where possible or hard armoring.
3. Design bridge foundations to withstand the scour depths for either the 100-year flood or smaller flood if it will cause scour depths deeper than the 100-year flood.
4. Check the bridge foundations against the scour depth associated with the 500-year flood. This flood event is considered an extreme event and the factor of safety on the bridge foundations shall be greater than or equal to 1.

9.05 Retaining Wall Design

- A. The Design Engineer is responsible for ensuring that the retaining wall selected for a given location is appropriate. The retaining wall selection process shall consider the following:
 1. Height: Any retaining wall exceeding four feet (4') in height measured from the bottom to the top of wall shall be engineered and require a separate permit issued through the building inspections department. The structural design shall be provided in accordance with the geotechnical recommendations and minimum design criteria provided in Section 9.03.
 2. Geometry: Determine applicability of wall type - cut, cut/fill, or fill – based on geometry, site constraints, existing and proposed topography, and wall alignment and location. Retaining walls (including the footing) shall not be constructed to encroach upon city right-of-way, public easements or public utilities without the consent of the city engineer.
 3. Economics: Evaluate the total installed cost of the wall and consider long-term maintenance requirements. Identify necessary excavation requirements (including shoring), required utility adjustments and costs, project schedule, construction phasing requirements, and these effects on the wall design and construction.
 4. Stability: The Design Engineer is responsible for the global stability of the wall. Evaluate all walls to ensure that the minimum applicable factors of safety are at least met (see Section 9.05.C), if not exceeded depending on the Design Engineer's judgment. When possible, avoid placing walls on slopes. A slope in front of the wall dramatically reduces the passive earth pressure (resistance), increasing the chance for wall failure. Additionally a slope in front of the wall will have a significant effect on global stability of the wall and embankment in which it resides. For situations where the walls above a slope cannot be avoided, a rigorous slope stability analysis shall be required in accordance with these Engineering Standards.
 5. Constructability: Determine whether walls are near water or subject to inundation or groundwater. Identify access limitations for equipment both during and after construction. Ensure adequate horizontal and vertical clearances are provided.
 6. Drainage: Design the wall to prevent the build-up of hydrostatic pressure behind the wall. If conditions warrant, the City may require the wall design to withstand full hydrostatic pressure load. The wall design shall consider potential deleterious short and long term effects of water inundation including scour and rapid draw down.
 7. Aesthetics: Ensure that aesthetic treatments of walls complement the retaining wall and does not interfere with the functionality of the wall. Detailed consideration shall be given to aesthetic treatments of retaining walls that involve landscaping. Additionally, the wall's drainage system design shall avoid potential compromise of the wall aesthetics because of water related damages.
 8. Loading: Design loads shall be in accordance with these Engineering Standards (for building code references, see Section 9.02), including construction loads and surcharge loads from slopes, structures, and vehicles.
- B. Analyze and design walls following accepted geotechnical engineering industry standards for the City of Celina area and in accordance with these Engineering Standards. In analysis, use earth

pressures that follow the requirements of the project's geotechnical investigation specifically addressing the retaining wall design requirements for the project's specific location.

- C. The Design Engineer must ensure that the retaining wall system is appropriate for its location and application. The Design Engineer shall design for all potential modes of wall system failure; including, sliding, overturning, bearing pressure, global stability, and structural capacity of the wall itself. The design of the retaining wall shall meet the following minimum factors of safety
 - a. Sliding: 1.5
 - b. Overturning: 2.0
 - c. Bearing Pressure: 3.0
 - d. Global Stability: 1.5
- D. Avoid perching wall on slopes steeper than 8H: 1V. When walls must be placed on slopes steeper than 5H: 1V, or the retaining wall height or the combined wall and slope heights exceed 8-ft., the geotechnical engineer shall conduct a short-term and long-term global stability analysis using applicable soil strength characteristics, geometry, and loading conditions (including load surcharge, hydrostatic, etc.). The Design Engineer is responsible for the design of the wall system, including its global stability.
- E. A series of two or more walls built in tiers shall be considered a single wall in height for the purposes of conforming to these Engineering Standards when the base of the upper tier is set back from the base of the lower tier less than two times the height of the lower tier wall.
- F. If TxDOT standard sheets pertaining to cast-in-place spread footing structural retaining walls are utilized, the Design Engineer shall ensure that the actual wall geometry and loading conditions are applicable to the standard wall design selected. The Design Engineer shall ensure that interruptions to the wall stem or footing reinforcement by openings, utilities, geometric changes or curved sections of the wall do not compromise the design and performance of the wall. No TxDOT standard wall design shall be modified unless the Design Engineer designs, draws, and seals the modified standard.
- G. TxDOT standard sheets pertaining to cast-in-place spread footing walls provide a choice between high pressure (HP) and low pressure (LP) footings. Selection by the Design Engineer is a function of the loading, geometry, and allowable soil pressures. **TxDOT standard sheets pertaining to cast-in-place spread footing walls are developed based on the wall being drained, and the design parameters for foundation and retained soils of a cohesion factor of zero, a friction factor of 30 degrees, and a unit weight of 120 pounds/cubic foot.** Give special consideration to the site-specific geotechnical requirements and whether a TxDOT standard wall design is applicable. Also give special consideration to walls subject to potential inundation.

9.06 Slope Stability Design Criteria

- A. All slopes exceeding 8-ft. in height with a steepness of 4H: 1V or greater, regardless of soil type, cut, or fill, shall be evaluated for global stability for both the short-term and the long-term conditions. Additionally, **any known areas of existing fill, deleterious material, or soft soils which have a height over 4 feet or slope angle greater than 6H:1V** shall be evaluated for global stability for both the short-term and the long-term conditions. Specific site conditions may require evaluation for additional types of slope failure, such as bearing capacity, settlement, shear, and undercutting. Calculations pertinent to the analysis shall be submitted with the construction drawings when required by the City.
- B. Use the following data to analyze global stability of a slope:
 - 1. Geometry (cross section and loading conditions);
 - 2. Location of the water table;
 - 3. Soil/rock stratigraphy; and
 - 4. Soil/rock properties (unit weight, Atterberg Limits, undrained and drained shear strength).
- C. For global stability of a slope, the minimum factor of safety of 1.5 is required unless the geotechnical engineer recommends a higher value.

9.07 Screening Wall Design Criteria

- A. Screening Walls shall meet the minimum requirements included in the Subdivision Ordinance, Section 8 and the Zoning Ordinance, Section 4.03 – Screening Standards
- B. An opening designed to allow for storm water drainage shall be provided unless it has been determined by the Director of Engineering Services that no drainage problems are anticipated. The opening shall be a uniform 2” high the full length between columns.
- C. All screening walls shall be designed by a Professional Engineer licensed in the State of Texas. Signed, sealed and dated plans shall be submitted to the City for review and permitting.

9.08 Excavation Support

- A. Trench excavation protection shall be used for the installation of linear drainage or utility facilities that result in trenches deeper than 5’. Such trench protection includes vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with Occupational Safety Health Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, “Excavations.”
- B. Temporary special shoring is used for installations of walls, footings, and other structures that require excavations deeper than 5’. Temporary special shoring is designed and constructed to hold the surrounding earth, water, or both out of the work area. It provides vertical or sloped cuts, benches, shields support systems, or other systems to provide the necessary protection in accordance with the approved design. Unless a complete design for temporary special shoring systems are included in the plans, the contractor is responsible for the design of the temporary special shoring system. The Contractor must submit to the City, for informational purposes only, the design calculations and details sealed by a Professional Engineer licensed in the State of Texas before constructing the shoring. The design of the shoring must provide protection in accordance with Occupational Safety Health Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, “Excavations.”

9.09 Construction Plans

- A. Constructions drawings and technical specifications for **all structural** construction shall include the following:
 - 1. Design engineer’s seal, date, signature, and Texas Board of Professional Engineers (TBPE) firm registration number;
 - 2. Name and date of issue of the codes and supplements to which the design conforms;
 - 3. Name and date of the project-specific geotechnical engineering report upon which the Design Engineer relied;
 - 4. Live load and other loads used in the design, including surcharge loads and potential exposure to storm water inundation. Specifically identify the applicable loads and their load factors;
 - 5. Identification of geotechnical investigation and report to which the design conform (including report name and number (if applicable), date of issuance, engineering firm name and address, firm TBPE firm registration number, and name of geotechnical engineer of record).
 - 6. Where plans indicate compacted soil, provide compaction specification.
 - 7. Specified compressive strength of concrete at stated ages or stages of construction for which each part of the structure is designed.
 - 8. The design shall specifically address construction loading and sequencing. Service loads shall not be applied until the concrete has reached its minimum specified compressive strength or the structure is adequately shored to withstand the service loads;

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9. Drainage system (if applicable), including material specification, diameter, daylight point, and outfall connection detail (if applicable), granular material (if applicable) specification, filter fabric material specification and installation requirements, and weep-holes (if applicable), including material type, diameter, and spacing;
 10. Size and location of all structural elements, reinforcement, and anchors;
 11. Identification of shop drawing requirements for fabrication, bending, and placement of concrete reinforcement. Provide bar schedules, stirrup and tie spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Provide additional details for reinforcement of openings in concrete walls and slabs. Shop drawings shall be provided in accordance with the requirements of the technical specifications and submitted to the City for review and approval.
 12. Provisions for dimensional changes resulting from creep, shrinkage, and temperature;
 13. Details of all contraction, isolation joints, or expansion joints and the appropriate spacing specified;
 14. Anchorage length of reinforcement and location and length of lap splices (if applicable);
 15. Type and location of mechanical splices of reinforcement (if applicable). Welding of reinforcement shall not be permitted unless approved by the Design Engineer and the Director of Engineering Services;
 16. The technical specifications for concrete mixtures shall be provided in accordance with the following:
 - a. Concrete for roadway pavement and related facilities (i.e. driveways, sidewalks, ramps, etc.) shall be in accordance with the City's technical specification 321313-Concrete Pavement;
 - b. Cast-in-place concrete applicable to TxDOT standard designs for storm drainage culverts and related structures, retaining walls, manholes, vaults, as well as bridges, shall be in accordance with the City's technical specification 033105-Concrete Structures-Cast-in- Place (TxDOT). Otherwise, concrete for cast-in-place structures shall be in accordance with the City's technical specification 033100-Concrete Structures Cast-in-Place (City); and
 - c. Precast concrete applicable to precast pipes, TxDOT standard designs for storm drainage culverts and related structures, manholes, vaults, as well as bridges, shall be in accordance with the City's technical specification 034105-Concrete Structures-Precast (TxDOT). Otherwise, concrete for precast structures shall be in accordance with the City's technical specification 034100-Concrete Structures-Precast (City);
 17. Responsibility for maintenance of the structure shall be clearly noted on the plans. The plans shall clearly reference a structure maintenance plan and schedule. The maintenance plan shall clearly identify any drainage system required to relieve hydrostatic pressure on the structural system and ensure that it remains fully functional throughout the life of the structure; and
 18. Sight visibility triangles (where applicable).

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

1. Plan view: The plan view shall include location of soil borings, surface and subsurface drainage structures and utilities that could be affected by wall construction.

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2. Elevation view: The elevation view shall include a profile of the existing ground line along the wall alignment, proposed finished grade at face of wall, limits of wall payment (if applicable), top of wall profile, soil boring log shown at the correct elevation and scale, wall rail if applicable, drainage structures and utilities as noted above. Unless noted otherwise and approved by the Director of Engineering Services, wall quantities shall be based upon the surface area of the wall from the top of wall to the bottom of wall. The bottom of wall is defined as the proposed finished grade at the face of the wall. The bottom of wall shall not be measured from the top of footing unless the top of footing is the proposed finished grade at the face of the wall.
 3. Estimated quantity table: Include the estimated quantity table for each retaining wall type. The table should contain the area of wall (for payment) and linear footage of railing (if applicable).
 4. Typical section. The typical section shall include a cross section with wall dimensions and showing the relationship of the wall to the roadway, property line, or controlling adjacency, control point(s) for horizontal and vertical alignment (typically the top outermost corner of the wall), indication of maximum slope on top of and in front of the wall, location of proposed finished grade, railing type, flume, and mow strip, etc. if applicable.
 5. General notes. The general notes shall include a note stating the required minimum embedment depth of the footing (minimum typically 1'), a note stating that the wall quantity shall be measured for payment between the top of wall and "x" ft. below finished grade, railing shop drawing requirements (if applicable), references to all standard sheets (if applicable) for pertinent information, and any other pertinent information regarding wall design and construction.
- C. **Spread Footing Retaining Wall** plans shall also include the following:
1. If TxDOT retaining wall standards are used, provide the panel design designation (for example, LC-10-32) for each wall panel corresponding to the appropriate cast-in-place spread footing wall standard sheet. The designation includes a reference to the controlling standard drawing, design height, and panel width.
 2. Location of expansion and allowable construction joints (assuming 32' panels; every third joint is typically designated as an expansion joint).
 3. Set bottom of wall (top of footing) horizontal and stepped to meet minimum embedment depth criteria. Distance from one step to the next is typically greater than 12". Provide bottom of wall elevations for all panels.
 4. Include the appropriate TxDOT standard sheets pertaining to cast-in-place spread footing walls if applicable. Otherwise provide typical section details including a cross section with dimensions and reinforcement layout and callouts.
 5. If TxDOT standard sheets pertaining to cast-in-place spread footing walls are not applicable to the design, a custom structural wall design shall be provided. The general notes shall specifically identify the applicable concrete specification, the requirement that no service loads shall be imposed until after the concrete has reached its specified minimum compressive strength, and that shop drawing submittals shall be required for fabrication, bending, and placement of concrete reinforcement.
- D. **Screening Wall** plans shall include the following information (in addition to the information included under 9.09A):
1. The title shall include the legal name of the property on which the wall is being constructed;
 2. A plan view of the wall showing its location, limits, and stationing;
 3. Wall material specification;
 4. Mortar specification (if applicable).
 5. A profile of the wall including grades for the top of the concrete mow strip, adjacent top of curb, sidewalk and finished floor of proposed and/or existing adjacent slabs;

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6. Elevation view of a typical column;
 7. Elevation view of the wall;
 8. Mow-strip detail;
 9. Drainage clearance under wall (uniform 2”);
 10. Steel tensile strength;
 11. Concrete compressive strength; and
 12. Wind load calculations
- E. **Gravity Retaining Walls** plans shall also include the following:
1. Wall height, including batter requirements;
 2. Wall material specification;
 3. Base embedment depth and width requirements, including key depth if applicable;
 4. Wall thickness at bottom and top of wall;
 5. Mortared zone requirements (if applicable), including zone thickness and the specification to mortar on all sides and no voids;
 6. Non-mortared zone requirements (if applicable), including zone thickness and the specification that stones must fit tightly; and
 7. Clay cap, including material specification and dimension requirements.
- F. **Calculations** pertinent to the design of any and all walls shall be submitted with the construction drawings when required by the City.
- G. All wall construction plans and specifications submitted to the City for review must include a permit application submittal.

9.10 Construction Inspection and Certification

- A. A permit is required for the construction of any wall as defined in these Engineering Standards.
- B. Third-party inspections shall be performed during construction, and reports provided to the City. The inspections and reports shall be performed at the following stages of construction (at a minimum):
- a. Sub-base preparation geotechnical testing
 - b. Pre-pour / sub-base / footing:
 - i. Drilled shaft drilling and concrete placement (if applicable); and
 - ii. Forming of footing, beam, placement of reinforcement (if applicable)
 - c. Wall construction;
 - d. Backfill placement - geotechnical testing
 - e. Drainage system construction (if applicable); and
 - f. Final completion
- C. A third-party shall certify wall construction inspections were performed at the prescribed stages of construction in accordance with Section 9.10.B. The inspection reports and final certificate of compliance shall be submitted to the City and include the following:
- a. Specific reference to the City-approved plans and specifications for the wall;
 - b. Specific reference to the address and/or legal description for the wall construction location;
 - c. Specific reference to the name and date of the project-specific geotechnical engineering report;
 - d. A certification letter signed and sealed by a licensed professional engineer in the State of Texas, that includes a statement that the wall system was constructed in general compliance with the geotechnical design criteria identified in the plans and specifications and the City-approved construction plans and specifications.

SECTION 10 – SURVEY REQUIREMENTS



10.01 General

In the interpretation and application of the provisions in these survey requirements, it is the intention of the City that the principals, standards and requirements provided herein shall be minimum standards for the projects involving survey, and where other Ordinances of the City are more restrictive, such Ordinances shall control, as they exist or may be amended.

10.02 Survey Datum, Markers, and Monuments

- a. The datum used shall be NAD 83. Datasheets for U.S. National Geodetic Survey (USNGS) NAD83 monuments are available online at: <http://www.ngs.noaa.gov/datasheets/>
- b. The vertical datum used is NAVD 88, based on USNGS monuments.
- c. Conversion for USNGS monuments in metric units to US Survey Feet shall be made using a conversion factor of 3937/1200 US Survey Feet per meter (3.280833333333).
- d. The projection used shall be Texas North Central Zone (4202) State Plane projections. Surface adjustment factor shall be 1.00012.
- e. Surveys markers shall be steel rods with a minimum diameter of 1/2 inch (#4 steel reinforcing bar) at least 18 inches long with caps identifying the responsible surveyor or firm.
- f. Monuments. Monuments shall be constructed according to the [City's GPS control monument requirements \(pdf\)](http://www.celina-tx.gov/DocumentCenter/View/1417) (<http://www.celina-tx.gov/DocumentCenter/View/1417>).

10.03 Survey Marking and Monumentation Requirements

- a. Survey markers shall be placed at :
 1. Lot corners, block corners, and lot line bearing changes.
 2. Intersection points of alleys and block lines.
 3. Curve and tangent points along lot, block, and right-of-way lines within the subdivision.
 4. Right-of-way dedications.
- b. Subdivision Monuments: At least two monuments must be placed at opposing ends of the subdivision. No monuments will be required within one thousand feet (1,000') of an existing monument.
- c. Capital Improvement Project Monuments: Any found existing monuments, markers, property corners, and proposed monuments shall be shown on the construction drawings, located by northing and easting.
- d. Marker and Monument Restoration: Any existing survey marker, monument, or property corner damaged or destroyed during new construction shall be reset prior to final acceptance.
- e. Electronic File Submittal: The City requires all plats include CAD files for incorporation to the City's record system. This data must be provided in Grid Coordinates or Surface Coordinates with scale factor. The electronic files shall include:
 1. Two monuments, with three dimensional coordinates
 2. All found and placed survey markers
 3. Parcel boundaries
 4. Rights-of-way and easement dedications.

10.04 Final Plat Acceptance

- a. Prior to final plat acceptance, all found and placed monuments must be found and reset, if necessary.
 1. The surveyor will provide two monuments acceptable to the City and establish grid coordinates in reference to other City of Celina monuments.

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2. Elevations shall be established on the appropriate datum in reference to other City of Celina monuments.
 3. The three-dimensional coordinates in grid coordinates shall be clearly shown on the final plat. The plat shall contain a note stating grid coordinates are not for design purposes.
 4. The plat shall utilize grid bearings with no assumed north.
 5. Distances shown on the plat shall be surface distances.
 6. An inspection should be completed after construction has finished to ensure final plat requirements have been met.

TS

TECHNICAL SPECIFICATIONS



SECTION 015813- PROJECT SIGN

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, and maintain Project Sign.

1.02 REFERENCES

- A. City of Celina Standard Detail for Project Sign.

PART 2 - PRODUCTS

- A. Contractor may contact any City approved manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Contractor shall coordinate with the City regarding the location prior to installation. The City shall provide on-site inspection of the installation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a per Each (EA) basis.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item and measured as provided under MEASUREMENT will be paid for at the unit bid price for “Project Sign” in accordance with the City of Celina’s Standard Detail for Project Sign. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to furnish and install Project Sign.

END OF SECTION

SECTION 017113- MOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

The work under this section of the specification shall include the establishment of offices and other facilities on the project site and the movement of personnel, construction equipment, and supplies to the project site or to the vicinity of the project site to enable the Contractor to begin work on the other contract items that will be performed by the Contractor. This Item also includes all costs associated with bonding and insurance.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a Lump Sum (LS) basis as the work progresses.
- B. The maximum bid amount for this Item shall be 5% of the total amount bid for the project.

4.02 PAYMENT

Partial payments of the bid for Mobilization will be as follows. The adjusted contract amount for construction items as used below is defined as the total contract amount less the bid for Mobilization.

- A. When 1% of the adjusted contract amount for construction items is earned, 50% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- B. When 5% of the adjusted contract amount for construction items is earned, 75% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- C. When 10% of the adjusted contract amount for construction items is earned, 90% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- D. When 50% of the adjusted contract amount for construction items is earned, 100% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.

END OF SECTION

SECTION 017416- DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Dust Control in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 203.8.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 203.8.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 024100- GENERAL SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All materials, labor, equipment, tools and superintendence necessary for the preparation of the project site not covered elsewhere in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 203.
- B. This Section also includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing
 - 4. Demolition
 - 5. Removal of all items within the limits of construction not specifically noted to remain.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 203.1, 203.2, and 203.3

1.03 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from City and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvaged materials: Carefully remove items indicated to be salvaged and store as directed by the City.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
 - 1. Call Dig TESS at 1-800-344-8377
 - 2. Contact City's ROW Division of Public Works at 972-382-2682 for locates
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 – PRODUCTS

Not used

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.1, 203.2 and 203.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

-
- A. This Item shall be measured on a Lump Sum (LS) basis, unless indicated otherwise and shall include the removal of all items within the limits of construction not specifically called out to remain.
 - B. Removal of existing pavement will be measured separately and paid for by the square yard (SY), regardless of thickness and type. Concrete curb and gutter removal will not be measured separately and is considered subsidiary to this item.
 - C. Removal of existing sidewalk and ramps will be measured separately and paid for by the square yard (SY), regardless of thickness and type.
 - D. Removal of existing inlets, headwalls, manholes, etc. will be measured separately and paid for per each (EA) inlet removed, regardless of the size of the existing inlet. Removal of existing pipe will not be measured separately and is considered subsidiary to this item.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 032100- REINFORCING STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforcing Steel in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.2.9.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.

1.03 RELATED SECTIONS

- A. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.
- B. Specified reinforcing steel (#4 bars and larger) shall conform to the requirements of ASTM A615, Grade 60.
- C. Grade 40 reinforcing steel (#3 bars) will only be allowed in sidewalks or with approval of the Director of Engineering Services.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will not be measured separately.

4.02 PAYMENT

- A. This Item will not be paid separately, but considered subsidiary to pertinent Items.

END OF SECTION

SECTION 032200- WELDED WIRE FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Welded Wire Fabric in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.2.10.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10 and 303.2.11.

1.03 RELATED SECTIONS

- A. Section 313700 – Riprap

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10 and 303.2.11.
- B. Welded Wire Fabric is acceptable as reinforcement for concrete riprap of bridge abutments only.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will not be measured separately.

4.02 PAYMENT

- A. This Item will not be paid separately, but considered subsidiary to pertinent Items.

END OF SECTION

SECTION 033100- CONCRETE STRUCTURES – CAST-IN-PLACE (CITY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Cast-in-Place (City) in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 702.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2 and 303.3.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.
- C. All concrete shall be sulfate resistant mixes. Mix Design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete drivers.
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.2 is hereby modified to allow only Type I / II Portland Cement.
- E. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.4 is hereby modified to allow only Class F fly-ash.
- F. Provide Class F or Class M concrete.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Measurement shall be specified in the Contract Documents.

4.02 PAYMENT

- A. Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 033101- DRILLED SHAFT FOUNDATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Drilled Shaft Foundations (including Traffic Signal Poles or Street Light Poles).

1.02 REFERENCES

- A. TxDOT Items 416, 420, 421, 440, and 448
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal.
- B. Section 265619 – Luminaire Pole

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 416.
- B. Type A concrete shall be used for non-reinforced foundations. Type C concrete shall be used for reinforced foundations.
- C. All concrete shall be sulfate resistant mixes. Mix design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete deliveries.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 416.
- B. A 3/4 inch chamfer (beveled) shall be formed on the top edge of each pole foundation.
- C. The Contractor shall probe before drilling foundations to determine the location of utilities and structures. Foundations shall be paid for once regardless of extra work caused by obstructions. Foundations shall not be placed within 3-feet of a water line or fire hydrant and must be a minimum of 25-feet from all tree trunks unless otherwise directed by the City. If any City or any other water utility is near a proposed pole foundation (within 3 feet), then the Contractor will hand dig to uncover the water line and verify that the proposed pole foundation location is satisfactory. The Contractor shall be liable for all damages done, and restoration to utilities as a result of their operations.
- D. Contractor shall contact the City for inspection prior to pouring any concrete foundation and digging for conduit runs at least 48 hours in advance (between 8 am – 5pm).
- E. No poles shall be placed on foundations prior to 7 days following pouring of concrete.
- F. Contractor shall clean up and remove all loose material resulting from construction operations.
- G. Top of foundation shall be 3 inches above the finished grade unless otherwise shown on the plans and shall be formed or provided a smooth finish satisfactory to the City. Foundation piers shall be drilled plum, the top of foundation poured level, and the top 3 inches of the exposed foundation above finished grade shall have the sono-tube removed.
- H. Anchor bolts shall extend above the top of the foundation concrete as shown on anchor bolt detail. Refer to manufacturer's specifications for bolt circle dimensions and anchor bolt specifications.
- I. Anchor bolts; ground rod, all reinforcing and conduit shall be in place before pouring concrete pier foundations. Foundations shall have one continuous concrete pour.

- J. Contractor shall keep a record set of plans and mark any differences between the locations shown in the plans and the as-built locations. This record set shall be provided to the City prior to acceptance of the work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 416.

4.02 PAYMENT

- A. Refer to TxDOT Item 416.
- B. Foundations shall be paid for once regardless of extra work caused by obstructions.

END OF SECTION

SECTION 033105- CONCRETE STRUCTURES – CAST-IN-PLACE (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures - Cast-In-Place (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 420.

1.02 REFERENCES

- A. TxDOT Item 420
- B. TxDOT and City Standard details, included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 420.2.
- B. All concrete shall be sulfate resistant mixes. Mix design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete deliveries.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 420.3 and 420.4.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 420.5 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT 420.6 or as indicated in the Contract Documents

END OF SECTION

SECTION 033106- CONCRETE RETAINING WALLS (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Retaining Walls (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 423.

1.02 REFERENCES

- A. TxDOT Item 423
- B. TxDOT Standard Details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 423.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 423.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 423 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT 423 or as indicated in the Contract Documents.

END OF SECTION

SECTION 034100- CONCRETE STRUCTURES – PRECAST (CITY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Precast (City) in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 702.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.
- B. All concrete shall be sulfate resistant.
- C. Provide Class F or Class M concrete.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Measurement shall be specified in the Contract Documents.

4.02 PAYMENT

- A. Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 034105- CONCRETE STRUCTURES – PRECAST (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Precast (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 424.

1.02 REFERENCES

- A. TxDOT Item 424
- B. TxDOT Item 425
- C. TxDOT Standard Details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 424.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 424.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 424 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT Item 424 or as indicated in the Contract Documents.

END OF SECTION

SECTION 071300- MOISTURE BARRIER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Moisture Barrier.

1.02 REFERENCES

- A. Project's Subgrade Investigation and Pavement Design Report (if available).

1.03 RELATED SECTIONS

- A. Section 321112 - Moisture Treated Subgrade

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The moisture barrier shall consist of a minimum of 10 mil polyethylene sheeting. Covered with a minimum 8 inches of lightly compacted soil.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The moisture barrier shall be placed horizontally on the treated subgrade from the edge of pavement extending a minimum 6 feet on either side of the pavement in a neat line after final compaction unless indicated otherwise on the plans.
- B. The barrier shall be covered with at least 8 inches of lightly compacted soil. Care should be taken not to rip or tear the poly sheeting during placement of the cover fill.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Square Yard (SY) basis.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Moisture Barrier." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Payment for the 8 inches of lightly compacted soil shall be considered subsidiary to the "Moisture Barrier" Item.

END OF SECTION

SECTION 260500- ELECTRIC CONDUCTOR

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Electric Conductors for Traffic Signals and/or Street Lighting.

1.02 REFERENCES

- A. TxDOT Item 620
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal
- B. Section 270500 – Conduit

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 620.
- B. All electrical connectors for breakaway poles shall be breakaway (BUSSMAN HEBW, LITTLEFUSE LEB, FERRAZ-SHAWMUT FEB, HMC FLOOD-SEAL SLK-MD or approved equal) in accordance with the latest TxDOT RID standards. All electrical connections for neutrals shall be breakaway and shall have a white colored marking and a permanently installed solid neutral (BUSSMAN HET, LITTLEFUSE LET, FERRAZSHAWMUT FEBN, HMC FLOOD-SEAL SDK-MD or approved equal).
- C. A continuous bare or green insulated copper wire No.6 or larger shall be installed in every conduit throughout the electrical and the traffic signals system in accordance with TxDOT Item 680, the electrical details, and the current edition of the National Electrical Code. This bare or green insulated copper wire shall be stranded for this project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 620.
- B. Where two or more conductors are present in one conduit or enclosure, the conductors shall be identified as shown in the electrical details. If the identification tag with two plastic straps is too large for the referenced conductors, a tag with a single plastic strap may be used if approved by the city. In any case, each tag shall indicate circuit number, letter, or other identification as shown in the plans.
- C. Grounding conductors that share the same conduit, junction box, ground box or structure shall be bonded together at every accessible point in accordance with the current edition of the National Electric Code.
- D. Electrical work performed by non-certified persons is not in accordance with the requirements of the contract and may be rejected as unsuitable for use due to poor workmanship. The required electrical certification course is available and is scheduled periodically by TEEX. Alternatively, the Contractor may purchase an entire course for their personnel to be held at a time and location of their choice as negotiated through TEEX. For more information, contact: TEXAS ENGINEERING EXTENSION SERVICE (TEEX), TxDOT ELECTRICAL SYSTEM COURSE, (979) 845-6563

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis for each single conductor, complete in place. The length is the straight line distance between the ground boxes, foundations, or pads.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Electric Conductor." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. This is a plan quantity measurement Item. The quantity to be paid is the quantity shown in the Bid Form.

END OF SECTION

SECTION 260501- ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All electrical service conductors, labor, equipment, tools and superintendence necessary to furnish and install Electric Service.

1.02 REFERENCES

- A. TxDOT Items 620 and 628
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.
- D. Irrigation Plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 620 and 628.
- B. The electrical service enclosure shall have a powder-coated paint finish of RAL9017 (TRAFFIC BLACK) or City approved equal to match the color of the traffic signal pole assemblies.
- C. Electrical Service for Traffic Signals will be provided by the City. Contractor shall provide and install electrical services for Street Lighting and Irrigation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All enclosure-mounted components shall be installed in the main service enclosure including all lighting components and the main disconnect as required by the plans. The main disconnect shall not be accessible from outside the main service enclosure.
- B. All neutral wire shall be white insulated wire only.
- C. The address for electrical service shall be obtained from the City of Celina. The electrical service for this project shall be billed in the name of City of Celina.
- D. If the Contractor is required to provide the service, the Contractor shall submit for approval four (4) copies of catalog cut sheets for each of the following items: Electrical Service Enclosure, Breakers, Lighting Contractor, Fuses, Terminal Blocks, Photocell and Socket, and Lighting Arrestor.
- E. The service enclosure shall be manufactured in a UL listed shop. It shall have a continuous piano hinge with stainless steel pin along the side. An enclosure with the hinge along the top of the box will not be acceptable. Service enclosures shall have no more than two (2) pieces of dead front trim. All conduits entering the service enclosure shall be through the bottom of the services enclosure.
- F. For traffic signal installations with luminaries and illuminated street name signs (ILSN), separate photocell and lighting contactor will be required for luminaries and ILSN (Total two photocells and two lighting contactor).
- G. Install in line fuses at all service connections.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured per Each (EA) electrical service installed or removed.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for as provided under measurement for "Electrical Service" in accordance with TxDOT

Item 628. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 265619- LUMINAIRE POLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Luminaire Poles for City of Celina standard street lighting.

1.02 REFERENCES

- A. Manufacturer's Standard Details and Specifications for Luminaire Pole.

1.03 RELATED SECTIONS

- A. Section 033101 – Drilled Shaft Foundation
- B. Section 265620 – Luminaire Fixture
- C. Section 260500 – Electric Conductor
- D. Section 260501 – Electrical Service
- E. Section 344135 – Ground Box
- F. Section 347113– Barricades, Signs, and Traffic Handling

1.04 SUBMITTALS

- A. Manufacturer's Standard Details and Specifications.
- B. The Contractor shall furnish four (4) sets of submittals of the carbon steel pole to the City. These submittals shall be approved by the City before the Contractor begins work.
- C. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials furnished by the Contractor shall be new, UL-listed, meet NEMA, NEC, AASHTO, and the Electrical Detail standard sheet requirements.
- B. The lighting assembly pole shall be 29.5 feet in height. The pole shall be a round tapered 11 gauge steel shaft with hand hole. Poles shall include breakaway coupling system that includes four couplings with associated hardware and a two piece aluminum skirt with attachment hardware. The aluminum skirt finish match color and type of finish specified for the light pole. The breakaway coupling system shall conform to current AASHTO standards and shall be approved by FHWA for breakaway characteristics at impact speeds for 20 to 60 mph.
- C. The assembly will contain either one or two bracket arms. The bracket arm shall be 4 foot in length, have a 2 3/8 inch OD and have a 21 inch upsweep. Finish color and finish type shall match that specified for the light pole.
- D. Luminaire Poles shall be either one of the following types:
 - 1. Valmont Industries, Inc. Twin Arm Catalog No. DS30-750A290-4D-FP with 30"x96" concrete pier.
 - 2. KW RTSU30-7.5-11-BLK-24S- BSC-1.0-SKT-NC
- E. All Luminaire Poles shall have a powder-coated paint finish of RAL9017 (TRAFFIC BLACK) unless otherwise directed by the City. All assemblies shall be hot dipped galvanized to ASTM 123 and 153 specifications. Once galvanizing is completed, all exposed surfaces shall be mechanically etched by blast cleaning to remove mill scale, impurities and nonmetallic foreign materials. All surfaces visually exposed are to be coated with a Urethane or Triglycidyl (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. The coating shall be electrostatically applied and cured in a gas fired convention oven by heating the steel substrate between 350 and 400 degrees Fahrenheit.

PART 3 - EXECUTION**3.01 PREPARATION**

- A. The Contractor shall notify the Traffic Department at least 7 business days prior to any work on this project and provide a construction schedule with weekly progress reports.
- B. The Contractor shall clean up and remove all loose material resulting from construction operations.
- C. All electrical work shall be in accordance with the most current National Electrical Code, City and TxDOT specifications and standards.
- D. The Contractor shall coordinate electrical services with the City of Celina and either ONCOR or COSERV representatives (according to their respective area).
- E. Proposed street light pole foundations shall be staked by the Contractor and approved by the City prior to installation.
- F. Erection of poles, luminaries and structures located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company and TxDOT prior to beginning such work.
- G. All shop drawings, work drawings or other documents which require review by the City shall be submitted by the Contractor sufficiently in advance of scheduled construction to allow no less than 14 calendar days for review and response by the City.
- H. If any overhead or underground power lines need to be de-energized, the Contractor shall call the electric company to do this work. Any cost associated with de-energizing the power line and/or any other protective measures required shall be at the Contractor's expense.
- I. All lighting poles, fixtures, and arms which are removed with this project shall be delivered to the City of Celina Public Works facility (107 E. Elm, Celina-Tx, 75009) by the Contractor and will remain the property of the City of Celina.
- J. Texas State Law, Article 1436C, makes unlawful the operation of equipment or machines within 10-feet of any overhead electrical lines unless danger against contact with high voltage overhead lines has been effectively guarded against pursuant to the provisions of the article. When construction operations require working near an overhead electrical line, the Contractor shall contact the owner/operator of the overhead electrical line to make adequate arrangements and to take necessary safety precautions to ensure that all laws, electrical line owner/operator requirements and standard industry safety practices are met.
- K. All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following items:
 - a. TxDOT Item 616 "Performance Testing of Lighting Systems"
 - b. TxDOT Item 620 "Electrical Conductors"

PART 4 - MEASUREMENT AND PAYMENT**4.01 MEASUREMENT**

- A. This Item shall be measured on a per Each (EA) basis, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Luminaire Pole." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Foundations shall be paid for once regardless of extra work caused by obstructions.

END OF SECTION



SECTION 265620- LUMINAIRE FIXTURE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Luminaire Fixtures for City of Celina standard street lighting.

1.02 REFERENCES

- A. Manufacturer's Standard Details and Specifications for Luminaire Fixture.

1.03 RELATED SECTIONS

- A. Section 265619 – Luminaire Pole
- B. Section 033101 – Drilled Shaft Foundation
- C. Section 347113 – Barricades, Signs, and Traffic Handling
- D. Section 260500 – Electric Conductor
- E. Section 344135 – Ground Box
- F. Section 260501 – Electrical Service

1.04 SUBMITTALS

- A. Manufacturer's Standard Details and Specifications.
- B. The Contractor shall furnish four (4) sets of submittals of the aluminum decorative fixture to the City. These submittals shall be approved by the City before the Contractor begins work.
- C. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials furnished by the Contractor shall be new, UL-listed, meet NEMA, NEC, AASHTO, and the Electrical Detail standard sheet requirements.
- B. Contractor shall provide luminaire fixtures. The luminaire fixture shall be a Hadco Profiler PA31 Series or Kim Archetype AR Series or approved equal and operate at 480 volts. Luminaire optics will produce an IESNA cutoff light distribution type as noted on the plans. Luminaire shall be 8 inches high by 33.75 inches in width with a housing made of low-copper die-cast aluminum alloy. Luminaire shall be able to mount on 2 3/8 inch OD bracket arm. Finish shall be electrostatically applied thermoset polyester powder coat color Traffic Black (RAL9017).
- C. Contractor shall provide luminaire fixtures. Unless otherwise noted in the plans, luminaire fixtures shall be either:
 1. KIM Lighting Catalog No. 2B/ARX/250PMH480/BL-P/HSF
 2. HADCO C1210D LUMINAIRE (BLACK, TYPE X, 250W PMH, 480V)
- D. Covers for the luminaire fixtures shall be a clear flat-glass insert.
- E. The ballast shall be core and coil pulse start metal halide designed to operate 250 watt pulse start metal halide lamps with 480 line volts.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to City of Celina's General Notes for Traffic Signals and Street Lighting.
- B. All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following items:
 - a. TxDOT Item 616 "Performance Testing of Lighting Systems"
 - b. TxDOT Item 620 "Electrical Conductors"



PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Luminaire Fixture." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 270500- CONDUIT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Conduit for Traffic Signals, Street Lighting, or Irrigation.

1.02 REFERENCES

- A. TxDOT Item 618
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.
- D. Irrigation Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signals
- B. Section 260500 – Electric Conductor

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 618.
- B. All conduit underground for signals and street lighting shall be Schedule 40 white PVC unless indicated otherwise. Conduit size shall be as shown in the plans.
- C. Conduit above ground shall be 2 inch rigid metal, unless otherwise directed by the City. Conduit size shall be as shown in the plans.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor shall secure permission from the proper authority and the approval of the City prior to cutting into or removing any sidewalks or curbs, which may be required for installation.
- B. The locations of conduit and ground boxes are diagrammatic only and may be shifted with City approval to accommodate field conditions.
- C. A colored cleaner primer shall be used on all PVC to PVC joints before application of PVC cement.
- D. Conduit shall be placed under existing pavement by an approved boring method unless otherwise directed by the City. Pits for boring shall not be closer than 2 feet from the edge of the pavement unless otherwise directed by the City.
- E. Water jetting will not be permitted.
- F. When boring is used under pavement conduit installations, the maximum allowable over-cut shall be 1 inch in diameter.
- G. When conduits are bored, the vertical and horizontal tolerances shall not exceed 18” as measured from the intended target point.
- H. All conduits shall be installed at a minimum depth of 36” below grade measured from the bottom of the concrete slab.
- I. The use of pneumatically driven device for punching holes beneath the pavement (commonly known as a “missile”) will not be permitted.
- J. The Contractor shall install a non-metallic pull rope in conduit runs in excess of 50 feet.
- K. When rigid metal conduit is exposed at any point and where rigid metal conduit extends into ground boxes, the metal conduit shall be bonded to the grounding conductor with grounding type bushings or by other UL listed grounding connectors approved by the City.
- L. PVC conduit systems that snap or lock together without glue that are designed and UL listed to be used for bored PVC electrical conduit applications will be allowed for bored PVC schedule 40.

No additional compensation will be paid to the Contractor when these specific purpose conduit systems are substituted for this purpose.

- M. Liquid-tight flexible metal (LTFM) conduit shall be used where the plans refer to flexible metal conduit. Flexible metal shall not be permitted.
- N. Contractor shall place duct seal at the ends of all conduits where conductors and/or cables are present with a permanently soft, non-toxic duct seal that does not adversely affect other plastic materials or corrode metals.
- O. The conduit shall be installed in a trench free of rocks that would damage the conduit and first 2 inches of backfill shall be free of rock.
- P. All conduit shall start and end in a ground box, foundation, or at a transformer pad along with a 1/4 inch polyline (pull string) with a break strength of 500 pounds or greater.
- Q. Each change of direction in the conduit run requires a ground box (pull box) unless it is less than 20 feet to the end of the run or unless otherwise directed by the City.
- R. Conduit shall be placed within an easement or street ROW. When placed in easements, the location of the conduit shall be 30 inches off the lot lines to avoid being damaged by fence post placement.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis for each Conduit type and size, complete in place. The length is the straight line distance between the ground boxes, foundations, or pads.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Conduit," of the size and type specified. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Flexible conduit will not be paid for directly but will be subsidiary to pertinent Items.
- C. Rigid metallic conduit elbows 1" and larger that are required to be installed on conduit systems will not be paid for directly but will be subsidiary to pertinent Items.
- D. This is a plan quantity measurement Item. The quantity to be paid is the quantity shown in the Bid Form.

END OF SECTION

SECTION 312316- EXCAVATION (ROADWAY)

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Excavations (Roadway) in accordance with Texas Department of Transportation Standard; *Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 110.

1.02 REFERENCES

- A. TxDOT Item 110.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 110.2.
- B. All excavation shall be unclassified, and shall include the removal of all materials encountered, regardless of their nature or the manner in which they are removed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 110.2
- B. Frequency of compaction testing shall not exceed one test for every three hundred linear feet 300' spacing or less, alternating from left quarter point to center line to right quarter point of the cross section width.
- C. For density and moisture requirements of moisture treated excavation areas see Section 321112 Moisture Treated Subgrade.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 110.3 or as indicated in the Contract Documents.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity for which payment will be made.

4.02 PAYMENT

- A. Refer to TxDOT Item 110.4 or as indicated in the Contract Documents.

END OF SECTION

SECTION 312317- UNCLASSIFIED CHANNEL EXCAVATION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Unclassified Channel Excavation in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.
- B. All excavation shall be unclassified, and shall include the removal of all materials encountered, regardless of their nature or the manner in which they are removed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

4.02 PAYMENT

- A. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity for which payment will be made.

END OF SECTION

SECTION 312323- SELECT FILL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to install Select Fill in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 132.

1.02 REFERENCES

- B. TxDOT Item 132.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 132.2, Type A.
- B. Eagle Ford may not be imported to other areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 132.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item unless noted otherwise.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items unless noted otherwise.

END OF SECTION

SECTION 312413- EMBANKMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Embankment in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 132.

1.02 REFERENCES

- A. TxDOT Item 132.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 132.2 and as specified in the Contract Documents.
- B. Eagle Ford may not be imported to other areas.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 132.3.
- B. Frequency of compaction testing shall not exceed one test for every three hundred linear feet 300' spacing or less ,alternating from left quarter point to center line to right quarter point for every layer of embankment.
- C. For density and moisture requirements of moisture treated embankments see Section 321112 Moisture Treated Subgrade.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Embankment will be measured by the cubic yard. The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. Shrinkage or swell factors will not be considered in determining the calculated quantities.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will be measured as provided for at the unit price bid for “EMBANKMENT” of the compaction method and type specified. The price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.
- B. No separate pay for sprinkling, rolling (including proof rolling).
- C. Correction of soft spots in the subgrade will be at the Contractor's expense.

END OF SECTION

**SECTION 312500- TEMPORARY EROSION, SEDIMENTATION, AND WATER POLLUTION
PREVENTION AND CONTROL**

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, maintain and remove Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201

1.03 SUBMITTALS

- A. The Contractor must provide a separate Storm Water Pollution Prevention Plan (SW3P) before the Notice to Proceed will be issued. The Erosion Control Plans included in the plans will not be considered a SW3P. The SW3P shall comply with the regulations established by the Texas Commission on Environmental Quality (TCEQ).
- B. The Contractor is required to submit all appropriate forms and pay all fees, including the NOI and NOT, as well as producing and submitting all inspection reports through the duration, as required, to the TCEQ and the City. The Contractor will be responsible for submitting all required forms and fees on behalf of the City, and shall submit two (2) copies of all NOIs and proof of payment to the City prior to Notice to Proceed is issued.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.
- B. Where existing grasses are disturbed, restoration shall consist of equal or better permanent vegetation. Provide a minimum of eight feet (8') of the appropriate seasonal seeded Curlex adjacent to all street and fire lane curbs and four feet (4') adjacent to alleys. The use of innovative products is encouraged, such as those made with composting materials, as long as they are approved by the Director of Engineering Services and permanent vegetative stabilization is established.
- C. Twenty four (24") to thirty six (36") inches in width of rock riprap shall be placed along the top and sides of the ground interface with all headwalls and end sections and street, alley, and fire lane stub outs.

2.02 EQUIPMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.
- B. Payment for the preparation of a Storm Water Pollution Prevention Plan shall be paid under the line item – “Storm Water Pollution Prevention Plan.”

END OF SECTION

SECTION 313419- GEOTEXTILE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to install Geotextile in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.6

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.6

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.6.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.6.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Geotextile". This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 313600- GABIONS AND GABION MATTRESSES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Gabions and Gabion Mattresses in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 459.

1.02 REFERENCES

- A. TxDOT Item 459

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 459.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 459.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 459.4.

4.02 PAYMENT

- A. Refer to TxDOT 459.5.

END OF SECTION

SECTION 313700- RIPRAP

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Riprap in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 432.

1.02 REFERENCES

- A. TxDOT Items 420, 421, 431, 432, and 440.
- B. City of Celina's Standard Details for Storm Sewer Curbed Flume.
- C. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 334915 – Safety End Treatments
- B. Section 312316 – Unclassified Street Excavation

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 432.2. Riprap type, (dry, grout, mortar) gradation and depth shall be specified in the plans.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 432.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 432.4. Replace the first sentence of TxDOT 432.4 with the following: "This Item shall be measured by the square yard (SY) of material complete in place."

4.02 PAYMENT

- A. Refer to TxDOT 432.5.

END OF SECTION

SECTION 321112- MOISTURE TREATED SUBGRADE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for the moisture treatment of the subgrade in all areas to be paved.

1.02 REFERENCES

- A. Project's Subgrade Investigation and Pavement Design Report (if available).

1.03 RELATED SECTIONS

- A. Section 071300 - Moisture Barrier

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Not used.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Weathered shale material encountered within 8 feet below finish subgrade shall be sub-excavated to a depth of at least the depth of required moisture treatment and replaced with on-site light brown or dark brown clays or other approved material.
- B. Moisture treatment shall extend at least 4 feet beyond the edge of pavement and to the depth as shown on the plans. The subgrade shall be moisture treated to a minimum of 3 percentage points above optimum moisture content at a minimum of 95 percent standard Proctor (ASTM D 698).
- C. Frequency of compaction testing shall not exceed one test for every three hundred linear feet 300' spacing or less ,alternating from left quarter point to center line to right quarter point for every layer of moisture treatment.
- D. Moisture treated lifts shall not exceed eighteen inches (18") of thickness.
- E. Any embankment that requires moisture conditioning treatment will be treated for the entire height of the embankment.
- F. Moisture treatment by injection is not an acceptable method to treat roadway subgrades.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Square Yard (SY) basis.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Moisture Treated Subgrade." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321113- LIME TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Item shall govern stabilization of the new or existing subgrade and shall consist of all labor, equipment and material necessary to pulverize the subgrade clays or existing pavements, add the specified percentage of hydrated lime, mix, mellow, remix and compact the mixture as specified in this Item. The Contractor shall be responsible for making allowances for subgrade bulking during stabilization to achieve design finished subgrade elevation and meeting specified thickness. The finished Item shall be a compacted and finished subgrade meeting the grades, thicknesses, lines and typical cross sections shown on the plans and specifications and having:
1. Less than 1 percent swell when tested under a 200 psf stress (ASTM D 4546 / AASHTO T 216).
 2. A minimum pH of 12.4 (ASTM D 2976 / AASHTO T 289).

1.02 REFERENCES

- A. Project's Subgrade Investigation and Pavement Design Report (if available).

1.03 RELATED SECTIONS

- A. Section 071300 – Moisture Barrier
B. Section 312316 – Unclassified Street Excavation
C. Section 321112 – Moisture Treated Subgrade

1.04 SUBMITTALS

- A. At least 30 days prior to beginning lime stabilization work, the Contractor shall furnish the City the following:
1. The proposed source and supplier of lime.
 2. Description of the proposed construction equipment, construction methods, expected production rates and planned sequence of lime stabilization of subgrade.
 3. A lime/on-site soil mix design in accordance with Eades-Grim Method. Design shall comply with the following requirements:
 - Minimum pH: 12.4 (ASTM D 2976/ AASHTO T 289) after completion of initial mixing with lime at ambient temperature.
 - Swell Potential: Less than 1.0 percent, in accordance with ASTM D 4546 / AASHTO T216 at 200 psf stress.
- B. The approval of the lime-soil mix design shall be at the discretion of the City. Once the design is approved in writing, the mix design shall be incorporated into these specifications by reference.
- C. During lime stabilization work, the Contractor shall furnish the following information to the City at the end of each day:
1. Certified truck weight tickets of lime, delivered to or used at the site.
 2. A summary of the amount of lime used each day, areas stabilized with lime and first mixed, areas second mixed, completed, and areas with curing completed

PART 2 - PRODUCTS

2.01 MATERIALS

All materials used in the construction shall meet the following requirements. In the event the Contractor wishes to use materials not listed in this section, the Contractor shall submit to the City a mix design data and proof of performance data as required by the City who shall review the submittal and

determine whether the materials will meet the design intent. No other materials shall be used without the written permission of the City.

- A. Lime - The lime shall meet the requirements of ASTM C977 / AASHTO M 216; contain at least 92 percent calcium and magnesium oxide, and the rate of slaking test for moderate reactivity per ASTM C110 / AASHTO T 232. All lime shall come from a single source, shall be the same source as used in the design, and shall be subject to periodic testing to confirm properties. Each shipment of lime shall be accompanied by a Certificate of Compliance stating the conformance of the product to these specifications. Certificates shall be provided to the City. In the event the Contractor changes lime sources, no work shall be done until the City accepts, in writing, a new lime-soil mix design using the new lime source.
- B. Water - Water used for slaking, mixing or curing shall be free of oil, salts, acid, alkali, sugar, vegetable, or other deleterious substances which may cause damage to the finished product. All water shall meet the material requirements AASHTO T 26. Known potable water may be used without testing.
- C. Soil - Subgrade soils used in the stabilization shall be of the same AASHTO or ASTM classification and Plasticity Index range as used in the approved mix design. All organics, roots and deleterious materials shall be removed from the area to be stabilized and shall be wasted. The condition of the subgrade soils must be approved by the City prior to beginning work.
- D. Asphalt - Asphalt used to seal the surface of the lime stabilized subgrade shall be CSS1h or other approved asphalt as approved by the City and shall conform to the requirements of TxDOT Item 300, "Asphalts, Oils and Emulsions". Each shipment shall be accompanied by a Certificate of Compliance stating the conformance of the product to these specifications which shall be provided to the City.

PART 3 - EXECUTION

3.01 EQUIPMENT

The machinery, tools and equipment necessary for proper execution of the work on this Item shall be on the project and approved by the City prior to beginning this Item. All machinery, tools and equipment used shall be maintained in a satisfactory working condition.

- A. Lime Storage - Lime shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed.
- B. Lime Weight Verification - When lime is furnished in trucks, the weight of lime shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the City. Scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".
- C. Slurry Equipment - Quick lime used to manufacture slurry on the project, or other location approved by the City shall be slurried in agitated slurry tanks. The slurring of Quick lime must be handled in such a way as to not generate any dust hazardous to job personnel or to the public or be potentially damaging to any adjacent property.
- D. Distributor Trucks - The distributor truck used for slurry placing shall be equipped with an agitator and a calibrated measuring device or as approved by the City and shall be in good working order. The Contractor shall provide to the City the spread rate calibration (or other acceptable means to calculate the spread rate) prior to use of the equipment.
- E. Mixers - Mixers shall be of appropriate size and capacity so as not to delay the project and shall be capable of pulverization to these specifications and mixing of the product.
- F. Compaction Equipment - Finishing equipment shall consist of smooth steel wheel vibratory compactors or pneumatic tired roller compactors having a minimum tire pressure of 90 psi. Other types of compaction equipment may be approved at the sole discretion of the City.

3.02 CONSTRUCTION

The completed course shall be uniformly stabilized, free from cracks, loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

- A. Preparation of Subgrade - Prior to stabilization the subgrade shall be compacted and shaped to conform to the typical sections, as shown on the plans with allowances made for bulking of the subgrade. The subgrade shall be moisture treated to the lines and grades shown on the plans and as provided for in the pavement design report. The minimum moisture content shall be 3 percentage points above standard Proctor optimum (ASTM D698) with compaction to at least 95%. If the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.
- B. In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans and as established by the City.
- C. Pulverization - The existing pavement or base material shall be pulverized or scarified so that 100 percent shall pass the one (1) inch sieve.
- D. Application - The design percentage by weight or pounds per square yard of lime to be added will be as shown on the plans and may be varied by the City if conditions warrant. Only two application methods are acceptable; dry application of pebble quick lime or slurried hydrate or quick lime. The rate of application shall be verified using the methods provided in ASTM D 3155.
- E. Dry quick lime shall be spread only on that area where the mixing operations can be completed during the same working day. Slurried quick lime shall be spread and mixed within 1 hour. Slurry exposed to the air for over 1 hour shall not be accepted.
- F. Unless otherwise approved by the City, the lime operation shall not be started when the air temperature is below 40° F and falling, but may be started when the air temperature is above 35° F and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed during periods of rain or when weather conditions in the opinion of the City are not suitable. **CAUTION:** Use of quick lime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quick lime.
- G. Double Application Method – When required, lime shall be applied using the double application method. All other requirements and methods shall remain in force except as follows. One-half the specified quantity of lime shall be applied, mixed and mellowed for at least 3 days or longer as required by the approved mix design. The remaining lime shall be applied, mixed, and mellowed for at least 3 days or longer as required by the approved mix design.
- H. Dry Placement - Pebble quick lime shall be distributed by a spreader approved by the City. The lime shall be distributed at a uniform rate to achieve the mix design lime content and in such a manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the City, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic. The material shall be sprinkled as approved by the City.
- I. Slurry Placement - Lime Slurry shall be delivered to the project in slurry form at or above the minimum lime concentration as listed in the approved mix design. The residue or "stones" remaining in the tank from the slurry procedure shall be spread uniformly over the length of the roadway currently being processed, or wasted, unless otherwise approved by the City. Slurry shall be of such consistency that it can be applied uniformly without difficulty.
- J. Initial Mixing - The mixing procedure shall be the same for "Dry Placement" or "Slurry Placement" as herein described. The soil and lime shall be thoroughly mixed by equipment approved by the City. A minimum of 4 passes of the mixer is required. The soil and lime mixture shall be brought to a moisture content at least four (4) percentage above the design optimum moisture content and

shall be left to mellow for three (3) days or longer as required by the approved mix design. The mixing shall continue until a homogeneous friable mixture of material and lime is obtained. The mixture shall have a minimum pH 12.4 (additional lime shall be required to meet this specification).

Minimum passing 3/4" sieve: 100 percent

Minimum passing No. 4 sieve: 60 percent

The mixture shall be sprinkled and mixed during the mellowing process as required to assist in the chemical reaction. Moisture contents shall remain above optimum for the entire mellowing period. Where measured sulfate level in the light brown clay of the Eagle Ford formation exceeds 0.5 percent (5000 ppm), or exceeds 2.5 percent (25,000 ppm) in the dark brown clay of the Eagle Ford formation, a double lime application is required. The mellowing period shall be extended for at least 5 days or as indicated in the mix design, whichever is longer.

- K. Final Lime Mixing - After the required mellowing period the second lime application, if required, shall be made. Upon approval by City, the material shall be uniformly mixed by the approved methods. If the mixture contains clods, they shall be reduced in size by approved pulverizing methods so that the remainder of the clods shall meet the following requirements (visual observation, not testing, required):

Minimum passing 1" sieve: 100 percent

Minimum passing No. 4 sieve: 60 percent

At final mixing, the lime, water content and pH for each course of subgrade stabilization shall conform to the following:

Lime: +1 percent above design percentage based on dry unit weight of soil or 7.5%, whichever is greater.

Water: +2 percentage points above optimum moisture content

pH: 12.4

Samples shall be taken at random locations by a qualified geotechnical testing laboratory selected by the Contractor and approved by the City per the City-required testing schedule.

- L. Compaction Methods - Compaction of the mixture shall begin immediately after the requirements listed above are met. NOTE: Where double mixing is required by the mix design, the required additional lime shall be added and the mixture shall be moisture conditioned and pulverized. Compaction shall continue until the entire depth of the mixture is uniformly compacted to a minimum of 95 percent of standard Proctor density (ASTM D698) at a minimum of two (2) percentage above optimum moisture content. All irregularities, depressions, or weak spots which develop as determined by the City shall be corrected immediately by scarifying the areas affected, adding or removing materials as required, and reshaping and re-compacting by moisture conditioning and rolling. The surface of the course shall be maintained in a moist, smooth condition, free from undulations, ruts and cracking, until other work is placed thereon or the work is accepted. In addition to the requirements specified for density, the full depth of the material shown on the drawings shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the geotechnical testing laboratory and submitted to the City. If the material fails to meet the density requirements, it shall be reworked to meet the requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the drawings and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course or pavement is placed, it shall be re-compacted and refinished at the entire expense of the Contractor. When shown on the plans or approved by the City, multiple lifts will be permitted.
- M. Finishing and Curing - After the final layer or course of lime-stabilized subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling with a pneumatic or other suitable roller sufficiently light to prevent hair line cracking. The finished surface shall not deviate by more than 0.04 feet (0.5 inch) from the actual finish grade. Any variations in excess of this tolerance

shall be corrected by the Contractor, at the Contractor's entire expense immediately prior to placement of the next paving course, in a manner satisfactory to the City. The completed section shall be moist-cured until a non-yielding surface is obtained to support construction traffic and the next layer of the pavement is constructed, as approved by the City. In the event the surface cannot be covered by the next layer of pavement or be kept moist, an asphalt membrane shall be applied at the rate of 0.25 gallons per square yard. The Contractor shall protect the membrane from traffic and contamination until the next layer of the pavement system is placed. Additional testing may be required to verify moisture content as determined by the City.

- N. Reworking a Section - When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified percentage of lime.
- O. Storm water Control- Lime (concentrated or diluted) shall not be allowed to enter a storm drain system or natural waterway. The lime shall be applied in a manner that prevents puddling or runoff. Runoff will be considered a spill. Spills shall be immediately reported to The City of Celina Storm water Inspector during City working hours or to the Fire Department dispatcher during evenings and weekends. The spill site shall be neutralized, cleaned up, and removed from the site. Washing down the spill is not allowed. This is subsidiary to the Lime Treatment item, and no additional payment shall be made.

3.03 TOLERANCES

The following requirements shall apply to the finished lime stabilized subgrade:

- A. Tolerance in Thickness - One measurement shall be taken at random locations by the geotechnical testing laboratory on center of roadway at 300 feet spacing along each roadway direction. When the measurement is not deficient by more than 0.5 inch from the plan thickness, full payment will be made. When such measurement is deficient more than 0.5 inch and not more than 1.0 inch from the plan thickness, two additional measurements shall be taken at random (typically, 25 feet either side of the deficient measurement) and used in determining the average thickness. When the average of the 3 measurements is not deficient by more than 0.5 inch from the plan thickness, full payment will be made. When the average thickness is deficient by more than 0.5 inch, the entire area shall be reprocessed at the Contractor's entire expense.

3.04 QUALITY CONTROL

- A. The City may periodically require tests by the geotechnical testing laboratory to assist him or her in evaluating the quality of work and Contractor performance. The Contractor shall assist the City by excavating and backfilling shallow areas as necessary to take density tests.
- B. Any constructed course which does not meet specification requirements shall be reworked, at the Contractor's entire expense, to bring that work within specification requirements. The City's test shall be used in evaluating whether project meets specification requirements. The following table provides minimum testing requirements:

TEST TYPE	TEST STANDARD	MINIMUM FREQUENCY OF TESTS
In-Place Soil Density and Moisture Content	ASTM D 698 ASTM D 1556 ASTM D 2167 ASTM D 2922 ASTM D 2216 ASTM D 3017	One test for every 300 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade.
pH	Eades and Grim procedures ASTM D 2976	One test per 600 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
Thickness		One test for 300 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
Compressive Strength	ASTM D 558 ASTM D 1633 ASTM D 2166	Four test cylinders shall be taken from a representative portion of the concrete being placed for every one hundred and fifty cubic yards(150 cy) of concrete pavement placed, but in no case shall less than two (2) sets of cylinders be taken from any one day's placement.)
Pulverization Testing	Tex-101-E, Part III	One test for every 600 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
Swell Potential	ASTM D 4546	One test for every 900 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade

Note: The City may test any other property of the materials or lime-soil mixture in this Item at intervals or occasions of his/her choosing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. The Lime Stabilized Subgrade shall be measured by the Square Yard (SY) complete in place and accepted for the thickness shown in the plans.
- B. The Lime shall be measured by the Ton (TN) complete in place.

4.02 PAYMENT

- A. The Lime Stabilized Subgrade shall be paid for at the unit contract price and shall be total compensation for preparing the roadbed, for loosening, pulverizing, application of lime, water content in the slurry mixture and mixing water; mixing, shaping, sprinkling, compacting, finishing, curing and maintaining; for manipulations required; and for all labor, equipment, fuels, tool, and incidentals necessary to complete the work, all in accordance with the plans and specifications.
- B. The Lime material shall be paid for at the unit contract price bid for Lime which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing and handling; and for all labor, equipment, fuels, tools, and incidentals necessary to complete the work.

END OF SECTION

SECTION 321116- FLEXIBLE SUBBASE OR BASE (CRUSHED STONE/CONCRETE)

PART 1 - GENERAL

1.01 DESCRIPTION

A. All material, labor, equipment, tools and superintendence necessary to furnish and install Flexible Sub-base or Base (crushed stone/concrete) in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.5.

1.02 REFERENCES

A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.5

PART 2 - PRODUCTS

2.01 MATERIALS

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.5.

PART 3 - EXECUTION

3.01 PREPARATION

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301. And 301.5.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.5.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.5.

END OF SECTION

SECTION 321123- SAND BEDDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to install Sand Bedding in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.2.2.6

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.2.2.6

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 504.2.2.6

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 504.2.2.6

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item unless otherwise noted.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321126- ASPHALT BASE COURSE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Asphalt Base Course in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 302.2, 302.3, 302.7, 302.8, 302.9, and 302.10

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

END OF SECTION

SECTION 321133- PORTLAND CEMENT TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Portland Cement Treatment in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

END OF SECTION

SECTION 321216- HOT MIX ASPHALT PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Hot Mix Asphalt Pavement in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 302.2, 302.3, 302.7, and 302.10

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

4.02 PAYMENT

- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

END OF SECTION

SECTION 321313- CONCRETE PAVEMENT

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Pavement in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303
- B. City of Celina Standard Details for Concrete Pavement

1.03 SUBMITTALS

- A. Submit mix design for each class of concrete.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2 and 303.3.
- B. All concrete shall be sulfate resistant mix design.
- C. Specified reinforcing steel (#4 bars and larger) shall be of domestic manufacture and shall conform to the requirements of ASTM A615, Grade 60.
- D. Grade 40 reinforcing steel (#3 bars) will only be allowed in sidewalks or with approval of the Director of Engineering Services.
- E. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.2 is hereby modified to allow only Type I / II Portland Cement.
- F. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.4 is hereby modified to allow only Class F fly ash.
- G. Expansion joints in paving shall be redwood boards only.

2.02 EQUIPMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.4.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.5 and 303.8. Samples of all materials for testing shall be solely the responsibility and expense of the Contractor.
- B. Conform to City of Celina's Standard Details for Concrete Pavement.
- C. Slip form pavement method shall be used for all public streets and alleys unless otherwise approved by the Director of Engineering Services. Hand formed pavement method may be used for turn lanes, deceleration lanes, driveway approach, or replacing a panel of public street or alley pavement.
- D. Curb shall be cast integral with paving unless otherwise approved by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.8.

- B. Monolithic curb shall be considered incidental to the work performed and materials furnished in accordance with this Item, and will not be paid for directly but will be subsidiary to Concrete Pavement unless otherwise specified in the plans and in the bid proposal.

END OF SECTION

SECTION 321314- ROLLING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Rolling in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1.2

PART 2 - PRODUCTS

2.01 MATERIALS

A. TAMPING ROLLER

1. Tamping rollers shall consist of two (2) metal rollers, drums or shells of not less than forty inches (40") in diameter, each not less than forty-two inches (42") in length and unit mounted in a rigid frame in such a manner that each roller may oscillate independently of another. Each roller, drum or shell shall be surmounted by metal studs with tamping feet projecting not less than seven inches (7") from the surface and spaced not less than six inches (6") nor more than 10 inches (10") measured diagonally center to center; and the cross-sectional area of each tamping foot measured perpendicular to the axis of the stud, shall be not less than five square inches (5") nor more than eight square inches (8"). The roller shall be of the type that by ballast loading, the load on each tamping foot may be varied uniformly from 125 p.s.i. of cross-sectional area. The load per tamping foot will be determined by dividing the total weight of the roller by the number of tamping feet in one row parallel to or approximately parallel to the axis of the roller.
2. The tamping roller shall be drawn by approved equipment of adequate tractive effort. Power equipment used in embankment construction shall be the crawler type tractor. Two (2) tamping rollers conforming to the above requirements, drawn by approved equipment, shall be considered a roller unit.

B. TIRE ROLLER

1. Tire rollers shall consist of not less than nine (9) pneumatic-tired wheels, running on axles in such a manner that the rear group of tires will not follow in the tracks of the forward group of wheels, and mounted in a rigid frame, and shall be of a type suitable for ballast loading. The distance between the front and rear axles shall be not less than five feet (5') no more than 10 feet (10').
2. The front axle shall be attached to the frame in such a manner that the roller may be turned in a minimum circle. The pneumatic tire roller shall have an effective rolling width of approximately sixty inches (60"), and shall be ballast loaded so that the load may be varied uniformly from not less than 100 p.s.i. of width of tire tread to 325 pounds per inch of tire tread. The roller, under working conditions, shall provide a uniform compression under all wheels. The total combined width of effective tire tread shall be not less than eighty-five percent (85%) of the effective rolling width. The pneumatic tire roller shall be drawn by an approved crawler type, a pneumatic tread tractor, or a truck of adequate tractive effort; and the roller when drawn by either type of equipment shall be considered a pneumatic tire roller unit. Power equipment for rolling on asphalt shall be equipped with pneumatic tires.

PART 3 - EXECUTION

3.01 PREPARATION

- A. The embankment or base course shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips at least one-half (1/2) of the width of the pneumatic tire roller unit. Alternate trips of the roller unit shall begin at the low sides and progress toward the high sides.
- B. The speed of the power roller and the tamping roller unit, unless otherwise directed by the City, shall be between two (2) and three (3) miles per hour. The speed of the pneumatic tire unit, unless otherwise directed by the City, shall be between four (4) and twelve (12) miles per hour for asphalt surfacing work and between two (2) and six (6) miles per hour for all other compaction work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321373- JOINT SEALANT

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Joint Sealant in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.5.4.7.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2 and 303.5

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.12.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.5.4.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321400- CONCRETE PAVERS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Concrete Pavers in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.
- B. Colors for use in Celina shall be approved by the City.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Item shall be measured complete in place per square-foot (SF) and in accordance with the Contract Documents.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.

END OF SECTION

SECTION 321613- CONCRETE CURB AND GUTTER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Curb and Gutter in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 203.4, 303 and 305.1
- B. City of Celina's Standard Detail for Concrete Curb and Gutter.

1.03 RELATED SECTIONS

- A. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 303.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.1.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Concrete Curb and Gutter will not be measured separately unless indicated otherwise.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Concrete Curb and Gutter". This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321645- DRIVEWAY APPROACH

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Driveway Approach in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items, 303, 305.1 and 305.2
- B. City of Celina's Standard Details for Driveway Approaches

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.1.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items and 305.2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on per Square Yard (SY) basis, specified by type (Commercial, Residential), complete in place. Measurement shall start at the back of the laydown curb and shall include the area of the curb radii as indicated in the Standard Details. Curbs on driveways shall not be measured separately but shall be included as a part of the driveway concrete.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Driveway Approach." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321650- REINFORCED CONCRETE SIDEWALK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Sidewalk in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303, 305.1 and 305.2
- B. TxDOT current Standard Details for Pedestrian Facilities
- C. Current Texas Department of Licensing and Regulation (TDLR) and Americans with Disabilities Act (ADA) requirements.

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 – Concrete Pavement
- C. Section 321655 – Barrier Free Ramp

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.1.
- B. Welded Wire Fabric is not acceptable as reinforcement.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items and 305.2.
- B. All Reinforced Concrete Sidewalk must be approved by TDLR prior to acceptance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Square Yard (SY) basis complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Reinforced Concrete Sidewalk.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Barrier Free Ramps shall be measured and paid for separately in accordance with Section 321655 – Barrier Free Ramp.

END OF SECTION

SECTION 321655- BARRIER FREE RAMP

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Barrier Free Ramps in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303, 305.1 and 305.2.
- B. TxDOT and City Standard Details for Pedestrian Facilities.
- C. Current Texas Department of Licensing and Regulation (TDLR) and Americans with Disabilities Act (ADA) requirements.

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 311313 – Portland Cement Concrete
- C. Section 321650 – Reinforced Concrete Sidewalk

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.
- B. All Barrier Free Ramps must be approved by TDLR prior to acceptance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on per Each (EA) basis, specified by type, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Barrier Free Ramp.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321660- CONCRETE MEDIAN NOSE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Median Noses in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 305.1, and 305.3.
- B. City of Celina's Standard Detail for Monolithic Median Nose

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 311313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.
- B. All median noses shall be monolithic in accordance with the City of Celina's Standard Detail for Concrete Median Nose.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on per Each (EA) basis, specified by Type (1 or 2), complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Concrete Median Nose." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Concrete Pavers within the medians shall be paid for separately.

END OF SECTION

SECTION 321665- REINFORCED CONCRETE HEADER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Header in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.4.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.4.
- B. City of Celina Standard Detail for Concrete Header

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 –Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Reinforced Concrete Header.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321723- PAVEMENT MARKERS AND MARKINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Pavement Markers and Markings.

1.02 REFERENCES

- A. TxDOT Items 666, 672, 677, and 678
- B. City of Celina's Standard Details for Pavement Markers and Markings.
- C. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 347113 – Barricades, Signs, and Traffic Handling

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 666, 672, 677, and 678.
- B. Refer to the City of Celina's Standard Details for Pavement Markers and Markings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 666, 672, 677, and 678.
- B. Each class of raised pavement marker shall be from the same manufacturer.
- C. Contact City for approval of pavement marking layouts prior to installation.
- D. Surface to which markers are to be attached by an adhesive shall be prepared by any method approved by the City to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond.
- E. Guides to mark the lateral location of pavement markings shall be established as shown on the plans. The Contractor shall establish the pavement marking guides and the City will verify the location of the guides.
- F. The pavement markers shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet of roadway. The maximum deviation shall not exceed two (2) inches nor shall any deviation be abrupt.
- G. Markers placed that are not in alignment of sequence, as shown on the plans or as stated in this specification, shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with TxDOT Item 677 "Eliminating Existing Pavement Markings and Marker", except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.
- H. Unless otherwise shown on the plans, the Contractor shall use the following adhesive materials for placement of markers:
 - 1. Epoxy adhesive for Class E markers.
 - 2. Bituminous adhesive for Classes A, B, C, and D markers on bituminous pavements.
 - 3. Epoxy adhesive for Class A, B, C, and D markers on Portland cement concrete pavements.
- I. Adhesive shall be applied in sufficient quantity to ensure that 100 percent of the bonding area of the raised pavement markers shall be in contact with the adhesive.
- J. Raised pavement markers, except Class E, shall be in contact with the pavement surface but shall be seated on a continuous layer of adhesive.

-
- K. Unless otherwise noted, adhesives shall be applied in accordance with the manufacturer's recommendations.
 - L. When bituminous adhesive is used, pavement and raised pavement marker temperature shall be at least 40 degree F. The bituminous adhesive shall not be heated above 400 degree F. The bituminous adhesive shall be agitated intermittently to ensure even heat distribution.
 - M. Epoxy adhesive shall be machine mixed.
 - N. Raised pavement markers shall be free of rust, scale, dirt, oil, grease, moisture, or contaminants which may adversely affect the adhesive bond.
 - O. Raised pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.
 - P. The roadway to be marked will remain open to traffic and the Contractor shall provide all necessary warning and barricading to insure the safety of the workmen and traffic, and the Contractor must insure proper maintenance of all warning and barricading devices at all times. Construction, signing, channelizing devices, and markings shall conform to the current *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) at all times.
 - Q. A minimum of one lane in each direction shall remain open to through traffic at all times.
 - R. The Contractor shall conduct the installation so as to minimize the duration of restricted traffic movements.
 - S. The Contractor shall apply pavement markers and markings during off-peak traffic hours (9:00 am – 3:30 pm) or as directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis complete in place or by Each (EA) and Linear Foot (LF) as indicated in the plans.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Pavement Markers and Markings." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Surface Preparation will not be paid for directly, but considered subsidiary to this Item.

END OF SECTION

SECTION 321725- PREFABRICATED PAVEMENT MARKINGS (WITH WARRANTY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Prefabricated Pavement Markings as indicated in the plans with a manufacturer's warranty bond for a 6 year period. The City will allow a Contractor provided warranty bond in lieu of the manufacturer's bond if all conditions of the manufacturer's warranty including the requirements of this Item are met. In such case, the Contractor is responsible for meeting the warranty requirements. Use the form provided by the City. The City will allow substitution of a contractor's bond with a manufacturer's bond after execution of the Contract prior to final acceptance.

1.02 REFERENCES.

- A. City of Celina's Standard Details for Pavement Markers and Markings.

1.03 RELATED SECTIONS

- A. Section 347113 – Barricades, Signs, and Traffic Handling

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Contractor shall use 3M 270 Tape (or approved equal) for all directional arrows and messages, and 3M 380 Tape for all longitudinal pavement markings and 12" channelization lines as indicated in the plan. Approved equal pavement markings must meet the TxDOT requirements of Type B markings in DMS-8240.

2.02 EQUIPMENT

- A. Provide equipment as required or directed according to the following (The provider of the warranty bond is responsible for providing equipment during the warranty period unless otherwise shown on the plans.):
1. Preparation and Application. Use equipment designed for the pavement preparation and application of the type of pavement marking material selected.
 2. Colorimeter. Provide a colorimeter using 45°/0° geometry CIE, D65 Illuminant, 2° standard observation angle meeting the requirements of ASTM E 1347, E 1348, or E 1349.
 3. Retro-reflectometer. Unless otherwise shown on the plans, provide a portable or mobile retro-reflectometer meeting the following requirements.
 - a. Portable Retro-reflectometer, provide a portable retro-reflectometer that meets the requirements of ASTM E 1710
 - b. Mobile Retro-reflectometer. Provide a mobile retro-reflectometer that:
 - is approved by the City and certified by the Texas Transportation Institute Mobile Retro-reflectometer Certification Program for project evaluation of retro-reflectivity
 - is calibrated daily, before measuring retro-reflectivity on any pavement stripe, with a portable retro-reflectometer meeting the following requirements: ASTM E 1710, entrance angle of 88.76°, observation angle of 1.05°, and an accuracy of ±15%;
 - Requires no traffic control when retro-reflectivity measurements are taken and is capable of taking continuous readings at or near posted speed.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Contractor to ensure a manufacturer's representative is present during installation of all pavement markings
- B. Prepare the pavement surface using controlled techniques that minimize pavement damage and hazards to the traveling public. Apply the materials, according to the manufacturer's recommendations, using widths, colors, shapes, and at locations as shown on the plans.
- C. Obtain approval for the sequence of work and estimated daily production. Use traffic control as shown on the plans or as approved. Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed, and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway. Apply markings in alignment with the guides and without deviating for the alignment more than 1 in. per 200 ft. of roadway or more than 2 in. maximum
- D. Remove all applied markings that are not in alignment or sequence as stated in the plans or as stated in the specifications at the Contractor's expense and in accordance with TxDOT Item 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment
- E. The City will conduct visual performance evaluations of the markings. For markings that do not meet the City's visual performance evaluation, the Contractor may present test results for color (using a colorimeter), retro-reflectivity (using a retro-reflectometer), and durability (in accordance with ASTM D 913) for the City's use in making acceptance or rejection decisions. For pavement markings not meeting performance requirements, repair or replace until reevaluation shows the Pavement Markers and Markings meet the performance requirements as approved by the City.
- F. Written Acceptance. The City will provide written acceptance after the Contractor meets the initial performance requirements. This written acceptance (see attached sample form) will include the date, location, length, and type of pavement markings.

3.02 PERFORMANCE REQUIREMENTS

- A. Color. Provide pavement markings consisting of pigments blended to provide color conforming to highway colors as shown in Table 1.

Table 1: Color Requirements

Federal 595 Color		Chromaticity Coordinates								Brightness (Y)
		1		2		3		4		
		x	y	x	y	x	y	x	y	
White	17855	.290	.315	.310	.295	.350	.340	.330	.360	60 min
Yellow	33538	.470	.455	.510	.489	.490	.432	.537	.462	30 min
Black										5 max

- B. Retro-reflectivity. Provide pavement markings for longitudinal markings meeting the minimum retro-reflectivity values listed in Table 2.

Table 2: Minimum Retro-reflectivity Requirements

Color	Retro-reflectivity, mcd/m ² /lx, Min
White	120
Yellow	120

-
- C. Durability. Provide pavement markings that do not lose more than 5% of the striping material in a 1,000- ft. section of continuous stripe or broken stripe (25 broken stripes). Pavement markings must remain in the proper alignment and location.
 - D. Performance Evaluation Procedures. Provide traffic control and conduct evaluations of color, retro-reflectivity, and durability as required or directed by the City.
 - 1. Color. Measure color using 45°/0° geometry CIE, D65 Illuminant, 2° standard observation angle in accordance with ASTM E 1347, E 1348, or E 1349.
 - 2. Retro-reflectivity. Unless otherwise shown on the plans, conduct retro-reflectivity evaluations of pavement markings with either a portable or mobile retro-reflectometer. Make all measurements in the direction of traffic flow, except for broken centerline on 2-way roadways, where measurements will be made in both directions. If using a portable retro-reflectometer, take a minimum of 1 measurement every mile on each series of markings (i.e., edge- line, center skip- line, each line of a double line, etc.), at locations approved by the City. If more than 1 measurement is taken, average the measurements. For all markings measured in both directions, take a minimum of 1 measurement in each direction. If the measurement taken on a specific series of markings within each mile segment falls below the minimum retro-reflectivity values, take a minimum of 5 more measurements at locations determined by the City within that mile segment for that series of marking. If the average of these 5 measurements falls below the minimum retro-reflectivity requirements, that mile segment of the applied markings does not meet the performance requirement. If using a mobile retro-reflectometer, review the results to determine deficient sections and deficient areas of interest. These areas do not meet the performance requirements.
 - 3. Durability. Measure durability in accordance with ASTM D 913 for marking material loss and visual inspection for alignment and location. Conduct evaluations at locations approved by the City.

3.03 WARRANTY REQUIREMENTS

- A. Each warranty period is for 6 yr. and starts the day after written acceptance.
- B. The marking warrantor is responsible for meeting the Performance Requirements for the duration of the warranty period.
- C. During the warranty period, the City will conduct periodic visual performance evaluations of the pavement markings. For retro-reflectivity the City will use Tex-828-B, “Determining Functional Characteristics of Pavement Markings.” The warrantor may be present during these evaluations. For areas, which, in the opinion of the City have a questionable visual evaluation, the warrantor may replace the pavement markings or may conduct a performance evaluation for the performance requirement in question, conduct retro-reflectivity evaluations using either portable or mobile retro-reflectometer unless otherwise indicated in the Contract Documents. The warrantor is responsible for traffic control when conducting performance evaluations.
- D. The warrantor will replace pavement markings that fail to meet the color, retro-reflectivity, or durability performance requirements during the warranty period, and must replace the pavement markings that fail to meet the performance requirements within 30 days of notification.
- E. All replacement pavement markings must meet the materials and performance requirements of this specification.
- F. The end of the warranty period does not relieve the warrantor from the performance deficiencies requiring corrective action identified during the warranty period.
- G. The City may exclude pavement markings from the replacement provisions of the warranty period, provided the City determines that the failure is a result of outside causes rather than defective material. Examples of outside causes are extreme wear at intersections, damage by snow or ice removal, and premature pavement failure.

- H. Provide a contact person, address and telephone number for notification of needed pavement markings replacement.
- I. Each class of raised pavement marker shall be from the same manufacturer.
- J. The pavement markers shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet of roadway. The maximum deviation shall not exceed two (2) inches nor shall any deviation be abrupt.
- K. Unless otherwise noted, adhesives shall be applied in accordance with the manufacturer's recommendations.
- L. The roadway to be marked will remain open to traffic and the Contractor shall provide all necessary warning and barricading to insure the safety of the workmen and traffic, and the Contractor must insure proper maintenance of all warning and barricading devices at all times. Construction, signing, channelizing devices, and markings shall conform to the current *Texas Manual on Uniform Traffic Control Devices (TMUTCD)* at all times.
- M. A minimum of one lane in each direction shall remain open to through traffic at all times.
- N. The Contractor shall conduct the installation so as to minimize the duration of restricted traffic movements.
- O. The Contractor shall apply pavement markers and markings during off-peak traffic hours (9:00am – 3:30 pm) or as directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis complete in place or by Each (EA) and Linear Foot (LF) as indicated in the plans.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Prefabricated Pavement Marking" of the color, shape, and width. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Surface Preparation will not be paid for directly, but considered subsidiary to this Item.

END OF SECTION

SECTION 328000- IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete Irrigation System as shown on plans as described herein.

1.02 REFERENCES

- A. Refer to City of Celina's Approved Material List.

1.03 RELATED SECTIONS

- A. Section 329223 – Turf grass Planting
 B. Section 329300 - Tree, Shrub, and Groundcover Planting

1.04 QUALITY ASSURANCE

A. Substitutions:

1. Time: Submit substitution request in writing seven (7) days prior to bid opening.
2. Required Submittal Material:
 - a. Sample proposed substitute sprinkler.
 - b. Manufacturer's data of sprinkler, discharge rates (GPM), minimum allowable operating pressure, maximum allowable spacing and distance of throw.
 - c. Detailed pressure loss computations if proposed differ from those specified.
 - d. If proposed substitute require a change in head and piping layout as designed, submit detailed drawings showing design changes and proposed layout.
3. Approval: Approval of proposed substitute will not relieve responsibility for providing a system that will operate according to intent of originally designed system.

B. Installer:

1. Irrigator licensed in State with 5 years minimum continuous experience installing systems of this size and complexity must supervise installation.
2. Complete mainline installation with personnel that have successfully installed equipment and materials as specified on at least three other projects equal in scope.

C. Testing: Perform required testing under observations of Owner. Give 48 hours' notice that such tests are to be conducted.

D. Assembly Procedures:

1. Do not alter design hydraulics by installing additional tees or elbows unless approved by Owner.
2. Prior to start of construction; confirm the static water pressure in writing to Owner. If static pressure differs from pressure shown on drawings, do not start work until notified to do so, in writing, by the Owner.

1.05 REFERENCES: The following ASTM designations apply:

- A536 Ductile Iron Fittings
- D2241 Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
- D2672 Bell-End Poly (Vinyl Chloride) (PVC) Pipe
- D2464 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Threaded, Schedule 80
- D2466 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Socket Type, Schedule 40
- D2467 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Socket Type, Schedule 80
- D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- D2287 Flexible Poly Vinyl Chloride (PVC) Plastic Pipe
- F656 Poly Vinyl Chloride (PVC) Solvent Weld Primer

- C213 AWWA Dual Compression Gasket Seal Fittings
- D2855 Making Solvent - Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- F477 Ductile Iron Fitting Gaskets

1.06 SUBMITTALS

- A. Product Data: Submit seven (7) copies of manufacturer's specifications and literature for all specified materials.
- B. Project Record Documents:
 - 1. Comply with Contract Documents and requirements.
 - 2. Locate by written dimension, routing of mainline piping, remote control valves and quick coupling valves. Locate mainlines by single dimensions from permanent site features provided they run parallel to these elements. Locate valves, intermediate electrical connections, and quick couplers by two dimensions at approximately 70 degrees to each other provided they are within 50 feet of a permanent site feature. Valves, electrical connections and quick couplers beyond 50 feet must be located by triangulation using three dimensions from building corners, walk intersections or similar junctures.
 - 3. When dimensioning is complete, transpose work to mylar reproducible tracings. Owner will provide tracings.
 - 4. Submit completed tracings prior to final acceptance. Mark tracings "Record Prints Showing Significant Changes". Date and sign plans.
 - 5. Provide three complete operation manuals and equipment brochures neatly bound in a hard back three-ring binder. Include any warranties and guarantees extended to the Contractor by the manufacturer of all equipment. Include seven (7) executed copies of "Guarantee for Landscape Irrigation System".

GUARANTEE FOR LANDSCAPE IRRIGATION SYSTEM

We hereby guarantee that the landscape irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the plans and specifications, ordinary wear and tear and unusual abuse or neglect expected. We agree to repair or replace any defects in material or workmanship, which may develop, and to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense. We will pay the costs and charges therefore upon demand. This guarantee shall remain in effect for a period of two (2) years from the date of Final Completion, as determined by the Owner or the Owner's Representative.

PROJECT: _____

LOCATION: _____



SIGNED: _____

COMPANY: _____

ADDRESS: _____

PHONE: (_____) _____ - _____

DATE OF ACCEPTANCE: _____ / _____ / _____

1.07 COORDINATION

- A. Complete sleeve installation (not otherwise provided) in coordination with paving and other concrete pours.
- B. Coordinate to ensure that electrical power source is in place.
- C. Coordinate system installation with work specified in other Sections and coordinate with landscape installer to ensure plant material is uniformly watered in accordance with intent shown on Plans.

1.08 WARRANTY AND MAINTENANCE

- A. Extend to Owner any warranties and guarantees provided by manufacturer of equipment used.
- B. Warranty materials and workmanship for a minimum of two years after final acceptance.
- C. Include repair of backfill settlement, packing the earth firmly around the heads, quick couplers, and valve boxes.
- D. Limit warranty to repair and replacement of defective materials or workmanship, including repair of backfill settlement.

1.09 CONNECTION TO DOMESTIC WATER SUPPLY

- A. Complete connection to water supply in accordance with governing codes and regulations.
- B. Provide and pay for any required permits.

PART 2 - PRODUCTS

2.01 DEFINITIONS

- A. Sprinkler Mains: Piping from water source to operating valves. Hydrant lines and quick coupling valves (QCV) are considered sprinkler mains.
- B. Lateral Piping: Piping from operating valves to sprinkler heads.

2.02 POLYVINYL CHLORIDE PIPE



A. Polyvinyl Chloride Pipe (hereinafter referred to as PVC pipe) shall be manufactured in accordance with the product standards as follows:

1. Mainline Piping-PVC, Schedule 40 - solvent weld joints
2. Lateral Piping-PS-22-70, SDR-21, Class 200 - solvent-weld joints
3. Marking and Identification: Permanently marked with the following information: manufacturer's name, pipe size, type of pipe and material, SDR Number, Commercial Standard Number, and NSF (National Sanitation Foundation) Seal.
4. Purple pipe required for all irrigation maintained by the City (medians, etc.).

2.03 PIPE FITTINGS:

- A. PVC Sch. 40.
- B. All PVC fittings shall be of the same material as the PVC pipe specified and be compatible with the PVC pipe furnished.
- C. Use only solvent recommended by the manufacturer of the PVC pipe and the manufacturer of the PVC fittings.

2.04 COPPER PIPE AND FITTINGS:

- A. Pipe: Type "M", hard, straight lengths, of standard size and dimensions.
- B. Fittings: Cast brass or wrought copper sweat-solder type.

2.05 VALVE WIRING:

- A. Single conductor copper type UF wire with 4/64 in. vinyl insulation U.L. approved for direct underground burial in 30 volt AC or less service.
- B. Valve wiring to controllers: Fourteen- (14) minimum (heavier if required based on length of run).
- C. Ground wiring from electric valves to controllers: Twelve- (12) gauge minimum (heavier if required based on length of run)

2.06 FLEXIBLE PVC NIPPLES: Lawn heads: Nominal ½" x 12" long flexible PVC.

2.07 SWING JOINT ASSEMBLY: Nipples for fixed copper risers, nominal ½" x 4" long.

2.08 PVC NIPPLES:

- A. High-Pop Shrub Head: ½" dia. Unitized O-Ring Assembly.
- B. Rotary Spray Head: ¾" dia. Unitized O-Ring Assembly.

2.09 MATERIALS LIST: Refer to plans.

2.10 MAINLINE SHUT-OFF VALVES:

- A. Four inch (4") and larger: Cast iron bodied, bronze fitted gate valves with gasket type pipe connections and a 200 W.O.G. rating. Valve stems shall be fit with square operating nuts of standard size. Manufacturer - Kennedy #597X or approved equal.
- B. Three inch (3") and smaller: Plastic bodied, ball valves with threaded connections and an ASTM standard F-1970 pressure rating.

2.11 DRAIN VALVES:

- A. Bronze bodied globe valves with rubber seats and threaded IPS pipe connections with a 125 W.O.G. rating. Valve stems shall be equipped with a round wheel handle.

2.12 QUICK COUPLER VALVES AND KEYS:

- A. Valves: One-inch (1") bronze bodied valves with a rubber seat and locking vinyl cover.
- B. Keys: Bronze construction with 1" MIP x ¾" FIP threads.
- C. Manufacturer: RAINBIRD 44LRC or approved equal.

2.13 REINFORCEMENT STAKES: Galvanized steel pipe 1-inch diameter, Sch. 40. Secure to QCV with stainless steel worm gear clamps.

2.14 ROTARY HEADS: At the discretion of the City of Celina, multi-stream multi-trajectory rotary nozzles, oscillating stream nozzles, bubbler systems, drip systems and rotor heads shall be installed on all irrigation systems. The city reserves the right to require efficient irrigation products where suitable.

- A. High impact plastic gear driven rotary heads with a 3/4" IPS connection. Head shall have interchangeable nozzles. Nozzle as specified on plans.
- B. Manufacturer: Hunter PGP or approved equal.

2.15 SPRAY HEADS:

- A. Pop-up spray heads, 4" or 12" pop-up assembly as shown with a poly carbonate body. Nozzles shall be efficient technology nozzles such as multi-stream multi-trajectory rotary nozzles, oscillating stream nozzles or other nozzles with a minimum precipitation rate of 1inch per hour and .7 minimum distribution uniformity Refer to plans for size.

2.16 ELECTRIC VALVES:

- A. Normally closed glass filled nylon body valve with a Buna N reinforced diaphragm fitted with a 24 volt, ¼ amp solenoid in a waterproof housing and pressure regulating module.

2.17 VALVE BOXES:

- A. Electric Valves:
 - 1. 12 in. x 17 in. x 12 in. deep plastic valve box with locking lid and extensions as required.
- B. Quick Coupling Valves:
 - 1. 10 in dia. x 12 in. deep plastic valve box with extensions as required.
- C. Backflow Preventer:
 - 1. Jumbo plastic valve box with locking lid and extensions as required.

2.18 WIRE SPLICES:

- A. Valve Wiring: Waterproof type connectors with plastic housing and non-settling sealant.
- B. DBY

2.19 RAIN/FREEZE SENSOR:

- A. Wireless Rain/Freeze Sensor with transmitter and receiver.
- B. Attach to top of 2" galvanized pipe 10 foot above grade and 2 feet below grade set in concrete.
- C. Paint pipe semi-gloss black.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which irrigation sprinkler system is to be installed.
- B. Verify that interfacing work specified elsewhere is complete.
- C. Notify Owner in writing of conditions detrimental to proper and timely completion of Work.
- D. Do not proceed until conditions are satisfactory.

3.02 INSTALLATION:

- A. General:
 - 1. Compliance: Complete installation in strict accordance with manufacturer's recommendation, which shall be considered a part of these specifications.
 - 2. Stake location of each sprinkler for approval of Owner before proceeding. Do not exceed manufacturer's maximum spacing limits.
 - 3. Piping Layout: Piping layout is diagrammatic. Route piping around trees and shrubs to avoid damage to plantings. Do not dig within balls of newly planted trees and shrubs.

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4. Discrepancies:
- a. Point out any discrepancy between the plans and the field conditions that may affect uniform coverage. Do not proceed until any design change made necessary by such discrepancy is approved by Owner.
 - b. Should such changes create extra cost, approval for extra compensation shall be obtained in writing by Owner before commencing work.
 - c. Should such changes create savings in cost, a written reduction in the contract price shall be approved in writing by Owner before commencing work.
- B. Excavations: Excavations are unclassified and include earth, loose rock, or combinations, in wet or dry state. Backfill trenches with material removed except if rock is encountered haul this material off site, and backfill to ensure a minimum of 3 inches of rock free soil surrounding pipe.
- C. Water Meter and Backflow Prevention: Refer to plans.

3.03 PIPE INSTALLATION:

- A. General: Width of trenches to be approximately twice as large as the pipe diameter
- B. Mainline and Lateral Piping: Install with 12 inches of soil cover over laterals and 24" coverage over 8" mainline and 18" coverage over 6" and small mainline.
- C. Trenching: Provide firm, uniform bearing for entire length of pipe to prevent uneven settlement. Wedging or blocking of pipe is not permitted. Remove foreign matter from inside of pipes before assembly. Keep inside of piping clean during and after layout of pipes.
- D. Backfill: Water jet and compact to 90% to prevent after-settling. Hand rake trenches and adjoining areas to leave grade in condition equal to before installation.

3.04 PVC PIPE AND FITTINGS ASSEMBLY:

- A. Solvent: Use solvent and procedures recommended by manufacturer to make solvent-welded joints. Thoroughly clean pipe and fittings before applying solvent.
- B. PVC to Metal Connections: Use Teflon tape.
- C. Threaded PVC Connections: Use threaded PVC adapters into which pipe may be welded. Use Teflon tape on threads.

3.05 ELECTRICAL VALVES:

- A. Provide valves in accordance with materials list and size according to plans.
- B. Install valves in a level position in accordance with manufacturer's specifications.
- C. Provide plastic valve box, centered over valve, flush with finish grade. Provide valve box extensions as required.
- D. Install 0.5 cubic feet washed pea gravel in bottom of valve box.

3.06 SPRINKLERS:

- A. General: Provide in accordance with materials list with nozzle in accordance with plans. Change nozzle degree and trajectory if wind conditions affect coverage. Receive approval from the Owner prior to any change. Install heads adjacent to walks and curbs 2 inches clear of paving.
- B. High-Pop Shrub Heads: Provide nozzles as indicated in 2.15; twelve (12") inch pop-up body. Attach to lateral piping with 1/2". Firmly tamp soil around base plate and leave head plumb. Underside of flange shall be set flush to 1" above finish grade.
- C. Lawn Heads: Attach sprinklers to lateral piping with flex PVC pipe. Firmly tamp soil around base plate and leave head plumb. Underside of flange shall be set flush to 1/4" above finish grade in hydro seeded areas and 1" above finish grade in solid sodded areas.
- D. Rotary Heads: Install as detailed on the plans on swing joints. Follow manufacturer's assembly and installation procedure. Set heads flush with finish grade or sod.

3.07 QUICK COUPLING VALVES (QCV): Provide in accordance with materials list and as detailed on plans, stake with a 1"galvanized pipe.

3.08 WIRING:

A. Sprinkler Controls to Valves:

1. Conduit is not required for U.F. wire unless otherwise noted on plans. Tuck wire under piping.
2. Make wire connections with waterproof connectors according to manufacturer's recommendations.
3. Provide a separate wire from controller to each electric valve. Provide a common neutral wire from controller to valves served by a particular controller.
4. Provide a 24 inch long wire coils at valves.
5. An expansion coil shall be provided every 200 feet, which consists of 10 wraps around a 1" PVC pipe or some other method approved by the Owner.
6. All valve wires from the same controller shall be bundled together every 10 feet with plastic electrical tape.

B. Wire Testing:

1. Before any backfills are placed over the communication cable, test the wires with a megger for wire installation resistance. Minimum insulation resistance to ground shall be 100K OHMS to ground. Any conductor not meeting this requirement shall be replaced and retested.
2. After backfill is completed, retest the wires with a megger. The minimum acceptable insulation resistance to ground on this test shall be 100K OHMS to ground. Replace and retest any conductor not meeting this requirement.

3.09 TESTING:

- A. Notify Owner to review work 48 hours prior to testing pipe and fittings for leaks.
- B. Test mains for a period of four hours under static pressure. If leaks (or pressure drops) occur, correct defect and repeat test.

3.10 FINAL ADJUSTMENT:

- A. Make final adjustments of sprinkler system prior to Owner's final inspection.
- B. Flush system by removing nozzles from heads on ends of lines and operating system.
- C. Adjust sprinklers for proper operation and proper alignment for direction of throw.
- D. Adjust each section for operating pressure and balance to other sections by use of flow adjustment on top of each valve. Correct operating pressure at last head of each section – 50 psi for rotary heads and 20 to 25 psi for spray heads.
- E. Adjust nuzzling for proper coverage. Prevailing wind conditions or slopes may indicate that arc of angle or trajectory of spray should be other than as shown on plans. Change nozzles to provide correct coverage.

3.11 CLEANUP: Keep premises clean and neat.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 329113- FERTILIZER

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Fertilizer in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 329119- TOPSOIL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Topsoil in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2 unless otherwise specified in the Contract Documents.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2 unless otherwise specified in the Contract Documents.

END OF SECTION

SECTION 329223- TURFGRASS PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work includes all labor, materials, and equipment for soil preparation, fertilization, planting, and other requirements regarding Turf grass planting areas shown on the plans.

1.02 RELATED SECTIONS

- A. Section 024100 - General Site Preparation
- B. Section 328000 - Irrigation System
- C. Section 329113 – Fertilizer
- D. Section 329119 - Topsoil

1.03 SUBMITTALS

- A. Delivery Receipts and Invoices: All delivery receipts and copies of invoices for materials used for this work shall be subject to checking by the Owner and shall be subsequently delivered to the office of the Owner.
- B. Samples and Producers' Specifications: Various samples, certificates, and specifications of seed, fertilizer, sand, compost, other soil amendments, and other materials shall be submitted for approval as required by subsequent sections of this specification.

PART 2 - PRODUCTS

2.01 TURFGRASS

- A. Bermuda grass Seed: Turfgrass seed shall be "Cynodon dactylon" (Common Bermuda grass). The seed shall be harvested within one (1) year prior to planting, free of Johnson grass, field bind weed, dodder seed, and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall not be a mixture. The seed shall be hulled, extra fancy grade, treated with fungicide, and have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85% using the formula: purity % times (germination % times plus hard or sound seed %). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.
 - 1. Certificate Submittal: Prior to planting, provide the Owner or his representative with the State Certificate stating analysis of purity and germination of seed.
- B. Sod: Turfgrass sod shall be "Cynodon dactylon" (Common Bermuda grass). Sod shall consist of stolon, leaf blades, rhizomes, and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than three-quarters (3/4") inch. Sod shall be alive, healthy, vigorous, free of insects, disease, stones, and undesirable foreign materials and grasses. The grass shall have been mowed prior to sod cutting so that the height of the grass shall not exceed two (2") inches. Sod shall have been produced on growing beds of clay or clay-loam topsoil. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival will be affected. All sod is to be harvested, delivered, and planted within a thirty-six (36) hour period of time. Sod shall be protected from exposure to wind, sun, and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots-to-roots and grass-to-grass.
 - 1. Dimensions: All sod shall have been machine cut to uniform soil thickness of one (1") inch plus or minus one-quarter (1/4") inch. All sod shall be of the same thickness. Rectangular sections of sod may vary in length, but all shall be of equal width and of a size that permits the sod to be lifted, handled, and rolled without breaking. Broken pads and torn, uneven ends will be unacceptable.

2.02 FERTILIZER



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- A. General: Fertilizer shall be a commercial product, uniform in composition, free flowing, and suitable for application with approved equipment, Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer which has been exposed to high humidity and moisture has become caked or otherwise damaged making it unsuitable for use will not be acceptable.
 - B. Initial Planting Application: Fertilizer for the initial planting application shall be of an organic base containing by weight the following (or other approved) percentages of nutrients: 15-15-15 (N-P-K), also containing 10-15% sulphate and traces of iron and zinc as required and approved by the Owner. At least 50% of the nitrogen component must be of a slow release formulation such as area-based and plastic resin-coated fertilizers.
 Specification Submittal: Submit a sample label or specifications of the fertilizer propose to be used for the Owner's approval.
 Post Planting Application: Fertilizer for the post planting application will be a chemical base fertilizer containing by weight the following percentages of nutrients: 21-0-0 (N-P-K) ammonium sulphate or the nitrogen equivalent of 33-0-0 ammonium nitrate.
 - 1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.

2.03 HYDRAULIC-MULCH MATERIALS

- A. Refer to the Public Works Construction Standards, NCTCOG 4th Edition, Item 202.6.4.4.
- B. Public Works Construction Standards, NCTCOG 4th Editions, Item 202.6.4.4 is hereby modified by excluding the compliance with NCTCOG Item 202.4 Fertilizer.
- C. Fertilizer for hydraulic mulching will comply with requirements of this specification.

2.04 SOIL AMENDMENTS (Not required.)

PART 3 - EXECUTION

3.01 GENERAL

- A. All turfing operations are to be executed across the slope, parallel to finished grade contours.

3.02 SOIL PREPARATION

- A. Contractor shall kill all vegetation prior to soil preparation.
- B. Tillage: Tillage shall be accomplished to loosen the soil, destroy existing vegetation, and prepare an acceptable seed/sprig/sod bed. All areas shall be tilled with a heavy duty disc or a chisel-type breaking plow, chisels set not more than ten (10") inches apart. Initial tillage shall be done in a crossing pattern for double coverage, followed by a disc harrow. Depth of tillage shall be five (5") inches. A heavy duty rototiller may be used for areas to be planted with sod.
- C. Cleaning: Soil shall be further prepared by the removal of debris, building materials, rubbish, weeds, and stones larger than three-quarters inch (3/4") diameter.
- D. Fine Grading: After tillage and cleaning, all areas to be planted shall be leveled; fines graded, and drug with a weighted spike harrow or float drag. The required result shall be the elimination of ruts, depressions, humps, and objectionable soil clods. This shall be the final soil preparation step to be completed before the commencement of fertilizing and planting.
- E. Rock Removal: During the soil preparation process, a "Rock Pick" or other approved piece of machinery shall be used to gather surface stones as small as three-quarter (3/4") inch in diameter. The Contractor shall be responsible for the disposal of collected materials as waste per "Clean Up" Paragraph 3.10.

3.03 FERTILIZING

- A. Initial Planting Application: The specified fertilizer shall be applied at the rate of (18) pounds per one thousand (1,000) square feet (800 pounds per acre).

1. Timing: The initial planting application of fertilizer for seeded/sprigged areas shall be applied after the soil preparation, but not more than two (2) days prior to Turfgrass planting. (Fertilizer shall be applied over sodded areas after planting, but not more than two (2) days later.)
- B. Post Planting Application: Thirty (30) days after planting, Turfgrass areas shall receive an application of 21-0-0 or 33-0-0 fertilizer at the rate of nine (9) pounds per one thousand (1,000) square feet (400 pounds per acre).
 1. Timing: The Owner or his representative will determine if it is too late in the growing season for the post planting application. In the event that it is, the application shall be made in the spring of the next year, or the cost of the application may become a credit due to the Owner.
 2. Post Planting Maintenance: See Paragraph 3.07. Areas without a uniform stand (complete coverage) that must be maintained later than thirty (30) days after the initial planting shall receive subsequent applications of fertilizer, as described above, every thirty (30) days until a uniform stand is achieved

3.04 PLANTING:

- A. Seeding: Following soil preparation and initial fertilizing, apply Bermuda grass seed at the rate of two (2) / three (3) pounds per one thousand (1,000) square feet (90/130 pounds per acre) or ryegrass seed at the rate of eight (8) pounds per one thousand (1,000) square feet (350 pounds per acre). Seed shall be uniformly placed with a Brillion seeder-cultipacker, or the seed shall be broadcast uniformly, followed by rolling with a weighted lawn roller.
 1. Timing: Bermuda grass shall not be seeded in planting periods other than the following unless special permission is granted by the Owner: April 15 to June 15, and August 15 to September 15.
 2. Hydraulic Mulch (where required): Refer to Public Works Construction Standards, NCTCOG 4th Edition, Item 202.6.4.4.
- B. Solid Sodding: Prior to laying the sod, the planting bed shall be raked smooth to true grade and moistened to a depth of four (4") inches, but not to the extent causing puddling. The sod shall be laid smoothly, tightly butted edge to edge, and with staggered joints. The sod shall be pressed firmly into contact with the sod bed by rolling or by hand tamping with an approved tamper so as to eliminate all air pockets, provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Following compaction, fine screened soil of good quality shall be used to fill all cracks between sods. Excess soil shall be worked into the grass with suitable equipment and shall be well watered. The quantity of fill soil shall be such that it will cause no smothering of the grass.

3.05 PROTECTION: No heavy equipment shall be moved over the planted lawn area unless the soil is again prepared, graded, leveled, and replanted. It will be the responsibility of this Contractor to protect all paving surfaces, curbs, utilities, plant materials, and any other existing improvements from damage. Any damages shall be repaired or replaced at no cost to the Owner. This Contractor will also locate and stake all irrigation heads, valve risers, etc., prior to beginning any soil preparation work.

3.06 ESTABLISHMENT AND ACCEPTANCE: Regardless of unseasonable climatic conditions or other adverse conditions affecting planting operations and the growth of the turf grass, it shall be the sole responsibility of the Contractor to establish a uniform stand of turf grass as herein specified. When adverse conditions such as drought, cold weather, high winds, excessive precipitation, or other factors prevail to such an extent that satisfactory results are unlikely, the Owner may, at his own discretion, stop any phase of the work until conditions change to favor the establishment of turf grass.

3.07 POST-PLANTING MAINTENANCE: Contractor shall begin maintenance immediately after each portion of grass area is planted. All planted areas will be protected and maintained by watering, weed

control, and replanting as necessary for at least thirty (30) days after initial planting and for as much longer as necessary to establish a **UNIFORM STAND WITH COMPLETE COVERAGE OF THE SPECIFIED GRASS**. It is anticipated that a minimum of one (1) mowing will occur before the grass areas are acceptable to the Owner. Only those areas which are not completely covered with the specified grass at the end of thirty (30) days will continue to be replanted and maintained by the Contractor until complete coverage and acceptable results are achieved. The automatic irrigation system will be available for the Contractor's use. Any other water equipment deemed necessary by the Contractor will be provided by the Contractor at his expense.

- A. Watering: Use the automatic irrigation system to apply at least one-half (1/2") inch of water over the entire planted area every three (3) days. Contractor shall water thoroughly and infrequently once grass is established to encourage deep root growth.
- B. Mowing: Once grass is established the planted area shall be mowed at least once a week during the growing season. Grass shall be mowed to a height of one (1") inch and shall not exceed four inches (4") in height. Mowing during dormant season will be done as necessary.
- C. Weed Control: No sooner than 45 days after grass has germinated any weed growth shall be arrested over the entire planted area.

3.08 **GRADING**: All grading and placing of topsoil on any given area will be done prior to the beginning of this work. It will be the Contractor's responsibility to maintain the existing grades and leave them in a true and even condition after planting turf grass. Finish condition of turf grass will be such that sod sits flush with paving (topsoil 1" below paving) and such that drainage grades and swales function and do not trap drainage on the paving.

3.09 **EROSION CONTROL**: Throughout the project and the maintenance period for turf grass, it is the Contractor's responsibility to maintain the topsoil in place at specified grades. Topsoil and turf grass losses due to erosion will be replaced by the Contractor until establishment and acceptance is achieved.

3.10 **CLEAN UP**: This Contractor shall remove any excess material or debris brought onto the site or unearthed as a result of his turf grass operations.

3.11 **GUARANTEE**: This Contractor shall guarantee all materials used for this work to be the type, quality, and quantity specified.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Measurement shall be specified in the Contract Documents.

4.02 PAYMENT

- A. Payment shall be specified in the Contract Documents

END OF SECTION

SECTION 329300- TREE, SHRUB, AND GROUNDCOVER PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work includes all final fine grading and minor leveling of planting areas, soil preparation, and planting. Furnish all labor, materials, equipment and services required as herein specified and indicated on the drawings. Refer to planting details on plans. NOTE: Plant beds to be left 1" below adjacent paving and slabs after settling.

1.02 RELATED SECTIONS

- A. Section 024100 - General Site Preparation
- B. Section 328000 - Irrigation System
- C. Section 329113 - Fertilizer

PART 2 – PRODUCTS

2.01 TOPSOIL

- A. All planting bed topsoil shall be soil/compost mix
- B. Submittal: Submit 1 gallon samples to Owner for Approval.
- C. Existing topsoil may be used or amended if it meets the requirements for imported soil and is approved by the landscape architect. Provide a minimum of one soil sample with accompanying soil test report for each topsoil type found on the site.

2.02 COMMERCIAL FERTILIZER

- A. Shall be organic base fertilizer containing the following minimum percentages of available plant nourishment, by weight 5-10-5 (N-P-K), mixed nitrogen, not less than fifty (50%) percent from an organic source and trace elements. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be accepted.
- B. Commercial fertilizer shall be a complete organic fertilizer, part of the element of which is derived from organic sources. It shall be the type percentages and applied at the rate specified in the soil analysis. Fertilizer shall be delivered mixed as specified in standard size bags, showing weight, analysis, and name of manufacturer, and shall be stored in a weatherproof storage place, and in such a manner that it will be kept dry and its effectiveness will not be impaired.
- C. Submittal: Submit labels to Owner for Approval.

2.03 SOIL AMENDMENTS (None required.)

2.04 MULCH

- A. Shall be shredded cypress bark mulch.
- B. Submittal: Submit a one (1) quart sample of proposed mulch for Owner approval.

2.05 ROOT ACTIVATOR (Not required.)

2.06 WATER: Water shall be available at the site via irrigation system. Water required in connection with planting will be furnished and paid for by the Owner provided it is not used in a wasteful manner. Any hose or other watering equipment shall be provided by the Landscape Contractor to water planting areas until the job is accepted by the Owner.

2.07 PLANT MATERIALS

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- A. **Plant Name and Location:** The names and locations of all plants are noted on the drawings. The nomenclature of all plant materials is per Standardized Plant Names, 1942 edition and Manual of Cultivated Plants by L. H. Bailey. Plant materials not conforming to these two references will be rejected by the Owner.
- B. **Quality and Size:** All plant materials shall be first class representatives of their normal species or variety unless otherwise specified. They shall have a habit of growth that is normal for the species and shall be healthy, shapely, well-rooted, and vigorous. All plant materials shall be free from insect pests, plant diseases, and injuries. The containers and balls of all plants delivered to the site shall be free from any weeds or grasses which could be considered noxious or objectionable; i.e., nutgrass or Johnson grass. **ALL PLANT MATERIALS SHALL BE EQUAL TO OR EXCEED THE MEASUREMENTS SPECIFIED ON THE PLANTING PLAN WHICH ARE THE MINIMUM ACCEPTABLE SIZES.** They shall be measured after pruning with the branches in normal position. The requirements for measurement, branching, grading, quality, balling and burlapping of plants specified generally follow the code of the standards currently recommended by the American Nursery and Landscape Association, in the American Standards for Nursery Stock.
- a. Trees shall not be headed back in the nursery or on site. Trees with multiple leaders, unless specified, will be rejected. Trees with damaged or crooked leader, bark abrasions, sunscald, disfiguring knots, insect damage, or cuts of limbs over 20 mm (3/4 in.) in diameter that are not completely closed will be rejected. The root flare shall be visible. Trees with girdling roots will be rejected.
- C. **Packaging:**
1. **Container Grown Plants:** Plants designated as “container grown” on the plans shall be full or heavy grade and shall have been growing in the specified size container for one full season prior to delivery to the site.
2. **Balled and Burlapped Plants (B&B):** Plants designated “B&B” on the plans shall be balled and burlapped. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Balls shall be firmly wrapped with burlap or similar materials and bound with twine, cord, or wire mesh. Where necessary, to prevent breaking or cracking of the ball during the process of planting, the ball may be secured to a platform.
3. **Alternate to B&B:** Plants grown in containers may be accepted as B&B provided that the plant has been growing in the container for one full growing season prior to delivery. Alternate must be approved by Owner.
- D. **Substitutions:** Substitutions will be permitted only upon submission of proof that any plant is not obtainable and authorization by the Owner or his representative by a Change Order providing for the use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of contract price.
- E. **Bio-stimulants:** shall contain soil conditioners, VAM, and endomycorrhizal and etomycorrhizal fungi spores and soil bacteria appropriate for existing soil conditions. Submit manufacturer literature for approval.

2.08 SOIL STERILANT: (Not required.)

2.09 WEED CONTROLLER: Shall be “Round-Up”

PART 3 – EXECUTION

3.01 LAYOUT



Location and spacing for plants and outline of areas to be planted shall be as denoted by stem location or by notations on the plan. All tree and shrub planting locations shall be staked by the Landscape Contractor and shall be approved by the Owner prior to digging the planting pits.

3.02 SCARIFICATION

- A. All bed areas to receive planting shall be scarified to a depth of twelve (12") inches and all debris, stone, rubbish, and weeds shall be removed from the site.
- B. Weed Control: Prior to scarification the Contractor shall apply "Round-Up" herbicide to all bed areas. Follow manufacturer's directions as to timing requirements for effective weed control.

3.03 BED PREPARATION

- A. Planting areas shall be dug and soil fully prepared, graded, and made ready to receive the plants before delivery of plant materials. After planting, all beds shall be one (1") inch above finished grade to allow for settling.
- B. Groundcover and Vine Planting Areas:
 1. Commercial Soil Mix: All planting beds shall be excavated to twelve (12") inches below finished grade by Landscape/General Contractor, and all debris, stone, rubbish, weeds, and topsoil shall be removed from the site. The subgrade shall then be tilled to a depth of six (6") inches and the planting bed shall be backfilled with soil compost mix. Upon replacement of topsoil with mix and after watering in, the bed should be at the specified level.
- C. Tree and Shrub Planting Pits:
 1. Planting Pits: After scarifying, the planting pits shall be excavated. All shrub pits shall be a minimum of six (6") inches larger in diameter and three (3") inches deeper than the shrub ball or root spread. All tree pits shall be a minimum of twelve (12") inches larger in diameter and 2-3 inches less deep than the root ball. All tree pits shall be tested for percolation. If water does not drain within 24 hours, drainage or a more suitable species or location shall be provided.
 2. Soil Mix: Soil mix for backfilling the tree and shrub planting pits shall be soil/compost mix as specified for Groundcover and Vine Planting Areas.
- D. Raised Planters:
 1. Backfilling: Planters shall be backfilled with specified commercial soil mix.

3.04 DELIVERY OF PLANT MATERIALS

Plants shall be packed and protected during delivery and after arrival at the site, against climatic, seasonal, wind damage, or other injuries, and at no time shall be allowed to dry out.

3.05 PROTECTION OF PLANT MATERIALS

All plants shall be handled so that roots are adequately protected at all times from drying out and from other injury. The balls of balled plants which cannot be planted immediately on delivery shall be "heeled in" for protection with soil mulch, straw, or other acceptable material.

3.06 SETTING THE PLANTS

All plants shall be planted in pits, centered, and set to touch such depth that the finished grade level at the plant after settlement will be the same as that at which the plant was grown. Each plant shall be planted upright and faced to give the best appearance or relationship to adjacent plants or structures. No burlap shall be pulled out from under balls or balls broken when taken from containers. All broken or frayed roots shall be cut off cleanly. Prepared soil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. When the hole is nearly filled add water, and allow it to soak away. Fill the hole to finished grade and form a shallow saucer around each tree or shrub by placing a ridge of topsoil around the edge of each pit after planting.

3.07 MULCHING

All plants will be mulched after planting with a three inch (3") deep layer of mulch material entirely covering the area around each plant except as noted. The root flare of trees shall not be covered with mulch. In the groundcover and massed shrub areas, the entire area between the plants is to be treated, regardless of plant spacing.

3.08 GRADING

The surface of all planting areas shall slope as shown on the plans. Unless otherwise shown, slope one-quarter (1/4") inch per foot (two (2%) percent gradient) away from foundations and walk.

3.09 CLEANUP

All excess soil, soil preparation materials, fertilizer, or plant containers shall be removed from the site upon completion of the work.

3.10 PRUNING AND SPRAYING

Each tree will be pruned to preserve the natural shape and character of the plant. All pruning will be done after delivery to the site, under supervision of the Owner. All soft wood or sucker growth and all broken or badly bruised branches shall be removed. All pruning diameter will be painted with tree surgery paint, applied on all cambium and other living tissues immediately after cuts are made. Immediately after planting and staking, all plant material except coniferous evergreens must be sprayed with an antidesiccant, if required, using an approved power sprayer for applying an adequate film over trunks, branches, and foliage. Antidesiccants and surgery paint shall be delivered in manufacturer's sealed containers and used in accordance with their recommendations.

3.11 MAINTENANCE

The Landscape Contractor is responsible for watering, cultivating, and other necessary maintenance (including regular mowing) until the completion and acceptance of the project.

3.12 INSPECTION FOR ACCEPTANCE

- A. Inspections: Inspection of work and planting to determine completion of the work, exclusive of possible warranty plant replacement, will be made by the Owner upon notice by the Landscape Contractor. The Owner needs not less than two (2) days' notice prior to the anticipated date, enabling him to schedule the inspection.
- B. Acceptance: Acceptance of all work and planting, exclusive of possible plant replacements subject to guarantee, will be granted to the Landscape Contractor, provided there are no deficiencies at inspection time. After inspection, the Landscape Contractor will be notified by a letter of acceptance of work by the Owner. All plants must be healthy (not dry or wilted) to be accepted.

3.13 GUARANTEE

- A. Terms: All shrubs and groundcover shall be guaranteed for a minimum of one (1) year and all trees for one (1) year or in accordance with the Contract Documents, whichever is greater. Guarantee begins upon Final Acceptance of project by City.
- B. Plant Replacement: At the end of each guarantee period, inspection will be made by the Owner and the Landscape Contractor. Any plant material required under this contract that is dead or not in satisfactory growth condition shall be removed and replaced with the same size and kind of plant specified, at no cost to the Owner.

3.14 MAINTENANCE GUIDE

The Landscape Contractor, upon delivery of the plant materials, shall deliver to the Owner a brief, written maintenance guide. This guide should describe recommended planting maintenance procedures, methods, products, quantities, timing, etc.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement shall be specified in the Contract Documents.

4.02 PAYMENT

B. Payment shall be specified in the Contract Documents

END OF SECTION

**SECTION 329600- REMOVAL, PROTECTION AND REPLACEMENT OF TREES,
SHRUBBERY, PLANTS, SOD, AND OTHER VEGETATION**

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for removal, protection and replacement of trees, shrubbery, plants, sod and other vegetation in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1
- B. ANSI A300, Pruning Standards
- C. City of Celina Tree Preservation Ordinance
- D. City of Celina Tree Protection Standard Details

1.03 RELATED SECTIONS

- A. Section 024100 - General Site Preparation

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.
- B. Unless otherwise specified on the plans, trees and shrubs with calipers greater than three (3”) inches shall not be cleared (removed) provided that both of the following conditions are met:
 - 1. The vegetation exists in an area that is not proposed for pavement, a structure, or the playing bounds of an athletic field.
 - 2. The vegetation is in an area where the cut or fill does not exceed six inches (6”).
- C. The Owner will assist the Contractor in identifying trees that are to be saved from clearing if not specified in the plans. The Contractor will protect such trees from construction damage such as trunk impacts and scrapes, limb breakage, compaction of soil within the drip line, and other injurious construction activities. If necessary, the Owner may direct the Contractor, at the Contractor’s expense, to erect protective stockades along the drip lines of trees that the Owner considers vulnerable to damage. Such stockades shall be of eight foot (8’) long by six inch (6”) diameter posts vertically buried three feet (3’) deep at six foot (6’) intervals along the drip line.
- D. Where grading or clearing and grubbing operations are to occur between trees that are to be preserved and protected, the Contractor will prune the lower branches of these trees as necessary to prevent their breakage and to permit access by construction machinery. Branches will be cut off to the trunk or major limb pursuant to ANSI A300. The Owner may direct that the Contractor remove additional branches in such a manner that the tree presents a balanced appearance. Scars will be treated with a heavy coat of an approved tree sealant.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1 unless otherwise specified in the Contract Documents.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1 unless otherwise specified in the Contract Documents.

END OF SECTION

SECTION 330131- WASTEWATER AND MANHOLE TESTING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to test wastewater mains and manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.1.5 and 507.5.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.1.5 and 507.5.

1.03 SUBMITTALS

- A. Copies of all test reports.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 WASTEWATER MAIN TESTING

The Contractor shall complete each of the following tests on all wastewater mains.

- A. Low pressure air testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.1.3.
- B. Deflection testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.1.4.

3.02 WASTEWATER MANHOLE TESTING

The Contractor shall complete one of the following tests on all wastewater manholes.

- A. Exfiltration testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.5.1.
- B. Vacuum testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.5.2.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Wastewater and manhole testing shall be subsidiary to the wastewater main and manhole bid items. No separate pay item for wastewater and manhole testing.

END OF SECTION

SECTION 330132- TELEVISION INSPECTION FOR WASTEWATER MAINS

PART 1 – GENERAL

1.01 DESCRIPTION

All material, labor, equipment, tools and superintendence necessary to perform television inspection of wastewater mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2.

1.02 REFERENCES

A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2

1.03 SUBMITTALS

A. CD or DVD with wastewater main television inspection videos and data log summary sheets.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 PREPARATION

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

A. Television inspection of wastewater mains shall be subsidiary to the wastewater main bid items.
No separate pay item for television inspection of wastewater mains.

END OF SECTION

SECTION 330510- TRENCHING, BACKFILLING AND COMPACTION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to perform Trenching, Backfilling and Compaction operations for utility construction in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504

1.03 SUBMITTALS

- A. Trench safety plan in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.3.

PART 2 – PRODUCTS

Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.2.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504.
- B. Trenches shall be excavated by a trenching machine, backhoe or dragline, except in locations where hand trenching is required. The banks of trenches shall be vertical, to a point one foot (1') above the top of pipe.
- C. The excavation shall not advance more than three hundred feet (300') ahead of the completed and backfilled line. Pipe shall be laid in all trenches that have been opened before the end of each day's work, unless the Contractor secures written permission to do otherwise from the Inspector.
- D. The final backfill shall be moisture treated to a minimum of 3 percentage points above optimum moisture content at a minimum of 95 percent standard Proctor (ASTM D 698).

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.7 for measurement of backfill.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.6 for measurement of trench safety.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.7 for payment of backfill.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.6 for payment of trench safety.
- C. All excavation for utility installation shall be considered subsidiary to the utility bid item. No separate pay item for excavation, backfill and/or trenching, unless otherwise noted.

END OF SECTION

SECTION 330523- TRENCHLESS UTILITY INSTALLATION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install utility lines using trenchless installation methods in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503
- B. City of Celina’s Standard Details included in the plans.

1.03 QUALITY ASSURANCE

A. DESIGN CRITERIA

The pipe casing (or carrier pipe on uncased bores) shall be designed by a Licensed Professional Engineer for the following loading conditions and applicable combinations thereof:

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

B. INSTALLER'S QUALIFICATIONS

Installation shall be by a competent, experienced contractor or sub-contractor. The installation contractor shall have a satisfactory experience record of at least three (3) years engaged in similar work of equal scope. All welding shall be performed by a certified welder in the state of Texas

C. PERFORMANCE REQUIREMENTS

Lateral or vertical variation in the final position of the pipe casing (or carrier pipe on uncased bores) from the line and grade established by the ENGINEER shall be permitted only to the extent of 1" in 10' feet, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe.

1.04 SUBMITTALS

Submittals shall include:

- A. Shop drawings of the casing pipe (or carrier pipe for uncased bores) from the manufacturer. Shop drawings shall include calculations for the design of the casing pipe (or carrier pipe for uncased bores) by a Licensed Professional Engineer.
- B. Provide Certificate of Adequacy of Design of casing and/or carrier pipe.
- C. Provide record data of casing insulators including sketches of insulators with material components and dimensions and proposed locations of insulators.
- D. Provide Pressure Grout material and method.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.2.
- B. High Density Polyethylene casing spacers are required unless otherwise specified. Refer to the City of Celina Approved Materials List.
- C. Steel casing pipe shall be new (or used if approved by the OWNER) 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.

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- D. Casing pipe shall have a red oxide primer inside and out (from manufacturer) in accordance with AWWA C- 210. Pipe joints shall be welded in accordance with AWWA C-206.

PART 3 – EXECUTION

3.01 GENERAL

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.3.
- B. All casing pipe joints shall be watertight with no water entering the casing from any sources prior to carrier pipe installation.
- C. The carrier pipe shall be installed within the casing between the limits indicated on the Plans to the specified lines and grades, and utilizing methods which include due regard for safety of workers, adjacent structures and improvements, utilities, and the public.
- D. Furnish all necessary equipment, power, water, and utilities for carrier pipe installation, insulator runner lubricant, grouting, and other associated Work required for the Contractor's methods of construction.
- E. Conduct all operations such that trucks and other vehicles do not interfere with traffic or create a dust or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of spoils and slurry spillage and any slurry discharges.
- F. All Work shall be done so as not to disturb roadways, adjacent structures, landscaped areas, or existing utilities. Any damage shall be immediately repaired to original or better condition and to the satisfaction of the Engineer.

3.02 INSTALLATION OF CARRIER PIPE

- A. Pipe Installation: Carrier pipe shall meet the requirements of the applicable Specification section. Remove all loose soil from casing. Grind smooth all rough welds at casing joints. Provide casing spacers, or insulators, or other approved devices, as required, to prevent flotation, movement, or damage to the pipe during installation and annular space grout placement. Every individual pipe section should be supported by spacers as shown in the City's Standard Details. Carrier pipe shall be installed without sliding or dragging it on the ground or in the casing in a manner that could damage the pipe. Coat the casing spacer runners with a non-corrosive/environmentally safe lubricant to minimize friction when installing the carrier pipe.
- B. Testing of Carrier Pipe: Testing of the carrier pipe joints shall be completed prior to the filling of the annular space between the casing and carrier pipe with grout. Pressure testing shall be performed in accordance with the specification for the selected pipe material. Any leakage found during this inspection shall be corrected.
- C. Backfill Annular Space with Grout: After the installation of the carrier pipe, the annular space (all voids) between the casing and the carrier shall be filled with grout so all remaining surfaces of the exterior carrier pipe wall and casing interior are in contact with the grout. Furnish the necessary grout, equipment, hoses, valves, and fittings for the backfilling operation. Grout shall be pumped through a pipe or hose. Use grout pipes, or other appropriate materials to avoid damage to carrier pipe during grouting. The grout shall be proportioned to flow and to completely fill all voids between the carrier pipe and the casing. The Contractor shall provide end seals, as approved by the Engineer at each end of the casing to contain the grout backfill. The end seals shall be designed to withstand the anticipated grouting pressure and be watertight to prevent groundwater from entering the casing. Block the carrier pipe during grouting to prevent flotation during grout installation. The Contractor shall also protect and preserve the interior surfaces of the casing from damage. It is the responsibility of the Contractor to submit to the Engineer sufficient information indicating all proposed equipment, materials, and the method for filling this void.

3.03 SAFETY

- A. The Contractor is responsible for safety on the job site. Perform all Work in accordance with the current applicable regulations of the Federal, State, and local agencies. In the event of conflict, comply with the more restrictive applicable requirement.

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- B. No gasoline powered equipment shall be permitted in jacking shafts and receiving shafts/pits. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations.
 - C. Methods of construction shall be such as to ensure the safety of the Work, Contractor's and other employees on site, and the public.
 - D. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are underground. Perform all required air and gas monitoring. Ventilation system shall provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in all underground work areas.
 - E. Perform all Work in accordance with all current applicable regulations and safety requirements of the Federal, State, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA. In the event of conflict, comply with the more stringent requirements.
 - F. The Contractor shall develop an emergency response plan for rescuing personnel trapped underground in a shaft excavation or pipe. Keep on-site all equipment required for emergency response in accordance with the agency having jurisdiction.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 503.4.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 503.4.

END OF SECTION

SECTION 331113- DUCTILE IRON PIPE AND FITTINGS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Ductile Iron Pipe and Fittings in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7 and Item 506.

1.02 REFERENCES

- A. ANSI/AWWA C104/A21.4 - American National Standard for Cement - Mortar Lining for Ductile-Iron Pipe and Fittings for Water, Latest Revision.
- B. ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement, Latest Revision.
- C. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- D. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- E. ANSI/AWWA C115/A21.15, AWWA Standard for Flanged Ductile-Iron Pipe with Ductile- Iron or Gray-Iron Threaded Flanges, Latest Revision.
- F. ANSI/AWWA C150/A21.50⁸, American National Standard for the Thickness Design of Ductile-Iron Pipe, Latest Revision.
- G. ANSI/AWWA C151/A21.51, AWWA Standard for Ductile Iron Pipe, Centrifugally Cast, Latest Revision.
- H. ANSI/AWWA C153/A21.53, AWWA Standard for Ductile-Iron Compact Fittings for Water Service, Latest Revision.
- I. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances, Latest Revision.
- J. AWWA C651, AWWA Standard for Disinfecting Water Mains, Latest Revision.
- K. AWWA Manual of Practice M41 Ductile-Iron Pipe and Fittings, Latest Revision.
- L. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.7 and 506.

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 331240 – Polyethylene Encasement
- C. Section 331245 – Tapping Sleeves for PVC and Ductile Iron Pipe
- D. Section 331260 – Mechanical Restraint for PVC and Ductile Iron Pipe

1.04 SUBMITTALS:

Submittals shall be in accordance with the General Conditions and shall include the following:

- A. Submittals required prior to fabrication
 - 1. Pipe design calculations sealed by a Licensed Engineer in the State of Texas.
 - 2. Pipe layout drawings including horizontal stations and locations and vertical elevations sealed by a Licensed Engineer in the State of Texas.
 - 3. Thrust restraint calculations sealed by a Licensed Engineer in the State of Texas.
 - 4. Certification with full compliance with the specifications
 - 5. Complete materials specification for each part to be furnished.
 - 6. Technical Bulletins and Brochures
 - 7. Statement of Warranty.
 - 8. An estimated delivery date for the equipment (which shall be stated in calendar days after the release date to the manufacturer).

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9. Name, address, phone number, and fax number of manufacturer's representative.
 10. Test to be run during manufacturing process

- B. Submittals required prior to Shipping
 1. Certified copies of all test.
 2. Lifting instructions

1.05 QUALITY ASSURANCE

- A. Manufacturer: Finished pipe shall be the product of one (1) manufacturer. Pipe manufacturing operations (pipe, fittings, lining, and coating) shall be performed at one (1) location.

1.06 DELIVERY AND STORAGE

- A. Delivery and Storage shall be in accordance with AWWA C600 and AWWA Manual of Practice M41.

PART 2 – PRODUCTS

2.01 DUCTILE IRON PIPE

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7.
- B. Buried ductile iron pipe may have mechanical joint, push-on joint, or restrained push-on joint.
- C. All ductile iron pipes shall be epoxy coated inside and out in accordance with ANSI standard 61.
- D. All buried pipe shall be polyethylene encased in accordance with AWWA C105.
- E. The pressure rating, thickness class, net weight of pipe without lining, length of pipe and name of manufacturer shall be clearly marked on each pipe.

2.02 DUCTILE IRON FITTINGS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7.
- B. Mechanical joints shall be furnished complete with accessories. Bolts and nuts shall be stainless steel.
- C. Fittings shall be ductile iron coated with epoxy coating inside and out in accordance to ANSI standard 61 or stainless steel.
- D. All buried fittings shall be polyethylene encased in accordance with AWWA C105.
- E. Unless otherwise specified, all fittings shall be of the mechanical joint type with a minimum pressure rating of 250 psi.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505.1 and 502.4.

3.02 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.
- B. Jointing Push-On Pipe
 1. Remove any foreign matter in the gasket seat of the socket, wipe gasket clean, flex gasket and place in socket with the large round end or bulb end entering first.
 2. Seat gasket evenly around the inside of the socket with the groove fitted over the bead. Remove any bulges.
 3. Apply a thin film of lubricant furnished by the pipe manufacturer to the inside surface of the gasket. No lubricant other than that furnished with the pipe by the pipe manufacturer will be allowed to be used.
 4. Wipe plain end of pipe, to be entered; clean and place in approximate alignment with the bell of the pipe to which it is to be jointed

5. Apply a thin film of the lubricant to the outside of the plain end about 1" back from the end.
 6. Align the pipe and carefully enter the plain end into the socket until it just makes contact with the gasket.
 7. Complete joint assembly by forcing the plain end of the entering pipe past the gasket until it makes contact with the bottom of the socket.
 8. The maximum deflection at each joint shall not exceed 80% of manufacturer's recommendation.
- C. Jointing Mechanical Joint Pipe
1. After carefully cleaning both spigot and bell and after slipping the following ring and the gasket over the spigot end, the spigot shall be slipped into the bell.
 2. A lubricant shall be applied to the spigot end to assist in the assembly as directed by the Inspector.
 3. The gasket shall be carefully seated by hand so as to be even in the bell at all points.
 4. After drawing up the follower ring to uniform bearing against the gasket the bolts shall be inserted and tightened by hand in pairs using bolts opposite each other.
 5. The nuts are to be tightened to hold the required pressure. Extension wrenches or pipes over wrench handles will not be permitted. Ten-inch (10") ratchet wrenches with a tension setting control shall be used to tighten the nuts unless other types of wrenches are approved by the Inspector.
 6. The finished joint shall be neat and uniform and shall be watertight.
- D. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
- E. Water mains twelve inches (12") and smaller in the right-of-way near storm inlets shall be constructed behind the inlet by pulling the pipe using longitudinal bending in accordance with the manufacturer's requirements.
- F. The maximum deflection angle of pipe joints shall be restricted to 80% of the manufacturers' recommendation. Otherwise, horizontal bends will be required.
- G. Potable water mains and wastewater mains must be installed in separate trenches.
- H. New tracer wire shall be installed in the trench with all water mains with a terminal box located in each water main valve pad.

3.03 HYDROSTATIC TEST

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.5 alternative 2-hour testing in accordance with AWWA C600.
- B. After the pipe has been laid and backfilled, but prior to replacement of pavement, each valve section of a newly laid pipe shall be subjected to a hydrostatic pressure test.
- C. Each valve section of pipe shall be slowly filled with water by means of a pump connected to the pipe in a satisfactory manner.
- D. The pump, pipe connection, and all necessary apparatus including gauges and meters shall be furnished by the Contractor. The City will furnish water for filling lines and making tests through existing mains.
- E. The test pressure shall be measured at the point of lowest elevation.
- F. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged.
- G. At intervals during the test the entire route of the pipe line shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided, and the test shall be repeated until satisfactory results are obtained.

3.04 PURGING AND DISINFECTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.7.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.2.

END OF SECTION

SECTION 331114- PVC PIPE FOR WATER DISTRIBUTION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Polyvinyl Chloride (PVC) Water Pipe For Water Distribution in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.14.

1.02 REFERENCES

- A. AWWA C900, AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100 mm through 300 mm) for Water Distribution
- B. AWWA C900-16, AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350 mm through 1,200 mm), for Water Transmission and Distribution
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.14, 502.4.2, and 502.5

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 331245 – Tapping Sleeves for PVC and Ductile Iron Pipe
- C. Section 331260 – Mechanical Restraint for PVC and Ductile Iron Pipe

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.14.
- B. Pipe shall be manufactured in the United States of America and shall be blue in color.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505.1 and 502.4.

3.02 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.4 and 506.
- B. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
- C. Water mains twelve inches (12”) and smaller in the right-of-way near storm inlets shall be constructed behind the inlet by pulling the pipe using longitudinal bending in accordance with the manufacturer’s requirements.
- D. The maximum deflection angle of pipe joints shall be restricted to 80% of the manufacturers’ recommendation. Otherwise, horizontal bends will be required.
- E. Potable water mains and wastewater mains must be installed in separate trenches.

3.03 HYDROSTATIC TEST

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.5, alternative 2-hour testing in accordance with AWWA C605. Testing pressure is 150 psi.
- B. After the pipe has been laid and backfilled, but prior to replacement of pavement, each valve section of a newly laid pipe shall be subjected to a hydrostatic pressure test.
- C. Each valve section of pipe shall be slowly filled with water by means of a pump connected to the pipe in a satisfactory manner.

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- D. The pump, pipe connection, and all necessary apparatus including gauges and meters shall be furnished by the Contractor. The City will furnish water for filling lines and making tests through existing mains.
 - E. The test pressure shall be measured at the point of lowest elevation.
 - F. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged.
 - G. At intervals during the test the entire route of the pipe line shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided, and the test shall be repeated until satisfactory results are obtained.

3.04 PURGING AND DISINFECTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.7.
- B. The contractor is solely responsible for injecting the chlorine disinfectant into the conduit, monitoring the solution, collecting samples, and performing the water analysis by an approved laboratory.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.2.

END OF SECTION

SECTION 331213- WATER SERVICE CONNECTIONS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Water Service Connections in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.

1.02 REFERENCES

- A. AWWA C800, AWWA Standard for Underground Service Line Valves and Fittings
- B. AWWA C901, Polyethylene Pressure Pipe and Tubing, 1 in. Through 3 in. for Water Service, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10
- D. City of Celina Standard Detail for Typical Service Connection.

PART 2 – PRODUCTS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.10 and 501.21.
- B. Water service pipe shall be polyethylene tubing with detectable tracing wire.
- C. Tracing wire shall be 10 AWG Standard with HDPE coating.
- D. Tape for the tracing wire shall be polypropylene.
- E. Service couplings, meter valves and corporation stops shall be “no-lead brass” fittings.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 502.10.3.
- B. Tracer wire shall be attached to the polyethylene tubing with two independent, continuous, spiral-wound polypropylene tape layers.
- C. Bullhead services that branch at the end of a service line to serve two or more customers will not be allowed.

3.02 CONSTRUCTION

- A. Service taps shall be made after the mains have been laid.
- B. A tapping saddle shall be used to connect service lines to pipe mains.
- C. The service pipe shall be placed at a minimum depth of twenty-four inches (24”) under the finished grade except where the service pipe shall pass under the curb. At this point the service pipe shall be a minimum of twenty-four inches (24”) under the top of curb or a minimum of six inches (6”) under the bottom of the curb and gutter section, or lime stabilized subgrade whichever is greater.
- D. Excessive bending of the service pipe, which will injure or reduce the cross sectional area of the pipe, will not be permitted.
- E. The length of the service pipe shall extend from the main to a point two feet (2’) back of the street curb or to the property line if no curb exists, unless shown otherwise on the plans.
- F. The service pipe shall be continuous with no fittings under paving.
- G. If there is a curb, the curb shall be saw-cut with “T” and marked with good quality blue paint at the point where the service pipe passes the curb.
- H. Sand embedment shall be required two feet (2’) on either side of the service saddle all the way around the water main.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.3.2.2.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.3.2.2.

END OF SECTION

**SECTION 331216- AIR VALVES FOR POTABLE WATER SYSTEMS AND WASTEWATER
FORCE MAINS**

PART 1 – GENERAL

1.01 DESCRIPTION

A. All material, labor, equipment, tools and superintendence necessary to furnish and install Air Release Valves for Potable Water Systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3.

1.02 REFERENCES

- A. AWWA C512, AWWA Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service, Latest Revision.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3
- C. City of Celina’s Standard Details for Combination Air Vacuum Valves.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3.
- B. Air valves for potable water systems shall be Vento-Mat Series RBX or approved equal.
- C. Air valves for wastewater force mains shall be Vento-Mat Series RGX or approved equal.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.2.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331217- RESILIENT SEATED GATE VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Resilient Seated Gate Valves for potable water systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2.

1.02 REFERENCES

- A. AWWA C509, AWWA Standard for Resilient Seated Gate Valves for Water Supply Service, Latest Revision.
 B. AWWA C515, AWWA Standard for Reduced Wall, Resilient Seated Gate Valves for Water Supply Service, Latest Revision.
 C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2
 D. City of Celina’s Standard Detail for Gate Valves.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2.
 B. Valve boxes shall be three (3) piece screw type cast iron of the extension type. The three (3) pieces shall consist of the top section, bottom section and cover.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.1.
 B. All valve locations shall be marked with a “V” saw-cut on the curb or pavement. The “V” shall point to the location of the valve as follows:

Valve in pavement	Upright “V”
Valve outside pavement	Upside Down “V”

- C. Valve boxes over four feet (4’) deep shall require extensions. Valve box extensions shall be cast iron. PVC pipe is not allowed.

3.02 HYDROSTATIC TEST

- A. Gate valves shall be tested at a hydrostatic test pressure of 400 psi and shall be guaranteed for 150 psi working pressure.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331218- BUTTERFLY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Butterfly Valves For Potable Water Systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5.

1.02 REFERENCES

- A. AWWA C504, AWWA Standard for Rubber-Seated Butterfly Valves, Latest Revision
 B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5
 C. City of Celina’s Standard Detail for Butterfly Valves.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5.
 B. Refer to City of Celina’s Approved Material List.
 C. Valves shall be Class 250.
 D. Valve boxes shall be three (3) piece screw type cast iron of the extension type. The three (3) pieces shall consist of the top section, bottom section and cover.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.
 B. All valve locations shall be marked with a “V” saw-cut on the curb or pavement. The “V” shall point to the location of the valve as follows:

Valve in pavement	Upright “V”
Valve outside pavement	Upside Down “V”

- C. The butterfly valve operator shall face away from the curb line on all installations.
 D. Valve boxes over four feet (4’) deep shall require extensions. Valve box extensions shall be cast iron. PVC pipe is not allowed.
 E. All operating nuts shall be extended to within six inches (6”) of final grade.
 F. Six inches (6”) bypass may be required by city on specific projects.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331219- FIRE HYDRANTS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Fire Hydrants in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.

1.02 REFERENCES

- A. AWWA C502, AWWA Standard for Dry-Barrel Fire Hydrants, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3
- C. City of Celina's Standard Details for Fire Hydrants.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 502.3.
- B. Refer to City of Celina's Approved Material List.
- C. Hydrant barrel inside diameter shall not be less than 7 ¼".
- D. All hydrants shall be equipped with two (2) hose nozzles and one (1) steamer nozzle. The hose nozzles shall be two and one-half inches (2 ½") nominal I.D. National Standard Thread. Pumper nozzle shall be four inches (4") nominal I.D. National Standard Thread. All nozzles shall be mechanically attached.
- E. All fire hydrants shall open by turning to the left (counter-clockwise).
- F. All hydrants shall be of the breakable type.
- G. All hydrants shall have a 4 mil epoxy coating on the interior of the shoe.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.2.
- B. All hydrants shall be painted with two coats of Aluminum, Silver paint.
- C. Fire hydrants shall be installed so the breakaway point will be no less than four inches (4") and no greater than eight inches (8") above the final grade elevation. If grade adjustments are made during residential or commercial construction, the fire hydrant shall be adjusted by builder to meet breakaway requirements listed previously before obtaining certificate of occupancy.
- D. Fire hydrants shall be located a minimum of three feet (3') and a maximum of six feet (6') from the back of curb of fire lane or public roadway, based on the location of the sidewalk. The fire hydrant shall not be located in the sidewalk.
- E. All fire hydrants shall be installed so that the steamer connection will face the fire lane or public roadway.
- F. Fire hydrants shall be located no closer than ten feet (10') from the curb return at street or fire lane intersections. No fire hydrant shall be installed within the radius point of an intersection.
- G. If required a blue reflector shall be placed just off center of the street or fire lane opposite fire hydrants. At intersections, reflectors shall be placed on both roadways opposite fire hydrant.
- H. Five-inch (5") Knox Storz guard adapter with 4.5 inch national standard thread with no locking caps are required on all fire hydrants.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.3.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.3.

END OF SECTION

SECTION 331240- POLYETHYLENE ENCASEMENT

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install polyethylene encasement around metal pipe and fittings in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.

1.02 REFERENCES

- A. AWWA C105, AWWA Standard for Polyethylene Encasement for Ductile Iron Pipe Systems.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.1.
- B. The polyethylene encasement may be in tube or sheet form and shall have a minimum thickness of 8 mils.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.2.
- B. The polyethylene seams and overlaps shall be wrapped and held in place by 2” wide plastic backed adhesive tape with 2 foot wide overlaps.
- C. The wrap on the barrel of the pipe shall be loose enough to allow the polyethylene encasement to shift with the soil.
- D. The polyethylene encasement shall be installed without breaks, tears or holes.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.4.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.4.

END OF SECTION

SECTION 331245- TAPPING SLEEVES FOR PVC AND DUCTILE IRON PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install tapping sleeves for polyvinyl chloride (PVC) and ductile iron water pipe in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 506.6.

1.02 REFERENCES

- A. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- B. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 506.6

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 502.10.2.3.
- B. Refer to City of Celina Approved Materials List, Latest Edition.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 506.6.
- B. Taps must be at least one nominal size smaller than the water main being tapped for connections to water mains larger than twelve inches (12”) in diameter.
- C. The minimum size tap allowed on water mains twenty inches (20”) and larger shall be six inch (6”).
- D. No tapping sleeves allowed on asbestos cement water mains.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 506.9.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition; Item 506.9.2.

END OF SECTION

SECTION 331260- MECHANICAL RESTRAINT FOR PVC AND DUCTILE IRON PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install thrust restraint for polyvinyl chloride (PVC) and ductile iron water pipe in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.2.

1.02 REFERENCES

- A. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- B. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.2

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.
- B. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
- C. Concrete thrust blocking shall be poured against undisturbed earth and will not bear against the backfill or bedding of another utility.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.4.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.4.

END OF SECTION

SECTION 333109- WASTEWATER LATERAL CONNECTIONS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Wastewater Lateral Connections in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.

1.02 REFERENCES

- A. ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4
- C. City of Celina Standard Details for Wastewater Laterals.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.17.
- B. Wastewater laterals shall be PVC SDR 35 in accordance with ASTM D3034 or PVC SDR 26 in accordance with ASTM D2241.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.
- B. The wastewater lateral shall extend from the wastewater main to the customer's property line. The elevation of the wastewater lateral at the property line shall be at such a depth that will provide for a lateral from the proposed building site with a minimum grade of one percent (1%) and a maximum grade of one and one-half percent (1.5%) from the building site to the property line. A depth in excess of six feet (6') at the property line is not approved.
- C. If there is a curb, the curb shall be saw-cut with "II" and marked with good quality green paint at the point where the wastewater lateral passes under the curb.
- D. A standard wastewater lateral connection shall consist of the service wye or tee and necessary fittings.
- E. All residential wastewater laterals shall be extended to a point ten feet (10') from the back of the property line at a maximum depth of four feet (4'). The lateral shall then be extended at a forty-five degree angle to four feet (4') above the finished grade and capped.
- F. Fittings are not permitted on wastewater service laterals between the wye and the property line.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.3.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.3.

END OF SECTION

SECTION 333110- PVC PIPE FOR GRAVITY WASTEWATER MAINS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Polyvinyl Chloride (PVC) Pipe For Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17, 505 and 507.

1.02 REFERENCES

- A. ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Latest Revision
- B. ASTM F679 Standard Specification for Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings, Latest Revision
- C. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17, 505 and 507

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 330131 – Wastewater and Manhole Testing
- C. Section 330132 – Television Inspection for Wastewater Mains

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17.
- B. Refer to City of Celina’s Approved Material List.
- C. All gravity PVC wastewater pipe shall be green in color.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.
- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.
- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

SECTION 333115- PRESSURE RATED PVC PIPE FOR GRAVITY WASTEWATER MAINS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Pressure Rated Polyvinyl Chloride (PVC) Pipe for Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15, 505 and 507.

1.02 REFERENCES

- A. ASTM D2241 Standard Specification for Polyvinyl Chloride (PVC) Pressure Rated Pipe (SDR Series), Latest Revision
- B. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals, Latest Revision
- C. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 330131 – Wastewater and Manhole Testing
- C. Section 330132 – Television Inspection for Wastewater Mains

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.
- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.
- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

**SECTION 333130- CENTRIFUGALLY CAST FIBERGLASS REINFORCED PIPE FOR
GRAVITY WASTEWATER MAINS**

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Centrifugally Cast Fiberglass Reinforced Pipe for Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.24, 505 and 507.

1.02 REFERENCES

- A. ASTM D3262 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Sewer Pipe, Latest Revision
- B. ASTM D4161 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals, Latest Revision
- C. ASTM D3840 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Non pressure Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.24, 505 and 507

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.24.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG; 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.
- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.
- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

SECTION 333913- WASTEWATER MANHOLE FRAMES AND COVERS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Wastewater Manhole Frames and Covers in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3.

1.02 REFERENCES

- A. ASTM A48 Standard Specification for Gray Iron Castings, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3 and 806.4.1
- C. City of Celina Standard Details for Manhole Lid and Frame

1.03 RELATED SECTIONS

- A. Section 333914 – Cast-in-Place Concrete Manholes
- B. Section 333915 – Precast Concrete Manholes

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3.
- B. Refer to City of Celina’s Approved Material List.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. All wastewater manhole covers shall be installed with inflow protection inserts.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 333914- CAST-IN-PLACE CONCRETE MANHOLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Cast-In-Place Concrete Manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1

1.03 RELATED SECTIONS

- A. Section 333913 – Wastewater Manhole Frames and Covers
- B. Section 330131 – Wastewater and Manhole Testing

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.1.1.
- B. A manhole-pipe connection must use water tight, size on size resilient connectors that allow for differential settlement and must conform to ASTM C923.
- C. A manhole located in a roadway or other paved area subject to vehicular traffic must meet or exceed the American Association of State Highways and Transportation Officials standard M-306 for load bearing.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. For fifteen inch (15”) to twenty-seven inch (27”) wastewater mains, the manhole shall have a minimum diameter of five feet (5’).
- C. For wastewater mains larger than twenty-seven inches (27”), the manhole shall have a minimum diameter of six feet (6’).
- D. Manholes deeper than fifteen feet (15’) shall have a minimum diameter of five feet (5’).
- E. The exterior of all concrete manholes shall be coated with bituminous waterproofing material.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 333915- PRECAST CONCRETE MANHOLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Precast Concrete Manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.

1.02 REFERENCES

- A. ASTM C478 Standard Specification for Precast Reinforced Concrete Manhole Sections, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1

1.03 RELATED SECTIONS

- A. Section 333913 – Wastewater Manhole Frames and Covers
- B. Section 330131 – Wastewater and Manhole Testing

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.1.1.
- B. A manhole-pipe connection must use water tight, size on size resilient connectors that allow for differential settlement and must conform to ASTM C923.
- C. A manhole located in a roadway or other paved area subject to vehicular traffic must meet or exceed the American Association of State Highways and Transportation Officials standard M-306 for load bearing.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. For fifteen inch (15”) to twenty-seven inch (27”) wastewater mains, the manhole shall have a minimum diameter of five feet (5’).
- C. For wastewater mains larger than twenty-seven inches (27”), the manhole shall have a minimum diameter of six feet (6’).
- D. Manholes deeper than fifteen feet (15’) shall have a minimum diameter of five feet (5’).
- E. The exterior of all concrete manholes shall be coated with bituminous waterproofing material.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 334113- REINFORCED CONCRETE PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Pipe in accordance Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 464.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 403, 420, 464, 467, and 473
- B. Section 330510 Trenching, Backfilling and Compaction
- C. City of Celina's Standard Detail for Storm Drain Embedment and Backfill.
- D. TxDOT standard details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 464.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 464.3. The *Excavation, Shaping, Bedding, and Backfill* section references TxDOT Item 400. The City of Celina's Standard Detail for Standard Storm Drain Embedment and Backfill detail shall replace Figure 1 in TxDOT Item 400.
- B. After compaction and subgrade preparation but prior to paving, television inspections tests are required on all storm sewer mains laterals and culverts as identified on the construction plans. The minimum information to be provided to the Owner and City's inspectors, in both text and video form, are line designation, length, slope, and joints. Acceptable video formats are VHS and DVD. Any line or lines found to be defective will be corrected and another television inspection shall be performed at the contractor's expense

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 464.4.

4.02 PAYMENT

- A. Refer to TxDOT 464.5.

END OF SECTION

SECTION 334200- REINFORCED BOX CULVERT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Box Culverts in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 462.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 403, 420, 421, 440, 462, 464, 466, 467 and 473
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 462.2

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 462.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 462.4.

4.02 PAYMENT

- A. Refer to TxDOT 462.5.

END OF SECTION

SECTION 334913- STORM SEWER MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Storm Sewer Manholes in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 465.

1.02 REFERENCES

- A. TxDOT Items 400, 420, 421, 440, 465, and 471
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)
- B. Section 034105 – Concrete Structures – Precast (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 465.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 465.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 465.4.

4.02 PAYMENT

- A. Refer to TxDOT 465.5.

END OF SECTION

SECTION 334914- HEADWALLS AND WINGWALLS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Headwalls and Wing-walls in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-TxDOT Item 466.

1.02 REFERENCES

- A. TxDOT Items 400, 420, 421, 430, 432, 440, 464, and 466
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 466.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 466.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 466.4.

4.02 PAYMENT

- A. Refer to TxDOT 466.5.

END OF SECTION

SECTION 334915- SAFETY END TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Safety End Treatment in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* –Item 467.

1.02 REFERENCES

- A. TxDOT 400, 420, 421, 432, 440, 442, 445, 460, 464, and 467
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 467.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 467.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 467.4.

4.02 PAYMENT

- A. Refer to TxDOT 467.5.

END OF SECTION

SECTION 334920- STANDARD AND RECESSED CURB INLETS AND OTHER INLETS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Standard and Recessed Curb Inlets and Other Inlets in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 465.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 420,421, 424, 464 and 465
- B. City of Celina's Standard Detail for Standard Storm Drain Embedment and Backfill.
- C. TxDOT standard details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Precast (TxDOT)
- B. Section 033100 - Concrete Structures – Cast-In-Place (City)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 465.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 465.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 465.4.

4.02 PAYMENT

- A. Refer to TxDOT 465.5.

END OF SECTION

SECTION 344113- INSTALLATION OF HIGHWAY TRAFFIC SIGNAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install a Traffic Signal in accordance with TxDOT Item 680.

1.02 REFERENCES

- A. TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 260500 – Electric Conductor
- B. Section 260501 – Electric Service
- C. Section 270500 – Conduit
- D. Section 033101 – Drilled Shaft Foundation
- E. Section 344125 – Vehicle and Pedestrian Signal Heads
- F. Section 344130 – Traffic Signal Cable
- G. Section 344135 – Ground Box
- H. Section 347113 – Barricade, Signs, and Traffic Handling

1.04 SUBMITTALS

- A. Shop Drawings for all traffic signal equipment as required by the City (5 copies).
- B. Shop Drawings for street signs (except illuminated signage) (5 copies).

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266.
- B. The Contractor shall furnish and install the pedestal pole assemblies.
- C. All traffic signal mast arm pole and pedestal pole assemblies shall be powder coated. The powder coat paint shall be RAL9017 (TRAFFIC BLACK) or City approved equal.
 - 1. All assemblies that are to be powder coated shall be hot dipped galvanized to ASTM 123 and 153 specifications. Once galvanizing is completed, all exposed surfaces shall be mechanically etched by blast cleaning to remove mill scale, impurities and non-metallic foreign materials. All surfaces visually exposed are to be coated with a urethane or Triglycidyl (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. The coating shall be electrostatically applied and cured in a gas fired convention oven by heating the steel substrate to between 350 and 400 degrees Fahrenheit.
- D. Roadway Illumination Assemblies (TxDOT Item 610):
 - 1. Luminaire ballasts shall be rated for operation at 240 volts.
 - 2. Luminaire lamps for this project shall be 250 Watt Metal Halide. The luminaire housings shall be powder coated using RAL 9017 (traffic black) paint or City approved equal. The covers for the luminaries shall be a clear flat-glass insert.
 - 3. When luminaires are to be installed on steel mast arm poles, a separate terminal strip in the signal pole access compartment shall be provided. The terminal strip shall be 4 circuit Buchanan Type 104SN or Kulka Type 985-GP-4 CU or equivalent.
 - 4. Sections of TxDOT standards RID (LUM1) and RID (LUM2) that pertain to High-Pressure Sodium (HPS) specifications are not applicable to this project.

5. The conductors from the service pole to the terminal strip shall be No. 8 XHHW wires. The conductors from the terminal strip to the luminaire shall be No. 12 XHHW wires.
- E. City Furnished Material
1. Install NEMA Controller Cabinet Assembly
 2. Install Illuminated Street Name Signs
 3. Install VIVDS Shielded Cable
 4. Install VIVDS Processor System
 5. Install VIVDS Camera Assembly
 6. Install VIVDS Set-up System
 7. Install Opticom Cable
 8. Install Opticom Detector
 9. Install Opticom Discriminator Module
 10. Install Ped Detect and Push Button Signs (2 Inch Push Button)
 11. Install count-down ped displays
 12. Install signal heads and LEDs
 13. Install electrical service pedestal panel
 14. Install traffic signal poles
 15. Install Ethernet cable for communications equipment.
 16. Install Ethernet cable for PTZ camera

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266.
- B. This project shall consist of furnishing and installing all materials and equipment necessary for a complete signal system at the proposed location. In addition to these Items, the contractor shall be responsible for the following:
 1. Furnishing and installing all signs for mounting on signal mast arms, pedestal poles, and existing sign posts. These signs shall be furnished in accordance with TxDOT Item 636 (subsidiary). Signs shall be mounted with City approved sign braces. The standard street name signs shall have 12" upper case and 12" lower case lettering with Highway Series B font (unless otherwise shown on the plans).
 2. During the 30-day test period, the Contractor shall utilize qualified personnel to respond to and diagnose all trouble calls. The Contractor shall repair any malfunctions to signal equipment supplied on the project. A local telephone number (not subject to frequent changes) where trouble calls are to be received on a 24-hour basis shall be provided to the City by the Contractor. The Contractor's response time to reported calls shall be within a reasonable travel time from a Dallas address, but not more than two (2) hours maximum. Appropriate repairs shall be made within 24 hours. The contractor shall keep a record of each trouble call reported in the log book provided by the City. The Contractor shall notify the City of each trouble call. The error log in the malfunction management unit (MMU) shall not be cleared during the 30-day test period without the approval of the City.
 3. The existing "stop" signs shall be removed after the traffic signals are in operation and returned to the City of Celina as noted.
 4. All Opticom Cable, opticom detectors with mounting brackets, and opticom discriminator module will be provided by the City of Celina. The contractor shall be responsible for installing and making the opticom system operational.
 5. The City will furnish the traffic signal controller and cabinet. The contractor shall connect all field wiring to the controller assembly. The City will assist in determining how the detector

6. loop lead-in cables are to be connected (i.e., series or parallel). The City will program the controller for operation, hook up the conflict monitor, detector units, and other equipment in the controller cabinet and turn on the controller. The contractor shall obtain the signal cabinet from the City of Celina signal shop. When using City supplied controllers, the contractor shall have a qualified technician on the project site to place the traffic signals in operation.
7. All VIVDS equipment including cameras, processor system, set-up system, and VIVDS cable will be provided by the City. The contractor shall be responsible for installing and making the VIVDS operational. The City will set-up VIVDS detection zones with Contractor's assistance in aiming cameras.
8. The Contractor shall provide at least 48 hours of notice to the City for pick-up of the City supplied equipment.
9. All nuts installed on the anchor bolts for traffic signal pole assemblies need to be installed using an air impact wrench followed by two impacts from a striker wrench.
10. The Contractor shall install the traffic signal pole and mast arm assemblies furnished by the City.
11. Erection of poles, luminaries and structures located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company and the City prior to beginning such work.
12. The Contractor shall install the pedestrian push button assemblies furnished by the City unless otherwise noted on the plans.
13. No extra compensation will be allowed for fulfilling the requirements stated above.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a Lump Sum (LS) basis.
- B. Contractor shall submit a Schedule of Values prior to beginning any work on this project.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit price for "Installation of Highway Traffic Signal." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete this work.

END OF SECTION

SECTION 344125- VEHICLE AND PEDESTRIAN SIGNAL HEADS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All labor, equipment, tools and superintendence necessary to furnish and install Vehicle and Pedestrian Signal Heads.

1.02 REFERENCES

- A. TxDOT Item 682
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signals

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 682.
- B. City furnished vehicle and pedestrian signal heads, LEDs and back plates. Contractor shall supply the mounting hardware.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 682.
- B. The Contractor shall install all vehicle and pedestrian signal heads, LEDs, and back plates furnished by the City of Celina.
- C. No exposed cable or wiring will be permitted.
- D. Signal heads mounted on poles and mast arms shall be level and plumb and aimed as directed by the City.
- E. The signal head to mast arm connection must allow for adjustment about the horizontal and vertical axis
- F. All mast arm mounted signal heads shall be turned down and all other signal heads shall be covered with burlap or other material approved by the City until placed into operation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 682.

4.02 PAYMENT

- A. All work performed in accordance with this Item will be paid for at the unit bid price for "Vehicle And Pedestrian Signal Heads," at the size and type specified. This price is full compensation for all labor, equipment, tools, and superintendence necessary to complete the work.

END OF SECTION

SECTION 344130- TRAFFIC SIGNAL CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install a Traffic Signal Cable.

1.02 REFERENCES

- A. TxDOT Item 684
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 684.
- B. Individual conductors shall be No. 14 AWG.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 684.
- B. The conductors in the Traffic Signal Cable shall be stranded.
- C. Each cable shall be identified as shown on the plans (CABLE 1, etc.) With permanent marking labels (PANDUIT TYPE PLM STANDARD SINGLE MARKER TIE, THOMAS & BETTS TYPE 5512M or equivalent) at each ground box and controller

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 684.

4.02 PAYMENT

- A. Refer to TxDOT Item 684.

END OF SECTION

SECTION 344135- GROUND BOX

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Ground Boxes for Traffic Signals and/or Street Lighting.

1.02 REFERENCES

- A. TxDOT Items 421, 440 and 624
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 624.
- B. All ground boxes used for lighting shall have "LIGHTING" and "DANGER-HIGH VOLTAGE" imprinted on the cover.
- C. All ground boxes used for signals shall have "SIGNALS" and "DANGER-HIGH VOLTAGE" imprinted on the cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 624.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis for each Ground Box, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Ground Box," of the size and type specified. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work, including installing the ground box and concrete apron.

END OF SECTION

SECTION 344140- TEMPORARY TRAFFIC SIGNAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, operate, maintain, reconfigure, and remove a Temporary Traffic Signal.

1.02 REFERENCES

- A. TxDOT Items 625, 627, and 681
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 625, 627, and 681.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 625, 627, and 681.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 681.

4.02 PAYMENT

- A. Refer to TxDOT Item 681.

END OF SECTION

SECTION 344150- SMALL ROADSIDE SIGN SUPPORTS AND ASSEMBLIES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Small Roadside Sign Supports and Assemblies.

1.02 REFERENCES

- A. TxDOT Items 421, 440, 441, 442, 445, 634, 636, 643, 644, and 656
- B. City of Celina and TxDOT’s Standard Details included in the plans.
- C. Signing Plans

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 644.
- B. The Contractor shall provide field galvanizing and metalizing equipment, per TxDOT Item 445, at all times and shall make repairs to galvanized surfaces according to these specifications at intervals as directed by the City.
- C. Any signs required that on not detailed on the plan sheets shall be in conformance with the most recent Texas MUTCD and the “Standard Highway Sign Designs for Texas.”
- D. All small sign assemblies shall be installed as shown in the City of Celina Standard Detail: “Sign Posts, Stop Signs, and Street Name Signs”
- E. Individual units requiring cleaning shall be washed with an approved cleaning solution to remove all grease, oil, dirt, smears, streaks, debris, and other foreign particles.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 644

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 644 and as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT Item 644 and as indicated in the Contract Documents.

END OF SECTION

SECTION 347113- BARRICADES, SIGNS, AND TRAFFIC HANDLING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Barricades, Signs, and Traffic Handling in accordance with the Contract Documents.

1.02 REFERENCES

- A. TxDOT Item 502
- B. TxDOT's Standard Details included in the plans.
- C. City of Celina's General Notes

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All traffic control devices requiring reflective sheeting shall have Type C -high specific intensity sheeting for signs with white backgrounds and Type E -fluorescent prismatic sheeting for signs with orange backgrounds.

PART 3 - EXECUTION

3.01 IMPLEMENTATION

- A. Refer to TxDOT Item 502.
- B. The Traffic Control Plan (TCP) shall be in accordance with the standard plan sheets WZ (BTS-1)-13 & WZ (BTS-2)-13 for signals, and as provided for in the latest edition of *Texas Manual on Uniform Traffic Control Devices for Streets and Highways* (TMUTCD).
- C. Barricades and warning signs, as appropriate, shall be placed at stockpiles to adequately warn motorists. At all stockpile sites that are less than 30 feet from the edge of any traveled lane, a Type III barricade shall be erected immediately in front of or at each end if required by the City. When a stockpile site equals or exceeds 100 feet in length, one object marker (OM- 2HP) per 100 feet shall be placed alongside the stockpile.
- D. All traffic control signs shall be clean and legible, and maintained clean and legible throughout the construction phases.
- E. The Contractor shall plan his or her work sequence in a manner that will cause the minimum interference with traffic during construction operations. Before beginning work, the Contractor shall submit, for approval by the City, a plan of construction operations outlining in detail a sequence of work to be followed, setting out the method of handling traffic along, across, and adjacent to work.
- F. If, at any time during construction, the Contractor's proposed plan of operation for handling traffic does not provide for safe, comfortable movement, the Contractor shall immediately change its operations to correct the unsatisfactory condition.
- G. Subject to the approval of the City and in accordance with the plans, portions of this project, which are not affected by or in conflict with the proposed method of handling traffic or utility adjustments, can be constructed during any phase.
- H. During construction, the Contractor shall furnish, place, and maintain vertical panels or drums as indicated in the plans along the edge of pavements and fills in accordance with the latest edition of TMUTCD. The vertical panels shall be supplemented with lights as directed by City.
- I. Barricades and signs shall be placed in such a manner as to not interfere with the sight distance of drivers entering the highway from driveways or side streets. To facilitate shifting, barricades and signs used in lane closures or traffic staging may be erected and mounted on portable supports. The designs of these supports shall be in compliance with current TxDOT and Texas MUTCD standards and are subject to the approval of the City.

- J. The Contractor shall provide and maintain flaggers at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and contractor's
- K. personnel, and as shown on the plans or as directed by the city. These flaggers shall be located at each end of the lane closure and shall be properly attired. The two flaggers shall be in two-way radio contact with each other at all times.
- L. The Contractor will not be permitted to commence work on the road before sunrise and shall arrange his work so that no machinery or equipment shall be closer than 30 feet to the traveled roadway after sunset except as authorized by the City. The Contractor must comply with the City's Noise Ordinance at all times.
- M. The Contractor shall keep traveled surfaces used in his hauling operation clear and free of dirt or other material.
- N. The use of rubber-tired equipment, licensed for operation on public highways, will be required for moving dirt and other materials along or across paved surfaces.
- O. Where the Contractor desires to move any equipment not licensed for operation on public highways on or across any pavement, the Contractor shall protect the pavement from all damage as directed by the City.
- P. No lane closures will be allowed prior to 9:00 a.m. or after 3:30 p.m., Monday through Friday unless otherwise directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis or on a Monthly (MO) basis as indicated in the Contract Documents.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Barricades, Signs, and Traffic Handling." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete all work including, but not limited to, signage, barricades, flagmen, temporary pavement markers and markings, detours, and temporary pavement.

END OF SECTION

AM

APPROVED MATERIAL LIST



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DESIGN REFERENCE	AWWA OR ASTM	PRODUCT	DESCRIPTION	TYPE / STYLE / MODEL	SIZE	MANUFACTURER
WATER						
2.1.6.A	C900	PIPE MAIN	PVC WATER	DR14 BLUE	4" - 8"	DOMESTIC
2.1.6.A	C900	PIPE MAIN	PVC WATER	DR18 BLUE	10"-12"	DOMESTIC
2.1.6.A	C900-16	PIPE MAIN	PVC WATER	DR18 BLUE	16" AND LARGER	DOMESTIC
		TRACER WIRE	OPEN CUT	1430B - SF		COPPERHEAD
		TRACER WIRE	DIRECTIONAL DRILLING	1245B - EHS		COPPERHEAD
		TRACER WIRE	PIPE BURST	PBX-50B		COPPERHEAD
		TRACER WIRE TEST STATION	SNAKEPIT	RB14BTP		COPPERHEAD
2.1.6.B	ANSI/AWWA C151 / A21.50	PIPE MAIN	DUCTILE	CL51 / ENGINEER APPROVAL	4"-64"	DOMESTIC
	PE4710	PIPE SERVICE	HDPE	SDR9 POLY	1" - 2"	DOMESTIC
	A-36 A-568 A-135 / AWWA C-210	PIPE CASING	STEEL ENCASEMENT	0.25 WALL W/RED OXIDE PRIMER	4" -24"	
	A-36 A-568 A-135 / AWWA C-210	PIPE CASING	STEEL ENCASEMENT	0.375 WALL W/ RED OXIDE PRIMER	27" - 42"	
	AWWA C105	POLY WRAP	POLYETHYLENE ENCASEMENT	8MILS		
		ADHESIVE TAPE		SCOTCHRAP NO.50	2" WIDE	POLYKEN
	ISO 9001:2000	CASING SPACER	HDPE	CASING SPACER	VARIOUS	RACI OR APPROVED EQUAL
2.1.6.C	ANSI/AWWA C153/A21.53 / NSF 61	FITTING WATER	MECHANICAL JOINT	C153 COMPACT	2" - 48"	DOMESTIC - TYLER UNION OR APPROVED EQUAL

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DESIGN REFERENCE	AWWA OR ASTM	PRODUCT	DESCRIPTION	TYPE / STYLE / MODEL	SIZE	MANUFACTURER
WATER						
2.1.6.	ANSI/AWWA C153/A21.53	FITTING RESTRAINT	EBAA MEGALUG	PV1100 FOR DUCTILE IRON	2" - 48"	EBAA IRON
2.1.6.	ANSI/AWWA C153 UL/FM ISO 9001-2008	FITTING RESTRAINT	TYLER TUFF GRIP	SERIES 100 FOR DUCTILE IRON	2" - 48"	DOMESTIC - TYLER UNION
2.1.6.	ANSI/AWWA C153 UL/FM ISO 9001-2008	FITTING RESTRAINT	TYLER TUFF GRIP	SERIES 2000 FOR PVC	2" - 48"	DOMESTIC - TYLER UNION
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	SADDLE	202B X CC THREAD	1" - 2" TAP	FORD
		METER SERVICE	SADDLE	BR2B X CC THREAD	1" - 2" TAP	MUELLER
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	CORPORATION STOP	F10003GNL / F10004GNL / F10006GNL / F10007GNL	1" - 2"	FORD
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	CORPORATION STOP	G15008	1" - 2"	MUELLER
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	SETTER	VB74-10W-41- GNL W/ 1X12" BRASS NIPPLE W/THREAD PROTECTION	1"	FORD
	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	SETTER	VB77-12-41-77- GNL W/2X12" BRASS NIPPLE W/THREAD PROTECTION	2"	FORD
	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	SINGLE CHECK METER NIPPLE (NO LEAD)	C38-44H1-2- 625- NL	1"	FORD

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WATER						
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	COUPLING	C44-44G NL / C44- 66G NL / C44-77G NL	1" - 2"	FORD
2.1.7.	C800 ANSI/NSF 61 NO LEAD	METER SERVICE	INSERT / SS STIFFNER	52 / 54 / 55	1" - 2"	FORD
		METER BOX	PLASTIC METER BOX WITH LID	DFW37A-12-1DSFDEEP CELINA	1" METER	DFW PLASTICS
		METER BOX	PLASTIC METER BOX	DFW65C-14-1DSFDEEP CELINA	2" METER	DFW PLASTICS
		METER VAULT	LARGE METER	ENGINEER APPROVAL	3" AND LARGER	PARK, TURNER, OLDCASTLE, OR APPROVED EQUAL
2.1.8.	C-515	VALVE MAIN	GATE VALVE	RESILIENT WEDGE	2" - 18"	MUELLER OR APPROVED EQUAL
2.1.8.	C-515	VALVE MAIN	GATE VALVE	RESILIENT WEDGE WITH BEVEL GEAR	20" AND LARGER	MUELLER OR APPROVED
2.1.8.	C-504	VALVE MAIN	BUTTERFLY VALVE	150B FLANGED OR MECHANICAL JOINT	20" AND LARGER	PRATT, MUELLER, OR APPROVED EQUAL
2.1.8. B	MANUAL M51	VALVE AIR	AIR RELEASE VALVE	RBX	2" AND LARGER	VENT O MAT, VENT TECH
2.1.8.B	MANUAL M51	VALVE AIR	AIR RELEASE VALVE	SERIES WAR 02	2" AND LARGER	PRATT
		VALVE AIR	AIR RELEASE VALVE BOX	DFW65C-14-1DSFDEEP CELINA	2" AND LARGER	DFW PLASTICS
	A-48 AASHTO	VALVE BOX	THREE PIECE VALVE BOX	6850 WITH LID	2" AND LARGER	DOMESTIC- TYLER UNION OR APPROVED EQUAL
2.1.9.		FIRE HYDRANT	HYDRANT	MA423 SUPER CENTURION	6" LEAD	MUELLER

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DESIGN REFERENCE	AWWA OR ASTM	PRODUCT	DESCRIPTION	TYPE / STYLE / MODEL	SIZE	MANUFACTURER
WATER						
		FIRE HYDRANT	HYDRANT	K-81-D GUARDIAN	6" LEAD	KENNEDY
		FIRE HYDRANT	HYDRANT	MEDALLION- F2545	6" LEAD	CLOW
		FIRE HYDRANT	HYDRANT	WATERMASTER 5CD250	6" LEAD	EAST JORDON
2.1.9		FIRE HYDRANT	STORZ ADAPTER	HYST-5.0-4.5NH-NS	5" STORZX 4.5NST	HYDRA-SHIELD
	C-207, C-900	FIRE RISER	IN-BUILDING RISER	SERIES IBR WITH FLANGED END CONNECTION ON THE OUTLET		AMES FIRE AND WATERWORKS
2.1.10	C-207	TAP MAIN	TAPPING SLEEVE	665 316 ALL STAINLESS		SMITH BLAIR OR EQUAL
2.1.11.		VALVE FLUSHING	AUTO FLUSHING VALVE	9800	DEAD END MAIN	ECLIPSE
SANITARY SEWER						
2.2.6.A	D3034	PIPE MAIN	PVC SEWER	SDR35	4" - 15"	
2.2.6.A	F679	PIPE MAIN	PVC SEWER	SDR26 HEAVY WALL	4" - 15"	
2.2.6.A	F679	PIPE MAIN	PVC SEWER	PS46 / PS115	18" AND LARGER	
2.2.6.A	D2241	PIPE FORCE MAIN	PVC SEWER	SDR26 CLASS 160	4" - 12"	
2.2.6.A	C900-16	PIPE FORCE MAIN	PVC SEWER	DR25 CLASS 165 GREEN	14" AND LARGER	
		TRACER WIRE	OPEN CUT	1430G - SF		COPPERHEAD
		TRACER WIRE	DIRECTIONAL DRILLING	1245G - EHS		COPPERHEAD
		TRACER WIRE	PIPE BURST	PBX-50G		COPPERHEAD
		TRACER WIRE TEST STATION	SNAKEPIT	RB14GTP		COPPERHEAD



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DESIGN REFERENCE	AWWA OR ASTM	PRODUCT	DESCRIPTION	TYPE / STYLE / MODEL	SIZE	MANUFACTURER
SANITARY SEWER						
	ISO 9001:2000	CASING SPACER	HDPE	CASING SPACER	VARIOUS	RACI OR APPROVED EQUAL
	A-36 A-568 A-135 / AWWA C-210	PIPE CASING	STEEL ENCASEMENT	0.25 WALL W/RED OXIDE PRIMER	4" -24"	
	A-36 A-568 A-135 / AWWA C-210	PIPE CASING	STEEL ENCASEMENT	0.375 WALL W/ RED OXIDE PRIMER	27" - 42"	
	ASTM D3212	GRAVITY FLOW PIPE ADAPTOR	SEWER TAP (REHAB)	INSERTA TEE		INSERTA FITTING CO.
	D3034 / F679 / F170 / ISO 9000	FITTING SEWER	GASKETED	SDR35 / SDR26 TO MATCH MAIN	4" - 18"	
		VALVE AIR	AIR RELEASE VALVE	WWAR 01	2" AND LARGER	PRATT
2.2.8. D	C-478	MANHOLE SAN SEWER	MANHOLE	CONSHIELD PRECAST	48" AND LARGER	HANSON (FORTERRA) AND TURNER
		PATCHING MATERIAL	MANHOLE	CONSHIELD JOINT SET		CONSHIELD
		MANHOLE SAN SEWER	MANHOLE(rubber sleeve)	GATOR WRAP	6" WIDE	INFI-SHIELD
		MANHOLE SAN SEWER	MANHOLE	I & I BARRIER		STRIKE PRODUCTS
		MANHOLE SAN SEWER	HDPE	MANHOLE INSERT	30" OD	S.S.I SEALING SYSTEMS INC.
		MANHOLE SAN SEWER	GRADE RING	INFRA-RISER IC3340F	33" I.D x 40" O.D.	EAST JORDON
		MANHOLE SAN SEWER	MANHOLE RING COVER	1480 30" NEW CONSTRUCTION	30" CLEAR OPENING	BASS HAYES, EAST JORDAN IRON WORKS
		MANHOLE SAN SEWER	WATERTIGHT MANHOLE RING COVER	1432 30" NEW CONSTRUCTION WATERTIGHT	30" CLEAR OPENING	BASS HAYES, EAST JORDAN IRON WORKS
STREET SIGNS AND LIGHT						
		SIGN POLE	FLUTED	SP4X 12	4" OD	BRANDON INDUSTRIES OR APPROVED EQUAL
		POLE BASE	SLIP-OVER	SB94	4" OD	BRANDON INDUSTRIES OR APPROVED EQUAL
		POLE FINIAL		FIN- CS4	4" OD	BRANDON INDUSTRIES OR APPROVED EQUAL



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Grass in Detention Ponds, Swales, Bio-retention Areas

GRASS/TURF			
COMMON NAME	SCIENTIFIC NAME	ACCEPTABLE FORM	REMARKS
PRAIRIE CORDGRASS	<i>SPARTINA PECTINATA</i>	CONTAINER/ SEED	BOTTOM
BUSHY BLUESTEM	<i>ANDROPOGON GLOMERATUS</i>	CONTAINER/ SEED	BOTTOM
CROWFOOT CARIC SEDGE	<i>CAREX CRUS-CORVI</i>	CONTAINER/ SEED	BOTTOM
EASTERN GRAMAGRASS	<i>TRIPSACUM DACTYLOIDES</i>	CONTAINER/ SEED	BOTTOM
LOWLAND SWITCHGRASS	<i>PANICUM VIRGATUM L</i>	CONTAINER/ SEED	BOTTOM
ALAMO SWITCHGRASS	<i>PANICUM VIRGATUM 'ALAMO'</i>	CONTAINER/ SEED	BOTTOM
LOMETA INDIANGRASS	<i>SORGHASTRUM NUTANS 'LOMETA'</i>	CONTAINER/ SEED	SLOPE
EARL BIG BLUESTEM	<i>ANDROPOGON GERARDII 'EARL'</i>	CONTAINER/ SEED	SLOPE
LITTLE BLUESTEM	<i>SCHIZACHYRIUM SCOPARIUM</i>	CONTAINER/ SEED	SLOPE
CANADA WILDRYE	<i>ELYMUS CANADENSIS</i>	CONTAINER/ SEED	SLOPE
SPRING OBEDIENT PLANT	<i>PHYSOSTEGIA INTERMEDIA</i>	CONTAINER/ SEED	SLOPE
MAXIMILIAN SUNFLOWER	<i>HELIANTHUS MAXIMILIANA</i>	CONTAINER/ SEED	SLOPE
HALBERD-LEAF HIBISCUS	<i>HIBISCUS LAEVIS</i>	CONTAINER/ SEED	SLOPE
HASKELL SIDEOATS GRAMA	<i>BOUTELOUA CURTIPENDULA</i>	CONTAINER/ SEED	SLOPE
BUFFALOGRASS	<i>BOUTELOUA DACTYLOIDES</i>	SOD	NATIVE
BERMUDAGRASS	<i>CYNODON DACTYLON</i>	SOD OR HYDRO-MULCH	ADAPTED

Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
TREES (LARGE SHADE)				
OAK, CHINQUAPIN	<i>QUERCUS MUEHLENBERGII</i>	SEE PLANS	80' H 80' W	NATIVE
TREES (MEDIUM SHADE)				
BALD CYPRESS	<i>TAXODIUM DISTICHUM</i>	SEE PLANS	80' H 50' W	NATIVE
ELM, CEDAR	<i>ULMUS CRASSIFOLIA</i>	SEE PLANS	90' H 80' W	NATIVE
PISTACHIO, CHINESE	<i>PISTACIA CHINENSIS</i>	SEE PLANS	70' H 50' W	ADAPTED
TREES (LIVING SCREEN)				
HOLLY, FOSTER	<i>ILEX X ATTENUATA 'FOSTERI'</i>	SEE PLANS	20' H 10' W	ADAPTED
HOLLY, NELLIE R.STEVENS	<i>ILEX X 'NELLIE STEVENS'</i>	SEE PLANS	25' H 15' W	ADAPTED
SHRUBS				
DWARF CRAPE MYRTLE	<i>LAGERSTROEMIA INDICA</i>	SEE PLANS	3' H 3' W	DWARF



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DWARF NANDINA	<i>NANDINA DOMESTICA</i>	SEE PLANS	3' H 3' W	DWARF
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SHRUBS				
DWARF YAUPON HOLLY	<i>ILEX VOMITORIA 'NANA'</i>	SEE PLANS	3' H 3' W	DWARF
HAWTHORN, INDIAN	<i>RHAPHIOLEPSIS INDICA</i>	SEE PLANS	3' H 4' W	ADAPTED
RED YUCCA	<i>HESPERALOE PARVIFLORA</i>	SEE PLANS	3' H 3' W	NATIVE
TEXAS SAGE, SILVERADO	<i>LEUCOPHYLLUM FRUTESCENS 'SILVERADO'</i>	SEE PLANS	3' H 3' W	NATIVE

Irrigation

BASIC PRODUCT CATEGORY	SUBCATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	SPECIFICATION	NOTES	NSF 61 CERTIFIED
ROTORS		HUNTER, RAINBIRD, TORO	HIGH EFFICIENCY			
SPRAY NOZZELS (TURF AREAS)		HUNTER, RAINBIRD, TORO	HIGH EFFICIENCY			
SHRUB NOZZLE ADAPTER (PLANT BED AREAS)		RAINBIRD				
SHRUB NOZZLES (PLANT BED AREAS)		RIGGS	SN8-24			
BRASS GATE VALVE, DOMESTIC MANUFACTURER		NIBCO	T-113			
DRIP IRRIGATION		NETAFIM	UNITECHLINE OR TECHLINE			
SOLENOID VALVE		RAIN BIRD	PEB-PRS-B SERIES			
QUICK COUPLING VALVES		RAIN BIRD	MODEL 44RC			
PVC BALL VALVES		SPEARS OR APPROVED EQUAL	COMPACT UNIT			
BACKFLOW PREVENTER		FEBCO	DOUBLE CHECK VALVE			
DOUBLE CHECK BOX			PLASTIC "JUMBO" DCA			

APENDIX A

DEFINITION AND ABBREVIATION

Definitions

The definitions within this Section are intended to provide descriptions for words and terms used within the Engineering Standards. When words and terms are defined herein, and are also defined in other ordinance(s) of the City, they shall be read in harmony unless there is an irreconcilable conflict, in which case the definition contained in this Section shall control for the Engineering Standards. Where no definition appears, then the term should be interpreted according to their customary usage in the practice of municipal planning and engineering. The City has the final determination of interpretation.

Words used in the present tense include the future; words in the singular number include the plural number, and words used in the plural number include the singular number. The word shall is mandatory and not directory. The word may is directory and not mandatory.

Approved, Accepted, Directed, Required, and Words of Like Import: Whenever they apply to the work or its performance, the words "directed," "accepted," "required," "permitted," "ordered," "designated," "established," "prescribed" and words of like shall imply the direction, requirement, permission, order, designation or prescription of the City; and "approved," "acceptable," "satisfactory" and words of like import shall mean approved by, acceptable to or satisfactory to the City.

Backfill: The term means the following (1) the placement of new dirt, fill, or other material to refill an Excavation; or (2) the return of excavated dirt, fill or other material to an Excavation.

City: The term City means the City of Celina or its authorized representative(s).

Compaction: The term refers to consolidating material to prevent future settlement

Contract or Contract Documents: Contract documents are all of the written, printed, typed, drawn instruments, plans, and specifications that comprise and govern the performance of the contract between the Owner and the Contractor.

Contractor: The person, persons, partnership, firm, corporation, association or organization, or any combination thereof, as an independent contractor entering into the contract for the execution of the work, acting directly or through a duly authorized representative. Contractor does not refer to the City.

Development: Refers to the project being designed or constructed. (See also Subdivision Ordinance)

City Engineer: The City Engineer or their authorized representative.

Easement: A property right giving an entity other than the owner permission to use a property for a specific purpose stated in the easement document. (See also Subdivision Ordinance)

Emergency Operations: Those operations and repairs necessary to prevent damage or injury and to protect the health or safety of the public or any person and the work necessary to address or prevent an immediate service interruption. Upgrading of facilities, new service installation and neighborhood improvement projects are not emergency operations.

Engineer, Owner's Engineer, Design Engineer: The Engineer or its duly authorized representative means the Engineer of the Owner, who is the Engineer of Record of the Contract Documents.

Equal: Materials, articles or methods that are of equal or higher quality than those specified or shown on the drawings, as determined by the City's sole discretion.

Excavation: Excavation means any activity that removes or otherwise disturbs soil, pavement, driveways, curbs, or sidewalks in the right-of-way or an easement.

100-Year Floodplain: The flood having a one percent (1%) chance of being equaled or exceeded in any given year, based upon a fully developed watershed and the City's criteria to accommodate a 100-year storm in a [Major Creek \(pdf\) \(http://www.celina-tx.gov/DocumentCenter/View/1416\)](http://www.celina-tx.gov/DocumentCenter/View/1416).

Owner: For the purposes of this manual, the term Owner refers to the entity that is financially responsible for developing and maintaining a particular site or project, either the City for public projects or the developer for private projects.

Plan or Plans: The plans are the drawings or reproductions made by or approved by the Owner showing in detail the location, dimension and position of the various elements of the project, including such profiles, typical cross-sections, layout diagrams, working drawings, preliminary drawings and such supplemental drawings as the Owner's Engineer may issue to clarify other drawings or for the purpose of showing changes in the work hereinafter authorized by the Owner.

Private Facilities or Improvements: Any improvements on private property where a public entity (i.e. the City) is not considered the Owner.

Public Facilities or Improvements: Public facilities and/or improvements include streets (including streetlights, street signs, signals and pavement markings), storm drainage systems, water lines, sanitary sewer lines, pedestrian improvements, or other similar improvements constructed within public right-of-way or easements. Typically, the City maintains public improvements after expiration of any applicable maintenance bonds.

Private Fire Service Main: Pipe and its appurtenances on private property beyond the meter supplying water for fire protection facilities such as automatic sprinkler systems

Private Water Line: Pipe and its appurtenances beyond the meter supplying potable water on private property.

Right of Way or Public Right of Way (ROW): A use of land dedicated by plat or metes and bounds to and for use by the public, which is separate and distinct from the lots and parcel abutting it, and which is not included within the dimensions or areas of such lots or parcels. Generally describes an area used for the provision of streets and utilities. Unless otherwise specified, the term right-of-way shall refer to a public right-of-way.

Specifications or Technical Specifications: Document giving a detailed description of the quantitative and qualitative requirements for products, materials, and workmanship

Utility Easement: A water, wastewater, or reuse water easement granted to the City.

Abbreviations and Acronyms

Wherever the abbreviations defined herein occur in the Engineering Standards, the intent and meaning shall be as follows:

%	Percent
‘	Foot or Feet
“	Inch or Inches
#, lbs.	Pound or pounds
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
am, a.m.	Before noon
ANSI	American National Standards Institute
Asph.	Asphalt
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
APWA	American Public Works Association
AWS	American Welding Society
AWWA	American Water Works Association
B/L	Base Line
cc	Cubic Centimeter
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CI	Cast Iron
C/L	Center Line
cm	Centimeter
CO	Cleanout
Conc	Concrete
Cond	Conduit
Corr	Corrugated
Cu	Cubic
cy, CY,C.Y.	Cubic Yard
CE	City Engineer
DI	Ductile Iron
Dia	Diameter
Elev	Elevation
F	Fahrenheit
fps	Feet per second
ft	Foot or Feet
Gal	Gallon
g, gm	Gram
HDPE	High Density Polyethylene
HP	Horsepower
hr	Hour
ID	Inside Diameter
in	Inch or Inches
Kg or kg	Kilogram
kPa	Kilopascals
L	Liter
LDPE	Low Density Polyethylene
LF	Linear foot or feet

LL	Liquid Limit
LLDPE	Linear Low Density Polyethylene
LMDPE	Linear Medium Density Polyethylene
m	Meter
Max	Maximum
MH	Manhole
Min	Minimum or Minute
MJ	Mechanical Joint
mm	Millimeter
Mono	Monolithic
mph	Miles per hour
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
MPa	Mega- pascal
NACE	National Association of Corrosion Engineers
Nat'l	National
NCTCOG	North Central Texas Council of Governments
NEMA	National Electrical Manufacturers Association
No.	Number
NPT	National Pipe Thread
NRMCA	National Ready-mixed Concrete
NTTA	North Texas Tollway Authority
o.d., OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
oz	Ounce
PCC	Portland Cement Concrete
PI, P.I.	Plasticity Index
pm, p.m.	Afternoon
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
R	Radius
RAP	Recycled/Reclaimed Asphalt Pavement
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
Reinf.	Reinforced or reinforcing
ROW	Right-of-Way
SS	Sanitary Sewer
Sec	Second
S.F. or sf	Square Foot
Sq.	Square
SSPC	The Society for Protective Coatings [formerly Steel Structures Painting Council]
Std	Standard
Str	Strength
SWPPP, SW3P	Storm Water Pollution Prevention Plan
SY	Square Yard
TAC	Texas Administrative Code
Tex-###-X	Refer to TxDOT Manual of Testing Procedures
TCEQ	Texas Commission on Environmental Quality [formerly Texas Natural Resource Conservation Commission (TNRCC)]
TMUTCD	Texas Manual on Uniform Traffic Control Devices
TxDOT	Texas Department of Transportation

TxDOT Item #	Refer to current TxDOT Standard <i>Specifications for Construction of Highways, Streets and Bridges</i>
UL	Underwriter's Laboratory
um,µm	Micrometers
US, U.S.	United States
USACE	United States Army Corps of Engineering
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
Vert	Vertical
Vol	Volume
Wt	Weight
WW	Wastewater
Yd	Yard