ORDINANCE #2023-07-00985

[Amending Code of Ordinances Chapter 13 Utilities: Planning and Design Drainage Criteria]

AN ORDINANCE OF THE CITY OF LUCAS, TEXAS, AMENDING THE CODE OF ORDINANCES BY AMENDING CHAPTER 13 TITLED "UTILITIES," BY AMENDING ARTICLE 13.07 TITLED "PLANNING AND DESIGN DRAINAGE CRITERIA", TO CONFORM TO THE DRAINAGE DESIGN MANUAL; PROVIDING FOR A REPEALING CLAUSE; PROVIDING FOR A SEVERABILITY CLAUSE; PROVIDING A SAVINGS CLAUSE; PROVIDING FOR A PENALTY OF FINE NOT TO EXCEED TWO THOUSAND DOLLARS ($2,000.00); AND PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, City staff recently updated the Drainage Design Manual to improve surface water drainage, and

WHEREAS, the City Council has determined it is in the best interest of the health, safety and welfare of the City to update the Code to reflect the requirements of the Drainage Design Manual.

NOW THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF LUCAS, TEXAS:

SECTION 1. That the City of Lucas Code of Ordinances is amended by amending Chapter 13 titled "Utilities", Article 13.07 titled "Planning and Design Drainage Criteria," to read as follows:

§13.07.001.   General

a) The drainage criteria included in this section are for the purpose of providing a set of guidelines for planning and designing storm drainage facilities in the city and within its extraterritorial jurisdiction. These criteria will be used by the department of public works, other city departments, consulting engineers employed by the city, and engineers for private developments in the city.

b) At a minimum, drainage plans shall include, but are not limited to the following:

1. Drainage area map;
2. Drainage area calculations (including size in acres, runoff coefficient, time of concentration, intensities for each required storm event and calculated flows for each storm event). Refer to the sample drainage area calculation table;
3. Inlet calculations. Refer to the sample inlet calculation table;
4. Open channel and/or storm sewer calculations. Refer to the sample open channel and storm sewer calculation tables;

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5. Plan view drawings including centerline alignment (with stationing) for all open channel and closed conduit conveyances;

6. Profile view drawings including alignment stationing and vertical slope for all open channel and closed conduit conveyances. Hydraulic information stating the quantity of flow (in cubic feet per second), the velocity of flow (in feet per second), the depth of flow (in feet), and the maximum capacity of each segment of the conveyance shall be included;

7. Cross sections on 100-foot intervals for all open channel conveyances including the 100-year water surface elevation. Each section shall demonstrate that a minimum of 1-foot of freeboard is provided. Hydraulic information stating the quantity of flow (in cubic feet per second), the velocity of flow (in feet per second), and the depth of flow (in feet) shall be included for each cross section;

8. Grading plans for detention and retention ponds;

9. Standard construction details and calculations for the outfall structures at each detention or retention pond for each storm event. The calculations shall demonstrate that post-development run-off rates are reduced to pre-development rates, or the capacity of downstream systems, whichever is less;

10. Storm sewer standard construction details; and

11. Any additional information as requested by the City Engineer.

c) The term Engineer shall be defined in this section to refer to a Professional Engineer licensed in the State of Texas. The Engineer shall be provided by the owner or land developer to provide design calculations and prepare construction plans in accordance with the Texas Engineering Practice Act. The City Engineer shall be defined in this section to refer to a Professional Engineer licensed in the State of Texas. The City Engineer acts as an agent of the city to verify general compliance with the City of Lucas development requirements and normal engineering practice.

§13.07.002.   Rational method for peak storm flows.

The formula to be used for calculating peak storm flows for drainage areas less than ~~200~~ 100 acres shall be the Rational Method, in which:

$Q = CIA$, where

    Q - is the peak storm flow at a given point in cubic feet per second (cfs)

    C - is the runoff coefficient that is equal to the ratio that the peak rate of runoff bears to the average rate (intensity) of rainfall;

    I - is the average intensity of rainfall in inches per hour for a storm duration equal to the time of travel for runoff to flow from the farthest point of the drainage area to the design point in question;

    A - The area that is contributing to the point of design.

Note: For drainage areas greater than 100 acres, peak storm flows shall be determined based on a flow routing analysis using detailed hydrographs such as the Natural Resource Conservation Service (NRCS) hydrologic methods that are available in such computer programs as HEC-HMS, etc.

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§13.07.003. Runoff coefficient

The runoff coefficient (C) shall consider the slope of the terrain, the character of the land use, the length of overland flow and the imperviousness of the drainage area and shall be determined based on ultimate land development. The runoff coefficient for the appropriate land used shall be as follows:

(1) Commercial/Parking Lots/Right-of-way 0.90.

(2) Industrial 0.90.

(3) Single-Family Residential 0.55.

(4) Multifamily 0.75.

(5) Parks and open space 0.35.

(6) Schools, churches, etc. 0.80.

§13.07.004. Rainfall intensity-frequency

a) The National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation-Frequency Atlas of the United States, Texas (2018) is recognized as the best available set of rainfall data for the State of Texas. This data (referred to as Atlas 14) provides point precipitation frequency values. Lucas City Hall (665 Country Club Rd, Lucas, Texas) has been selected to define standard rainfall intensity values throughout the city. All developments must be analyzed using the most recently adopted rainfall intensities, included as table 1. Redevelopment sites with receiving drainage infrastructure that was previously designed using a previous rainfall intensity standard are required to analyze and design stormwater facilities using the updated values.

b) Time of Concentration

The time of concentration, which is the longest time of travel for runoff to flow from any point of the subject drainage area to the design point, consists of the time required for runoff to flow overland plus the time required to flow in a street gutter, storm drain, open channel, or other conveyance facility. A minimum time of concentration of fifteen (15) minutes shall be used for Single-Family Residential, Parks and Open Space areas and a minimum time of concentration of ten (10) minutes shall be used for Right-of-Way, Commercial, Industrial, Multi-Family Residential, School and Church areas.

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

channel flow. The time of concentration flow path and sheet flow path shall be made available to the City upon request.

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

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

T_t = travel time (hr)
n = Manning's roughness coefficient (Table 13.1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (4.0 inches)
S = slope of hydraulic grade line (land slope, ft/ft)

Table 13.1 Sheet Flow 'n' Values

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

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

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

T_t = travel time (hr)
L = flow length (ft)

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$$V = \text{velocity (fps)}$$
$$\text{Unpaved} = 16.1345 * S^{0.5}$$
$$\text{Paved} = 20.3282 * S^{0.5}$$

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

$$T_t = \frac{L}{3600V}$$
$$V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n}$$

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

§13.07.005.   Unit Hydrograph Methodologies.

For contributing drainage areas greater than 100 acres, the unit hydrograph method shall be used to determine the peak storm discharge quantities. This method shall also be used for verification of adequacy of stormwater detention facilities with contributing drainage area that are equal to or greater than 20 acres.

The use of a unit hydrograph method shall be based upon standard and accepted engineering principles used in the profession. Acceptable methods include the NRCS Technical Release Number 55 (TR-55) for drainage areas 100 acres to 2,000 acres and NRCS's Technical Release Number 20 (TR-20), or the United States Army Corps of Engineers HEC-HMS models for drainage areas 100 acres or more. When the flood study involves a watershed that does not already have any available hydrology model, or in the case where conversion of an existing model to a later version hydrology model is desired, the City's preference is the latest version of HEC-HMS model available.

When the unit hydrograph method is used, a flood study report shall be prepared and provided to the City Engineer, documenting the methodology, assumptions, derivation of all data used, and results of the study. To maintain consistency of all hydrologic studies within the City, the following requirements/conditions shall be used when performing the unit hydrograph method. These requirements/conditions shall be included in the plan set and the flood study report:

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a) Compute both pre-construction conditions (based on existing off-site watershed conditions) and post-construction conditions and show comparison in summary table of results.

b) In addition to part a, compute the projected ultimate developed conditions to determine design elevations and erosion protection.

c) 24-hour rainfall storm totals.

d) Time of Concentration (Tc) and Lag Time Calculations, computed to the nearest 0.01 hour: The lag time is generally considered to be 0.6 x Tc. The Tc calculations should include sheet flow travel time, shallow concentrated flow travel time, channel flow travel time, and travel time associated with any storm sewer system pipes, street gutter flow, and other travel times. Storm sewer pipe travel time may be derived based on design velocities and pipe flow lengths from available or proposed sewer pipe plans. General guidelines pertaining to NRCS TR-55 methodology for determining flow times for sheet flow, shallow concentrated flow, channel flow, and other flow types are included in the section above. The length of sheet flow used with the unit hydrograph method should be limited to 100 feet.

e) When using a unit hydrograph procedure, mixing the hydrology modeling data with data based on differing procedures is not acceptable.

f) Drainage areas shall be rounded to the nearest 0.01 acre (0.000001 sq. mi.) in hydrology models, as well as for areas of land use and soil categories when computing composite runoff curve numbers.

g) Impervious areas of a drainage basin should be included within the computed composite runoff curve number calculations used in the hydrology models (instead of using a percentage of impervious area in combination with a weighted curve number in hydrology models that contain that option).

h) Stream reach hydrograph routing computations within hydrology models must be performed using a procedure that accounts for the effects of channel and floodplain storage (such as Modified Puls method), so that impacts on flood discharges due to loss of flood valley storage within the reach, whether caused by currently proposed construction or due to future development, can be determined.

i) NRCS runoff curve numbers listed in NRCS's TR-55 fur urban and residential districts are generally inappropriate for typical developments in the City of Lucas, due to the indicated low percentage of impervious areas indicated with the values. Therefore, curve numbers typical of conditions in the City of Lucas are included in Table 13.2. These values should be used in most cases; however, other curve numbers for conditions not listed in Table 13.2 may be derived and used if reasonably justified and documented.

j) Options available in hydrology models to automatically compute pond spillway discharges, based on spillway or outlet type of configuration, are sometimes limited, and often do not adequately represent the designed spillway. In such cases, pond water surface elevations versus discharges may need to be computed by other methods and entered into the hydrology model as user defined paired data.
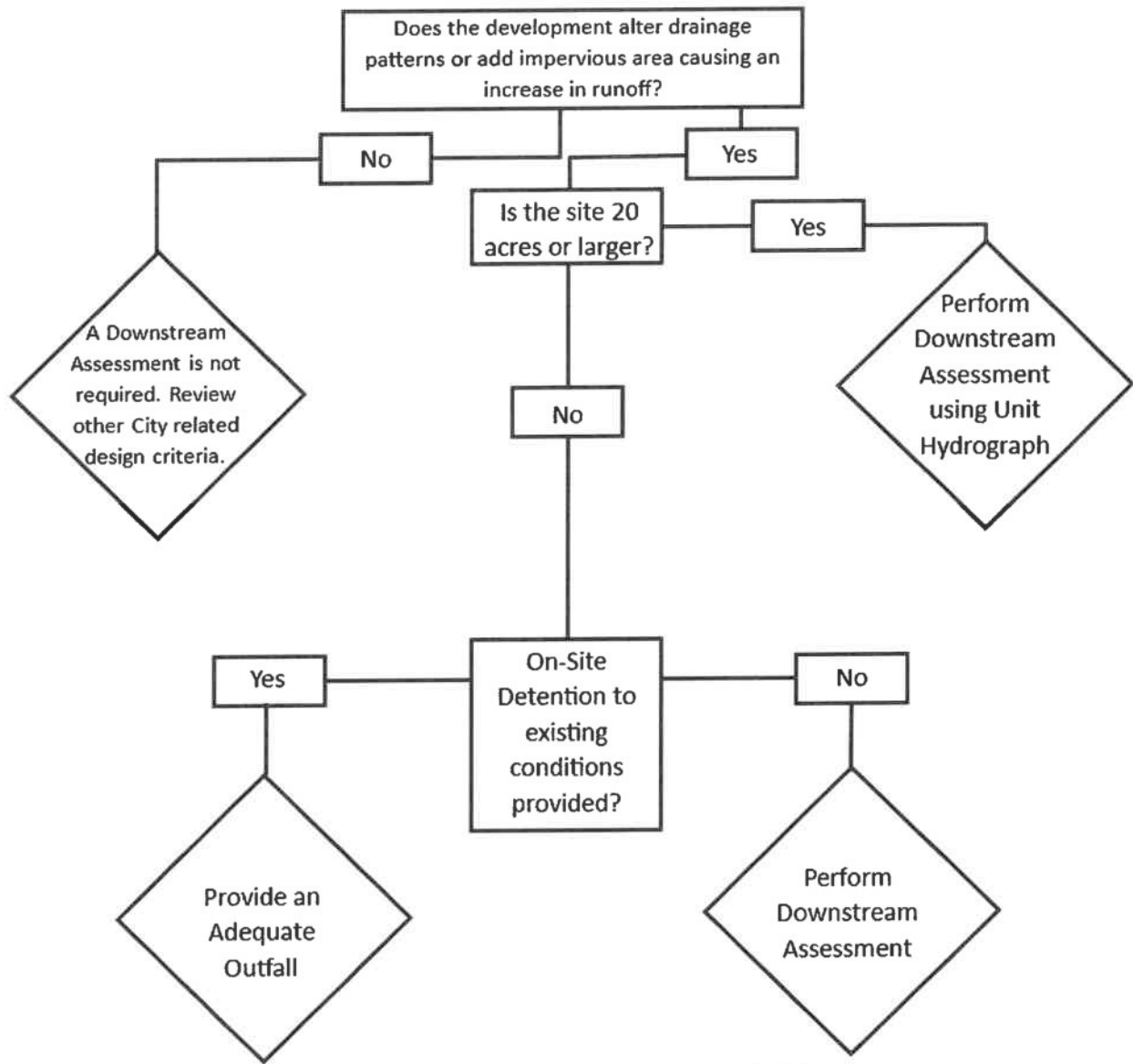
Table 13.2 NRCS Runoff Curve Numbers

Land Use Classification	Hyrdologic Soil Group			
	A	B	C	D
Wooded (fair)	36	60	73	79
Wooded (good)	30	55	70	77
Open Space/Range/Pasture (fair)	49	69	79	84
Open Space/Range/Pasture (good)	39	61	74	80
Cultivated, Straight Row	72	81	88	91
Cultivated, Contoured w/o Terrace	70	79	84	88
Cultivated, Contoured and Terrace	66	74	80	82
Residential (R-2 / ED)	63	77	84	88
Residential (R-1 / R-1.5)	66	78	85	88
Bare Soil	77	86	91	94
Commericial/Business/Multifamily	89	92	94	95
Industrial	81	88	91	93
Dirt or Gravel Roads ROW	76	85	89	91
Paved Road ROW	83	89	83	93
Inundated	100	100	100	100
Urban High Runoff Equivalent	83	89	92	94

*Urban high runoff equivalent is used only for projected fully developed watershed conditions.

§13.07.006. Downstream Assessment.

Storm water discharge from a development shall not cause adverse impacts to adjacent, upstream, or downstream properties or facilities. The design of a storm drain facility must account for the offsite flows that are routed through the development, flows generated by the development, and the impacts of the development and the drainage system on downstream facilities. Figure 13.1 below summarizes the process for determining if a Downstream Assessment will be required.

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Figure 13.1 – Downstream Assessment Flow Chart

Does the development alter drainage patterns or add impervious area causing an increase in runoff?

No → A Downstream Assessment is not required. Review other City related design criteria.

Yes → Is the site 20 acres or larger?

Is the site 20 acres or larger? → Yes → Perform Downstream Assessment using Unit Hydrograph

Is the site 20 acres or larger? → No → On-Site Detention to existing conditions provided?

On-Site Detention to existing conditions provided? → Yes → Provide an Adequate Outfall

On-Site Detention to existing conditions provided? → No → Perform Downstream Assessment

Downstream Assessments shall be prepared and submitted with the construction plans for review by the City. The study shall evaluate the capacity of the downstream system within the Zone of Influence. If the downstream system has less than fully developed capacity, the study shall demonstrate the development will produce no adverse impacts during the 2, 5, 10, 25 and 100-year storm events. No adverse impacts may include, but are not limited to:

a) No new or increased flooding of existing structures.

b) No increases in water surface elevations unless contained within the banks of an existing channel including 1-foot freeboard.

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c) Post-development channel velocities above 5-fps shall not be increased by more than 5% above pre-development velocities. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion.

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

e) The Downstream Assessment shall extend to a point downstream, known as the Zone of Influence (ZOI), where the proposed development creates no adverse impacts. For properties less than 20 acres, the Downstream Assessment may use the 10% Rule to determine the Zone of Influence, which ends at the point where the total drainage area is 10 times greater than the total drainage area for the site. As an example, if a structural control drains 10 acres, the Zone of Influence ends at a point where the total drainage area is at least 100 acres.

f) For all other properties, the Zone of Influence will be defined by a detailed hydrologic and hydraulic modeling analysis. The City Engineer may require analysis beyond the ZOI established by the Engineer.

g) If the subject development is part of a larger development, the Downstream Assessment must include the larger development, and the Zone of Influence shall be determined based on the entire property.

§ 13.07.007. Storm sewer design.

Stormwater in excess of that allowed to collect in the streets shall be intercepted in inlets and conveyed in a storm sewer system. Storm sewer capacity shall be calculated by the Manning's formula:

$$Q = AV, \text{ and}$$

$$Q = 1.486 \, AR2/3S1/2n$$

where

Q is the discharge in cubic feet per second;
A is the cross-sectional area of the conduit in square feet;
V is the velocity of flow in the conduit in feet per second;
R is the hydraulic radius in feet, which is the area of flow divided by the wetted Perimeter.
S is the slope of the hydraulic gradient in feet per-foot;
n is the coefficient of roughness.

The recommended roughness coefficients to use in the design of a storm sewer system are as follows:

Type of Storm Drain Manning's Coefficient

Concrete Box Culvert 0.015

New Concrete Pipe 0.013

Standard, unpaved, with or without bituminous coating corrugated metal pipe 0.024

Paved invert, 25% of periphery paved corrugated metal pipe 0.021

Paved invert, 50% of periphery paved corrugated metal pipe 0.018

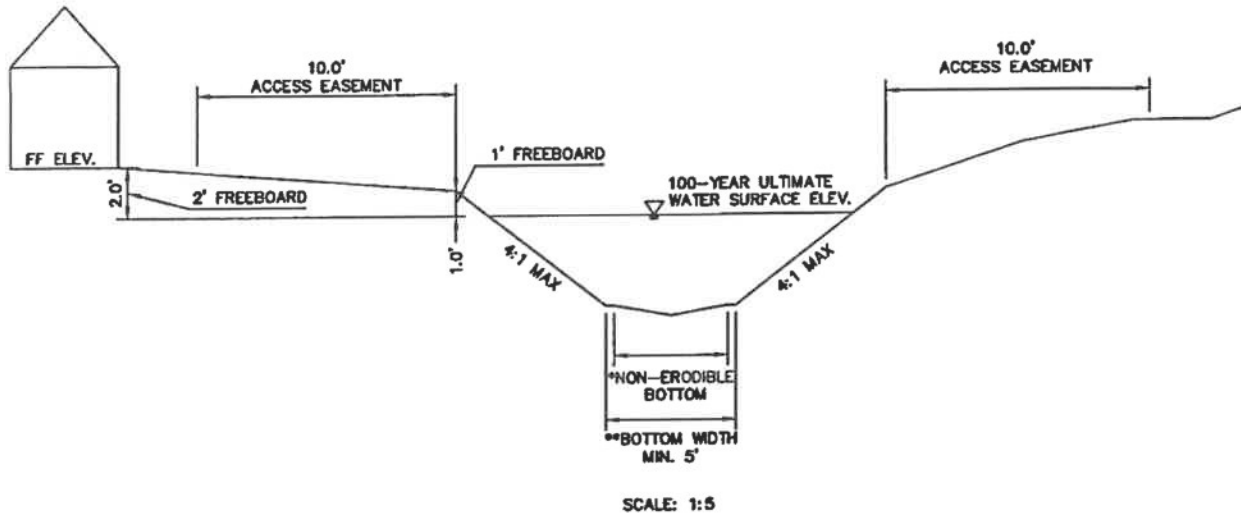100% paved and bituminous coated corrugated metal pipe 0.013

In the design of the storm sewer system, the elevation of the hydraulic gradient of the storm sewer shall be a minimum of 0.5 feet below the elevation of the adjacent street gutter. Storm sewer pipe sizes shall be so selected that the average velocity in the pipe will not exceed 15 feet per second nor less than 3 feet per second. The minimum grade recommended for storm sewer pipe is 0.30%. Closed storm sewer systems shall be installed in all areas where the quantity of storm runoff is 300 cubic feet per second, or less at the discretion of the city. A closed storm sewer system may be constructed when the quantity exceeds 300 cfs at the discretion of the City. Hydraulic gradients shall be calculated and lines drawn for each storm sewer.

§ 13.07.008. Intentionally left blank for future use.
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§13.07.009. Open Channel Design.

Excavated open channels shall be designed to convey the full design discharge. The allowable excavated channel cross section is shown on Figure 13.2. The maximum velocity allowed for unlined, vegetated excavated channels is 5-foot/s.

Figure 13.2: Open Channels – Excavated

10.0'
ACCESS EASEMENT

10.0'
ACCESS EASEMENT

FF ELEV.

2.0'

2' FREEBOARD

1' FREEBOARD

100–YEAR ULTIMATE
WATER SURFACE ELEV.

1.0'

4:1 MAX

4:1 MAX

*NON–ERODIBLE
BOTTOM

**BOTTOM WIDTH
MIN. 5'

SCALE: 1:5

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

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

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

a) Unlined unvegetated excavated channels are not allowed. Construction of excavated channels will not be considered complete until the channel banks are stabilized. Vegetation selected for channel cover must conform with allowable vegetation from the Approved Material List.

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

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

d) Channel armoring for erosion control shall be provided where deemed necessary by the City Engineer.

e) If the channel cannot be maintained from the top of the bank, a maintenance access ramp shall be provided and included within the drainage easement.

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

g) All open channels require a minimum freeboard of 1-foot freeboard.

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h) The minimum slope for an excavated improved channel is 1%.

i) Water surface elevations and flow velocities in channels are impacted by the maintenance condition in the channel. Calculations shall be performed assuming maintained and unmaintained vegetative conditions. Lower (maintained) Manning's values shall be used to determine maximum velocities, while higher (unmaintained) Manning's values shall be used to determine water surface elevations per Figure 13.3.

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

k) An Erosion Hazard Setback shall be included within the Floodplain Drainage Easement for the channel. The purpose of this setback is to reduce the potential for any damage to property or infrastructure caused by the erosion of the bank. The erosion hazard setback shall be determined as follows, and is provided in Figure 13.3:

   1. For stream banks composed of material other than rock, locate the toe of the natural stream bank. Project a 4:1 line sloping away from the bank until it intersects finished grade. From this intersection add 15 feet away from the bank. This shall be the limit of the erosion hazard setback. For stream banks composed of rock, the 4:1 line may start at the top of rock in the creek bank.
   2. Figure 4.4 is intended to illustrate various scenarios under which the erosion hazard setback can be applied. Scenario 1 shows a situation where the setback may be located outside the Floodplain boundaries. Scenarios 2 and 3 show locations where the erosion hazard setback will be located inside the Floodplain boundaries.

l) Any modifications within the area designated as erosion hazard setback will require:

   1. A geotechnical and geomorphological stability analysis.
   2. Mitigation for flowline degradation, erosion at outside bends, or other areas of erosive risk. Mitigation could include but is not limited to:
      i. Grade control
      ii. Bendways
      iii. Headcut armoring
      iv. Slope stabilization

Table 13.3 provides allowable ranges for roughness coefficients of open channels.

Table 13.3: Channel Roughness Coefficients

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

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Figure 13.3: Natural Open Channels

NATURAL CHANNELS: SETBACKS AND EASEMENTS

SCENARIO 1

(E)
15' 10' (B) (D)
10' 15'
1' (A) 1'
(C)
4:1 4:1

SCENARIO 2

(E)
(D)
15' 15'
(C)
1' (A) 1'
(B)
10' 10'
4:1 4:1

SCENARIO 3

(E)
1' (A) 1'
(C)
15' (D)
15'
4:1 4:1

(A) 100-YEAR FULLY DEVELOPED OR EFFECTIVE FEMA FLOODPLAIN
(B) 10-FOOT ACCESS AREA
(C) 1-FOOT FREEBOARD
(D) 15-FOOT EROSION HAZARD SETBACK
(E) EXTENTS OF FLOODPLAIN DRAINAGE EASEMENT

§13.07.010. Culverts and Bridges

a) Culverts.

1) All culverts, headwalls, wingwalls, and aprons shall be designed in conformance with the City Standard Details. The Engineer is responsible for selecting the applicable detail. The design of culverts shall include the determination of upstream backwater conditions as well as downstream velocities and flooding conditions. Consideration shall be given to the discharge velocity from culverts, and the limitations specified culverts with the limitation that culvert pipe diameter shall be a minimum 18". A headwall is required at exposed ends. Under private driveways, permanent culverts (those with reinforced concrete, asphalt, or AASHTO #3 gravel paving over the culvert) and temporary culverts (those without paving over the culvert) shall be constructed with reinforced concrete or minimum 16 gauge galvanized corrugated steel pipe. Temporary culverts and driveways must be removed within 18 months of permit issuance and the open channel reconstructed to its original design. Under public roads, reinforced concrete culverts are required. Permanent culvert design shall include minimum embedment of Class B+ per the North Central Texas Council of Governments (NCTCOG) design manual drawing 3020 dated October 2004.

2) Culvert calculations shall be provided to the City for review. Calculations may include, but are not limited to, headwall, tailwater, and flowline elevations, lowest adjacent grade and structure elevations, inlet and outlet control calculations and velocity calculations.

3) There is a minimum 1-foot freeboard from top of grade at a culvert crossing to the 100-year fully developed water surface elevation. An emergency overflow path shall be identified and provided on the construction plans. An emergency overflow path is the path the stormwater will take when the drainage facilities become clogged or do not function in the manner as to which it was designed. The emergency overflow path shall be limited to public right-of-way or drainage easements.

4) Culverts should always be aligned to follow the natural stream channel. The Engineer shall provide sufficient information to analyze the upstream and downstream impacts of the culvert and illustrate the interaction of the channel and culvert alignment.

5) Headwalls and Entrance Conditions:

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

ii. The culvert entrance losses are provided in Table 13.4. The values of the entrance coefficient Ke represent a combination of the effects of entrance and approach conditions. Losses shall be calculated using the following formula:

$$H_e = K_e \left(\frac{v^2}{2g} \right)$$

$H_e =$ Entrance head loss (ft)
$K_e =$ Entrance loss coefficient
$v =$ velocity (ft/sec)
$g =$ gravitational constant (32.2 ft/sec²)

6) Concrete culvert headwalls and wingwalls shall use natural stone or brick veneer. The material palette shall be similar and complimentary to materials used throughout the development and are subject to approval by the City Engineer.

Table 13.4: Culvert Entrance Loss Coefficients

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

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b) Bridges.

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

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

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

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

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

        v. Bridges are to be designed with the lowest point (low beam) low chord at least 2-foot above the fully developed 100-year water surface elevation.

    2) A scour analysis shall be submitted with the construction plans.

§13.07.011. Stormwater Detention Pond Design

a) Detention facilities shall be designed based upon the following minimum criteria:

1. Detention shall be provided for the 2, 5, 25, and 100-year design storms based on the results of a downstream assessment. Sites without a downstream assessment will be required to provide detention to undeveloped runoff rates.

2. The minimum bottom slope for above-ground detention facilities shall be 1%.

3. The Engineer shall provide an operations and maintenance plan for the detention/retention facility as part of the design. The operations and maintenance plan shall indicate the ingress and egress locations to enter and maintain the pond, maintenance roles and responsibilities, contact information for the party responsible for the maintenance, and a maintenance schedule. Plan shall be recorded in the Collin County Real Property Records.

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

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5. All detention/retention facilities shall demonstrate and provide an adequate outfall in accordance with City Requirements. An adequate outfall is a structure or location that is adequately designed as to not cause adverse flooding conditions, erosion, or any other adverse impacts. An adequate outfall shall also have capacity to convey the increased fully developed runoff.

b) Detention Storage Calculation.

1. Detention facilities without upstream detention areas and with drainage areas of 20 acres or less can be designed using the Modified Rational Method otherwise the Unit Hydrograph Method shall be used.

2. If the Unit Hydrograph Method is used, the model shall extend through the Zone of Influence (see § 13.07.006) and include existing detention facilities within the Zone of Influence watershed.

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

4. If detention storage is located within a floodplain, the storage amount lost to the floodplain elevation must be modeled with unit hydrograph or the detention storage raised above the floodplain elevation.

c) Pond and Spillway Geometry.

1. Detention/retention facilities shall be designed with an emergency bypass/spillway in case the primary outfall ceases to function as designed. The emergency bypass/spillway shall be designed to pass a minimum of the 100-year pond inflow.

2. Detention/retention facilities shall have a minimum of 1-foot of freeboard above the 100-year water surface elevation.

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

4. The minimum finish floor elevation for any lot adjacent to a detention/retention facility shall be 2 feet above the adjacent 100-yr fully developed water surface elevation.

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

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

7. Access shall be provided to the banks and bottom of a detention facility for maintenance.

    i. Engineer shall provide an operations and maintenance plan that will detail access.

    ii. Retention facilities shall address dewatering procedures.

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

9. Underground detention facilities shall be designed with reinforced concrete if located under fire lane or within city right of way.

d) Texas Commission Environmental Quality Requirements for Dams. The Texas Commission on Environmental Quality (TCEQ) provides design and review criteria for construction plans and specifications, construction, operation and maintenance, inspection, repair, removal, emergency management, site security, and enforcement of dams.

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

Retention facilities must obtain a TCEQ water rights permit if applicable. Refer to TCEQ for water rights regulations. For retention facilities without a water rights permit, the Engineer shall provide a signed statement to the City stating the water rights permit is not required.

§ 13.07.012. Tables and forms.
The following tables and forms are outlined and depicted below.[1]

§ 13.07.013   Energy Dissipators.

a) The Engineer shall be responsible for all energy dissipation designs. This may include channel armoring, gabion structures, gabion mattresses, rip-rap, turf reinforcement mats, and others as proposed

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

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[1] *Editor's Note: Said tables and forms can be found as attachments to this chapter.*

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

§ 13.07.014   Floodplain Alterations.

a) No construction is allowed within floodplain areas (FEMA Effective floodplain or City of Lucas Fully Developed floodplain), but construction is allowed in those areas that have been reclaimed from the floodplain.

b) Floodplain alteration shall be allowed only if all the following criteria are met:

   1) Flood studies shall include flows generated for existing conditions and fully developed conditions for the 2, 5, 25, and 100-year storm events.

   2) Alterations shall not increase the 100-year fully developed water surface elevation on other properties.

   3) Alterations shall be in compliance with FEMA guidelines.

   4) Alterations of the floodplain shall meet the requirements of Section 13.07.006.

   5) Alterations shall result in no loss of valley storage for a Major Creek, and a 15% maximum loss of valley storage for any other tributary for any reach, except at bridge and culvert crossings where it can be proven that there are no detrimental effects downstream.

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

   7) The floodplain shall be altered only to the extent permitted by equal conveyance on both sides of the natural channel, as defined by the United States Army Corps of Engineers in a HEC-RAS analysis. The right of equal conveyance applies to all owners and uses, including greenbelt, park areas, and recreational areas. Owners may relinquish their right to equal conveyance by providing a written agreement to the City Engineer.

   8) A grading permit and/or construction plan approval shall be required to perform any grading activities on site.

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

   10) Floodplain alterations shall incorporate and consider other City planning documents and ordinances such as the Tree Preservation Ordinance, the Subdivision Ordinance, and the Floodplain Ordinance.

11) Unless a pre-existing model is in place, United States Army Corps of Engineers (USACE) HEC-HMS and HEC-RAS shall be used. A request to use another type of hydrologic or hydraulic model must be submitted to the City Engineer for approval. Modified Puls method shall be used for flood routing information to ensure that the cumulative effects of the reduction in floodplain storage of floodwater will not cause downstream or upstream increases in water surface elevations and erosive velocities. If Modified Puls method is not feasible, a request to use another type of flood routing method must be submitted to City Engineer for approval.

c) The Engineer is responsible for providing documentation of the relevant USACE approved permits prior to beginning modification to the floodplain or impacts to Waters of the US (WoUS) or for providing a signed and sealed statement detailing why such permits are unnecessary.

d) Verification of Floodplain Alterations:

1) The owner/developer shall furnish, at their expense, to the City Engineer sufficient engineering information to confirm that the minimum finished floor elevations proposed are as required by this ordinance.

2) Construction plans will not be released for construction within areas subject to a Conditional Letter of Map Revision (CLOMR) or amendment until accepted by the City Engineer and FEMA.

3) Letters of Map Revision (LOMR) application shall be submitted to the City Engineer prior to submittal to FEMA no later than 60 days from the City's final acceptance of the construction.

4) All submittals to FEMA shall be submitted to the City Engineer prior to submittal to FEMA. A copy of all responses to FEMA comments shall be submitted to the City.

§ 13.07.015   Drainage Easements.

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

1) Overflow paths are to be located within a minimum 10-foot drainage easement.

2) A Floodplain Drainage easement is required to be dedicated over open channels or creeks. See Figure 13.3. (Erosion Hazard Setback)

3) A Drainage and Detention Easement is required to be dedicated over detention facilities.

b) Floodplain Drainage Easements shall be dedicated for all floodplains and shall include an erosion hazard setback to reduce the potential for damage due to erosion of the bank.

c) Drainage and Detention Easements shall be dedicated for all detention/retention facilities.

SECTION 2. To the extent of any irreconcilable conflict with the provisions of this Ordinance and other ordinances of the City of Lucas and which are not expressly amended by this Ordinance, the provision of this Ordinance shall remain and be controlling.

SECTION 3. That should any word, sentence, paragraph, subdivision, clause, phrase or section of this Ordinance be adjudged or held to be unconstitutional, illegal, or invalid, the same shall not affect the validity of the remaining portions of this Ordinance or the City of Lucas Code of Ordinances, as amended hereby, which shall remain if full force and effect.

SECTION 4. An offense committed before the effective date of this Ordinance is governed by prior law and the provisions of the Ordinances of the City of Lucas, as amended, in effect when the offense was committed and the former law is continued in effect for this purpose.

SECTION 5. That any person, firm or corporation violating any of the provisions or terms of this Ordinance shall be subject to the same penalty as provided for in the Code of Ordinances, as amended, and upon conviction in the municipal court shall be punished by a fine not to exceed the sum of Two Thousand Dollars ($2,000.00) for each offense, and each and every day such violation shall continue shall be deemed to constitute a separate offense.

SECTION 6. That this Ordinance shall take effect immediately from and after its passage and publication in accordance with the provisions of the Charter of the City of Lucas, and it is accordingly so ordained.
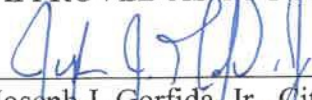
DULY PASSED AND APPROVED BY THE CITY COUNCIL OF THE CITY OF LUCAS, COLLIN COUNTY, TEXAS, ON THIS 3RD DAY OF AUGUST, 2023.

APPROVED:

Jim Olk, Mayor

APPROVED AS TO FORM:

Joseph J. Gorfida, Jr., City Attorney

ATTEST:

Kent Souriyasak, Assistant City Manager

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