Sulphur Brine Field

Containment Levee Plan

Submitted by:

Westlake

Prepared by:

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ReCon Engineering Project No. 23261173

Revision 2

April 19, 2024

STATE OF LOUISIANA
GLEN A. BOAZ
REG. No. 29016
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING
4-19-24

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APPENDIX

1.0 BACKGROUND

Order 3.i. of the Third Supplement to Compliance Order No. IMD 2022-027 issued by the State of Louisiana Department of Natural Resources Office of Conservation requires Westlake US 2, LLC (Westlake) to submit “a plan to construct a containment system around the potential affected area at the surface.”

Westlake and its contractors prepared the plan described herein in response to the above-described order. Westlake’s compliance with that order is not an admission that such a system is needed currently or a commitment to construct the described structures and improvements. Westlake reserves the right to challenge any order requiring construction of a containment system and to change the components of this proposal based on changes in circumstances occurring after its submission.

Westlake proposes the following components:

- Engineered earthen levees constructed with low permeability compacted clay soils surrounding the possible impact site (see Figure 1). These levees will be constructed by improving the levee surrounding the existing reservoir commonly referred to as Salt Lake. Additional levees will be installed east of PPG 7 and around all active and dormant Westlake well sites. The additional levees will be referred to herein as the “Well Levee” and “Dome Levee”.
- Four major weir drainage structures will allow transfer of water from one side of the containment levee to the other. Two structures will include three 36-inch diameter drainpipes and two will include two 36-inch diameter drainpipes that run through the levees. Each pipe will have valves which can be manually opened or closed to allow water transfer to the outside of the levee.
- Two smaller single 36-inch diameter drainpipe weir structures are planned for the east side Well Levee and one near the southwest corner of Salt Lake. The Well Levee weir will drain to Central Pond.
- Two pump stations will be constructed within the levee system to remove and/or utilize containment water following an event. Two electric pumps and one diesel pump are proposed for each station. One pump will be the primary pump and the others will be installed spares for redundancy.

2.0 INTRODUCTION

This plan describes the basis of the levee system layout, drainage structures, levee elevation, materials of construction, water treatment and control, etc.:

- Anticipated impact zone;
- Levee location;
- Current runoff receiving streams;
- Elevation of levee system;
- Levee system configuration
- Levee construction materials;

- Levee system engineering and construction;
- Water Level Control;
- Water Treatment

Each of these items is addressed in greater detail in the sections that follow in this Levee System Plan.

3.0 SITE INFORMATION

The majority of the brine field site in question is currently owned by Sulphur Dome, LLC and Westlake. Westlake also leases property to mine brine that is used in the Chlor-Alkali process at the Westlake South facility. Other landowners that may be impacted by the levee construction are Brimstone History Society, Apollo Lake Charles, Bell Mineral LLC, Julia B Est. Pollock, Keith Hobgood, and LOLC LLC according to public records gathered from Calcasieu Parish Police Jury.

The soils at the site are identified as Guyton, Judice, and Morey by USDA Soil Survey and fall into the Hydraulic Soil Groups C or D. These soils typically have land slopes in the 0 to 1% range and rarely flood. Vegetation consists of grass, naturally growing trees, and ponds. A large portion of the containment system will surround the existing Salt Lake.

4.0 LEVEE SYSTEM PLAN

The initial levee system plan submitted by Westlake has been revised based on comments noted during the January 30, 2024 meeting with State of Louisiana Department of Energy and Natural Resources (DENR), land owners, and operators held at the Sulphur Brine Field and March 15th, 2024 teleconference meeting with DENR officials.

A recommendation was made during the January 30th meeting to determine if the high bank line of the Salt Lake could be used as the main confining structure in combination with another structure/levee to confine Brine Wells 6 and 7 located on the east side of the pond. Following the meeting, using the high bank line of the Salt Lake as the main confining structure/levee was investigated and found to be favorable. As such, the levee configuration was revised to reflect the utilization of the Salt Lake bank in combination with a Well Levee to manage water discharge from the site following an event.

During the March 15th meeting, DENR requested the entire salt dome be contained with the upmost caution for the wellbeing of the public. As such Revision 2 reflects these requested changes with preliminary details of the additional weirs, pumping station, and infrastructure.

4.1 IMPACT ZONE

The impact zone was identified in the Lonquist “Surface Expression Impact Zone Estimate” document updated November 2, 2023. See Figure 4 page 6 of 41 of indicated document. The initial impact zone has been identified to have a diameter of 678 feet with the epicenter located 488 feet due west of Well 7B. The final impact zone is indicated to have a diameter of 1841 feet. See following Figure 1 and drawings SK-APP1-02.02 through SK-APP1-03.02 that indicated both impact zones in the Appendix.

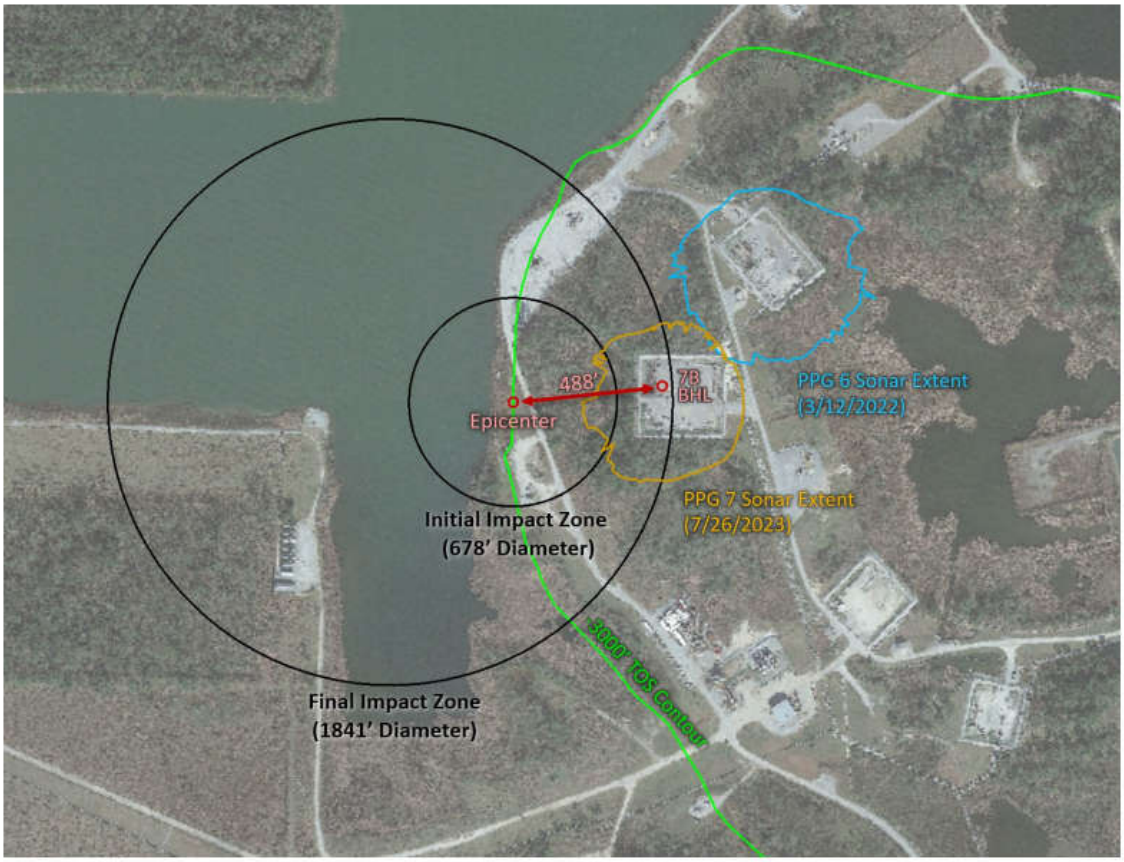


Figure 1 – Impact Zone Diagram (Obtained from Lonquist document dated 11/2/2023)

4.2 LEVEE SYSTEM LAYOUT

Using the indicated impact zones as the starting point, the levee was positioned along the high bank line of Salt Lake. Slight adjustments were made at the southwest side of Salt Lake due to a lower elevation of the high bank line. Preliminary investigations of the elevations along Salt Lake bank yielded a typical elevation near 14.0 feet with the water elevation at 11.0 feet MSL. In addition to the Salt Lake levee, a Well levee was routed around Well No. 7, and a Dome levee encompasses all known well sites to complete the Levee System. The proposed levee layout incorporates an approximate 313 acres for the Salt Lake, and 166 acres within the Dome Levee.

4.3 RECEIVING STREAMS

Two stormwater receiving streams have been identified at the Brine Field site as shown in Figure 2. One is the Bayou Choupique drainage lateral located on the south side of the property. It receives stormwater runoff that originates from the west side of the property. The other receiving stream is Bayou D'Inde drainage lateral that enters the east side of the property at about the midpoint of the facility and receives stormwater from the east side of the property.

Three weir drainage structures are planned around the Salt Lake Levee. Weir Structure 1 located on the West side and Weir Structure 2 in the Southwest corner will both discharge to

the Bayou Choupique drainage lateral. The third weir structure (Weir Structure 3) will be located on the east side of Salt Lake at a current drainage culvert that is located about mid-way along the Northeast Pond's east bank. This culvert currently discharges runoff to the ponds located east of the Brine site and then to a Bayou D'Inde drainage ditch.

A fourth drainage weir (Weir Structure 4) will be located in the Well Levee. This drainage structure will drain runoff collected between the existing Salt Lake high bank and Well Levee around the No.7 Brine Well pad and discharge to Central Pond. Weir Structures 5 and 6 located on the Southeast corner of the Dome Levee will discharge directly into the Bayou D'Inde Drainage Lateral.

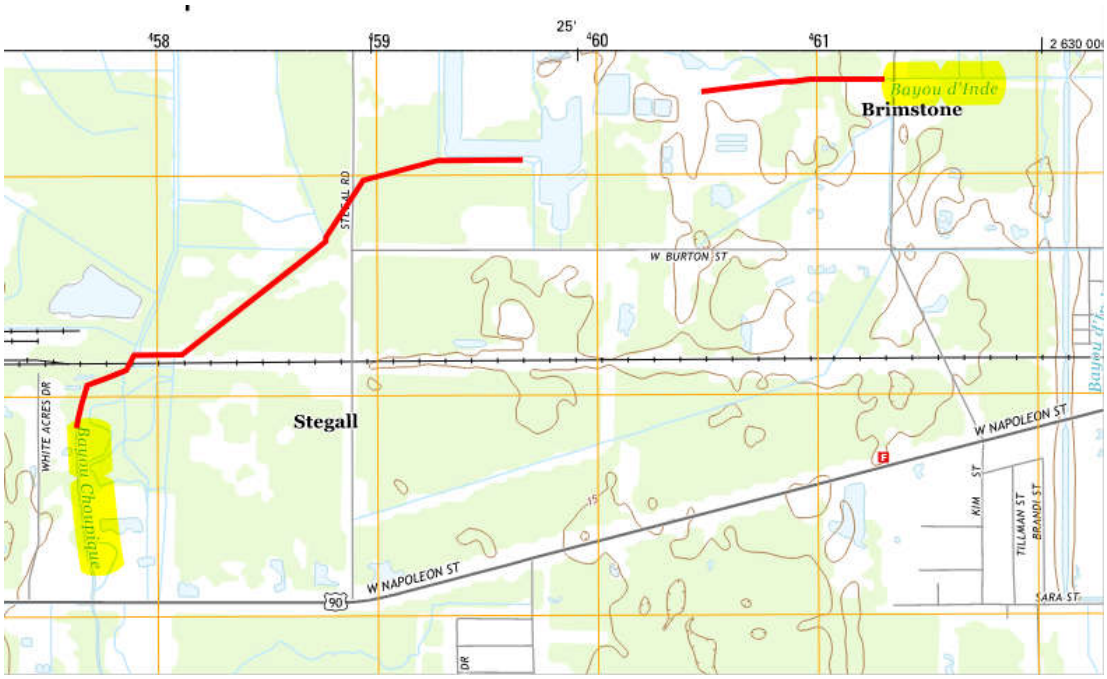


Figure 2 – Topographic Map Indicating Two Receiving Streams

4.4 TOP ELEVATION OF LEVEE SYSTEM

The water elevation in Salt Lake fluctuates depending on the amount of rainfall, but typically ranges from 11 to 12 feet MSL. The ground level varies across the site from 8 to 17 feet averaging between 12 and 13 feet. The high bank line around Salt Lake is typically around 14.0 feet (MSL).

The Sulphur Dome site is located outside of FEMA indicated flood zones and is designated Zone X, which indicates the site is not in a flood zone.

Based on the typical high bank line elevation around Salt Lake of 14.0 feet, the top of levee was set at a minimum elevation of 14.5 feet. This elevation would allow 3.5 feet of freeboard above Salt Lake's normal water surface elevation of 11.0 feet.

Several rainfall frequency estimates were considered to determine potential water level amounts at times the weirs are closed. It was determined that maintaining 3.5 feet of freeboard should not overtop the levee for most rainfall events. Example: A 500 Year storm event having

a 60-day duration would produce 40.6 inches of rainfall, which is less than the 42 inches of freeboard. Rainfall amounts were obtained from NOAA Atlas 14 Volume 9 Version 2. Information is included in Appendix, page 21.

4.5 LEVEE CONFIGURATION

The top of the levee will be set at approximately 3.5 feet above the Salt Lake surface elevation of 11.0 feet. The levee top will be the access road for the containment system and will be 14 to 16 feet wide to provide mobility for vehicles and equipment. The top will be surfaced with crushed aggregate placed on top of a geotextile fabric. Side slopes of the fill material will be 2 on 1. The total base width of the levee will vary depending on the existing ground elevations but can approach a width of 40 feet. See levee detail in appendix drawing SK-APP1-07.02.

4.6 LEVEE SYSTEM CONSTRUCTION MATERIALS

Clay soil material has been selected as the main levee construction material due to its low permeability properties and reliability over long durations. The following table includes the preliminary materials and quantities for the construction of the Levee System.

Major Construction Materials and Supplies

ITEM	APPROXIMATE QUANTITY
Clay Soil Material	16,650 cubic yards
Geotextile Fabric	15,000 feet at 10 feet wide
Aggregate	4,500 cubic yards
Weir Structures	4 major and 2 minor (6 total)
Grass Seeding	50 acres
Pump Station 2000 gpm	1 Unit
Pump Station 1000 gpm	1 Unit
Cable Tray and Power Feed	5700 feet
12” Dia. HDPE Pipe	3350 feet
10” Dia. HDPE Pipe	2350 feet

4.7 LEVEE SYSTEM ENGINEERING AND CONSTRUCTION

The outlined levee system on drawing SK-APP1-02.02 will be designed and installed proactively to contain the potential release of hydrocarbons and brackish water into the downstream drainage laterals. New drainage ditches around the perimeter of the Salt Lake will be constructed diverting current surface drainage outside directly to Bayou Choupique.

Four weirs are planned to control the Salt Lake level at 11 feet; providing the necessary freeboard for the potential No.7 expression. These locations will be equipped with salinity monitors and lighting for routine monitoring of the containment structure's stormwater discharge. The Salt Lake and Dome pump structures and foundations (Pump Station 1 and 2) as shown on drawing SK-APP1-05.02 will be installed with the levee system.

Final engineering and design will begin after DENR approval of the levee system outlined in this document and drawings. Engineering duration is dependent upon geotechnical information of the area soils as well as an area drainage/topography survey. Geotechnical results will impact levee design determining the required materials of construction while the area drainage survey will aid in defining culvert, weir, and pumping station locations. Proactive efforts are being made to expediate the receipt of the necessary geotechnical and survey data. Contacts and details are being prepared currently for these activities to begin work within the middle of 2024.

The following preliminary construction durations are highly dependent on weather conditions. As information becomes available during detail design, construction activities will be evaluated for opportunities to work concurrently to expedite construction reducing overall project duration. A total duration of approximately 13 months is estimated with project completion by Q3 2025. Installation of the levee system is estimated with the following durations:

- Engineering and Design – Complete in Q4 2024
  - Survey – efforts started Q1 2024, estimated completion end of Q2 2024
  - Geotechnical – levee areas prioritized estimated completion end of Q2 2024 remaining areas to follow Q3 2024
  - Evaluate and design based on survey and geotechnical data Q3-Q4 2024
  - Submit deliverables for construction Q4 2024
- Permitting
  - USACE Wetlands Permit
  - DEQ Stormwater Discharge Permit
  - Landowner permissions
- Clearing and Drainage – Start end of Q2 beginning of Q3 (Estimated duration 5 months)
  - Clearing to begin once proper permits/permissions obtained
  - Drainage improvements to follow upon receipt of topography data
- Weir Installation – Start early Q4 2024 (Estimated duration 6 months)
  - Weir locations to be finalized with topography data
- Levee System – Start late Q4 2024 (Estimated duration 6 months)
  - The Southern and Eastern sides of the containment will be prioritized due to the proximity to residentials areas.
  - Weir locations to be determined prior to beginning levee construction
- Pump Stations – Start early Q1 2025 (Duration 7 months)
  - Infrastructure construction
- Water Treatment Area Development – Start mid Q1 2025 (Duration 1 month)

5.0 WATER CONTROL AND TREATMENT PLAN

In the event of a surface expression of the No.7B Brine Well all surface water at the expression site should be contained to prevent offsite freshwater contamination. Preliminary engineering and design development will be performed for the pumps and water treatment equipment during the levee system engineering and design. Additional details of the proposed water control and treatment are as follows.

5.1 WATER LEVEL CONTROL

Microseismic and subsidence monitoring serve as early indicators of the potential onset of a No.7 surface expression. All levee weir structures are to be closed following any indication of anomalous seismicity or subsidence to prevent the release of any contaminants or brackish water. After seismic and subsidence has ceased, and it is deemed safe to assess damage the following will be implemented.

Inspection of the levees, weirs and pump structures will be performed, and plans established for repairs and/or modifications will be implemented as deemed necessary. Efforts to minimize environmental impacts will be implemented. This will include the capture of surface hydrocarbons and water sampling to determine the appropriate water treatment equipment.

Temporary water treatment equipment and pumps will be utilized to treat and maintain the water levels inside the containment levees until such time as a permanent solution can be installed. A combination of water treatment for solution brine mining and surface drainage discharge will be utilized. To discharge in the bayous the water will need to be treated for hydrocarbons, sludge, and salinity levels. If used for brine mining the water will need to be treated so that it has no negative effects on chlorine manufacturing equipment.

5.2 WATER TREATMENT

Future requirements for long-term water treatment and usage plans will be designed and developed. Water samples will be acquired at the appropriate surface expression location(s) to determine treatment needs. Westlake will work with knowledgeable water treatment experts to determine the appropriate treatment process(es) as outlined in the “Sulphur Brine Field Alternate Water Source” document submitted to the Louisiana Department of Natural Resources Office of Conservation in response to Order 5.a of the Third Supplement to Compliance Order No. IMD 2005-027. Preliminary calculations show the need to treat approximately 3,000 gpm based on containment size and sizeable rainfall events. Treatment equipment will be designed for a combination of on-site solution mining use as well as discharge to the local drainage system if required. Site infrastructure will be evaluated for potential future needs along with preliminary layouts of temporary and/or permanent process equipment locations.

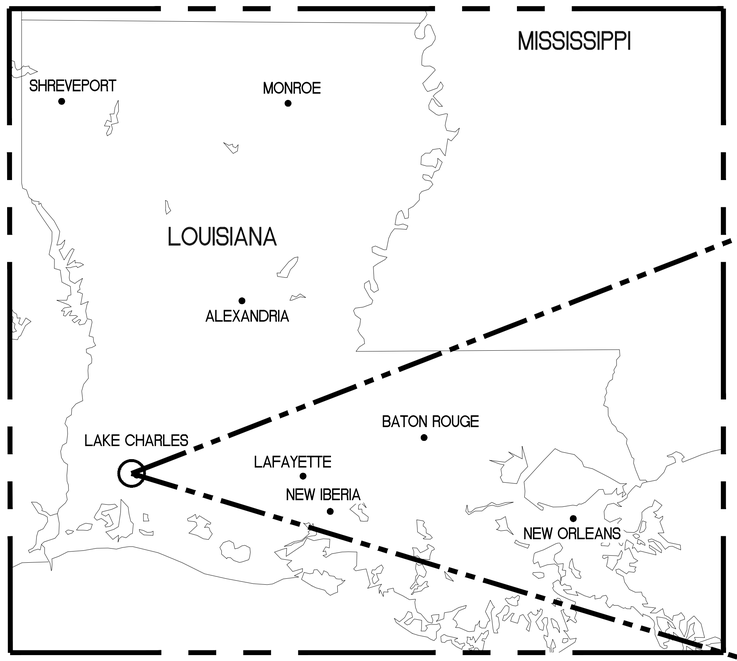
APPENDIX

WESTLAKE US2, LLC

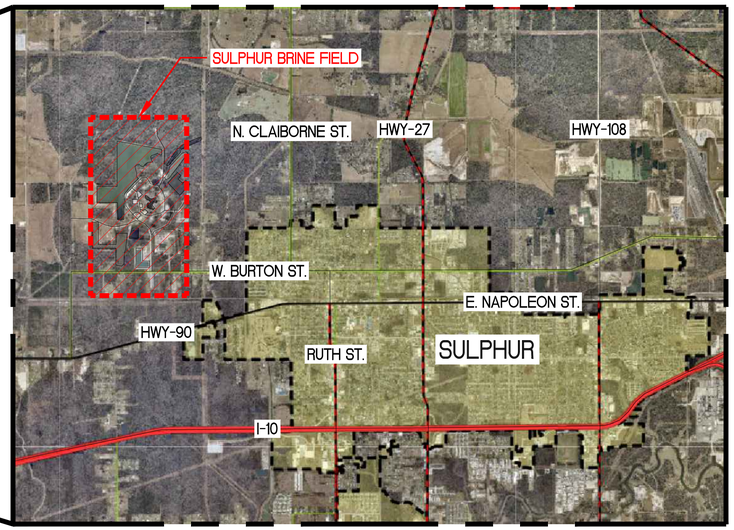
CALCASIEU PARISH, LOUISIANA

SULPHUR BRINE FIELD

LEVEE SYSTEM REV. 2 (APRIL 19, 2024)



STATE MAP
SCALE: N.T.S.



VICINITY MAP
SCALE: N.T.S.

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GLEN A. BOAZ
REG. No. 29016
REGISTERED PROFESSIONAL ENGINEER IN CIVIL ENGINEERING
4-19-24

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Westlake

North American Chlor-Alkali & Derivatives ™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
COVER SHEET

DRAWN BY B. WHITTINGTON DATE 4/2024 SCALE AS SHOWN
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APPROVED BY _____ DATE _____ SHEET 1 OF 10
DWG. SK-APP1-01.02

FORM NO. 32A10808

LEVEE SYSTEM SITE PLAN
SCALE: N.T.S.

NOTES:

1. LEVEE SYSTEM TO BE BUILT SURROUNDING EXTERIOR SALT LAKE, CENTRAL POND, AND BRINE WELLS OPERATING AREA.
2. SIX DRAINAGE WEIRS ARE TO BE CONSTRUCTED AROUND THE SALT LAKE. THEY WILL BE LOCATED ON THE WEST SIDE, SOUTHWEST SIDE, NORTHEAST SIDE, SOUTHEAST SIDE, EAST SIDE OF WELL LEVEE, AND THE EAST SIDE OF DOME LEVEE.
3. PUMPS WILL BE INSTALLED SOUTH OF THE SALT LAKE AND THE EAST SIDE OF DOME LEVEE.

LEGEND:

- SALT LAKE, DOME, AND WELL LEVEES
- IMPACT ZONE ESTIMATE
- ** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023
- DRAINAGE DITCHES
- WATER PIPE
- CABLE TRAY
- PUMP STRUCTURES

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
SITE PLAN

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FORM NO. 32A10808

LEVEE SYSTEM PLAN
SCALE: 1" = 300'

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NOTES:

1. SIX WEIR STRUCTURES ARE TO BE CONSTRUCTED TO CONTROL POND WATER ELEVATION FOR RAINFALL EVENTS.
2. STRUCTURES 1 & 2 DISCHARGE TO BAYOU CHOUPIQUE. WEIR STRUCTURES 3, 4, 5, & 6 DISCHARGE TO BAYOU D'INDE.

LEVEE SYSTEM NOTES:

APPROX. AREA WITHIN SALT LAKE LEVEE: 313 ACRES

APPROX. LENGTH OF SALT LAKE LEVEE: 17,479'

APPROX. LENGTH OF WELL LEVEE: 1,932'

APPROX. AREA OF DOME LEVEE: 166.3 ACRES

APPROX. LENGTH OF DOME LEVEE: 6,322'

APPROX. AREA TO BE CLEARED FOR LEVEE: 6.5 ACRES

LEGEND:

- SALT LAKE, DOME, AND WELL LEVEES
- IMPACT ZONE ESTIMATE
- ** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023
- DRAINAGE DITCHES
- WATER PIPE
- CABLE TRAY
- PUMP STRUCTURES

STATE OF LOUISIANA
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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
LEVEE SYSTEM PLAN

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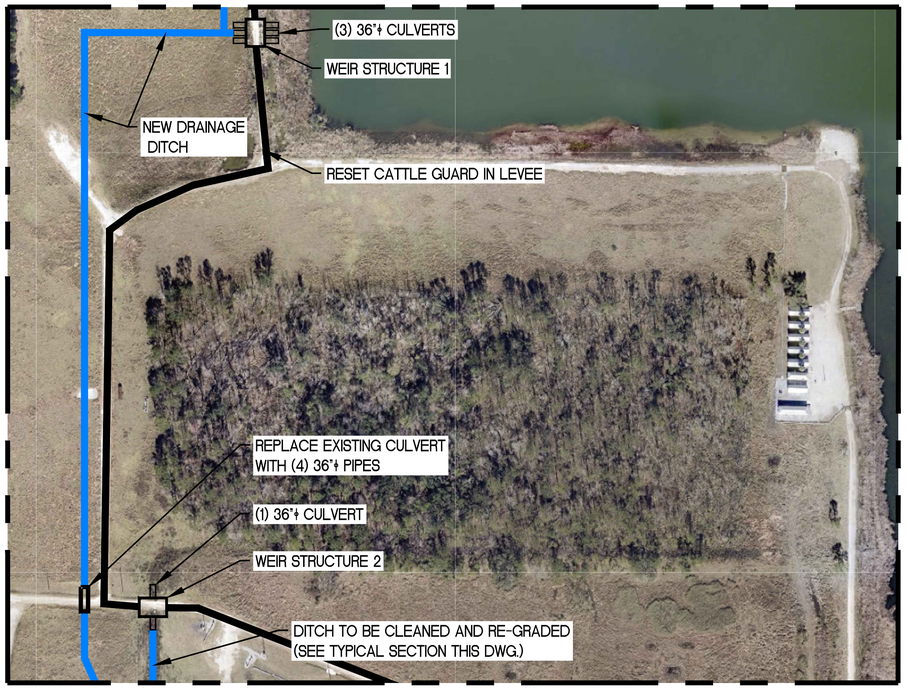

WEIR STRUCTURE 1 & 2
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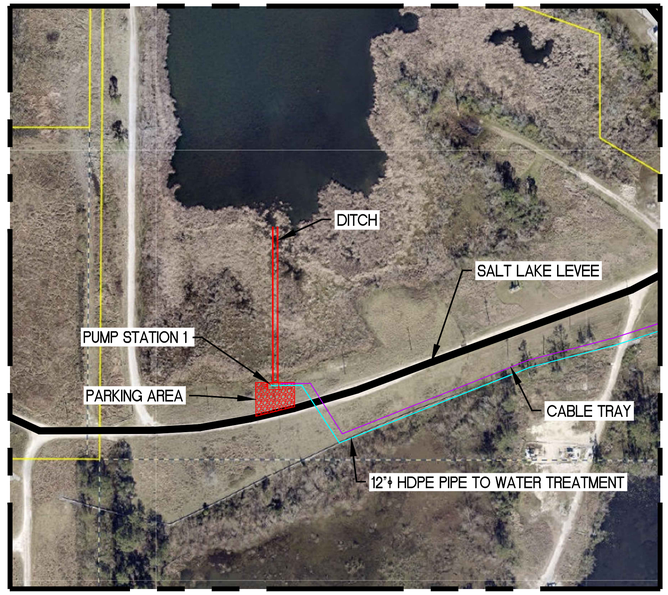

PUMP STATION 1
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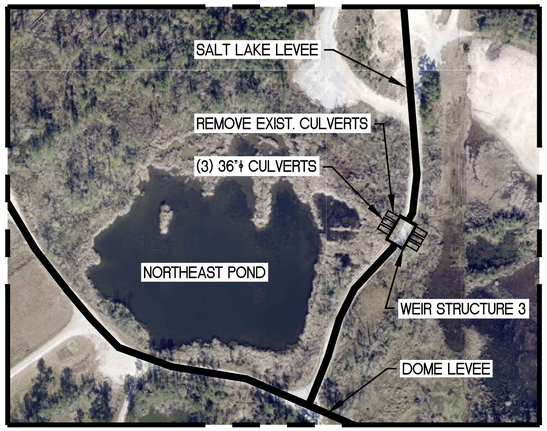

WEIR STRUCTURE 3
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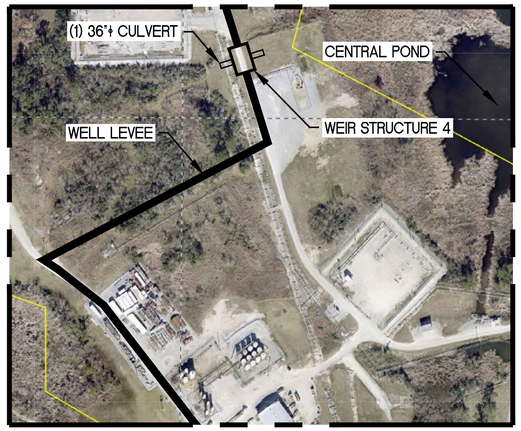

WEIR STRUCTURE 4
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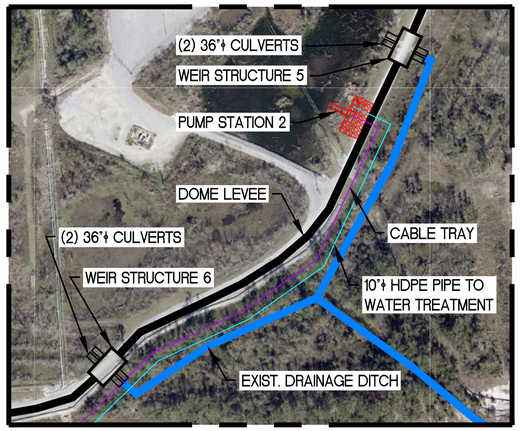
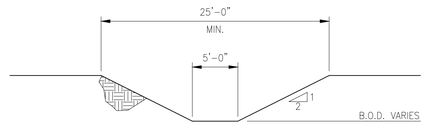


WEIR STRUCTURE 5, 6, & PUMP STATION 2
SCALE: 1" = 150'



SECTION

DRAINAGE DITCH
SCALE: 1/8" = 1'-0"

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
WEIR STRUCTURE AND PUMP PLANS

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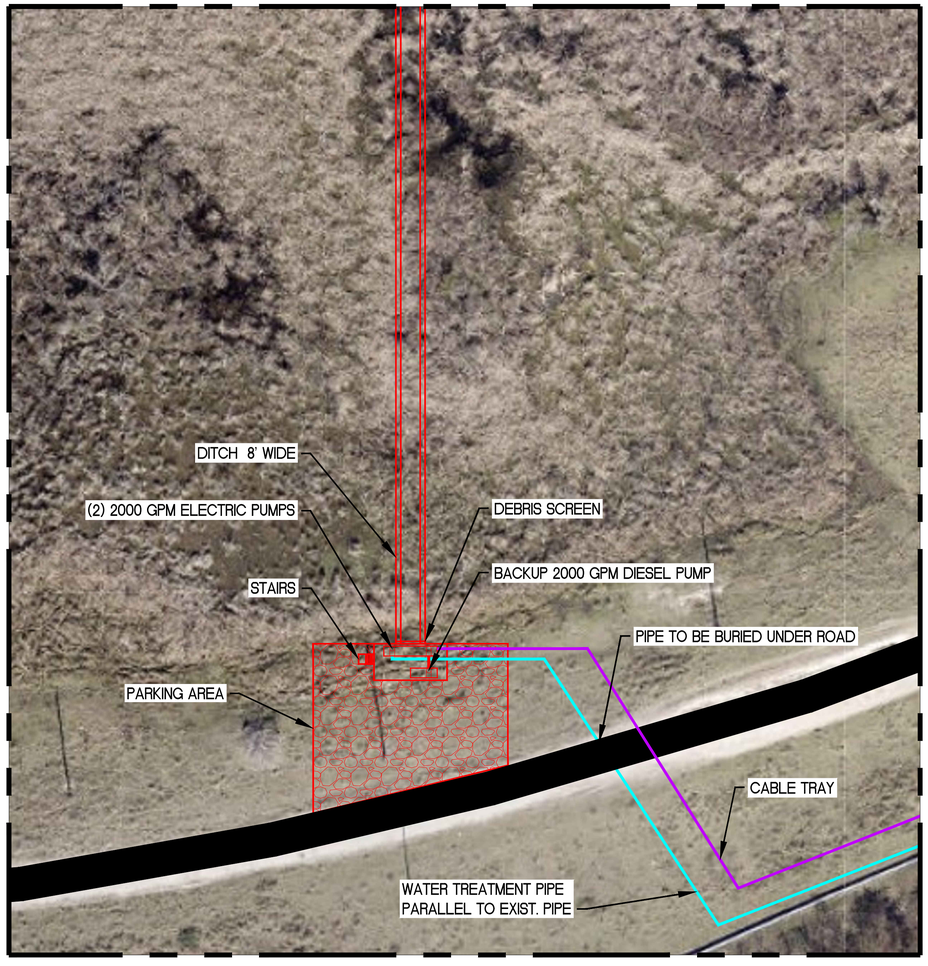
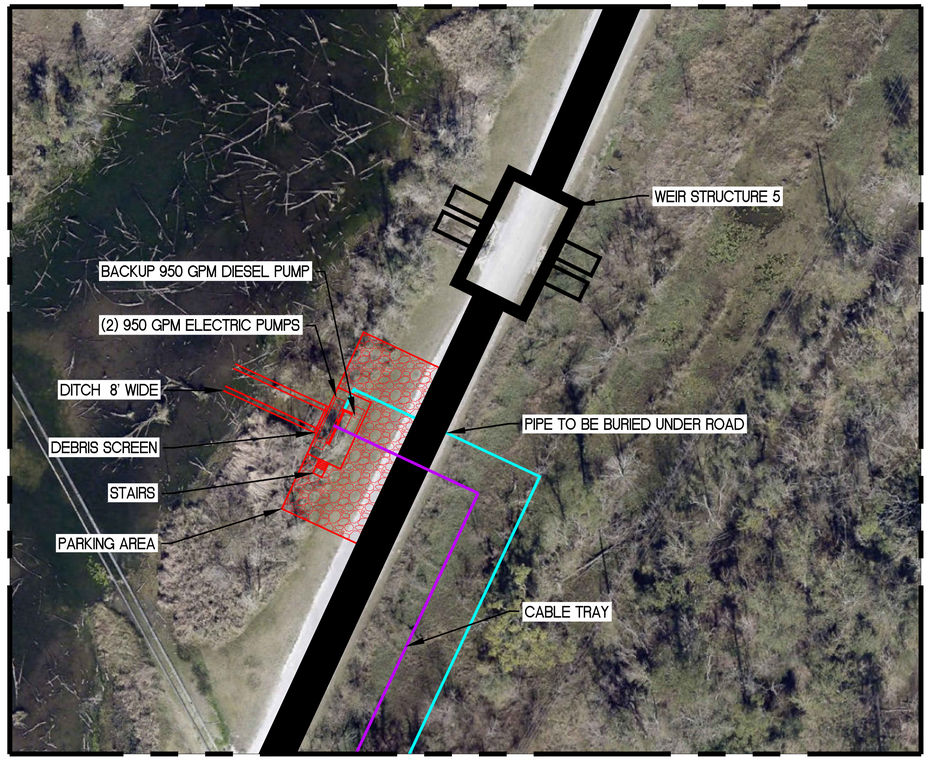


PUMP STATION 1 ENLARGED PLAN
SCALE: 1" = 30'



PUMP STATION 2 ENLARGED PLAN
SCALE: 1" = 30'

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SULPHUR BRINE FIELD — CIVIL
PUMP STATION 1 & 2
ENLARGED PLAN

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WATER TREATMENT STATION ENLARGED PLAN
SCALE: 1" = 50'

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SULPHUR BRINE FIELD — CIVIL
PROPOSED WATER TREATMENT STATION
ENLARGED PLAN

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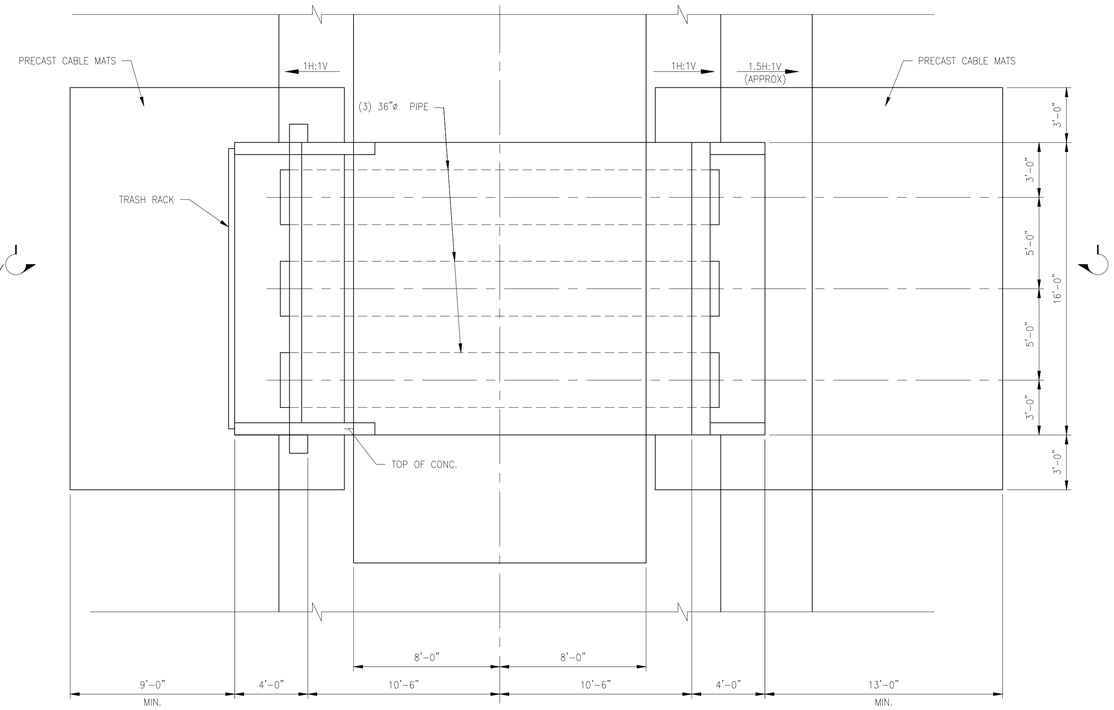
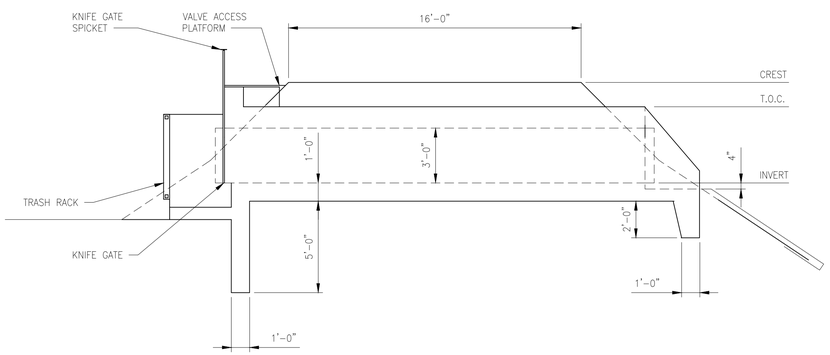


TYPICAL WEIR STRUCTURE PLAN
SCALE: 1/4" = 1'-0"



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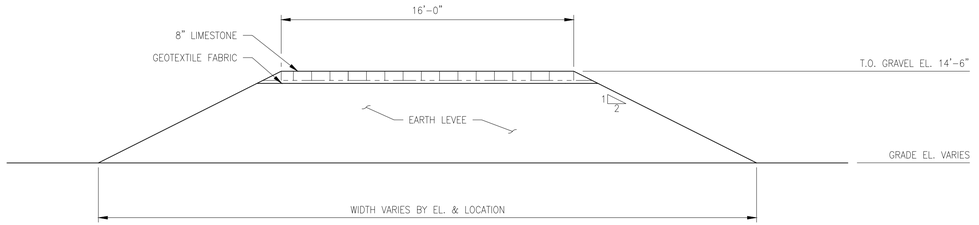

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TYPICAL LEVEE DETAIL
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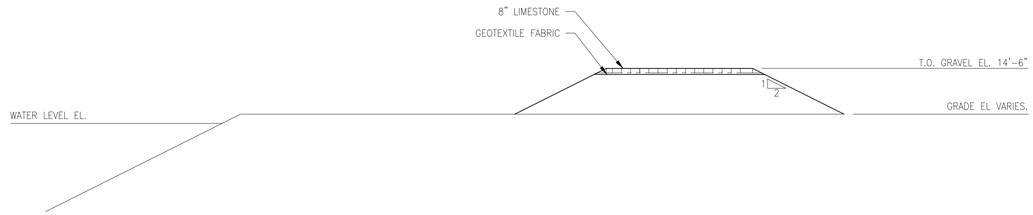

SECTION

TYPICAL LEVEE DETAIL
SCALE: 1/8" = 1'-0"

REVISIONS

ISSUED: 3/11/2024
FOR: RECORD
BULLETIN NO.:

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STATE OF LOUISIANA
GLEN A. BOAZ
REG. No. 29016
REGISTERED PROFESSIONAL ENGINEER IN CIVIL ENGINEERING
4-19-24

DATE: 4/2024

ISSUE FOR RECORD

RECON Management • Engineering Inspection
SULPHUR, LA.
PLOTTED: 4/19/2024 11:10 AM
JOB NO: 23261173
FILE SK-APP1-07.DWG
APPROVED:

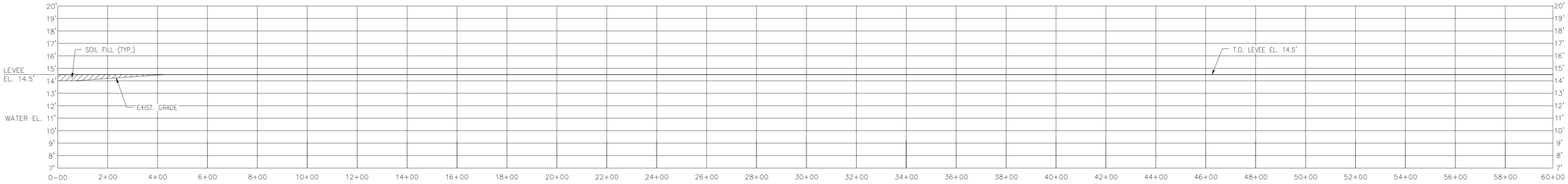
Westlake

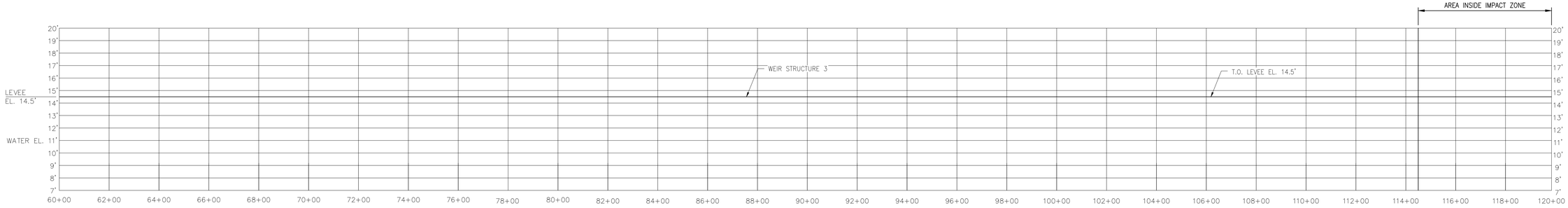
North American Chlor-Alkali & Derivatives ™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

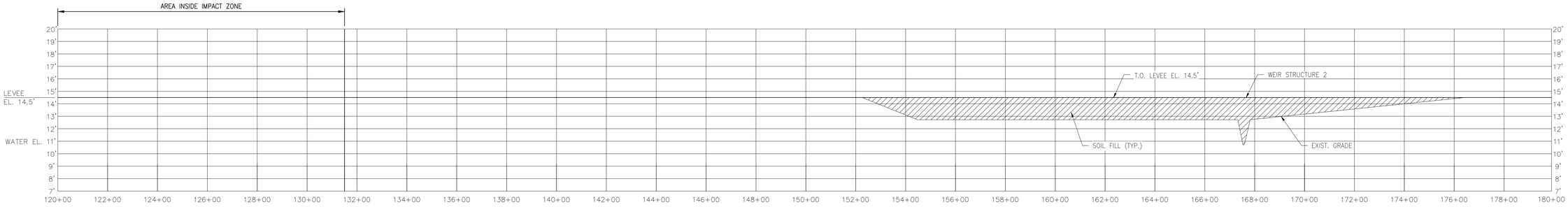
SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
LEVEE AND WEIR STRUCTURE DETAILS

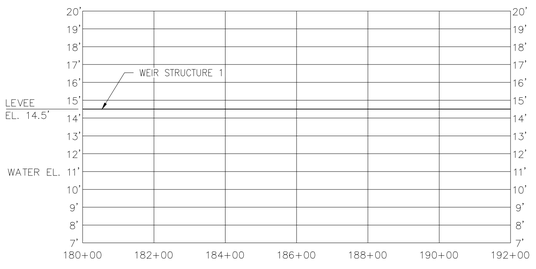
DRAWN BY B.WHITTINGTON DATE 4/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE
APPROVED BY DATE SHEET 7 OF 10
DWG. SK-APP1-07.02

FORM NO. 32A10808









SALT LAKE LEVEE PROFILE

SCALE:
HORIZONTAL: 1" = 200'
VERTICAL: 1" = 4'

STATE OF LOUISIANA
GLEN A. BOAZ
REG. No. 29016
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING
4-19-24

DATE: 04/2024

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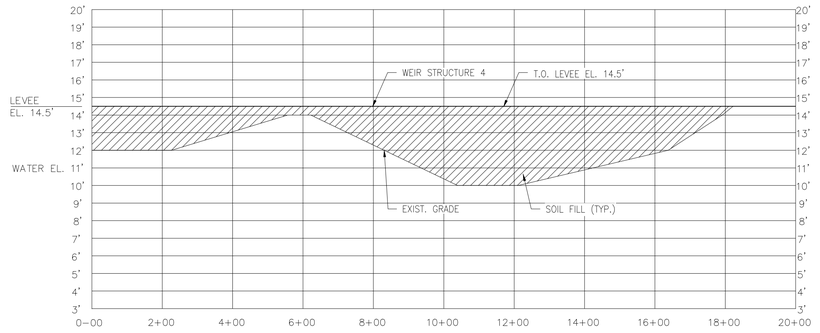
North American Chlor-Alkali & Derivatives™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

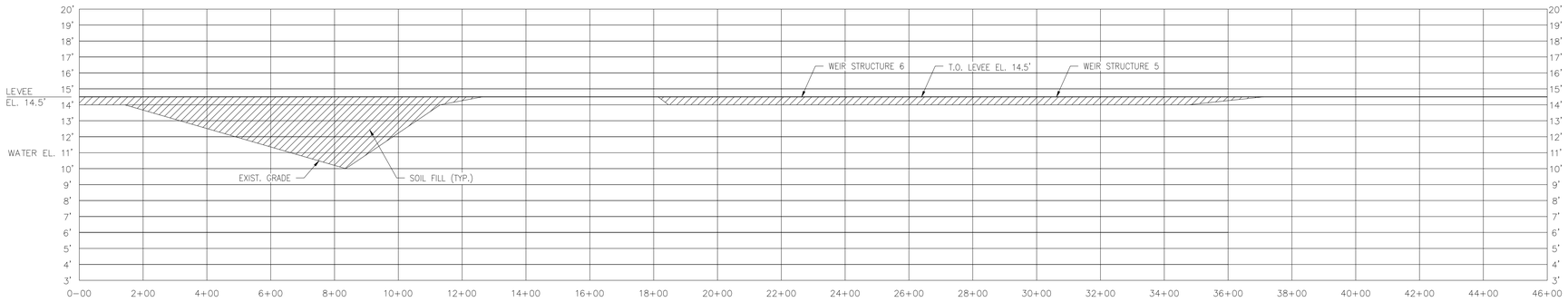
SULPHUR BRINE FIELD — CIVIL
SALT LAKE HIGH BANK LEVEE
PROFILE

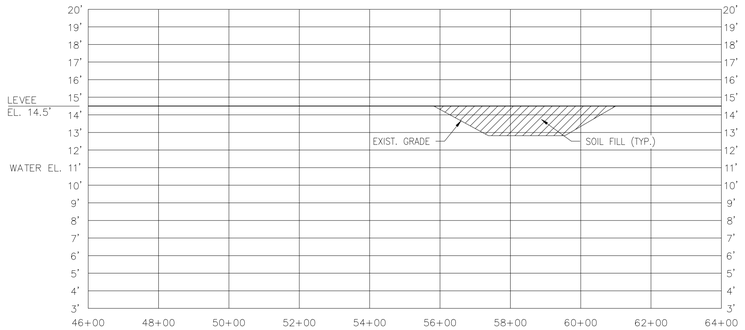
DRAWN BY DATE 4/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE
APPROVED BY DATE SHEET 8 OF 10
DWG. SK-APP1-08.02

FORM NO. 32A10808



WELL LEVEE PROFILE





DOME LEVEE PROFILE

SCALE:
HORIZONTAL: 1" = 200'
VERTICAL: 1" = 4'

STATE OF LOUISIANA
GLEN A. BOAZ
REG. No. 29016
REGISTERED PROFESSIONAL ENGINEER IN CIVIL ENGINEERING
4-19-24

DATE: 4/2024

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JOB NO.:
FILE: SK-APP1-09.DWG
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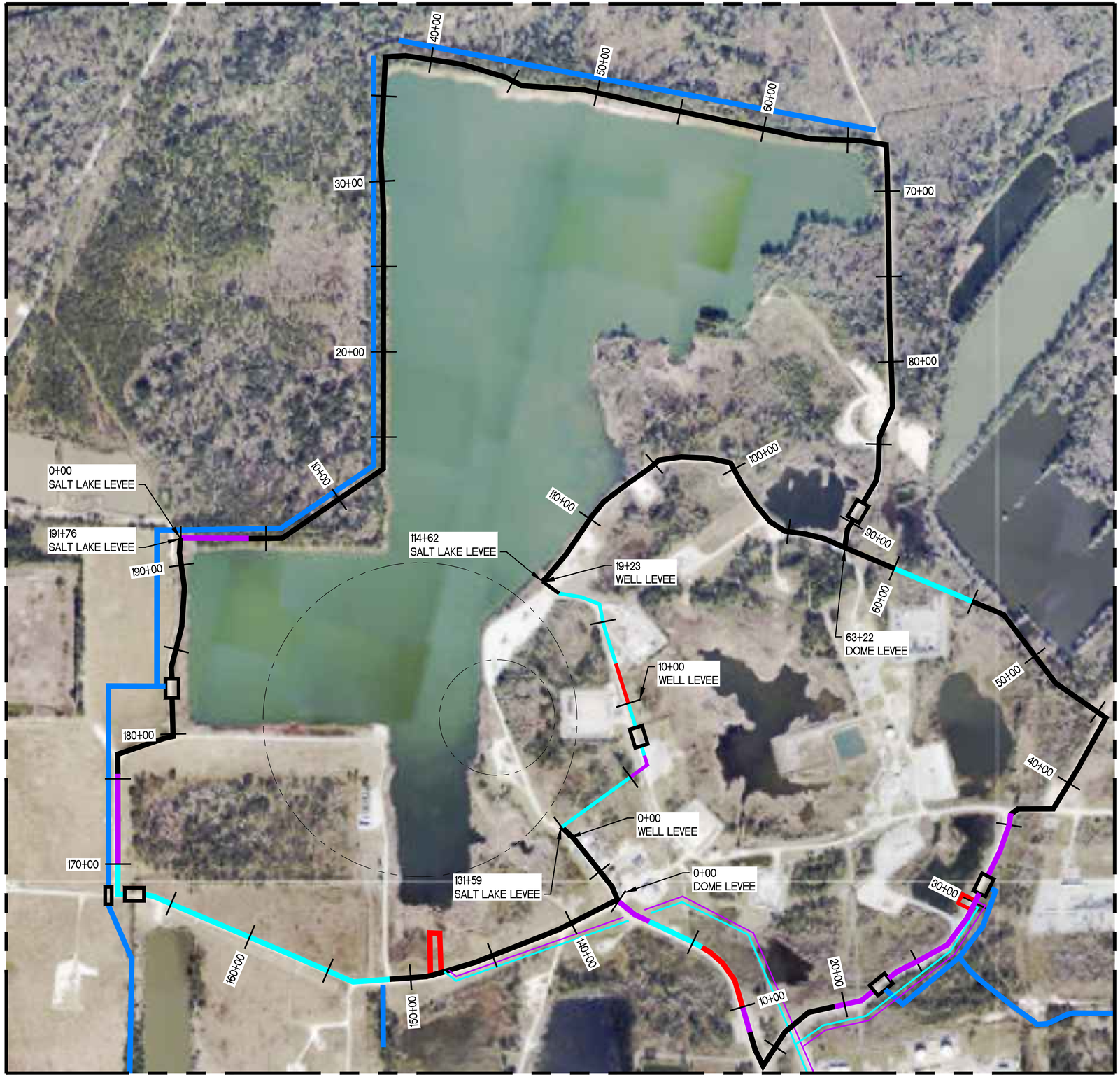
North American Chlor-Alkali & Derivatives ™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

SULPHUR BRINE FIELD — CIVIL
DOME AND WELL LEVEE PROFILES

DRAWN BY _____ DATE 4/2024 SCALE AS SHOWN
CHECKED BY _____ DATE _____ CHARGE _____
APPROVED BY _____ DATE _____ SHEET 9 OF 10
DWG. SK-APP1-09.02

FORM NO. 32410808



LEVEE SYSTEM FILL SCHEMATIC
SCALE: 1" = 300'

N

REVISIONS

ISSUED: CONST.
FOR: CONST.
BULLETIN NO.: CONST.

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED.

LEVEE SYSTEM NOTES:

APPROX. AREA WITHIN SALT LAKE LEVEE: 293.8 ACRES
APPROX. LENGTH OF SALT LAKE LEVEE: 19,176'
APPROX. AREA OF WELL LEVEE: 19.3 ACRES
APPROX. LENGTH OF WELL LEVEE: 1,923'
APPROX. AREA OF DOME LEVEE: 166.3 ACRES
APPROX. LENGTH OF DOME LEVEE: 6,322'
APPROX. AREA TO BE CLEARED FOR LEVEE: 6.5 ACRES

LEGEND:

- LEVEES
- IMPACT ZONE ESTIMATE FROM LONQUIST
- STATIONS EVERY 500'
- 0-1' FILL
- 1'-3' FILL
- 3'-6' FILL

STATE OF LOUISIANA
GLEN A. BOAZ
REG. No. 29016
REGISTERED PROFESSIONAL ENGINEER IN CIVIL ENGINEERING
4-19-24

DATE: 4/2024

ISSUE FOR RECORD

RECON Management • Engineering Inspection
SULPHUR, LA.
APPROVED:
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Westlake

North American Chlor-Alkali & Derivatives ™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
FILL SCHEMATIC

DRAWN BY ____ DATE 4/2024 SCALE AS SHOWN
CHECKED BY ____ DATE ____ CHARGE ____
APPROVED BY ____ DATE ____ SHEET 10 OF 10
DWG. SK-APP1-10.01

FORM NO. 32A10806

NOAA Atlas 14, Volume 9, Version 2
Location name: Sulphur, Louisiana, USA*
Latitude: 30.2556°, Longitude: -93.413°
Elevation: 6 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

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.567** (0.456-0.716)	**0.646** (0.519-0.817)	**0.776** (0.621-0.983)	**0.883** (0.703-1.12)	**1.03** (0.792-1.35)	**1.14** (0.860-1.52)	**1.25** (0.913-1.72)	**1.36** (0.957-1.93)	**1.51** (1.02-2.20)	**1.62** (1.07-2.41)
10-min	**0.830** (0.667-1.05)	**0.947** (0.760-1.20)	**1.14** (0.909-1.44)	**1.29** (1.03-1.65)	**1.51** (1.16-1.98)	**1.67** (1.26-2.23)	**1.83** (1.34-2.51)	**2.00** (1.40-2.82)	**2.21** (1.50-3.22)	**2.37** (1.57-3.52)
15-min	**1.01** (0.814-1.28)	**1.15** (0.927-1.46)	**1.39** (1.11-1.76)	**1.58** (1.26-2.01)	**1.84** (1.41-2.41)	**2.04** (1.54-2.72)	**2.23** (1.63-3.06)	**2.43** (1.71-3.44)	**2.70** (1.82-3.93)	**2.89** (1.91-4.30)
30-min	**1.48** (1.19-1.86)	**1.70** (1.36-2.15)	**2.06** (1.65-2.61)	**2.35** (1.87-3.00)	**2.75** (2.12-3.61)	**3.06** (2.30-4.08)	**3.36** (2.45-4.61)	**3.66** (2.57-5.17)	**4.06** (2.74-5.91)	**4.35** (2.88-6.47)
60-min	**1.97** (1.58-2.49)	**2.27** (1.82-2.86)	**2.76** (2.21-3.50)	**3.20** (2.54-4.07)	**3.82** (2.96-5.06)	**4.32** (3.27-5.80)	**4.84** (3.54-6.68)	**5.38** (3.79-7.65)	**6.13** (4.16-8.98)	**6.72** (4.44-9.98)
2-hr	**2.47** (1.99-3.10)	**2.83** (2.29-3.56)	**3.47** (2.79-4.37)	**4.04** (3.23-5.11)	**4.88** (3.81-6.46)	**5.58** (4.25-7.48)	**6.31** (4.66-8.69)	**7.10** (5.04-10.1)	**8.21** (5.61-12.0)	**9.09** (6.04-13.4)
3-hr	**2.79** (2.26-3.49)	**3.20** (2.59-4.01)	**3.95** (3.18-4.95)	**4.63** (3.72-5.84)	**5.69** (4.48-7.54)	**6.58** (5.05-8.83)	**7.55** (5.60-10.4)	**8.60** (6.14-12.2)	**10.1** (6.96-14.8)	**11.3** (7.57-16.7)
6-hr	**3.38** (2.75-4.20)	**3.89** (3.16-4.83)	**4.85** (3.94-6.05)	**5.78** (4.66-7.23)	**7.23** (5.75-9.60)	**8.49** (6.57-11.4)	**9.88** (7.40-13.6)	**11.4** (8.22-16.1)	**13.7** (9.47-19.8)	**15.5** (10.4-22.6)
12-hr	**4.01** (3.28-4.94)	**4.66** (3.81-5.75)	**5.89** (4.80-7.29)	**7.08** (5.74-8.80)	**8.95** (7.16-11.8)	**10.6** (8.23-14.1)	**12.4** (9.32-16.9)	**14.4** (10.4-20.2)	**17.3** (12.1-24.9)	**19.7** (13.3-28.5)
24-hr	**4.69** (3.86-5.74)	**5.48** (4.51-6.72)	**6.98** (5.72-8.59)	**8.41** (6.86-10.4)	**10.7** (8.56-14.0)	**12.6** (9.86-16.7)	**14.7** (11.2-20.0)	**17.1** (12.5-23.9)	**20.5** (14.4-29.4)	**23.3** (15.9-33.7)
2-day	**5.43** (4.49-6.61)	**6.35** (5.25-7.74)	**8.07** (6.64-9.86)	**9.69** (7.94-11.9)	**12.2** (9.85-15.9)	**14.4** (11.3-18.9)	**16.7** (12.7-22.5)	**19.3** (14.2-26.8)	**23.1** (16.3-32.9)	**26.2** (18.0-37.5)
3-day	**5.89** (4.88-7.14)	**6.89** (5.71-8.37)	**8.74** (7.22-10.6)	**10.5** (8.60-12.8)	**13.1** (10.6-16.9)	**15.4** (12.1-20.1)	**17.8** (13.6-23.9)	**20.5** (15.1-28.3)	**24.4** (17.3-34.6)	**27.6** (19.0-39.3)
4-day	**6.24** (5.19-7.55)	**7.31** (6.07-8.85)	**9.25** (7.66-11.2)	**11.1** (9.10-13.5)	**13.8** (11.2-17.8)	**16.1** (12.7-21.0)	**18.7** (14.3-24.9)	**21.4** (15.8-29.4)	**25.4** (18.0-35.8)	**28.6** (19.7-40.6)
7-day	**7.15** (5.97-8.60)	**8.32** (6.94-10.0)	**10.4** (8.66-12.6)	**12.3** (10.2-15.0)	**15.2** (12.4-19.5)	**17.7** (14.0-22.9)	**20.4** (15.6-27.0)	**23.2** (17.2-31.7)	**27.3** (19.5-38.3)	**30.7** (21.3-43.4)
10-day	**8.00** (6.70-9.58)	**9.22** (7.71-11.1)	**11.4** (9.50-13.7)	**13.4** (11.1-16.2)	**16.3** (13.3-20.7)	**18.8** (15.0-24.2)	**21.5** (16.6-28.4)	**24.4** (18.1-33.1)	**28.5** (20.4-39.8)	**31.8** (22.1-44.8)
20-day	**10.5** (8.86-12.5)	**11.9** (10.0-14.2)	**14.3** (12.0-17.1)	**16.3** (13.6-19.6)	**19.3** (15.7-24.1)	**21.7** (17.3-27.5)	**24.2** (18.7-31.5)	**26.9** (20.0-36.0)	**30.5** (21.9-42.2)	**33.4** (23.4-46.8)
30-day	**12.6** (10.6-15.0)	**14.2** (12.0-16.8)	**16.8** (14.1-20.0)	**19.0** (15.9-22.7)	**22.0** (17.9-27.3)	**24.4** (19.5-30.7)	**26.9** (20.8-34.7)	**29.4** (21.9-39.0)	**32.7** (23.6-44.8)	**35.3** (24.8-49.2)
45-day	**15.2** (12.9-17.9)	**17.1** (14.4-20.2)	**20.1** (16.9-23.8)	**22.5** (18.9-26.8)	**25.9** (21.0-31.7)	**28.4** (22.6-35.4)	**30.9** (23.9-39.5)	**33.3** (24.9-44.0)	**36.5** (26.4-49.7)	**38.9** (27.5-54.0)
60-day	**17.4** (14.7-20.4)	**19.5** (16.5-23.0)	**23.0** (19.4-27.1)	**25.7** (21.6-30.6)	**29.4** (23.9-35.9)	**32.1** (25.7-39.9)	**34.8** (27.0-44.3)	**37.4** (27.9-49.1)	**40.6** (29.4-55.0)	**43.0** (30.4-59.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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 average recurrence interval) 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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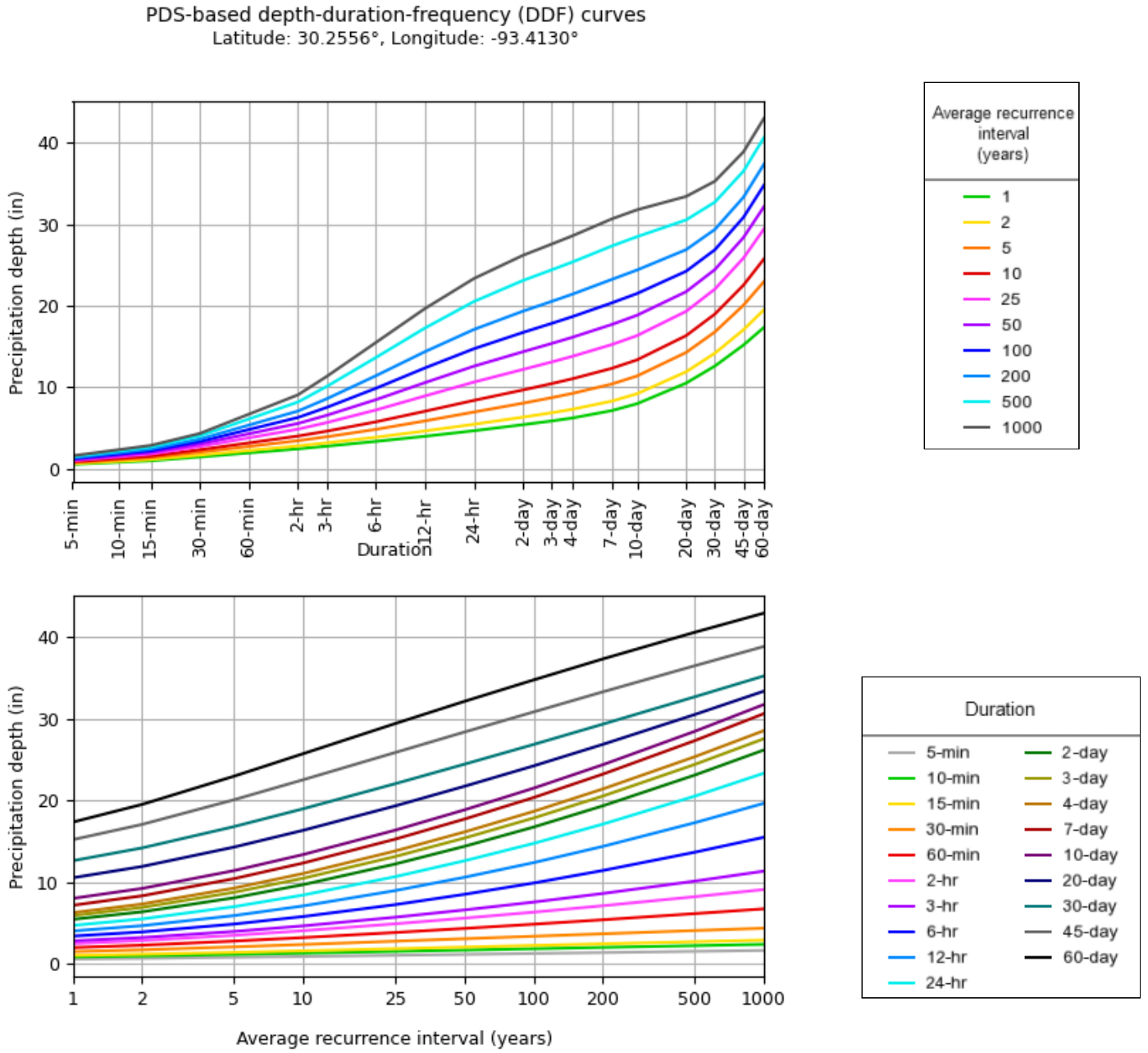
PF graphical



NOAA Atlas 14, Volume 9, Version 2

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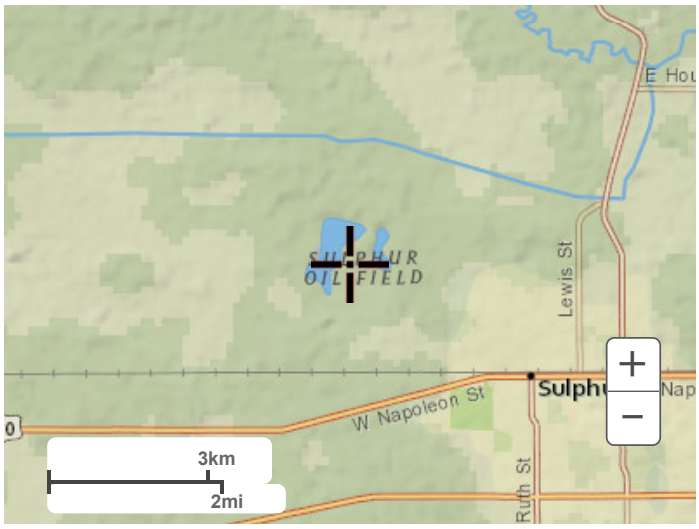
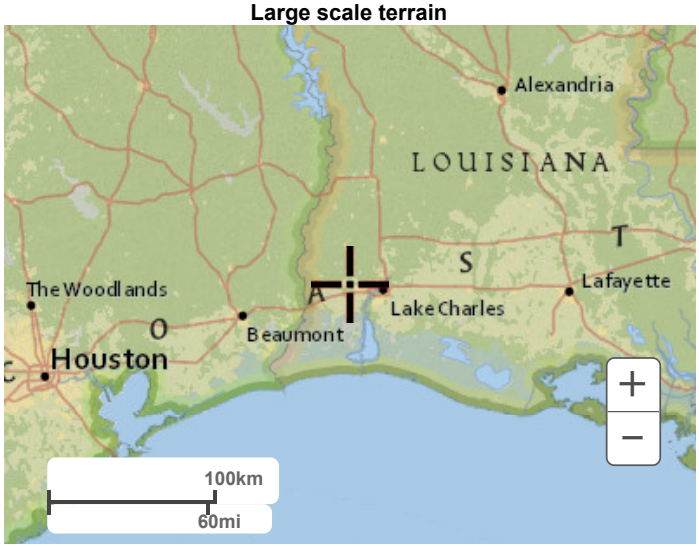
Maps & aerials

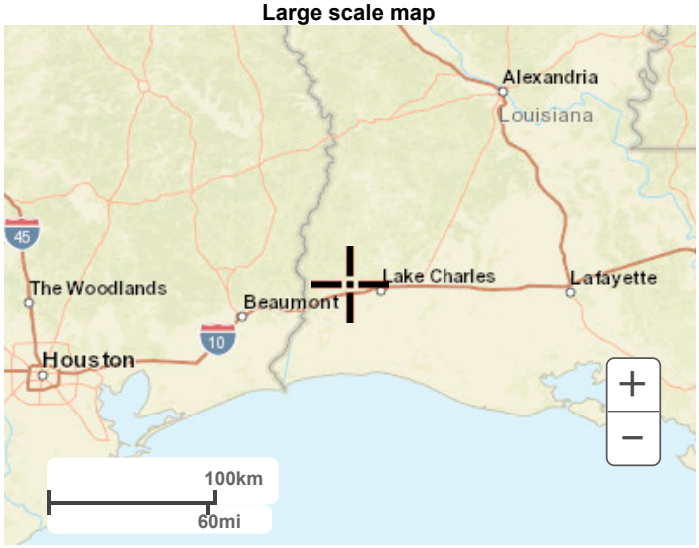
Small scale terrain



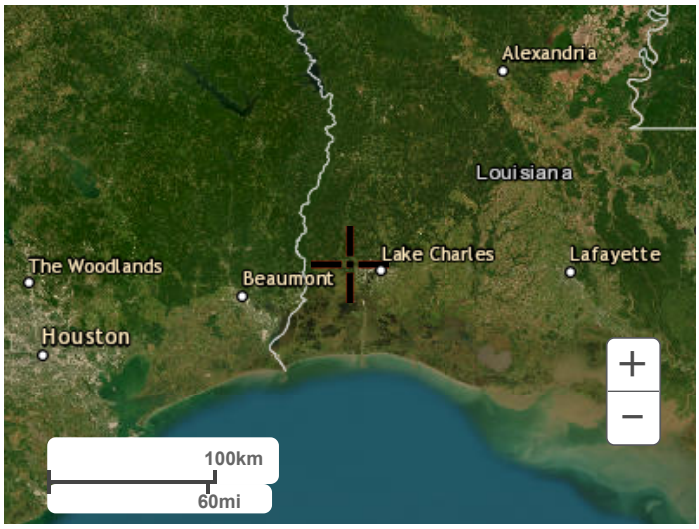
Large scale terrain



Large scale map



Large scale aerial



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National Water Center
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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