BROOKSHIRE - KATY DRAINAGE DISTRICT

Most Common Review Comments

"How an Applicant can Expedite Permit Review & Approval"

Last Revised in July 2024

OVERVIEW & PURPOSE

This document informs applicants of our reviewers' most common review comments.

By carefully reviewing this document before your 1st submittal, applicants can address many of the typical comments in the beginning stages of the design to reduce the number of re-submittals and helping speed up the permit review and approval process – our ultimate goal.

Moreover, applicants should review the Brookshire-Katy Drainage District's (DISTRICT) latest Rules and Regulations and all relevant information/ guidelines (all found on the DISTRICT's website) before submitting a permit application package for review.

TABLE OF CONTENTS

1. TOP (Preliminary & Final) PLAT COMMENTS 3

2. TOP DRAINAGE PLAN COMMENTS 5

2.1. **General** 5

2.2. **Cover Sheet** 6

2.3. **Drainage Area Maps (DAM) – Existing & Proposed (2-yr & 100-yr)** 6

2.4. **Off-site Sheet Flow** 7

2.5. **Grading Plan, Fill/ Excavations, & Perimeter Swales** 8

2.6. **Emergency/Extreme Event Overflow Spillways** 9

2.7. **Drainage (Hydraulic) Calculations** 11

2.8. **DETENTION – General Items** 15

2.9. **Detention Pond Sizing Calculations** 17

2.10. **Detention Pond Overall Layout and Cross Section** 19

2.11. **Floodplain Fill and Mitigation** 20

2.12. **Drain Time** 21

2.13. **Pump Station** 22

2.14. **Retaining Walls** 24

2.15. **Maintenance Items** 24

2.16. **Geotechnical Report** 25

2.17. **Storm Sewer/ Channel Plan and Profile Sheets** 25

1. TOP (Preliminary & Final) PLAT COMMENTS

1. Review the DISTRICT website and ensure you are **using the latest Signature Block** for the Plat. The signature block is not required for the preliminary plat submittal but will need to be included in the final Plat.

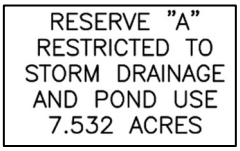
2. Title plat "Preliminary Plat of…" or "Final Plat of…"

3. In the Title, include the project name, acreage, lots, reserves, blocks, and date.

4. Neighboring properties (or lot and block number if a platted subdivision) and drainage facilities should be labeled, and recording information should be included.

5. Streets are labeled with Right-of-Way (ROW) widths delineated and called out – (if they exist) with recordation information. **FYI, most of the County Roads do not have recordation; they are occupied ROW**.

6. Any storm sewer/ drainage facility located within a **reserve** must be designated for drainage purposes, or a storm sewer easement must be provided. Please identify the specific use of the restricted reserve – see Sample.



7. If the property is located within the floodplain/floodway, provide/label all floodplain/floodway boundaries on the Plat and plans.

8. (if applicable) Provide LOMR document exhibits.

9. Oil/Gas Pipeline:
   - Add a note stating whether pipelines are or not located within the boundaries of the Plat.
   - All oil/gas pipelines, pipeline easements, and wells with ownership through the subdivision have been shown.

10. Provide Surveyor certification signature block - Name, Firm Name/ No., address, and phone number of the surveyor that prepared the Plat and of the owner.

11. All **existing** and **proposed drainage easements and fee strips** should be delineated, called out, and recording information provided (deed recording vol. and page, clerk's file number, the grantee (e.g., TxDOT, City, Public, etc.), type (e.g., easement or fee strip)).

12. <u>If Proposed Development encompasses an existing or proposed DISTRICT easement:</u>
    - The DISTRICT may require additional drainage easement on your tract in order to improve the conveyance of floodwaters and provide sufficient access for maintenance operations to be performed on the DISTRICT's easements. **Please request a meeting to discuss the matter further with the DISTRICT Engineering Team.**
    - Copy of the CPL (required for the Final Plat)
    - Right-of-way/ Easement dedications are clearly shown and dimensioned.

- If proposing drainage easements to the DISTRICT, they should be called out on the Plat and plans as "proposed XX-ft wide Brookshire-Katy Drainage District Easement." Drainage easements can be dedicated to the DISTRICT either by Plat or a separate instrument .*If dedicated to a separate instrument, the proposed drainage easement must be recorded prior to approval of the permit.
- **Ultimate ROW Analysis must be performed by the developer's engineer** using flows from DISTRICT Master Drainage Plan Phase I. Analysis must include calculations and ultimate ROW cross-section. See the example below.

BKDD Ultimate ROW Channel Capacity Calculation

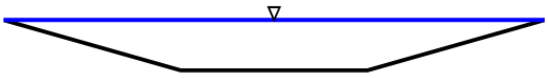
Ultimate Cross Section C

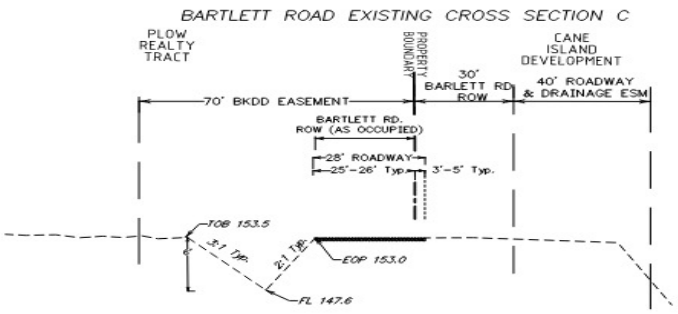
Inputs

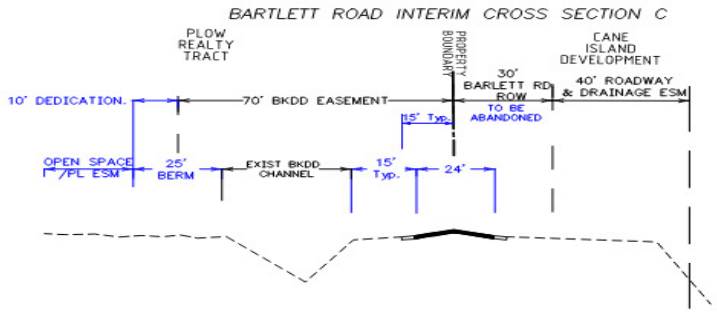
Bottom width, b	38	ft
Side slope 1 (horiz./vert.)	4	
Side slope 2 (horiz./vert.)	4	
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.035	
Channel slope, S	0.001421321	rise/run
Flow depth, y	9	ft

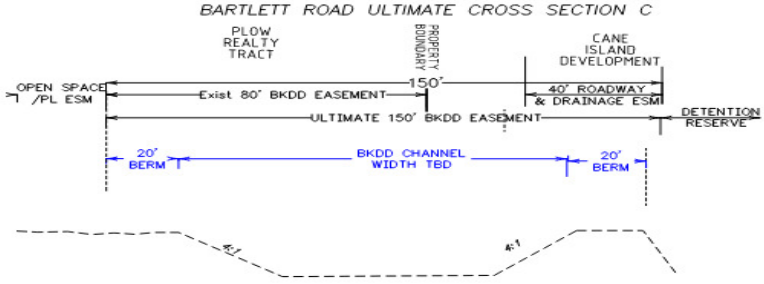
Results

Flow area, a	666.0217	ft^2
Wetted perimeter, P_w	112.2159	ft
Hydraulic radius, R_h	5.9350	ft
Velocity, v	5.2467	ft/sec
Flow, Q	3494.2509	cfs
Velocity head, h_v	0.4278	ft
Top width, T	110.0000	ft
Froude number, F	0.38	









2. TOP DRAINAGE PLAN COMMENTS

2.1. General

2.1.1. Please review the DISTRICT website and ensure you are using the latest DISTRICT notes, standard construction details, and drainage/detention summary tables.

2.1.2. Clearly show/ label all existing and proposed Development within the tract. The proposed Development needs to include a darker, bold line type, and the existing Development should be a lighter, grey line type. Add callouts and labels to confirm all existing and proposed Development.

2.1.3. A comment response letter with your re-submittal.

2.1.4. All existing and proposed drainage easements and fee strips should be delineated, called out, and recording information provided (deed recording vol. and page, clerk's file number, the grantee (i.e., TxDOT, City, Public, etc.), type (e.g., easement or fee strip)). If proposing drainage easements to the DISTRICT, they should be called out on the Plat and plans as "proposed XX-ft wide Brookshire-Katy Drainage District Easement." Drainage easements can be dedicated to the DISTRICT either by Plat or separate instrument. *If dedicated by a separate instrument, the proposed drainage easement must be recorded prior to approval of the permit. The developer's engineer must perform An Ultimate ROW Analysis using flows from DISTRICT Master Drainage Plan Phase I. Analysis must include calculations and an ultimate ROW cross-section. See the example on the previous sheet.

- When applicable – provide:
    - Detention Facility Maintenance Agreement (DFMA) – A DFMA is required for any development that includes detention facilities and improvements are proposed to the site. Coordinate all matters related to the DFMA directly with the District's legal counsel.
    - TxDOT Permit – If discharging flow or proposing a driveway to a TxDOT ROW (FM Roads, US 90, I-10), a copy of the approved permit must be included with the plan review submittal. The first plan submittal will be reviewed without the permit. However, the second submittal will not be reviewed until a copy of the permit (access and discharge) is provided.
    - Pipeline Letter of No Objection (LONO) – If proposed improvements cross or encroach a pipeline easement.
    - Municipal Utility District (MUD) LONO – If the Development is located within MUD or the Development's detention capacity is allocated by MUD detention facilities, a LONO from the MUD is required.

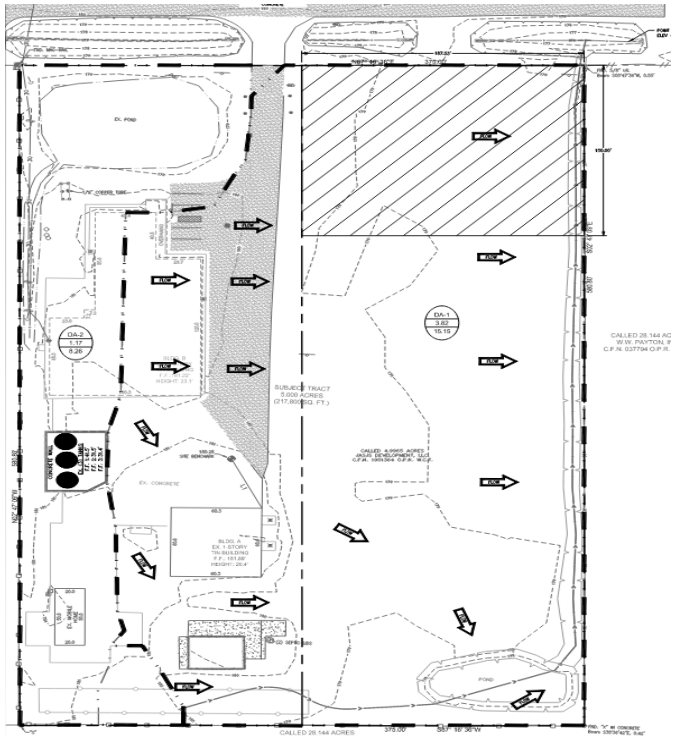
2.2. **Cover Sheet**

- Signed and Sealed by a licensed Texas Professional Engineer, including the Engineering Firm's Registration No.
- Owner, Engineer, Surveyor Information
- Location and Vicinity map.
- Index
    - COVER SHEET
    - DISTRICT GENERAL NOTES
    - DRAINAGE AREA MAP – EXISTING & PROPOSED
    - DISCHARGE/RUNOFF CALCULATIONS – EXISTING & PROPOSED
    - GRADING PLAN
    - STORM SEWER/CHANNEL OVERALL PLAN
    - STORM SEWER HYDRAULIC CALCULATIONS
    - DETENTION POND OVERALL
    - DETENTION POND CROSS SECTIONS
    - DETENTION POND SIZING AND OUTFALL CALCULATIONS
    - STORM SEWER/STREET PLAN & PROFILE SHEET (FOR SUBDIVISION)
    - DETAILS SHEET (SEE DISTRICT WEBSITE FOR APPLICABLE DETAILS)

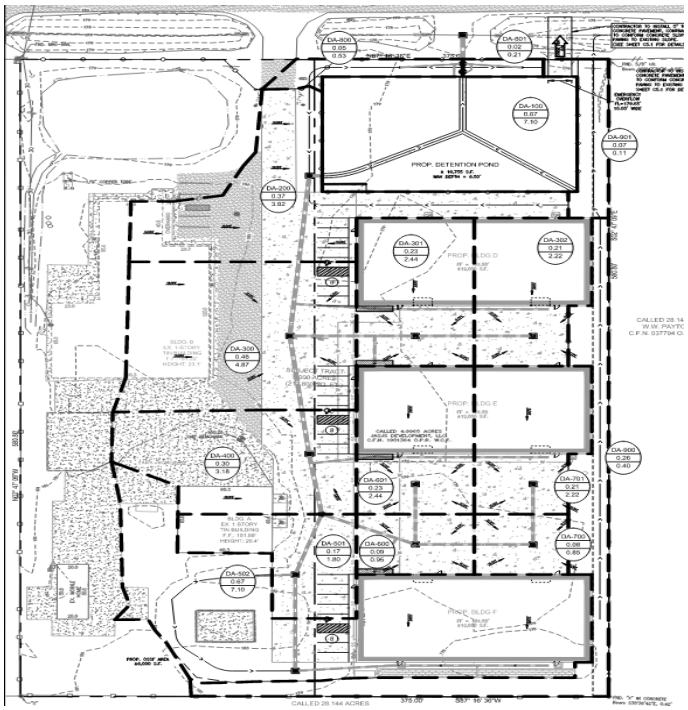
2.3. **Drainage Area Maps (DAM) – Existing & Proposed (2-yr & 100-yr)**

2.3.1. Delineate **existing and proposed (2-yr and 100-yr)** drainage areas (acres), including **offsite contributing areas (100-yr).**

2-yr Existing DAM

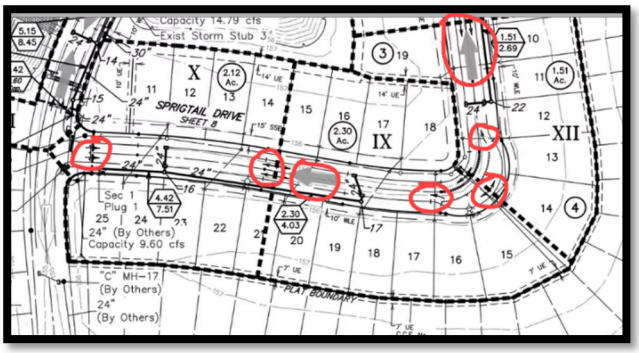


2-yr Proposed DAM



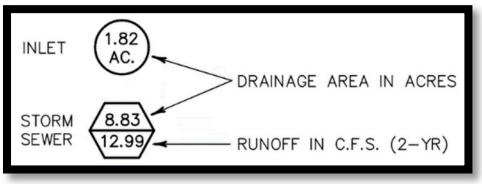
2.3.2. Each Sub-Drainage Area (in Acres) must be delineated.

2.3.3. 2-yr & 100-yr Sheet Flow Direction Arrows should be shown in plans.



2.3.4. The 2-yr and 100-yr Drainage Area Map – must include the following:

- Provide a callout that corresponds to the hydraulic calculation and includes the cumulative drainage area and flow (cfs) - be sure the legend states the cumulative is either the design event (2-yr) or the 100-year event runoff.
- Runoff in cubic feet per second (cfs) for each INLET Sub-Drainage Area
- Cumulative acreage & cfs for each MH/ Storm Sewer



2.3.5. Location and labels for existing and proposed drainage/detention facilities (storm sewer, inlets, swales, pond, outfall, etc).

2.3.6. Location and dimensions of all existing and proposed DISTRICT drainage easements.

2.4. Off-site Sheet Flow

2.4.1. On-site and Off-site contour lines (with elevation labels) and proposed grades are clearly shown and labeled. Contours or spot elevations should be provided a minimum of 50 feet for sites less than 5 acres and at least 200 feet for sites greater than 5 acres to verify if there are off-site flows that need to be accounted for in your design.

2.4.2. Any off-site sheet flow that passes through the tract in pre-developed conditions must be routed through the proposed detention system of the Development or routed to a public easement/ROW in post-developed conditions. If there are off-site flows, the drainage calculations should account for these flows (up to 100-yr storm event) accordingly, which may require additional detention volume or perimeter channels/swales to route the off-site flow appropriately. The Applicant will need to provide sufficient details and calculations on the plans to show how the off-site flow is being incorporated into the design and prove that no adverse impacts are proposed to adjacent properties or downstream facilities based on the post-development conditions.

2.5. Grading Plan, Fill/ Excavations, & Perimeter Swales

2.5.1. The grading plan should provide adequate contours, spot elevation, and topographic information to verify and confirm overland sheet flows (off-site and on-site) through the proposed Development.

2.5.2. If the fill is placed or excavation is proposed that modifies the natural flow of water on the property, then the Applicant is required to mitigate the altered flow.

2.5.3. Unless agreed to in writing by the adjoining landowners, fill material shall be placed no closer than ten (10) feet from the property lines. (see Perimeter Swales for additional information).

2.5.4. Unless agreed to in writing by the adjoining landowners, excavations, except approved drainage facilities, shall not be allowed closer than twenty (20) feet plus twice the depth of the excavation from the property lines.

Perimeter (Off-Site Interceptor) Swales

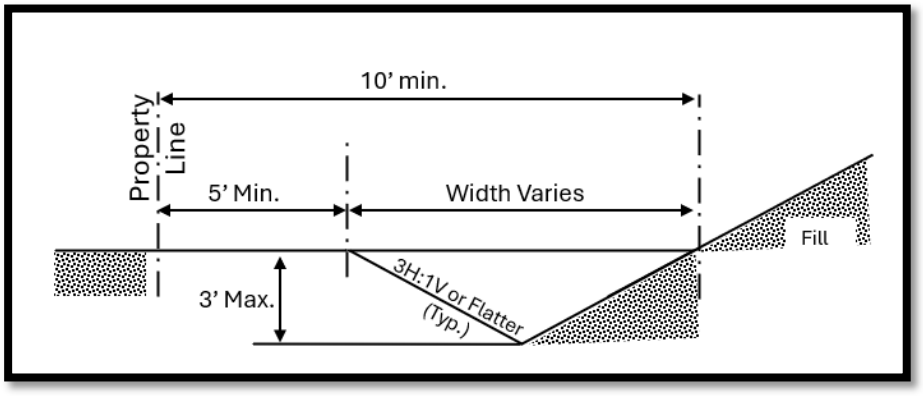
2.5.5. To ensure that adjacent property parcels bordering the project site do not experience sheet flow blockage, ponding, and/or drainage flows that exceed pre-development conditions for storm events up to and including the Atlas-14 100-year storm event, the Applicant shall implement proper grading and/or perimeter swales (i.e., runoff catchment device) between the fill and property line within its property – see Figure below.

- The Applicant must provide calculations and details of the perimeter swales, which must be sized to convey 100-yr off-site flow.

2.5.6. It is the liability and responsibility of the proposed Development and its Engineer to comply with the Texas Water Code 11.086.

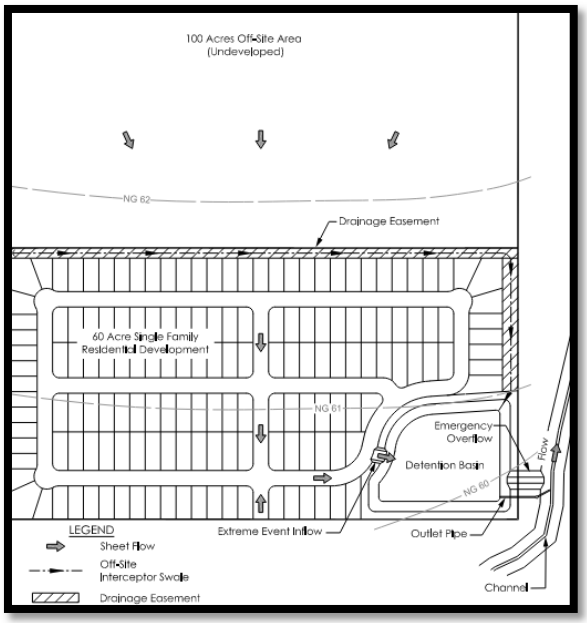
2.5.7. A cross-section at every property line boundary should be provided (see Figure below).

- Please include the property line, interceptor swale(s), the existing and proposed grades of the site, and adjacent properties.

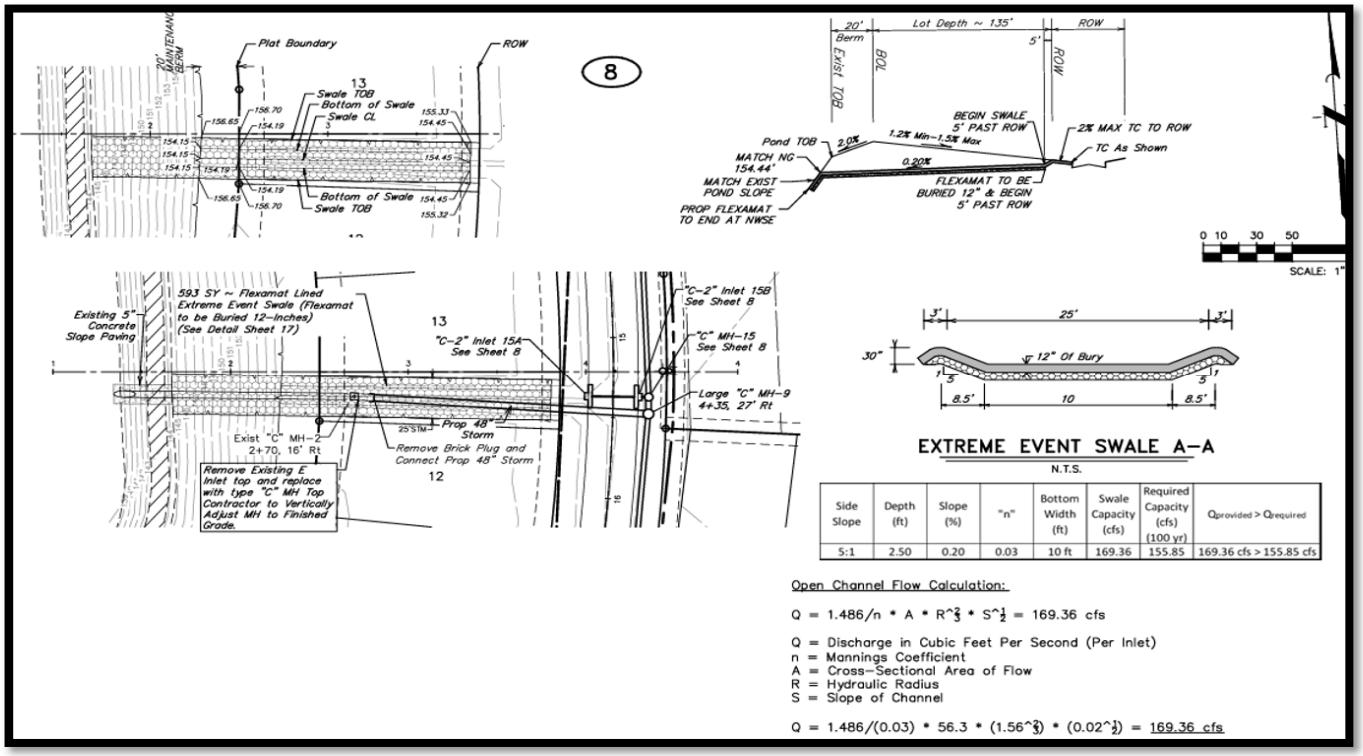


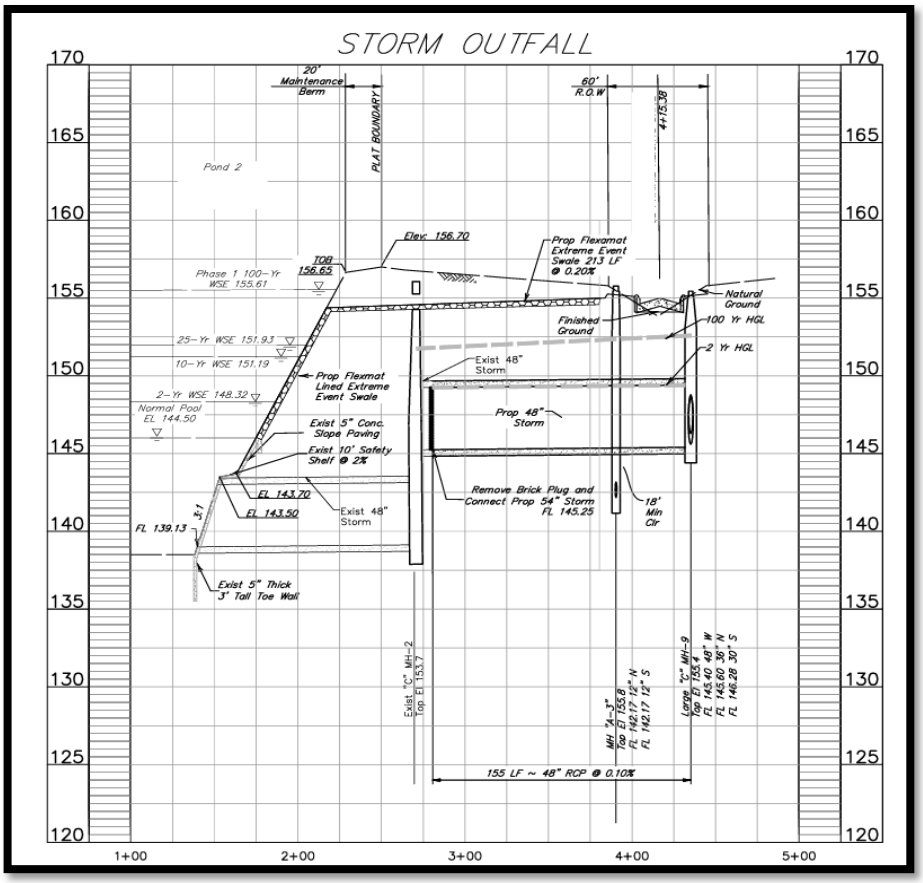
2.6. **Emergency/Extreme Event Overflow Spillways**

2.6.1. The Applicant must provide **two gravity emergency overflow spillways** (grass lined with flexamat or concrete) in addition to the pipe outlet to protect structures from flooding. See DISTRICT standard details.

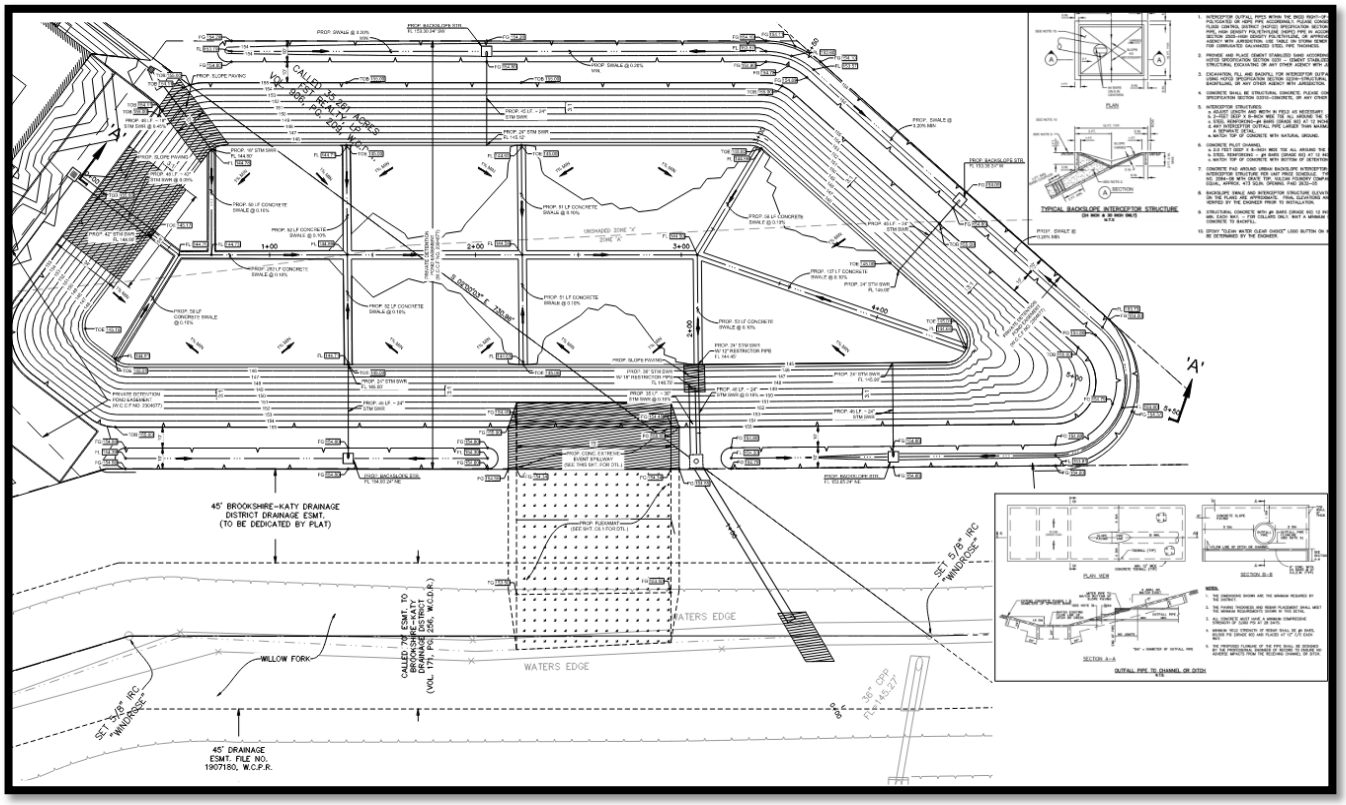


1. Emergency overflow spillway from <u>Streets to the pond.</u>





2. Emergency overflow spillway from <u>Pond to Public ROW.</u>



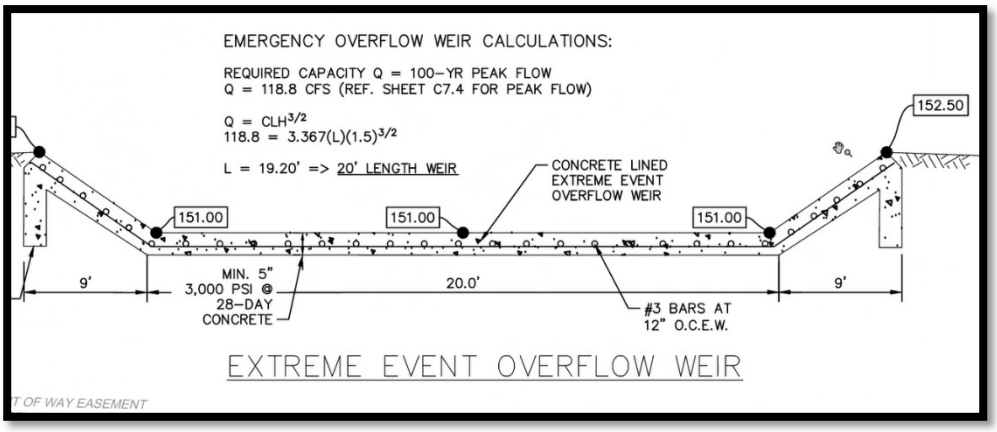
2.6.2. If the spillway is not immediately adjacent to a receiving public waterway, an on-site drainage channel could be utilized to provide a clear path for conveyance and discharge to a public stream without affecting adjacent property owners.

2.6.3. In no cases shall an emergency overflow spillway connect to a curb and gutter street.

2.6.4. Provide arrows illustrating how the extreme event sheet flow within your Development is routed to the detention pond and point of overflow from the pond to the Public ROW.

2.6.5. Show the location, dimensions, materials, and details of the emergency overflow spillways on the plan set.

2.6.6. The emergency overflow spillways must be sized to convey 100-yr peak flow (prior to detention and outfall restriction). Provide sizing calculations and details on plans. See examples in this section.



2.7. Drainage (Hydraulic) Calculations

2.7.1. The Applicant must include the DISTRICT Summary Tables (See DISTRICT Website).

2.7.2. Reference supplementary Drainage Impact Analysis (DIA) report on plans, if applicable.

2.7.3. A table showing the calculated runoff for each delineated drainage area for the 2-yr and 100-yr storm events (See DISTRICT Website (Storm Sewer Backup Calculations Table – Template) and sample/ screen capture below). Calculations should include, but not be limited to, the following:

- Runoff coefficient (C) – (see Table E in DISTRICT rules).
  - When using a weighted C value, provide calculations and formulas to show how the weighted C was determined.
- Rainfall intensity (i) - verify e, b, and d coefficients are being used (see Table I in DISTRICT rules).

  Provide the formula used to calculate the rainfall intensity on the plans.
- Peak flow (Q), - frequency factor of 1.25 should be used for the 100-yr storm event calcs.

- Time of concentration (Tc) – Provide backup calculations for Tc. For developments that are not included in a drainage impact analysis (DIA), you must show the Tc flow paths for both the existing and proposed conditions on the drainage area maps. Include Tc calcs and formula used (see DISTRICT rules).
- Manning's "n" – verify if the correct values are being used (see Table F in DISTRICT rules)
- Design velocity (ft/sec) – typically, this should be approximately 3 ft/sec. If higher design velocities are used, provide backup information to justify the design.
- Hydraulic Grade Line (HGL) elevations for upstream and downstream (ft) - 2-yr storm (HGL must be below gutter) and 100-yr storm (HGL is max 12" above gutter).
    - Add a note stating how the starting HGLs were determined.

2.7.4. Ensure that the hydraulic calculations clearly reference and match the drainage area and junctions (MH, inlets) shown on the overall drainage sheet.

2.7.5. Hydraulic calculations should show that the HGL for the 2-yr storm is contained within the storm sewer and below the gutter line. Provide grate/rim and gutter elevations to verify the HGL is contained within the underground storm sewer system.

2.7.6. Hydraulic calculations should show that the HGL for the 100-yr storm is contained within the site and does not exceed 1 ft above the top of the gutter. Provide top-of-gutter and top-of-curb elevations to verify the HGL meets this requirement.

2.7.6.1. ** In proposed Master Planned Communities ONLY, if the HGL exceeds 12" above the gutter line, consider using the City of Houston Method 1 and Method 2 checks, as applicable, to justify a cascading effect down streets within a subdivision and no adverse impacts are proposed to surrounding lots. Include calculations on plans to support design.

2.7.7. Starting HGLs (Tail Water) must be called out, and a note must be provided on plans on how it was determined. Please reference the table below. However, if the HGL at the connection point is known, please use whichever is higher.

Hydraulic - Storm Sewer Backup Calculations Table – Template

Project Name: ____________________

BKDD Application ID: ____________________

System: **2-yr & 100-yr Storms**

Atalas-14 Rainfall Intensity Coefficients

	2-YR	**100-YR**
e =	0.8126	0.6829
b (in.) =	62.855	86.233
d (min) =	12.655	11.1001
Cf=	1	1.25

Drainage Area	Manhole From	Manhole To	Contributing Area (Acres)	Total Area (Acres)	Runoff Coefficient C	Sum of C*A	Intensity (in/hr) 2-yr	Intensity (in/hr) 10-yr	Intensity (in/hr) 100-yr	Flow (ft3/s) 2-yr	Flow (ft3/s) 10-yr	Flow (ft3/s) 100-yr

Time of Concentration (mins)	Pipe Length (feet)	Pipe Diameter or Rise (in)	Box Span (in)	Slope (%)	Mannings "n"	Design Capacity (cfs)	Design Velocity (ft/sec)	Fall (feet)	Manhole Drop (feet)	Flowline Elevation Upstream (feet)	Flowline Elevation Downstream (feet)

Design Storm = 2-yr HGL Starting Elevation = Existing 2-yr HGL at STM tie in or NWSE ____________ (ft)						
			A	B	C	
Actual Velocity (ft/sec)	Hydraulic Gradient (%)	Change in Head (feet)	Elevation of Hyd. Grad. Upstream (feet)	Elevation of Hyd. Grad. Downstream (feet)	Gutter Elevation Upstream (feet)	Difference between C - A

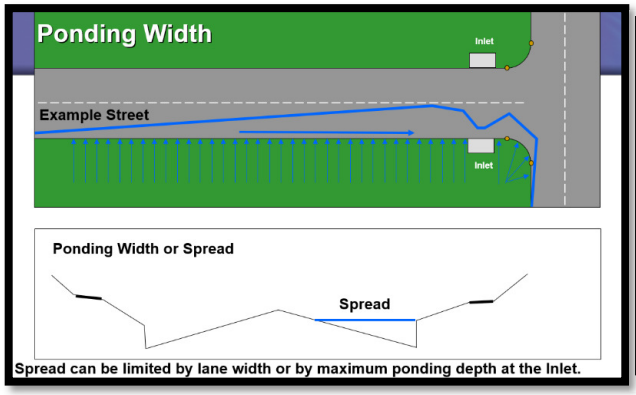
Design Storm = 100-yr HGL Starting Elevation = Existing 100-yr HGL at STM tie in or 25-yr WSE ____________ (ft)									Method 1		Method 2		
			E	F	G	H							
Actual Velocity (ft/sec)	Hydraulic Gradient (%)	Change in Head (feet)	Elevation of Hyd. Grad. Upstream (feet)	Elevation of Hyd. Grad. Downstream (feet)	Gutter Elevation Upstream (ft)	Top of Curb Elevation Upstream (ft)	Difference between G - E	Difference between H - E	Max Ponding	Upstream HGL Below Max Ponding (Pass/ Fail)	Maximul Allowable Overland Flow (Qoallow)	Required Overland Flow (Qoreqd) Qt-Qc	Qallow_> Qreqd (Pass/ Fail)

Starting Water Surface Elevation and Hydraulic Gradient - Summary Table		
If the outflow is into:	The hydraulic gradient shall be calculated using the following:	
	2-yr*	100-yr
Storm Sewer	Top of the outlet pipe, assuming pipes are connected at the soffit. If pipes are connected at the flow line, the top of the larger receiving pipe must be used. If a starting tailwater other than the top of the pipe is chosen, the consultant shall analyze the storm system from outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.	2 feet above the top of the outlet pipe. If a starting tailwater other than 2 feet above the top of the pipe is chosen, the consultant shall analyze the storm system from outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.
Roadside Ditch	Free outfall	Top of the outlet pipe
Channel	Free outfall	Top of the outlet pipe
Storm Sewer outfall to Detention Pond	Top of the outlet pipe	25-yr Pond water surface elevation (WSE)

* For the design storm, the hydraulic gradient shall at all times be below the gutter line

2.7.8. **For Subdivision and Roadway** - Provide Ponding Width/ Inlet Spread Calcs for 2 yr.

- On a residential street, the Spread shall be no greater than the distance from the curb to the center crown of theroadway (i.e., 28-ft pavement (one lane each way) with a 6-inch curb; spread should not exceed 13.5-ft.)
- For a roadway with two or more lanes in each direction, the Spread shall be no greater than the distance from the curb to the inside edge of the outside lane.



Spread: Calculate 2-year rainfall flow approaching each inlet from each direction. Additional inlets may be required if the Spread exceeds the maximum allowable value. The Spread in a typical prismatic curb-and-gutter street may be calculated using the following relationships:

$$Q = (K_g/n)(S_x^{1.67})(S_o^{0.5})(T^{2.67}), \text{ and}$$
$$T = y/S_x$$

Where: K_g = 0.56 (US Customary Units) or 0.376 (SI Units)
n = Manning's roughness coefficient
S_x = Transverse slope (or cross slope) (ft/ft),
S_o = Longitudinal pavement slope (gutter slope) (ft/ft)
T = Spread (ft), and
y = Ponded depth (ft)

Inlet Spread Calculations

Node	Side	Cross Slope (ft/ft)	Longitudinal Slope (ft/ft)	Flow (ft3/s)	Depth (ft)	Spread (ft)
				2 Yr	2 Yr	2 Yr
Inlet B-B 1A	Left	0.02	0.0031	1.00	0.18	8.96
	Right	0.02	0.007	0.78	0.14	7.00
Inlet B-B 1B	Left	0.02	0.0031	1.44	0.21	10.28
	Right	0.02	0.0073	1.85	0.19	9.60
Inlet B-B 3A	Left	0.02	0.0034	0.79	0.16	8.07
	Right	0.02	0.0037	0.72	0.15	7.65
Inlet B-B 3B	Left	0.02	0.003	1.36	0.20	10.12
	Right	0.02	0.003	1.87	0.23	11.39
Inlet B-B 9A	Left	0.02	0.003	1.41	0.21	10.26
	Right	0.02	0.003	1.35	0.20	10.08
Inlet B-B 13A	Left	0.02	0.0033	1.28	0.19	9.71
	Right	0.02	0.007	0.84	0.14	7.21
Inlet B-B 13B	Left	0.02	0.003	1.61	0.22	10.78
	Right	0.02	0.0032	0.70	0.16	7.78
Inlet B-B 16A	Left	0.02	0.003	1.49	0.21	10.48
	Right	0.02	0.003	0.22	0.10	5.07
Inlet B-B 16B	Left	0.02	0.003	2.17	0.24	12.05
	Right	0.02	0.003	0.37	0.12	6.20
Inlet B-B 28A	Left	0.02	0.003	0.82	0.17	8.38
	Right	0.02	0.003	1.37	0.20	10.13
Inlet B-B 28B	Left	0.02	0.0032	1.19	0.19	9.51
	Right	0.02	0.003	2.13	0.24	11.96
Inlet B-B 29A	Left	0.02	0.003	0.60	0.15	7.45
	Right	0.02	0.0031	1.07	0.18	9.18
Inlet B-B 29B	Left	0.02	0.003	1.15	0.19	9.50
	Right	0.02	0.003	2.15	0.24	12.01
Inlet B-B 24A	Left	0.02	0.003	1.27	0.20	9.87
	Right	0.02	0.003	0.96	0.18	8.86
Inlet B-B 24B	Left	0.02	0.003	2.32	0.25	12.35
	Right	0.02	0.0037	1.18	0.18	9.23

Inlet Spread Calculations

Node	Side	Cross Slope (ft/ft)	Longitudinal Slope (ft/ft)	Flow (ft3/s)	Depth (ft)	Spread (ft)
				2 Yr	2 Yr	2 Yr
Inlet B-B 18A	Left	0.02	0.003	0.76	0.16	8.15
	Right	0.02	0.003	0.61	0.15	7.47
Inlet B-B 21A	Left	0.02	0.007	1.00	0.15	7.69
	Right	0.02	0.003	0.85	0.17	8.48
Inlet B-B 21B	Left	0.02	0.007	1.92	0.20	9.81
	Right	0.02	0.003	0.99	0.18	8.99
Inlet B-B 19A	Left	0.02	0.01	0.25	0.09	4.28
	Right	0.02	0.007	0.70	0.13	6.72
Inlet B-B 19B	Left	0.02	0.01	0.25	0.09	4.28
	Right	0.02	0.007	0.70	0.13	6.72
Inlet B-B 22A	Left	0.02	0.0042	0.47	0.13	6.38
	Right	0.02	0.0078	1.22	0.16	8.11
Inlet B-B 22B	Left	0.02	0.003	1.36	0.20	10.10
	Right	0.02	0.007	2.25	0.21	10.43
Inlet B-B 23A	Left	0.02	0.003	0.36	0.12	6.12
	Right	0.02	0.003	1.03	0.18	9.13
Inlet B-B 23B	Left	0.02	0.003	0.70	0.16	7.89
	Right	0.02	0.003	2.04	0.24	11.77

Inlet Capacity Equation

Q = (0.56/n)(Sx^1.67)(So^0.5)(T^2.67)

Where:

T = y/Sx

n = Mannings roughness coeffient
Sx = Transverse slope (or cross slope) (ft/ft)
So = Longitudinal pavement slope (gutter slope) (ft/ft)
T = Spread (ft)
y = Ponded depth (ft)

2.8. DETENTION – General Items

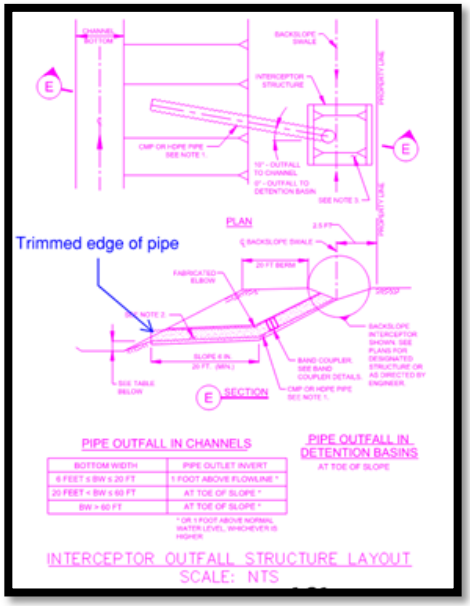
2.8.1. A Detention Facilities Maintenance Agreement (DFMA) is required for any development that includes detention facilities and improvements proposed to the site. Coordinate all matters related to the DFMA directly with the District's legal counsel at bkddlegal@johnsonpetrov.com.

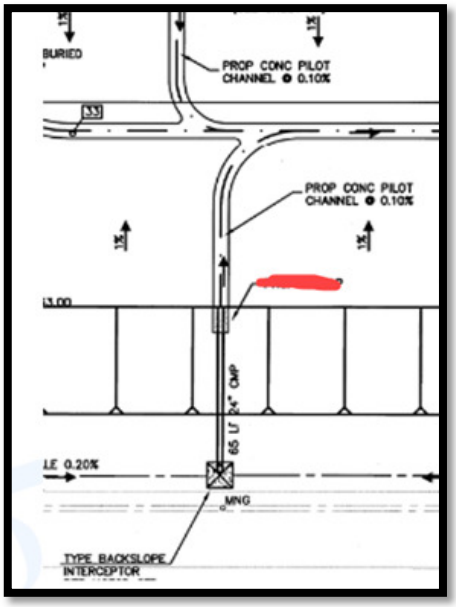
2.8.2. Detention is based on the developed/modified area; this includes any area where the land is being disturbed from the pre-developed condition.

2.8.3. Detention facilities must include maintenance berms (MB), side slopes, erosion protection at outfalls and spillways, and a minimum of 1 ft of freeboard.

2.8.4. If the pond depth is greater than 6 ft, then backslope interceptors are required. For wet bottom ponds, pond depth is the vertical distance measured from NWSE to the Top of the Bank.

2.8.5. Backslope swales and interceptor structures should be placed around the pond, within the berm, to capture runoff along the berm and prevent erosion concerns from runoff overtopping the top of banks.





2.8.6. Berms should grade to drain either away or towards the pond and not be flat. A typical berm slope of 1-2% is preferred. Ponds greater than 6' deep should drain away from the pond. Ponds less than 6 feet deep will be allowed to drain towards the pond.

2.8.7. It is recommended that if the Development includes a detention facility, the geotechnical Report provides recommendations for the design of the facility (i.e., short/long term drawdowns, slope stability, water table depths, the use of in-situ materials such as clay liner for wet ponds, etc.). A boring should be within the proposed detention site and a minimum of 10' below the proposed elevation.

2.8.8. Given your pond design of a 3:1 side slope (or greater than 6 ft in depth with a wet bottom), a geotechnical report needs to be provided as reference material that includes an analysis of the

detention pond. The Report should analyze the side slopes for long and short-term drawdowns and slope stability since a 3:1 side slope is proposed. Borings for the Report are recommended to be taken a minimum of 10' below the toe elevation of the pond.

2.8.9. Gate valves or other backflow prevention devices are not allowed on outfall pipes.

2.8.10. For pumped detention ponds – See the following section.

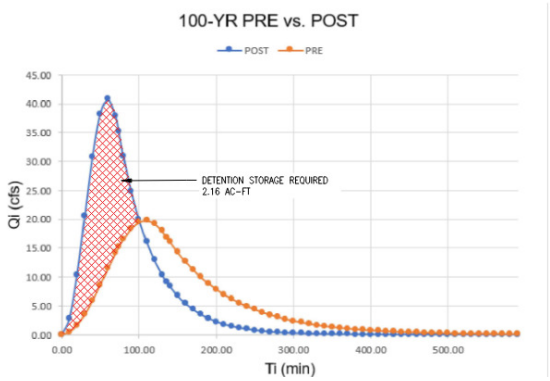
2.8.11. Underground detention is allowed. If utilized, a stormwater maintenance plan must be provided.

2.8.12. Please review the DISTRICT website and ensure you include the latest Standard Construction Details and completed Drainage/Detention Summary tables, as applicable to the project.

2.9. Detention Pond Sizing Calculations

2.9.1. For small developments (less than 5 acres for commercial or 10 acres for residential) – Detention volume required = 0.65 x Area of site with modified cover (this includes mowing/grading of open areas and not just impervious cover)

2.9.2. For developments up to 200 acres – The detention volume required must be determined using the small watershed method (Malcom's Method) using hydrographs. The required detention volume is equal to the maximum cumulative difference between the inflow and outflow runoff curves. See below for an example.



ti	Ti (min)	Qpost (cfs)	Qpre (cfs)	Storage (cu. ft.)	Storage (ac-ft)
0	0.00	0.00	0.00	0.00	0.00
600	10.00	2.76	0.41	1413.04	0.03
1200	20.00	10.30	1.60	6635.87	0.15
1800	30.00	20.58	3.48	16897.42	0.39
2400	40.00	30.80	5.88	31848.18	0.73
3000	50.00	38.20	8.62	49594.97	1.14
3600	60.00	40.76	11.46	67176.87	1.54
4200	70.00	37.81	14.17	81356.20	1.87
4440	74.00	35.26	15.17	86177.07	1.98
4800	80.00	30.94	16.53	89998.38	2.07
5400	90.00	24.88	18.34	93919.40	2.16
6000	100.00	20.00	19.45	94250.22	2.16

2.9.3. Detailed detention pond sizing and outfall calculations are included in the plans. Must include the following:

- 1 ft of freeboard (space between 100-yr WSE and the Top of the Bank) is required for all developments.
- Stage-storage tables (see DISTRICT summary tables on the website)

E.	Detention Stage/Storage – Summary Table *If using a pump - add Stage/ Discharge					
Elevation	**Area (SF)**	**Incremental Storage Volume in cubic ft**	**Cumulative Storage in cubic ft**	**Converted Cumulative Storage to ac-ft**	**Critical Elevations/ Note**	**Gravity or Pumped**
42						Pumped
42.17					Typical Pool (for wet ponds)	Pumped
43						Pumped
44						Pumped
44.45						Gravity
45					2-yr WSE	Gravity
45.51						Gravity
46					10-yr WSE	Gravity
47					100-yr WSE	Gravity
47.6					Emergency spillway/ overflow weir	Gravit
48					Pond Top (1-ft freeboard from 100-yr WSE)	

- Outfall and restrictor pipe (orifice or weir) details and calculations. Ensure outfall calculations are not included in the hydraulic calculations with the internal storm sewer. See DISTRICT rules for more info.
- If outfalling into a channel, the outfall should be directed at a 30-degree angle in the direction of positive flow. Use DISTRICT standard detail for outfalls.
- If Development is included in the Master Planned Community with off-site detention ponds, please provide:
    - Your Detention Service Area Map
    - Your Detention Summary Table (see DISTRICT summary tables on the website) and exhibit of the detention service area must be provided.

If proposing **multiple detention ponds**, please include the summary table below.

Detention Storage Provided For Project Area			
Project Name	**BKDD Permit No.**	**Pond Name**	**Proposed Detention (acre-ft)**
Project "X"	202X-YYY	PO-1	26.30
		PO-2	81.47
		PO-3	32.90
		TOTAL	**140.682**

If proposing **multiple projects**, please include the summary table below:

Applied Detention Summary					
Project Name	**BKDD Permit No.**	**Acreage (acres)**	**Impervious Cover (acres)**	**Applied Detention (acre-ft)**	**Remaining Detention (acre-ft)**
Project "A"	202X-YYY	100.00	80.00	50.00	90.68
Project "B"	202X-ZZZ	89.00	70.00	50.00	40.68
Project "C"	202X-RRR	50.00	45.00	10.00	30.68

- If underground detention is proposed, details of the underground storage tanks from the manufacturer are required and a maintenance plan must be provided.

2.10. Detention Pond Overall Layout and Cross Section

2.10.1. Maintenance Berm – Check for correct width (ft) (see table in DISTRICT rules).

2.10.2. Pond slopes (3:1, 4:1, etc.) - If less than 3:1, see DISTRICT Rules.

2.10.3. Pond layout with flow line information provided at all inflow and outfall points.

2.10.4. A pilot channel is required for dry bottom ponds.

2.10.5. Pond cross sections must show elevations for the top of the bank, bottom, toe, and flow lines at inflow/outfall pipes.

2.10.6. Show water surface elevations for 2-year, 25-year, and 100-year storm events.

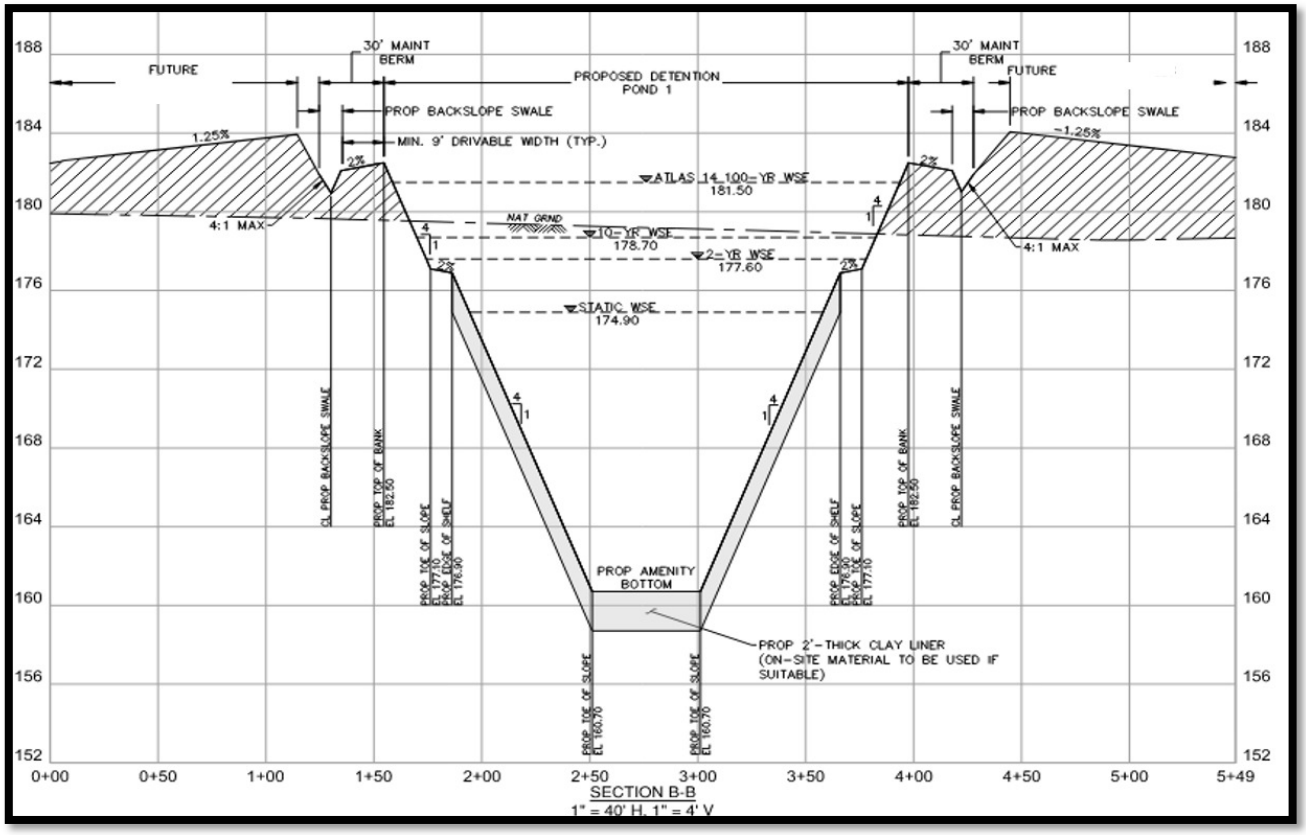
2.10.7. Plans include standard details for detention ponds.

2.10.8. Whether the pond shape is rectangular or curvilinear, the minimum radius of curvature for corners is 25 feet.

2.10.9. Provide detention pond X-section. Include (if applicable) TOB, TOE, pipe elevations, side slope, bottom slope, traverse slope, 2-,10-,25-,100-yr WSE, pumped/gravity elevations, and mitigation/detention elevations.

2.10.10. Label the pond top of bank, toe, and bottom, and call out elevations.

2.10.11. A geotechnical report must be provided for all wet bottom ponds.



SECTION B-B
1" = 40' H, 1" = 4' V

2.11. Floodplain Fill and Mitigation

2.11.1. The DISTRICT is not the Floodplain Manager (FMA) with jurisdiction to issue floodplain permits. The FMA would be the Cities or Counties, depending on the location of the Development.

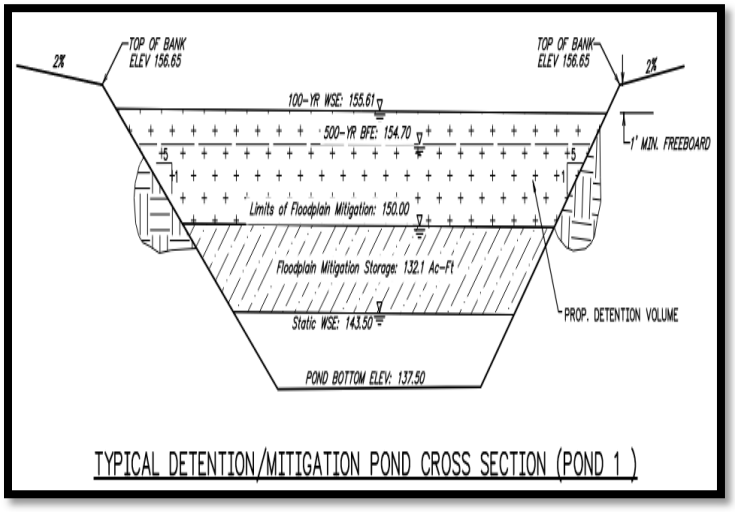
2.11.2. The DISTRICT does check the floodplain mitigation calculations as a cursory review for these entities. You will need to coordinate with the applicable floodplain administrator for more information on a floodplain permit.

2.11.3. If there is a floodplain on the property, provide/ label all floodplain boundaries on plans.

2.11.4. (if applicable) Provide LOMR back documents, FEMA approvals, and exhibits.

2.11.5. A plan sheet should be provided that identifies the fill/cut areas with the fill/cut calculations.

2.11.6. The detail below illustrates mitigation vs detention volume within ponds (see example).



TYPICAL DETENTION/MITIGATION POND CROSS SECTION (POND 1)

2.12. Drain Time

The allowable drain time is defined as the maximum allowable time to drain 80% of the detention basin volume. This is required to preserve detention storage for successive storm events, which could affect the drainage system. Drain time is evaluated without a tailwater condition (free outfall), starting at the maximum water surface elevation in the detention basin from a 100-year storm event. The consultant is responsible for determining the appropriate conditions to analyze and flow rate(s) to compute drain time.

Empty detention basins within 24 hours, when possible. The maximum drain time is 48 hours (2 days) to drain 80% of the volume. If the drain time is longer than 48 hours, an increase in detention volume will also be required, as shown in the table below.

The detention volume is increased to account for the volume of another rainfall event because the longer the drain time, the greater the chance of another rain event.

***Table** - Drain Time and Increase in Detention Volume*

Drain Time	Increase in Detention Volume above the required by:
1-2 Days	0%
3 Days	5%
4 Days	10%
5 Days	15%
6 Days	20%
7 Days	25%

In no case shall a drain time longer than seven (7) days (168 hours) with or without pumps be allowed to meet the minimum design requirements. For larger Developments (greater than 200 acres), it shall be coordinated, reviewed, and approved in writing by the District Engineer prior to commencing significant portions of the design effort and submittal.

2.13. Pump Station

If the pond includes both pump and gravity discharge, the stage storage summary must reflect the total volume and discharge rate for pumped vs. discharged. See DISTRICT rules for pump station/discharge criteria.

2.13.1. No more than fifty percent (50%) of the detention basin capacity shall be pumped. A gravity outflow shall be provided for the basin volume above pumped storage. However, if discharging to a TxDOT ditch and allowed by TxDOT (please provide approval backup documentation), a maximum of seventy-five percent (75%) of the detention basin capacity may be pumped.

2.13.2. An outfall from a pumped discharged system shall not discharge directly into the receiving drainage system (i.e., channel, roadside ditch, etc.). It shall be routed to a junction box (i.e., stilling manhole, basin, etc.) for energy dissipation prior to reaching the gravity discharge and/or ultimate outfall.

2.13.3. The pump station shall have at least two pumps (a lead pump and a lag pump).

2.13.4. The pump force main shall be equipped with a float (ultrasonic is preferred) at the well and at the discharge point.

2.13.5. A return line to the detention basin shall be provided from the pump station in the event the restrictor capacity is exceeded during a flooding event.

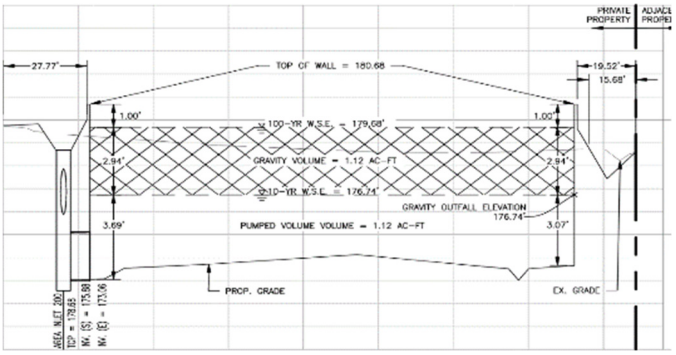
2.13.6. Emergency power to the pump station is not required; however, if not provided, the electrical panel shall include a fully operational transfer switch with necessary connections to connect a portable generator.

2.13.7. The Simplified Method formula for required storage volume for small projects is not allowable for pumped systems, and detention storage must be analyzed using stage-storage discharge for the 100-year storm event.

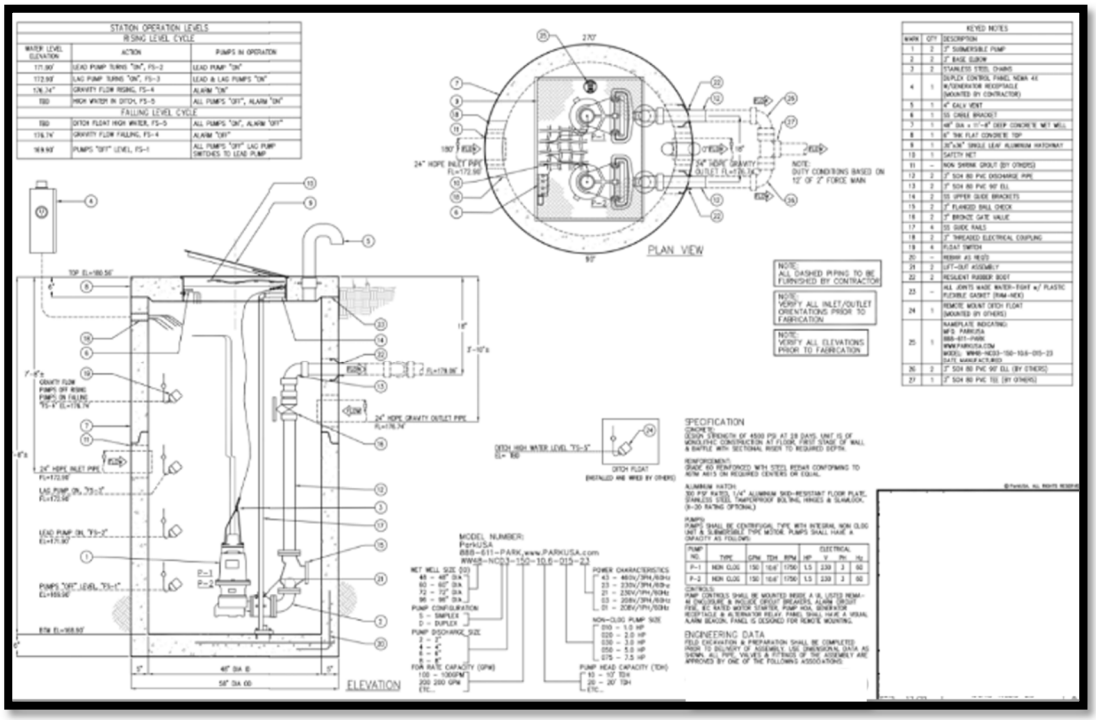
2.13.8. A stage storage summary table and cross-section profile of the pond that reflects the total volume and discharge rate for pumped vs. discharged must be included. See examples below.

STAGE/STORAGE - STAGE/DISCHARGE TABLE

Water Surface Elevation	Stage (ft)	Storage at Elevation (cf)	Head (ft)	Discharge Rate (c.f.s.)	Cumulative Time at Elevation (hrs)	
179.68	6.78	97,492	2.69	2.07	47.16	GRAVITY
179.00	6.10	86,122	2.01	1.79	45.64	
178.00	5.10	69,427	1.01	1.27	43.04	
176.74	3.84	48,431	-	0.35	38.44	
176.00	3.10	36,122	-	0.35	28.67	PUMPED
175.00	2.10	19,513	-	0.35	15.49	
174.80	1.90	16,194	-	0.35	12.85	
174.00	1.10	3,913	-	0.35	3.11	
172.90	-	-	-	0.35	0.00	



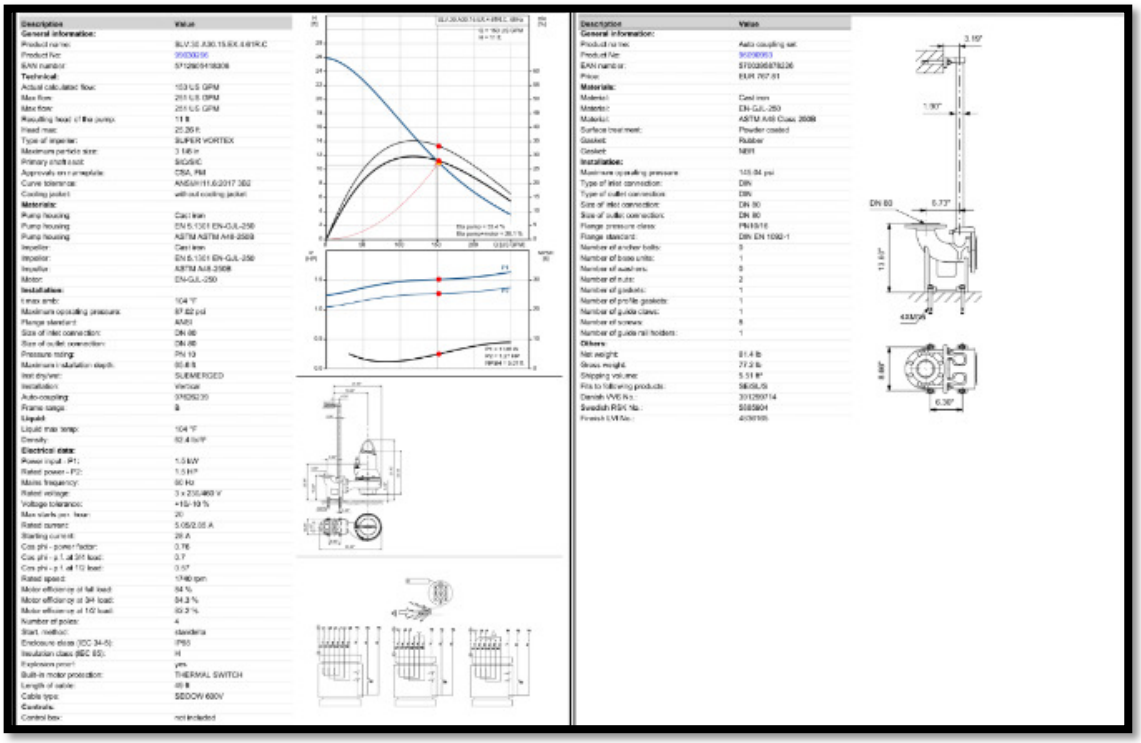
2.13.9. Include the structural design of the pump station well.



2.13.10.The following pump information shall be provided: (See example below)

Pump system and performance curve.

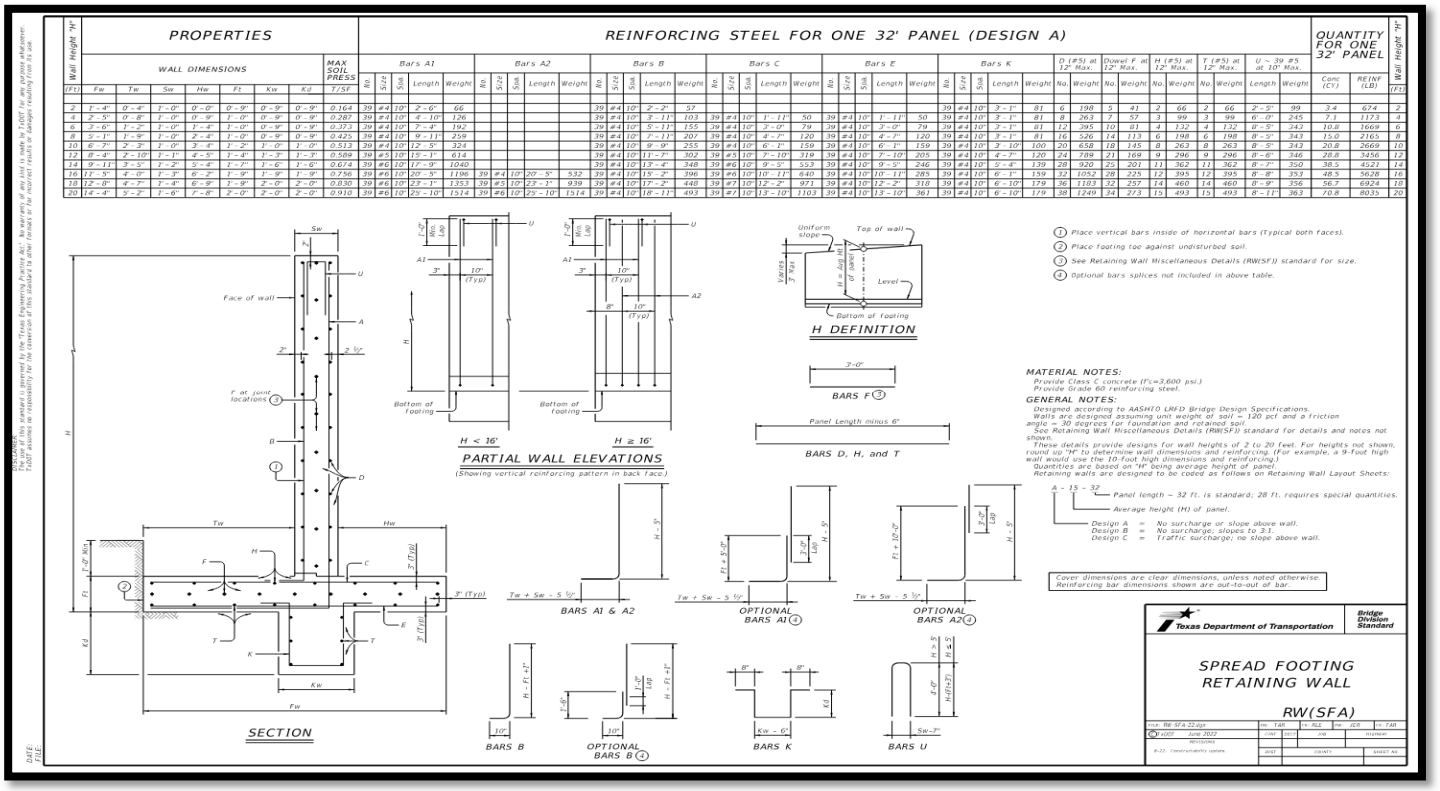
- Pump motor control system wiring diagram.
- Pump vendor/manufacturing information.
- Discharge rate.
- Pump on/off schedule



2.14. **Retaining Walls**

2.14.1. The following minimum, but not limited to, requirements shall be included in the plans:

- Structural analysis and calculations
- Detail – we prefer standard TxDOT details for retaining walls
- Geotechnical Report that includes soil analysis for proposed retaining walls. Especially important if the waterway is nearby, that will add hydrostatic pressure in a storm event.



2.15.**Maintenance Items**

- Please ensure we have access to our easements. If curbs are proposed, they will need curb cuts or ramps.
- Access across emergency spillways (min. 6:1 slope),
- Access Ramps & Gates when applicable

2.16. Geotechnical Report

2.16.1. To ensure we hold paramount the safety, health, and welfare of the public.

Before initiating the final design of a detention pond or channel, a detailed soil investigation by a professional geotechnical engineer licensed in the State of Texas shall be undertaken, principally if the proposed pond is over six (6) feet deep and/or two (2) acres in size. Exceptions may be made if justifications are provided by the engineer of record.

2.16.2. The following minimum, but not limited to, requirements shall be addressed within the Report:

- Stability of the basin side slopes for short-term and long-term conditions. (If basin depth ≤ 5 feet, a slope stability analysis is not required; however, a geotechnical report is still required to address the other issues.)
- Stability of the permanent poolside slopes (i.e., rapid drawdown, short/long term stability)
- Evaluation of bottom instability due to excess hydrostatic pressure.
- Control of groundwater and its elevation.
- Identification of dispersive soils.
- Potential erosion problems.
- Constructability issues.
- Evaluation of inflow and outflow structures.
- Investigation into the potential for structural movement in areas adjacent to the basin may be required. This is due to the induced loads from existing or proposed structures.

2.17. Storm Sewer/ Channel Plan and Profile Sheets

2.17.1. A key map showing the location of street(s), if necessary, for large subdivisions

2.17.2. Show elevations for the top of curb/pavement flowlines at storm sewers and ditches.

2.17.3. Ensure the pavement is providing the cascading effect

2.17.4. Stationing in profile view that matches plan view.

2.17.5. Label storm sewer diameter, slope, and pipe material for every pipe segment and structure (inlets, manholes, bends (with a degree of bend), and other appurtenances).

2.17.6. Manholes at all confluences greater than 45 degrees, at the junction of three or more lines, at a junction where the downstream pipe size changes, and every 250 feet from an access point for drains less than or equal to 30" diameter or 300 feet from an access point for drains larger than 30" diameter.

2.17.7. Cross-section detail of existing and/or proposed swales and ditches, including extreme event spillway

2.17.8. Show 2-year and 100-year hydraulic grade lines (HGL)for each segment of the storm sewer system.

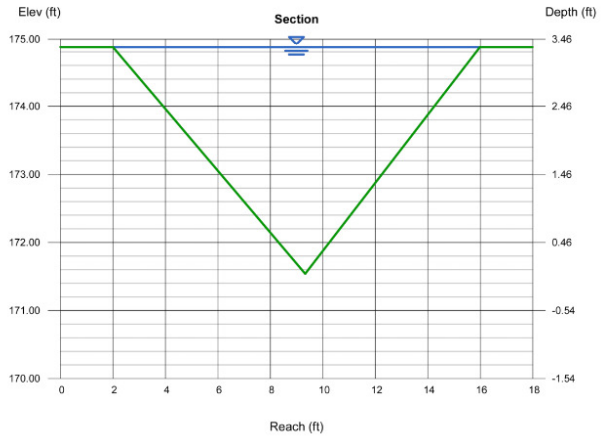
2.17.9. Provide Culvert Backup calculations.

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 10 2023

La Segarra Blvd-Upstream Ditch

Triangular		**Highlighted**	
Side Slopes (z:1)	= 2.20, 2.00	Depth (ft)	= 3.33
Total Depth (ft)	= 3.33	Q (cfs)	= 35.90
		Area (sqft)	= 23.29
Invert Elev (ft)	= 171.54	Velocity (ft/s)	= 1.54
Slope (%)	= 0.10	Wetted Perim (ft)	= 15.49
N-Value	= 0.040	Crit Depth, Yc (ft)	= 1.79
		Top Width (ft)	= 13.99
Calculations		EGL (ft)	= 3.37
Compute by:	Q vs Depth		
No. Increments	= 10		



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 24 2023

La Segarra Blvd Culverts-(2) 30

Invert Elev Dn (ft)	= 171.30	**Calculations**	
Pipe Length (ft)	= 187.00	Qmin (cfs)	= 0.00
Slope (%)	= 0.13	Qmax (cfs)	= 36.00
Invert Elev Up (ft)	= 171.54	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 30.0		
Shape	= Circular	**Highlighted**	
Span (in)	= 30.0	Qtotal (cfs)	= 36.00
No. Barrels	= 2	Qpipe (cfs)	= 36.00
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Circular Concrete	Veloc Dn (ft/s)	= 4.34
Culvert Entrance	= Groove end projecting (C)	Veloc Up (ft/s)	= 6.17
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2	HGL Dn (ft)	= 173.27
		HGL Up (ft)	= 172.98
Embankment		Hw Elev (ft)	= 173.63
Top Elevation (ft)	= 175.50	Hw/D (ft)	= 0.83
Top Width (ft)	= 148.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 187.00