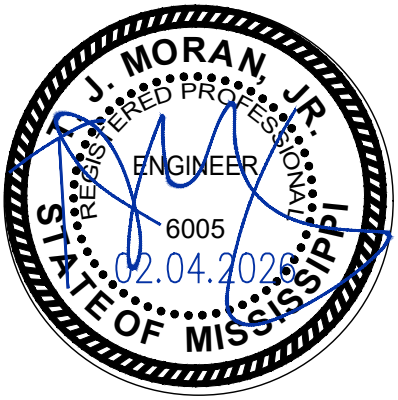
2026

Drainage Analysis

WEBSTER STREET - PARCEL 149E-0-29-014.002

PREPARED BY: TERRY MORAN AND ASSOCIATES, PLLC



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Drainage Analysis and Stormwater Compliance Submittal

City of Bay St. Louis, Mississippi — Sec. 22-37(a) Basin Stormwater Management Design Criteria

Project parcel information

Hancock County GIS Parcel: 149E-0-29-014.002 (Webster St, Bay St. Louis, MS 39520)

PLSS Township/Range: T8S, R13W (Township 8 South, Range 13 West)

1) City requirement and compliance basis

Sec. 22-37(a) Minimum control requirements: Post-development peak discharge for the 10-, 25-, and 100-year storms shall not exceed the corresponding pre-development peak discharge rates.

Compliance approach used in this submittal

DA1 → Pond 1 (detained; controlled outlet)

DA2 → Pond 2 (detained; controlled outlet)

Each pond is designed such that, for each storm event:

$$\boldsymbol{Q}_{\text{pond,out}} \leq \boldsymbol{Q}_{\text{pond,pre}}$$

Primary outlet is a submerged orifice; a high-stage rectangular notch provides only the additional discharge needed at the 100-year stage to match (but not exceed) the pre-development 100-year discharge.

2) Hydrology method and inputs

2.1 Rational Method

$$\boldsymbol{Q = C\, i\, A}$$

$\boldsymbol{Q}$= peak runoff (cfs)

$\boldsymbol{C}$= runoff coefficient

$\boldsymbol{i}$= rainfall intensity (in/hr) at $\boldsymbol{T_c}$

$\boldsymbol{A}$= drainage area (ac)

2.2 Time of concentration and NOAA intensities (Tc = 10 minutes)

$\boldsymbol{i_{10} = 7.99}$in/hr

$\boldsymbol{i_{25} = 9.45}$in/hr

$\boldsymbol{i_{100} = 11.70}$in/hr

2.3 Runoff coefficients

Pre-development: $\boldsymbol{C_{pre} = 0.30}$

Post-development: $\boldsymbol{C_{imp} = 0.90}$, $\boldsymbol{C_{perv} = 0.40}$

Weighted post coefficient:

$$\boldsymbol{C_{post}} = (\%\boldsymbol{Imp})\ \mathbf{0.90} + (\%\boldsymbol{Perv})\ \mathbf{0.40}$$

3) Drainage areas and coefficients

3.1 Areas and imperviousness

Drainage Area	Total Area (SF)	Area (ac)	Impervious (SF)	% Imp
DA1 → Pond 1	26,906.5543	0.617689	14,897.8356	55.37%
DA2 → Pond 2	27,992.0524	0.642609	19,939.2954	71.23%

3.2 Runoff coefficients

Drainage Area	$\boldsymbol{C_{pre}}$	$\boldsymbol{C_{post}}$
DA1	0.30	0.67684
DA2	0.30	0.75616

4) Rational Method peak discharges (pre vs post)

4.1 10-year event ($\boldsymbol{i = 7.99}$)

Area	$\boldsymbol{Q_{pre}}$(cfs)	$\boldsymbol{Q_{post}}$(cfs)
DA1 → Pond 1	1.481	3.340
DA2 → Pond 2	1.540	3.882
TOTAL	3.021	7.223

4.2 25-year event ($\boldsymbol{i = 9.45}$)

Area	$\boldsymbol{Q_{pre}}$(cfs)	$\boldsymbol{Q_{post}}$(cfs)
DA1 → Pond 1	1.751	3.951
DA2 → Pond 2	1.822	4.592

Area	Q_{pre}(cfs)	Q_{post}(cfs)
TOTAL	3.573	8.543

4.3 100-year event ($i = 11.70$)

Area	Q_{pre}(cfs)	Q_{post}(cfs)
DA1 → Pond 1	2.168	4.892
DA2 → Pond 2	2.256	5.685
TOTAL	4.424	10.577

5) Required release targets (each pond released at its pre-development rate)

Pond	$Q_{pre,10}$	$Q_{pre,25}$	$Q_{pre,100}$
Pond 1 (DA1)	1.481 cfs	1.751 cfs	2.168 cfs
Pond 2 (DA2)	1.540 cfs	1.822 cfs	2.256 cfs

6) Detention storage requirement

Modified Rational storage equation used:

$$V_{st} = 0.08264\,(Q_{in} - Q_{out})\,T_c$$

with $T_c = 10$ min $= 0.1667$ hr. (Computed in ac-ft and converted to ft^3.)

6.1 Required storage volumes (ft^3)

Storm	Pond 1 V_{st}	Pond 2 V_{st}
10-year	1,116	1,405
25-year	1,320	1,662
100-year	1,634	2,058

7) Pond geometry and computed water surface elevations (WSE)

Stage-storage is computed assuming linear change in surface area with depth between bottom and top areas.

7.1 Pond 1 geometry

Bottom Elev = 15.00 ft, $A_b = 643.2280$sf

Pond rim / structure top = 17.05 ft (slightly raised to keep notch top above WSE100)

Area slope based on prior geometry (linear side slopes); resulting top area at 17.05 is consistent with the same slope assumption.

Computed WSE at required storage

Event	Storage (ft^3)	WSE (ft)
10-year	1,116	16.146
25-year	1,320	16.298
100-year	1,634	16.514

7.2 Pond 2 geometry (per current design)

Bottom Elev = 8.00 ft, $A_b = 50$sf

Pond rim / structure top = 12.05 ft (slightly raised to keep notch top above WSE100)

Top area at 12.00 is 1,258 sf; top area at 12.05 is taken by linear extension of the side slope.

Computed WSE at required storage

Event	Storage (ft^3)	WSE (ft)
10-year	1,405	10.889
25-year	1,662	11.156
100-year	2,058	11.530

8) Outlet design — orifice release at each event, notch weir sizing for Q100, and outfall pipe sizing

8.1 Orifice equation (submerged)

$$Q_o = C_d A_o \sqrt{2gH}$$

Assumptions:

$$C_d = 0.62$$

$$g = 32.2 \text{ ft/s}^2$$

Primary orifice size (both ponds): 8-inch diameter
Orifice is set so that at WSE10, $\boldsymbol{Q_o = Q_{pre,10}}$(most restrictive event), ensuring 10/25/100 outflows do not exceed pre-development values.

8.2 Pond 1 outlet performance (8" orifice + 2-ft notch)

Orifice centerline elevation (set by 10-year control)

Required head at WSE10 for $\boldsymbol{Q_{pre,10} = 1.481}$cfs with 8" orifice: $\boldsymbol{H_{10} = 0.727}$ft

$$\boldsymbol{E_{o,CL} = WSE_{10} - H_{10} = 16.146 - 0.727 = 15.419\ \text{ft}}$$

Projected orifice release at each event

Event	WSE (ft)	Head $\boldsymbol{H}$(ft)	Orifice $\boldsymbol{Q_o}$(cfs)	Target $\boldsymbol{Q_{pre}}$(cfs)
10-year	16.146	0.727	1.481	1.481
25-year	16.298	0.879	1.628	1.751
100-year	16.514	1.095	1.817	2.168

Notch weir sizing to make up the remaining Q100 flow

Required additional flow at 100-year:

$$\boldsymbol{Q_{w,100} = 2.168 - 1.817 = 0.351}\ \text{cfs}$$

Rectangular sharp-crested notch:

$$\boldsymbol{Q_w = 3.33\ L\ H^{3/2}}$$

Notch width fixed: $\boldsymbol{L = 2.0}$ ft(inside 6'×6' structure)

Solve for required head at 100-year:

$$\boldsymbol{H_{req} = 0.141}\ \text{ft} \approx \boldsymbol{1.67}\ \text{in}$$

Notch invert/crest elevation (bottom of opening):

$$\boldsymbol{E_{crest} = WSE_{100} - H_{req} = 16.514 - 0.141 = 16.373\ \text{ft}}$$

Notch top elevation (top of opening): 6 inches below structure top

Structure top = rim = 17.05 → $\boldsymbol{E_{top} = 16.55}$ ft

Notch opening height: $\boldsymbol{16.55 - 16.373 = 0.177}$ ft $\approx \boldsymbol{2.12}$ in

Weir width check: 2.0 ft ≤ 5.0 ft max

8.3 Pond 2 outlet performance (6" orifice + 2-ft notch)

Orifice centerline elevation (set by 10-year control)

Required head at WSE10 for $\boldsymbol{Q_{pre,10} = 1.540}$cfs with 8" orifice: $\boldsymbol{H_{10} = 0.786}$ft

$$\boldsymbol{E_{o,CL} = 10.889 - 0.786 = 10.103\ \text{ft}}$$

Projected orifice release at each event

Event	WSE (ft)	Head $\boldsymbol{H}$(ft)	Orifice $\boldsymbol{Q_o}$(cfs)	Target $\boldsymbol{Q_{pre}}$(cfs)
10-year	10.889	2.639	1.540	1.540
25-year	11.156	2.906	1.616	1.822
100-year	11.530	3.280	1.717	2.256

Notch weir sizing to make up the remaining Q100 flow

Required additional flow at 100-year:

$$\boldsymbol{Q_{w,100} = 2.256 - 1.717 = 0.539}\ \text{cfs}$$

With $\boldsymbol{L = 2.0}$ft:

$$\boldsymbol{H_{req} = 0.207}\ \text{ft} \approx \boldsymbol{2.5}\ \text{in}$$

Notch invert/crest elevation:

$$\boldsymbol{E_{crest} = 11.530 - 0.207 = 11.343\ \text{ft}}$$

Notch top elevation (6 inches below rim/structure top):

Structure top = rim = 12.05 → $\boldsymbol{E_{top} = 11.55}$ ft

Notch opening height: $\boldsymbol{11.55 - 11.343 = 0.207}$ ft ≈ $\boldsymbol{2.5}$ in

Weir width check: 2.0 ft ≤ 5.0 ft max

8.4 Outfall pipe sizing (must convey pre Q100 rate)

Outfall conveyance from each pond shall be sized/verified to pass at least the pre-development 100-year discharge:

Pond 1: $\boldsymbol{Q_{pre,100} = 2.168}$cfs

Pond 2: $\boldsymbol{Q_{pre,100} = 2.256}$cfs

outfall pipe size: 12-inch approximately .3% slope for both ponds 1 and 2

9) Summary and conclusion

Summary

Peak runoff was computed using the Rational Method for 10-, 25-, and 100-year storms at Tc = 10 minutes.

DA1 is detained in Pond 1 and DA2 is detained in Pond 2.

Each pond is controlled to release at or below its pre-development peak rates for 10/25/100.

Required storage volumes were computed with the Modified Rational storage equation, and corresponding WSE10/WSE25/WSE100 were determined from each pond's geometry.

Each pond's orifice is set to meet the pre-10 discharge at WSE10. A 2-foot-wide notch provides the additional flow needed at WSE100 to reach (but not exceed) the pre-100 discharge.

Outfall conveyance is sized to pass the pre Q100 flow from each pond.

Conclusion (Sec. 22-37(a))

With the detention storage volumes, water surface elevations, and outlet stage-discharge performance documented above, the design provides controlled discharges that do not exceed pre-development peak discharge rates for the 10-, 25-, and 100-year storm events, satisfying Sec. 22-37(a).

10) Operations and Maintenance Plan (included as compliance submittal)

Because the onsite open ditch is part of the City's primary runoff conveyance path through the property, O&M requirements include both detention basins and the ditch segment within property limits / maintenance easements.

10.1 Minimum maintenance tasks (ponds)

1. Detention pond maintenance

• Maintain vegetated slopes and bottoms; repair erosion, rills, settlement, or bare areas promptly.

• Maintain riprap at inflow points; repair displacement/scour.

• Maintain 6-inch sump/forebay inlet depressions; remove sediment as needed to preserve pretreatment and storage.

2. Floatables capture during mowing

• During each mowing event, remove and properly dispose of floatable debris and contaminants from pond surfaces and inlet/outlet areas.

• Minimum frequency: monthly.

3. Clean outlets and overflow structures annually

• Remove sediment/debris/vegetation from orifice openings, protective screens/trash controls, weir notch/crest, and outlet structure components.

• Minimum frequency: annually.

4. Annual pond performance inspection

• Document that inlets are stabilized, outlets are unobstructed, basin slopes/bottoms remain stable, and no excessive sedimentation or downstream scour is occurring.

• Minimum frequency: annually.

10.2 Minimum maintenance tasks (onsite open ditch within property limits)

• Mowing/vegetation control:

o Growing season: monthly

o Non-growing season: every 3 months

• Debris/floatables removal: monthly (performed with mowing; minimum)

• Sediment/obstruction removal: annually (minimum) and as needed where shoaling/debris dams reduce conveyance

• Erosion/scour repair: annually (minimum) and after major storms where observed

10.3 Maintenance frequency summary (minimum)

• Mowing: monthly (growing season), every 3 months (non-growing season)

• Debris cleanup (ponds + ditch): monthly minimum

• Outlet/overflow cleaning (ponds): annually minimum

• Annual inspections (ponds + ditch): annually minimum

Appendix A – NOAA Atlas 14

NOAA Atlas 14, Volume 9, Version 2
Location name: Bay Saint Louis, Mississippi, USA*
Latitude: 30.3177°, Longitude: -89.3331°
Elevation: 19 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

AMS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Annual exceedance probability (1/years)								
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500	1/1000
5-min	**7.38** (5.93-9.24)	**9.40** (7.52-11.8)	**10.9** (8.69-13.7)	**12.9** (9.94-16.5)	**14.4** (10.9-18.6)	**15.9** (11.6-20.9)	**17.4** (12.3-23.3)	**19.4** (13.2-26.5)	**20.9** (13.8-28.9)
10-min	**5.41** (4.34-6.76)	**6.88** (5.51-8.62)	**7.99** (6.36-10.0)	**9.45** (7.27-12.1)	**10.6** (7.96-13.6)	**11.7** (8.52-15.3)	**12.8** (8.97-17.1)	**14.2** (9.64-19.4)	**15.3** (10.1-21.1)
15-min	**4.40** (3.53-5.50)	**5.59** (4.48-7.00)	**6.49** (5.17-8.16)	**7.68** (5.91-9.83)	**8.58** (6.47-11.1)	**9.47** (6.92-12.4)	**10.4** (7.30-13.9)	**11.5** (7.84-15.8)	**12.4** (8.24-17.2)
30-min	**3.36** (2.70-4.20)	**4.31** (3.45-5.39)	**5.02** (4.00-6.31)	**5.96** (4.59-7.63)	**6.67** (5.03-8.63)	**7.38** (5.39-9.70)	**8.09** (5.69-10.8)	**9.02** (6.12-12.3)	**9.72** (6.45-13.4)
60-min	**2.26** (1.82-2.83)	**2.89** (2.32-3.62)	**3.40** (2.71-4.27)	**4.09** (3.17-5.28)	**4.65** (3.52-6.04)	**5.22** (3.83-6.90)	**5.81** (4.10-7.83)	**6.63** (4.51-9.09)	**7.27** (4.82-10.0)
2-hr	**1.42** (1.15-1.76)	**1.82** (1.47-2.25)	**2.14** (1.72-2.66)	**2.60** (2.04-3.34)	**2.98** (2.28-3.84)	**3.37** (2.50-4.43)	**3.79** (2.70-5.07)	**4.38** (3.00-5.96)	**4.84** (3.23-6.63)
3-hr	**1.06** (0.866-1.30)	**1.36** (1.11-1.68)	**1.61** (1.30-1.99)	**1.98** (1.57-2.54)	**2.29** (1.77-2.95)	**2.62** (1.96-3.43)	**2.98** (2.13-3.97)	**3.48** (2.40-4.72)	**3.89** (2.61-5.30)
6-hr	**0.637** (0.524-0.774)	**0.827** (0.679-1.01)	**0.992** (0.810-1.21)	**1.24** (0.988-1.57)	**1.44** (1.12-1.84)	**1.67** (1.25-2.16)	**1.91** (1.38-2.52)	**2.25** (1.57-3.03)	**2.54** (1.71-3.42)
12-hr	**0.372** (0.310-0.448)	**0.495** (0.410-0.596)	**0.599** (0.494-0.724)	**0.751** (0.605-0.942)	**0.877** (0.689-1.11)	**1.01** (0.768-1.30)	**1.16** (0.844-1.52)	**1.37** (0.957-1.82)	**1.53** (1.04-2.05)
24-hr	**0.217** (0.183-0.258)	**0.292** (0.245-0.348)	**0.354** (0.295-0.423)	**0.444** (0.360-0.549)	**0.517** (0.409-0.644)	**0.595** (0.454-0.754)	**0.678** (0.497-0.876)	**0.794** (0.560-1.05)	**0.888** (0.608-1.17)
2-day	**0.124** (0.105-0.146)	**0.166** (0.140-0.195)	**0.200** (0.168-0.236)	**0.249** (0.204-0.305)	**0.289** (0.231-0.356)	**0.332** (0.255-0.416)	**0.377** (0.278-0.481)	**0.440** (0.312-0.573)	**0.491** (0.338-0.643)
3-day	**0.089** (0.076-0.104)	**0.117** (0.100-0.137)	**0.141** (0.119-0.166)	**0.175** (0.144-0.213)	**0.203** (0.163-0.249)	**0.233** (0.180-0.290)	**0.264** (0.196-0.336)	**0.309** (0.220-0.400)	**0.344** (0.238-0.448)
4-day	**0.070** (0.060-0.081)	**0.092** (0.079-0.107)	**0.110** (0.094-0.129)	**0.137** (0.113-0.166)	**0.158** (0.128-0.193)	**0.181** (0.141-0.225)	**0.206** (0.153-0.260)	**0.240** (0.172-0.310)	**0.268** (0.186-0.348)
7-day	**0.046** (0.040-0.053)	**0.059** (0.051-0.068)	**0.070** (0.060-0.082)	**0.086** (0.072-0.104)	**0.100** (0.081-0.120)	**0.114** (0.089-0.140)	**0.128** (0.096-0.161)	**0.149** (0.107-0.191)	**0.166** (0.116-0.213)
10-day	**0.036** (0.031-0.041)	**0.046** (0.040-0.053)	**0.054** (0.046-0.062)	**0.066** (0.055-0.078)	**0.075** (0.061-0.090)	**0.085** (0.067-0.104)	**0.096** (0.072-0.119)	**0.111** (0.080-0.141)	**0.123** (0.086-0.157)
20-day	**0.024** (0.021-0.027)	**0.029** (0.026-0.033)	**0.034** (0.029-0.038)	**0.040** (0.034-0.047)	**0.045** (0.037-0.053)	**0.050** (0.040-0.061)	**0.056** (0.042-0.069)	**0.063** (0.046-0.080)	**0.069** (0.049-0.088)
30-day	**0.019** (0.017-0.021)	**0.023** (0.020-0.026)	**0.027** (0.023-0.030)	**0.031** (0.026-0.036)	**0.035** (0.029-0.041)	**0.038** (0.030-0.046)	**0.042** (0.032-0.051)	**0.047** (0.034-0.059)	**0.051** (0.036-0.064)
45-day	**0.015** (0.014-0.017)	**0.019** (0.017-0.021)	**0.022** (0.019-0.024)	**0.025** (0.021-0.029)	**0.028** (0.023-0.032)	**0.030** (0.024-0.036)	**0.033** (0.025-0.040)	**0.036** (0.026-0.045)	**0.039** (0.027-0.049)
60-day	**0.013** (0.012-0.015)	**0.017** (0.015-0.019)	**0.019** (0.017-0.021)	**0.022** (0.019-0.025)	**0.024** (0.020-0.028)	**0.026** (0.021-0.031)	**0.028** (0.021-0.034)	**0.031** (0.022-0.038)	**0.032** (0.023-0.040)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of annual maxima series (AMS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and annual exceedance probability) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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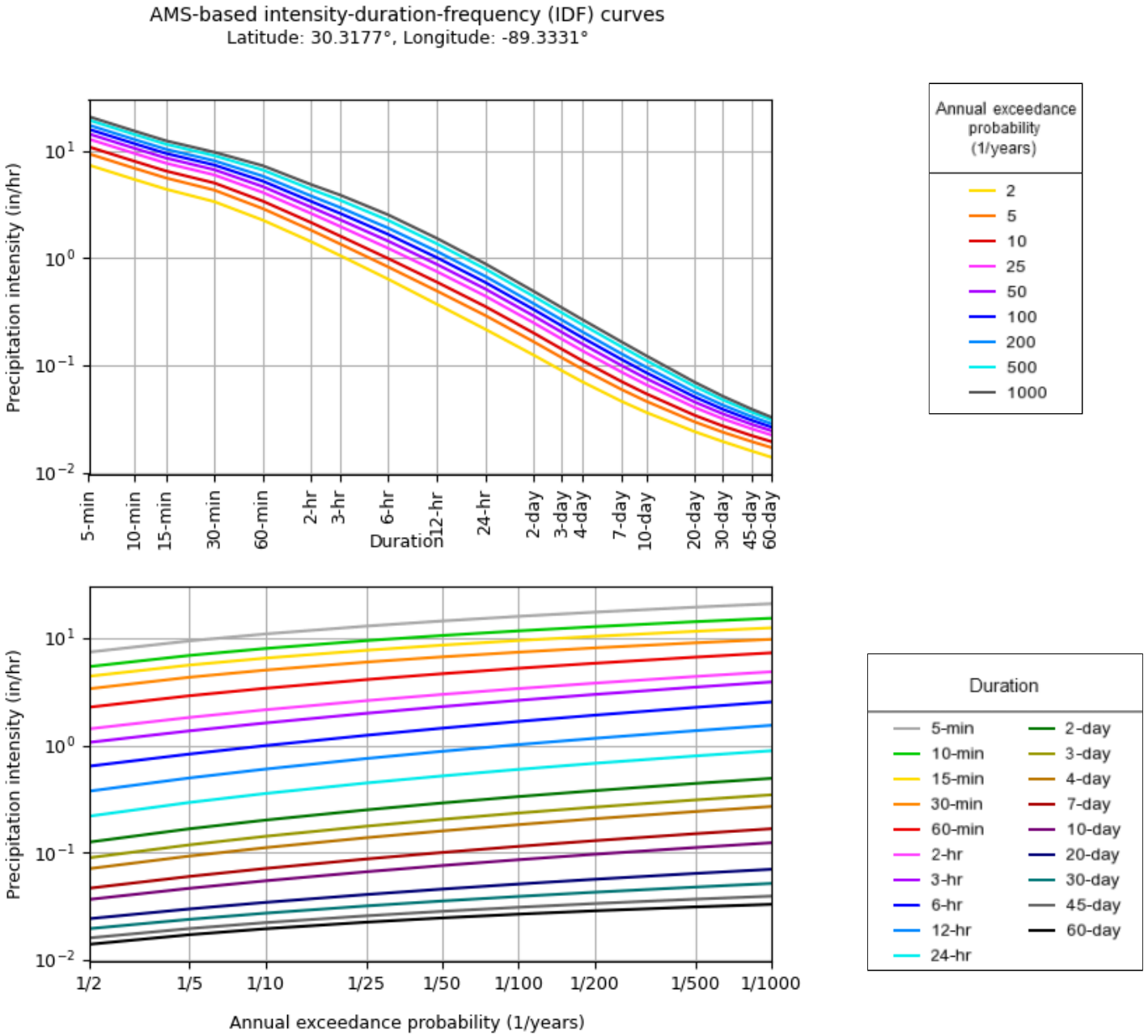
PF graphical



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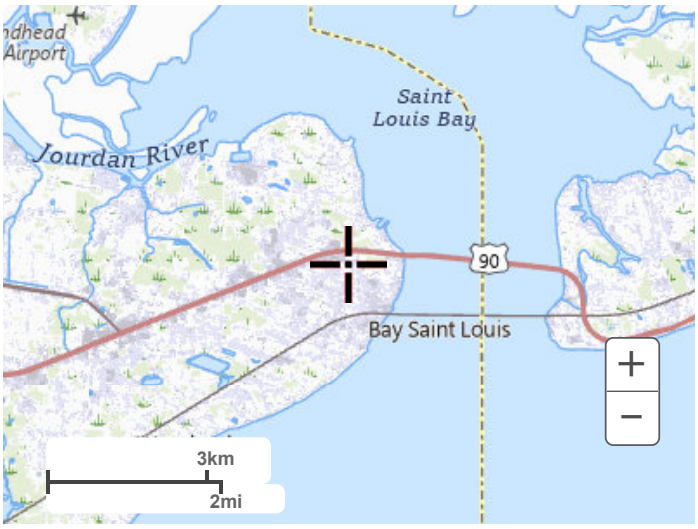
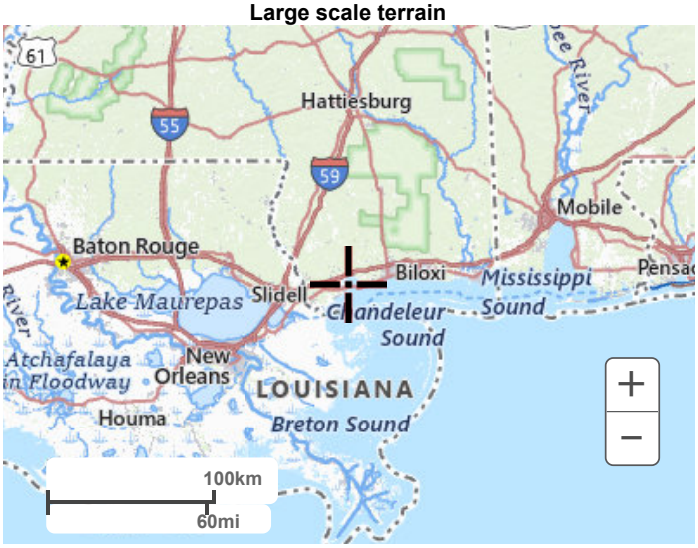
Maps & aerials

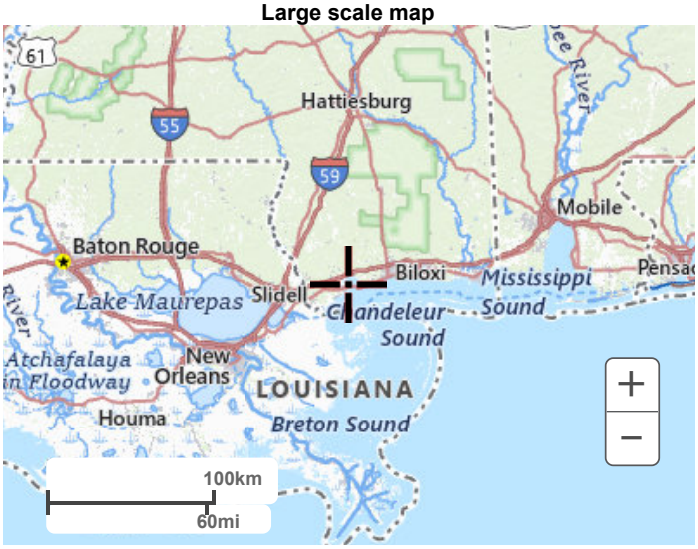
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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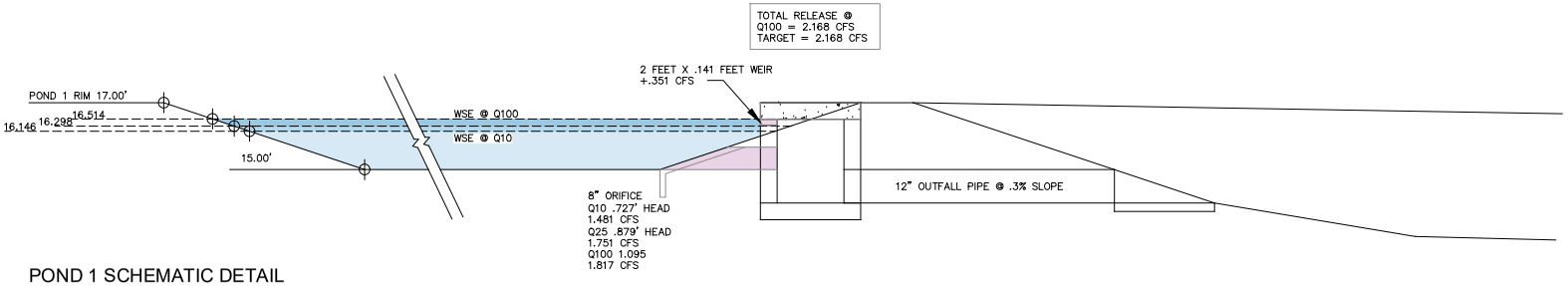
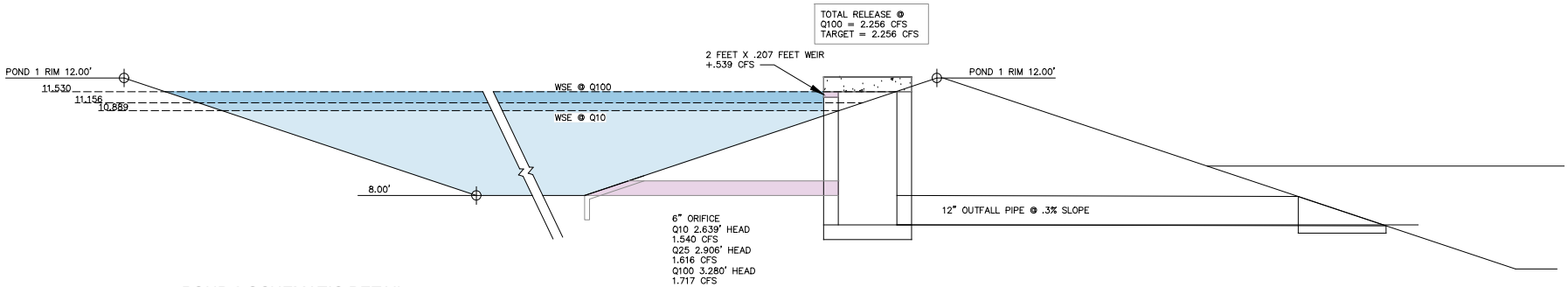
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix B – Detention Pond Schematic



POND 1 SCHEMATIC DETAIL



POND 2 SCHEMATIC DETAIL

APPENDIX B

Appendix C – Parcel Drainage Map

da1

da2

DETENTION
POND 1

DETENTION
POND 2

20 UNITS/ 28 BEDS
44 PARKING SPACES

BLDG C
(6) 2 BR Units
18 SPACES
REQUIRED

BLDG B
MIRRORED ORIENTATION
(6) 1 BR Units
13 SPACES REQUIRED

BLDG A
STANDARD ORIENTATION
(6) 1 BR Units
13 SPACES REQUIRED

DITCH TO BE
RELOCATED AS NECESSARY

SETBACK
EASEMENT
PROPERTY LINE