CITY OF CORPUS CHRISTI

Engineering Services Department

INFRASTRUCTURE DESIGN MANUAL

Corpus Christi Engineering

MARCH 2022

CITY OF CORPUS CHRISTI

ENGINEERING SERVICES

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January 25, 2022

The January 2022 edition of the City of Corpus Christi Infrastructure Design Manual (IDM) will be effective for public improvement plans submitted after March 01, 2022.

Maintaining current and adequate standards for public infrastructure helps prevent unnecessarily having to expend scarce public resources to correct prematurely failing infrastructure. This IDM captures in a single volume the basic design criteria for all public infrastructure that will become the maintenance responsibility of the City. By capturing all design requirements in a comprehensive volume we enable infrastructure designers to more efficiently use their time.

Respectfully,

Jeff H. Edmonds, P.E.
Director of Engineering Services

City of Corpus Christi

Infrastructure Design Manual

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City of Corpus Christi

Infrastructure Design Manual

Chapter 1

GENERAL REQUIREMENTS

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GENERAL REQUIREMENTS

1.1 CHAPTER INCLUDES

A. Research and submittal requirements for projects inside the city limits of Corpus Christi or within City's extraterritorial jurisdiction (ETJ).

1.2 REFERENCES

The following references (latest edition or revision) are hereby incorporated into this design manual by reference and shall be adhered to as applicable:

a. Texas Accessibility Standards (TAS) of the Architectural Barriers Act, Article 9102, Texas Civil Statutes

b. City of Corpus Christi Unified Development Code (UDC)

c. City of Corpus Storm Water Master Plan (Draft)

d. City of Corpus Water Master Plan

e. City of Corpus Wastewater Mater Plan

f. City of Corpus Christi Standard Construction Specifications

g. City of Corpus Christi Storm Water Standard Details

h. City of Corpus Christi Water Standard Details

i. City of Corpus Christi Wastewater Standard Details

j. Rules and Regulations published by Texas Commission on Environmental Quality (TCEQ)

   i. TCEQ, Water Supply Division, Rules and Regulation for Public Water Systems

   ii. TCEQ, Design Criteria for Sewer Systems, Texas Administrative Code

   iii. Texas Administrative Code Chapter 217 Design Criteria for Wastewater Systems

k. State of Texas Engineering Practice Act

l. State of Texas Professional Land Surveying Practices Act

m. Mobility Corpus Christi Plan

n. American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures

o. Texas Manual on Uniform Traffic Control Devices (TMUTCD)

1.3 CITY STANDARD DOCUMENTS AND DETAILS

a. Location - City Standard Documents and Design Details are available from the Engineering Services Homepage on the City's website @

https://www.cctexas.com/services/construction-and-property-services/architects-and-engineering-firms

to include:

a. Standard Construction Contracts (Front Ends)

b. Standard Construction Specifications

c. Standard Construction Details

d. Unified Development Code

b. Responsibilities - Designers are required to utilize the latest version of any City standard document on all projects.

1.4 STANDARD OF CARE

Professional Engineers (P.E.)

a. P.E.s are governed by the Texas Engineering Practices Act

i. Ch. 1001 of the Texas Occupations Code

b. P.E.s are required for design of public projects in excess of stated dollar amounts per project type in order to protect the public health, safety, and welfare

c. P.E.s are expected to provide the standard of care and due diligence that is required by law and is common to the practice of engineering

1.5 ABBREVIATIONS IN THIS MANUAL:

ADA = Americans with Disabilities Act

AWWA = American Water Works Association

BMP = Best Management Practice

CCN = Certificate of Convenience and Necessity; per Texas Water Code

CDBG = Community Development Block Grant

CIP = Capital Improvement Program or Cast-Iron Pipe, whichever is applicable

DI = Ductile Iron

EPIC = Environmental Permits, Issues, & Commitment's sheet

ETJ = Extraterritorial Jurisdiction

FL = flow line

FLDC = Fire Line Detector Check

GPM = gallons per minute

GPS = Global Positioning System

HMACP = Hot Mixed Asphaltic Concrete Pavement

MH = manhole

NFPA = National Fire Protection Association

NIP = Neighborhood Improvement Program

NOI = Notice of Intent

NOT = Notice of Termination

NTS = Not to Scale

OCL = property that is located outside of the City Limits

OH = overhead

OS&Y = Outside Stem and Yoke

PCCP = Portland Cement Concrete Pavement

P.E. = Professional Engineer

PS = Pump Station

PSI = p.s.i. or pounds per square inch

PVC = Polyvinyl Chloride

RAS = Registered Accessibility Specialist

ROW = Right of Way

SW = storm water

SWL = Storm Water Line

SW3P = Storm Water Pollution Prevention Plan

TAS = Texas Accessibility Standards

TCEQ = Texas Commission on Environmental Quality

TDLR = Texas Department of Licensing and Regulation

TS&V = Tapping Sleeve and Valve

TxDOT =Texas Department of Transportation

UDC = Unified Development Code

UE = Utility Easement

UG = underground

UTP = Unified Transportation Plan

W = water

WL = water line (pipe)

WW = wastewater

WWL = wastewater line (pipe)

1.6 DEFINITIONS

The vocabulary words used in this document have the usual and customary definitions as used in the industry and in the dictionary unless otherwise noted in this section or by City Ordinance No. 4168, Municipal Planning and Engineering Practices, and hereby shall supersede the normal and customary use of the word.

Approved Drawings - Drawings prepared by a Licensed P.E. that have been stamped 'Released for Construction' and signed by an authorized employee of the City

Auto Flusher - A device that is attached to the water main which can be programmed to release water automatically at certain intervals for the purpose of flushing the water main

Backflow Protection - The prevention of a contaminant from entering into the City water distribution system either by mechanical means or by a physical air gap per TCEQ 290

Backflow Testing Certification - A certificate or report by a State-licensed and City-registered Backflow Assembly Tester that certifies the test and maintenance of a backflow device

Bypass Assembly - An assembly which consists of tees, valves, and piping that is connected to either side of a device for the purpose of reducing pressure to the device by isolating the device and allowing water to bypass around the device

City - The City of Corpus Christi, Texas, a municipal corporation, and those acting in official capacity on behalf of the City

City Contracts - Contracts that are made between the City and any other entity or individual, with final responsibility for enforcement of contracts resting with the City Manager

City Attorney - The City Attorney for the City of Corpus Christi, Texas and/or his duly authorized assistants and agents

City Council - The Council of the City of Corpus Christi, Texas

City Engineer - The authorized representative of the City, or his designee having approval authority of design standards and construction contracts for the City.

City Manager - The Manager of the City of Corpus Christi

Commercial Projects - Building permit projects that include public improvements such as fire hydrants, fire lines, and FLDC vaults and/or any public water improvements

Construction Meter - A temporary water meter that is attached to and locked by the City onto a fire hydrant for the purposes of dispensing construction water to permitted persons or entities

Contractor - A Utility Contractor who installs water distribution system improvements for either the City or for a developer

Dead-End Main - Any water main that is 100 feet or longer in length and terminate at a point other than at a connection to another line or main within the distribution system

Design Analysis - Narratives and calculations necessary to support design of a project.

Designer - The Engineer or person responsible for designing the proposed project

Developer - The person or entity or their representative proposing to improve their property by adding to or modifying City infrastructure

Development Services Engineer - The Engineer in the Special Services Section of the Department of Development Services, in the City of Corpus Christi, Texas, or his duly authorized representative

Distribution System Looping or **Loop** - Alignment or routing of water distribution mains using a minimum of two independent routes of water flow a water main that starts at an existing water main and connects to another existing water main, providing for distribution system looping to avoid dead-end mains

Drawings - Plan, profile, detail, and other graphic sheets to be used in a construction documents which define character and scope of the project.

Easements - Areas set aside for installation and maintenance of public or private utilities

Engineer - A professional engineer (P.E) licensed by the State of Texas

Executive Director of Water Utilities - The person or their representative designated by the City of Corpus Christi to oversee all the water operations in the City of Corpus Christi, also called CEO

Fee Schedule - The list of fees pertaining to the water distribution system as adopted by ordinance; also Water Fee Schedule

Finished Grade - The level of the top surface (soil/concrete/asphalt/etc.) of the anticipated improvement

Fire Line - A term used to define a privately owned and maintained water main that feeds a fire sprinkler system or other privately-owned fire protection system, is governed by the National Fire Protection Association regulations, and is physically isolated from the water distribution system by means of a valve at the main, and a backflow protection device in the system

FLDC Assembly - The term used for a Fire Line Detector Check (FLDC) assembly which consists of a Double-Check Detector Assembly, with outside-stem-and-yoke (OS&Y) valves on both sides, as per the Standard Water Details

Force Main - A pressure-rated conduit which conveys WW from a PS to a discharge point

Industrial Areas - Defined as high-density areas that include the industrial-zoning districts

Land Surveyor - A surveyor currently registered and in good standing with State of Texas Board of Professional Engineers and Professional Land Surveyors (TBPELS).

Loop - A water main that starts at an existing water main and connects to another existing water main, providing for distribution system looping to avoid dead-end mains

Mains - A collective term that includes AWWA-approved pipes, fittings, valves, fire hydrants, and other appurtenances required for the water distribution system, to include:

Transmission Main - Mains larger than 16-inches inside diameter (ID) that are used to transport water from treatment facilities to distribution areas and are identified in the Water Master Plan

Grid Main - Mains of 12 to 16 inches ID that serve as distribution supply mains and are identified in the Water Master Plan

Distribution Main - Mains of 6, 8, or 12 inches ID that are connected to the grid mains and provide fire protection and domestic water service

Major Water Projects - Projects whose designs are coordinated through the City Engineering Department, which may include CIP, CDBG, NIP, and TxDOT or other projects

Medium-to-High Density - Defined as denser than two-family dwellings

Meter Yoke - The end of the service line that has the curb stop and to which the meter is attached

OCL Water Contract - The 'Standard Form Contract for Providing Water Where Property is Situated Partly or Wholly Beyond City Limits' for that is signed by an applicant and whose requirement is based on the City Code of Ordinances, Article VIII Water Service Outside City, Section 55-110-114

Pigging the Line - The process of pulling a device known as a 'pig' through a pipe for the purpose of removing any debris from the inside of the pipe

Plumbing Code - The most current Plumbing Code adopted by the City Council

Private Fire Service Line - As defined by NFPA-13

Record Drawings - The electronic, red-lined drawings that are created by the Engineer of Record at the end of the project to reflect changes as noted in the field set of red-lined drawings kept by the Contractor

Residential Areas - Defined as low density areas that include farm buildings, one-family dwellings, two-family dwellings, travel-trailer park districts, and manufactured home districts

Review Authorities - The authorized representatives of City departments, divisions, branches or sections responsible for reviewing and approving calculations for project design within the City.

Service Lines - Water lines that are tapped to the main at one end and directly connected to domestic service meters or irrigation meters at the other end

'Shall' and 'May' - As used herein, the word 'shall' is mandatory, while the word 'may' is permissive

Standard Details - The most current approved drawing details maintained and distributed by the City Engineer for use in City projects, found on the Engineering Services website

Standard Construction Specifications - The water distribution system standard specifications maintained by Engineering Services and provided on their website

Sub-divider - The term 'sub-divider' or 'Developer' are synonymous and are used interchangeably, as set out in the UDC

Subdivision - The division of any lot, tract, or parcel of land into two or more parts, lots, or sites, as set out in the Unified Development Code

Subdivision and Commercial Projects - Plans for subdivisions and commercial projects drawn up by the Developer and have been approved by the City

Service Lead - the WW line that connects a building to the WW main that is located within the public ROW or UE and serves no more than two homes

Stub Outs - minimum 5-feet of WW line extended from a MH for future expansion and terminated with a WW plug

Temporary Dead-end Main - A dead-end main where a complete extension for a looped line is already programmed to begin construction within three years

Untreated Water - Raw water that has not yet been treated at the water treatment plant

Utility Department Engineer - Person who is employed by the Executive Director of Water Utilities to make engineering decisions about utilities for the City

Water Blend - Untreated water that blends Lake Texana/Colorado River Water with Nueces River Water

Water Distribution System - The system which consists of all mains in the water distribution system of the City

Water Inspector - An individual, licensed by TCEQ with at least a Class C Water License, and that acts on behalf of the Executive Director of Water Utilities.

Water Master Plan - The latest plan adopted by City Council that uses projections to describe the future development of the water distribution system

Water Standards or Water Distribution Standards - The directions and requirements contained in the City of Corpus Christi Water Distribution

WW Line - A public WW line located within a public ROW or UE

City of Corpus Christi

Infrastructure Design Manual

Chapter 2

GRAPHIC REQUIREMENTS

Chapter 2
GRAPHIC REQUIREMENTS

2.01 CHAPTER INCLUDES

Research and submittal requirements for projects inside the city limits of Corpus Christi or within City's extraterritorial jurisdiction (ETJ).

2.02 SOFTWARE AND FILE FORMAT

a. **AutoCAD** – all files for both references and deliverables shall be provided in .DWG file extension format compatible with the most recent version of AutoCAD.

b. **AutoCAD Conversion** - files that can be converted into .DWG format without losing readability or functionality will be acceptable.

2.03 STANDARD DETAIL DRAWINGS

a. **Standard Details** - Standard Details shall be part of the sheet set and customized per project by the engineer and designer for sealing by the engineer of record.

b. **Standard Detail Location** - located on the Engineering Services website at cctexas.com.

2.04 GENERAL SHEET REQUIREMENTS

a. **City Drawing Index Numbers** - All drawings shall be numbered according to the City's standard drawing numbering system. The design professional shall obtain drawing numbers from the assigned City Project Manager. The title index must clearly identify the City's drawing number and sheet title for every sheet included in the set.

b. **Plan Sheet Size** - Plan sets shall be produced on 22" x 34", ANSI D full-sized paper with scaling appropriate for full-sized sheets.

c. **Plan Sheet Printing Size** - Plans will often be printed, distributed, and handled in half-size (11"x17"), so all sheets should contain a disclaimer and 'proof' scale to allow a user to determine which scale they should be using based on the size of the print.

d. Sealing Requirements - Plans shall be sealed on all pages by a Texas P.E. as required by TBPE latest guidance and state law, Texas Engineering Practice Act and Rules. Survey control sheets shall be sealed and signed by a State of Texas RPLS.

e. City Standards - City Standards shall be included in the plans as applicable.

f. Drawing Requirements - Drawings shall be developed with appropriate scaling to provide bidders and constructors with the information they need, to include proposed pavement sections, cross-sections, details, lines, grades, existing topography, existing infrastructure, proposed infrastructure, and utilizing plan and profile views of any underground infrastructure.

g. Scaling Requirements

I. Minimum scale is 1" =200', and appropriate scaling is required to show details or special structures.

II. Designers shall clearly indicate the scale at which all details or plan view are drawn.

III. Graphic scales shall be used on all civil, site, and other plan drawings.

h. North Arrow - A north arrow shall be located on all sheets as appropriate.

i. Stationing - Stationing shall never start at 0+00, but instead start at 1+00, and label stationing by number every 100', and stationing shall always be from left to right across each sheet.

j. Match Lines - Match lines shall be located at the ends of the plan views of any page, to include labeling for matching station and sheet number.

k. Sections

I. Sections shall be lettered in consecutive order on each drawing.

II. The direction of section view is indicated by the direction of the arrow.

III. Heavy dark lines indicate the direction of the cutting plane.

IV. Reference text shall be placed at the bottom of the section.

V. Sections shall be titled.

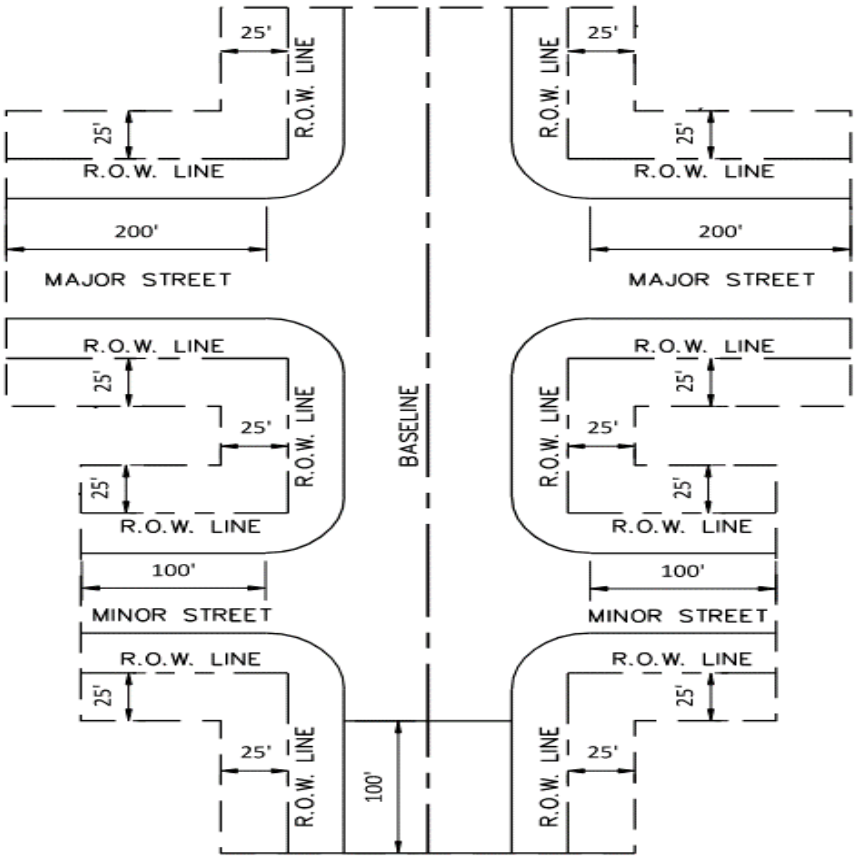
l. Details

I. Details shall be numbered in consecutive order on each sheet. Reference mark text shall be placed at the bottom of the detail.

II. Details shall be titled.

m. Survey Controls - Survey controls shall be tied to City monumentation.

n. Survey Requirements - as shown in Figure 2.1:



o. Plan and Profile Requirements - P&P views shall contain line labeling, dimensioning, type of materials, geometric requirements, stationing, existing and proposed utilities, flow lines, top of curb, top of rim, and other relevant design information.

p. Reference Files - Sheet sets shall include all reference files required to represent the drawings in their entirety.

q. Lines, Leaders, and Dimensions.

I. Line types, weights, and sizes shall be appropriate and shown in the legend.

II. Line types shall be solid and heavy for proposed (new) work, and lighter or dashed lines for existing conditions.

III. Leader style shall be set to attach the leader to the top of the multi-line text callout.

IV. Leader lines shall be placed as close as possible to the object being identified.

V. Multiple leader lines shall be parallel if possible.

VI. Leader lines shall have closed, filled arrows.

VII. Only dimensions necessary for completion of the work shall be shown, and where possible, all dimensions shall be outside of the figure.

VIII. When a dimension or figure is not to scale designer shall indicate 'NTS'.

IX. All dimensions shall be in the English units of measure. If required, metric equivalent measurements shall be shown in parenthesis.

r. Hatching - Hatching shall be appropriate and not obscure information needed by bidders or contractors.

s. Font Size and Style

I. Font size shall be appropriate for readability on 11"x17" (Tabloid/ANSI B) sheets, as it is common practice to use half-sized sheets.

II. Minimum font size is 3/32-inch high, using all uppercase and vertical lettering.

III. Font shall be 'Roman S'

t. Sheet Order

I. Sheets shall be ordered from general to specific, with specific disciplines such as Civil, Structural, Architectural, Mechanical, and Electrical grouped together within the sheet set.

u. Sheet Content

I. General Arrangement of sheets should contain the following:

i. Title Sheet with Vicinity and Location Maps and Sheet Index
ii. General Notes and Legend
iii. Quantity Sheet with Testing Schedule
iv. Civil Sheets
v. Structural Sheets
vi. Architectural Sheets
vii. Mechanical Sheets
viii. Electrical Sheets
ix. SCADA Sheets
x. SW3P
xi. Traffic Control

II. Civil Sheets shall typically contain the following:

i. Existing Site Plan
ii. Demolition Plan
iii. Site Plan at 1” =20’ or 1” =50’
iv. Plan and Profile Sheets
v. Plan at 1” =20’ or 1” =50’
vi. Profile (horizontal) at 1” =20’ or 1” =50’
vii. Profile (vertical) at 1” =5’ or 1” =2’
viii. Details at 1” =1’ or 1” =2’ or 1” =10’
ix. Drainage Area Map

III. Structural Sheets shall typically contain the following:

i. Structural Foundation Plans at ¼” = 1’ or 1/8” = 1’
ii. Sections and Elevations at ½” =1’ or NTS
iii. Details at ½” =1’ or NTS

IV. **Architectural Sheets** shall typically contain the following:

i. Site Plan
ii. Floor Plans
iii. Schedules
iv. Building Elevations
v. Building Cross Sections
vi. Wall Sections
vii. Exterior Details
viii. Interior Details
ix. Reflected Ceiling Plan
x. Roof Plans
xi. Miscellaneous Details
xii. Landscape and/or Irrigation Drawings

V. **Mechanical Sheets** shall typically contain the following:

i. Heating Ventilating, and Air Conditioning.
    1. Utility Site Plan at ¼" =1' or ⅛" =1'
    2. HVAC Plans at ¼" =1' or ⅛" =1'
    3. Sections
    4. Details at ¼" =1' or ¾" =1' or 1" =1' or NTS
    5. Schedules
    6. Schematics/Diagram

ii. Plumbing
    1. Utility Site Plans at ¼" =1' or ⅛" =1'
    2. Plumbing Plans at ¼" =1' or ⅛" =1'
    3. Sections
    4. Details at ¼" =1' or ¾" =1' or 1" =1' or NTS
    5. Schedules
    6. Schematics/Flow Diagrams

VI. **Electrical Sheets** shall typically contain the following:

i. Electrical Site Plan at 1" =20' or 1" =50'
ii. Legends and Symbols
iii. Lighting Plans at ¼" =1' or ⅛" =1'
iv. Lighting Details at ¼" =1' or ¾" =1' or 1" =1'
v. Receptacle and Power Plans
vi. Communication Systems Plans & Details

vii. Line Diagrams
viii. Riser Diagrams
ix. Conduit and Feeder Schedules
x. Panelboard Schedules
xi. Panel Details
xii. Control Panels

VII. **SCADA Sheets** shall typically contain the following:

i. General SCADA Architecture
ii. DSC I/O Documentation
iii. Logic Drawings
iv. Loop Sheets
v. P&ID
vi. PFD
vii. Instrument Lists

VIII. Revisions

i. Revision block - revisions shall be indicated in the revision block
ii. Record of revisions - All revision notations shall be retained
iii. Clouds and Colors - all revisions shall be clouded in red

2.05 SUBMITALS

a. Proper Dating and Sealing and Signature.

I. Each submittal that is not for bidding or construction shall be marked with the following statement per Rule 131.138 Section (8) of the Texas Engineering Practice Act.

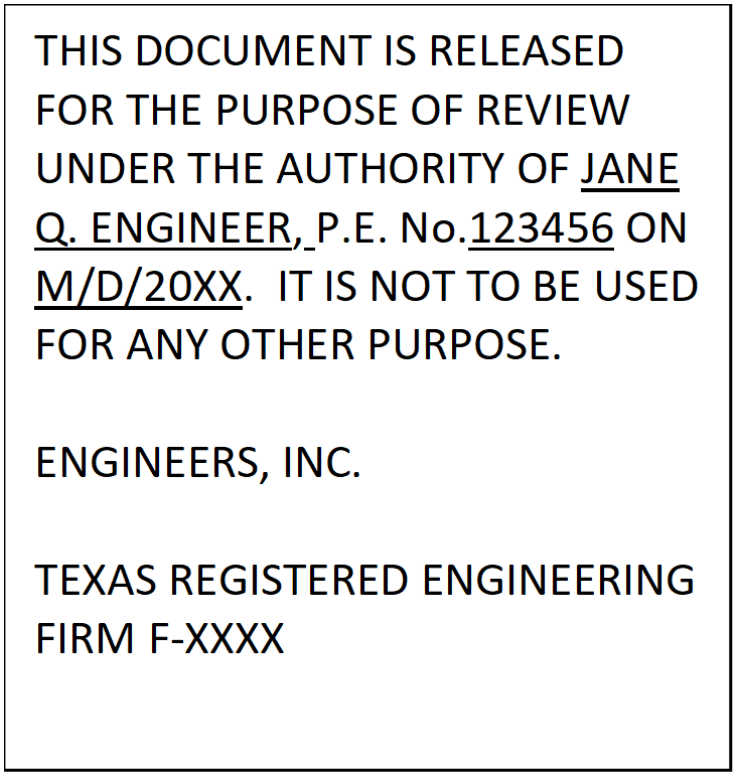


Figure 2.2: Sealing Requirements

II. Final Drawings for Bid or Construction shall be sealed, signed, and dated by a Texas P.E. per the Texas Engineering Practice Act.

2.06 OWNERSHIP AND RE-USE OF DRAWINGS AND INFORMATION

a. City is the Owner - The City of Corpus Christi is the owner of all original drawings produced under contract with Engineering Services or otherwise for a City project.

b. Delivery of Drawings - At the completion of design, the design firm will deliver to the City all original drawings prepared for the project, as well as an electronic copy of the same.

c. Reuse of Drawings - As owner of the drawings, the City expressly reserves the right to copy and re-use the information in any drawing or CAD file, and such re-use does not obligate the City to pay the original design professional for any such re-use.

2.07 STORM WATER POLLUTION PREVENTION PLAN SHEETS (SW3P)

a. Responsibility of Designer - the designer shall prepare the SW3P sheets for the bid set to sufficient level to provide bidders with quantities and subcontractors with the information they need to file the NOI and NOT, such as:

I. EPIC Sheet
II. Standard BMPs
III. Plan view of deployed BMPs

b. Responsibility of the Contractor - the contractor shall file the SW3P NOI and NOT and follow the SW3P plan as shown in the drawings.

c. Responsibility of the City Construction Inspector - the City construction inspector shall require that the SW3P plans be followed and BMPs remain in place as needed to control silt runoff during construction.

2.08 TRAFFIC CONTROL SHEETS

a. The decision to include traffic control in the designer's scope will be up to the City Traffic Engineer and Engineering Services.

b. The designer shall prepare the Traffic Control Plan in accordance with City requirements and TxDOT or other applicable standards. It is expected that these responsibilities would include sheets with such items as:

I. Advance Warning Signage

II. Traffic Control Plan View

III. Traffic Control Details

IV. Detours

c. TCP shall include signage types, barrels/barricades/other devices called out by type, detour routes with temporary signage/speed bumps/pavement markings, and other details or notes as needed to convey Contractor responsibilities.

2.09 TEXAS ACCESSIBILITY STANDARDS AND AMERICANS WITH DISABILITIES ACT COMPLIANCE

a. Designer Responsibilities

I. Register and pay all project fees

II. Design project to eliminate architectural barriers per the applicable law or code

III. Follow City standards for sidewalks, driveways, and curb ramps as applicable

IV. Submit registrations and plans to TDLR through a RAS to comply with laws and codes for required registration timeframes, plan reviews, and final inspections.

V. Schedule a final RAS inspection to confirm TAS/ADA compliance.

VI. Ensure RAS closes out paperwork with TDLR for proper project closeout.

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Chapter 3

STORM WATER DESIGN REQUIREMENTS

Chapter 3

STORM WATER DESIGN REQUIREMENTS

3.01 CHAPTER INCLUDES

A. Research and submittal requirements for projects inside the city limits of Corpus Christi or within City's extraterritorial jurisdiction (ETJ).

3.02 PURPOSE

a. Provides storm water (SW) design standards for public infrastructure
b. Provide design guidance to try to protect the safety and welfare of the public
c. To establish uniform criteria for the analysis, design, and construction of storm water drainage facilities in the City of Corpus Christi and in its extra-territorial jurisdiction.

3.03 LEVEL OF PROTECTION

a. Transportation Projects

Storm Water facilities associated with transportation projects shall be designed using the level of protection as shown below based on the City's Urban Transportation Plan definitions of road classifications:

a. Rural Roads

   i. 5-year design storm must be contained in roadside swales
   ii. 100-year design storm must not indicate ponding above the finished floor elevation of adjacent habitable structures.

b. Local/Neighborhood Streets

   i. 5-year design storm must be contained within conveyance system design and not pond across the roadway at inlets higher than the curb line
   ii. 100-year design storm must not indicate ponding above the finished floor elevation of adjacent habitable space

c. Residential Collector, Parkway Collector, and Commercial Collector Streets
   i. 5-year design storm must be contained within the conveyance system

ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures.

d. Arterial Streets

i. 25-year design storm must be contained within the conveyance system and roadway, and inlet design shall not pond across more than one lane
ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

e. Major Highways and Freeways

i. 50-year design storm must be contained within the conveyance system, and inlet design shall not indicate ponding across more than one lane
ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures.

b. Storm Water Projects

Storm Water conveyance facilities both above and ground and under-ground (UG) shall be designed using the level of protection as shown below:

a. Minor Underground Storm Conveyance (<200 acres contributing area)

i. 5-year design storm HGL at or below top of curb and MH rims
ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

b. Minor Channels (<200 ac. contributing area)

i. 5-year design storm HGL shall indicate at least 1 foot of freeboard to top of bank
ii. 00-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

c. Minor Channel Culverts (<200 ac. contributing area)

i. 5-year design storm can be conveyed with no adverse impacts
ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

d. Minor Channel Bridges (<200 ac. contributing area)

    i. 5-year design storm HGL shall indicate at least 1 foot of freeboard to bottom chord of bridge
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

e. Temporary Ditches (<200 ac. contributing area)

    i. 5-year design storm shall indicate at least 1 foot of freeboard to top of bank
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

f. Intermediate Underground Storm Conveyance (200ac.<contrib. area<500 ac.)

    i. 25-year design storm HGL at or below top of curb and MH rims
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

g. Intermediate Channels (200ac.<contrib. area<500 ac.)

    i. 25-year design storm HGL shall indicate at least 3 feet of freeboard to top of bank, with a 1-foot minimum when necessary
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

h. Intermediate Channel Culverts (200ac.<contrib. area<500 ac.)

    i. 25-year design storm can be conveyed with no adverse impacts
    ii. 25-year design storm can be conveyed with no adverse impacts

i. 25-year design storm can be conveyed with no adverse impacts

j. Intermediate Channel Bridges (200ac.<contrib. area<500 ac.)

    i. 25-year design storm HGL shall indicate at least 2 feet of freeboard to bottom chord of bridge
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

k. Major Underground Storm Water Conveyance (>500ac. acres contributing area)

    i. 50-year design storm HGL at or below top of curb and MH rims
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

l. Major Channels (>500ac. acres contributing area)

    i. 25-year design storm HGL shall indicate at least 3 feet of freeboard to top of bank
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

m. Major Channel Culverts (>500ac. acres contributing area)

    i. 50-year design storm can be conveyed with no adverse impacts such as overtopping the driving surface
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

n. Major Channel Bridges (>500ac. acres contributing area)

    i. 50-year design storm HGL shall indicate at least 1 foot of freeboard to bottom chord of bridge
    ii. 100-year design storm shall not indicate ponding above the finished floor elevation of adjacent habitable structures

o. Storm Water Pumping Stations

    i. 100-year design storm

p. Seawalls and Associated Outlet Control Structures

    i. 100-year design storm

3.03 HYDROLOGY

a. Hydrologic Analysis

a. Hydrologic Analyses shall be based on ultimate land development as anticipated in applicable City of Corpus Christi adopted Area Development Plans

b. Rational Method for drainage areas 200 acres or less

i. Peak runoff 'Q' determined by formula Q=CIA where
   1. Q = Peak Runoff
   2. C = runoff coefficient
   3. I = design rainfall intensity in inches/hour
   4. A = drainage area in acres

ii. Design rainfall intensity or 'I' is determined from the Atlas 14 data set
   1. I - b/(Tc+d)^e where
      a. Tc = time of concentration in minutes
      b. b, d, & e = empirical factors that characterize IDF curves for Nueces County
   2. Obtain values from Atlas 14 data set
      a. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html
   3. Runoff coefficient 'C' is dependent on land use, soil type, overland slope, and other factors as appropriate
   4. 'C' values shall be determined based on the following table of values:

Table 3.1: Runoff Coefficient (C)

Rational Method Runoff Coefficient (C)				
Land Use	**Zoning District**	**Overland Slope**		
		<1%	1%<S<3.5%	>3.5%
Pasture				
Type A Soils (Sand)	F-R	0.25	0.35	0.40
Type B Soils (Clay)	F-R	0.30	0.40	0.50
Cultivated Fields				
Type A Soils (Sand)	F-R	0.25	0.55	0.65
Type B Soils (Clay)	F-R	0.30	0.60	0.70
Lawn				
Type A Soils (Sand)	-	0.05	0.08	0.12
Type B Soils (Clay)	-	0.15	0.18	0.22
Wooded Tracts				
Type A Soils (Sand)	-	0.15	0.18	0.25
Type B Soils (Clay)	-	0.18	0.20	0.30
Single Family				
Residential Estate	RE	0.30	0.35	0.40
Lots > 1/3 acre	RA	0.30	0.40	0.50
1/4 acre<Lots<1/3 acre	R-1A	0.40	0.50	0.60
Lots < 1/4 acres	R-1A/R-1B/R-1C	0.50	0.55	0.60
Multi-Family Districts				
Townhouses	R-TH	0.60	0.65	0.70
Multi-Family	R-2	0.60	0.65	0.70
Trailer Park	R-MH	0.60	0.65	0.70
Manufactured Home	R-MH	0.60	0.65	0.70

Apartment	A-1/A-1A/A-2	0.75	0.80	0.70
Tourist	AT	0.75	0.80	0.70
Business Districts				
Professional Office	AB	0.75	0.80	0.85
Neighborhood Bus.	B-1/B-1A	0.75	0.80	0.85
North Beach	BD	0.75	0.80	0.85
Island	B-2A	0.75	0.80	0.85
Bayfront	B-2A	0.75	0.80	0.85
Business	B-3	0.75	0.80	0.85
General Business	B-4	0.75	0.80	0.85
Primary Business	B-5	0.85	0.85	0.85
Primary Business Core	B-6	0.85	0.85	0.85
Industrial Districts				
Limited Industrial	I-1	0.50	0.65	0.80
Light Industrial	I-2	0.50	0.65	0.80
Heavy Industrial	I-3	0.60	0.75	0.85
Rail Yards	-	0.20	0.30	0.40
Open Spaces				
Parks/Greenbelts	-	0.20	0.30	0.30
Playgrounds	-	0.25	0.35	0.35
Cemeteries	-	0.25	0.35	0.35
Streets/Paving				
Asphalt	-	0.80	0.80	0.80
Concrete	-	0.85	0.85	0.85
Sidewalks/Drvieways	-	0.85	0.85	0.85
Roofs	-	0.85	0.85	0.85

c. HEC-HMS Analysis for areas greater than 500 acres

i. For drainage areas greater than 500 acres, Atlas 14 data shall be used for modeling with the USACE Hydraulic Modeling System (HEC-HMS) for the hydrological analysis in the design of channels, culverts, and bridges.
   1. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html
   2. as shown in Table 3.2 below:

Table 3.2: Rainfall Depth for Corpus Christi

Duration (min)	Rainfall Depth (inches) for Corpus Christi, Texas by Precipitation Frequency - 90% Confidence								
	1-year	2-year	5-year	10-year	25-year	50-year	100-year	200-year	500-year
5	0.48	0.57	0.70	0.82	0.98	1.10	1.23	1.36	1.53
10	0.76	0.90	1.12	1.30	1.56	1.96	1.96	2.16	2.42
15	0.97	1.14	1.41	1.63	1.95	2.44	2.44	2.69	3.03
30	1.38	1.61	1.99	2.30	2.73	3.41	3.41	3.77	4.26
60	1.81	2.12	2.63	3.06	3.66	4.60	4.6	5.12	5.84
120 (2hrs)	2.19	2.63	3.32	3.92	4.78	6.21	6.21	7.03	8.20
180 (3hrs)	2.40	2.93	3.75	4.47	5.53	7.33	7.33	8.38	9.90
360 (6hrs)	2.76	3.46	4.50	5.44	6.84	9.31	9.31	10.80	12.90
720 (12hrs)	3.13	3.99	5.27	6.44	8.20	11.30	11.30	13.30	16.10
1440 (24hrs)	3.50	4.54	6.07	7.49	9.62	13.40	13.40	15.80	19.20

3.04 HYDRAULICS

a. Inlets and Gutters

a. Inlets

i. Drainage sag inlets shall be placed at all low points and on-grade inlets shall be placed at suitable intervals along extended gutter slopes as necessary to provide the level of protection against ponding on the roadway relative to the individual street designation in the UTP.

ii. Inlet type, size, and spacing shall be properly designed to not exceed the ponding extents or depths as described in 3.01.a

b. Gutters
    i. Longitudinal concrete gutter slopes along roadways shall not be less than 0.3% (0.003 ft/ft)
    ii. Longitudinal concrete gutter slopes in cul-de-sacs shall not be less than 0.4% (0.004 ft/ft)
    iii. Transverse pavement slopes for outer lanes shall not be less than 2.0% (0.02 ft/ft)

b. Underground Storm Water Drainage Systems

a. Hydraulic Design of underground storm conveyance shall be performed using software tools commonly used for storm sewer design
b. All hydraulic analysis shall include the appropriate tailwater in the calculations
    i. Tailwater elevations shall be determined through appropriate engineering analysis, known water surface elevations for the flood interval, FEMA FIRMs, City Storm Water maps, or other resource deemed acceptable by the City Engineer.
c. Pipe material shall be reinforced concrete pipe (RCP) or box (RCB) under roadway pavement
d. Minimum SW pipe size is 18-inch regardless of location
e. Minimum RCP size under pavement is 18-inches for lateral lines or trunk lines
f. Minimum RCB size is 3-ft. X 2-ft.
g. Minimum pipe slopes shall be per Table 3.3 below:

Table 3.3: Minimum Pipe Slope

Minimum RCP Slope		
Nominal Pipe Size	**Minimum Slope**	
(inches)	(Foot/Foot)	(%)
18	0.0012	0.12
24	0.00080	0.080
30	0.00058	0.058
36	0.00046	0.046
42	0.00037	0.037
48	0.00030	0.030
54	0.00020	0.020
60	0.00020	0.020
66	0.00020	0.020
72	0.00020	0.020

h. Minimum Cover
    i. 2 feet for Class III RCP as defined by ASTM C-76
    ii. 1 foot for Class IV RCP
    iii. No maximum velocity for laterals
i. Manholes (MH)
    i. 600-foot maximum spacing
    ii. MH required at each change in pipe size
    iii. MH required at directional changes >5°
    iv. MH alternatives include junction box or post/curb inlets
j. Hydraulic Grade Line (HGL)
    i. At or below rim elevation at MH rims for minor design-year event per UTP designation
    ii. At or below top of curb for major design-year event per UTP designation

c. Channels, Culverts, and Bridges

a. Hydraulic design software

i. For drainage areas up to 500 acres, hydraulic design shall be performed by industry standard software packages
ii. For drainage areas over 500 acres, hydraulic design of channels, culverts, and bridges shall be performed using the United States Army Corps of Engineers River Analysis System (HEC-RAS

b. Hydraulic design requirements

In addition to the level of protection requirements outlined in 3.01, additional design requirements are found below:

i. Rural Roadside Ditches

1. Side Slopes 3:1 (H:V) or flatter
2. Freeboard not required
3. Minimum Velocity is 2 fps when flowing full
4. Erosion protection
    a. Vegetative cover shall be established in all ditches
    b. Erosion protection mats and topsoil may be required to protect against erosion and to help establish vegetation
5. Drainage Easements shall be required if the ditch cannot be fully contained within the road ROW

ii. Earthen Channels

1. Includes temporary ditches
2. Bottom width shall be 6 feet minimum
3. Side slopes shall be 4:1 (H:V) or flatter
4. Freeboard shall be as shown in Section 3.01
5. Maintenance strip of 20 feet minimum width shall be required on both sides of the channel
6. Maximum velocity allowed shall be 5 fps unless erosion-resistant treatments are included
7. Erosion protection

    a. Vegetative cover shall be established in all ditches

b. Erosion protection mats and topsoil may be required to protect against erosion and to help establish vegetation
c. Stream bed and slope protection required at bends, confluences, and outfalls

iii. Concrete-lined channels

1. Bottom width shall be 8 feet minimum
2. Side slopes shall be 1.5:1 (H:V) or flatter
3. Freeboard shall be 1 foot minimum for design-year event
4. Maintenance strip of 20 feet minimum shall be required on both sides of the channel
5. Maintenance Access shall be required at crossing structures and at 2000-ft intervals
6. Maximum velocity allowed shall be 12 fps

iv. Culverts

1. Minimum size per 3.04.b
2. Freeboard not required
3. Maximum velocity is 15 fps
4. Design loading is HS20-44 highway loading
5. Bedding for RCP shall be granular bedding as shown on Table 1 of the City Storm Water Standard Details
6. Bedding for RCB shall be cement stabilized sand bedding
7. Backfill per City Standard Specifications 022020 and 027402
8. Stream bed and slope protection required at upstream and downstream ends
9. Culvert ends shall be protected from traffic impacts by the use of Safety End Treatments (SETs)
10. Culverts 24-inches and larger will be protected from traffic impacts by SETs with steel cross-pipe

v. Conveyance system design shall utilize Manning's roughness coefficients or 'n' value as shown in Table 3.4:

Table 3.4: Manning's Roughness Coefficient (n)

Manning's Roughness Coefficients (n)			
Type of Channel/Conduit/Conveyance	**Roughness Coefficient (n)**		
	Minimum	**Normal**	**Maximum**
Reinforced Concrete Pipe/Reinforced Concrete Box	0.012	0.013	0.017
Excavated or Dredged Channels:			
	0.011	0.013	0.015
Earthen Channels Stratight and Uniform:			
clean after weathering	0.016	0.018	0.020
with short grass/few weeds	0.022	0.027	0.033
Earthen Channels Winding or Naturalized:			
no vegetation	0.023	0.025	0.030
some grass and weeds	0.025	0.030	0.033
dense weeds and plants	0.030	0.035	0.040
earth bottom with rubble sides	0.028	0.030	0.035
stony bottom and weedy banks	0.025	0.035	0.040
cobble bottom and clean sides	0.030	0.040	0.050
Channel not maintained with weeds and brush not cut:			
dense weeds as high as flow depth	0.050	0.080	0.120
clean bottom with brush on sides	0.040	0.050	0.080
clean bottom , brush on sides, highest stage of flow	0.045	0.070	0.011
dense brush high stage	0.080	0.100	0.140
Natural Streams:			

clean, Straight, Full Stage, no rifts or deep pools	0.025	0.030	0.033
clean, Straight, Full Stage, some stones and weeds	0.030	0.035	0.040
clean, winding, some pools and shoals	0.033	0.040	0.045
clean, winding, some weeds and stones	0.035	0.045	0.050
clean, winding, lowest stages, more ineffective flow areas	0.040	0.048	0.055
sluggish reaches, weedy, deep pools	0.050	0.070	0.080
Flood Plains/Overbanks:			
Pasture, no brush:			
short grass	0.025	0.030	0.035
high grass	0.030	0.035	0.050
Cultivated Areas:			
no crop	0.020	0.030	0.040
mature row crops	0.025	0.035	0.045
mature field crops	0.030	0.040	0.050
Brush:			
scattered brush with heavy weeds	0.035	0.050	0.070
light brush and trees in winter	0.035	0.050	0.060
light brush and trees in summer	0.040	0.060	0.080
medium to dense brush in winter	0.045	0.070	0.110
medium to dense brush in summer	0.070	0.100	0.160
Trees:			
dense willows, summer, straight channel	0.011	0.015	0.200

cleared land with stumps no brush	0.030	0.040	0.050
cleared land with brush	0.050	0.060	0.080
heavy stand of timber with flood stage below branches	0.080	0.100	0.120
heavy stand of timber with flood stage in the branches	0.100	0.120	0.160

vi. Coefficients from the 'normal' column are to be used for design
vii. Coefficients from the 'normal' column are to be used for design
viii. Coefficients from the 'minimum' and 'maximum' columns are used to analyze existing systems

3.05 NO ADVERSE IMPACT

a. No Adverse Impacts Downstream

a. For new developments, redevelopments, roadway expansions, drainage system improvements, and other improvements that will increase the impervious cover, decrease the time of concentration (Tc), or increase peak flows from drainage areas, or where the establishment of an extreme event (100-year) overflow corridor is not feasible, mitigation of adverse storm water impacts shall be required.
b. Mitigation may be accomplished by local, private, on-site storm water detention facilities or by regional storm water detention facilities.

b. Pre-Developed Peak Runoff

a. Storm water detention facilities shall be designed to release the post-development storm water runoff from a site at a controlled rate, which does not exceed the pre-developed peak runoff rate.
b. If local private on-site storm water detention facilities are provided, they shall be designed using the appropriate methodology for their acreage and require a licensed professional engineer to inspect and certify that the facility is functioning as originally designed.

3.06 STORM WATER DRAINAGE EASEMENTS AND ROW

a. Minimum required drainage ROW/Easement width shall per UDC
b. Minimum required drainage ROW/Easement width for SW Channels
    a. Inclusive of required channel top width plus required maintenance strips

3.07 MISCELLANEOUS STORM WATER DESIGN CRITERIA

a. Floodplain Development

a. Development in delineated floodplains is restricted and must meet the requirements established by the Federal Emergency Management Agency (FEMA)

b. Finished Floor Elevation

a. New construction in FEMA flood hazard areas must have a minimum first floor elevation for habitable living space of 15 inches above the Base Flood Elevation (BFE)
b. New construction outside FEMA flood hazard areas must have a minimum first floor elevation for habitable living space of 18 inches above the lowest adjacent top of curb, crown of road, or top of bank of any adjacent channel, whichever is higher.

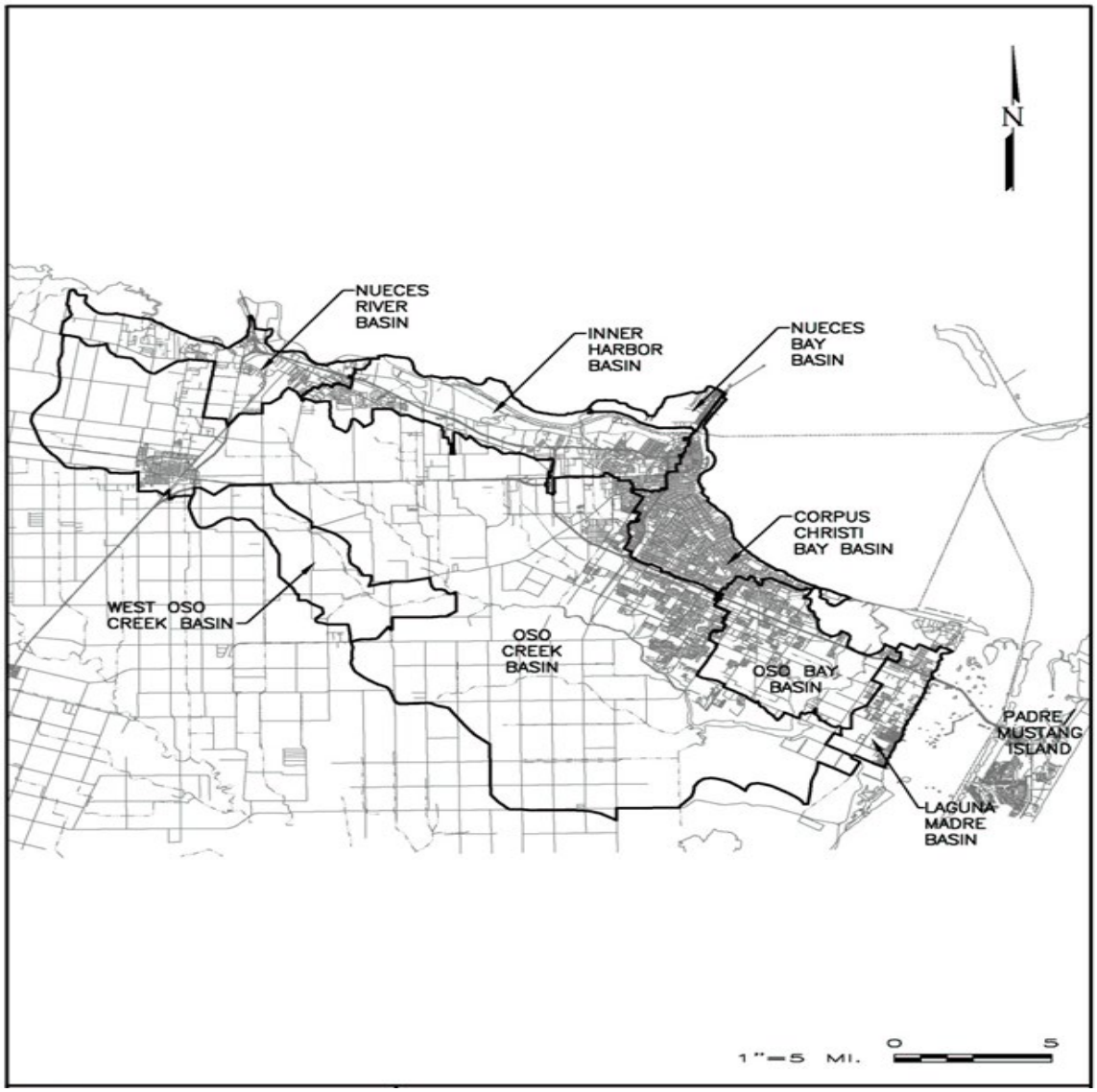
c. Lot Grading and Drainage

a. Lot grading shall be from back to front toward the street, swale, or inlet
b. Lot grading shall be at a minimum slope of 1%
    i. 1% for HMAC pavement
    ii. 0.3% for PCC pavement
c. Surface drainage from on lot across another lot in a residential subdivision shall not be allowed without establishment of a drainage easement

d. Drainage Basins

a. Drainage basins are as described in Figure 3.1:

Figure 3.1: Corpus Christi Drainage Basins



City of Corpus Christi

Infrastructure Design Manual

Chapter 4

WATER DISTRIBUTION SYSTEM DESIGN REQUIREMENTS

Chapter 4

WATER DISTRIBUTION SYSTEM DESIGN REQUIREMENTS

4.01 CHAPTER INCLUDES

A. Research and submittal requirements for projects inside the city limits of Corpus Christi or within City's extraterritorial jurisdiction (ETJ).

4.02 GENERAL PROVISIONS

a. Administration

a. Ownership of Mains

i. After the City has accepted completion of the construction of the water mains, and after the warranty on the construction of the water mains has expired, the mains shall become sole property of the City and will be subject to its control and management.

b. Obligation to Provide Water Service

i. Every customer who receives water service from the City will be subject to the City Charter, Unified Development Code, and the Water Distribution Standards.
ii. Failure to comply with the Water Distribution Standards may result in the revocation of water service.

c. Conflicting Jurisdictions

i. When a proposed subdivision is required to plat by the City of Corpus Christi and is within an area served by a utility district other than within the City of Corpus Christi CCN, the Subdivider and/or Developer shall obtain approval for construction from the other district, before proceeding with the work.
ii. OCL Areas in the City's CCN jurisdiction shall comply fully to the Water Distribution Standards.

iii. An OCL Water Contract shall be required from applications who desire water service and are located outside the City limits.

d. Main Extension Charges
   i. Taps made to a water main for a main extension shall be subject to an extension charge as determined by Ordinance in the water fee schedule.

b. Approved Materials and Standards

a. Approved Materials

   i. All materials proposed for use in the water distribution system shall be approved in accordance with the City of Corpus Christi Standard Construction Specifications by the Utilities Department.

b. Variances and Waivers

   i. Variances and Waivers to the Water Standards may be requested on a case-by-case basis.
   ii. Any request for deviation or variance from the Water Standards must be submitted to the Executive Director of Water Utilities in writing and must have prior written approval from the Executive Director before it is installed or constructed.
   iii. If a response to a variance request is not provided by the Executive Director within ten (10) working days of receiving the written request, the variance request shall not be approved.

c. Changing the Water Standards

   i. Whenever changes to the Water Distribution Standards are needed, they shall be made by the Executive Director of Water Utilities.
   ii. The Executive Director of Water Utilities will, at his discretion, give public notice before the changes are made.
   iii. The Executive Director of Water Utilities reserves the right to change the Water Distribution Standards immediately to address conditions that are deemed to be a hazard to public safety.

d. Regulations

i. The water distribution system design shall comply with the standards and regulations found in the Federal Registers and in the Texas Administrative Code as enforced by the Texas Commission on Environmental Quality and the Texas Department of State Health Services and shall conform to the requirement for peak hour customer demand and system operational demands as determined by the Executive Director of Water Utilities.
ii. Unless otherwise specified within the Water Distribution Standards, the design, location, materials, and standards of construction of the water distribution system shall be those commonly used and adopted by the industry for the intended area of application.

e. Engineered Design and Drawings

i. Civil/Utility Drawings

1. Utility drawings signed and sealed by an Engineer licensed by the State of Texas shall be required for the construction of all improvements to the water distribution system.
2. All drawings and details for the public water improvement project shall be in the plans that are submitted for review.
3. Whenever the Executive Director of Water Utilities assess that more detail is needed in the proposed drawings, the City reserves the right to require the Engineer to provide more details and/or calculations before the plans can be approved.

f. Submittals

i. Specs and Details and Manufacturer Certification

1. Upon request, the Developer or Contractor shall furnish the City with Specification sheets showing completed details, dimensions, and materials used for any of the proposed construction of the water distribution system.
2. Upon request, the Developer or Contractor shall furnish the City with a certified letter from the Manufacturer stating that their material meets the specifications.
3. Upon request, the Developer or Contractor shall furnish the City with a certified copy of the physical tests of all materials used in the

manufacture and installation of the material or product provided as performed by a Sub-contractor, and/or provided by the Manufacturer.

ii. Field Drawings

1. Red-lined drawings of the proposed water construction shall be maintained on the job site by the Contractor, to include GPS coordinates with an accuracy of 1-foot or less for all new valves and fire hydrants.
2. The approved changes to the drawings shall be promptly marked in red by the Contractor on the field drawings at the time the changes are made, or it may result in a delay of payment to the Contractor.
3. Upon construction completion, the Contractor shall provide the red-lined drawing to the Engineer of Record, who will use the red-lined drawing to produce the Record Drawings of the project.

iii. Record Drawings

1. The Engineer of Record shall provide a certified electronic red-lined copy of the Record Drawings to the Executive Director of Water Utilities in PDF for each project designed.
2. Site development projects to previously platted properties shall require Record Drawings.
3. The Record Drawings shall show the GPS coordinates of all new valves and fire hydrants with a GPS accuracy of 1-foot or less.

iv. Certification of Compliance

1. Along with the transmittal for the electronic, red-lined copy of the Record Drawings, the Engineer shall submit a sealed letter, certifying that they have verified that the Record Drawings reflect what was actually built in the field.

v. Operation of Valves

1. No valve or other control device on the existing water distribution system shall be operated for any purpose by anyone other than the Utilities Department, unless it is done under the direct supervision

of the Utilities Department and under the direct supervision of the Executive Director of Water Utilities.

vi. Tapping the Main

1. Tapping of a live main shall be performed only by City Utilities Department crews under the direct supervision of a certified City employee who has obtained at least a TCEQ 'C' Water License.
2. The Contractor shall coordinate all work with the certified licensed City employee who will be inspecting the work, giving at least seventy-two (72) hours prior to the requirement of the tap being made.
3. The Contractor performing a tap to the main must be pre-approved on the City's Approved Utility Tapping Contractor list.

vii. Notification of Interruptions

1. The Developer or Contractor shall give two (2) business days' notice to the Executive Director of Water Utilities or their approved representative prior to notifying the affected residents about any interruption of service.
2. The Developer shall notify the affected residents in writing at least twenty-four (24) hours before interrupting water service.

viii. Emergency Notification

1. Whenever unforeseeable events are such that interruptions to the water service must occur immediately, verbal and/or written notification shall be made by the Contractor to the Executive Director of Water Utilities and to those who will be affected by the shutdown immediately.

4.03 WATER LINES

a. Location of Mains

a. All water mains shall be located on public ROW or public UE as approved by the Executive Director of Water Utilities

b. Looping of Water Mains

a. All proposed water distribution system mains shall start and end at a source of potable water within the water distribution system
b. No dead-end mains shall be allowed in the distribution system, unless authorized by the Executive Director of Water Utilities.

c. Maximum Length of Mains

a. Grid Mains

i. Grid mains shall not exceed either of the two following lengths:
1. 6,000 feet
2. or a length that would, by fluid hydraulics, render the line incapable of producing the flows and pressures required.

b. Distribution Mains

i. Distribution mains shall not exceed either of the two following lengths:
1. 3,000 feet
2. or a length that would, by fluid hydraulics, render the line incapable of producing the flows and pressures required

d. Alignment of Water Mains

a. All water mains shall be located in the public ROW or dedicated UE
b. The placement of the mains shall be along the dedicatd streets between the curb and the sidewalk, or as approved by the Executive Director of Water Utilities.
c. When installed in a UE, the water main can be centered, or it shall be located to one side, to maintain the required separation from other utilities or provide for construction equipment access.
d. Valves placed in roadways will be placed outside of the wheel-path, typically in the middle of the traffic lane between the two wheel-paths within that lane.

e. Extensions

a. All new lots with the boundaries of the City's CCN must provide water mains along the entire street frontages of the property.
b. Extensions of water mains shall be of adequate size to provide for fire flow and shall originate and end at points in the water distribution system which will provide for effective circulation and efficiency of operation, as determined by the Executive Director of Water Utilities.
c. The design of an extension shall take into effect the adequate capacity of present and future requirements for the area to be benefited as noted on City development plans, the distribution system efficiency, the ease of maintenance requirements, the anticipated life of such extensions, and the constructability, as determined by the Executive Director of Water Utilities.
d. Tapping Sleeves and Valves shall be used to tie into the existing mains whenever possible to reduce the possibility of service interruptions and contamination.
e. No water main extension shall be connected to the system if the cost to the City is so great that in the opinion of the Executive Director of Water Utilities, the expense is not justified on sound business principles.

f. Cul-de-Sacs

a. All proposed mains that extend into cul-de-sacs shall be looped

g. Proposed Dead-End Mains

a. Water quality must be addressed in all proposed designs
b. Proposed dead-end mains will not be allowed
c. In extreme situations, dead-end mains may be considered by the Executive Director of Water Utilities.
d. If considered, the Engineer shall work with the Utilities Department on the design of the proposed system so that water quality is addressed by the design.
e. Unless pre-approved by the Executive Director of Water Utilities, stub outs for future connections will not be permitted.

h. Existing Dead-End Mains

a. Where a proposed development includes areas currently served by dead-end mains, or where the development proposes to connect to a dead-end main, required infrastructure improvements that provide for establishing water

distribution system looping, and the elimination of dead-end mains shall be designed.

i. Temporary Dead-End Mains

a. Dead-end mains may be temporarily permitted for phased construction, provided that the water distribution system shall not be activated for service beyond where the point where looping requirements are met.
b. For the Developer to activate the temporary dead-end, the Developer must provide looping, using a temporary main of minimum four-inch (4-in.) polyethylene that is placed in a temporary utility easement of five-feet (5-ft.) minimum or in a public ROW.

j. Utility Easements (UE)

a. A UE is required within private property along all Arterial and Collector streets and within private property in all locations where mains are proposed.
b. The public UE shall be a minimum of 15 feet wide for pipes less than 12 inches in diameter except along Collector streets.
c. Utility easements along and parallel to Collector streets are required to be a minimum of ten-feet (10-ft.)
d. Transmission mains (12-inches and larger) must be installed in UEs that have a minimum width of twenty-five-feet (25-ft.).
e. No permanent structure shall be built in a UE.
f. Anything built or placed in a UE shall be considered temporary and shall be subject to demolition or removal.
g. UEs must be drawn on the construction plans.
h. A plat shall not be approved without the required UEs properly drawn on the plat.
i. Certificates of Occupancy shall not be issued until the associated UEs have been recorded at the County Courthouse.
j. The purpose of water line easements shall be to provide an easement for water mains only, excluding all other utilities.

k. Pipe Sizes

a. Pipe sizes shall be those approved by the Executive Director of Water Utilities.
b. Pipe sizes shall be designed by the Engineer to provide the required pressure and flow.

l. Minimum Size of Mains

a. The minimum size of any main on the water distribution system, excluding service lines and temporary mains, shall be six inches (6-in.) unless otherwise approved by the Executive Director of Water Utilities.

m. Separation from Wastewater Lines or Manholes

a. The separation distances between the water main and the wastewater system shall be in accordance with the applicable requirements from the Texas Administrative Code as interpreted by TCEQ.

n. Main Material

a. Mains used in the water distribution system shall be AWWA-approved for use on domestic water systems, as per City Specifications, and as approved by the Executive Director of Water Utilities
b. PVC and DI are the only allowed pipe materials for water distribution
c. Proposed transmission main material will be evaluated on a case-by-case basis
d. Minimum pressure rating for pipe sizes through 12-inch is 250 psi and minimum pressure rating for pipe sizes 14-inches and larger is 150 psi.

o. Distance from Buildings

a. No water main shall be installed within fifteen feet (15-ft.) horizontally to the nearest edge of an existing building foundation, and no building foundation shall be built within fifteen feet (15-ft.) horizontally from the outer edge of an existing water main.

p. Utility Clearance - clearances between water mains and other utilities shall be:

a. TCEQ Clearance - the clearances required by TCEQ between water mains and sanitary sewer systems, to include WW lines and WW MHs.
b. Parallel Utilities - no utilities shall be installed parallel to and above or below within 18-inches horizontally from the outer edge of the water main and parallel on either side of the line for the entire length of the water line.
c. Crossing Utilities - Crossings of all utilities shall be a minimum distance of 18-inches from the outer face of the water main in all directions unless otherwise approved by the Utilities Department. Approved and designed variances to the

minimum clearance shall be prominently marked on the Water Layout portion of the Construction drawings.

q. Depth of Cover

a. The depth of cover shall be measured from the surface of the finished grade to the top of the pipe barrel.
b. Unless otherwise shown on the drawings, the depth of cover shall be a minimum of 36 inches and a maximum of 48 inches under pavement.
c. Field changes that have been approved by the Engineer of Record and deviate from the Construction drawings shall be promptly red-lined on the field drawings by the Contractor.
d. Approved and designed variances to the minimum and maximum clearances shall be prominently marked in the Water Layout portion of the Construction drawings.

r. Parallel Fire Protection

a. For streets that have 100-ft. or greater ROW width or 4 travel lanes or greater
    i. parallel fire protection shall be required
    ii. fire hydrants are required on both sides of the street ROW.

s. Private Concrete Streets

a. Unless otherwise approved by the Executive Director of Water Utilities, water mains shall not be installed under private concrete streets.
b. Water mains shall be installed in UEs, away from the concrete roadway.
c. All mains crossing concrete streets shall be in an appropriately sized casing.
d. Service lines that cross under private concrete streets shall be increased by at least one full size from that otherwise specified herein and shall be installed in UEs.

t. Transmission Mains

a. Transmission Mains shall be built in accordance with accepted engineering practices for the area and in accordance with all applicable health and safety standards, as required by TCEQ and the Executive Director of Water Utilities.
b. Transmission Mains shall meet all operational integrity requirements as **determined by the Executive Director of Water Utilities.**

u. Untreated and Blend Water

a. Distribution piping for Untreated Water and Blend Water shall comply with the provisions of the Transmission Main requirements.

4.04 Valves and Fittings

a. Approved Valves

a. All valves must be AWWA-approved for use in domestic drinking water systems.
b. All valves must follow City of Corpus Christi Standard Construction Specifications.

b. Valve Spacing

a. For all grid and distribution mains (not transmission mains), the maximum spacing between valves shall be no more than 600-feet on center
b. Valves shall be located near fire hydrant assemblies when possible
c. Spacing and location of valves on Transmission Mains shall be approved by the Executive Director of Water Utilities.

c. Minimum Number of Valves

a. The minimum number of valves in the immediate proximity of a ‘tee’ shall be 2.
b. The minimum number of valves in the immediate proximity of a ‘cross’ shall be 3.
c. Follow City Standard Water Details for valve installation at intersections.

d. Valve Sizes

a. The size of the valve shall match the diameter of the main it is connected to

e. Non-Rising Stems

a. Unless otherwise specified, all valves in the water distribution system shall open left (counterclockwise), parallel to the main, and shall be non-rising stem valves.

f. Tapping Sleeve & Valve (TSV)

a. Tapping sleeves shall be appropriate for the size of pipe to be tapped.
b. Sleeves on asbestos-concrete pipe shall be full-bodied stainless steel.
c. All TSV shall be hydrostatically tested and approved prior to installation.
d. All TSV shall pass with zero leakage for 5 minutes at 75 psi prior to tapping.

g. Gate Valves

a. Resilient-seat gate valves shall be used for grid and distribution mains.

h. Transmission Main Valves

a. Butterfly or resilient-seat gate valves may be used for sizes of larger than 16 inches as approved by the Utilities Department.
b. Valves shall open left (counter-clockwise) and be clearly labeled on the construction drawings, along with the number of turns to close.

i. Bypass Assemblies

a. Gate valves that are 24 inches or larger shall have bypass assemblies.

j. Operating Wheels

a. Valves that are 24 inches and larger both in vaults and above ground shall have the main valve stem furnished with a combination hand-wheel and operating nut.

k. Position Indicators

a. All valves that are both above ground and in vaults, except for OS&Y valves, shall be furnished with a position indicator.

l. Air Release Valves

a. Air-release valves shall be used on mains, wherever the Engineer of Record determines that they are required.

m. Fittings

a. Fittings shall be mechanical joint ductile iron or as approved by the Executive Director of Water Utilities.
b. Fittings that are 3 inches or smaller shall be of brass or as approved by the Executive Director of Water Utilities.
c. Fittings for polyethylene service lines shall be restrained compression fittings with stainless steel inserts.

n. Cast Iron Valve Boxes

a. Cast iron valve boxes shall be provided over all operating valve nuts.
b. The word 'WATER' shall be cast in the top cover and should otherwise be equal to the standard City pattern as defined in the City's Standard Water Details.
c. Boxes and lids shall be given a coat of hot tar dip.
d. The extension pipe of the valve boxes shall be 8-inch C-900 PVC and shall extend from the valve box support lip to the top surface of the valve body.
e. Cast iron boxes shall be firmly supported, free and clear of the valve, and maintained centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished grade.

o. Valve Extensions

a. Valve extensions shall be provided for valve nuts that are more than 5 feet deep.
b. Valve extensions shall be factory-made, and the Executive Director of Water Utilities shall approve the length and type of extension prior to installation.
c. Valve extensions shall have a valve box installed over them and the extension pipe of the valve boxes shall be 8-inch C-900 PVC and shall extend from the valve to the valve nut.

p. Elevation of Valve Boxes

a. The top of valve boxes shall be flush with the finished grade in improved areas.
b. The top of valve boxes shall be set 24 inches above natural ground and protected with steel bollards in cultivated areas.

q. Valve Vaults

a. All geared valves shall be set in reinforced concrete vaults as designed by the Engineer of Record.
b. Vaults not in paved areas shall have spring-loaded aluminum access lids.
c. Vaults in paved areas shall have HS-20 load rating.
d. The wrench nut of the valve shall be readily accessible for operation through the vault opening.
e. If valve vaults are installed in areas of vehicular traffic, they must be equipped with aluminum H-20 traffic-loading rated lids and the Contractor or Developer must provide submittals that document the engineered lid capacity.
f. Construction drawings for the installation of the valve vault must be provided by the Developer to the City and approved by the Executive Director of Water Utilities.
g. Vaults shall be constructed in a manner that will permit access for minor valve repairs and afford protection to the pipe from impact or settlement where the pipe passes through the vault walls.

4.05 FIRE PROTECTION

a. Fire Hydrant Specifications

a. Standard - Fire hydrants shall conform to AWWA standards
b. Break-away Couplings
    i. All fire hydrants shall be of the traffic-model type, equipped with safety break-away couplings on both the hydrant barrel and the stem.
    ii. Break-away couplings shall be designed to break away to protect other parts of the hydrant during traffic collisions but weakened steel or cast-iron bolts shall not be acceptable for break-away barrel couplings.
c. Shut-Off - Only compression-type shut-offs will be acceptable
d. Nozzles - Fire hydrants shall be equipped with two threaded hose nozzles of 2 ½-inches inside diameter with one larger nozzle of 4-inch inside diameter
e. Nozzle Threads
    i. The hose nozzles shall have two-and-one-half inch (2 ½”) National Standard Thread (7 ½ threads per inch).
    ii. larger nozzle shall have six (6) threads per inch, with an outside diameter of four-point-six-five- eight inches (4.658”), pitch diameter of four-point-five-four-three inches (4.543”), and a root diameter of four-point- four-zero-six inches (4.406”).
f. Valve opening - the minimum size of the main valve opening at the base of the fire hydrant shall not be less than five-and-one-fourth inches (5 ¼”) inside diameter

g. Valve Seat Ring - the valve seat ring shall not be made an integral part of the shoe, and it shall be bronze and shall thread into a bronze drain ring
h. Nozzle Cap Chains - fire hydrants shall be supplied without nozzle cap chains
i. Open Left - fire hydrants shall open counter-clockwise
j. Color - the upper barrel, bonnet, and nozzle caps of the fire hydrant shall be factory-coated chrome yellow
k. Operating Nuts - the operating cap nuts shall be tapered pentagon 1 3/16-inch point-to-face base and 1 1/8-inch point-to-face at the top of the nut, and the operating stem nut shall be made of bronze
l. Barrel Sections - the fire hydrant shall be made in two or more-barrel sections with flanges connecting the upper barrel to the lower barrel and the lower barrel to the shoe
m. Stainless Steel Bolts - all the bolts in the body of the fire hydrant shall be 304 or 316 stainless steel.
n. Weep Hole Mechanism
    i. Fire hydrants shall drain through weep holes located at the seat of the fire hydrant
    ii. Drain holes shall be in the open position when the fire hydrant is closed
    iii. Drain valves operating through springs or gravity are not acceptable.

b. Fire Hydrant Location

a. Fire hydrants shall be installed in UEs or in public ROW, at street intersections or on streets between property lines to avoid future driveway conflicts.
b. Fire hydrants shall be installed between the curb and sidewalk nearest the property lines and accessible to the Fire Department during routine maintenance or emergencies.

c. Fire Hydrant Spacing

a. In single-family and two-family (duplex) residential areas, fire hydrants shall be located with a maximum spacing of 600 LF on center as measured along the centerline of the street.
b. In commercial, light industrial, and heavy industrial areas, fire hydrants shall be located with a maximum spacing of 300 LF on center as measured along the centerline of the street.
c. The spacing and location of fire hydrants on transmission mains shall be those approved by the Executive Director of Water Utilities.

d. Fire Flow Requirements

a. Main lines in residential areas shall be sized so that the minimum flow of water from any single fire hydrants shall be no less than 750 gpm with 20 psi residual pressure considering the domestic use of 3 gpm for every lot in the subdivision.
b. Commercial areas shall be sized so that the minimum fire flow from any single fire hydrant shall no less than 1,500 gpm with 20 psi residual pressure.
c. Main lines in light and heavy industrial areas shall be sized so that the minimum fire flow from any single fire hydrant shall not be less than 3,000 gpm with 20 psi residual pressure, considering any anticipated domestic flow required in the area being served.
d. If the Developer cannot meet these standards, they may also use the current adopted Fire Code to meet fire flow requirements.

e. Fire Hydrant Barrier Protection

a. Whenever there is a risk of vehicular traffic damage to fire hydrants, bollards must be installed.
b. Bollards for fire hydrant protection shall be of 6-inch diameter galvanized steel pipe set in a concrete foundation that is 42 inches deep and 18 inches in diameter.
c. Bollards shall extend 4 feet above finished grade, shall be filled with concrete with a molded rounded top to shed moisture and painted with red reflective paint.
d. Bollards shall be spaced no more than 5 feet apart and shall be configured according to the City Standard Water Details.

f. Maximum Distance to Residential Lots

a. The maximum distance from a fire hydrant to the edge of anyone-family and two-family residential lot shall be 500 feet.

g. Horizontal Clearances from Fire Hydrants

a. All fire hydrants shall have a 3-foot radius clear horizontal distance from the outer edge of the fire hydrant barrel to any vertical obstruction.
b. All fire hydrants shall be readily accessible for Fire Department use at all times.
c. Fire hydrants shall have a minimum of 18 inches from the back of the curb to the front edge of the larger nozzle connection.
d. Fire Hydrant pumper nozzle shall be facing the direction of the street or in a direction that the fire truck can readily access the fire hydrant

e. When located next to a sidewalk, the outer face of the large nozzle cap shall be no closer than 6 inches from the edge of the sidewalk

h. Out of Service

a. Fire hydrants that are placed out of service shall be identified by a black coating
b. For fire hydrants that are placed out of service temporarily, the fire hydrant shall be wrapped securely with 8-mil black plastic
c. For fire hydrants that are placed out of service for an extended period of time, the entire fire hydrant will be painted black

i. Private Fire Lines with Hydrants

a. Unless approved in writing by the Executive Director of Water Utilities, private fire lines shall not be allowed
b. If a private fire line is approved and permitted, a water meter and a double check detector shall be installed at the property line
c. Private fire lines and hydrants shall be maintained by the owner.

j. Fire Hydrants in Sidewalks

a. Fire Hydrants shall not be installed in sidewalks unless no other location is reasonably available and full ADA access can be maintained on the sidewalk.
b. In the event that there is no other location, and a fire hydrant is to be installed in a sidewalk, fire hydrants shall be located so that sidewalks have a minimum of 3 feet radius of unobstructed sidewalk passageway around the fire hydrant.

k. Fire Hydrant Assemblies

a. Fire hydrant assemblies shall be constructed as per the City Standard Water Details.

l. Depth of Bury vs. Break-away Coupling

a. Fire hydrants shall be buried to the bury line as specified by the fire hydrant manufacturer.
b. If a bury line is not specified by the fire hydrant manufacturer, the break-away flange of the fire hydrant shall be installed between 2 inches and 6 inches above the finished grade so that the fire hydrant will be sheared off when hit by a vehicle.

c. Bolts used for the break-away coupling shall be those specified by the manufacturer

m. Post-Indicator Valves

a. Post-indicator valves shall be installed as per the National Fire Protection Association Code

4.06 PLAN STANDARDS FOR INSTALLATION OF WATER LINES

a. Alignment Conflict

a. Water mains shall be noted to be installed in accordance with the specified lines and grades as shown on the Construction drawings.
b. Fittings, valves, and fire hydrants shall be noted to be installed at the locations specified in the Construction drawings.
c. Where the grade or alignment is obstructed by existing utility structures such as conduits, duct-banks, pipes, and connections to sewers or drains, etc., the plans shall note that the obstruction shall be protected at the Contractor's expense, in cooperation with owner of the utility structures.
d. Plans shall be noted that it is the Contractor's responsibility for temporary support and adequate protection of all underground, surface, and above ground utility structures encountered in the progress of the work.
e. On subdivision and private development projects the responsibility for adjustment of utilities shall be borne by the Developer.
f. Plans should be noted that any field changes made to the engineered drawings must be approved by the Engineer prior to installation and immediately recorded on the field red-lined drawings.

b. Plumb Installation

a. All valves and fire hydrant stems shall be noted to be installed plumb prior to the hydrostatic testing of the main

c. Polyethylene Wrapping

a. As per TCEQ, all ductile iron pipe, valves, and fittings (other than in encasement pipe or vaults) shall be noted to be wrapped in 8-mil polyethylene material, which can be either black or clear.

b. The wrapping shall be noted to be lapped in such a manner that all surfaces of the pipe, valves, and fittings, including joints, shall have a double thickness of polyethylene that is lapped a minimum of 18 inches with the lap on the lower quadrant of the pipe to prevent backfill from coming into the encasement and secured with polyvinyl tape or twine at maximum 6-foot intervals.
c. Notes on wrapping should also include that wrapping applied ahead of installation must be handled with care and that any wrapping that is damaged shall be repaired in a manner satisfactory to the Executive Director of Water Utilities so as to best protect the pipe.
d. Backfill notes shall state that sand backfill shall be placed in a manner that will not injure the wrapping and shall be compacted under, around the sides, and over the pipe in a manner that will minimize settlement.

d. Sand Encasement

a. All pipe and fittings which are not enclosed in a concrete vault or placed in an encasement pipe shall be completely encased with a minimum of 8 inches of sand around the outer edge of the pipe.
b. For pipes that are 16-inch diameter or larger, sand encasement shall be 12 inches around the outer edge of the pipe.
c. Sand encasement includes the bottom, sides, and top of the pipe or fittings, to include bell joints so that all portions of the main that are to be buried are encased to insulate the pipe from the natural ground and the backfill.
d. Sand backfill material shall be in accordance with the City Standard Construction Specifications.
e. Sand encasement shall be subject to testing, as directed by the Executive Director of Water Utilities.
f. Sand that does not meet specifications, the sand shall be rejected and all disapproved material shall be removed from the work site at the Contractor's expense.

e. Final Backfill Zone

a. This zone exists above the sand encasement up to the ground surface.
b. The material in the backfill zone shall be in accordance with the City's Standard Construction Specifications and the Water Standard Details and shall be determined to be appropriate based on the intended use of the finished grade surface, with roadway utility trenches generally requiring cement stabilized sand for at least a portion of the backfill to prevent trench collapse under the new roadway.

f. Over-Excavation

a. Any part of the trench that is over-excavated shall be corrected with cement sand backfill as defined in the City Standard Water Details.

g. Trenches

a. Trenches shall be excavated true and parallel to the pipe center line with minimum clearances as specified.
b. Trenches shall be wide and deep enough to account for sand encasement.
c. Where stumps and roots are encountered, they shall be removed flush with the sides of the trench.

h. Restraining the Main

a. An appropriate number and type of restrained fittings shall be required at all bends, tees, crosses, and blow-off valves.
b. All special main restraints shall be designed by the Engineer, shall be included in the drawings, and shall be approved by the Utilities Department prior to installation.
    i. Restrained Joints
        1. Restrained fittings, metal harnesses, tie rods and clamps, or swivel fittings shall be used to prevent movement of the pipe and joint
        2. Restraining devices and design configurations shall be specified by the Engineer and shall be project specific.
        3. All restrained fittings and devices shall be installed according to the manufacturer's specifications.
        4. Steel rods and clamps shall be galvanized or otherwise rust-proofed with hot coal tar enamel.
        5. All fittings shall be wrapped with polyethylene wrapping per TCEQ.
    ii. Thrust Blocks
        1. Thrust blocks shall only be used on transmission mains, as determined by the Engineer.
        2. All thrust blocks shall be designed by the Engineer.
        3. Material for thrust blocks shall be designed by the Engineer and shall be placed between undisturbed soil and the pipes and fittings being anchored.
        4. The blocking shall be placed so that the pipe and fittings shall be accessible for repair.

i. Pipes and Fittings

a. Installation of pipe and fittings shall be done in accordance with the manufacturer's recommendations, unless such recommendations are in conflict with provisions herein, in which case the provisions herein shall prevail.

j. Pipe Deflection

a. Pipe deflection shall not exceed 75% of the maximum allowances recommended by the manufacturer.

k. Linear Locator Tape and Tracer Wire

a. A linear locator tape shall be installed directly above all water pipe on the top surface of the sand encasement.
b. Tracer wire is required for non-metallic pipe installations per the City Standard Water Details.

4.07 TAPS AND METERS

a. Service Lines

a. All water service lines shall be metered
b. Water service lines shall be of materials approved by AWWA for domestic water
c. Service line connections may be made on water lines that are 12 inches in diameter or smaller
d. Service lines may be connected to fire hydrant leads, provided that the service tap is made ahead of the fire hydrant valve, allowing the fire hydrant to be shut off and serviced without the interruption of service to any customer
e. To avoid having to install a post-indicator valve on a fire line, domestic water service lines may be connected immediately after the valve that supplies the fire line
f. Acceptable water service connection sizes will be ¾-in, 1-in., 2-in., 4-in., 6-in., and 12-in.

b. Domestic Water Meters

a. The location of all domestic water meters shall be specified in the drawings and shall be in immediate proximity to the public ROW or UE.
b. More than one domestic water meter is permitted for a single property, provide the meter serves a different tenant.

c. Whenever the Executive Director of Water Utilities determines that multiple buildings on a single property are spaced too far apart and additional water meters are warranted, then more than one domestic water meter may be allowed for a single owner or tenant occupying both structures.

c. Separate Irrigation Water Meters

a. In addition to domestic meters, separate water meters are permitted for lawn irrigation systems.
b. Irrigation water meter locations shall be specified in the Construction drawings.
c. Whenever the Executive Director of Water Utilities determines that landscaped areas on a single property are spaced too far apart, more than one irrigation water meter may also be permitted for a single property.

d. Location of Water Meters

a. The water meters shall be located in grassy areas at the edge of the public ROW or UE.
b. The Developer shall mark the requested location of the water meter with a 2 x 4 stake painted blue.
c. The Utilities Department shall make every effort to install the water meter at the requested location, however, the location of the water main and the accessibility of the requested location will determine the final placement of the water meter.
d. If no marking is provided to by the Developer, the Water Department shall place the meter in the most cost-effective location for the City.

e. Fire Line Meters

a. Whenever a double check is required on a fire line due to the line being too small for a double check detector, a water meter for the fire line will be required.
b. These meters will be provided with an OS&Y valve ahead of the meter.
c. Meters shall otherwise comply with the City Standard Water Details.

f. Costs for Taps and Meters

a. The Developer/Contractor shall be responsible for all of the costs associated with tapping the main.
b. The cost for the taps and meters are found in the Utility Fee Schedule.
c. All taps and meters shall be paid for prior to installation.

g. Larger Meters

a. For meters and/or taps that are larger than those specified in the Utility Fee Schedule, adequate information must be provided to the Executive Director of Water Utilities so a specific price quote can be provided.
b. If the 3-in. and 4-in. meters are not installed above ground, they shall be installed in meter vaults as specified in the City Standard Water Details.
c. Meters that are 6 inches and larger shall be installed above ground.

h. Meter Manifold

a. If a meter manifold is installed, a 1-in. tap will support a maximum of (2) meters of ¾-in.
b. If a meter manifold is installed, a 2-in. tap will support a maximum of (8) meters of ¾-in.
c. Any other design configuration for a water meter manifold shall be designed and sealed by the Engineer and shall be supported by calculations when requested by the Executive Director of Water Utilities.
d. Depending on the size of the water meter manifold, a meter vault may be required, as determined by the Executive Director of Water Utilities, and as specified in the City Standard Water Details.

i. Making Taps and Setting Meters

a. Active mains can only be tapped by Approved Water Utility Tapping Contractors or under direct supervision by Utility Department representative.
b. The Utility Department Crews are the only ones that are permitted to install City-read water meters.

j. Residential Subdivision Pre-Taps

a. In residential subdivisions, the Developer shall provide either a single-service connection, consisting of a 1-in. service tap, a 1-in. single-service line, a ¾-in. curb stop, and a meter box that is approved by the Executive Director of Utilities, or a double-service connection, considsting of a 1-in. service tap, a 1-in. service line, a 1-in. double-meter manifold with (2) ¾-in. curb stops and meter boxes that are approved by the Executive Director of Utilities.
b. The double-service connection assembly and meter box are to be set in the public ROW or UE straddling the property line of the properties served.

c. The pipe material for the service lines shall be Polyethylene or as specified in the Standard Water Details.
d. The distance from the curb stops and meter yoke below finished grade shall be 12 inches, and the distance behind the curb shall be 2 feet.

k. Curb Markings

a. Pre-Tap locations shall be marked with a brass 'W' of approximately 1 ½-in. in size placed on the face of the concrete curb at the location where the curb stop was installed.

l. Construction Meters

a. Construction meters shall be provided, set, moved, and tested by the City

4.08 BACKFLOW PREVENTION

a. Backflow Protection

a. All service connections where an actual or potential contamination hazard exist shall be protected from contamination due to backflow by a backflow protection device.
b. Backflow protection devices shall be installed to comply with the most current adopted version of the Plumbing Code and as specified herein.

b. Irrigation Systems

a. In irrigation systems, the public water supply shall be protected from contamination using the appropriate backflow protection device, as outlined in the most current version of the Plumbing Code.

c. Fire Lines

a. A valve shall be installed at connections to the City water main.
b. Fire Lines shall be protected using a double-check detector assembly.
c. For smaller fire lines, such as residential-type fire lines that do not have a double-check detector, a double-check may be installed.
d. The fire line shall be controlled using an OS&Y valve to shut off the meter.
e. Above-ground double-check detector assembly shall be installed at the edge of the street ROW of UE in close proximity to the public water main.

f. Double-check detector vaults may be used as approved by the Executive Director of Water Utilities.
g. The above-ground piping and assembly shall be protected from freezing, as directed by the Fire Marshal.
h. The above-ground piping and assembly shall have a concrete pad beneath it and shall be protected with bollards from vehicular traffic where applicable.
i. The valves on both sides of the backflow protection device shall be OS&Y valves.
j. Drawings for the installation of the fire line must be provided by the Developer and approved by the Executive Director of Water Utilities before installation.

d. FLDC at Street Exemptions

a. Under the following circumstances, exemptions from the requirement to install the backflow protection device near the street ROW or UE shall be granted as follows:
    i. Less than 100 feet - when the distance from a looped main to a fire sprinkler system riser is less than 100 feet, the backflow protection device may be installed inside the building, on the riser .
    ii. Compound meter
        1. Except on residential-type of fire lines, whenever the water meter provides for domestic and fire water, a compound meter shall be required.
        2. The domestic line may be separated from the fire line piping inside the Mechanical Room and the backflow preventor device on the fire line shall be required inside the building.
        3. Compound meters that are over 4 inches in diameter shall be installed above ground at the edge of the public ROW or UE.

e. Construction Meters

a. A reduced-pressure-principle backflow prevention device shall be located on the downstream side of the construction meter to protect the water distribution system from contamination during use of the construction water.

f. Testing Backflow Devices

a. It shall be the responsibility of the Developer to have all backflow prevention devices tested and certified upon installation, relocation, and repairs.
b. A maintenance and testing certificate shall be provided to the City of Corpus Christi annually to certify the proper operation of each backflow preventer.

4.09 INSPECTION

a. Water Inspections

a. All public water improvements shall be inspected and approved by the Utilities and Engineering Departments.
b. Inspections shall occur before the improvements are backfilled or covered up to ensure that the improvements are built according to the plans and specifications.
c. The Developer or Contractor shall give a notice of at least 72 hours for inspection requests.

b. Acceptance of Main

a. Acceptance of a main shall not be made until all of the proposed work is inspected and approved by Utilities and Engineering Construction Department, the Record Drawings are received from the Engineer, and the warranty phase walk-through and corrections have been completed.

4.10 TESTING PROCEDURES

a. Hydrostatic Test

a. The Contractor shall provide all the materials, equipment, and labor necessary to accomplish the hydrostatic testing of the new water main.
b. The Contractor shall not be considered ready for the test until the Water Inspector has confirmed that all valves are accessible and open, all fire hydrants are properly set, and all the curbs and gutters have been installed.

b. Preparation of Hydrostatic Test

a. Water for filling the line shall be provided by the City of Corpus Christi through a water meter assigned to the Contractor.
b. The Contractor is responsible for paying the applicable water rate.
c. A gauge and meter for testing shall be supplied by the City.
d. A test pump with the appropriate connection points as approved by the Executive Director of Water Utilities shall be provided by the Contractor.
e. The meter shall be connected directly to the main being tested but shall be protected against extreme pressures by the sue of a 1-inch safety relief valve set at a test pressure of 10 psi.
f.

c. 2-Hour Test

a. The first hydrostatic test shall be a 2-hour test at a pressure of 150 psi.
b. The allowable leakage during this portion of the test shall be based on the sum of the leakage allowed in the AWWA and TCEQ standards for the type and quantities of pipe and appurtenances being used.
c. The allowable leakage shall be calculated by the Engineer based on the material quantities of actual main installed.
d. The required document shall be signed and sealed by the Engineer and made available to the Water Inspector prior to the test.
e. The results of the test shall be recorded and kept by the Executive Director of Water Utilities until such time as the warranty phase walk-through and corrections have been completed.

d. 24-Hour Test

a. To insure the public health, safety, and general welfare of the population served by the City of Corpus Christi, the Executive Director of Water Utilities shall have only licensed personnel supervise and direct all water main sterilization, taps, connections, and operations per TCEQ.
b. The developer/contractor shall disinfect the new water main in accordance with AWWA and TCEQ standards.

e. Preparation for Bacti Test

a. All pipes, valves, fire hydrants, and fittings shall be stored on timbers and kept clean.
b. Where soil or other substances have come into contact with the water surfaces of the pipe or fittings, the interior shall be washed and sterilized with a 2% solution of calcium hypochlorite.

f. Bacti Test

a. Once a new main has passed the hydrostatic test, it must be disinfected according to AWWA and TCEQ standards and allowed to stand for 48 hours.
b. After the sterilization period is completed, one end of the new line shall be connected to an existing pipe on the distribution system that is the same size or larger and shall be flushed by the Contractor under the direct supervision of the Water Inspector.

c. The hypo-chlorinated water shall be disposed of in accordance with TCEQ regulations.
d. After the flushing of the new main, a water sample shall be taken.
e. After a 24-hour incubation period for the water sample, the results of the bacteriological test shall be obtained.
f. If the sample does not pass TCEQ purification standards, the sterilization procedure shall be repeated.
g. A series of 2 bacteriological test failures shall require the Contractor to 'pig' the system before any more bacteriological samples shall be collected.
h. No new piping shall be accepted as part of the water distribution system prior to the time that the new system can be sterilized, tested, and accepted by the Water Inspector.

City of Corpus Christi

Infrastructure Design Manual

Chapter 5

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

Chapter 5

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

5.01 PURPOSE

This chapter sets design criteria for WW facilities (including collection systems) within the public right-of-way or utility easements

5.02 DESIGN REQUIREMENTS

5.02.01 Required Drawings

To obtain a permit for the construction of a proposed WW line or WW service lead traversing a public ROW or UE to an existing WW line, a plan and profile drawing of the proposed WW line shall be prepared and submitted to the City for approval.

5.02.02 Drawing and Design Contents

a. The detailed drawings will show the exact location of the proposed line in the street, alley, or UE with respect to the edge of the ROW, any nearby utilities, the 100-year flood plain elevation within the project area and any major features such as structures or landscaping that will affect construction.

b. WW lines and MHs shall be identified by number, letter, or other identification shown on the WW layout sheet

5.02.03 Drawing Requirements

a. All WW lines and all WW connections shall be shown in both plan and profile views on the drawings]

b. WW Plan Views shall contain:

1. Pipe size
2. Pipe size change
3. Pipe material
4. Pipe material change
5. Elevations of FL to 0.01 ft. called into and out of each MH
6. Dead Ends
7. Existing ground surface and proposed finished grade elevations
8. Topographical features

9. All Utility Easements
10. All existing OH or UG utilities of any type
11. Proposed service connections
12. Locations of pressure pipe or casings for WL crossings or other special condition
13. Limits of special backfill, tunnels, bores, and casings
14. All structures within 25 feet of the proposed WWL
15. Stationing along proposed WWL (can use street stationing)
16. Direction of flow

c. The profile shall show other UG and surface utilities and features, both in parallel and for crossings, with labels or callouts or keyed tables to include:

1. Pipe size
2. Pipe slope
3. Pipe slope changes
4. Elevations of FL to 0.01 ft. called into and out of each MH
5. Elevations of FL to 0.01 ft. called out at each match line
6. Dead Ends
7. Existing ground surface and proposed finished grade elevations
8. Bedding and backfill per Standard Specifications and Details
9. Size and material changes
10. Direction of flow
11. MHs labeled by letter or number and with stationing and rim, depth, and FL elevations
12. Stationing along proposed WWL (can use street stationing)
13. All existing UG utilities of any type
14. Proposed service connections
15. Locations of pressure pipe or casings for WL crossings or other special condition
16. Limits of special backfill, tunnels, bores, and casings
17. All structures within 25 feet of the proposed WWL

d. WW laterals, MHs, and service connections shall be detailed separately from the main

5.02.04 WW Utility Easements

a. WW UEs shall be a minimum width of 15 feet

b. WW UEs for 18-inch or larger mains shall be a minimum width of 20 feet

c. WW UEs for mains deeper than 15 feet shall be a minimum width of 20 feet

5.02.05 WW Service Connections

a. Each single-family dwelling shall have its own service and cleanout

b. Each duplex shall have a single 4-in. service and cleanout with a wye to serve each unit separately

c. Service leads for single-family dwellings or duplexes shall not require a MH

d. Service leads for commercial developments may be required to have a MH at the main connection based on length of service line, predicted WW flows generated by the development, and/or required pipe size

e. All service leads require full saddle connections with an orientation between 1:30 and 3:00 or between 10:30 and 9:00

f. Service lines shall be designed to have the minimum number of bends to be permittable

5.02.06 WW General Requirements

a. Materials and construction shall conform to the latest City Standard Specifications and Details

b. Unless noted otherwise, all WW lines and service leads shall be embedded in granular bedding from 6-in. below to 12-in. above the pipe

c. Backfill for paved and non-paved areas will be as shown in the City Standard WW Details and Specification Section 022020

d. WW improvements shall be located in a public ROW or UE

e. UEs shall not have a closed end

f. MHs located in the 100-year flood plain shall be sealed and vented per TCEQ

g. MHs located in driveways shall be sealed and vented per TCEQ

h. MHs shall not be located between the top of banks for ditches, swales, or creeks

5.02.07 WW Line Size

a. The minimum pipe diameter for a WW line shall be 8-in.

b. 4-in. WW lines are only allowed for service leads for individual homes or duplexes

c. 6-in. and larger WW lines are only allowed for commercial properties

d. The City shall have final say as to the configuration of any proposed WW line in regard to the orderly and non-duplicative expansion of the City's WW system

e. The City shall have the final say as to the size and depth required for an WW line, as well as for any exception or waiver requested

5.02.08 WW Line Depth

a. WW lines shall be placed a minimum of 3-ft. of cover below the pavement section, other finished grade, or natural ground

b. Maximum depth for 8-in. through 12-in. dia. WW lines shall be 20 feet

c. Maximum depth for large diameter WW lines is 30 feet

5.02.09 WW Line Slope

a. To avoid stagnation from being too flat or to avoid leaving solids behind from being too steep, the City of CC has adopted minimum and maximum slopes that are within the TCEQ min/max slope limits, but are more restrictive

b. TCEQ minimum slopes are derived from a minimum velocity of 2.0 fps

c. City of Corpus Christi desired minimum velocity is 2.3 fps (6-in to 27-in)

d. TCEQ maximum slope is derived from a maximum velocity of 10.0 fps

e. City of Corpus Christi desired maximum velocity is 4.5 fps (6-in to 27-in.)

f. TCEQ minimums and maximum slopes from the Texas Administrative Code 217.53(l)(2)(A) shall only be allowed to resolve otherwise unresolvable conflicts

g. City of Corpus Christi minimum and maximum slopes for pipe diameters of 6-in. to 27-in. are as shown in Table 5.1:

Table 5.1: Minimum and Maximum WW Line Slopes

City of Corpus Christi Minimum and Maximum WW Line Slope				
Nominal Pipe Size	**Minimum Slope**		**Maximum Slope**	
(inches)	(Foot/Foot)	(%)	(Foot/Foot)	(%)
6	0.007	0.70	0.0246	2.46
8	0.0044	0.44	0.0173	1.73
10	0.0033	0.33	0.0121	1.21
12	0.0026	0.26	0.0097	0.97
15	0.0019	0.19	0.0072	0.72
18	0.0015	0.15	0.0057	0.57
21	0.0013	0.13	0.0046	0.46
24	0.0011	0.11	0.0038	0.38
27	0.0009	0.09	0.0033	0.33

h. Pipe slopes for pipes larger than 27 inches must be calibrated by the design engineer utilizing Manning's formula with an n-value of 0.013 and a minimum full pipe velocity of 3.0 fps

5.02.10 WW Line Alignment

a. Gravity WW lines shall be placed in a straight alignment and uniform slope between manholes

b. WW line alignment shall comply with all portions of TCEQ requirements

c. Curved alignment with offset joints deflected <5% shall have MHs at 300-foot intervals

5.02.11 WW Manholes

a. All WW MHs shall be fiberglass, whether liners or new MHs

b. MH covers shall be 32-inches per City Standard Details and TCEQ requirements

c. MHs are required at all:

i. Changes in alignment

ii. Changes in pipe size or material

iii. Changes in pipe slope

iv. Junction points

v. At intersections and cross streets

vi. Every 500 LF

vii. At the upstream end (beginning) of all WW systems

d. Drop MHs shall be as required by TCEQ and City WW Standard Details

e. Internal drop connections shall not be allowed

f. MH covers in pavement shall be HS-20 traffic-rated

g. MH covers in certain locations may be required to be bolted covers

5.02.12 WW Lift Stations

a. Lift stations shall conform to TCEQ requirements

b. Final authority on lift station design is at the sole discretion of the City

5.03 SEPTIC TANKS

5.03.01 City preference and sole discretion

a. It will always be the City's preference to connect all structures to the appropriate nearby WW line

b. The developer shall bear the cost of the utility extensions to serve any new structure

c. If it can be demonstrated to the satisfaction of Development Services that there is no practical alternative to a septic system, permission may be granted at the sole discretion of the City

5.03.02 Requirements

a. Septic tanks and drain fields shall comply with applicable City, County, and State codes per TCEQ

5.04 ON-SITE WASTEWATER FACILITIES

5.04.01 Review and Approval

a. Review and approval of on-site WW treatment facilities shall be on a case-by-case basis

b. Any proposed on-site WW treatment facility must comply fully with TCEQ requirements

c. Approval is at the sole discretion of the City

5.05 SUBMITTALS

5.05.01 Preliminary Design Submittals to include:

a. Copies of any coordination documents indicating approvals or exceptions granted by the City

b. Design calculations for line sizes and grades

c. Contour map of project area

d. Plan and Profile sheets of proposed improvements

e. Geotechnical soils identification and testing report

5.05.02 Final Design Submittals to include:

a. Final design or coordination documents

b. Review comments

c. Final drawings

d. Final specifications

e. Engineering Design Report, signed and sealed

5.06 QUALITY ASSURANCE

5.06.01 Professional Engineer

Designs and design drawings shall be prepared under the direct supervision of a Professional Engineer licensed in the State of Texas, and all submittals shall be marked with the P.E.'s seal or disclaimer as required by the practice act

5.07 RESEARCH REQUIREMENTS

5.07.01 Responsibility

It is the sole responsibility of the design engineer to research existing utility and ROW/UE information and to display them accurately on the design drawings

5.08 DESIGN ANALYSIS

5.08.01 Calculations to be provided as follows:

a. Calculation of the design flows for the completed development project, to include all phases or ultimate condition

b. Calculations for design of any on-site treatment plant or septic system

City of Corpus Christi

Infrastructure Design Manual

Chapter 6

STREET DESIGN REQUIREMENTS

Updated November 17, 2022

Chapter 6 STREET DESIGN REQUIREMENTS

6.1 ROADWAY DESIGN STANDARDS

a. All streets shall, at a minimum, be designed and installed in accordance with the Urban Transportation Plan (UTP) Guidelines, Comprehensive Plan, applicable area development, master plans, the approved Mobility Plan, and the Design Standards.

b. Streets shall be designed for a 30-year life in accordance with the American Association of State Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures ("the AASHTO Design Guide") 1993 Edition and supplements unless a later edition of the AASHTO Design Guide is required by the Design Standards under the latest edition of the Infrastructure Design Manual and supplements. (Ordinance 030023, 12/10/2013)

c. In the event of any conflicts between the Design Standards and any edition or supplement to the AASHTO Design Guide, the Design Standards prevail.

d. Any variations or deviations to the Street Design requirements/standards shall be **approved by Director of Public Works**

6.2 ROADWAY GEOMETRIC DESIGN STANDARDS

6.2.1 Street Classifications and Street Design Standards per UTP Guidelines

a. Designers shall adhere to the Urban Transportation Plan Guidelines as shown in the UTP and the roadway geometric design criteria are shown in the table below.

b. Roadway geometric design shall follow AASHTO and National Association of City Transportation Officials (NACTO) guidelines, and the Unified Development Code (UDC).

c. Urban Streets are classified as below:

1. Local streets (L-1A, L-1B)
2. Non-Local Streets
   - I. Minor residential collector (RC1)
   - II. Collector (C1)
   - III. Secondary collector (C2)
   - IV. Primary collector (C3)
   - V. Parkway collector (P1)

VI. Minor arterial (A1)

VII. Secondary arterial (A2)

VIII. Primary arterial (A3)

IX. Freeways (FR)

~~d.~~ All urban streets within the City and ETJ shall be designed with curb and gutter, underground utilities and storm drainage systems to the appropriate design year storm as indicated in Chapter 3 unless otherwise approved by the City Development Services Engineer.

e. Rural Streets are classified as below:

i. Local rural streets (LRS)

ii. Minor rural arterial (RA1)

iii. Secondary rural arterial (RA2)

iv. Primary rural arterial (RA3)

f. Rural streets may be designed with above ground storm drainage systems to the appropriate design year storm as indicated in Chapter 3.

g. Center medians shall be designed with a minimum of 16-feet to accommodate shelter for dedicated left turn lanes.

6.2.2. Street Right-of-Way Dimensional Standards

Street right-of-way dimensional standards for different street classification shall be as shown in the table.

Table 6.2.2.A Local Street Standards

Local Street Section Type	Right of Way Width	Planting/ Utility Area	Street Section Width (BC)	Bump-Out *	Tied Sidewalk	Sidewalk Required Both sides	Traffic Lanes	Parking Sides Allowed	Max Trips/Day and Max Length	Cul-de-sac and Max Length
L-1A	50 ft	6 ft	28 ft	With= 6 ft Without = 0 ft	Not Allowed	Yes **	2-way	Two	1,600 trips/day NTE 2,640 ft	Yes (800')
L-1B	50 ft	7 ft	28 ft	6 ft	Required	Yes **	2-way	Two	1,600 trips/day NTE 2,640 ft	Yes (800')

1) Design Speed for local street is 25 miles per hour (MPH)

2) Sidewalk width for local streets is 4 ft.

3) *Bump-Out spacing parallel to curb: Minimum 150 feet, Maximum 300 feet

4) **Sidewalks not required if lot is a minimum of 22,000 square feet and zoned Farm Rural or Residential Estate

Table 6.2.2.B Non-Local Street Standards Table

Non-local Streets*	ROW Width (ft.)	BB Width (ft.)	Through Lanes	Median / Turn Lane	Spacing (miles)	Sidewalk** (ft.)	Back of Curb to Property Line (ft.)	Avg. Daily Trips
Minor Residential Collector (RC1)	60	40	2	No	0.25 to 0.5	5	10	1,000 - 3,000
Collector (C1)	60	40	2	No	0.25 to 0.5	5	10	4,000 - 8,000
Secondary Collector (C2)	65	41	3	Center turn	0.25 to 0.5	5	12	8,000 - 10,000
Primary Collector (C3)	75	50	4	No	0.25 to 0.5	5	12.5	10,000 – 14,000
Parkway Collector (P1)	80	40	2	--	0.25 to 0.5	5 to 8	14.5 to 25.5	4,000 – 8,000
Minor Arterial (A1)	95	64	4	Center turn	1.0 to 1.5	5	15.5	15,000 - 24,000
Secondary Arterial (A2)	100	54	4	Median	1.0 to 1.5	5	15	20,000 – 32,000
Primary Arterial (A3)	130	79	6	Median	1.0 to 1.5	5	17.5	30,000 – 48,000
Freeway (FR)	400	Varies	--	Median	--	No	19	60,000 – 200,000

(Ordinance 030769, 02/16/2016)

1. *Non-local streets contain curb and gutter and underground drainage.
2. Sidewalk width for non-local streets is 5 ft.

Table 6.2.2.C Rural Street Standards Table

	ROW Width (ft.)	Pavement Width (ft.)	Lanes	V-Ditch or Left Turn	Bikeway Capable	Sidewalk*	Roadside Ditch Width
Local Rural Streets (LRS)	60	26	2	--	No	No	34
Minor Rural Arterial (RA1)	125	44	2	--	No	No	40.5
Secondary Rural (RA2)	150	82	4	Center turn	No shoulder	No	41.5
Primary Rural Arterial (RA3)	250	76	4	Median v-ditch	No shoulder	No	48

(Ordinance 030769, 02/16/2016)

Table 6.2.2.D Geometric Design Criteria

Design Element Width	Preferred (Feet)	Minimum (Feet)
Travel Lanes	11	10
Turn Lanes	12	10
Median Width at Turn Lanes	17	15
Median Width Face of Curb to Face Of Curb	17	4
Center Turn Lane Width	12	10
Standard Bike Lane	7	6
Buffered Bike Lane	10	8
Buffered Sidewalk	5	5
Tied-Sidewalk	5	5
Multi-Use Side Path	10	8
Shared Use Path/Hike N Bike Trail	14	12
One-Way Cycle Track, Both Sides	6	6
Landscape/Parking Buffer	5	2

6.2.3 Pedestrian and Bicycle Accommodations

a. Sidewalks shall be per the Street Classifications and Street Design Standards

b. Curb Ramps shall be to the Texas Accessibility Standards (TAS)

c. Driveways shall have the appropriate cross slope per TAS

d. Medians shall be designed with pedestrian shelter where appropriate

e. Bus Stops shall be designed to RTA standards such that they do not encroach into the required sidewalk passage area per TAS

f. Developers should consider connectivity beyond project limits for sidewalks, shared use and multi-use paths.

6.2.4 Curb Radii

a. The curb radius is the radius of curvature, measured from the center of curvature, of a physical curb-return at the corner of a street intersection.

b. In selection of curb radii, the designer shall consider the needs of all roadway and pedestrian traffic and use appropriate representative design vehicle templates.

c. Curb radii around cul-du-sacs shall be as follows:

   i. Single-Family Residential = 48-ft.

   ii. All other areas = 50-ft.

d. Other curb radii shall be as in Table below:

Table 6.2.4.A Standard Curb Radius by Intersection Type and Angle

Intersection Type			Standard Curb Radius by Intersection Angle	
			90°	80° TO 90°
Local	to	Local	15-FT.	15-FT.
Local	to	Collector	20-FT.	20-FT.
Local	to	Arterial	20-FT.	20-FT.
Collector	to	Collector	25-FT.	25-FT.
Collector	to	Arterial	25-FT.	25-FT.
Arterial	to	Arterial	30-FT.	35-FT.
Industrial Zone			45-FT.	50-FT.

6.2.5 Curb and Gutter

a. Curb and Gutter shall be considered a stormwater appurtenance for estimating cost

b. For most roadways, a 6-in. curb is required.

c. For hot-mixed asphaltic concrete roadways, a 2-ft. wide Portland cement concrete curb and gutter is required, to include 6-inches of curb width and 1 ½-feet of gutter width.

d. For Portland cement concrete pavement, the gutter area is integral with the pavement panel, and the 6-inch curb is placed on top of the pavement panel per City Standard Details.

6.2.6 Objects in the R.O.W.

a. Above ground infrastructure such as fire hydrants, trees, traffic signal controller cabinets, blow-off valves, power poles, light poles, traffic/pedestrian signage, or other such appurtenances shall not be placed within the sidewalk, or otherwise encroach on ADA/TAS pedestrian space or RTA bus stops and pads.

b. Designers shall coordinate with the RTA in regard to placement and design of benches, pads, turnouts, and bus stop locations. Bus stops can only be placed, moved, or removed with RTA concurrence.

6.2.7 Design Speed

a. Design speed shall be set by City Ordinance

b. The minimum design speed shall be 25 m.p.h.

6.2.8 Sight Distance

a. **Intersection Sight Distance**

   i. Approach and Departure Sight Triangles shall be Per American Association of State Highway and Transportation Officials (AASHTO) *Green Book* and National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* latest editions.

   ii. Designers, Engineers, and Constructors shall not obstruct sight triangles.

   iii. The design vehicle for sight distance is a passenger car.

iv. Easement dedications shall be required as needed to accommodate appropriate sight triangles.

v. Designers, Engineers, and Constructors shall utilize decision points derived from sight triangles combined with stopping sight distance when designing intersection treatments and advance warning signs, signals, striping, and devices.

b. **Stopping Sight Distance**

i. Stopping Sight Distance per the AASHTO Green Book and TxDOT/FHWA Texas MUTCD.

c. Passing Sight Distance

i. Passing Sight Distance per AASHTO and TxDOT/FHWA where applicable.

Table 6.2.8.A Minimum Required Stopping Sight Distances for Dry Conditions

Vehicle Speed	Reaction Distance	Breaking Distance	Summed Distance	Stopping Sight Distance
(mph)	(feet)	(feet)	(feet)	(feet)
15	55.1	21.6	76.7	80
20	73.5	38.4	111.9	115
25	91.9	60.0	151.9	155
30	110.3	86.0	196.7	200
35	128.6	117.6	246.2	250
40	147.0	153.6	300.6	305
45	165.4	194.4	359.8	360
50	183.8	240.0	423.8	425
55	202.1	290.3	492.4	495

6.2.9 Left Turn Lanes

a. Left turn lanes are required at all signalized intersection approaches

b. Left turn lanes are required at all median openings

c. Queueing capacity shall be determined by appropriate traffic studies and 30-year projections and accommodated in the design of the queue lane.

d. Dual left turn lanes shall be approved only after an appropriate traffic study that includes alternatives assessment to handle the anticipated volumes.

6.2.10 Intersection Standards

a. Through-lane offsets from entering lane to receiving lane shall not exceed 3-feet.

b. Roundabout intersections shall be considered for any intersection with an appropriate traffic study considering traffic volumes and directions, as well as alternative treatments such as all-way stops and traffic signalization, to include 30-year projections and appropriate design vehicles in the approach roadways to ensure required roundabout radius.

    i. All roundabouts will feature splitter islands with pedestrian shelter upon entry, appropriate signage, appropriate lighting, appropriate pedestrian elements, and a truck curb and mow strip in the central island.

    ii. Central island art or landscaping shall not obstruct safe site zones or be a hazard to vehicles that may leave the roadway.

6.2.11 Horizontal Curve Radii

a. Curve Radii design shall be based on the design speed of the roadway and any super-elevation that may be part of the design.

b. Minimum curve radii for collectors and arterials are 500 feet.

c. Minimum curve radii for local streets are 300 feet per AASHTO Table 3-13b Minimum Radii and Superelevation for Low-Speed Urban Streets.

d. Maximum super-elevation will be 4%

e. Reverse super-elevation shall not be allowed on any City roadways

6.2.12 Vertical Geometric Requirements

a. Minimum grade line shall be 0.3%

b. Grades for curb returns shall be determined on a case-by-case basis.

c. Arterials shall feature super-elevation per AASHTO requirements

d. Vertical curves

   i. shall be designed and constructed when the algebraic difference exceeds 1%

   ii. elevations shall be shown at 10-foot intervals in plans

   iii. maintain a minimum of 0.03-foot elevation change at 10-foot intervals

   iv. determine minimum vertical curve lengths based on AASHTO design criteria with minimum not less than 3 times design speed.

e. Minimum grade line around a cul-du-sac shall be 0.70 percent

f. Pavement cross-slopes shall be

   i. Minimum 2%

   ii. Maximum 4%

6.3 PAVEMENT DESIGN AND CONSTRUCTION STANDARDS

6.3.1 Pavement Structure.

a. Through The design of pavement structures shall be in accordance with the AASHTO *Guide for Design of Pavement Structures*, 1993 or latest approved edition.
b. The pavement design report shall be prepared and signed by, or under the supervision of, a professional engineer registered in the State of Texas.
c. The minimum design requirements as outlined herein shall be used for pavement design.

6.3.2 Length of Service Life.

a. Pavement shall be designed with a **thirty-year** service life.

6.3.3 Traffic Load, Reliability and Pavement Structures.

a. The traffic load is the cumulative expected 18-Kip equivalent single axle loads (ESAL) for the service life.

b. The following 18-Kip ESAL and Reliability Level shall be used in the design of streets for each street classification.

Table 6.3.3A Pavement Design Specifications

Street Classification	ADT Lower Limit	ADT Upper Limit	18-Kip ESAL*	Reliability Level
Primary Arterial (A3)	30,000	48,000	6,000,000	R-95
Secondary Arterial (A2)	20,000	32,000	4,000,000	R-95
Minor Arterial (A1)	15,000	24,000	3,500,000	R-95
Primary Collector (C3)	10,000	14,000	2,600,000	R-90
Secondary Collector (C2)	8,000	10,000	2,000,000	R-90
Collector (C1) and Parkway Collector (P1)	4,000	8,000	1,200,000	R-80
Minor Residential Collector (RC1)	1,000	3,000	1,200,000	R-70
Local Residential - Section L-1 (A-B)	-	-	50,000	R-70

*This is the minimum 18-KIP ESAL value. For all arterials, collectors and non-residential local streets (based on zoning) the engineer shall evaluate the existing ADT and traffic type distribution and use the greater of the 30-year projection of the field verified ESAL or the ESAL value established in this Table.

c. The Traffic loads for primary and secondary arterials, collector and local residential collector streets shall include bus traffic.

d. The lane distribution factor shall be as follows:

   i. Total number of lanes in both directions 4 (2 in each direction) or less, the Lane Distribution Factor is 1.0.

   ii. Total number of lanes in both directions 6 (3 in each direction), then lane Distribution Factor is 0.7

   iii. Total number of lanes in both directions less than 8 (4 in each direction), then Lane Distribution Factor is 0.6

6.3.1 Input Design Values:

a. Pavement design input values include the current AASHTO Input Design Values for pavement calculations including Serviceability, Effective Modulus of Subgrade Reaction, k (pci), Concrete Pavement Load Transfer Coefficients, and Drainage Coefficients based on soil type. These input design values are outlined in the following tables:

Table 6.3.4A - Input Serviceability Values

	Serviceability	Flexible - Local Streets	Flexible - Collectors & Arterials	Rigid Concrete
Serviceability - *Ride quality & ability to serve the type of vehicles (automobiles & trucks) that use the facility*	**Initial Serviceability, (p0)**	4.2	4.2	4.5
	Min. Terminal Serviceability (Pt)	2.5	2.5	2.5
	Standard Deviation (S0)	0.45	0.45	0.39

Table 6.3.4B – Mr and Concrete Elastic Modulus Values for Concrete Pavement Design

28-Concrete Modulus of Rupture (Mr)	Mr = 600 psi at 28-days
28-day Concrete Elastic Modulus (psi)	4,000,000 psi

If the Engineer utilizes a different value of Mr, it must be documented with an explanation. The use of a different value for the Concrete Elastic Modulus should also be documented with an explanation.

Table 6.3.4C - Modulus of Subgrade Reaction, k (pci) for Concrete Pavement Design

Effective Modulus of Subgrade Reaction, k (pci)				**k Value (pci)**
Base Layer Combination for Concrete Pavement Support	Major Arterials	*Option 1*	4" of asphaltic concrete pavement (ACP) or 4" asphalt stabilized base (ASB)	300
		Option 2	Min. 6” compacted crushed limestone base	200
		Option 3	Minimum 12” lime, cement or lime /cement stabilized subgrade	200
	Minor Arterials & C1, C2 & C3 Collectors		Minimum of 4” crushed limestone Base or 8” lime, cement, or lime / cement stabilized subgrade	200
	Local Streets		Lime stabilized clay subgrade	110
	Local Streets		Lime/cement stabilized subgrade	200
	Local Streets		Sand subgrade	200
	Local Streets		Cement stabilized sand subgrade	240

Table 6.3.4D - Concrete Pavement Load Transfer Coefficients

Load Transfer Coefficient		
CRCP or Load Transfer Devices at Transverse Joints	**Tied PCC Shoulders, Curb & Gutter, or > 2 lanes in 1 Direction**	
	Yes	**No**
Yes	2.6 for CRCP, 2.7 for JCP	3.2
No	3.1	3.6

Table 6.3.4E - Drainage Coefficients

Drainage Coefficient	1.0 for clay Type A Soils
	1.05 for sand Type B Soils

6.3.2 Pavement Design Considerations

a. Other pavement design considerations include the criteria for the final design concrete pavement thickness based on the results of the AASHTO calculations, requirements of the geotechnical study, lime treatment and lime/cement treatment requirements for Type A clay soils, geogrid considerations, and the use of stabilized sand for utility trench stabilization are described in the Tables below.

Table 6.3.5A - Concrete Pavement Thickness Procedure

Concrete Pavement Thickness	The computed concrete slab thickness with fractions of inches round the thickness up or down to the nearest full or 1/2 inch. Minimum rigid pavement thickness is 6 inches.

Table 6.3.5B - Geotechnical Study Requirements

Geotechnical Study	A soil investigation **must be performed for the design of pavement** structures.
	The number of borings and locations shall be sufficient to accurately determine the natural in-situ soil strata and the thickness of the existing pavement constituents along the route. The maximum boring spacing should be 750 lf. Minimum boring depth shall be 10 feet in pavement areas, 20 feet for utility borings and 25 feet for traffic signal and light poles.
	Any existing soil information that is available either from the City or private sources will be provided as supplemental information for the new geotechnical study.

Table 6.3.5C - Lime Stabilized Subgrade and Lime/Cement Subgrade Requirements

In general, roadbed soil having a plasticity index (P.I.) greater than 20 shall be treated with lime or lime/cement to reduce the PI to below 20.	
The following test methods shall be used to determine the percent lime to be used:	
Subgrade - Lime Stabilization	pH determination for minimum lime content ASTM D 6276 - Eads-Grim Test. Minimum amount of lime to raise the pH to 12.4 or higher.
	7– Day Unconfined compressive Strength > 150 psi Treated Material PI <20
	TxDOT Test Method 121-E
	Lime min. 6% all cases
Subgrade – Lime/Cement Stabilization	Sulfate testing should also be conducted before placement of lime to evaluate the potential for sulfate induced heave from the lime stabilization. Lime stabilization should be initially performed in general accordance with TxDOT Item 260. Once the minimum 24-hour mellowing period for lime is complete, the lime stabilized subgrade should be cement stabilized with cement per TxDOT Item 275. Microcracking is required. The organic content of the subgrade should not exceed 1%.
Lime treated or lime/cement treated subgrade will be included as a structural layer in pavement design calculations.	

Table 6.3.5D – Subgrade Treatment Options for Various Soil Types

Soil Type	Subgrade PI	PVR (in)	Subgrade Treatment Options
Sand Type B	0-20	0-1.0	8" Compacted Subgrade or 8” Cement Stabilized Subgrade*
Clay Type A1	< 20	0.3-1.0	8” Moisture Compacted Subgrade or 6” Cement Stabilized Subgrade or Type 2 Geogrid over 8” Moisture Conditioned Subgrade
Clay Type A2	20-35	1.0-2.0	8" Lime Stabilized Subgrade or 6” Cement Stabilized Subgrade or Type 2 Geogrid with 8” Lime Stabilized Subgrade
Clay Type A3	35-50	2.0-4.0	12” Lime Stabilized Subgrade or 8” Lime/Cement Stabilized Subgrade or Type 2 Geogrid with 12” Lime Stabilized Subgrade
Clay Type A4	>50	4.0 +	12” Lime/Cement Stabilized Subgrade

Table 6.3.5E - Geogrid Requirements

(To be approved by the Director of Public Works)

Geogrid	The use of a City-approved geogrid without lime stabilization is an acceptable option only for Type A1 clay soils having a subgrade PI<20 The use of geogrid for Clay Types A2 and A3 clay soils is allowed if used in conjunction with lime stabilized subgrade.
	Considerations for using geogrid in place of lime-modification include speed of construction, same day restoration of access to driveways, protection from plastic deformation or loss of soil strength in soil layers below the improved zones, and other considerations such as the actual PI of the subgrade as outlined in this section.
	City-approved geogrid includes any geogrid classified as Type 2 geogrid by TxDOT under the most current version of TxDOT Departmental Materials Specification DMS-6240 per City Standard Specification Section 022040 Street Excavation.
	The layer coefficient ratio (LCR) for flexible pavement design with geogrid shall not exceed 1.2.

Table 6.3.5F Utility Trench Cement Stabilized Sand Requirements

Cement Stabilized Sand for Utility Trench Backfill	PI<20 for stabilization of utility trenches
	Shall contain a minimum of 2 sacks of Standard Type I Portland cement per cubic yard of sand and compacted to not less than 95% Standard Proctor density per City Standard Specification Section 022020 Excavation and Backfill for Utilities.

Table 6.3.5G Alternative Pavement Materials, Private Development Pavement and Public Roadway Pavement Considerations
(To be approved by the City Departments as outlined)

Alternate Pavement Materials **(Alternative materials to be approved by the Director of Public Works)**	Alternative pavement materials may be used where the existing soil or subsurface conditions, or the alternative materials, provide a level of drivability comparable to the materials otherwise required by this section.
	Proposals for alternative pavement materials with supporting engineering documentation may be submitted to the City for consideration for use.
	The combination of materials will be allowed for the various layers of the pavement structure as shown in below table.
Private Development Pavement	The Director of Development Services in consultation with the **Director of Public Works** in accordance with the standards provided herein must approve the pavement combination for private development.
Public Roadway Pavement **(Bond/Capital improvements Projects)**	The **Director of Engineering** must approve the pavement combination for public work.

Table 6.3.5H Curb & Gutter and Street Cross Slope Requirements

Curb & Gutter	Curb and gutter shall be installed as shown on the City Standard Details and as required in the appropriate road section. The treated subgrade and flexible base shall extend at least 2 feet beyond the back of curb. Transitions between the curb and gutter sections to either existing curb and gutter sections or roadside ditches shall be detailed in such a way as to ensure positive drainage to the nearest drainage system.
Cross-slopes	The road section cross-slope from the crown to the gutter shall be a consistent 2% minimum.
	The maximum acceptable cross-slope on new construction or full depth reconstruction is 4%.
	Crown to crown transitions is required at intersections and neither concrete nor asphalt valley gutters are allowed.

Table 6.3.5l – Pavement Materials Requirements by Pavement Type and Layer

Type	Layer	Material/Treatment		Standard or Specification
All	Subgrade Stabilization	Density Requirement	95% Standard Proctor Density	ASTM D698
		Moisture Requirement	0 to +4% of OMC	
		Lime Stabilization	Type A Clay Soils Only	TxDOT 260; TEX 121-E
		Cement Stabilization	Type B Sandy Soils and Type A Clay soils with PI<25.	TxDOT 275
		Lime Modification w/ Cement Stabilization	Type A4 Clays	TxDOT 260 (lime); TxDOT 275 (cement)
	Flexible Base	Only TxDOT Type A, Gr. 1-2 crushed limestone base allowed on City roadway projects without pre-approval		
		Density Requirement	98% Modified Proctor Density	ASTM D1557
		Moisture Requirement	+ or - 2%	
		Cement Stabilization	Optional	TxDOT 275
		Geogrid	Only for PI<20 or used in combination with lime stabilized subgrade for Type A2 or A3 Clays	TxDOT DMS-6240; City of CC Section 022040
Flexible	Seal Coat	One-Course Surface Treatment		TxDOT 306/316
	Prime Coat	MC-30		TxDOT 310
	HMAC Base Course	Type B	2.5-in (min)	TxDOT 300/334
	Tack Coat			--
	HMAC Surface Course	Type D		TxDOT 300/334
Rigid	HMAC Bond Breaker	Type D		TxDOT 300/334
	Portland Cement Concrete Pavement	Reinforcement	Continuously Reinforced	TxDOT 360
			Jointed Plain with Dowels	TxDOT 360

Table 6.3.5J Min. Pavement Layer Thickness

Pavement Type	Roadway Type	Material & Type	Minimum Thickness	Additional Guidance
All	All	Flexible Base	4 in. Rigid; 6-in. Flexible	2 feet behind curb for urban roads and 2 feet beyond the edge of pavement for rural roads
All	All	Asphalt Treated Base	4-in.	-
All	All	Lime Treated Subgrade	8-in.	for stabilization or modification
All	All	Cement Treated Subgrade	8-in	for stabilization or modification
All	All	Lime/Cement Treated Subgrade	8-in	for stabilization or modification
HMACP	All	One-Course Surface Treatment	One Course	for all flexible base under HMACP
HMACP	All	Base Course (Type B)	2.5-in.	-
HMACP	All	Surface Course (Type D)	1.5-in.	-
HMACP	Left and Right Turn Lanes	Flexible Base	12-in.	-
HMACP		Asphalt Paving Surface Course (Type D)	4-in.	-
PCCP	All	Bond Breaker (Type D)	1-in.	per geotechnical report
PCCP	All	Portland Cement Concrete Pavement	6-in.	-

Table 6.3.5K Min. Residential Section on Type A1-A4 (Clay) Soils using HMACP – Section L-1 (A-B)

	Soil Type	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Treated Subgrade
Section L-1 (A-B)	Clay Type A1	Compacted Subgrade or Cement Stabilized Subgrade or Type 2 Geogrid with 8" moisture conditioned subgrade	2"	6"	8"
	Clay Type A2	Lime Stabilized or Cement Stabilized or Type 2 Geogrid with lime stabilized subgrade (8%)	2"	8"	8"
	Clay Type A3	10” Lime Stabilized or 10" Lime/Cement Stabilized or Type 2 Geogrid with 10" Lime Stabilized Subgrade	2”	9"	12”
	Clay Type A4	10" Lime/Cement Stabilized Subgrade	2.5”	9”	12”

Table 6.3.5KA Min. Residential Section on Type RC1 (Clay) Soils using HMACP – Minor Residential Collector

	Soil Type	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Treated Subgrade
Minor Residential Collector	Clay Type A1	Compacted Subgrade or Cement Stabilized Subgrade or Type 2 Geogrid with 8" moisture conditioned subgrade	3"	10"	8"
	Clay Type A2	Lime Stabilized or Cement Stabilized or Type 2 Geogrid with lime stabilized subgrade (8%)	3"	10"	8"
	Clay Type A3	10" Lime Stabilized or 10" Lime/Cement Stabilized or Type 2 Geogrid with 10" Lime Stabilized Subgrade	3"	10"	12"
	Clay Type A4	10" Lime/Cement Stabilized Subgrade	3"	10"	12"

Table 6.3.5L Min Pavement Section on Type A1-A4 (Clay) Soils using HMACP - Collector (C1) and Parkway Collector (P1)

Street Class.	Soil Type	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Treated Subgrade
Collector (C1) and Parkway Collector (P1)	Clay Type A1	Compacted Subgrade or Cement Stabilized Subgrade or Type 2 Geogrid with 8" moisture conditioned subgrade	4”	11”	8"
	Clay Type A2	Lime Stabilized or Cement Stabilized or Type 2 Geogrid with lime stabilized subgrade (8%)	4”	11”	8"
	Clay Type A3	10” Lime Stabilized or 10" Lime/Cement Stabilized or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4”	11”	12”
	Clay Type A4	10" Lime/Cement Stabilized Subgrade	4”	11”	12”

Table 6.3.5M Min. Pavement Section on Type A Clay Soils using HMACP

Street Class.	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Lime Treated Subgrade
Secondary Collector (C2)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4.5"	11"	12”
Primary Collector (C3)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4.5"	13"	12”
Minor Arterial (A1)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	4.5"	15"	12”
Secondary Arterial (A2)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	5"	15"	12”
Primary Arterial (A3)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	5.5"	16"	12”

Table 6.3.5N Min. Section on Type A (Clay) Soils using PCCP

Structural Material	Residential Section L-1 (A-B)	Minor Residential Collector	Collector (C1) and Parkway Collector (P1)	Secondary Collector (C2)	Primary Collector (C3)	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
Concrete (4,400 psi min)	6"	6"	6.5”	7”	7”	8”	8.5"	9”
Flexible Base (Type A, Grade 1-2)	-	-	-	-	-	6"	6"	6"
Subgrade	8" Stabilized	8" Stabilized	8" Stabilized	12" Lime Stabilized	12" Lime Stabilized	12" Lime Stabilized	12" Lime Stabilized	12" Lime Stabilized

Table 6.3.5O Min. Structural Pavement Sections on Type B (Sandy) Soils using HMACP

Structural Material	Section L-1 (A-B)	Local Minor Residential Collector	C1 Collector	C2 Collector	C3 Collector	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
HMAC Pavement (Type D)	2"	3"	3.5"	4"	4"	4"	4.5"	5"
Flexible Base (Type A, Grade 1-2)	6"	9"	11"	11"	13"	13"	14"	14"
Subgrade	8" Cement Stabilized	8" Cement Stabilized	8" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized

Table 6.3.5P Min. Pavement Section on Type B (Sandy) Soils using PCCP

Structural Material	Section L-1 (A-B)	Local Minor Residential Collector	C1 and P1 Collector	C2 Collector	C3 Collector	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
PCCP (4,000 psi min)	6"	6"	6.5"	7"	7"	8"	8.5"	9"
Subgrade	8" Cement Stabilized	8" Cement Stabilized	8" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized

6.3.3 Design Parameters Specific to Rigid Pavements

a. There are several design parameters required by the 1993 AASHTO Guide that are specific to rigid pavements. The following sections provide guidance regarding these parameters for roadways designed for the City as outlined in the following table.

Table 6.3.6A Rigid Concrete Pavement Requirements

28-day Concrete Modulus of Rupture	The Mr of concrete is a measure of the flexural strength of the concrete as determined by breaking concrete beam test specimens. A modulus of rupture of 680 psi at 28 days shall be used with the current City specification for concrete pavement. If a different value is used it must be documented with an explanation.
28-day Concrete Elastic Modulus	Elastic modulus of concrete is an indication of concrete stiffness and varies depending on the coarse aggregate type used in the concrete. A modulus of 5,000,000 psi shall be used for City pavement designs. If a different value is used it must be documented with an explanation.
Load Transfer Coefficient	The load transfer coefficient is used to incorporate the effect of dowels, reinforcing steel, tied shoulders, and tied curb and gutter on reducing the stress in the concrete slab due to traffic loading and therefore causing a reduction in the required concrete slab thickness. Required Load Transfer Coefficients are shown in Table 6.3.4D
Drainage Coefficient	The drainage coefficient characterizes the quality of drainage of the subbase layers under the concrete slab. Good draining pavement structures do not give water the chance to saturate the subbase and subgrade; thus, pumping is not as likely to occur. Subbase shall be designed to be dense-graded, non-erosive, and stabilized. Required Drainage Coefficients are shown in Table 6.3.4E.
Joint Spacing and Details	Construction joint spacing should not exceed 15 ft in either the longitudinal or transverse direction. The depth of saw cut should be a minimum of ¼ of the slab depth (⅓ the slab depth is recommended) if utilizing a conventional saw or 1 inch when using an early entry saw (early entry sawing is recommended). The width of the joint will be a function of the sealant chosen to seal the joint. It is recommended that a joint seal be utilized to minimize the introduction of incompressible material into the joint. It is recommended that dowel bars be used to provide load transfer and reduce differential movement (or faulting) across transverse joints. Dowels should be smooth (1” diameter for 6” to 7” concrete pavements, 1.25” diameter for 8-9” Concrete Pavements, and 1.5” diameter for 10 inch pavements.) (Grade 60 steel) spaced 12 inches on center with an embedment length of at least 8 inches. Dowels are not required at contraction joints for pavements less than 8” thick. Tie bars should be used to tie longitudinal joints within the pavement lanes and at the shoulder. Tie bars should be deformed #4 bars at a minimum (Grade 60 steel) spaced 36 inches on center with a minimum length of 30 inches. Isolation joints must be used around fixed structures including light standard foundations and drainage inlets to offset the effects of differential horizontal and vertical movements. Pre-molded joint fillers should be used around the fixed structures prior to placing the concrete pavement to prevent bonding of the slab to the structure and should extend through the depth of the slab but slightly recessed from the pavement surface to provide room for the joint sealant.

b. Continuously reinforced concrete pavements (CRCP) is a type of concrete pavement that does not require any transverse contraction joints. Transverse cracks are expected in the slab, usually at intervals of 1.5 - 6 ft (0.5 - 1.8 m). CRCP is designed with enough embedded reinforcing steel (approximately 0.6-0.7% by cross-sectional area) so that cracks are held together tightly. Determining an appropriate spacing between the cracks is part of the design process for this type of pavement. CRCP design for City of Corpus Christi projects should be performed in general accordance with the requirements of the TxDOT Pavement Design Manual (June 2021). CRCP designs generally cost more than JPCP or JRCP designs initially due to increased quantities of steel. However, they can demonstrate superior long-term performance and cost-effectiveness. In this area, a big advantage is the reduced soil moisture penetration through the concrete due to reduced jointing. Subgrade softening and pavement deterioration in the joint areas is therefore reduced considerably resulting in longer pavement life and better ride quality. CRCP also makes a good candidate for resurfacing with asphalt concrete due to its tight crack widths and minimal vertical movement between adjacent joints due to restraint from the steel which reduces the frequency and severity of reflective cracking.

c. Concrete pavements may also be constructed according to TxDOT detail CPCD–14. For collector / arterial pavements with pavement thickness 8 inches or greater, dowels are required at all transverse joint locations. For Local roads dowels are only required at transverse construction joints. Joint details are required on all plans with rigid pavements and shall be designed in accordance with:

http://wikipave.org/index.php/Joints

http://wikipave.org/index.php/Joint_Layout

6.3.4 Guidance for Designers and Engineers

a. The following tables discuss Roadway Design Approach for Roadway Designers and Geotechnical Engineers, the Approach and Requirements for the Type B sand soils and the Type A clay soils in the Corpus Christi area including the subgrade stabilization methods such as geogrid on clay soils, lime stabilization of Type A2, A3 & A4 clay soils, cement stabilization of Type A1 clay soils and Type B sand soils and lime/cement stabilization for Type A3 or A4 clay soils.

Table 6.3.7A Roadway Design Approach

Roadway Design Approach for Roadway Designers and Geotechnical Engineers	Roadway designers and geotechnical engineers shall utilize a combination of subgrade treatments, road base, road base treatments, bond breaker, and HMACP or PCCP pavement to form the structural design section for City roadways. All layers in the section shall contribute to the structural strength of the pavement based on typical design practices. Some layers contribute to moisture control, such as lime-modified subgrade, bond breakers, and seal coats, while other layers contribute to structural strength or structural stability in the section such as moisture-controlled/density-controlled subgrade, cement-treated subgrade, geogrid, lime-stabilized subgrade, moisture-controlled/density-controlled base, cement-treated base, and HMACP and PCCP. All layers should be working together to reduce differential movements, deformations, and failures based on design guidance for level of service/reliability level for each roadway type in the City's Unified Development Code (UDC), UTP, and as shown in the IDM. Should an Engineered design section produce components having less thickness the minimum sections provided by the City, these differences should be explained in the geotechnical report. i.e. a higher than normal CBR, etc.
	For all types of paving, rigid paving or flexible paving, a stable platform for building the roadway must be achieved ahead of pavement construction. One key requirement to achieve a stable roadbed platform is the required use of cement-stabilized sand in utility trenches per City Standard Specification Section 022020 Excavation and Backfill for Utilities to prevent settlement and deformation of utility trenches under the roadway pavement.
	For the pavement design of a particular roadway segment, geotechnical engineers will provide a variety of pavement sections for use by the City and the design engineer during the pavement selection process. All geotechnical reports will include both flexible and rigid pavement section options for roadways unless specifically scoped otherwise. These pavement sections will include cement-stabilized subgrade in sand areas, lime-stabilized subgrade in mid to high PI clay areas and lime-modified subgrade with or without geogrid in mid to low PI clay areas. The geotechnical engineer has the option of offering sections with cement stabilized base in low PI clay or sand or lime-modified in clay areas. The geotechnical engineer has the option of offering geogrid stabilized sections in Type A1 Clays and can be used in conjunction with lime in Type A2 and A3 Clays. Lime/cement stabilization should be used on the extremely high PI Type A4 clays.

Table 6.3.7B Approach for Type "B" Sandy Soils and Type "A" Clay Soils

Approach for Type "B" Sandy Soils	For sandy soils, such as low PI Type B soils primarily located at North Beach, Flour Bluff, and Padre and Mustang Islands, it is a requirement to cement stabilize the subgrade, which is a very fine sand, to avoid issues with localized collapses and deformations for both flexible and rigid pavements. Cement stabilization of roadway base may also be considered.
General Approach for Type "A" Clay Soils - Lime Stabilization, Lime/Cement Stabilization or Geogrid	For clay soils, it is a requirement to add lime to minimize the improved compacted subgrade layer from shrink/swell cycles or loss of soil strength and bearing capacity. The addition of lime is either to achieve lime modification to create a stable building platform or to reach a specified contribution to the pavement structural value or both. Lime modification alone may be insufficient to prevent differential movement in extreme wet/dry events and the addition of geogrid or cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Geogrid can also replace up to 8 inches of lime-modified subgrade under certain circumstances as outlined herein.

Table 6.3.7C Subgrade Improvement – Minimum Thickness

Subgrade Improvement Min. Thickness	Geotechnical engineers will use a representative PI based on the mean of PI measurements plus ½ their standard deviation. Subgrade improvements will be for a minimum of 8-inches thickness for all roadways. Typical guidance on the application of subgrade treatments is as shown Table 6.3.5C and Table 6.3.5D.

Table 6.3.6D Type "A" Clay Soils - Lime Stabilization

Type "A" Clay Soils - Lime Stabilization	For higher PI clays (PI > 20), the addition of lime sufficient to achieve lime stabilization is typically required to minimize shrink/swell and the potential for loss of soil strength in the improved layer and to create a stable building platform. Lime stabilization is also required to achieve a specified soil strength in the pavement section to bridge over areas of varying soil strength in the soil layers below the improved zone, as well as to reduce supersaturation of the subgrade that would lead to loss of soil strength followed by rutting and pumping. Lime stabilization does not require the use of geogrid. The Engineer will determine the sulfate content of the existing subgrade in accordance with Tex-145-E and organic content in accordance with Tex-148-E before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 1.0% and proceed as directed. For lime-stabilized sections, geogrid is not required and shall not be substituted for lime stabilization with soils having a PI>20. The minimum thickness for lime stabilized subgrade is 8- inches. Lime modification alone may be insufficient to reduce differential movement in extreme wet/dry events and the addition of geogrid or utilizing lime/cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Lime/cement stabilization increases subgrade strength and reduces moisture infiltration from the sides.

Table 6.3.6E Type "A" Clay Soils - Cement Stabilization of Aggregate Bases

Cement Stabilization	Cement stabilization of Type A clay soils is not allowed unless the subgrade PI is or has been modified to below 30 and organics are less than 1%. In all cases of cement stabilization, whether for subgrade or base, microcracking must be employed ahead of applying the bond breaker/seal coat to prevent reflective cracking from moving up throughout the entire pavement profile to affect level of service or reliability at the pavement surface. Cement stabilization shall be executed according to TxDOT Specification Section 275.

Table 6.3.6G Lime/Cement Stabilization

Approach for Type "A" Clay Soils - Lime/Cement Stabilization	Lime-modified subgrades can also be stabilized with cement after a PI < 30 has been achieved. Lime-modified subgrade requires the contractor to work the lime into the specified subgrade layer rather than just proof-rolling, thereby providing a firm, dry, and stable platform on which to build up the pavement structure. In order for cement to be activated as a stabilizing agent, a PI < 30 is required, sulfate levels < 7,000 ppm are required, and organic material is limited to <1%.

6.3.5 Guidance for Bidders and Contractors

a. The following table discusses considerations for Bidders and Contractors.

Table 6.3.7A Guidance for Bidders and Contractors

Bidders	Bidders are to bid per plan and specification. Bidders should seek to clarify any questions about alternate products or materials during the question-and-answer period. Bidders should not anticipate approval of alternate products or materials after award.
Contractors	Contractors shall install the product specified or called in the plans unless a value- engineering proposal has been presented by the Contractor through the Change process outlined in Specification Section 00 72 00 General Conditions and accepted by the City Engineer as indicated by his signature on the change agreement. All credits back to the City must be accounted for in any value-engineering agreement per 00 72 00, to include contract time and labor.
	The addition of geogrid to a lime-modified layer will be expected to add time and cost. For flexible pavement on low PI clays, the subtraction of lime modification and replacement by geogrid would be expected to subtract time and cost.
	Consideration for the use of geogrid in lieu of lime can be made to expedite construction, protect commercial or residential property, to quickly restore traffic o in other cases as outlined in this Section.
	Lime stabilization shall be executed according to TxDOT Specification Section 260 and TxDOT standard Tex 121-E.
	Cement stabilization shall be executed according to TxDOT Specification Section 275.
	Geogrid stabilization shall be provided according to TxDOT DMS-6240 and City Standard Specification Section 022040 - Street Excavation.

City of Corpus Christi

Infrastructure Design Manual

Chapter 7

TRAFFIC SIGNALIZATION DESIGN REQUIREMENTS

Chapter 7

TRAFFIC SIGNALIZATION DESIGN REQUIREMENTS

7.01 PURPOSE

The purpose of this chapter is to outline the basic design criteria for traffic signalization within the City public right-of-way and highlight key elements of the City's signal design parameters for new signal installations and /or modernizations. A traffic signal installation shall include the traffic signal and all auxiliary material and equipment necessary to control vehicular and pedestrian traffic in the manner intended by the City.

7.02 REFERENCES

a. Texas Manual on Uniform Traffic Control Devices (TMUTCD)

b. City of Corpus Christi – Traffic Signalization Specifications, Latest Edition

c. City of Corpus Christi – Signalization Standard Product List, Latest Edition

d. TxDOT Standard Specifications, Latest Edition

e. Refer to Reference List in Chapter 1

7.03 REQUIREMENTS FOR NEW TRAFFIC SIGNALS

a. **Signal Warrants:** For the installation of new traffic signals to be considered, the City requires the proposed signal to meet at least one signal warrant. The requirements for traffic signal warrants are found in the TMUTCD. A signal warrant is a minimum condition in which a signal may be installed. However, satisfying a warrant does not mandate the installation of a traffic signal. A warranting condition indicates that an engineering study is required to determine whether the signal is justified. The City Traffic Engineer shall make the final recommendation regarding the location of any new traffic signal.

b. **Engineering Study**: An engineering study will be required for all proposed traffic signal installations. The engineering study shall evaluate the effects of the proposed traffic signal on traffic flows, traffic delays, and intersection safety. The engineering study shall include the estimation of future volumes and an analysis of the progression of traffic through the signal system, as defined by the City Traffic Engineer. The study includes the level-of-service (LOS) analysis of the signal for the a.m. and p.m. peak hours. Depending on the location and circumstances, a LOS analysis may be required by the City for other peak times as well. Based on the results of the engineering study, the appropriate number of lanes, length of turning

lanes, and signal phasing will be determined. Close coordination with the City is required throughout the engineering study to develop the optimum intersection configuration.

7.04 TRAFFIC SIGNAL DESIGN PROCESS

a. Prior to the design or modification of a signalized intersection, the designer shall meet with the City Traffic Engineer and City Signal Superintendent to review the scope and requirements for the traffic signal design. The following items shall be discussed:
    i. Traffic Studies, Crash History
    ii. Intersection geometrics and adjustments
    iii. ROW parameters
    iv. Pedestrian and bicycle accommodations
    v. Lighting for the intersection
    vi. Power source location and type
    vii. Signal interconnection and impacts to adjacent signals
    viii. Proposed controller location
    ix. Existing equipment – removal or usage
    x. Phased construction and temporary signals
    xi. Other conditions
b. The City will provide the designer with the latest available City Traffic Signalization Specifications and the Signalization Standard Product List to incorporate into the design documents. The designer is responsible to verify any updates to the documents with the City prior to completion of design.
c. Design Submittal Process:
    i. Typically, three submittals are required for approval for construction of the signal. These are typically 60, 90, and 100 percent design submittals. All traffic signal plans shall be submitted on 22" x 34" sheets that can be reduced to 11”x17” half size drawings.
    ii. The first (60 percent) submittal shall include the existing conditions plan sheet showing topographic survey information, and a proposed signal layout plan sheet. The signal plan layout sheet shall contain the proposed location of curbs, construction centerlines, lane configuration and striping, proposed locations of the signal poles, controller and service equipment, existing utility

and right-of-way information, proposed right-of-way easements, legend, signal, and pedestrian head locations, numbering and displays, sign locations and displays, and detection zones and numbering.

iii. The second (90 percent) submittal shall include an annotated existing conditions sheet showing items to be removed or salvaged to the City, the refined signal layout plan, and signal detail sheets to show signal phasing, proposed conduit, and wiring information. The City will verify the items to be salvaged and returned to the City.

iv. Utility Coordination. Prior to the 90 percent submittal, the designer shall coordinate an effort to pothole the locations of the proposed signal poles to identify any existing utility conflicts. The designer shall coordinate with the local electrical service provider the location for the power to the controller cabinet.

v. If there are no outstanding design issues after the second submittal, the third (100 percent) submittal shall be signed and sealed by a Texas licensed Professional Engineer.

7.05 TRAFFIC SIGNAL GENERAL NOTES

The following general notes should be included and/or modified for each design:

1. It is the intent of the plans and specifications to provide all new equipment and hardware for the proposed signal installation except as noted in these plans. Any items required but omitted are the responsibility of the contractor and will be subsidiary to the appropriate bid item.
2. All existing utilities within the vicinity of the signal pole and pedestrian pole foundations shall be located by the contractor prior to construction.
3. The contractor shall notify the city's traffic signal superintendent at 361-826-1610 before commencing traffic signal work and before activating, deactivating, or modifying any part of the traffic signal system.
4. The contractor shall install and activate new signal equipment prior to removal of the old equipment. The contractor is responsible to maintain operation of the existing traffic signal or provide temporary signalization in accordance with TMUTCD requirements.
5. Contractor is responsible for troubleshooting any outage prior to contacting the City.
6. Contractor shall remove existing signal poles, signals, luminaires, pedestrian signals, push buttons, radar detection units, ptz camera, antennas, and signage as indicated on the existing conditions and removals plan sheet. All

signal equipment deemed salvageable by the city's traffic signal superintendent will be removed by the contractor and delivered to the city. All other unwanted signal equipment shall become the property of the contractor and removed from the project site.

7. Contractor shall cut abandoned existing foundations 2 ft. Below grade. Remove abandoned pull boxes and backfill. Remove all existing wire from inside abandoned conduit after completion of new conduit. Cut and cap existing conduits.
8. Wind speed design for poles and foundations shall be 100 mph.
9. Locations of radar presence detection devices, as depicted, are general and the manufacturer's representative must evaluate the location to provide the most effective coverage.
10. The traffic signal controller will be programmed by city street department crews and will include the timing of each phase for vehicles and pedestrians as well as programming the detection zones for each radar device.
11. The contractor is responsible for coordination with the city's it department and keeping the city's fiber optic line in service during construction.
12. Contractor will provide and install one (1) photocell, contact relay, and service switch for all ilsn signs and luminaires.
    a. The following notes shall be included for new electrical services:
        1. The contractor will install new metered electrical services at the following intersections: *(list intersection, corner where meter is located, and adjacent address)*
        2. Contractor must contact AEP Texas at 1-877-373-4858 to apply for a new meter installation and obtain an electric service ID number "ESI ID' for each intersection.
        3. Contractor is required to obtain city electrical permits and pay associated permit fees for the project. Contractor must obtain city permit releases before the meters can be installed. The city electrical permit application can be found on the following website: HTTPS://DSFORMS.CCTEXAS.COM/. City development services can be reached at PERMITREQUESTS@CCTEXAS.COM OR (361) 826-3240.
        4. Contractor must contact the city traffic signal superintendent to setup the electrical account with the city's retail electrical provider and schedule the meter installation. Contractor to request the

meter installation date to coincide with the completion date of the city electrical inspection.

7.06 TRAFFIC SIGNAL DESIGN PLAN

a. Plan Requirements

i. North shall always be oriented up or to the right on all plans. The major arterial shall be horizontal on the plan.

ii. The Signal Plan shall be drawn at a 1”=20’ scale. A scale block shall be included on the plan. For areas that require greater detail (such as the corner that has the controller), a blown-up detail may be necessary at a 1”=10’ scale.

iii. All proposed signal equipment, including signal poles, mast arms, signal heads, mast arm signs, junction boxes, conduits, PTZ cameras, controller, and service cabinet shall be shown as bold.

iv. All existing and proposed right-of-way information shall be shown and labeled on the plan, including easements needed for signal equipment. The line type shall be different for easements and right-of-way – proposed and existing.

v. All proposed curbs, sidewalks, and pavement shall not be shown screened back, but of a lighter line type. Proposed striping and existing curb/striping (to remain) information shall be shown on the plan in gray scale.

vi. Construction centerlines for each road are required, with equations to existing monuments. Stationing shall be labeled every 100 feet.

vii. All proposed and existing underground and overhead utilities shall be shown and labeled on the plan in gray scale.

viii. Radar detection shall be required unless otherwise specified by the City.

ix. The traffic signal design shall conform to the National Electric Code and traffic signal equipment shall conform to NEMA standards.

x. Use aluminum base extensions for the signal controller cabinet foundation.

b. Traffic Signal Wiring

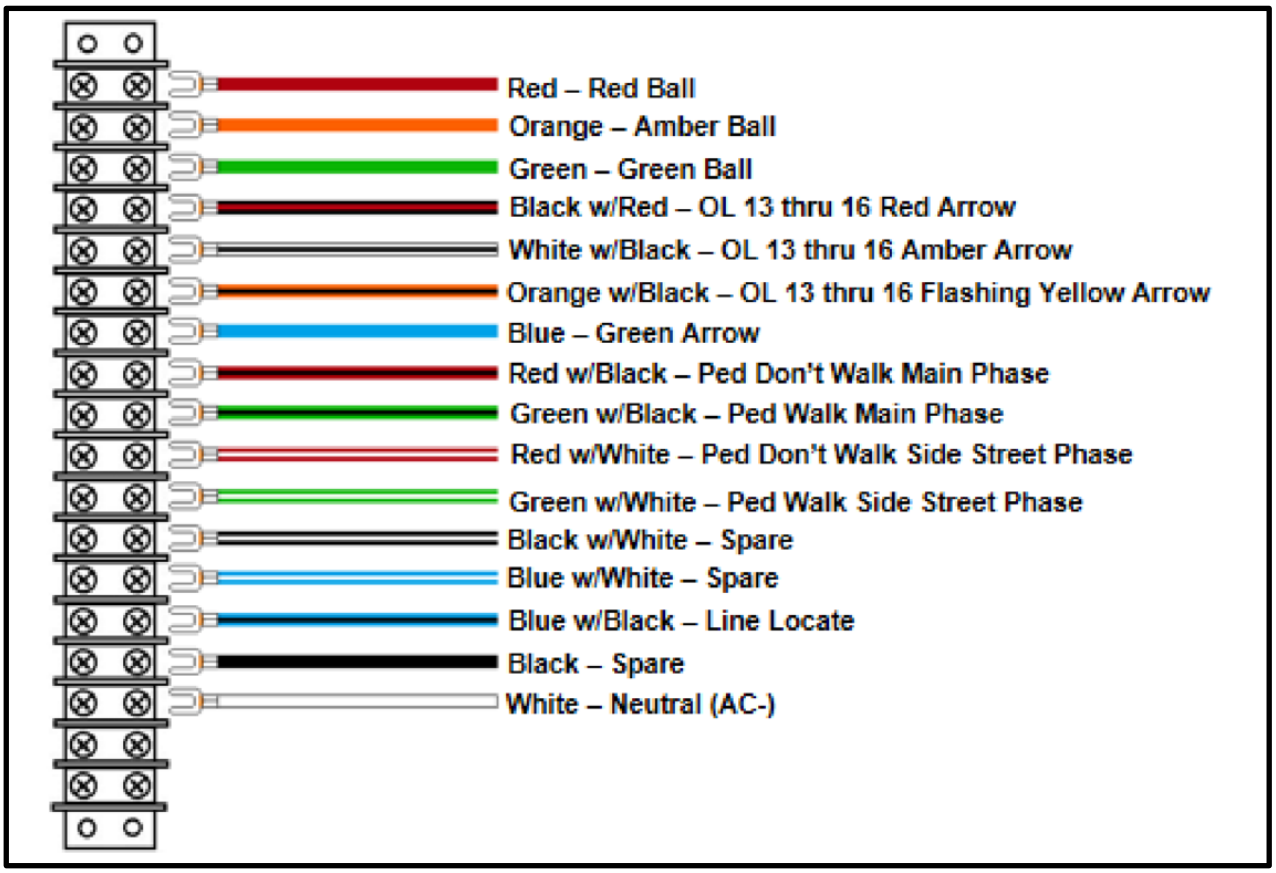
i. A conduit/wiring schedule shall include conduit run numbers, conduit size, wire type, device (e.g., electrical conductors, illumination, ILSN, APS cable, signal cable, PTZ camera, radar detection, and communications), pull cord when applicable, and comments.

ii. For designs that include modifications to an existing signal, all existing wire runs affected by the design shall be shown on the conduit/wiring schedule.

iii. The City will provide the designer with the latest available City Terminal Layout for wiring inside the traffic signal cabinet.

iv. For the run from the signal pole terminal block to the controller, a 16-conductor #14-gauge cable will be used. The typical cable color scheme and usage at the terminal block are shown in Figure 7.1:

Figure 7.1: Terminal Block Layout for 16-Conductor Signal Cable



i. Pedestrian displays and push buttons are required at all signalized intersections unless the pedestrian movement is prohibited. Crosswalks should be located as close as possible to the intersection. Push buttons shall not be placed more than 5 feet from the normal path of the pedestrian, and no more than 10 feet from the edge of curb, shoulder, or pavement. Special consideration should be given to people with disabilities when locating the push buttons.

ii. A pedestrian signal head shall be provided at each end of every signalized crosswalk at the intersection. Pedestrian signal head location shall be in accordance with the TMUTCD.

iii. All pedestrian indications shall be of the LED type.

iv. All new traffic signals and traffic signal modifications with pedestrian phasing shall use pedestrian indications of the “Countdown” type. For traffic signal modifications, new pedestrian signal housings may be necessary to accommodate the “Countdown” type pedestrian indications.

v. Plastic pedestrian heads are not acceptable.

vi. Provide curb ramps and truncated domes at every corner that has a pedestrian crossing.

vii. If the traffic signal pole is more than 10 feet from the landing area of the curb ramp, then install the push button(s) on a push-button pole adjacent to the curb ramp.

viii. A dedicated 2 conductor signal cable shall be wired for each Accessible Pedestrian Signals (APS) push button.

d. Traffic Signal Signage

i. Determination of sign placement shall be in accordance with the TMUTCD.

ii. Each signal pole mast arm shall have one street name sign or internally illuminated street name sign (ILSN). Intersections with at least one arterial street shall have ILSN signs installed on all signal poles.

e. Temporary Traffic Signalization

Provide the following notes on projects that require temporary signalization

1. Temporary traffic signal installation and signal timings are the responsibility of the contractor. Contractor shall install temporary traffic signal for the duration of the traffic control and adjust it as needed throughout the different phases of construction. The temporary traffic signal shall be span wire temporary or portable traffic signals. Contractor is responsible to maintain the temporary signal during the project. Adjustments to the existing signal are not acceptable for TCP signal control (vehicle signal heads shall be in the center of travel lanes). If contractor needs to use existing signal as part of the temporary due to unforeseen conflicts, contractor shall notify signal department at 361-826-1610, and contractor shall restore the signal back to original once temporary signal is removed.

2. The item temporary traffic signal is full compensation for installation, operation, maintenance, reconfiguration, and removal of the temporary traffic signal consisting of traffic signal pole assemblies, vehicle and pedestrian signal heads, vehicle radar detection, associated equipment, signs, luminaires, ground boxes, conduit, traffic signal cables, conductors, wire strand, and electrical services; installation and removal of foundations; and materials equipment, labor, tools, and incidentals. Review TxDOT specification 681 for more details
3. Signal contractor shall submit temporary signal layouts to the city's traffic signal superintendent at the City signal department for approval.
4. Contractor shall coordinate with power company to obtain electrical service for temporary traffic signal.
5. All channelizing devices to be activated prior to activating traffic signals for the appropriate phase, stage and step.
6. Temporary signal heads to be relocated throughout construction to align with travel lanes.
7. It is the contractor responsibility to maintain the integrity of existing equipment and traffic signal cable. Existing cable in the mast arm damaged by the contractor shall be replaced at the contractor's expense.
8. Existing communication cable shall be maintained at all times.
9. Reuse existing signal equipment when available, but temporary traffic signal span wire with timber poles or portable signals shall be installed when there is a shift in travel lanes. Vehicle signal heads need to be in the center of travel lanes.
10. Contractor shall cover existing traffic signal heads and signs as required for lane closures and detours.
11. Contractor shall cover pedestrian signal heads and push buttons in both directions as required when there is blockage of crosswalk access.
12. Vehicle and pedestrian signal heads when not activated will be covered with high durable traffic signal covers that read "not in service". Signal heads facing up or down will not be acceptable. Plastic bags or burlap bags are not acceptable for signal covers.
13. Traffic signal interruption is not permitted. Contractor must keep intersection operating with the traffic signal at all times. Provide police officer as needed for traffic control.

City of Corpus Christi

Infrastructure Design Manual

Chapter 8

Street Lighting
Design Policy and Guidelines

Chapter 8

Street Lighting Design Policy and Guidelines

1.1 PURPOSE

It is the City of Corpus Christi's practice to provide street lighting upon public traveled ways to a level that provides for the safe passage of vehicles and pedestrians. The purpose of the *Street Lighting Design Policy and Guidelines* is to provide guidelines and outline the process for the design of street lighting within the City of Corpus Christi.

1.2 GENERAL GUIDELINES

Street lighting installations are generally installed as part of a private development or City Capital Improvement project. Installations can also occur based on the review of a citizen request to add additional lighting in residential areas or as part of a public safety request from the Police, Fire, or Public Works Departments. All street lighting installations must be reviewed and approved by the Traffic Engineering Division of the Public Works Department.

Streetlights construction as part of a residential subdivision project or improvement related to a Capital Improvement project shall be designed by an Engineer, licensed in the State of Texas. The electric service provider shall only be responsible for the electrical design, equipment and appurtenances as outlined in their tariff.

This policy is intended to be used in conjunction with the latest version and supplemental revisions or guidelines of the City of Corpus Christi Construction and Material Specifications, the American National Standards Institute/Illuminating Engineering Society Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (ANSI/IES RP-8-18), and the National Electric Safety Code (NESC). Due to rapidly changing street lighting technology, the Engineer sealing the street lighting plan is responsible for all project details and using good engineering judgement consistent with recommend practices. It is the Engineer's responsibility to consult with City Staff and coordinate with the electric service provider to ensure the most appropriate fixture installation. In cases where other Federal, State, or City standards or regulations or more restrictive in their requirements, the more restrictive shall govern.

A. Luminaire Requirements

Uniform lighting will be used on new projects for local, collector and arterial streets. All streetlights installed within City right-of-way, property, and easements, are required to include light emitting diode (LED) luminaries. Installations shall be constructed per City standards, approved street lighting plan, in accordance with the franchise utility lighting tariff, and must be

field inspected and approved prior to requesting energizing or acceptance. The bracket arm length shall be selected based on pole locations and photometric requirements. Bracket arms should be positioned perpendicular to the street centerline.

Light distribution types shall be selected based upon the best alternative to meet the lighting requirements while minimizing light pollution onto adjacent areas. It is expected that most intersections and cul-de-sacs will utilize Type 3 distribution and Type 4 distribution along local, collector and arterial streets to illuminate the street and adjacent pedestrian areas.

B. Pole Material

a. All new streetlight systems in new residential subdivisions shall utilize concrete poles.
b. In existing areas, where overhead distribution exists, new streetlight luminaires may be installed on wood poles, metal poles or utility distribution poles owned by the electric service provider.
c. Other material type options, including decorative street light poles, may be utilized but shall require coordination and approval from the electric service provider and the Department of Public Works. Developers or Homeowner Associations are responsible for additional costs for the selected streetlighting system.

C. Electrical Service Providers

a. Electrical services for streetlights within the City of Corpus Christi are provided by either American Electric Company (AEP) or Nueces Electric Cooperative (NEC). Each electric service provider is responsible for providing the luminaire, poles, and other electrical appurtenances as part of a street lighting design which is defined in their tariff. Costs for construction and electrical services not defined in the tariff will be the responsibility of the Developer, for development projects, or the City for Capital Improvement or public safety requests. Written approval from the City to the responsible electric service provider is required for new street light systems or modifications to existing street lighting systems. Modifications include, but are not limited to, relocation, removal, upgrade to an existing pole or light fixture.
b. The user of this document should refer to the City of Corpus Christi ’s GIS viewer City of Corpus Christi Open Data (arcgis.com) for more information on the possible owner of the street lighting system**.**

D. Development Projects

a. **Streetlights Required.**
Streetlights shall be required for all lots and parcels being developed or constructed unless excepted by Section 1.2.3.B. Additionally, streetlights may be required for lots and parcels containing existing structures being improved or altered.

b. **Streetlights Exceptions**
   i. Farm-Rural and Residential Estate Districts will not be required to install a streetlight system along the streets, but shall as a minimum, be required to install streetlights at intersections, cul-de-sacs, horizontal curves, and other locations deemed necessary for public safety by the Traffic Engineering Division.
   ii. For commercial and industrial developments where the internal streets are not offered for public dedication, a street lighting system will not be required. The Developer shall only be responsible for providing a streetlighting system on the external public street frontage.

c. **Developer Responsibility.**
   i. Developers of residential, commercial, and industrial developments are responsible for coordinating with the appropriate electric service provider on all aspects of the electrical design and installation within and adjacent to their development project.
   ii. The Developer is responsible for all costs associated with the design, material, and installation of streetlights. The guidelines in this policy have been created to aid the Developer and Engineer design a street lighting layout that will meet the City of Corpus Christi guidelines and provide the utility company a standard design format from which to start their street light electrical service design.
   iii. The Developer shall submit a streetlight plan to the Traffic Engineering Division for approval as part of the Public Improvement Construction Plans and must provide the City proof of payment for streetlight construction prior to plat recordation.
   iv. The Developer shall be responsible for utility initiation charges and energy usage charges until a project is accepted by the City of Corpus Christi.

v. Streetlight systems shall be installed with underground electric service on all newly developed dedicated public streets in City limits unless only overhead distribution and wood pole street lighting systems exist in an area. In such cases, the design should utilize existing or new wooden utility poles for any additional streetlights. Mixing of various pole material types is prohibited unless approved by the Traffic Engineering Division.
vi. Existing streetlights which must be relocated or removed due to the construction of new streets, driveways, or other factors related to the development shall be the responsibility of the Developer.

d. **City Responsibility.**
   i. The City's Traffic Engineering Division is responsible for reviewing and approving all streetlight plans submitted with a Preliminary Plat, Final Plat, Planned Unit Development, Public Improvement Construction Plan, or Site Plan.
   ii. The City's Traffic Engineering Division shall send a copy of the approved plan and letter of authorization (on City letterhead) to design the electrical plan to the appropriate electric service provider. The letter should include, at minimum, the number of lights, preferred wattage, private or City ownership of proposed streetlights and contact information.

E. Capital Improvement Projects

a. **Streetlights Required.**
   i. Streetlights shall be required for all City "Street" Capital Improvement Projects unless excepted by Section 1.2.3.B.
b. **Streetlights Exceptions.**
   i. Streetlights shall only be exempted from projects where the existing streetlight system meets the criteria established in this policy.
c. **City Responsibility.**
   i. It is the City's practice to upgrade the street lighting along all street to current recommended levels as part of capital improvement projects, including but not limited to street, water, wastewater, storm sewer, and parks and recreation projects.
   ii. The City's Engineering Services Department will be responsible for coordinating with the Traffic Engineering Division of Public Works to review and approve the street lighting plan.
   iii. An Engineer, licensed in the State of Texas, will be responsible for designing the street lighting plan associated with the project.

iv. Engineering Services is responsible for coordination with the appropriate electric service provider on all aspects of the electrical design and installation for a Capital Improvement project. The guidelines in this policy have been created to aid the City and Engineer design a street lighting layout that will meet the City of Corpus Christi guidelines and provide the electric service provider a standard design format from which to start their street light electrical service design. This includes determination of the responsibility for the following:
    1. Installation of conduit and pull boxes.
    2. Funding for all costs associated with the design, material, and installation of streetlights.

v. Street lighting shall be installed with underground electric service on all dedicated public streets in City limits unless only overhead distribution and wood pole street lighting exist in an area. In such cases, the design should utilize existing or new wooden utility poles for any additional streetlights. Mixing of various pole material types is prohibited unless approved by the Traffic Engineering Division.

F. Residential, Police, Fire, Public Works, & Other Public Safety Requests.

a. **Streetlights Required.**
    i. Additional streetlights shall be installed at intersections, mid-block locations, cul-de-sacs, crosswalks, playgrounds, school zones, and other areas upon request by residents, Police, Fire, or Public Works Departments unless excepted by Section 1.2.3.B.

b. **Streetlights Exceptions.**
Streetlights related to public safety requests shall not be installed in the following circumstances:
    i. A study has not been performed by the Traffic Engineering Division to warrant the streetlight. This study, at minimum, shall consider the roadway geometry, crash history, available lighting in the area, environmental factors, human factors, and whether other alternatives to lighting should be considered.
    ii. Traffic Engineering has deemed a streetlight may be warranted based on a study, but written consent is not received from abutting property owners.

iii. The streetlight will be installed as part of a planned Capital Improvement or other City Project.

c. **City Responsibility**
   i. The City's Traffic Engineering Division of Public Works shall review and approve the street lighting request. The guidelines in this policy have been created to aid the City with any public safety request for street lighting, will meet the City of Corpus Christi guidelines, and provide the electric service provider a standard design format from which to start their street light electrical service design.
   ii. The Traffic Engineering Division shall be responsible for coordination with the appropriate electric service provider on all aspects of the electrical design and installation the request which include, but are not limited to, the following:
      1. Written consent from abutting property owners.
      2. Determination of any necessary easements required for electrical service.
      3. Responsibility for the installation of conduit and pull boxes.
      4. Funding for all costs associated with the design, material, and installation of streetlights.
   iii. Street lighting shall be installed with underground electric service on all requests in City limits unless only overhead distribution and wood pole street lighting exist in an area. In such cases, the design should utilize existing or new wooden utility poles for any additional streetlights. Mixing of wood and metal pole streetlights is prohibited unless approved by the City.

G. Pole Attachments

a. **City-Owned.**
   i. The City may allow third parties to use City-owned poles for supplemental purposes such as antenna for data networks, communications, wireless services, installation of banners, etc. Written approval from the Department of Public Works is required and use shall be subject to City permits, license and maintenance requirements.

b. **Electric Service Provider-Owned.**
   i. Requests for permission to use poles owned by a electric service provider must be directed to the appropriate company**.**

H. Street Light Design Guidelines

The design of streetlight is influenced by many factors including, but not limited to, the location of existing utility poles, fire hydrants, block lengths, driveways, property lot lines, trees, and human and environmental factors. Not all street lighting scenarios will be covered in this policy. It is the responsibility of Engineers to use good engineering judgement consistent with recommend practices when developing a streetlight plan.

a. **General Design Guidelines.**

All streetlighting of public and private streets within the City of Corpus Christi shall be designed to not only address lighting of streets, but also adjacent bikeways and pedestrian pathways when associated with the “street” right-of-way. Streetlights on shall meet the standards set forth in the Recommended Practice for Design And Maintenance Of Roadway And Parking Facility Lighting (ANSI/IES RP-8-18) and any supplemental revisions.

b. **Underground Electric Service.**

Streetlighting shall be installed with underground electric service in all newly developed public streets, unless otherwise noted in Sections 1.2.4, 1.2.5, and 1.2.6. Curb returns shall be installed after the installation of the electrical system, including underground vaults. Coordination with the appropriate electric service provider is required for electrical service.

c. **Street Light Location and Spacing.**

i. Final pole locations shall be determined based on an approved streetlight plan from the City’s Traffic Engineering Division and electrical plan by the electric service provider.
ii. Streetlights shall be located at a minimum at all street intersections, mid-block along residential streets, center of a cul-de-sac, on the outside of horizontal curves and knuckle, on vertical curves (crest and sag locations), dead end streets (temporary or permanent) and at all marked crosswalks.
iii. At “T” intersections, a streetlight should be located on either corner of the intersection of the street that ends.

iv. Where possible, streetlights shall be staggered on alternate sides of streets classified as either a local, collector or parkway collector street and has a maximum of two travel lanes.
v. Streetlights shall be paired, where possible, on alternate sides of the roadway on streets classified as either a collector or arterial and has three or more lanes.
vi. Existing wood poles may only be used for mounting of streetlights, if approved by the owner of the poles and the City.
vii. Along local residential streets or residential area, streetlights are recommended to have a minimum spacing of approximately 150-feet and maximum spacing of 500-feet (+/- 10' for driveway and property line adjustment) for adequate roadway illumination purposes. Lighting should be provided at midblock locations regardless of block length. Cul-de-sacs longer than 150-feet, measured from the centerline of the intersecting street, are required to have a streetlight at the center of the cul-de-sac (+/- 10' for driveway and property line adjustment).
viii. Along collector and arterial streets, streetlights are recommended to have a maximum spacing of 300 feet and a minimum spacing of 150 feet.
ix. Street light poles and luminaires shall always be located to avoid conflicts with above -ground and below-ground public and private infrastructure.
x. Within residentially zoned areas avoid the placement of streetlights that would bother residents. Poles are typically installed between property lines and away from obstructions such as trees, manholes, water meters, fire hydrants and inlets.
xi. Shielding may be necessary to limit the spill-over of light onto and into adjacent residential buildings and other public and commercial uses such as hospitals and hotels.

d. **Mounting Height.**

i. The mounting height along pedestrian walkways should be lower than mounting heights for street lighting (10 to 25 feet).
ii. The minimum streetlight mounting height for new residential developments is 25 feet and should not exceed 28 feet.
iii. It is recommended that the mounting height should not exceed 30 feet in residential areas or 40 feet in other areas where the lighting system is being upgraded or retrofitted. These recommendations may only be exceeded in cases where overhead power lines may

limit pole and luminaire mounting heights or electric service provider specifications and requirements govern and require a higher mounting height.

iv. Along arterials, the use of higher wattage fixtures at long spacing and high mounting heights is generally recommended.

v. Along collector and local streets, higher wattage lamps and mounting heights should not be used as they provide more illumination than is needed over the **roadway and result in** undesirable spillover light onto private property.

e. **Intersections**

i. A single HID luminaire source of 150 watts or less (of LED equivalent) is recommended for local and collector streets.

ii. A single HID luminaire source of 250 watts or less (of LED equivalent) is recommended for arterial streets.

iii. A single HID luminaire source shall be provided at a minimum of one-leg of a “T” intersection. “T” intersections are considered intersections which have approaches with only one-lane in each direction.

iv. A minimum of two HID luminaire sources shall be provided at an intersection with three-legs or more. Three-leg intersection is considered an intersection which has more than one lane on the approach and intersecting street.

v. A minimum of two HID luminaire sources shall be provided on local and collector streets with four legs.

vi. Four HID luminaire sources shall be provided on arterial streets with four legs or more.

f. **Signalized Intersections.**

A light emitting diode (LED) luminaire be mounted on top of all new mast arms. All existing fixtures at signalized intersections shall be upgraded to an LED luminaire as part of any maintenance or upgrade to the mast arm. The fixture shall be mounted perpendicular to the flowline. A combination of streetlights, mounted on poles and/or mast arms may be used to provide lighting at a signalized intersection. A minimum of four streetlights shall be placed at an arterial street intersection, unless directed by the Traffic Engineering Division.

g. **Railroad Crossing Lighting.**

Railroad crossing lighting will conform to the latest version of the Railroad-Highway Grade Crossing Handbook (FHWA).

h. **Lighting in Texas Department of Transportation Right-of-Way.**

All lighting along roadways maintained by the Texas Department of Transportation, including bridge underpasses, where vehicles, pedestrians, bicyclists, or equestrians may be present, shall require lighting. Proposed street lighting plan must be reviewed and approved the local Texas Department of Transportation Office.

i. **Attached Sidewalks.**

Install streetlighting behind sidewalks in an easement or public right-of-way. A minimum of 1-foot clearance should be provided on local streets, from the back of curb, and 2-feet clearance provided, from back of curb, on collector and arterial streets. Poles located within the clear zone shall be on a breakaway foundation.

j. **Detached Sidewalks.**

Install streetlighting between the curb and sidewalk, where possible. A minimum of 1-foot clearance should be provided on local streets, from the back of curb and sidewalk, and 2-feet clearance provided, from back of curb and sidewalk, on collector and arterial streets. Poles located within the clear zone shall be on a breakaway foundation.

k. **Rural Street Design.**

On streets without curb and gutter, the streetlight shall be placed, within an easement or public right-of-way, no closer than 10-feet from the edge of the travel lane.

l. **Median Design.**

Street light installations in medians are discouraged. However, to avoid conflicts trees (full shade) shall not be placed within 30- feet of a streetlight, ornamental trees shall be no closer than 15-feet to any streetlight, proposed pole locations shall yield to mature trees, and proposed trees should be relocated. Poles located within the clear zone shall be on a breakaway foundation.

m. **Street Light Plan.**

Except for public safety requests per Section 1.2.5, all street lighting systems shall be prepared by a licensed Engineer in State of Texas. All installations within City right-of-way will require coordination and assistance from the franchise utility power provider and must be approved by the Traffic Engineering Division of the Department of Public Works prior to installation. In new subdivisions, a street lighting plan will be required prior to approval of the subdivision.

n. **Public Utility Conflicts.**

When locating proposed lighting, avoid possible conflicts with public utilities, including but not limited to fire hydrants, water, sanitary sewer, and storm sewer lines and manholes.

o. **Roundabout Lighting.**

Roundabout lighting shall be in accordance with recommendations of IES DG-19-08 “Design Guide for Roundabout Lighting.” Lighting shall make roundabout visible from a distance and make key conflict areas more visible. If continuous street lighting is not present, transition lighting is to be provided. The mounting height should be uniform throughout the intersection and not less than on any approach road and the minimum illuminance required should not be less than the highest level of lighting for any of the approach roads.

p. **Clearance.**

All underground streetlight facilities shall be located a minimum of 3 feet horizontally and 18 inches vertically from all other utilities. Clearance may be adjusted with electric service provider approval.

2.0 STREET AND PEDESTRIAN CLASSIFICATIONS

Street lighting requirements are based on the type of roadway, roadway surface classification, and traffic volume. Lighting classifications are tied to the street type or pedestrian area being illuminated. Listed below are the various street and pedestrian classifications.

Local: Includes streets used for direct access to residential, commercial, or industrial property. They make up a large percentage of the total street system, but a small portion of vehicular traffic.

Collector: Includes streets that service traffic between major and local streets. They are used mainly for traffic movements within residential, commercial, or industrial areas and do not handle long, through trips. These streets provide direct service to abutting properties.

Arterial (Major): Part of the roadway system that serves as the principal network for through-traffic flow and provides access to abutting property. These streets connect areas of principal traffic generation and important rural roadways entering and leaving the city.

Alley: Narrow public way within a block, generally used for vehicular access to the rear of abutting properties.

Median: Portion of a divided street physically separating the traveled way for traffic in opposite directions.

Sidewalk: Includes areas that are paved or improved for pedestrian use, located within the public right-of-way, adjacent to roadways for vehicular use.

Pedestrian walkway: A public walk for pedestrian traffic, not necessarily within or adjacent to public right-of-way used for vehicular traffic.

Bikeway: Any road, street, path or way that is intended for exclusive or shared use of bicycles and other modes of transportation.

Pedestrian activity must also be analyzed as part of a street lighting analysis and is typically based on the abutting land use. It is the responsibility of the Engineer to select the appropriate pedestrian activity level. Listed below are nighttime pedestrian classification levels and the land uses they are typically associated with.

High: Commercial areas in urban environments that have high nighttime pedestrian activity. Lighting systems should increase the visibility of pedestrians. The use of horizontal and vertical illuminances is recommended to account for the visual environment and high probability for detection of pedestrians. (Over 100 pedestrians per hour)

Medium: Any area that has a moderate nighttime pedestrian activity. Examples include community facilities and recreation centers. Pedestrian safety and guidance to primary travel ways are key elements for lighting systems in these areas. (10 to 100 pedestrians per hour)

Low: Lighting system in residential areas that allow both the driver and pedestrian to visually orient in the environment, detect obstacles, identify other pedestrians, and see signs. (10 or fewer pedestrians per hour)

3.0 LIGHTING LEVELS

Lighting shall be designed based on guidelines from the ANSI/IES RP-8-18 Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting. The following tables and pole placement figures are from the ANSI/IES RP-8-18. Any changes to the document supersede the values and information below.

ILLUMUNANCE FOR INTERSECTIONS (lux/fc)				
STREET CLASSIFICATION	**PEDESTRIAN ACITIVITY CLASSIFICATION**			**E_{avg}/E_{min} (lux/fc)**
	HIGH	**MEDIUM**	**LOW**	
Major/Major	**34/3.2**	**26/2.4**	**18/1.7**	**3:1**
Major/Collector	**29/2.7**	**22/2.0**	**15/1.4**	**3:1**
Major/Local	**26/2.4**	**20/1.9**	**13/1.2**	**3:1**
Collector/Collector	**24/2.2**	**18/1.7**	**12/1.1**	**4:1**
Collector/Local	**21/2.0**	**16/1.5**	**10/0.9**	**4:1**
Local/Local	**18/1.7**	**14/1.3**	**8/0.7**	**6:1**

Table 3.0.1 PAVEMENT ILLUMINANCE CRITERIA FOR FULL INTERSECTION LIGHTING (lux/fc).

STREET CLASSIFICATION	**PAVEMENT CLASSIFICATION**			**UNIFORMITY RATIO**
	R1 lux/fc	**R2 & R3 lux/fc**	**R4 lux/fc**	
Major	**6/0.6**	**9/0.8**	**8/0.7**	**3.0**
Collector	**4/0.4**	**6/0.6**	**5/0.5**	**4.0**
Local	**3/0.3**	**4/0.4**	**4/0.4**	**6.0**

TABLE 3.0.2 PAVEMENT ILLUMINANCE CRITERIA FOR PARTIAL (ISOLATED) INTERSECTION LIGHTING (lux/fc)

ILLUMUNANCE FOR INTERSECTIONS (lux/fc)				
STREET CLASSIFICATION	**PEDESTRIAN ACITIVITY CLASSIFICATION**			**E_{avg}/E_{min} (lux/fc)**
	HIGH	**MEDIUM**	**LOW**	
Major/Major	**34/3.2**	**26/2.4**	**18/1.7**	**3:1**
Major/Collector	**29/2.7**	**22/2.0**	**15/1.4**	**3:1**
Major/Local	**26/2.4**	**20/1.9**	**13/1.2**	**3:1**
Collector/Collector	**24/2.2**	**18/1.7**	**12/1.1**	**4:1**
Collector/Local	**21/2.0**	**16/1.5**	**10/0.9**	**4:1**
Local/Local	**18/1.7**	**14/1.3**	**8/0.7**	**6:1**

TABLE 3.0.3 RECOMMENDED PAVEMENT ILLUMINANCE FOR ROUNDABOUTS, BASED ON PEDESTRIAN ACTIVITY CLASSIFICATION

MAINTAINED ILLUMINANCE VALUES FOR WALKWAYS/BIKEWAYS			
AREA	**E_{agv} (lux/fc)**	**$E_{v,min}$ (lux/fc)**	**E_{avg}/E_{min*} (lux/fc)**
Mixed Vehicle and Pedestrian	**20/1.9**	**10/0.9**	**4.0**
Pedestrian Only	**10/0.9**	**5/0.5**	**4.0**

TABLE 3.0.4 RECOMMENDED VALUES FOR HIGH PEDESTRIAN ACTIVITY AREAS

E_{avg}- Minimum maintained average horizontal illuminance at pavement
E_{min}- Minimum horizonal illuminance at pavement
$E_{v,min}$- Minimum vertical illuminance at 1.5m above the pavement in both directional and parallel to the main pedestrian flow. Pedestrian Only areas apl.
*Horizonal Only

MAINTAINED ILLUMINANCE VALUES FOR WALKWAYS/BIKEWAYS			
AREA	**E_{agv} (lux/fc)**	**$E_{v,min}$ (lux/fc)**	**E_{avg}/E_{min*} (lux/fc)**
Pedestrian Only	**5/0.5**	**2/0.2**	**4.0**

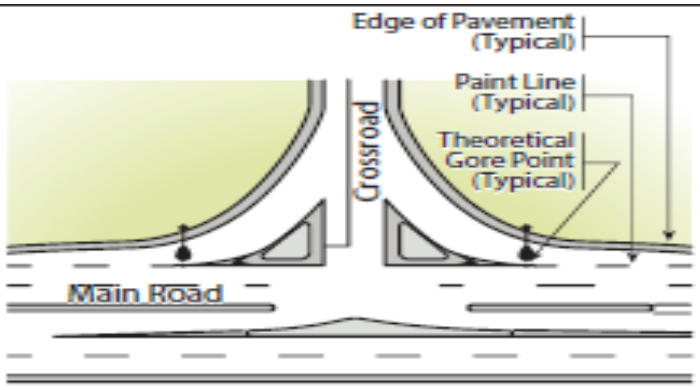
TABLE 3.0.5 RECOMMENDED VALUES FOR MEDIUM PEDESTRIAN ACTIVITY AREAS

E_{avg}- Minimum maintained average horizontal illuminance at pavement
E_{min}- Minimum horizonal illuminance at pavement
$E_{v,min}$- Minimum vertical illuminance at 1.5m above the pavement in both directional and parallel to the main pedestrian flow. Pedestrian Only areas apl.
*Horizonal Only

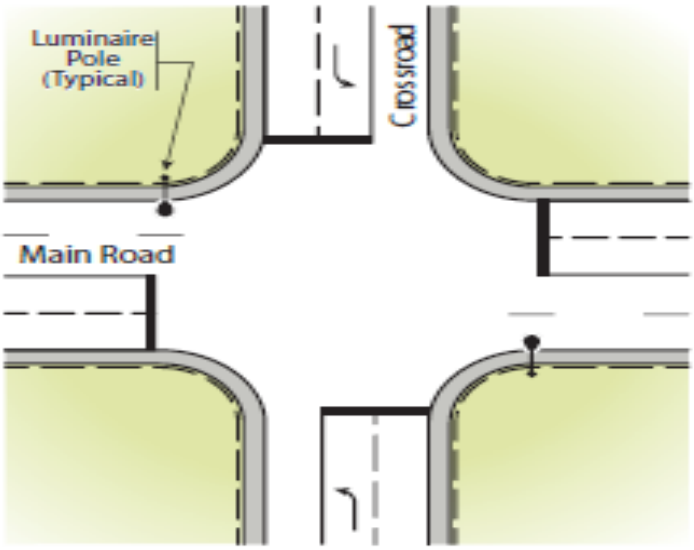
MAINTAINED ILLUMINANCE VALUES FOR WALKWAYS/BIKEWAYS			
AREA	**E_{agv} (lux/fc)**	**$E_{v,min}$ (lux/fc)**	**E_{avg}/E_{min*} (lux/fc)**
Rural/Semi-Rural Area	**2/0.2**	**1/0.1**	**10.0**
Low Density Residential (2 or fewer dwelling units per acre)	**3/0.3**	**1/0.1**	**6.0**
Medium Density Residential (2 or fewer dwelling)	**4/0.4**	**1/0.1**	**4.0**

TABLE 3.0.6 RECOMMENDED VALUES FOR MEDIUM PEDESTRIAN ACTIVITY AREAS

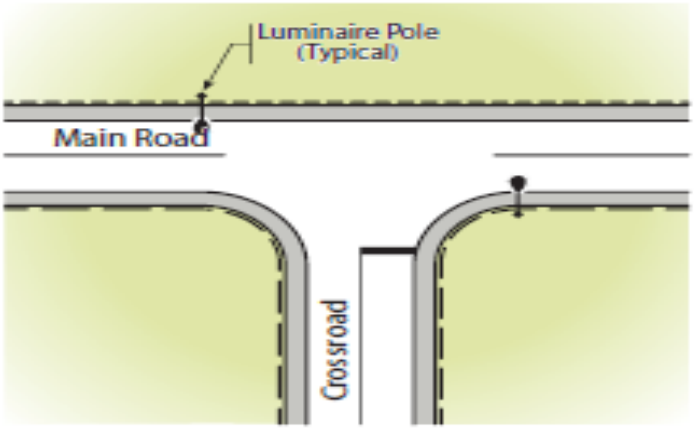
E_{avg}- Minimum maintained average horizontal illuminance at pavement
E_{min}- Minimum horizonal illuminance at pavement
$E_{v,min}$- Minimum vertical illuminance at 1.5m above the pavement in both directional and parallel to the main pedestrian flow. Pedestrian Only areas apl.
*Horizonal Only



Typical Three-Leg Intersection



Typical Four-Leg Intersection



Typical "T" Intersection

4.0 STREETLIGHT SUBMITTALS

A streetlight plan must be submitted to the City's Traffic Engineering Division for review and approval prior to the approval of a site plan, public improvement construction plan, or Capital Improvement Project Construction plan. The following is required with a streetlight plan submittal.

A. Streetlight Plan (New Residential Subdivisions)

a. Provide the location, type, spacing and mounting height of all proposed lighting.
b. Property lines, streets, sidewalks, easements, trees should be clearly identified and labeled.

B. Streetlight Plan (Capital Improvement Project)

a. Provide the location, type, wattage, and height of all proposed lighting.
b. Property lines, streets, sidewalks, easements, trees should be clearly identified and labeled.
c. Provide the location of all pull boxes dimensioned from the streetlights, curbs, or other features.
d. Location of the service point (power source).
e. Location of conduit service runs dimensioned from the face of curb, edge of pavement or back of sidewalk (as applicable).
f. Size and type of conduit used (2" minimum).
g. Size and number of wires.
h. Photometric layout.

City of Corpus Christi

Infrastructure Design Manual

Chapter 9

LANDSCAPING DESIGN REQUIREMENTS

Chapter 9

LANDSCAPING DESIGN REQUIREMENTS

1.0 MEDIANS

A. Purpose

Medians are the center portion of a street that separates opposing directions of travel. Medians vary in width and purpose and can be raised with curbs or painted and flush with the pavement. Medians on low-speed urban thoroughfares are used for access management, accommodation of turning traffic, safety, pedestrian refuge, landscaping and lighting and utilities. Based on these functions, this guidance addresses raised curbed medians with a discussion of alternate applications such as flush medians interspersed with landscaped median islands.

In addition to their operational and safety functions, well-designed and landscaped medians can serve as a focal point of the street or an identifiable gateway into a community, neighborhood, or district. Wider medians can provide pedestrian refuge at long intersection crossings and midblock crossings. Medians vary in width depending on available right of way and function. Because medians increase the width of a street, the designer must weigh the benefits of a median against the increase in pedestrian crossing distance and possible decrease in available streetside widths.

With some innovation in design, curbed medians can provide biofiltration swales to retain and improve the quality of stormwater runoff. Flexibility in median width design revolves around the median's function, appurtenances, and landscaping to be accommodated in the median and available right of way. The designer needs to consider the trade-offs between the provision of a median and other design elements, particularly in constrained rights of way.

Boulder, Colorado

Albuquerque, NM

B. General Principles and Considerations

General principles and design considerations regarding medians include the following:

a. Where medians are provided at intersections as refuge, they should be wide enough to accommodate groups of pedestrians, wheelchair users, bicyclists and people pushing strollers. To keep streets compact and pedestrian-scaled, median width typically should not exceed 18 feet in walkable urban environments except on ceremonial view corridors and parkways or where dual left turns are provided.
b. On boulevards and wide avenues (more than 60 feet) where median dimensions need to remain continuous and left turn lanes are provided, medians should be 16—18 feet, to allow for a turn lane plus pedestrian refuge.
c. At lower urban speeds (25 to 30 mph) there is no need to provide an offset between the median curb face and the travel lane.

C. Median Widths

Median width may vary to accommodate a pedestrian refuge and/or turn lane. For example, designers may remove on-street parking near intersections in order to laterally shift the travel lanes to accommodate a median with a turn pocket. Where right of way is available, a continuous dimension for the median is preferred.

a. On multilane thoroughfares, medians aid pedestrians in their crossing. A median of 6 to 8 feet can be more desirable to a crossing pedestrian than the same width added to another element of the thoroughfare.
b. Raised medians in low-speed urban contexts should be constructed with vertical curbs to provide refuge for pedestrians, access management and a place to install signs, utilities, and landscaping. If emergency access is a concern, mountable curbs should be considered in special locations (where medians are carried across intersections, access managed thoroughfares near fire stations, or within 200 to 300 feet of an intersection approach that frequently experiences long queues). Mountable medians can be super-reinforced with grasscrete pavers or concrete with added rebar.
c. Narrow medians (4 feet or less) should only be used to restrict turning movements, to separate opposing directions of traffic and to provide space for traffic control devices (Figure 1). A 4-foot median may also be landscaped with shrubs.

Figure 1. Narrow medians, such as on this boulevard in Chicago, should only be used to restrict turning movements, separate opposing traffic and create space for traffic control devices. Source: The Congress for the New Urbanism.

d. In constrained rights of way, consider narrower medians with attractive hardscape and urban design features in lieu of planting, or provide a discontinuous median as right of way permits.
e. Landscaping on medians should be designed in a manner that does not obstruct sight-distance triangles.
f. At intersection crossings, where the median is wide enough (see Table 1), extend the median nose beyond the crosswalk to provide an enclosed pedestrian refuge (Figures 2 & 3).

Figure 2. Median nose extended beyond the crosswalk to provide an enclosed pedestrian refuge. Source: Kimley-Horn and Associates, Inc.

Figure 3. This boulevard median serves as a pedestrian refuge, a community gateway and area for landscaping. Source: Kimley-Horn and Associates, Inc.

g. Recommended Practice

Table 1 presents the recommended practice for median widths for various functions within low-speed thoroughfares (35 mph or less). The recommendations assume arterial and collector streets in urban contexts with operating speeds of 35 mph or less. Most of the guidance in this report is not applicable to flush or depressed medians or to raised medians with mountable curbs. Note that median widths are measured from face of curb to face of curb.

Thoroughfare Type	Minimum Width	Recommended Width
Median for access control		
All thoroughfare types	4 feet	6 feet[1]
Median for pedestrian refuge		
All thoroughfare types	6 feet	8 feet
Median for street trees and lighting		
All thoroughfare types	6 feet[2]	10 feet[3]
Median for single left-turn lane		
Collector avenues and streets	10 feet[4]	14 feet
Arterial boulevards and avenues	12 feet	16-18 feet
Median for dual left-turn lane		
Arterial boulevards and avenues	20 feet	22 feet
Median for transitway		
Dedicated rail or transit lanes	22 feet	22-24 feet
Added median width for platforms	10 feet for each side platform 30 feet for center platform	

Table 1. Recommended Median Widths on Low-Speed Walkable Thoroughfares (35 mph or less)

a. A 6-foot-wide median is the minimum width for providing a pedestrian refuge.
b. Six feet (measured between curb faces) is generally considered a minimum width for proper growth of small trees less than 4 inches in diameter at maturity. A 10-foot median is recommended for larger trees.
c. Wider medians to provide generous landscaping are acceptable, if desired by the community. However, avoid designing medians wider than necessary to

support its desired function at intersections. This can reduce the operational efficiency of the intersections and invite undesirable behavior of crossing traffic such as side-byside queues, angled stopping and so forth.

d. A 10-foot-wide median allows for a striped left-turn lane (9 to 10 feet wide) without a median nose.

2.0 MIDBLOCK CROSSINGS

A. Midblock crossings provide convenient locations for pedestrians to cross urban thoroughfares in areas with infrequent intersection crossings or where the nearest intersection crossing creates substantial out-of-direction travel. Installing midblock crosswalks can help channel pedestrians to the safest midblock location, provide visual cues to allow approaching motorists to anticipate pedestrian activity and unexpected stopped vehicles and provide pedestrians with reasonable opportunities to cross during heavy traffic periods when there are few natural gaps in the approaching traffic streams (Figure 4).

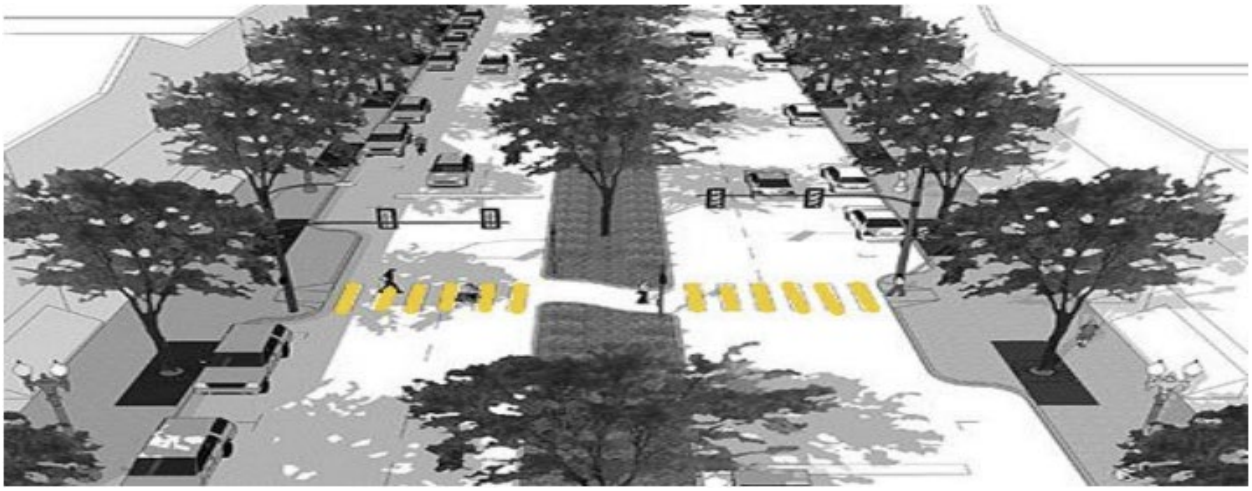


Figure 4. Midblock crosswalks provide opportunities to cross streets with long distances between intersection crossings. Source: Claire Vlach, Bottomley Design & Planning.

B. “Z” Midblock Crossings.

"Z" crossing configurations should be used for midblock crossings with medians wherever possible (see Figure 5). Provide an at-grade channel in median at a 45-degree angle toward advancing traffic to encourage pedestrians to look for oncoming traffic.

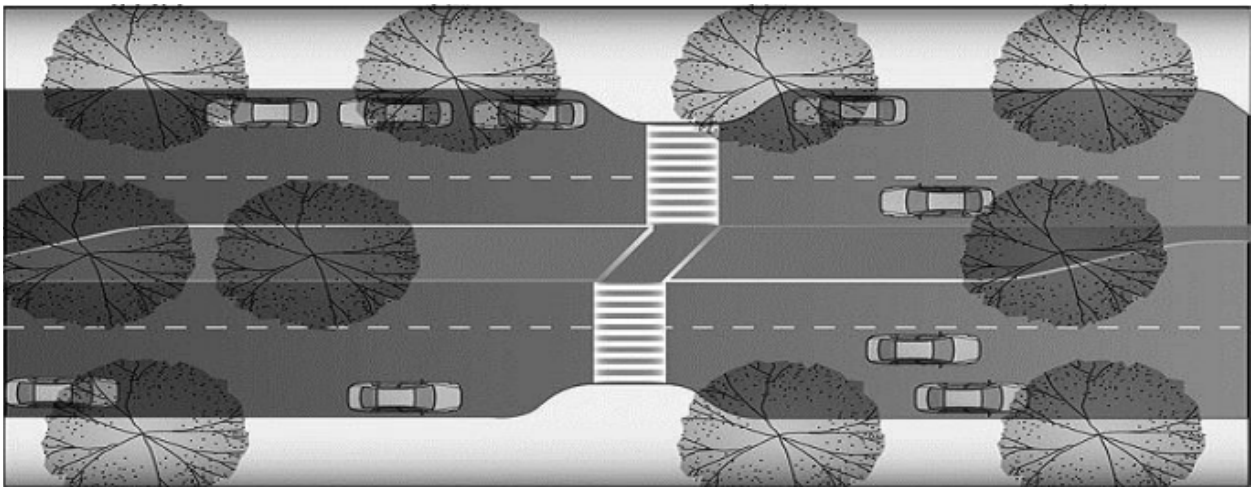


Figure 5. Midblock crossings with a "Z" configuration force pedestrians crossing the median to look toward oncoming traffic. Avoid street trees that interfere with visibility. Source: Kimley-Horn and Associates, Inc.

A strategy to calm traffic speeds in advance of and at a midblock crossing is to raise the pavement to meet the sidewalk elevation by use of gentle ramps (see Figure 6). Consider use of overhead flashing beacons.

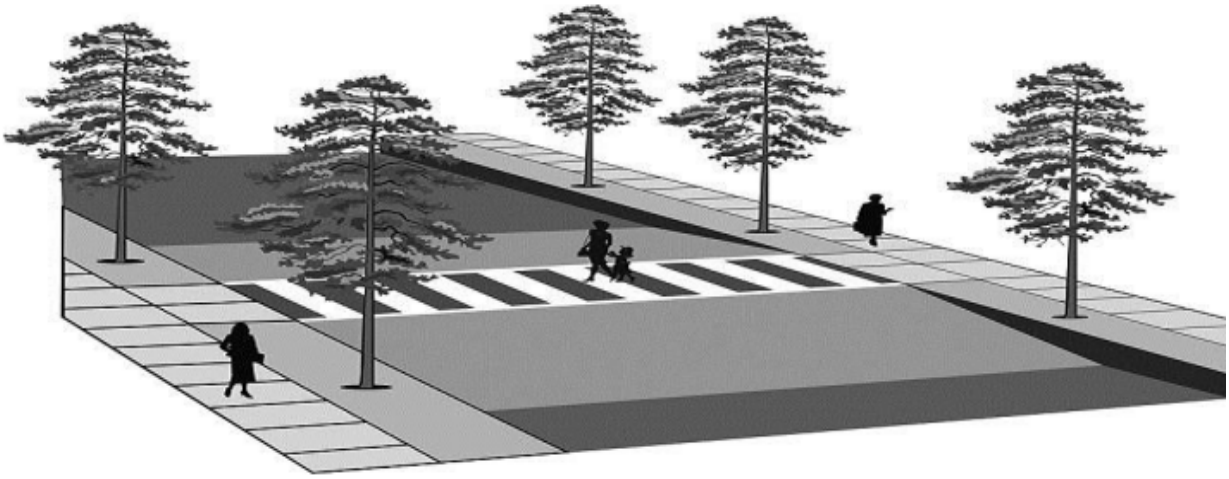


Figure 6. The raised roadway crosswalk concept combines midblock crosswalks with traffic calming devices. Source: Kimley-Horn and Associates, Inc.

C. Recommended Practice for Midblock Crossings

General principles and considerations regarding midblock crossings include the following:

When and Where to include a Midblock Crossing
• On streets with an average daily traffic volume (ADT) of 12,000 vehicles per day or less.
• On multilane streets carrying less than 15,000 ADT if a raised pedestrian refuge median is provided.
• Where operating speeds are less than 40 mph.
• Where a minimum pedestrian crossing volume of 25 pedestrians per hour for at least four hours of a typical day.
• Where adequate sight distance is available for pedestrians and motorists.
General
• Consider providing a marked midblock crossing when protected intersection crossings are spaced greater than 400 feet or so that crosswalks are located no greater than 200 to 300 feet apart in high pedestrian volume locations, and meet the criteria below.
• Midblock crossings may be considered when there is significant pedestrian demand to cross a street between intersections, such as connecting to major generators or transit stops.
• Midblock crosswalks should be located at least 100 feet from the nearest side street or driveway so that drivers turning onto the major street have a chance to notice pedestrians and properly yield to pedestrians who are crossing the street.
Recommendations
• Provide overhead safety lighting on the approach sides of both ends of midblock crosswalks.
• Provide wheelchair ramps or at-grade channels at midblock crosswalks with curbs and medians.
• Provide raised median pedestrian refuge at midblock crossings where the total crossing width is greater than 60 feet, and on any unsignalized multi-lane thoroughfare crossing.
• Provide advance crosswalk warning signs for vehicle traffic.
• Appropriate stopping sight distance is a critical part of the design of midblock crossings. Refer to AASHTO's *Policy on Geometric Design of Streets and Highways* (2004) for guidance in determining sight distance.
• Midblock crossings should be identifiable to pedestrians with vision impairments. Where there is a signal, a locator tone at the pedestrian detector might be sufficient. A tactile strip across the width of the sidewalk at the curb line and at pedestrian refuge islands needs to be used so that visually impaired pedestrians are alerted to the presence of the crossing.

Source: Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations, FHWA, 2002 Manual on Uniform Traffic Control Devices, FHWA, 2009 Edition Guide for the Planning, Design and Operation of Pedestrian Facilities, AASHTO, 2004

3.0 LANDSCAPING FOR PUBLIC RIGHT-OF-WAY STRUCTURES

Planting choices for public right-of way structures are made considering plant hydrozones, specific site conditions, unique character zone, soil types, slopes, extent of water use and maintenance, and their ability to provide year-round ornamental value. Plantings with low irrigation requirements are being promoted through the use of xeric plants and restricted irrigation methods. Appendix A includes a list of many acceptable trees, shrubs, vines, groundcovers, and ornamental grasses that can be used to create attractive streetscapes for public right-of-way structures while reducing stormwater runoff.

A. Goals:

The goals of these design standards are as follows:

Develop design standards and guidelines for improved landscaping in publicly owned and maintained streetscapes or medians which are:

1. Aesthetically pleasing
2. Require limited maintenance
3. Consistence with the City's water conservation efforts
4. In conformance to Area Development and /or Specific Plans
    i. The design and planting of roadside drainage ditches are not included in these design standards.
    ii. Design of streetscapes located rearward of the curb face incorporating pedestrian sidewalks on Arterial and Collector streets shall follow the adopted Section 6.13 Streetscape Zone Standards under the City's Unified Development Code (UDC)

B. Specific Standards:

i. Ground Cover Materials
    1. No pavers will used in publicly owned and maintained streetscapes or medians unless in areas as otherwise specified in the Comprehensive Area Development Plan
    2. Limited use of unstained, unstamped concrete.
    3. Acceptable materials will include (in order of priority)
        a. decomposed crushed granite gravel
        b. rock
        c. reclaimed/recycled concrete
        d. mulch

e. recycled tires or glass

4. Selection of material shall consider area drainage flow patterns

C. Turf

i. No turf will be planted unless otherwise identified in the Area Development or Specific Plan applicable for that area in addition, special consideration may be given to roadside embankments where turf is required to stabilize side-slopes
ii. If embankments or large areas make it cost prohibitive to use hardscaping or plants throughout, tall native grasses shall be used.
iii. If under extreme circumstances turf is required shade and drought tolerant turf such as Zoysia grass shall be used.

D. Trees and Plantings

i. Trees and plantings will be limited to those listed in the Corpus Christi Water Department's Xeriscaping Guidelines or those listed for Region 2 in the Texas Agricultural Extension Services' Xeriscape: (Appendix A).
ii. Must be consistent with the City's Public Tree Plan.
iii. Planting of trees that produce flowers and fruit will be limited to medians that will not include walking paths and which are wide large enough to prevent flowers and fruit from dropping adjacent streets. These trees will not be planted in streetscapes or landscape strips.
iv. Location of utilities should be considered when planting trees. At maximum size trees (nor their roots) shall interfere with utility lines/infrastructure. Tree wells or other structural enclosures are encouraged to minimize potential for root intrusion.
v. Use plants that will not encroach on the sidewalk right-of-way in streetscapes or landscape strips or impede ADA access.
vi. Palm trees will be limited to specific corridors along gulf and bay front areas.

E. Plant Spacing

i. Small-caliper trees can be healthy in medians that are at least 6 feet wide, as long as a critical root area is provided. A 10-foot-wide median is recommended for larger trees.

ii. Maintain a horizontal offset (minimum of 18 inches) between the trunk and median curb face and prune to maintain sight distance (Figure 7).

Figure 7. Maintain a minimum 18-inch offset between the face of median tree (at maturity) and the face of curb. Source: Dan Burden, walklive.org

iii. Trees closer than 50 feet from the ends of medians must be regularly pruned to maintain sight distance. Trees should always be located and maintained so that the motorists' clear vision of any traffic control signs or signals will be assured at all times, retaining a vertical clearance between 2.5 feet (or 3 feet from pavement surface) and 8 feet from the top of the curb.

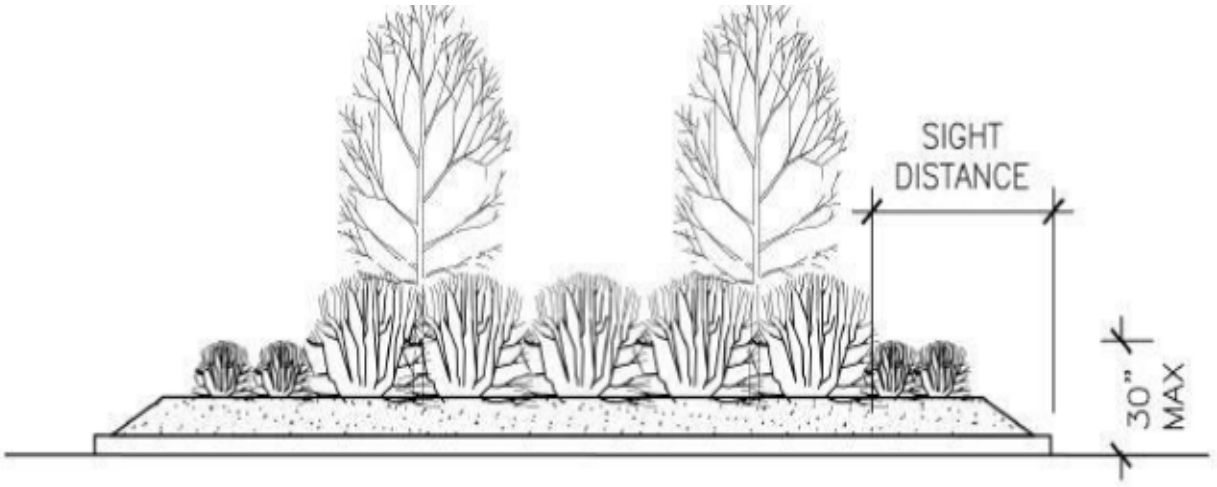


Figure 8. Sight Distance Measurements for Traffic Circles. Source: City of Boulder. CO., "Landscape Guidelines".

iv. Should the community desire a continuous canopy of trees in the median, space trees between 15 and 30 feet on center, depending upon the tree species.
v. Branches that extend beyond the curb into the travel lane should be pruned to a minimum height of 13 feet above the pavement.
vi. Plan tree spacing and canopy height along with other elements such as light standard spacing and height, utility placement and height and traffic control devices to minimize interference and provide adequate lighting and sight lines when trees are mature. Contact local utility providers to ensure compliance with required setbacks (see sidebar for an example of setback requirements).
vii. When hardscape is used between median trees, structural cells (modular, pre-engineered cell systems designed for water management, soil, and tree roots), supported reinforced panels, or other methods should be used to promote healthy roots under the hardscape.
viii. To maintain healthy median landscaping, an adequate watering and drainage system needs to be provided. Drought-tolerant plantings should be used when an irrigation system is not available. Provide under draining when needed for soil conditions.

F. Utility Setbacks

In urban areas, the community may find it desirable to plant trees in raised curbed medians for aesthetic purposes. Landscaping and trees in medians are strongly encouraged in context sensitive design, not only for aesthetics but also for shade, heat island reduction and storm-water interception. The use of medians for pedestrian refuge is recommended to reduce the pedestrian barriers created by wide urban arterials and to support safe design of midblock crossings. As refuges, medians allow pedestrians to focus on crossing one direction of the street at a time, therefore reducing conflicts and decisions. At intersections, pedestrian refuges assist all pedestrians, especially the elderly, to safely cross streets. In general, the guidance in this report is consistent with AASHTO in regard to low-speed urban thoroughfares. General utility setback guidelines include the following:

Example Landscape Setbacks from Utilities	
Overhead Electric	10, 15, or 20 feet, depending on tree height
Underground Electric	5, 10, or 15 feet, depending on tree size
Gas Lines	5, 10, or 15 feet, depending on tree size
Water Main	10, 15, or 20 feet, depending on tree size
Sanitary Sewer Main	15 feet all tree species
Fire Hydrant	5 feet all landscaping, 10 feet all trees
Water Meter	5 feet all landscaping, 10 feet all trees
Street Lights	10 feet all trees
Electric Transformers	10 feet front access, 5 feet other sides—all landscaping
Switch Cabinet	10 feet front and back access, 5 feet other sides.

Table 3.
(Source: Gainesville, FL, Regional Utilities Vegetation Management Tree Planting Guidelines)

G. Irrigation Systems

i. Irrigation systems will be limited to drip, bubbler, or micro emitter irrigation systems.
ii. Trees and ground cover should have separate irrigation lines so each can be irrigated for the proper hydrozone.
iii. Automatic controllers must be installed and programmed to:
    1. operate according to conservation methods required by the Water Department
    2. monitor moisture in each zone and adjust run times to satisfy minimum needs of plantings
iv. The recommend coverage of the irrigation system should be 30% of the project streetscape and median area. Median and streetscape areas shall be considered separate and distinct individual areas under this guidance.
v. No individual area should exceed irrigation in 50 percent of the area being improved. The remaining area should be hardscaped, native or use bioswales or other green infrastructure design methods as sole source of irrigation.
vi. Backflow preventers must be in stainless steel panel enclosures or other materials selected suitable for our coastal environment.
vii. Additional irrigation controller system requirements are included under Appendix B.

4.0 STORMWATER MANAGEMENT & CONSTRUCTION FEATURES

A. Special Consideration with Stormwater Management

The management of stormwater on walkable urban thoroughfares improves the walking and bicycling environment, aesthetics, and the quality of the community as a whole. Green stormwater management practices add value and functionality and should be considered in thoroughfare improvement projects.

B. Background and Purpose

Urban areas have a high percentage of impervious surfaces. This creates the need for stormwater systems that can carry the runoff away from the area or treat, absorb and/ or detain the runoff at its source. Failure to sufficiently handle stormwater can result in increased volume and rate of runoff from impervious surfaces increasing the demand for stormwater system capacity. If the system capacity cannot be increased, this can cause flooding and erosion, increase sedimentation, and damage the natural habitats that accept the runoff. Further, the concentration of pollutants in the runoff can impact water quality.

A "green street" is a thoroughfare that provides water-quality treatment, retention and/or detention for some or most stormwater within the right of way through use of vegetated facilities, usually swale areas, to reduce, delay and/or filter the amount of water piped directly to outfalls. This report provides a brief discussion of reducing and treating stormwater using source control or treatment control best management practices (BMPs). BMPs are used to accommodate stormwater runoff in one or more ways:

C. Bioswales and Rain Gardens in Stormwater Management

Pervious surfaces and "green" stormwater management should be used in medians, planting strips, planters, islands, sidewalk extensions and other applicable spaces within the right of way where natural stormwater detention, filtration, or absorption is desired, soil conditions are compatible, and where a suitable design is compatible with and supportive of the desired use of the thoroughfare and surrounding uses.

Bioswales and rain gardens are depressed areas that are normally highly porous but are planted with low-maintenance, frequently indigenous types of grass or vegetation that are compatible with the detention, absorption, and filtration functions they are designed to serve. Several guidelines can be followed to develop swales as a green approach to stormwater management:

a. Consider swales for use in medians, planting strips, planters, curb extension, islands, or other green areas of significant size where runoff can be collected and detained until filtered or absorbed or flowed into inlets at the end of swales.
b. Employ swales where they can slope downward from the curb or sidewalk.
c. Design gutters and curbs so water can enter the swale through breaks or other openings in the curbs; provide for runoff to enter swales directly from adjacent sidewalks or piped from elsewhere in the right of way.
d. Considering appearance, cleaning, maintenance, and amount of stormwater to be handled in the design of BMPs.
e. Blend BMPs in with the rest of the thoroughfare design and context; consider pedestrian connectivity; parking, bicycle and transit needs and provisions; safety; and emergency access.
f. Use native, flood-tolerant plants that need little watering, fertilizers, or maintenance.
g. Develop and implement a cleaning and maintenance program to preserve stormwater system functionality, appearance, and plants.
h. Install various commercially available traps, filters and detention or retention devices. Consider the maintenance requirements of these devices.
i. If the local soil doesn't percolate or if the median slopes, the design will need a subsurface drain inlet to the storm drain system at the downstream end (as shown in the photo below). Consider that loose soil around the plants would be carried into the storm drain with the first storm requiring fabric or other erosion control on the soil or a sediment trap in the inlet structure.

The photos below show examples of median bioswales, but similar swales can be located in planting strips adjacent to curbs or other locations within the right of way.

Source: City of Gresham, OR

D. Construction

For guidance in the construction of bioswales and raingardens, please refer to the “Corpus Christi LID Guidance Manual” for more in-depth discussion, examples, and schematics.

APPENDIX A
5.0 ACCEPTABLE LANDSCAPING MATERIALS

Xeriscape Corpus Christi, a nonprofit organization, in cooperation with local participating nurseries, have teamed up to help homeowners select plants that are proven performers in the Coastal Bend. **Local nurseries** will place Water-Wise labels on the selected plants to make plant selection easier. Once established, these plants will help you save water in your landscape. To request a free Xeriscape-to-Go booklet, call the City of Corpus Christi Water Hotline at (361) 826-1600.

TREES

Scientific Name	Common Name
Acacia farnesiana	Huisache, Sweet Acacia
Carya illinoensis	Pecan
Chilopsis linearis	Desert Willow
Cordia boissiere	Wild Olive
Ehretia anacua	Anaqua or Sandpaper Tree
Erythrina crista-galli	Fireman's Cap
Fraxinus berlandieriana	Rio Grande Ash
Fraxinus X 'Fan-Tex'	Fan-Tex Ash
Ilex vomitoria	Yaupon Holly Tree
Lagerstroemia spp.	Crapemyrtle ('Basham Party Pink' and 'Natchez', 'Catawba')
Parkinsonia aculeata	Retama, Jerusalem Thorn
Persea borbonia	Native Sweetbay (sandy soils only)
Pithecellobium flexicaule	Texas Ebony
Prosopis glandulosa	Mesquite
Pyrus kawkamii	Ornamental Evergreen Pear
Quercus polymorphus	Mexican Live Oak
Quercus virginiana	Live Oak (Nursery Grown Only)
Sapindus drummondii	Western Soapberry
Sophora secundiflora	Texas Mountain Laurel
Ulmus crassifolia	Cedar Elm
Ulmus parvifolia	Chinese Evergreen Elm
Vitex agnus-castus	Lavender Tree

PALMS & CYCADS

Arecastrum romanzoffanum (Cocos plumose)	Queen Palm
Brahae armata	Mexican Blue Palm
Butia capitata (Cocos australis)	Pindo or Jelly Palm
Chamaerops humilis	Mediterranean Fan Palm
Cycas revoluta	Sago Palm
Dioon edule	Mexican Sago Palm
Livistona chinesnsis	Chinese Fan Palm
Phoenix dactalifera	True Date Palm
Raphis excelsa	Lady Palm
Sabal minor	Palmetto Palm
Sabal palmetto	Cabbage Palm (Florida Sabal)
Sabal texana	Texas Sabal
Trachycarpus fortunei	Windmill Palm
Washingtonia robusta	Fan Palm
Washingtonia filifera	Fan Palm (Freeze Hardy)

SHRUBS, VINES AND HERBACEOUS PERENNIALS

Acalypha wilkesiana	Copperleaf, Copperplant
Agave americana	Century Plant
Aloe vera	Aloe vera, Medicine Plant
Alpinia zerumbet (green and variegated)	Shell Ginger
Antigonon leptopus	Coral Vine, Queen's Wreath
Apentia cordifolia	Heart Leaf Ice Plant
Artemesia 'Powis Castle'	Artemesia X 'Powis Castle'
Asparagus sprengeri	Asparagus Fern
Asparagus sprengeri "Myers"	Foxtail Fern
Aspidistra elatior	Aspidistra, Cast Iron Plant
Bambusa multiplex	Clumping Bamboo
Bauhinia congesta	Dwarf Orchid Tree
Berberis (Mahonia) trifoliata	Agarita, Agarito
Bougainvilla spp.	Bougainvillea
Bulbine frutescans	Bulbine frutescans
Caesalpinia spp.	Bird of Paradise Bush, Mexican Poinsianna
Callistemon citrinus	Bottlebrush
Campsis radicans	Trumpet Vine, Trumpet Creeper
Carissa spp.	Natal Plum
Cortaderia selloana	Pampas Grass
Cyrtomium falcatum	Holly Fern
Dasylirion texanum	Sotol
Dietes (Moraea) bicolor	Yellow African Iris
Duranta repens	Sky Flower

APPENDEX B

6.0 MINUMUM IRRIGATION SYSTEM SPECIFICATIONS

A. Display Features:

a. Minimum high contrast 3.25” backlit mono LCD screen with 128x64 pixels resolution.
b. Minimum screen LCD brightness of 250 lumens.

B. Operating Features:

Must support up to:

a. 100 zones in any combination of two-wire and conventional wire
b. 40 separate programs with overlapping run times
c. 20 bisensor soil moisture sensors
d. 3 points of connection (POC).
e. 7 normally open or normally closed master valves and pump starts for the entire system.
f. 7 separate normally closed or normally open pause or event devices and concurrently operate up to 15 typical AC solenoids over two-wire or up to 6 typical AC solenoids over conventional wire.

The operating system must also:

a. Assign and configure any zone to one or more programs.
b. Maximize watering efficiency and minimize total irrigation time to prioritize cycles for zones that have already started to water over zones that have not started.
c. Automatically stack up to at least 10 overlapping programs and run any number of programs concurrently if permitted by the zone concurrency settings.
d. Learn the actual flow for each zone when one or more flow meters are configured in the system.
e. Execute a high-flow or low-flow shutdown based on total system flow or on flow per flow meter.
f. Schedules watering based on available flow to maximize concurrent valve operation and minimize total water time.
g. Run a diagnostic test weekly on normally open master valves to help prevent a normally open master valve from “sticking” open.

h. Detect and repair all address conflicts for devices that are connected to the two-wire from the controller.
i. Support two-way communication with two-wire decoders (biCoders) to gather information about the two-wire voltage and communication integrity, the solenoid voltage and current, and status (open circuit, short circuit, or ok).
j. Store all program and history information in non-volatile memory.

C. Programmable Features

The system must be capable of:

a. Programming up to 8 start times per program in 10-minute increments.
b. The run times for zones from 1 second to 18 hours in 1 second increments.
c. Programming the day intervals in even days, odd days, or odd days excluding the 31st, and create a custom 7-day calendar, and historical calendar with customizable half-months.
d. Programming soak and cycle times for each program and specify hours during each day of the week when water can or cannot be applied in 1-hour increments for each 24-hour period.
e. Programming start, stop and pause irrigation modes to each program, including timed-based, eventbased, and soil moisture sensor-based behaviors.
f. programming the system manually by entering a design flow for each zone, with or without an installed flow meter.
g. Automatically calibrating soil moisture thresholds and make irrigation decisions based on those thresholds.
h. Adjusting a seasonal water budget from 10% to 200% by program.
i. Scheduling up to 8 future “event” dates when no watering will occur.
j. Manually operating one zone, or all zones of a program, with programmable run times, delay before starting first zone, and time between zones.
k. Searching for and identifying all devices connected to the two-wire and list them according to device type and serial number.
l. Addressing two-wire decoders by serial number by assigning each zone address a device serial number.
m. Re-addressing any two-wire decoder from the controller by re-assigning the device’s serial number to a new zone address.
n. Assigning any station or terminal number on a multi-station from the controller to any zone address in any order.
o. Backing up all programming and historical data with any USB flash drive.
p. Establishing 3 levels of local and remote PIN protection: status & stop, manual runs, and full programming access.

q. Configuring pipe-stabilization time for flow management.

D. Messages & Alerts

The system must be capable of:

a. Providing real-time soil moisture measurements and watering feedback to the user.
b. Including integrated tools and software that self-diagnose problems and generate alerts and messages, and then display the messages on the screen and remotely.
c. Displaying on-screen historical run time information that includes total run time and water used for the last two watering days.
d. Displaying actual or estimated flow values.
e. Displaying a 7-day scalable soil moisture graph with 12 readings per day.
f. Displaying all pause and stop conditions in message screens that are accessible from the main screen. The system must be able to display one message for each condition so the user can clear each message independently.
g. Displaying high flow alerts, low flow alerts, pause messages and conditions, and rain delays, wire faults, as well as other operating conditions.

E. Central Control & Remote Control

Transformer Input

a. Requires 120 VAC, 50 Hz to 60 Hz and a minimum of a 5-amp breaker.

Power Output

a. Station Output: 30 VAC RMS over two-wire
b. Supports up to 1.45-amp output.

Solenoid Specification

a. Requires a typical solenoid with approximately 400 milliamps of inrush current and approximately 200 milliamps holding current.

Surge

a. 10 levels of surge protection.
b. Up to 5 levels of surge protection built into the controller boards.
c. Minimum surge response time of 1 picosecond.

Enclosure Options

a. "C" Cabinet—Wall Mount Enclosure
   i. Dimensions: 10.13" x 12.00" x 4.75"
   ii. 16 Gauge, powder-coated
b. "X" Cabinet—Wall Mount Enclosure
   i. Dimensions: 15.50" x 12.38" x 6.40"
   ii. 16 Gauge, powder-coated
c. "XS" Cabinet—Wall Mount Enclosure
   i. Dimensions: 15.50" x 12.38" x 6.40"
   ii. 16 Gauge, 304-grade stainless steel
d. "P" Pedestal Enclosure
   i. Dimensions: 17.38" x 36.25" x 12.63"
   ii. 16 Gauge, 304-grade stainless steel

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