TCEQ Interoffice Memorandum

TO: Office of the Chief Clerk
Texas Commission on Environmental Quality

THRU: Chris Kozlowski, Team Leader
Water Rights Permitting Team

FROM: Hal E. Bailey, Jr., Project Manager
Water Rights Permitting Team

DATE: July 10, 2020

SUBJECT: Lavaca Navidad River Authority
WRPERM 13728
CN604423210, RN111015590
Application No. 13728 for a Water Use Permit
Texas Water Code §§ 11.121,11.042, 11.085, Requiring Mailed and Published Notice
Lavaca River, Lavaca River Basin
Jackson County

The application and fees were received on March 23, 2020. Additional information was received on June 25, 2020. The application was declared administratively complete and accepted for filing with the Office of the Chief Clerk on July 10, 2020. Published and mailed notice to water right holders of record within the Lavaca River Basin is required pursuant to Texas Administrative Code 295.151. All fees have been paid and the application is sufficient for filing.

Hal E. Bailey, Jr.

Hal E. Bailey, Jr., Project Manager
Water Rights Permitting Team
Water Rights Permitting and Availability Section

OCC Mailed Notice Required ☑ YES ☐ NO

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

July 10, 2020

Mr. Patrick Brzozowski, General Manager
Lavaca-Navidad River Authority
4631 FM 3131
Edna, Texas 77957

VIA E-MAIL

RE: Lavaca Navidad River Authority
WRPERM 13728
CN604423210, RN111015590
Application No. 13728 for a Water Use Permit
Texas Water Code §§ 11.121,11.042, 11.085, Requiring Mailed and Published Notice
Lavaca River, Lavaca River Basin
Jackson County

Dear Mr. Brzozowski:

This acknowledges receipt of additional information on June 25, 2020.

The application was declared administratively complete and filed with the Office of the Chief Clerk on July 10, 2020. Staff will continue processing the application for consideration by the Executive Director.

Please be advised that additional information may be requested during the technical review phase of the application process.

If you have any questions concerning the application, please contact me via email at hal.bailey@tceq.texas.gov or at (512) 239-4615.

Sincerely,

Hal E. Bailey, Jr.

Hal E. Bailey, Jr., Project Manager
Water Rights Permitting Team
Water Rights Permitting and Availability Section

Hal Bailey

From: Karen Gregory [redacted] >
Sent: Thursday, June 25, 2020 2:31 PM
To: Hal Bailey
Cc: Patrick Brzozowski; Bill Dugat; Michael V. Reedy
Subject: Application No. 13728 for a Water Use Permit
Attachments: Letter Hal Bailey TCEQ WR.pdf; Board Resolution TCEQ Application 2016.pdf; Notices and Certification JC.pdf; LTYEP_Conservaton_Alternatives.pdf; Technical Memorandum_ 03.01.18.pdf

Good afternoon Mr. Bailey:

On behalf of Patrick Brzozowski and in response to your correspondence dated June 3, 2020, please find attached information you have requested.

If you need additional information or have questions, please contact Patrick Brzozowski at 361 782.5229 or pbrzozowski@lnra.org.

Respectfully,

Karen Gregory
Deputy General Manager - Administration
Lavaca-Navidad River Authority
P. O. Box 429
4631 FM 3131
Edna, TX 77957
361.782.5229 office
361.781.2129 cell

LNRA LAVACA-NAVIDAD RIVER AUTHORITY — Manage Conserve Protect

Lavaca-Navidad River Authority
P.O. Box 429 Edna, Texas 77957

June 25, 2020

Hal E. Bailey, Jr., Project Manager
Water Rights Permitting Team
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

Re: Lavaca Navidad River Authority
WRPERM 13728
CN 604423210, RN111015590
Application No. 13728 for a Water Use Permit

Dear Mr. Bailey:

Enclosed is the required additional information requested per your correspondence dated June 3, 2020. Our submittal includes:

- Copy of LNRA BOD Resolution 2017-001 showing evidence that Patrick Brzozowski is authorized to sign the application, pursuant to Title 30 TAC § 295.14(5)
- Copy of the notices and certified mailing cards sent to each member of the governing body of Jackson County
- Copy of documentation supporting the applicants proposed use of water
- Copy of the Technical Memorandum covering the geotechnical investigation and preliminary engineering analysis of LNRA's proposed off-channel reservoir for use by the TCEQ Dam Safety Section

I hope the enclosed information satisfies your request. If you have questions or need additional information concerning our application, please advise.

Sincerely,

Patrick Brzozowski, P.E.
General Manager

cc: Bill Dugat, Bickerstaff Heath Delgado Acosta LLP
Mike Reedy, Freese & Nichols Inc.

Enclosures

Lavaca-Navidad River Authority
P.O. Box 429 Edna, Texas 77957

June 12, 2020

Via Certified Mail Receipt # 7011 3500 0002 3553 8980

The Honorable Jill Sklar
Jackson County Judge
115 West Main, Room 207
Edna, Texas 77957

Re: Notification of Application for Water Rights Permit

Dear Judge Sklar:

In compliance with 30 TAC § 295.42, I am sending this letter to the members of the Jackson County Commissioners Court as official notification that the Lavaca Navidad River Authority (LNRA) has submitted a water rights permit application to the Texas Commission on Environmental Quality (Commission).

LNRA's application requests the Commission to issue a water rights permit authorizing the diversion of water from the Lavaca River, the temporary storage of the diverted Lavaca River water in Lake Texana and final storage of this water in an off-channel storage reservoir. As a condition of our permit application, once LNRA has been awarded this new water right on the Lavaca River, LNRA's existing water rights on the Lavaca River including the Stage II reservoir authorization, will be canceled.

LNRA's actions today will secure the water rights necessary to provide a reliable surface water supply for use in Jackson County into the future. We look forward to working with the Court as we work towards the development of this important water resource.

I have enclosed a concept overview map for informational purposes. If you have any questions or need additional information, please call me.

Sincerely,

Patrick Brzozowski, P.E.
General Manager

Enclosure

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Sent To Judge Jill Sklar

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Judge Jill Sklar
115 W Main #207
Edna TX 77957

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Lavaca-Navidad River Authority
P.O. Box 429 Edna, Texas 77957

June 12, 2020

Via Certified Mail Receipt # 7011 3500 0002 3553 6801

The Honorable Wayne Hunt, Commissioner
Jackson County Precinct 1
c/o County Judge
115 West Main, Room 207
Edna, Texas 77957

Re: Notification of Application for Water Rights Permit

Dear Commissioner Hunt:

In compliance with 30 TAC § 295.42, I am sending this letter to the members of the Jackson County Commissioners Court as official notification that the Lavaca Navidad River Authority (LNRA) has submitted a water rights permit application to the Texas Commission on Environmental Quality (Commission).

LNRA's application requests the Commission to issue a water rights permit authorizing the diversion of water from the Lavaca River, the temporary storage of the diverted Lavaca River water in Lake Texana and final storage of this water in an off-channel storage reservoir. As a condition of our permit application, once LNRA has been awarded this new water right on the Lavaca River, LNRA's existing water rights on the Lavaca River including the Stage II reservoir authorization, will be canceled.

LNRA's actions today will secure the water rights necessary to provide a reliable surface water supply for use in Jackson County into the future. We look forward to working with the Court as we work towards the development of this important water resource.

I have enclosed a concept overview map for informational purposes. If you have any questions or need additional information, please call me.

Sincerely,

Patrick Brzozowski, P.E.
General Manager

Enclosure

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Commissioner Wayne Hunt
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Edna, TX 77957

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LAVACA · NAVIDAD RIVER AUTHORITY

Lavaca-Navidad River Authority

P.O. Box 429 Edna, Texas 77957

June 12, 2020

Via Certified Mail Receipt # 7011 3500 0002 3553 6795

The Honorable Wayne Bubela, Commissioner
Jackson County Precinct 2
c/o Jackson County Judge
115 West Main, Room 207
Edna, Texas 77957

Re: Notification of Application for Water Rights Permit

Dear Commissioner Bubela:

In compliance with 30 TAC § 295.42, I am sending this letter to the members of the Jackson County Commissioners Court as official notification that the Lavaca Navidad River Authority (LNRA) has submitted a water rights permit application to the Texas Commission on Environmental Quality (Commission).

LNRA's application requests the Commission to issue a water rights permit authorizing the diversion of water from the Lavaca River, the temporary storage of the diverted Lavaca River water in Lake Texana and final storage of this water in an off-channel storage reservoir. As a condition of our permit application, once LNRA has been awarded this new water right on the Lavaca River, LNRA's existing water rights on the Lavaca River including the Stage II reservoir authorization, will be canceled.

LNRA's actions today will secure the water rights necessary to provide a reliable surface water supply for use in Jackson County into the future. We look forward to working with the Court as we work towards the development of this important water resource.

I have enclosed a concept overview map for informational purposes. If you have any questions or need additional information, please call me.

Sincerely,

Patrick Brzozowski, P.E.
General Manager

Enclosure

(361) 782-5229 Fax: (361) 782-5310 www.lnra.org info@lnra.org

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115 W Main #207
Edna TX 77957

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X Jill S. Sklar
☐ Agent
☐ Addressee

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Lavaca-Navidad River Authority
P.O. Box 429 Edna, Texas 77957

June 12, 2020

Via Certified Mail Receipt # 7011 3500 0002 3553 6788

The Honorable Johnny E. Belicek, Commissioner
Jackson County Precinct 3
c/o Jackson County Judge
115 West Main, Room 207
Edna, Texas 77957

Re: Notification of Application for Water Rights Permit

Dear Commissioner Belicek:

In compliance with 30 TAC § 295.42, I am sending this letter to the members of the Jackson County Commissioners Court as official notification that the Lavaca Navidad River Authority (LNRA) has submitted a water rights permit application to the Texas Commission on Environmental Quality (Commission).

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Sincerely,

Patrick Brzozowski, P.E.
General Manager

Enclosure

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Sent To Commissioner Belicek
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City, State, ZIP+4 Edna TX 77957

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Commissioner Johnny Belicek
115 W Main #207
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Lavaca-Navidad River Authority
P.O. Box 429 Edna, Texas 77957

June 12, 2020

Via Certified Mail Receipt # 7011 3500 0002 3553 6757

The Honorable Dennis Karl, Commissioner
Jackson County Precinct 4
c/o Jackson County Judge
115 West Main, Room 207
Edna, Texas 77957

Re: Notification of Application for Water Rights Permit

Dear Commissioner Karl:

In compliance with 30 TAC § 295.42, I am sending this letter to the members of the Jackson County Commissioners Court as official notification that the Lavaca Navidad River Authority (LNRA) has submitted a water rights permit application to the Texas Commission on Environmental Quality (Commission).

LNRA's application requests the Commission to issue a water rights permit authorizing the diversion of water from the Lavaca River, the temporary storage of the diverted Lavaca River water in Lake Texana and final storage of this water in an off-channel storage reservoir. As a condition of our permit application, once LNRA has been awarded this new water right on the Lavaca River, LNRA's existing water rights on the Lavaca River including the Stage II reservoir authorization, will be canceled.

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I have enclosed a concept overview map for informational purposes. If you have any questions or need additional information, please call me.

Sincerely,

Patrick Brzozowski, P.E.
General Manager

Enclosure

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Sent To Commissioner Dennis Karl

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Commissioner Dennis Karl
115 W Main #207
Edna, TX 77957

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☐ Addressee

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TECHNICAL MEMORANDUM

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TO: Pat Brzozowski, P.E.

CC: Michael Reedy, P.E.

FROM: Tony Bosecker, P.E. and Shawn Hutcherson, P.E.

SUBJECT: Geotechnical Investigation and Preliminary Engineering Analysis

DATE: March 1, 2018

PROJECT: LVA17406 – Proposed Off-Channel Reservoir Due Diligence

STATE OF TEXAS
TONY BOSECKER
80158
REGISTERED
PROFESSIONAL ENGINEER

03/01/2018
Freese and Nichols, Inc.
Texas Registered Engineering
Firm F-2144

PROJECT DESCRIPTION

This technical memorandum summarizes the results of the geotechnical investigation performed for the proposed Off-Channel Reservoir (OCR) Due Diligence Study and provides preliminary engineering analysis for OCR development. This work was provided under Freese and Nichols, Inc. (FNI) project number LVA17406, authorized by the contract with Lavaca Navidad River Authority.

The geotechnical investigation and subsequent preliminary engineering analysis were conducted to aid in the evaluation of an approximate 2,500-acre site, owned by Formosa, proposed as an OCR site. The recommendations in this study are according to the following scope of services:

- Select locations for up to fifteen (15) exploratory borings (grid with boring spacing of about 4,000) at the site for identification and evaluation of subsurface materials. All borings will be drilled to a maximum depth of 50 feet.

- Laboratory testing shall be performed on samples obtained from the borings to determine soil classification and pertinent engineering properties of the subsurface materials.

- Develop assessment of subsurface conditions and soil properties indicated by the field and laboratory work and the implications for design.

- Perform preliminary seepage analysis using generalized hydraulic conductivity values based on gradation tests and industry accepted correlations based on soil classification. The seepage analysis will be performed for one typical cross section.

- Perform preliminary slope stability analysis using shear strength parameters based on soil classifications and industry accepted correlations. Results of global stability analyses (rotational failure) and pertinent analysis output figures displaying the failure surface, calculated factor of safety, and water surface elevations for one representative cross section will be provided.

- Develop assessment of expected construction related issues.

- Develop up to four potential configurations using up to two cells that provide the desired storage.
- Adjust the potential configurations to accommodate yield and environmental constraints.
- Develop a typical section, including erosion protection, cutoff and minimum slopes.
- Evaluate the potential for on-site borrow material.
- Develop a proposed inlet and outlet structure configuration that would be typical for the identified configurations.
- Perform Preliminary Design Flood Analysis and maximum wave calculations to determine a minimum overflow spillway and needed freeboard.
- Based on further analysis and evaluations regarding permitting issues, select a final configuration for further development.

This technical memorandum has been prepared based on our current knowledge and understanding of the proposed project. Changes in the configuration or location of the proposed OCR, as described in this document, may require modification of the recommendations contained in this technical memorandum. This memorandum presents the results of the geotechnical investigation and preliminary engineering analysis in a direct and abbreviated manner and is not intended to serve as a detailed report.

Pertinent project details are summarized in Table 1.

Table 1 – Project Summary

Project Location:	Jackson County, Texas – 2 miles west of Highway 172, 7 miles SE of LNRA's Palmetto Bend dam and 2 miles east of the Formosa Plant
Proposed Improvements:	Evaluate an approximate 2,500-acre site, currently owned by Formosa, as a future location for an Off-Channel Reservoir

SUBSURFACE EXPLORATION AND LABORATORY TESTING

The subsurface exploration for the proposed OCR Due Diligence Study consisted of drilling fifteen (15) exploratory core borings each to a depth of 50 feet. The borings were drilled between September 27, 2017 and October 6, 2017 and the boring locations are presented on the Boring Location Map included with this memorandum.

The borings were drilled by Terracon using a Dietrich D-50 track-mounted drill rig. Zack Ready of Geoscience Consultants International supervised the drilling and logged the borings. The borings were drilled using continuous flight augers and rotary wash methods to the terminal depth of 50 feet below ground surface. Push tubes and a split-spoon sampler were used to collect samples within the borings. The split-spoon sampler was used in conjunction with the Standard Penetration Test (STP). The borings were observed for indications of subsurface water

entry during drilling and were checked for accumulated water before being backfilled with bentonite chips and topped with soil cuttings.
Laboratory testing was performed on selected samples by Gorrondona and Associates, Inc. Testing was performed to allow for material classification according to the Unified Soil Classification System (USCS) and to evaluate pertinent engineering properties of the materials. These tests included moisture content, unit dry weight, Atterberg limits, percentage passing a No. 200 Sieve, grain size analysis, unconfined compression tests and crumb dispersion tests. The results of these tests are presented on the boring logs (See Appendix B) and in Appendix C – Laboratory Test Results.

The boring logs were prepared from the field logs and represent a generalized interpretation of the stratigraphy encountered within each boring based on field descriptions, *in situ* testing, and laboratory test results. Stratigraphy lines shown on the logs correspond to the approximate boundary between strata. *In situ*, this transition can be, and often is, gradual. The boring logs are included with this memorandum along with a key to the symbols and terms used on the logs.

GENERALIZED SUBSURFACE CONDITIONS

GEOLOGY

The approximate 3,000-acre site is located within the Beaumont geologic formation, either in areas predominantly in clay or areas predominantly in sand. The predominantly clay portion of the Beaumont formation consists of "dominantly clay and mud of low permeability" (Bureau of Economic Geology, Geologic Map of Texas, 1992 (University of Texas at Austin)). Specifically, the formation consists of light- to dark-gray and bluish- to greenish-gray clay and silt, intermixed and interbedded; contains beds and lenses of fine sand, decayed organic matter, and many buried organic-rich, oxidized soil(?) zones that contain calcareous and ferruginous nodules. Very light gray to very light yellowish-gray sediment cemented by calcium carbonate is present in varied forms, veins, laminar zones, burrows, root casts, nodules. Locally, small gypsum crystals are present. Plastic and compressible clay and mud were deposited in flood basins, coastal lakes, and former stream channels on a deltaic plain" (from Moore and Wermund, 1993a, 1993b).

The predominantly clay portion of the Beaumont formation consists of "yellowish- to brownish-gray, locally reddish orange, very fine to fine quartz sand, silt, and minor fine gravel, intermixed and interbedded. It includes stream channel, point-bar, cravasse-splay, and natural levee ridge deposits, and clayey fill in abandoned channels. It forms poorly defined meander-belt ridges and pimple mounds aligned approximately normal to coast and 1-2 m higher than surrounding interdistributary silt and clay. Channel fill is dark-brown to brownish-dark-gray, laminated clay and silt, organic -rich. The formation includes marine delta-front sand, lagoonal clay, and near-shore marine sand beneath and landward of bays along the coast" (from Moore and Wermund, 1993a, 1993b).

STRATIGRAPHY

The site stratigraphy varies across the site but is composed primarily of sandy lean (CL) and fat (CH) clays, clayey sands (SC) and sands (SP). Stiff to hard clays generally overlie very loose to dense sands with alternating clays and sands of variable thicknesses beneath the sands. The upper clays (CL and CH) are dark brown and brown near the surface and transition to light brown, reddish brown and light gray with depth. Atterberg limits tests performed on the upper clays resulted in liquid limits ranging from 29 to 79 and plasticity indices ranging from 10 to 49 with percentages passing a No. 200 Sieve ranging from 51 to 100 percent. The sands beneath the upper clays were light brown and reddish brown. The sands had percentages passing a No. 200 Sieve ranging from 6 to 34 percent.

A summary of the generalized stratigraphy is provided in the table below. The ranges contain the limits within the designated stratigraphy. Reference to the boring logs should be made for more details specific to the materials and subsurface transitions observed within each boring.

Table 2 – Generalized Stratigraphy

Stratum	Depth Range	Description
1	0-50	Dark brown to light brown, reddish brown and light gray, stiff to hard, **LEAN (CL) and FAT (CH) CLAY**; $29 \leq LL \leq 79$, $10 \leq PI \leq 49$, $51 \leq P200 \leq 100$
2	6-38	Light brown and reddish brown, very loose to very dense, **CLAYEY SANDS (SC) and SANDS (SP)**
3	18-50	Yellowish brown, reddish brown and light gray, medium stiff to hard, **LEAN (CL) and FAT (CH) CLAY**; and light to dark brown, reddish and yellowish brown, loose to very dense **CLAYEY SANDS (SC) and SANDS (SP)**

GROUNDWATER

The borings were advanced using techniques that allow for direct and indirect observations of seepage and groundwater during drilling operations. The borings were advanced with continuous flight augers and used rotary wash drilling techniques which require water for drilling fluid. Observations for seepage and groundwater were made in all of the borings before the introduction of drilling fluids.

Groundwater was encountered in all of the borings except for one (B-105). During drilling, groundwater was encountered at depths ranging from 10.8 feet to 28 feet below ground surface (bgs). The observations are only indicative of conditions at the time and place indicated. A groundwater study has not been performed for this project, and long-term observations would be necessary to evaluate the groundwater levels and fluctuations. The occurrence of groundwater can vary due to many factors, including seasonal changes, site topography, surface runoff, the layering and permeability of subsurface strata, water levels in waterways, etc. Groundwater at this site will likely be influenced by seasonal flows within Keller Creek channel that runs through the site.

GEOTECHNICAL ANALYSIS AND DISCUSSION

EMBANKMENT DESIGN

Two footprints for the OCR were evaluated. The smaller footprint is located north and west of Keller Creek (refer to Figure 2) and attempts to avoid or minimize potential mitigation requirements. The larger footprint (refer to Figure 3) generally encompasses most of the subject property, but it will require mitigation due to rerouting of Keller Creek and existing wetlands on the site (especially south and east of Keller Creek). Storage volumes were developed based on a firm yield analysis prepared by FNI and included in a separate memorandum.

Several different embankment configurations were evaluated for the different storage volumes developed. These configurations included varied slope angles for both the upstream and downstream side of the embankment. These included the following: (1) 4H:1V upstream and downstream; (2) 3.5H:1V upstream and 4H:1V downstream; (3) 3.5H:1V upstream and downstream; (4) 3H:1V upstream and 3.5H:1V downstream; (5) 3H:1V upstream and downstream. Using these different configurations along with different storage volumes (3 for the smaller footprint and 3 for the larger footprint), calculations were performed to determine dam height. Wave runup calculations were performed for these alternatives to determine the amount of freeboard needed for each footprint. A discussion on wave runup is included in a later section of this memorandum. Based on these factors, a cut (excavation) and fill (compacted fill) balance was performed to optimize the use of the onsite soil as fill material for the embankment. Refer to Table 3 for a summary of the different scenarios.

TABLE 3

LNRA OFF CHANNEL RESERVOIR - SMALL FOOTPRINT (~1440 ACRES)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
30,284	54.8	47.8	28.3	26.5	4H:1V both	5,129,043	4,605,376	11,000
30,284	54.9	47.9	28.4	26.5	3.5H:1V up; 4H:1V down	4,972,530	4,409,966	65,000
30,284	55	48	28.5	26.5	3.5H:1V both	4,816,343	4,211,093	124,000
30,284	55.2	48.2	28.7	26.5	3H:1V up; 3.5H:1V down	4,503,968	4,035,706	18,000
30,284	55.3	48.3	28.8	26.5	3H:1V both	4,347,781	3,828,124	85,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
40,378	60.1	53.1	27.1	33.0	4H:1V both	7,184,209	6,459,495	6,000
40,378	60.2	53.2	27.2	33.0	3.5H:1V up; 4H:1V down	7,004,106	6,165,550	138,000
40,378	60.4	53.4	27.4	33.0	3.5H:1V both	6,648,617	5,901,317	82,000
40,378	60.6	53.6	27.6	33.0	3H:1V up; 3.5H:1V down	6,297,195	5,628,785	39,000
40,378	60.8	53.8	27.8	33.0	3H:1V both	5,948,539	5,347,868	6,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
50,007	65.2	58.2	26.0	39.2	4H:1V both	9,477,887	8,543,937	(14,000)
50,007	65.3	58.3	26.1	39.2	3.5H:1V up; 4H:1V down	9,254,832	8,136,407	193,000
50,007	65.5	58.5	26.3	39.2	3.5H:1V both	8,822,550	7,762,921	177,000
50,007	65.7	58.7	26.5	39.2	3H:1V up; 3.5H:1V down	8,397,590	7,379,691	178,000
50,007	66	59	26.8	39.2	3H:1V both	7,775,769	7,020,973	(23,000)

LNRA OFF CHANNEL RESERVOIR - LARGE FOOTPRINT (~2500 ACRES)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
50,133	54.4	45.6	30	24.4	4H:1V both	5,444,270	4,964,357	(65,000)
50,133	54.4	45.9	30	24.4	3.5H:1V up; 4H:1V down	5,444,270	4,722,860	177,000
50,133	54.5	46	30.1	24.4	3.5H:1V both	5,163,476	4,512,885	134,000
50,133	54.6	46.1	30.2	24.4	3H:1V up; 3.5H:1V down	4,889,949	4,299,086	102,000
50,133	54.7	46.2	30.3	24.4	3H:1V both	4,616,713	4,081,440	74,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
60,222	57.2	48.7	29.6	27.6	4H:1V both	6,776,150	6,005,637	93,000
60,222	57.3	48.8	29.7	27.6	3.5H:1V up; 4H:1V down	6,438,965	5,742,972	52,000
60,222	57.4	48.9	29.8	27.6	3.5H:1V both	6,106,140	5,476,041	19,000
60,222	57.5	49	29.9	27.6	3H:1V up; 3.5H:1V down	5,774,769	5,204,819	(8,000)
60,222	57.6	49.1	30	27.6	3H:1V both	5,444,270	4,929,283	(29,000)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
75,357	61.4	52.9	29	32.4	4H:1V both	8,877,160	7,756,918	233,000
75,357	61.5	53	29.1	32.4	3.5H:1V up; 4H:1V down	8,516,721	7,400,436	265,000
75,357	61.7	53.2	29.3	32.4	3.5H:1V both	7,808,051	7,078,650	(51,000)
75,357	61.8	53.3	29.4	32.4	3H:1V up; 3.5H:1V down	7,458,368	6,709,821	3,000
75,357	61.9	53.4	29.5	32.4	3H:1V both	7,114,206	6,335,984	67,000

Depending on which footprint is selected and what storage volume is used, the embankment height will range from 24 to 39 feet and will be about 25 feet wide at the crest. The embankment will have 3H:1V side slopes on both the interior and exterior slopes (see Figure 4). Embankment slope angles are governed by soil cement construction issues on the interior slopes and maintenance (mowing and potential surface slides) on the exterior slopes in addition to the global stability of the embankment.

The embankment should consist of compacted earth fill, soil cement for slope protection on the interior slopes, and a toe drain constructed within the base of the embankment about 30 feet from the downstream toe. The toe drain will have periodic outlets along the downstream toe of the embankment.

The toe drain system will consist of a 4-foot by 4-foot thick clean gravel surrounded by a 3-foot thick filter sand. At periodic locations, the toe drain will discharge via a 12-inch diameter HDPE or PVC pipe to a concrete discharge structure located at the downstream toe. The concrete structures will discharge into perimeter drainage channels.

A ramp will be constructed on the inside of the reservoir to provide access for maintenance and cleaning. A 2-foot layer of soil cement will be placed on the ramp and interior slopes of the reservoir to provide slope protection from wave action and protection during maintenance and cleaning.

The exterior slopes of the reservoir will be grassed.

CONSTRUCTION MATERIALS

The proposed reservoir site will use onsite materials to balance the cut and fill requirements. Depending on the storage volume and the footprint selected, up to 3 feet will be excavated from the interior of the reservoir to construct the embankment. Soils consisting of lean (CL) to fat (CH) clays, and to a lesser extent clayey sand (SC) material, were found in the upper 3 feet across the site. These materials are suitable for use in the embankment. A homogeneous embankment is recommended, although utilizing the leaner clays and clayey sands when possible in the outer portions (shell) of the embankment will help reduce potential surface slides due to dessication cracking.

Granular material for the soil cement and toe drain system should be obtained from an offsite source since these types of materials are not readily available onsite.

ANALYSIS OF LABORATORY DATA

Data from the laboratory tests performed on samples collected during the field investigation were analyzed to develop generalized conditions across the proposed site. The purpose of these averages is to determine if soil types available during excavation will be suitable embankment material for design. The coarse analysis evaluated average values for each of five rows of borings, with each row containing three borings. For each row, test results were averaged across the three borings, in 10-foot depth intervals. Table 4 presents the averaged values. A legend for the abbreviated field and laboratory tests provided in Table 4 are as follows:

- dd – dry density (pcf)
- -200 – percent passing the #200 sieve
- LL – liquid limit
- PL – plastic limit
- PI – plasticity index
- Qu – unconfined compression test (tsf)
- N – blows per foot
- HP – hand penetrometer (tsf)

Table 4: Average Test Results across Proposed Site

Borings 101-103

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	104	72	45	19	26	0.7	11	3.0
10-20	100	53	62	22	40	1.2	10	2.8
20-30	-	86	67	23	44	-	11	2.8
30-40	91	-	70	23	47	2.9	14	4.1
40-50	-	99	49	19	30	-	9	3.0

Borings 104-106

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	111	84	41	18	23	0.8	9	2.7
10-20	109	65	41	20	21	2.4	12	2.8
20-30	95	75	44	23	22	1.5	16	1.9
30-40	-	92	53	20	33	-	12	3.5
40-50	-	-	-	-	-	-	11	2.7

Borings 107-109

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	114	84	47	17	30	2.9	-	3.7
10-20	104	56	56	26	30	3.0	16	3.3
20-30	-	56	-	-	-	-	23	0.8
30-40	96	91	59	24	35	2.2	-	2.8
40-50	-	-	-	-	-	-	63	1.9

Borings 110-112

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	113	72	57	21	37	1.8	8	3.1
10-20	96	56	80	35	45	2.4	20	3.0
20-30	106	100	68	30	38	1.9	11	3.8
30-40	99	69	57	25	32	2.6	7	3.8
40-50	-	-	-	-	-	-	3	2.2

Borings 113-115

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	122	76	47	18	29	3.0	23	3.6
10-20	99	44	71	31	40	2.0	11	2.5
20-30	102	67	43	22	21	2.7	31	4.1
30-40	-	98	60	26	34	-	35	3.1
40-50	-	-	-	-	-	-	-	2.7

The data indicates that conditions are relatively similar across the site, with primarily fine-grained soil in the upper 10 feet, a zone of sandy clay and clayey sand from 10 to 20 feet, and then generally increasing in fines content with depth below 20 feet.

DISPERSIVE SOILS

Crumb dispersion tests were performed on 26 soil samples to determine if the clays onsite are dispersive in nature. Dispersive clays have different properties from normal clays because their electrochemical makeup is different. The presence of dispersive clays in an embankment can lead to piping (erosion) failures.

The test results performed on selected samples of the clay soils at the site are included in Appendix D and here as follows: Six of the samples tested were determined to be highly dispersive (Grade 4), one sample was classified as dispersive (Grade 3), two were classified as slightly dispersive (Grade 2) and 17 (Grade 1) were considered to be non-dispersive. About 25 percent of the samples tested were classified as dispersive or highly dispersive. It is anticipated that soils for the embankment will be obtained onsite within the upper four feet of the surface. Eleven of the 26 samples that were tested were from soils that were within the upper 4 feet. Of those eleven samples tested, four samples were classified as highly dispersive. While not desirable, dispersive soils can be used in the construction of the embankment provided they are encapsulated with non-dispersive soils. Dispersive soils should not be exposed on the slopes or within three feet of the surface of the embankment. A larger concern with respect to dispersive soils at the site is in the bottom of the unlined reservoir. If the dispersive soils are widespread across the proposed bottom of the OCR, a slurry trench (3-foot to 5-foot wide and 40-50 feet deep) constructed beneath the embankment could effectively cut off potential piping (erosion) failures due to dispersive soils.

GEOTECHNICAL DESIGN PARAMETERS

Geotechnical parameters were developed for use in seepage and slope stability analyses. Estimated parameters are based on the general characteristics of sampled materials, as no hydraulic conductivity and shear strength testing was performed during this study.

Seepage Parameters

The embankment material will be sourced from the upper few feet of soil across the site. This material ranges in percent fines from 35% to 98%, with an average of 78% across the site. The index value for liquid limit for this material ranges from 29 to 79, with an average of 47. The plasticity index values range from 10 to 49, with an average of 29. The average values suggest a borderline material between lean and fat clay. Based on this data, a horizontal hydraulic conductivity equal to 3.0E-07 cm/sec (9.8E-09 ft/sec) is selected based on the clay material, and then increased 100% to 6.0E-07 cm/sec (2.0E-08 ft/sec) to account for the 20+% sand content. An anisotropy Kv/Kh value of 0.25 is assumed.

Some clay zones within the foundation were found to have fines contents of 90% or greater. A horizontal hydraulic conductivity of 3.0E-07 (9.8E-09 ft/sec) is estimated for the foundation clay material, with an anisotropy of 0.25 assumed.

Clayey/silty sand zones with greater than 13% fines are assumed to have a horizontal hydraulic conductivity of 1.0E-05 cm/sec (3.3E-07 ft/sec), with an anisotropy Kv/Kh ratio of 0.25.

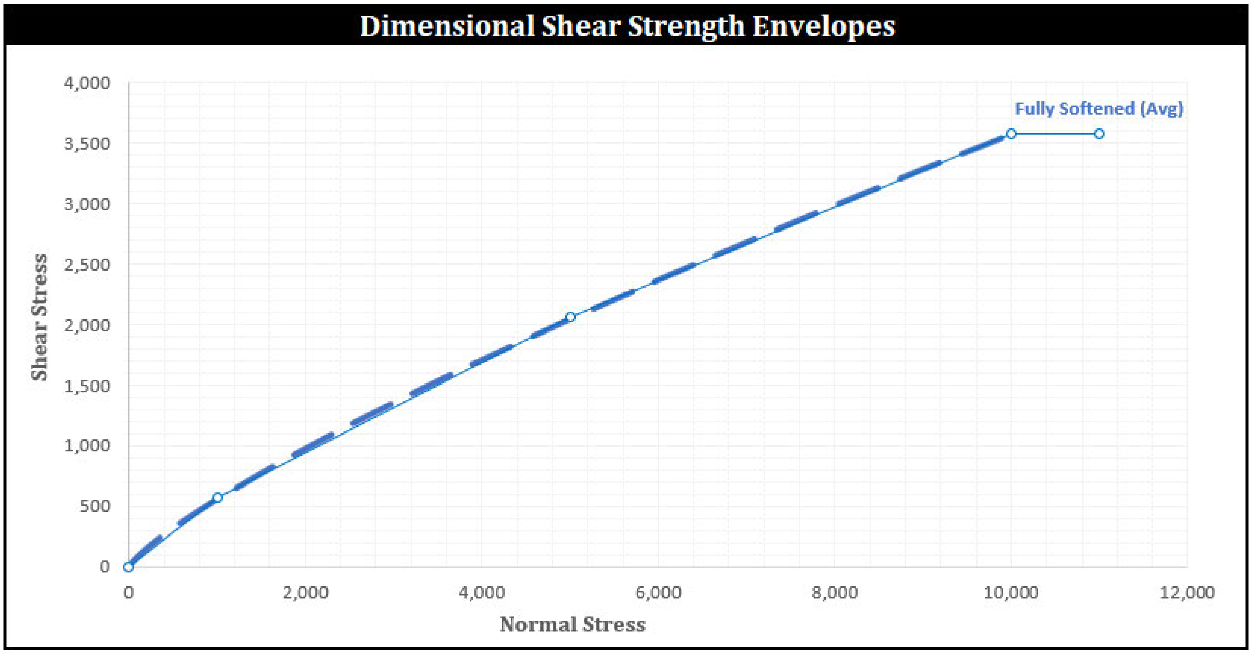
For sand zones with less than 13% fines, data from particle size analyses performed on samples collected during the site investigation were used with the Kozeny-Carmen method for estimating hydraulic conductivity. An average vertical hydraulic conductivity of 4.8E-03 cm/sec (1.6E-04 ft/sec) is estimated. An anisotropy of 0.5 is assumed, resulting in an estimated horizontal hydraulic conductivity of 9.6E-03 cm/sec (3.2E-04 ft/sec).

Shear Strength Parameters

At the conceptual design level, the only shear strength testing performed in the laboratory consisted of unconfined compression strength tests (UCS) on cohesive material. The UCS results provide an estimate of undrained shear strength of fine-grained collected samples. Testing performed in the field consisted of Standard Penetration Tests and hand penetrometers. SPT data can be used to estimate insitu density of coarse-grained materials and correlated drained strength values. Hand penetrometer data is used to determine the consistency of fine-grained collected samples, which can be helpful identifying areas of weak and highly compressible soil.
The UCS test results ranged from 0.7 to 3.3 tsf, with an average of 2.1 tsf. A UCS value of 1.4 tsf is selected as representative for the fine-grained foundation material, resulting in an undrained shear strength of 1400 psf. The hand penetrometer results range from 0.75 to 4.5+ tsf, indicating foundation consistency ranging from stiff to hard.

The SPT test results ranged from 4 to 63 blows per foot within the materials classified as poorly graded sand, and an average value of 22. A correlation developed by Peck was used to estimate drained shear strength based on the blow count value. The correlation shows a range of secant friction angles from 30 to 36 degrees for blow counts between 10 and 30. A secant friction angle value of 33 degrees is selected as representative for initial stability modeling.

For the fine-grained embankment and foundation soils, a typical peak strength envelope of 24 degrees and 230 psf cohesion is selected as representative. This envelope is consistent with the values published in NAVFAC 1986 for an intermediate CH/CL material. The undrained shear strength of the embankment material is assumed to be 1000 psf, consistent with a medium stiff to stiff clay. Given the moderate to high plasticity of the clay on-site, and related capacity for shrinking and swelling, fully softened shear strength (FSS) parameters have also been estimated. The FSS can be used to analyze a slope for susceptibility to shallow slides, which are typically 5 to 6 feet in depth. These potential shallow slides are considered a maintenance issue if addressed in a timely manner. The FSS parameters were estimated using the correlation developed by Castellanos 2016. The correlation uses the measured liquid limit, plasticity index, and clay fraction for a material to estimate a fully softened shear strength envelope represented by a power curve function. For this estimation, the average of the maximum and the mean values for each parameter were used to represent the 75th percentile value, weighting the strength envelope towards the lower bound strength envelope. The values used were: liquid limit of 63, plasticity index of 39, and an estimated clay fraction of 47%. The resulting FSS envelope is presented in Figure A, and an equivalent piece-wise function using Mohr-Coulomb parameters presented in Figure B.



All Stress Units:	PSF	All Angle Units:	DEGREES

Figure A: Fully Softened Shear Strength Envelope

Piece-Wise Function M-C Values			
Description:		FSS, Average	
Normal Stress Range		φ'	c'
0	1,000	29.7	0.0
1,000	5,000	20.3	218.7
5,000	10,000	17.0	531.8
10,000	11,000	0.0	3583.9

Figure B: Fully Softened Shear Strength Envelope using Mohr-Coulomb Piece-Wise Function

For the clayey sand foundation soils, a typical peak strength envelope of 31 degrees and 230 psf cohesion is selected as representative. This envelope is consistent with the values published in NAVFAC 1986 for an SC material.

Summary of Selected Geotechnical Parameters

Table 5 summarizes the parameters discussed for seepage and slope stability analyses.

Table 5: Preliminary Design Parameters

Material	Unit Weight	Drained Strength		Undrained Strength		Hydraulic Conductivity	
	g	φ'	c'	φ	c	k	K_v/K_h
	(pcf)	(deg)	(psf)	(deg)	(psf)	(ft/sec)	
Sandy Clay, embankment	125	24	230	0	1000	2.0E-08	0.25

Table 5: Preliminary Design Parameters (cont.)

Sandy Clay, foundation	125	24	230	0	1400	2.0E-08	0.25
Clay	125	19	230	0	1400	9.8E-09	0.25
Clayey Sand	125	31	230	0	1400	3.3E-07	0.25
Sand	120	33	0	-	-	3.2E-04	0.50

SEEPAGE ANALYSIS

A finite element model was developed to evaluate seepage conditions using the SEEP/W module within GeoStudio 2016. A maximum embankment height of 38 feet was analyzed. Steady state seepage was evaluated with normal pool at elevation 59 feet, crest elevation at EL 65 feet, upstream and downstream toe of slope at EL 27 feet, and an initial groundwater surface at EL 17 feet. Based on data from the field investigation, the foundation materials between 10 and 30 feet below existing ground surface vary between clay, sandy clay, clayey sand and poorly graded sand. Various scenarios were evaluated to determine how different combinations of each of these materials affect developed pore pressures. It was found that the condition where a vein of sand within the foundation, which extends below the reservoir and under the embankment, but is unable to daylight downstream, presents the most critical state regarding location and magnitude of pore pressures. The sand vein is capable of developing high pore pressures below the embankment and downstream toe. After determining the critical condition, different design elements were added to the embankment and foundation in an attempt to mitigate against the predicted pore pressures. The design elements evaluated included cut-off trenches, drainage trenches, embankment vertical and horizontal filters, toe drain, and downstream relief wells. The toe drain appears to manage seepage through the embankment provided that relief wells were included and controlled the pressures within the foundation sand vein. A relief well consists of a pipe that is installed in a vertical borehole and backfilled with sand or gravel. The pipe (usually 4 inches in diameter or greater made of stainless steel) consists of a lower screened section and a solid section above. In order for the relief wells to be effective, they must penetrate the sand vein. The pipe is a conduit for release of the pressure by passive means (i.e. no pumping). While the toe drains and relief wells are not directly connected, they may share the same discharge structure depending on the spacing of the toe drains and relief wells. Layers of sand were noted in the bore logs as deep as 48 feet. Given these depths, relief wells are likely to be a cost effective and practical method for controlling the foundation pressures. The relief well system and the toe drain are not connected hydraulically but may share a discharge structure.

Without the downstream relief wells, the risk of uplift and blowout of the downstream toe of slope increases significantly. This is in addition to a decrease in stability of the downstream slope. Uplift and blowout of the downstream toe could lead to backwards piping of foundation materials and eventual uncontrolled release of the reservoir.

SLOPE STABILITY ANALYSIS

A limit equilibrium model was developed to evaluate slope stability using the SLOPE/W module within GeoStudio 2016. Each scenario utilized the Spencer method to calculate the factor of safety. Pore pressures developed in the seepage analysis were utilized in the slope stability analyses. When appropriate, tension cracks were introduced to the model to prevent tensile force from developing within the soil, and the tension cracks were conservatively assumed to be 100% filled with water. Four scenarios were evaluated for slope stability: End of Construction (EOC), Steady State Seepage (SSS), Rapid Drawdown (RDD), and Fully Softened (FSS).

The EOC scenario evaluates the embankment and foundation at the end of construction and during first filling of the reservoir. Low permeability soils in the foundation are assumed to have not undergone consolidation due to the increased loading of the constructed embankment, and the low permeability soils in the embankment have not yet consolidated under their self-weight. Unconsolidated-undrained (UU) shear strengths are assigned to the low permeability soils. The relatively high permeability soils (sand) are assigned drained shear strength parameters. Pore pressures are only accounted for within the high permeability soils, while pore pressures are accounted for in the UU shear strength of the low permeability soils.

The SSS scenario evaluates the embankment and foundation under long-term conditions, assuming a steady-state seepage flow regime develops through the embankment. This assumption is conservative for a pump storage reservoir if water levels fluctuate regularly. Drained shear strengths are assigned to all soils, and pore pressures from the seepage analysis are accounted for within all soils.

The RDD scenario evaluates the upstream embankment slope for the condition where the reservoir is lowered at a rate faster than the embankment soils can dissipate developed pore pressures. The staged undrained strength method developed by Duncan, Wright and Wong was utilized to analyze the RDD scenario. This method evaluates the slope using drained strengths and consolidated-undrained strengths after drawdown to determine the limiting condition (lowest factor of safety). The pore pressures from the steady state seepage analysis were utilized to develop the initial pore pressure condition, prior to drawdown.

The FSS scenario evaluates the downstream slope when moderate to high plasticity soils are used to construct an embankment. These soils are susceptible to large volume changes between periods of wet and dry weather. Repeated volume change cycles have the effect of reducing slope stability over time. The reduced soil shear strength due to this weathering effect is referred to as “fully softened”. Fully softened shear strength is applied to the upper 10 feet of the embankment and above the SSS phreatic surface, the zone typically influenced by the weathering effects. Shallow slides associated with the FSS scenario are typically triggered after an intense rainfall event that follows an extend period of dry weather. To simulate the pore pressures developed during the rainfall event, a pore pressure coefficient of 0.29 was used, which is based on past experience with similar projects. The pore pressure coefficient method simply estimates the pore pressure at a specific point by multiplying the total overburden stress at that point by the pore pressure coefficient.

The side slopes of the embankment were set at 3.5 horizontal to 1 vertical during the first model run. Factors of safety for EOC, SSS and RDD scenarios were in excess of the minimum values required by TCEQ Dam Safety program for new dams. TCEQ does not have a minimum for the FSS scenario. The side slopes were then analyzed at 3 horizontal to 1 vertical (3H:1V), and again, all factors of safety exceed the TCEQ required minimum values. Slopes steeper than 3H:1V can present difficulties during maintenance operations, and increase the risk of shallow side development. No slopes steeper than 3H:1V were analyzed. A summary of the calculated factors of safety for each scenario are present in Table 6. Figures illustrating the model results are provided in Appendix E.

Table 6: Slope Stability Factor of Safety Summary

Scenario	**Slope Stability Factor of Safety (3H:1V)**	
	Calculated FOS	**TCEQ Req. Minimum**
EOC	1.5	1.25
SSS	1.8	1.5
RDD	1.4	1.2

Table 6: Slope Stability Factor of Safety Summary (cont.)

FSS	1.30	-

FREEBOARD CALCULATIONS

The necessary freeboard for the reservoir was calculated by comparing the maximum wave height with runup from a design level wind with the Probable Maximum Flood (PMF) level combined with a strong wind. Since there are not any governing criteria from the TCEQ or other entities with regard to selection of wind speed, the design level wind is based on historical maximum wind speeds recorded for the area, which is equivalent to a Category I hurricane. The process finds a critical sustained wind speed that can be maintained long enough to generate full wave heights for the given fetch and depth of the reservoir. For the smaller reservoir, the fetch is 1.5 miles and the calculated maximum wind speed is 72.7 mph sustained for 19.5 minutes. This would generate a wave height of 3.9 feet. Considering the potential setup and runup, this correlates to maximum height of 5.9 feet. This would correlate to a minimum of six feet of freeboard.

The PMF is equivalent to the Probable Maximum Precipitation (PMP) since the drainage area is simply the reservoir area itself. For this part of the state, the PMP is 49 inches. Typical procedures would assume wind speeds of half the maximum described above. This would generate a maximum wave height of 2.9 feet. Combining the PMF with the wave height would suggest a freeboard of seven feet for the smaller reservoir.

For the larger reservoir, which has a fetch of 2.3 miles, a similar process provided a maximum wave height of 8.3 feet, compared to a PMF of 49 inches plus a wave height of 3.9 feet. In this case the wave height controls and a freeboard of 8.5 feet would be suggested.

SLOPE PROTECTION

Soil cement will be utilized for wave protection on the upstream slope. The downstream slopes of the embankment will be protected with grass. A grassed slope should be kept mowed and maintained to prevent the growth of trees that can damage the embankment.

HYDRAULIC STRUCTURES

The proposed reservoir was reviewed in multiple configurations, but each configuration will each have the same three hydraulic structures incorporated to control inflow water pumped into the reservoir, releases piped out, and possible overflows if the storage level rises too high, for the safety of the structure.

The configuration of the inlet piping was based on the assumption of a 300 MGD pumping facility with a maximum flow velocity in the pipe of 6 fps. This would suggest a 120-inch pipeline from the diversion point through the inlet into the reservoir. This would be a pipe under the embankment that would turn up and into the reservoir, as shown in Figure 5. The final capacity of the diversion pumping station is not set, so changes in the assumed rate will affect the size of the inlet pipe needed. A 120-inch diameter pipe is considered a maximum practical size for such piping and an increase in the capacity would likely mean the use of dual pipes.

The configuration of the outlet piping was based on the assumption of a 75 MGD release capacity, also with a maximum flow velocity in the pipe of 6 fps. This would suggest a 60-inch pipeline through the outlet of the reservoir. This would also be a pipe under the embankment that would be at the lowest point in the reservoir, as shown in Figure 6, and then drain to the release point selected on the river. The flows would then be picked up by downstream users. The final capacity of the outlet piping is not set, so changes in the assumed rate will affect the size of the pipe needed.

The third hydraulic structure is an emergency overflow. This would be a low spot in the embankment, generally set 2 or 3 feet above the maximum operating pool level. If, due to malfunction or operator error, the maximum inflow is maintained above the maximum operating pool level, the emergency overflow capacity would be set to allow this same flowrate to be released without risking an overtopping of the embankment. A fifty-foot-wide overflow would provide the 300 MGD capacity with a little more than 2 feet of depth over the weir. The weir would be covered with soil cement and a discharge channel from the overflow down into a natural drainage channel away from the embankment would also be constructed of soil cement. If this was set at 2 to 3 feet above the maximum operating level, then there would still be more than 2 to 3 feet of freeboard above that maximum flow level, preventing any possible overtopping of the embankment due to these issues. This overflow channel would also provide some small discharge during an extreme rainfall event, possibly reducing the needed freeboard slightly. This contribution was not considered in the freeboard calculations due to the level of unknowns, but should be identified during the final design.

CONCLUSIONS

- Suitable soils are available onsite for embankment construction.
- Balance of cut and fill earthwork quantities can be achieved for both the small and large footprint.
- Due to an underlying sand layer beneath the reservoir and proposed embankment, uplift pressures are significant enough to potentially cause blowout and instability of the downstream toe.
- Uplift pressures can be reduced and minimum safety factors (TCEQ minimum requirements) can be met for both uplift and slope stability through the use of relief wells and a toe drain near the downstream toe.
- 3H:1V side slopes for both upstream and downstream slope are suitable provided relief wells and a toe drain are installed.
- Approximately 35 percent of the soil samples that were taken from the upper four feet of the surface tested as highly dispersive. The dispersive soils may be used, if needed, as part of the embankment provided they are encapsulated with at least 3 feet of non-dispersive soil.
- A larger concern with respect to dispersive soils at the site is in the bottom of the unlined reservoir. If the dispersive soils are widespread across the proposed bottom of the OCR, a slurry trench (3-foot to 5-foot wide and 40-50 feet deep) constructed beneath the embankment could effectively cut off potential piping (erosion) failures due to dispersive soils.
- Freeboard height required due to maximum wave runup is 6 feet for the small footprint and 8.5 feet for the large footprint.
- Based on a 300 MGD pumping facility with a maximum flow velocity of 6 fps, a 120-inch diameter inlet pipe would be needed to carry the flow.

- Based on a 75 MGD release capacity and a maximum flow velocity of 6 fps, a 60-inch diameter outlet pipe will be needed.
- A 50-foot wide emergency overflow will provide the 300 MGD capacity with a little more than 2 feet of depth over the weir.
- Based on this preliminary study, this site is feasible for development of an Off-Channel Reservoir.

LIMITATIONS

This memorandum was prepared specifically for use by Lavaca-Navidad River Authority (LNRA) and Freese and Nichols, Inc. for this particular project and shall not be used for other projects or purposes. This work was performed in a manner consistent with the level of care and skill ordinarily exercised by other members of the engineering profession practicing in the same locality, under similar conditions, and at the date the services were provided. Freese and Nichols, Inc. makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The information and opinions contained in this memorandum are based on field observations, subsurface explorations, laboratory tests, seepage and slope stability analyses and present knowledge of the proposed project. It is possible that soil or groundwater conditions could vary between or beyond the points explored. Paragraphs, statements, test results, boring logs, figures, etc., should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the purpose of this memorandum.

- **END OF MEMORANDUM -**

Appendix A – Figures

Appendix B – Boring Logs and Boring Log Legend & Nomenclature

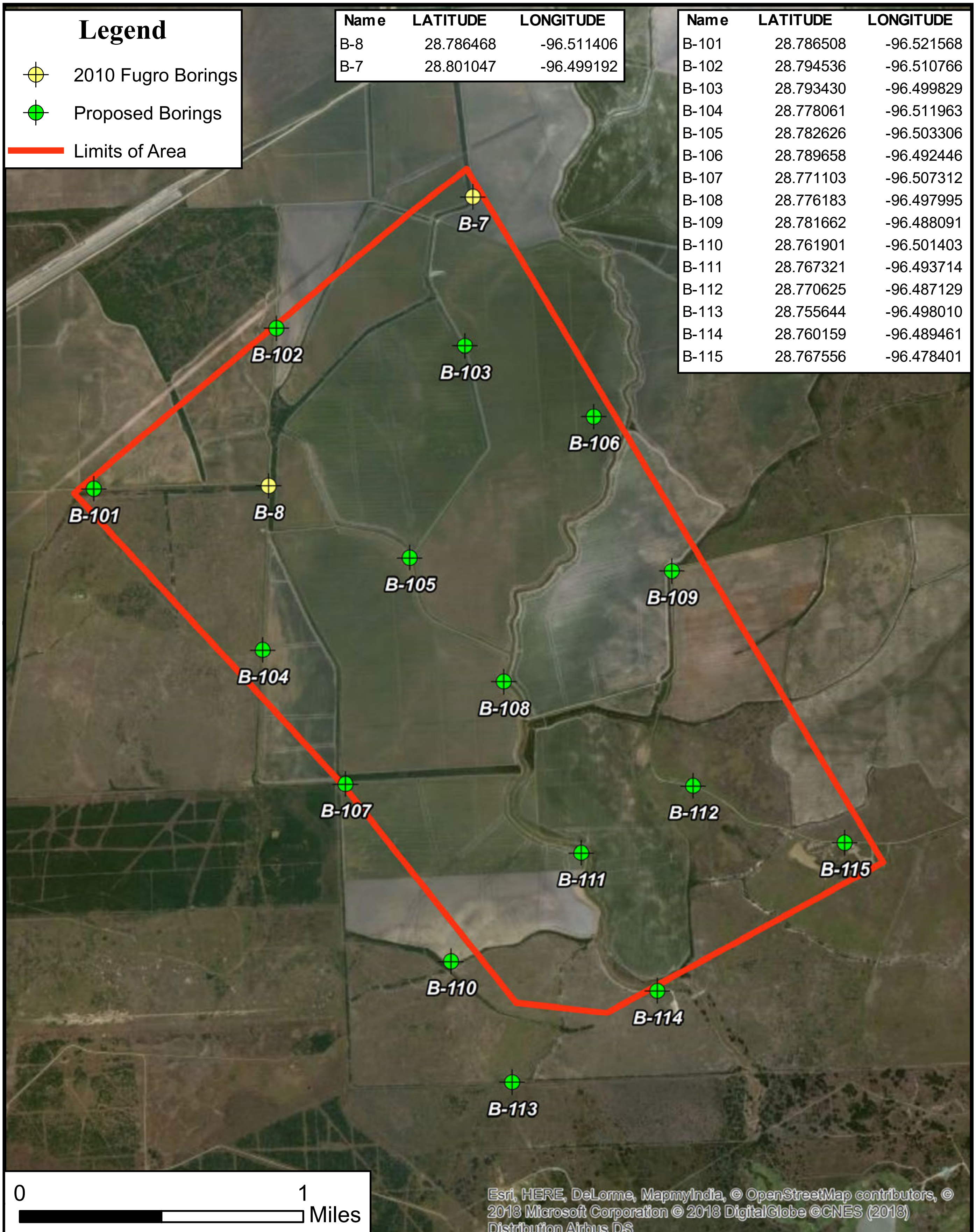
Appendix C – Laboratory Testing Results

Appendix D - Crumb Dispersion Test Results

Appendix E – Seepage and Slope Stability Results

Appendix A

Figures



Name	LATITUDE	LONGITUDE
B-8	28.786468	-96.511406
B-7	28.801047	-96.499192

Name	LATITUDE	LONGITUDE
B-101	28.786508	-96.521568
B-102	28.794536	-96.510766
B-103	28.793430	-96.499829
B-104	28.778061	-96.511963
B-105	28.782626	-96.503306
B-106	28.789658	-96.492446
B-107	28.771103	-96.507312
B-108	28.776183	-96.497995
B-109	28.781662	-96.488091
B-110	28.761901	-96.501403
B-111	28.767321	-96.493714
B-112	28.770625	-96.487129
B-113	28.755644	-96.498010
B-114	28.760159	-96.489461
B-115	28.767556	-96.478401

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N
W E
S

Lavaca Navidad River Authority
OCR Due Diligence Study

Boring Location Plan

FN JOB NO: LVA17406
FILE: OCR Lavaca.mxd
DATE: 2/14/2018
SCALE: 1:30,000
DESIGNED: Tony Bosecker
DRAFTED: MPT

FIGURE 1

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N
W E
S

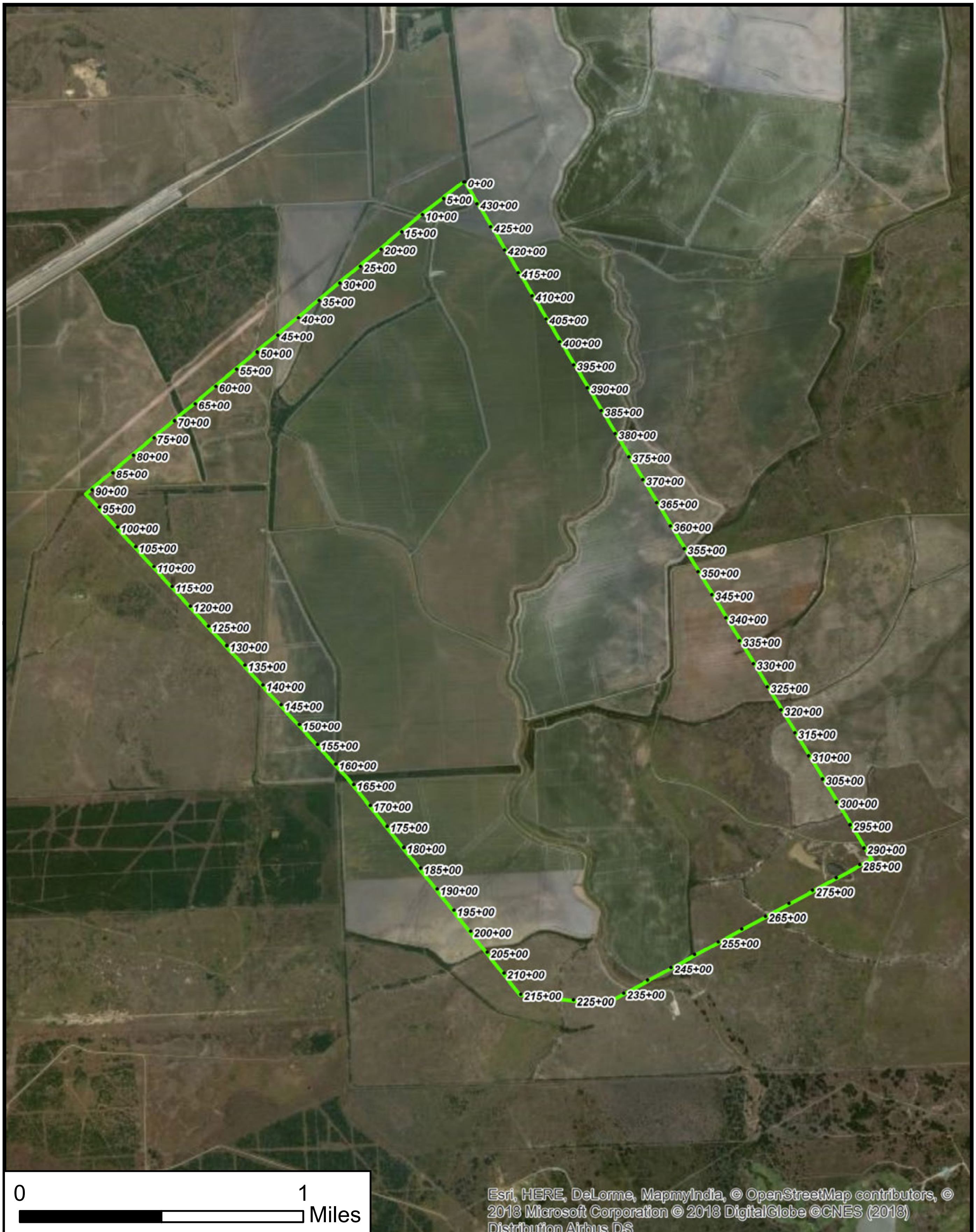
Lavaca Navidad River Authority
OCR Due Diligence Study

Small Footprint (1450 acres +/-)

FN JOB NO	LVA17406
FILE	OCR Lavaca.mxd
DATE	2/14/2018
SCALE	1:30,000
DESIGNED	Tony Bosecker
DRAFTED	MPT

2

FIGURE



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Phone - (817) 735 - 7300

N
W E
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Lavaca Navidad River Authority
OCR Due Diligence Study

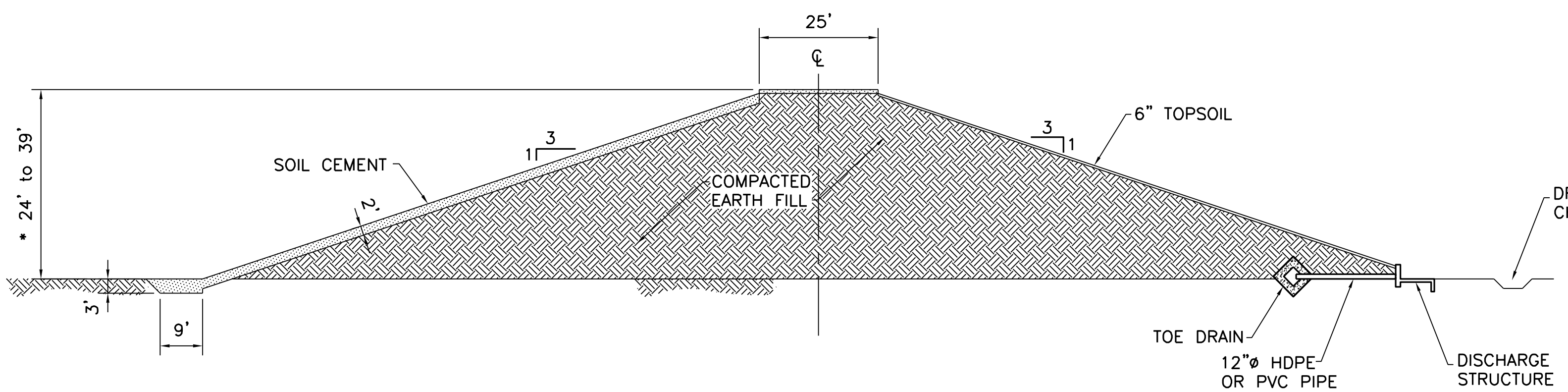
Large Footprint (2500 acres +/-)

FN JOB NO	LVA17406
FILE	OCR Lavaca.mxd
DATE	2/14/2018
SCALE	1:30,000
DESIGNED	Tony Bosecker
DRAFTED	MPT

3

FIGURE

N:\WRD\report\FIG 4.dwg LAYOUT: LAYOUT
Jan 16, 2018 - 4:30pm LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



* DAM HEIGHT VARIES DEPENDING ON STORAGE VOLUME AND RESERVOIR FOOTPRINT

TYPICAL EMBANKMENT SECTION

1"=20'

Date: Jan 16, 2018 - 4:30pm User: mlp File: N:\WRD\report\FIG 4.dwg

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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

PROPOSED OCR DUE DILIGENCE

EMBANKMENT SECTION - TYPICAL

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	DAB
DRAFTED	MLP
FILE	FIG 4.dwg
FIGURE	4

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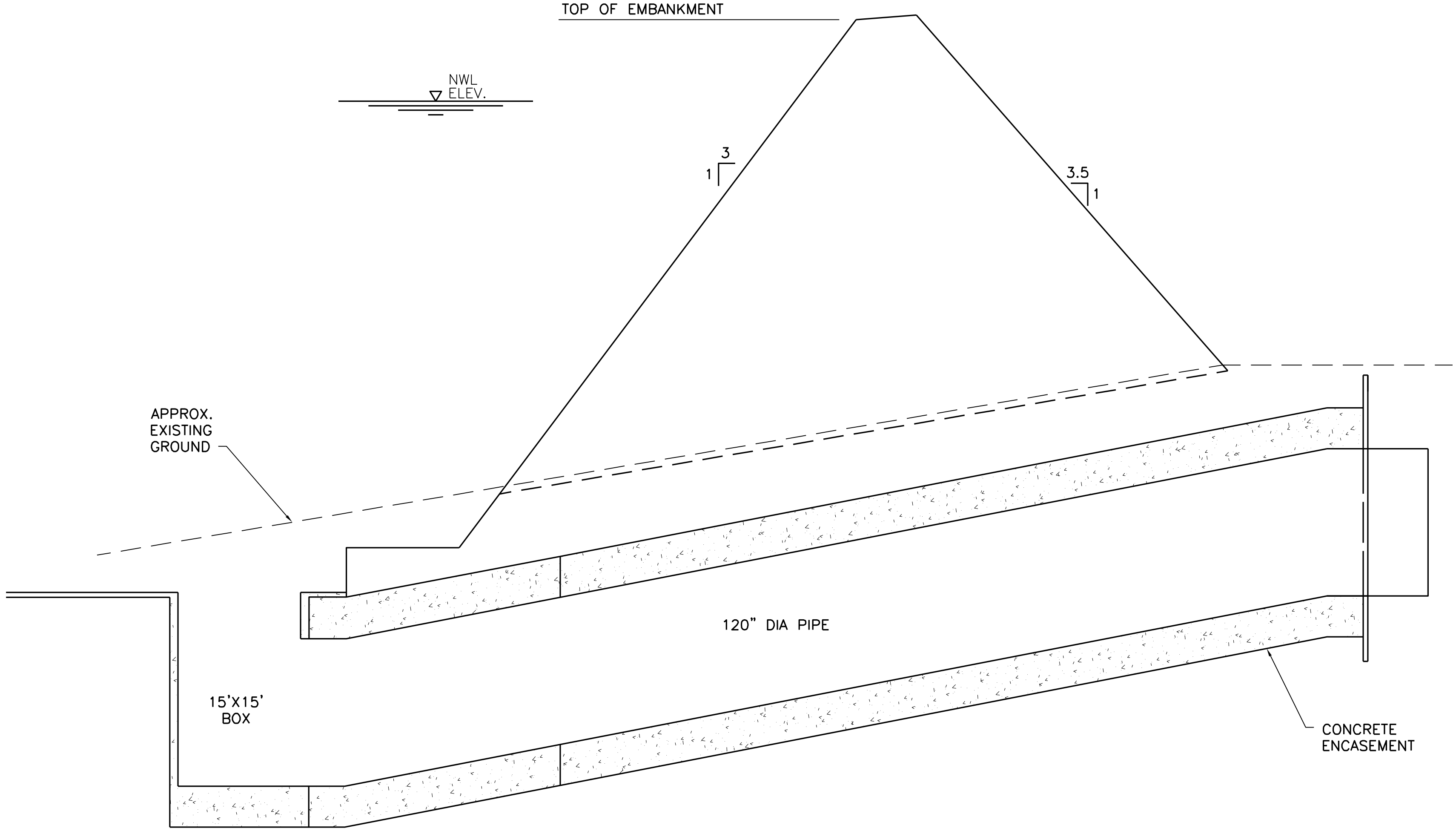
Engineering Firm F-2144

N:\WRD\report\FIG X.dwg LAYOUT: LAYOUT (2)
Jan 17, 2018 - 9:38am LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

PROPOSED OCR DUE DILIGENCE

INLET PROFILE

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	JLR
DRAFTED	MLP
FILE	FIG X.dwg
FIGURE	5

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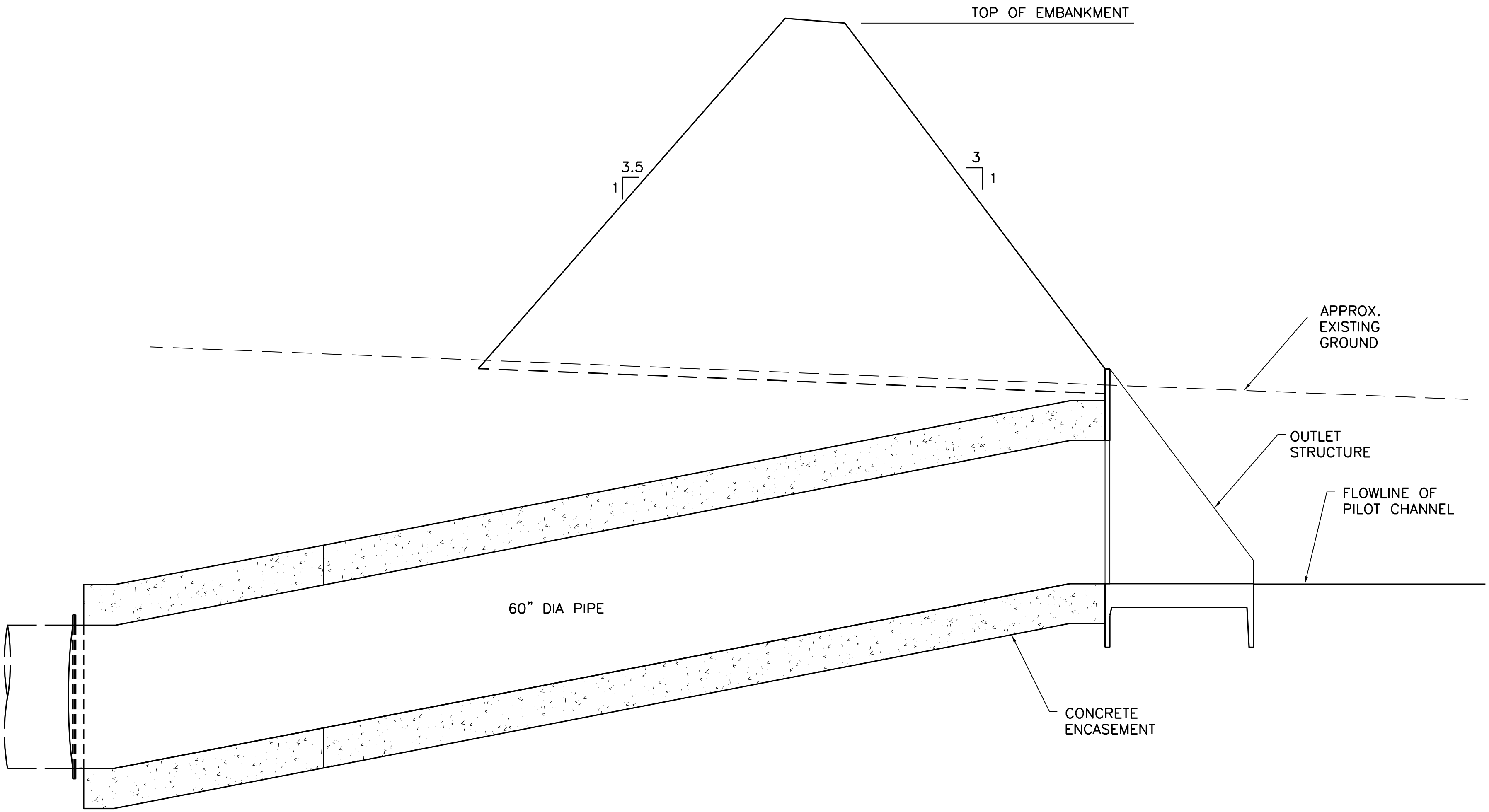
Engineering Firm F-2144

Date: Jan 17, 2018 - 9:38am User: mlp File: N:\WRD\report\FIG X.dwg

N:\WRD\report\FIG X.dwg LAYOUT: LAYOUT
Jan 17, 2018 - 9:38am LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



Date: Jan 17, 2018 - 9:38am User: mlp File: N:\WRD\report\FIG X.dwg

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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

PROPOSED OCR DUE DILIGENCE

OUTLET PROFILE

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	JLR
DRAFTED	MLP
FILE	FIG X.dwg
FIGURE	6

Freese and Nichols, Inc.
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Appendix B

Boring Logs and Boring Log Legend & Nomenclature

FREESE AND NICHOLS

LOG OF BORING NO. B-101

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.786508

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.521568

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	31			SANDY LEAN CLAY, brown and dark gray, hard, dry, some silt									
	U-2		4.5 (P)	40				11		75	29	15	14			
5	U-3		4.5 (P)	44			-trace calcareous particles, slightly moist at 4 feet									
	U-4		3.5 (P)	42			6/ LEAN CLAY, light brown, very stiff, moist, trace calcareous particles, with sand									
	U-5		1.75 (P)	54			8/ SANDY LEAN CLAY, light brown and red-brown, mottled, moist, stiff, very fine-grained, with sand (Beaumont Formation)	19	104	71	42	16	26	0.74	15.1	
10																
	U-6		1.5 (P)	46												
15																
	U-7		2.5 (P)	29			18/ SILTY LEAN CLAY, red-brown, very stiff, wet, trace calcareous particles (Beaumont Formation)									
20																
	U-8		4.5 (P)	63			23/ SILTY LEAN CLAY, red-brown, hard, moist, trace calcareous fragments, fragments have trace fossils-root traces (Beaumont Formation)									
25																
	SPT-9	2-4-4 (8)					28/ SILTY SAND, red-brown, loose, wet, trace clay (Beaumont Formation)									

Water Observations:
11.1 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-101

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.786508

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.521568

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SILTY SAND, red-brown, loose, wet, trace clay (Beaumont Formation) *(continued)*									
33	SPT-10	6-9-11 (20)					LEAN CLAY, red-brown, very stiff, moist, with sand (Beaumont Formation)									
35																
38	U-11		3.75 (P)	88			FAT CLAY, yellow-brown and light gray, very stiff, moist, trace sand lenses, trace fossil fragments (Beaumont Formation)	33	91		70	23	47	2.88	3.7	
40																
43	U-12		2.25 (P)	94			LEAN CLAY, yellow-brown and light gray, very stiff, moist, with sand lenses and sandy partings (Beaumont Formation)									
45																
48	U-13		0.75 (P)	100			CLAYEY SAND, yellow-brown, wet (Beaumont Formation)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
11.1 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-102

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.794536
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.510766
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	SPT-1	4-6-8 (14)					SANDY LEAN CLAY, dark brown, stiff to hard, dry, trace red-brown clay seams									
	U-2		4.5 (P)	33				12		51	29	13	16			
5	U-3			52			-sand layer from 4 to 4.5 feet									
	SPT-4	6-6-6 (12)					6/ SAND, light brown and red-brown, medium dense to loose, dry, medium-to-fine-grained (Alluvium)									
	SPT-5	7-5-5 (10)														
10																
						▽										
	SPT-6	2-2-3 (5)						24								
15																
	SPT-7	7-8-6 (14)														
20							19.3/ LEAN CLAY, red-brown, stiff, moist (Beaumont Formation)									
	U-8		1.0 (P)	23			23/ SANDY SILT, light brown, wet, fine-to-medium-grained, medium stiff to stiff (Beaumont Formation)	24		68	NP	NP	NP			
25																
	SPT-9	4-5-8 (13)					28/ FAT CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation)	28		100	67	23	44			

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-102

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.794536

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.510766

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation) *(continued)*									
	U-10			75												
35							CLAYEY SAND, dark brown, moist (Beaumont Formation) 34.5/									
	U-11			83												
40																
	SPT-12	5-5-6 (11)					LEAN CLAY, light green-gray, stiff, moist, fine-grained glauconitic sand 43/									
45																
	SPT-13	3-2-4 (6)														
50							Total boring depth 49.5 ft.									
55																

Water Observations:
13 ft At time of drilling

Remarks:

LOG OF BORING NO. B-103

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.793430

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.499829

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		2.75 (P)	42			FAT CLAY, dark brown, very stiff, moist, trace sand (Alluvium)									
	U-2		2.75 (P)	44												
5	U-3		2.0 (P)	56			4/ FAT CLAY, light brown, stiff to very stiff, moist, some sand, trace calcareous particles, trace iron staining (Alluvium) -with sand at 7 feet	27		91	79	30	49			
	U-4		1.75 (P)	67			7/ CLAYEY SAND, light brown, moist, fine-grained (Alluvium)									
	U-5		1.75 (P)	69												
10							9.5/ SANDY LEAN CLAY, light brown and light gray, stiff, moist, mottled (Alluvium)									
15	U-6		3.5 (P)	75			13/ FAT CLAY, red-brown, very stiff, moist, trace light gray lenses, trace fine-grained sand (Beaumont Formation)									
20	U-7		3.5 (P)	100				26	100	99	62	22	40	1.23	2.9	
	U-8			67			23/ CLAYEY SAND, light brown and red-brown, wet, fine-to-medium-grained (Beaumont Formation)									
25							24.8/ SAND, light brown, wet, trace clay (Beaumont Formation)									
	SPT-9	4-5-6 (11)					28/ CLAYEY SAND, red-brown, loose, wet, fine-grained (Beaumont Formation)	28								

Water Observations:
23 ft At time of drilling
14.4 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-103

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.793430

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.499829

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, loose, wet, fine-grained (Beaumont Formation) *(continued)*									
	SPT-10	4-3-4 (7)														
35							LEAN CLAY, red-brown, medium stiff, moist, some sand, trace fossils (Beaumont Formation) 34.2/									
	U-11		4.5 (P)	75			LEAN CLAY, red-brown, hard, moist, trace sand, trace iron stain 38/									
40																
	U-12		4.5 (P)	71				18		99	49	19	30			
45																
	U-13		4.5 (P)	79												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
23 ft At time of drilling
14.4 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-104

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.778061
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.511963
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	SPT-1	5-9-6 (15)				LEAN CLAY, light gray and brown, stiff, dry, 3 inch layer of gravel and fossil material on road, with sand (Fill)									
	U-2	5-4-5 (9)				-charcoal fragments at 2.5 feet									
3						SANDY LEAN CLAY, light gray and light brown, very stiff, dry, fine-grained (Alluvium)									
5	U-3		3.0 (P)	33											
	U-4		3.5 (P)	48			18	111	53	34	13	21	0.78	5.6	
8						SANDY LEAN CLAY, light gray, moist, natural (Alluvium)									
	U-5			71											
10															
	SPT-6	7-7-10 (17)				-coloring to light brown at 13 feet	20		57						
15															
20						SAND, light brown, medium dense, wet, fine-to-medium grained (Beaumont Formation)									
	SPT-7	3-5-8 (13)													
23						FAT CLAY, red-brown, stiff, moist, trace fine-grained sand (Beaumont Formation)									
	SPT-8	4-6-6 (12)													
25															
	U-9		2.25 (P)	100			29	95	100	63	25	38	1.48	3.6	
29.5															

Water Observations:
11.1 ft At time of drilling

Remarks: 0-15 feet - continuous flight auger; 15-50 feet - rotary wash.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-104

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.778061

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.511963

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, moist, fine-to-medium grained (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	75												
35																
38	SPT-11	3-3-5 (8)					LEAN CLAY, light green-gray, medium stiff to stiff, moist, glauconitic, highly plastic (Beaumont Formation)									
40																
	U-12		1.75 (P)	100			-2 inch chert fragments and 1/4 inch shell fragments, trace fossils at 43.2 feet									
45																
	U-13		0.75 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
11.1 ft At time of drilling

Remarks:
0-15 feet - continuous flight auger; 15-50 feet - rotary wash.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-105

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.782660

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.503300

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5+ (P)	81			FAT CLAY, dark brown, hard, dry, trace roots and sand									
	U-2		4.5+ (P)	29												
5	U-3		2.5 (P)	40			4/ FAT CLAY, dark brown, very stiff, moist									
	U-4		2.25 (P)	31			-coloring change to light grayish-brown, trace calcareous particles at 6 feet									
	U-5		2.5 (P)	52			8/ FAT CLAY, red-brown and light gray, very stiff, moist, trace calcareous particles (Beaumont Formation)	22		95	61	21	40			
10																
	U-6		3.75 (P)	83			13/ SILTY FAT CLAY, red-brown and light gray, very stiff, moist (Beaumont Formation)	22	108	100	50	20	30	3.33	8.7	
15																
	U-7		3.5 (P)	63												
20																
	U-8			79			23/ CLAYEY SAND, red-brown, moist, very-fine-to fine-grained, medium dense, trace clay and silt (Beaumont Formation)	21			25	20	5			
25																
	U-9		1.5 (P)	100												

Water Observations:
Dry At Time Of Drilling

Remarks: 0-25 feet - continuous flight auger; rotary wash - 25-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-105

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.782660

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.503300

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, moist, very-fine-to fine-grained, medium dense, trace clay and silt (Beaumont Formation) *(continued)*									
	SPT-10	6-8-9 (17)														
35																
38							SILTY FAT CLAY, yellow-brown, stiff to hard, moist, trace sand (Beaumont Formation)									
	SPT-11	4-5-6 (11)						24		92	53	20	33			
40																
	SPT-12	4-5-6 (11)														
45																
	U-13		4.5+ (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
Dry At Time Of Drilling

Remarks:
0-25 feet - continuous flight auger; rotary wash - 25-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-106

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/6/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.795140
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.491122
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/6/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		1.0 (P)	33			FAT CLAY, dark brown, medium stiff to stiff, moist, trace silt -grading into light gray below 1 foot									
	U-2		1.5 (P)	44												
5	U-3		3.0 (P)	83			LEAN CLAY, red-brown, very stiff, moist, trace iron stain, trace fine-grained sand (Beaumont Formation) 4/									
	U-4		2.25 (P)	100				18		96	38	17	21			
	U-5		1.5 (P)	100			SANDY LEAN CLAY, red-brown, moist to wet, stiff, some light gray clayey sand (Beaumont Formation) 8/	22		94	29	19	10			
10																
	U-6		1.25 (P)	100			SANDY LEAN CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation) 13/	23	109	92	31	20	11	1.47	10.2	
15																
	SPT-7	1-2-3 (5)					SAND, red-brown, loose, wet, fine-to-medium grained, trace clay (Beaumont Formation) 18/									
20																
	SPT-8	3-4-5 (9)														
25																
	SPT-9	15-15-12 (27)					SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation) 28/									

Water Observations:
13 ft At time of drilling
12.5 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-106

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/6/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.795140
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.491122
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/6/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation) *(continued)*									
	U-10		3.75 (P)	100			SANDY LEAN CLAY, red-brown, very stiff, moist, glauconitic clay mottling, trace clayey sand seams (Beaumont Formation) 33/									
35																
	U-11		3.75 (P)	100												
40							-with 2-inch seam and sub-angular gravel fragments, iron staining and trace calcareous particles at 39.5 feet									
	U-12		1.75 (P)	92			CLAYEY SAND, red-brown, moist (Beaumont Formation) 43/									
45																
	U-13		4.5+ (P)	83			SANDY CLAY, green-gray and red-brown, hard, dry, iron staining, trace lignite particles (Beaumont Formation) 48/									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling
12.5 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-107

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.771155
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.507484
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		3.75 (P)	40			FAT CLAY, dark brown, very stiff, dry, trace fine-grained sand (Residual Soil)									
	U-2		2.5 (P)	40												
5	U-3		3.25 (P)	52												
	U-4		3.5 (P)	67			5.5/ FAT CLAY, light gray and red-brown, very stiff, dry, with fine-to-medium grained sand, trace calcareous particles, mottled, trace iron stain (Beaumont Formation)	18	114	82	55	18	37	2.88	10.8	
	U-5		3.5 (P)													
10																
	U-6		2.5 (P)				13/ CLAYEY SAND, red-brown, moist to wet, medium dense, fine-grained (Beaumont Formation)									
15																
	SPT-7	13-15-19 (34)					18/ SAND, brown, dense, wet, fine-to-medium grained, trace clay (Beaumont Formation)									
20																
	SPT-8	12-20-29 (49)														
25																
	U-9			75			28/ FAT CLAY, red-brown, hard to very stiff, dry, trace fine-grained sand (Beaumont Formation)									

Water Observations:

13 ft At time of drilling

12.2 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring backfilled with cutting and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-107

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.771155

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.507484

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, hard to very stiff, dry, trace fine-grained sand (Beaumont Formation) *(continued)*									
							-hard at 33 feet									
	U-10		4.25 (P)	65				27	98	100	67	26	41	2.2	3.3	
35																
							-trace gypsum particles and laminations at 38 feet									
	U-11		3.5 (P)	83			-trace glauconitic clay partings at 39 feet									
40																
							LEAN CLAY, light brown and light gray, very stiff, dry, mottled, trace fine-grained sand, trace iron stained sand seams (Beaumont Formation)									43/
	U-12		2.75 (P)	100												
45																
							-vertical glauconitic clay seams from 48 to 50 feet									
	U-13		2.25 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling
12.2 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring backfilled with cutting and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-108

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.776183

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.497995

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/28/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	54			SILTY LEAN CLAY, light gray and light brown, hard, moist, with fine-grained sand									
	U-2		4.5+ (P)	50			2/ LEAN CLAY, dark brown, hard, dry, trace calcareous particles with trace fine-grained sand (Alluvium)	19		84	45	16	29			
5	U-3		3.0 (P)	35			-moist at 4 feet									
	U-4		4.5 (P)	83			6/ SANDY LEAN CLAY, light gray and yellow-brown, hard, moist, with fine-grained sand (Alluvium)									
	U-5		2.0 (P)	27			8/ SANDY LEAN CLAY, light gray and yellow-brown, stiff, dry, with fine-grained sand, trace iron staining (Alluvium)	17		79	41	17	24			
10																
	SPT-6	1-1-3 (4)					13/ SAND, light brown, very loose, wet, trace clay									
15																
	SPT-7	3-5-6 (11)					18/ FAT CLAY, red-brown, stiff, wet, trace sand and silt (Beaumont Formation)									
20																
	SPT-8	9-9-10 (19)					23/ SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation)									
25																
	SPT-9	4-5-6 (11)					28/ SANDY LEAN CLAY, red-brown, stiff, wet, trace sand (Beaumont Formation)									

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-108

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.776183

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.497995

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/28/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, red-brown, stiff, wet, trace sand (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	117			33/ LEAN CLAY, red-brown, very stiff, moist, trace calcite crystals, with silt (Beaumont Formation)									
35																
	U-11		1.5 (P)	75			38/ FAT CLAY, light gray and light brown, stiff, trace silt (Beaumont Formation)	33	91	98	64	26	38	1.5	3.1	
40																
	U-12		2.0 (P)	83												
45																
	U-13		0.75 (P)	71			48/ GLAUCONITIC CLAY, green-gray, medium stiff, moist, with glauconitic sands (Beaumont Formation)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-109

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/2/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.781662

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.488091

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/2/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		3.5 (P)	29			LEAN CLAY, light brown, very stiff, medium-to-fine grained 0.5/									
							FAT CLAY, dark brown, hard, very stiff, dry to moist, with sand									
	U-2		4.5 (P)	77												
							-trace fossil fragments at 4 feet									
5	U-3		4.5+ (P)	69												
							LEAN CLAY, red-brown and light brown, hard,dry, with sand, very fine-to-fine gravel 5.8/									
	U-4		4.5 (P)	52			-coloring to light brown at 5.8 feet									
	U-5		4.5 (P)	40			-some fossil fractures and calcareous particles and nodules from 8.5 to 10 feet	13		92	46	17	29			
10																
							FAT CLAY, red-brown, very stiff,moist, little to no sand, silty (Beaumont Formation) 13/									
	U-6		3.5 (P)	79												
15																
							-with fine-grained sand at 18 feet									
	U-7		3.75 (P)	75				25	104	100	56	26	30	3	9.8	
20																
							SAND, red-brown, medium dense, fine-to-medium grained, some clay (Beaumont Formation) 23/									
	SPT-8	4-5-8 (13)														
25																
							LEAN CLAY, red-brown, medium stiff, moist, with sand or sand seams and layers 28/									
	U-9		0.75 (P)	88			29.5/									

Water Observations:
23 ft At time of drilling
17.4 ft After drilling

Remarks: 0-25 feet - continuous flight auger; rotary wash - 25-49.5 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-109

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/2/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.781662
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.488091
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/2/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, light brown, loose to medium dense, wet (Beaumont Formation) *(continued)*									
33	U-10		1.75 (P)	88			SANDY LEAN CLAY, red-brown, stiff, moist, mottled with light gray clay, fine-grained (Beaumont Formation)	24	99	76	47	20	27	2.9	7.3	
35																
38	U-11			63			SAND, light brown, loose, wet, some clay, fine-to-medium grained, with glauconitic sand and calcareous particles (Beaumont Formation)									
40																
43	SPT-12	13-26-37 (63)					SAND, light brown and red-brown, wet, very dense, fine-to-medium grained, trace clay (Beaumont Formation)									
45																
48	SPT-13	5-8-12 (20)					LEAN CLAY, red-brown and green-gray, very stiff, moist, with glauconitic sand, mottled (Beaumont Formation)									
49.5							Total boring depth 49.5 ft.									
50																
55																

Water Observations:
23 ft At time of drilling
17.4 ft After drilling

Remarks:
0-25 feet - continuous flight auger; rotary wash - 25-49.5 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-110

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.761901

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.501403

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	27			LEAN CLAY, light brown to brown, hard, dry, with fine-grained sand									
2	U-2		2.5 (P)	60			SANDY LEAN CLAY, tan and light brown, very stiff, dry, with sand lenses, fine-grained									
4 / 5	U-3		4.5 (P)	50			SANDY LEAN CLAY, light brown and light gray, hard, dry -with calcareous particles from 5.7 to 6 feet	17		72	46	17	29			
6	U-4		4.5 (P)				CLAYEY SAND, red-brown, medium dense, dry, fine-grained -red-brown, wet below 8 feet									
	SPT-5	8-7-7 (14)														
10																
	SPT-6	9-11-14 (25)														
15																
18	SPT-7	4-6-17 (23)					SAND, light brown, very stiff, wet, trace clay									
20																
23	U-8		3.5 (P)	75			FAT CLAY, red-brown, very stiff, moist, fine-grained sand (Beaumont Formation)									
25																
	U-9		3.75 (P)	79				26	102	100	64	30	34	2.98	8.1	

Water Observations:
17 ft At time of drilling
12.1 ft After drilling

Remarks: 0-19.5 feet - continuous flight auger; rotary wash - 19.5-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-110

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.761901

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.501403

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, very stiff, moist, fine-grained sand (Beaumont Formation) *(continued)*									
	U-10		4.5 (P)	92			33/ SANDY LEAN CLAY, light brown, hard, moist, fine-grained, trace iron staining, trace sandy laminations and lenses, trace light clay laminations (Beaumont Formation)	20		71	36	17	19			
35							-with increase of light gray clay laminations below 37 feet									
	U-11		4.25 (P)	83												
40																
	U-12		2.5 (P)	100			43/ LEAN CLAY, light brown and light gray, very stiff, moist, mottled, trace sandy partings									
45																
	U-13		2.75 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
17 ft At time of drilling
12.1 ft After drilling

Remarks: 0-19.5 feet - continuous flight auger; rotary wash - 19.5-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

LOG OF BORING NO. B-111

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.767370

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.493600

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	52		FAT CLAY, dark brown, hard, dry, trace fine-grained sand and calcareous particles (Residual Soil)									
	U-2		4.5 (P)	33											
4/						FAT CLAY, light gray, stiff, moist, trace calcareous particles and nodules (Residual Soil) -with small calcareous cobbles approximately 4 inches in diameter below 6 feet -transitions into sandy fat clay at 6 feet									
5	U-3		1.25 (P)	54											
	U-4		2.0 (P)	46			19		85	54	19	35			
8/						FAT CLAY, red-brown and light gray, very stiff, moist, mottled, trace calcareous particles (Beaumont Formation)									
	U-5		2.75 (P)	48			17	113	98	72	26	46	1.8	7.5	
10															
	U-6														
15															
16/						CLAYEY SAND, red-brown, loose, wet (Beaumont Formation)									
18/						FAT CLAY, red-brown, stiff, moist, trace light brown very fine-grained sand lenses (Beaumont Formation)									
	SPT-7	4-6-6 (12)													
20															
	SPT-8	3-5-6 (11)					33		100	75	31	44			
25															
28/						SANDY LEAN CLAY, red-brown, very stiff, moist to wet, with very fine-grained sand (Beaumont Formation)									
	U-9		3.75 (P)	100											

Water Observations:
10.8 ft Seepage at time of drilling
28 ft 24 hours after drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-111

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.767370
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.493600
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, red-brown, very stiff, moist to wet, with very fine-grained sand (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	88			FAT CLAY, red-brown, very stiff, moist (Beaumont Formation) 33/	27	99	100	78	33	45	2.55	6.3	
35							-with sand and trace laminations alternating light gray and light brown at 34.9 feet									
	U-11		3.5 (P)	100												
40																
	U-12		2.0 (P)	100			FAT CLAY, light gray and light brown, stiff to very stiff, moist, mottled, little to no sand, glauconitic (Beaumont Formation) 43/									
45																
	U-13		1.5 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
10.8 ft Seepage at time of drilling
28 ft 24 hours after drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-112

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/1/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.770625
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.487129
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/1/2017
Drill Method: CFA & Rotary Wash
Elevation:

SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
U-1		.25 (P)	42		CLAYEY SAND, light brown, very loose to loose									
SPT-2	3-4-3 (7)													
SPT-3	3-1-4 (5)				3.8/ CLAYEY SAND, tan, loose, wet, with crushed fossil and clay, fine-grained sand (Beaumont Formation)	14		35						
SPT-4	2-3-4 (7)													
SPT-5														
SPT-6	6-9-12 (21)				13/ CLAYEY SAND, light brown and red-brown, medium dense, fine-to-medium grained									
U-7		3.0 (P)	92		18/ FAT CLAY, red-brown, very stiff to stiff, moist, trace sand, some silt (Beaumont Formation)	28	96	100	80	35	45	2.36	6.1	
U-8		4.25 (P)	98		-hard to stiff, some sandy layers and lenses below 24 feet	20	110	100	65	28	37	0.78	3.4	
SPT-9	3-4-6 (10)													

Water Observations:
17 ft At time of drilling

Remarks: 0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-112

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/1/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.770625

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.487129

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/1/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, very stiff to stiff, moist, trace sand, some silt (Beaumont Formation) *(continued)*									
35	U-10			88			-light brown to tan, with 2 1/2 inch crushed fossil layer at 33.5 feet -light brown to tan, with 2 1/2 inch crushed fossil layer at 34.5 feet									
40	SPT-11	4-4-3 (7)					CLAYEY SAND, tan, loose, wet, with crushed fossil and clay, fine-grained sand (Beaumont Formation) 38/									
45	SPT-12	5-1-2 (3)					CLAY, light gray, soft, moist , glauconitic (Beaumont Formation) 43/									
50	SPT-13															
							Total boring depth 49.5 ft.									
55																

Water Observations:
17 ft At time of drilling

Remarks: 0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

LOG OF BORING NO. B-113

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.755644

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.498010

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		1.75 (P)	33			SANDY LEAN CLAY, brown, stiff, dry -with trace shell fragments from 0.1 to 0.2 feet									
	U-2		1.75 (P)	33												
5	U-3		4.5 (P)	52			4/ LEAN CLAY, light gray, hard, dry, fossil fragments, mottled with sandy laminations									
	U-4		4.5 (P)	42												
	U-5		4.5 (P)	58				13	122	58	44	18	26	3	4.7	
10																
	SPT-6	5-4-5 (9)					13/ SAND, light brown, loose to very loose, dry, fine-to-medium grained, trace clay									
15						▽										
	SPT-7	1-1-3 (4)					-wet at 18 feet									
20																
	SPT-8	5-7-6 (13)					23/ SANDY LEAN CLAY, light brown, stiff, wet	24		94	27	18	9			
25																
	SPT-9	4-7-9 (16)														

Water Observations:
16 ft At time of drilling

Remarks: 0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-113

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.755644

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.498010

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, light brown, stiff, wet *(continued)*									
33	U-10		4.0 (P)	79			FAT CLAY, red-brown, very stiff to hard, moist, fine-grained sand, trace light gray clay seams and laminations (Beaumont Formation)	24		99	64	28	36			
35																
	U-11		3.25 (P)	94			-trace gypsum in sandy laminations from 38 to 40 feet									
40																
43	U-12		3.5 (P)	100			LEAN CLAY, light brown and light gray, very stiff, moist, mottled, fine-grained sand (Beaumont Formation)									
45																
48	U-13		2.5 (P)	90			FAT CLAY, light green-gray, very stiff, moist, trace light brown laminations, glauconitic (Beaumont Formation)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
16 ft At time of drilling

Remarks:
0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-114

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/29/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.760159

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.489461

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	63			SANDY LEAN CLAY, light brown, hard, dry, trace roots (Residual Soil)									
3/	U-2		4.5 (P)	27			FAT CLAY, light gray, hard to very stiff, dry, trace iron staining, glauconitic (Beaumont Formation)									
5	U-3		3.75 (P)	42												
6/	U-4		3.0 (P)	67			FAT CLAY, red-brown and light gray, very stiff, mist, trace calcareous particles, with sand, mottled (Beaumont Formation)	18		94	55	20	35			
8/	U-5		1.0 (P)	38			SANDY LEAN CLAY, red-brown, medium stiff, moist (Beaumont Formation)									
10																
13/	SPT-6	3-4-5 (9)					FAT CLAY, red-brown, stiff to very stiff, light gray mottling, with sand, very fine-grained (Beaumont Formation)									
15																
	U-7		2.5 (P)	100				26	99	100	71	31	40	2.03	6.7	
20																
23/	U-8		3.75 (P)	88			FAT CLAY, red-brown, very stiff to hard, moist, trace sand lenses (Beaumont Formation)									
25																
28/	U-9		4.5 (P)	100			FAT CLAY, light gray and red-brown, very stiff, moist, mottled, glauconitic, trace sand (Beaumont Formation)	22	102	100	58	25	33	2.7	9.5	

Water Observations:
28 ft At time of drlling
22.7 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-114

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/29/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.760159

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.489461

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, light gray and red-brown, very stiff, moist, mottled, glauconitic, trace sand (Beaumont Formation) *(continued)*									
	U-10		2.75 (P)	100												
35																
	U-11		2.5 (P)	88				25		100	62	26	36			
40																
							-trace calcareous particles from 43 to 45 feet									
	U-12		2.0 (P)	96												
45							-trace fossils (bivalves) at 45 feet									
							-trace sandy lenses from 48 to 50 feet									
	U-13		2.25 (P)													
50							Total boring depth 50.0 ft.									
55																

Water Observations:
28 ft At time of drlling
22.7 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-115

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.767556

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.478401

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	35			SANDY LEAN CLAY, light brown, hard, dry, medium-to-fine grained									
2	U-2		4.5 (P)	27			SANDY LEAN CLAY, brown and orange-brown, hard to very stiff, dry									
5	SPT-3	15-14-16 (30)														
	SPT-4	10-14-8 (22)					-shell fragments and calcareous particles from 6.8 to 7.5 feet	9		74	43	16	27			
8	SPT-5	6-6-10 (16)					SAND, red-brown, medium dense, dry, trace calcareous fragments and chert, trace clay									
10																
13	SPT-6	10-11-12 (23)					SAND, light brown, medium dense to dense, dry									
15																
	SPT-7	6-4-6 (10)					-red-brown, lean clay seam/layer from 19.4 to 19.5 feet									
20																
	SPT-8	11-23-23 (46)														
25																
28	SPT-9	16-21-29 (50)					SAND, light brown, very dense to dense, wet (Beaumont Formation)									

Water Observations:
18 ft At tine of drilling
16.9 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-115

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.767556

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.478401

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, light brown, very dense to dense, wet (Beaumont Formation) *(continued)*									
	SPT-10	11-16-19 (35)					-trace clay from 33 to 34.5 feet									
35																
	U-11		3.0 (P)	73			FAT CLAY, light brown and yellow-brown, very stiff, dry -trace fossil seam from 38.6 to 38.7 feet (38/)	26		95	53	23	30			
40																
	U-12		1.75 (P)	79			LEAN CLAY, yellow-brown, stiff, moist, trace shell fragments and fossil fragments (43/)									
45																
	U-13		4.0 (P)	54			LEAN CLAY, red-brown, hard, moist, trace glauconitic nodules, fine-grained sand (48/)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
18 ft At tine of drilling
16.9 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

BORING LOG LEGEND AND NOMENCLATURE

Abbreviations		
U – Undisturbed Sample (tube)	SPT – Standard Penetration Test	NT – Not Testable
A – Auger Sample	TCP – Texas Cone Penetration	NP – Non Plastic
CS – Continuous Sample	CFA – Continuous Flight Auger	ATD – At Time of Drilling
C – Rock Core	HSA – Hollow Stem Auger	AD – After Drilling

General Terms

Term	Description
Blow Counts	Results from either the Standard Penetration Test (SPT) or the Texas Cone Penetration (TCP) test.
Recovery	Length of sample or core recovered divided by the total length pushed, driven, or cored (expressed as a %)
Rock Quality Designation (RQD)	Cumulative length of unfractured pieces of core material more than 4 inches in length divided by the total length of material cored (expressed as a percentage)

Consistency of Cohesive Soil

Description	Comp. Strength, tsf	SPT Blows	TCP Blows	Criteria
Very Soft	< 0.25	0 – 2	0 – 8	Sample sags under its own weight and is easily deformed
Soft	≥ 0.25 – < 0.5	> 2 – 4	> 8 – 20	Easily pinched between fingers and remolded with light finger pressure
Medium Stiff	≥ 0.5 – < 1.0	> 4 – 8	N/A for TxDOT	Imprinted easily with fingers and remolded with firm finger pressure
Stiff	≥ 1.0 – < 2.0	> 8 – 15	>20 – 40	Imprinted with strong finger pressure or indented easily with fingernail
Very Stiff	≥ 2.0 – < 4.0	> 15 – 30	> 40 to 80	Light imprint from finger or light indent with fingernail
Hard	≥ 4.0	> 30	>80	Difficult to indent with fingernail

Apparent Density of Cohesionless Soil

Description	SPT Blow Count	Texas Cone Blow Count
Very Loose	0 – 4	0 – 8
Loose	> 4 – 10	> 8 – 20
Medium Dense	> 10 – 30	> 20 to 80
Dense	> 30 – 50	80 to ≥ 5”
Very Dense	> 50	0” to < 5”

Soil Structure

Description	Criteria
Stratified	Alternating layers of varying material/color with layers ≥ 1/4-inch thick
Laminated	Alternating layers of varying material/color with layers < 1/4-inch thick
Fissured	Breaks along definite planes with little resistance
Slickensided	Fracture planes appear polished or glossy; shows movement direction
Blocky	Cohesive soil that can be broken into small, angular lumps
Lensed	Inclusion of small pockets of soil that is different from dominate type
Homogenous	Same color and appearance throughout

Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

Textural Adjectives

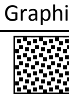
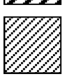
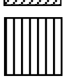
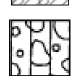
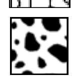
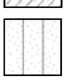
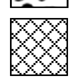
Textural Item	Description
Pit	Pinhole sized openings
Vug	Small openings up to 4 inches in size
Cavity	Opening larger than 4 inches
Honeycomb	Numerous and grouped pits and vugs
Vesicle	Small openings in volcanic rocks

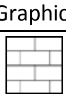
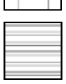
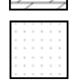
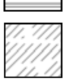
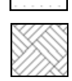
BORING LOG LEGEND AND NOMENCLATURE

Rock Hardness Descriptors			
Grade	Approx. Comp. Strength, tsf	Approx. TCP Range	Field Test
Very Soft	< 10 - 100	>6”	Can be peeled with pocket knife, crumbles under firm blows of geological hammer
Soft	100 - 500	4” - 6”	Can be peeled with pocket knife with difficulty, indented by firm blows of geological hammer
Hard	500 - 1000	1” - 5”	Cannot be peeled with pocket knife, can be fractured by single firm blow of hammer
Very Hard	1000 - 2000	0” - 2”	Specimen requires more than one blow of geological hammer to fracture it
Extremely Hard	> 2000	0”	Specimen requires many blows of geological hammer to fracture it

Degree of Rock Weathering	
Description	Criteria
Unweathered	No evidence of chemical or mechanical alteration
Slightly Weathered	Slight discoloration of surface or discontinuities; < 10% volume altered
Weathered	Discoloring evident; 10 to 50% of volume altered
Highly Weathered	Entire mass discolored; alteration through majority of rock
Decomposed	Rock reduced to soil consistency with some rock-like texture

Rock Bedding Structure	
Description	Criteria
Laminated	< 3/8 inch
Very Thinly Bedded	3/8—1 inch
Thinly Bedded	1 inch—4 inches
Moderately Bedded	4 inches—1 foot
Thickly Bedded	1 foot—3 feet
Very Thickly Bedded	3– 10 feet
Massive	> 10 feet

Soil Column Graphic Symbols*			
Graphic	Represented Soil Types	Graphic	Represented Soil Types
	Fat Clay, Fat Clay with sand, Sandy Fat Clay		Well-Graded Sand or Poorly-Graded Sand; little to no fines
	Lean Clay, Lean Clay with sand, Sandy Lean Clay, Silty Clay		Clayey Gravel, Gravel-Sand-Clay Mixtures
	Inorganic Silt and Organic Silt		Silty Gravel, Gravel-Sand-Silt Mixtures
	Clayey Sand, Clay-Sand Mixtures		Well-Graded Gravel or Poorly-Graded Gravel; little to no fines
	Silty Sands, Sand-Silt Mixtures		Fill with Significant Debris or Deleterious Material

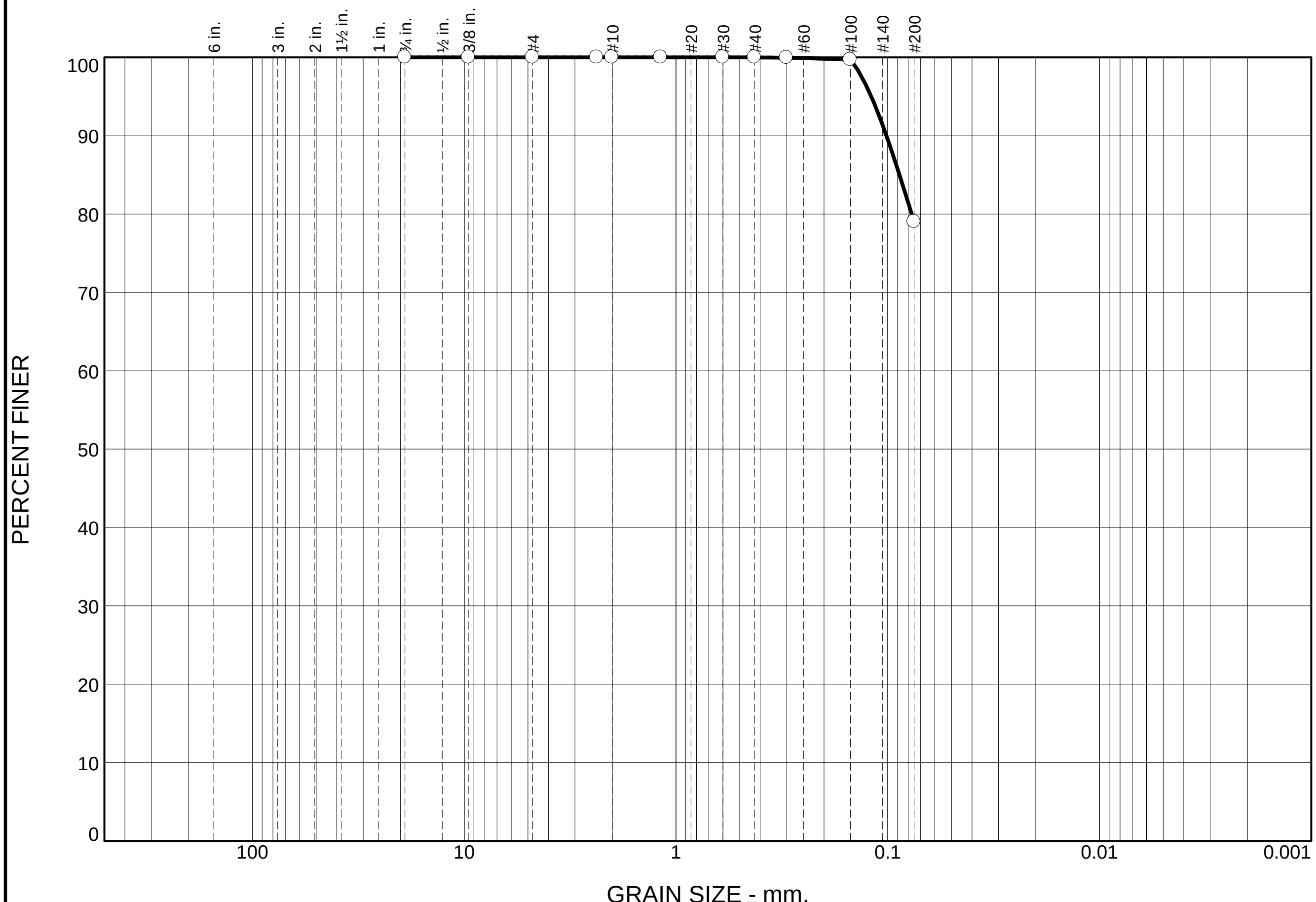
Rock Column Graphic Symbols*			
Graphic	Represented Rock Types	Graphic	Represented Rock Types
	Limestone, Shaly/Marly Limestone, Limestone with Shale		Marl, Marl with Limestone, Marl with Shale
	Shale, Shale with Limestone		Sandstone, Shaly Sandstone, Sandstone with Shale
	Mudstone		Generic Bedrock Symbol

* Combined graphics may be used for dual classifications. Not all graphics represented. Refer to lithology description for soil classification or rock type.

Appendix C

Laboratory Testing Results

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	21.0	79.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0880							

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-101 **Depth:** (28.0-29.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-101
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
211.41	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.10	100.0
			#100	0.61	99.7
			#200	44.37	79.0

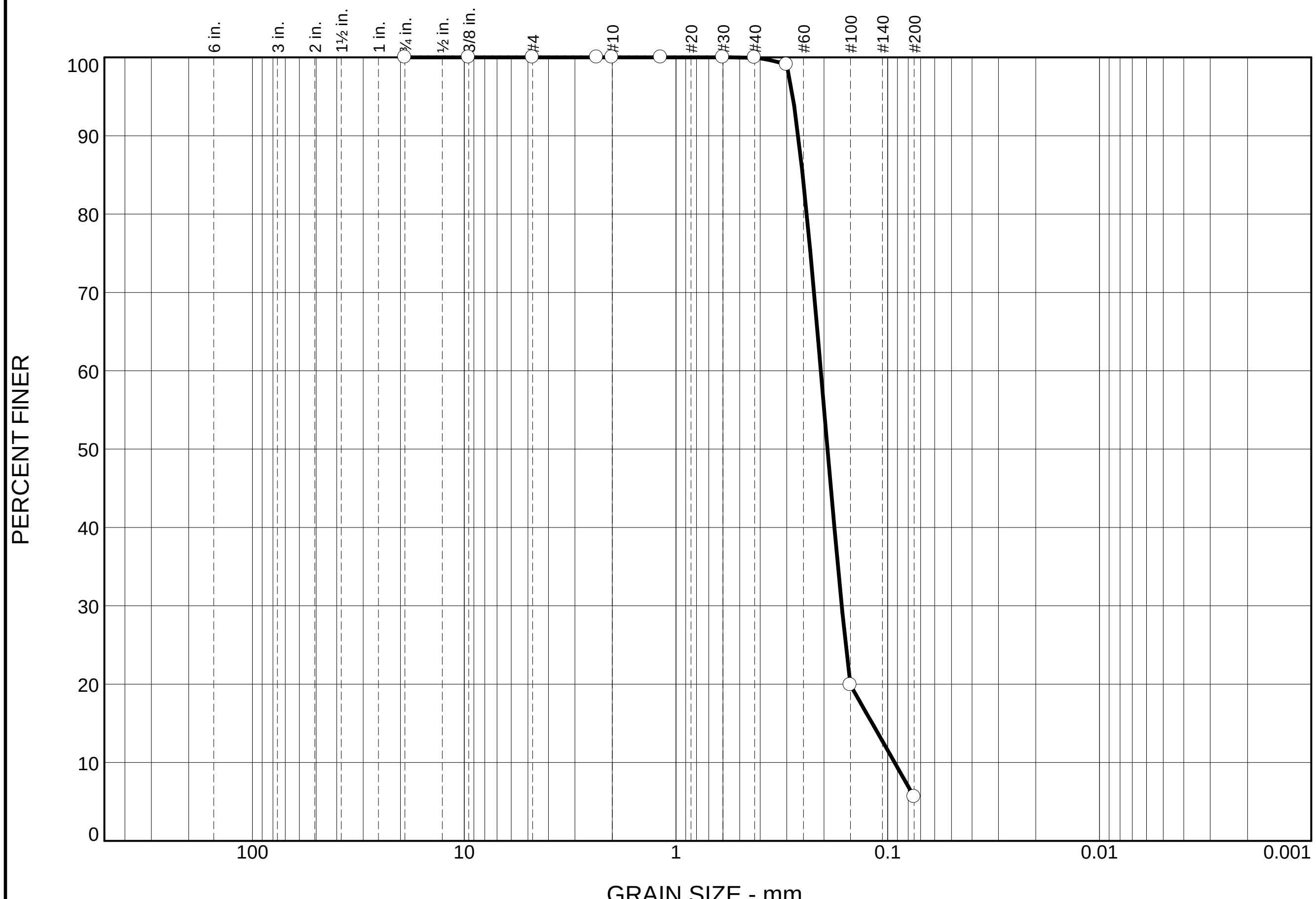
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	21.0	21.0			79.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
								0.0770	0.0880	0.1014	0.1196

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	94.4	5.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2521	0.2069	0.1925	0.1650	0.1183	0.0928	1.42	2.23

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-102 **Depth:** (13.0-14.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-102
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
292.39	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.10	100.0
			#50	2.69	99.1
			#100	234.25	19.9
			#200	275.96	5.6

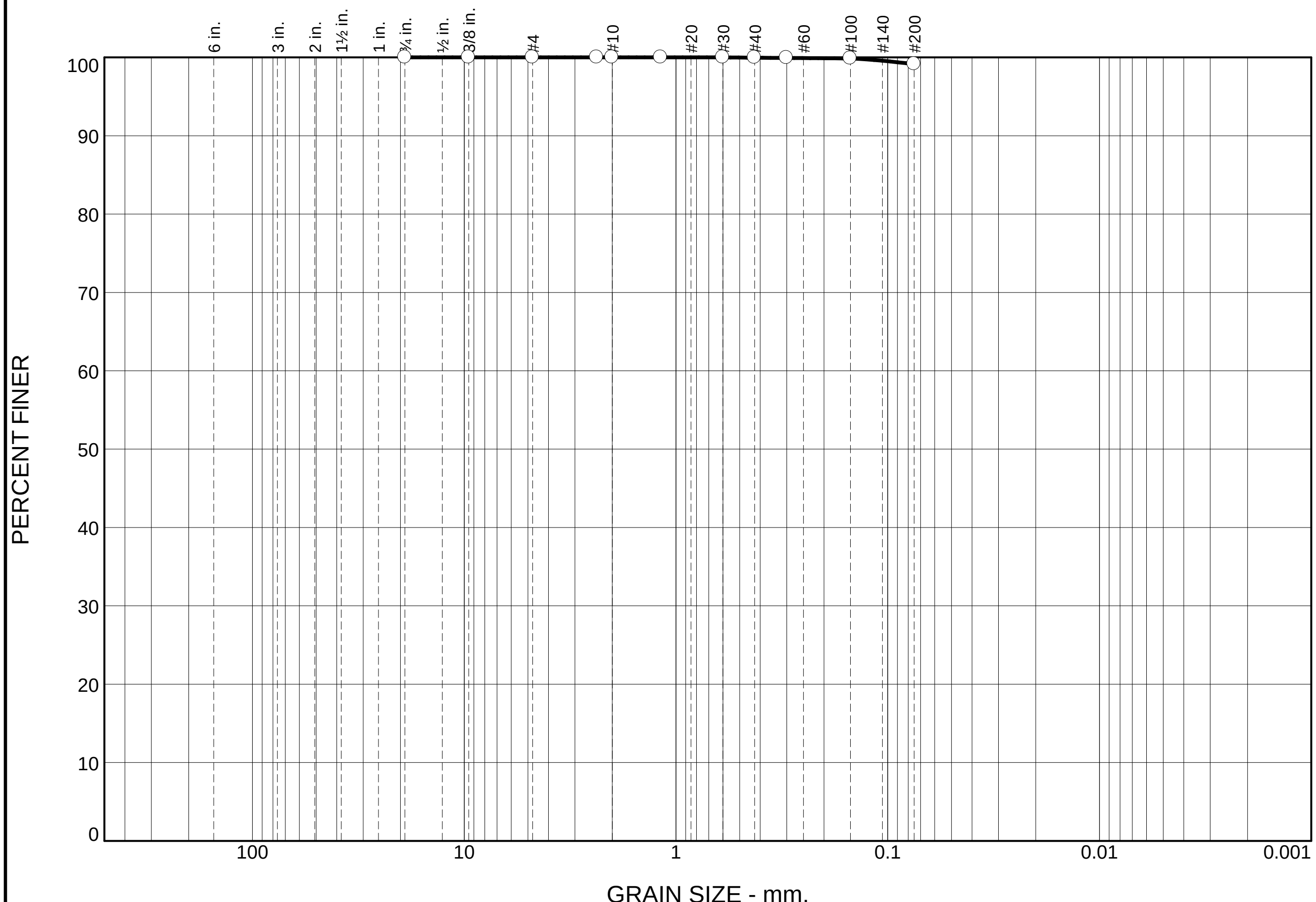
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	94.4	94.4			5.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0928	0.1183	0.1502	0.1650	0.1787	0.1925	0.2069	0.2413	0.2521	0.2648	0.2808

Fineness Modulus	C_u	C_c
0.81	2.23	1.42

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	0.9	99.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-103 **Depth:** (28.0-29.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-103
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
151.30	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.06	100.0
			#50	0.11	99.9
			#100	0.21	99.9
			#200	1.29	99.1

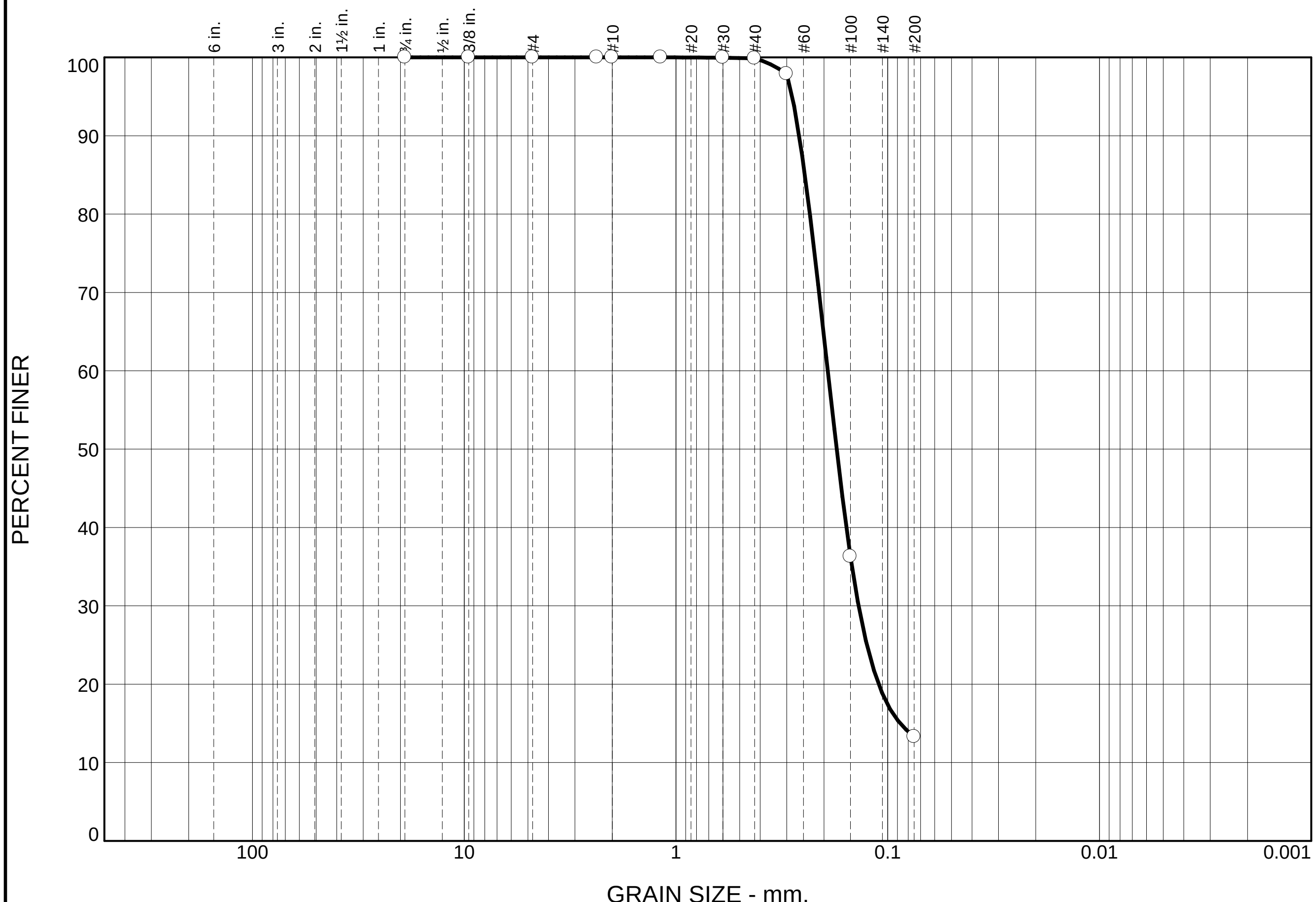
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9			99.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
○	0.0	0.0	0.0	0.0	0.1	86.6	13.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2463	0.1919	0.1743	0.1372	0.0873			

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-104 **Depth:** (20.0-21.5) ft.

Remarks:

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Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-104
Depth: (20.0-21.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
177.85	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.07	100.0
			#40	0.24	99.9
			#50	3.76	97.9
			#100	113.30	36.3
			#200	154.21	13.3

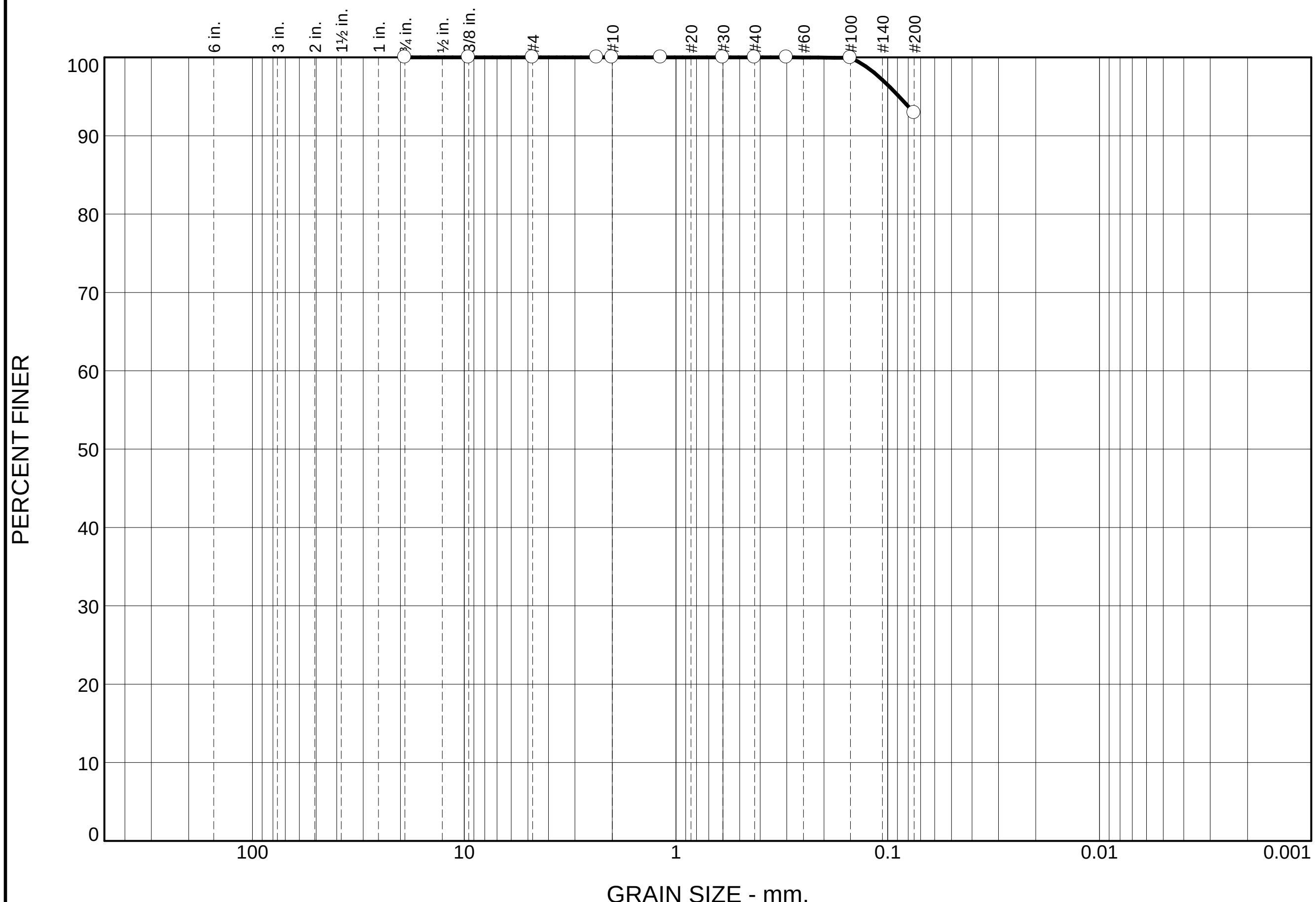
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	86.6	86.7			13.3

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0873	0.1104	0.1372	0.1568	0.1743	0.1919	0.2331	0.2463	0.2619	0.2825

Fineness Modulus
0.66

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	7.1	92.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	25	20								

	Material Description	USCS	AASHTO
○		CL-ML	A-4(3)

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-105 **Depth:** (23.0-25.0) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-105
Depth: (23.0-25.0) ft.
Liquid Limit: 25
Plastic Limit: 20
USCS Classification: CL-ML
AASHTO Classification: A-4(3)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
187.48	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.00	100.0
			#100	0.13	99.9
			#200	13.28	92.9

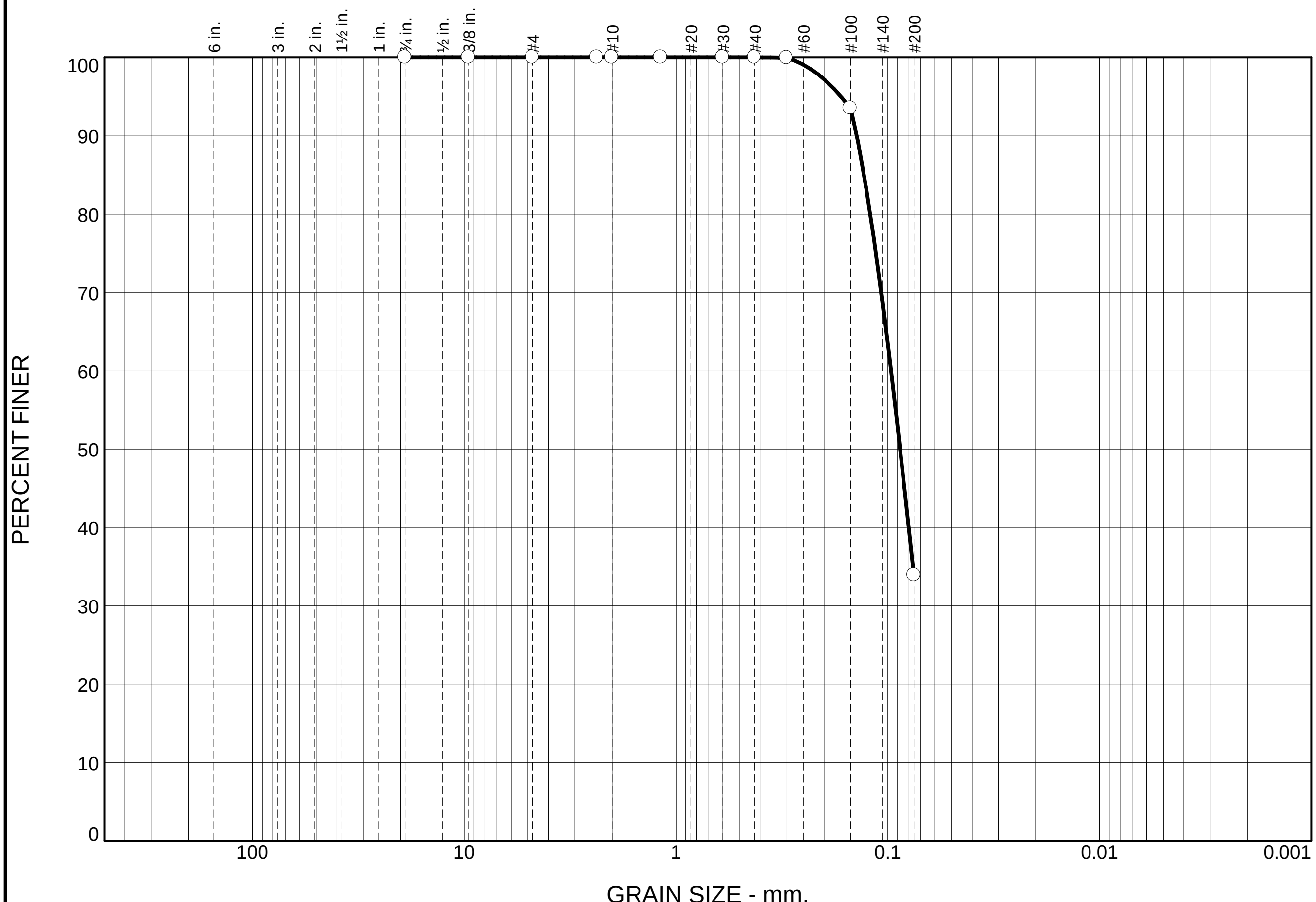
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.1			92.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
											0.0884

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	66.1	33.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1294	0.0965	0.0874					

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-106 **Depth:** (23.0-24.5) ft.

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Houston, Texas

Remarks:

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-106
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
155.29	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.09	99.9
			#100	10.07	93.5
			#200	102.66	33.9

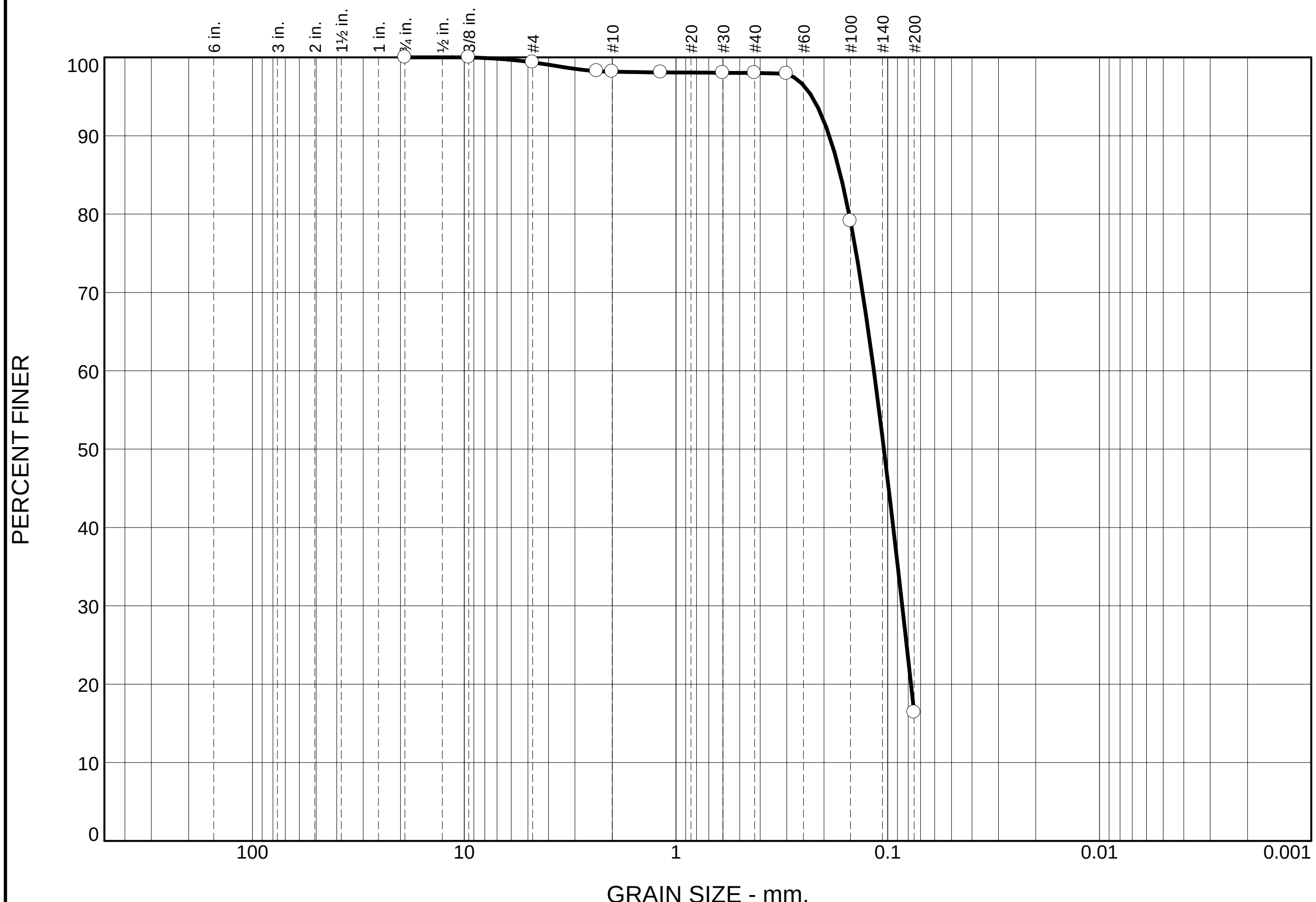
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	66.1	66.1			33.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0794	0.0874	0.0965	0.1209	0.1294	0.1401	0.1663

Fineness Modulus
0.07

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	1.2	0.2	81.6	16.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1672	0.1163	0.1043	0.0854				

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-107 **Depth:** (23.0-24.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-107
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
161.36	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	1.02	99.4
			#8	2.82	98.3
			#10	2.93	98.2
			#16	3.09	98.1
			#30	3.17	98.0
			#40	3.22	98.0
			#50	3.38	97.9
			#100	33.69	79.1
			#200	134.89	16.4

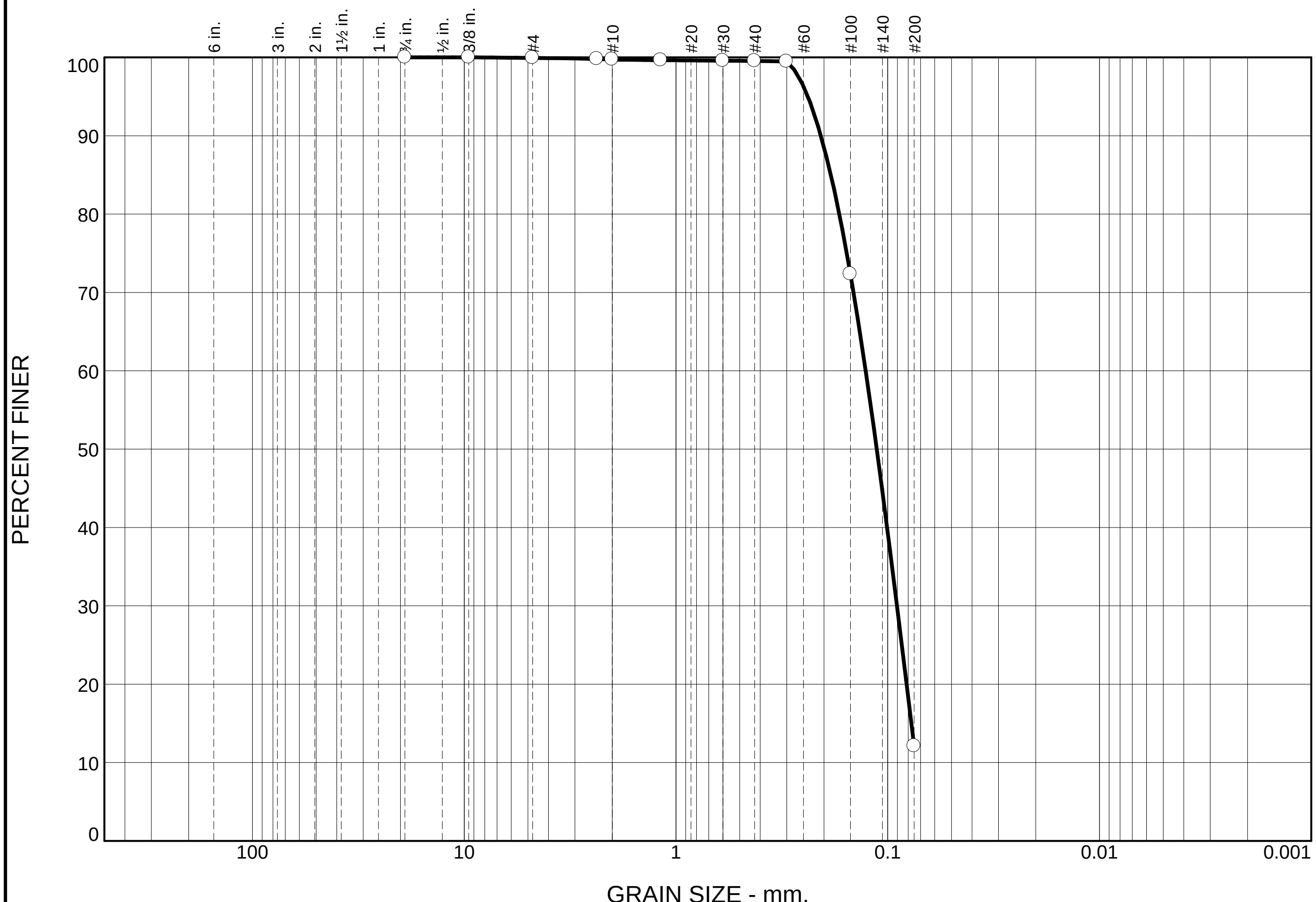
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.6	0.6	1.2	0.2	81.6	83.0			16.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.0776	0.0854	0.0942	0.1043	0.1163	0.1522	0.1672	0.1888	0.2280

Fineness Modulus
0.29

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.1	0.2	0.2	87.4	12.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1856	0.1271	0.1127	0.0904	0.0773			

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-108 **Depth:** (13.0-14.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-108
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
182.08	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.13	99.9
			#8	0.38	99.8
			#10	0.50	99.7
			#16	0.66	99.6
			#30	0.77	99.6
			#40	0.83	99.5
			#50	0.97	99.5
			#100	50.36	72.3
			#200	160.03	12.1

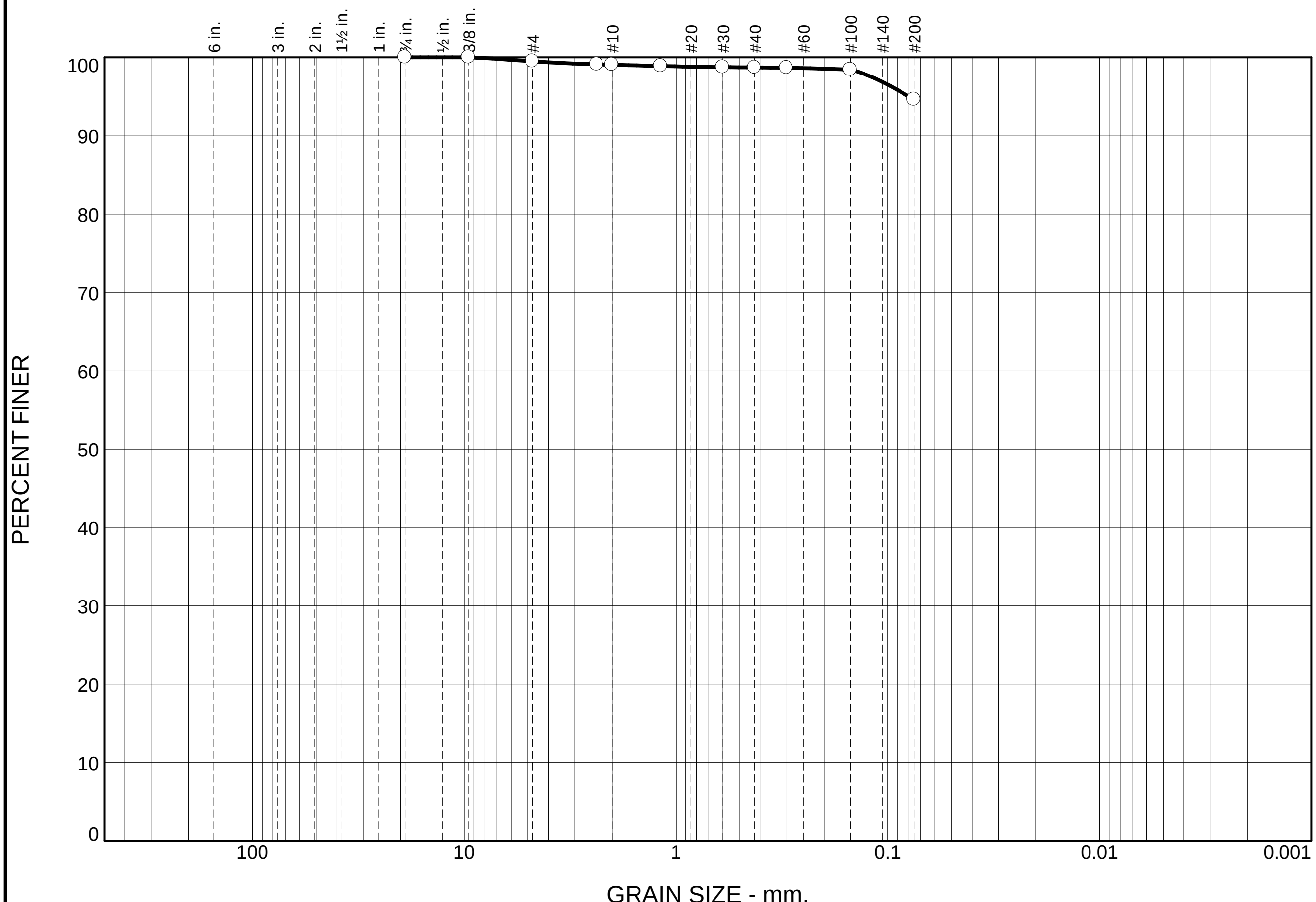
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.1	0.1	0.2	0.2	87.4	87.8			12.1

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0773	0.0814	0.0904	0.1007	0.1127	0.1271	0.1693	0.1856	0.2069	0.2382

Fineness Modulus
0.29

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.4	0.4	4.1	94.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-109 **Depth:** (23.0-24.5) ft.

Remarks:

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Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-109
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
164.71	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.84	99.5
			#8	1.47	99.1
			#10	1.56	99.1
			#16	1.81	98.9
			#30	2.07	98.7
			#40	2.13	98.7
			#50	2.19	98.7
			#100	2.60	98.4
			#200	8.86	94.6

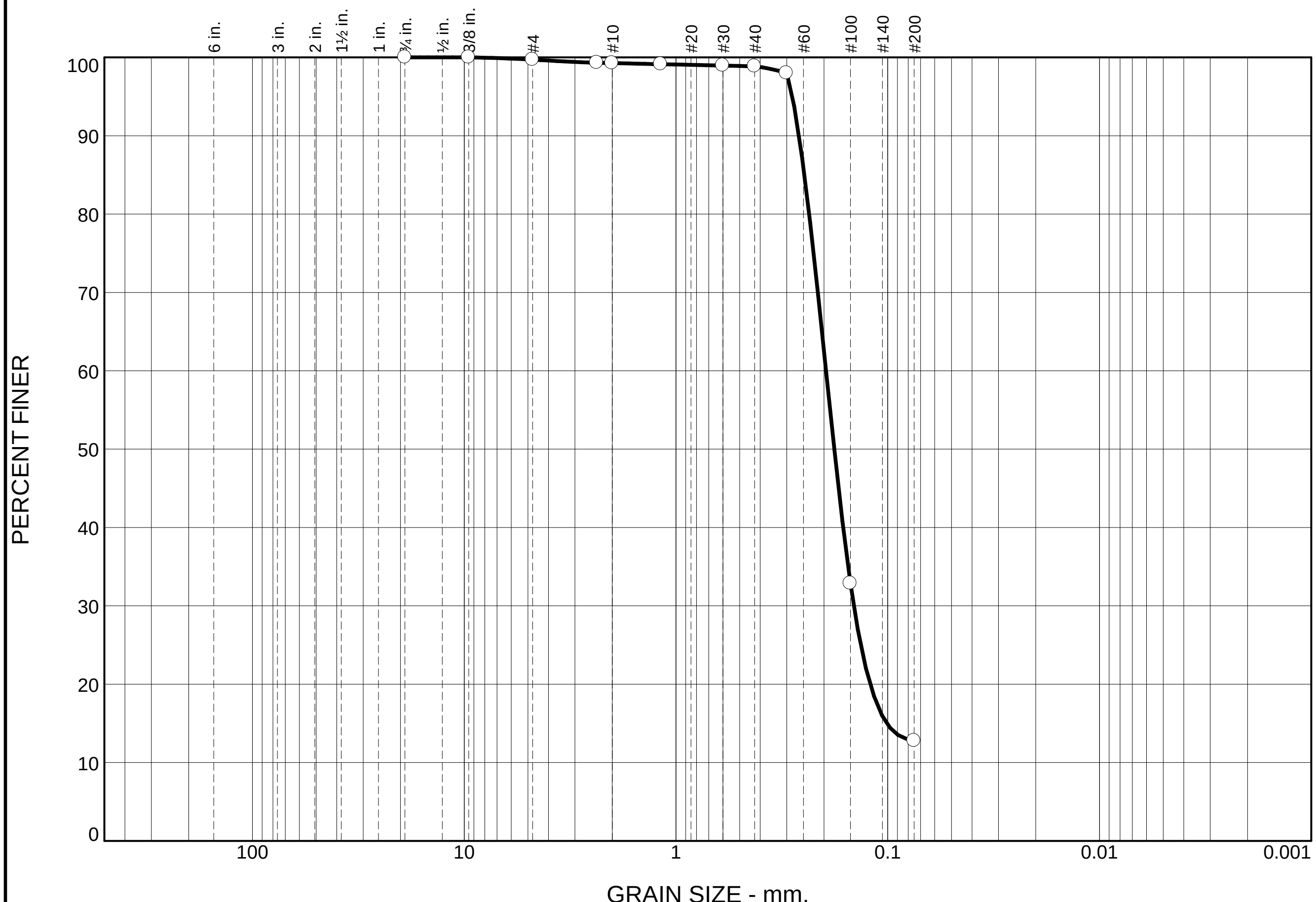
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.5	0.5	0.4	0.4	4.1	4.9			94.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
											0.0793

Fineness Modulus
0.07

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.3	0.4	0.4	86.1	12.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2475	0.1955	0.1788	0.1446	0.1011			

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-110 **Depth:** (18.0-19.5) ft.

Remarks:

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Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-110
Depth: (18.0-19.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
178.12	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.52	99.7
			#8	1.22	99.3
			#10	1.29	99.3
			#16	1.55	99.1
			#30	1.86	99.0
			#40	2.03	98.9
			#50	3.57	98.0
			#100	119.60	32.9
			#200	155.34	12.8

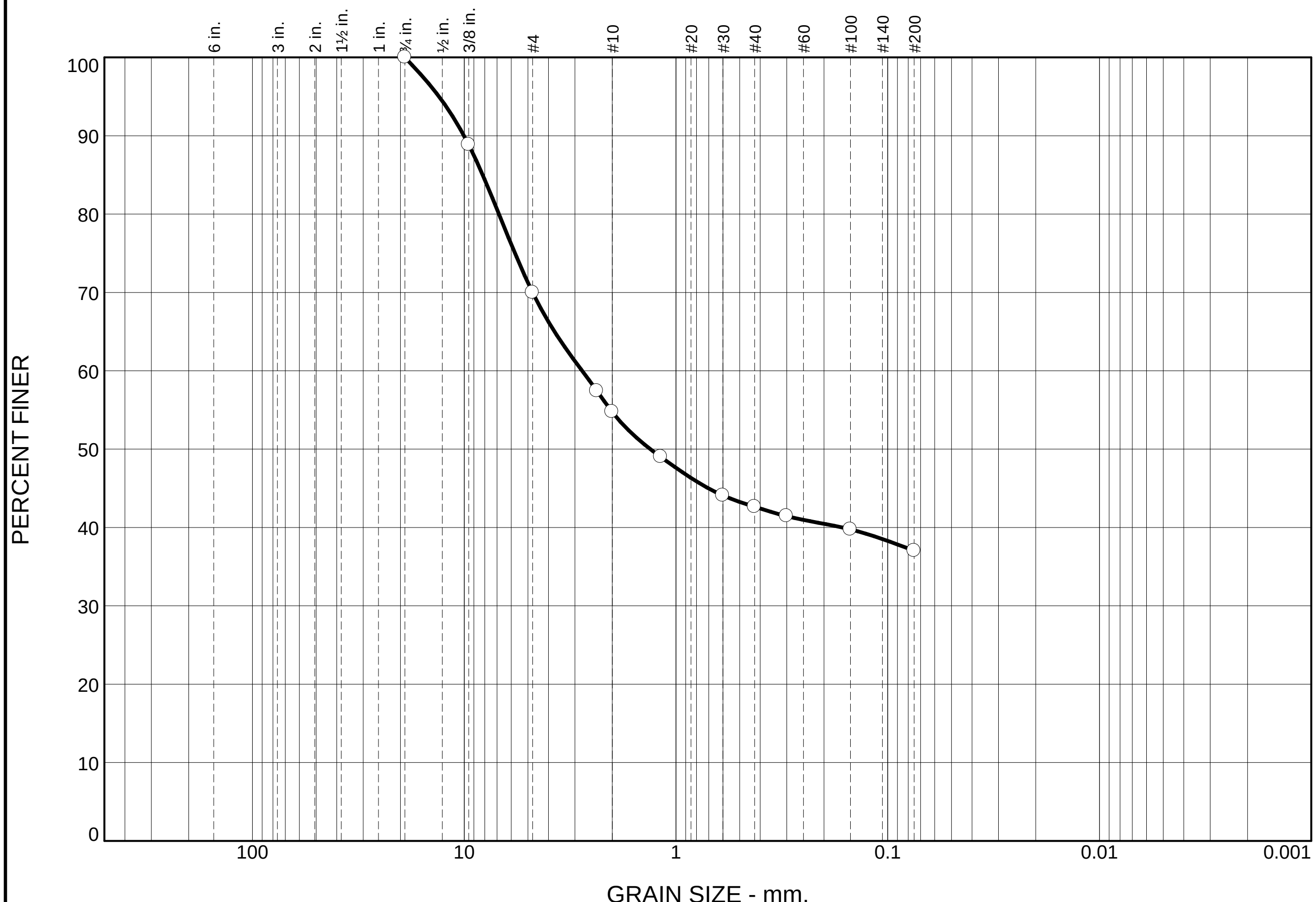
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	0.4	0.4	86.1	86.9			12.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.1011	0.1210	0.1446	0.1624	0.1788	0.1955	0.2349	0.2475	0.2625	0.2822

Fineness Modulus
0.72

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	30.0	15.2	12.2	5.6	37.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			8.1816	2.7755	1.3204					

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-112 **Depth:** (38.0-39.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-112
Depth: (38.0-39.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
166.46	0.00	0.00	0.75"	0.00	100.0
			3/8"	18.55	88.9
			#4	50.00	70.0
			#8	70.88	57.4
			#10	75.32	54.8
			#16	84.87	49.0
			#30	93.08	44.1
			#40	95.47	42.6
			#50	97.47	41.4
			#100	100.28	39.8
			#200	104.81	37.0

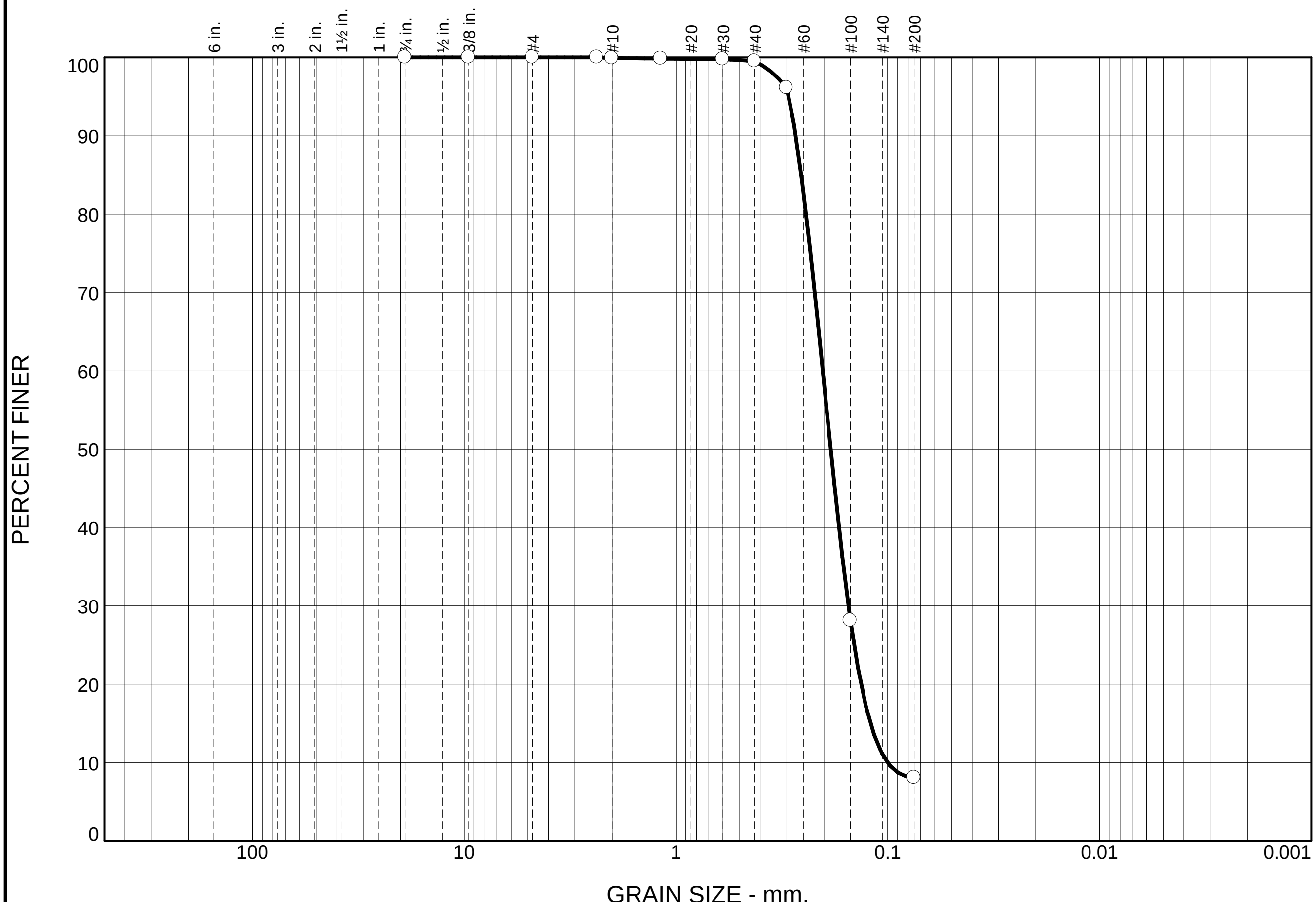
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	30.0	30.0	15.2	12.2	5.6	33.0			37.0

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.1638	1.3204	2.7755	6.8528	8.1816	10.0207	13.1504

Fineness Modulus
3.09

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.4	91.4	8.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2560	0.2026	0.1859	0.1533	0.1206	0.1003	1.16	2.02

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-113 **Depth:** (18.0-19.5) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-113
Depth: (18.0-19.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
220.19	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.19	99.9
			#16	0.33	99.9
			#30	0.50	99.8
			#40	1.07	99.5
			#50	8.56	96.1
			#100	158.25	28.1
			#200	202.38	8.1

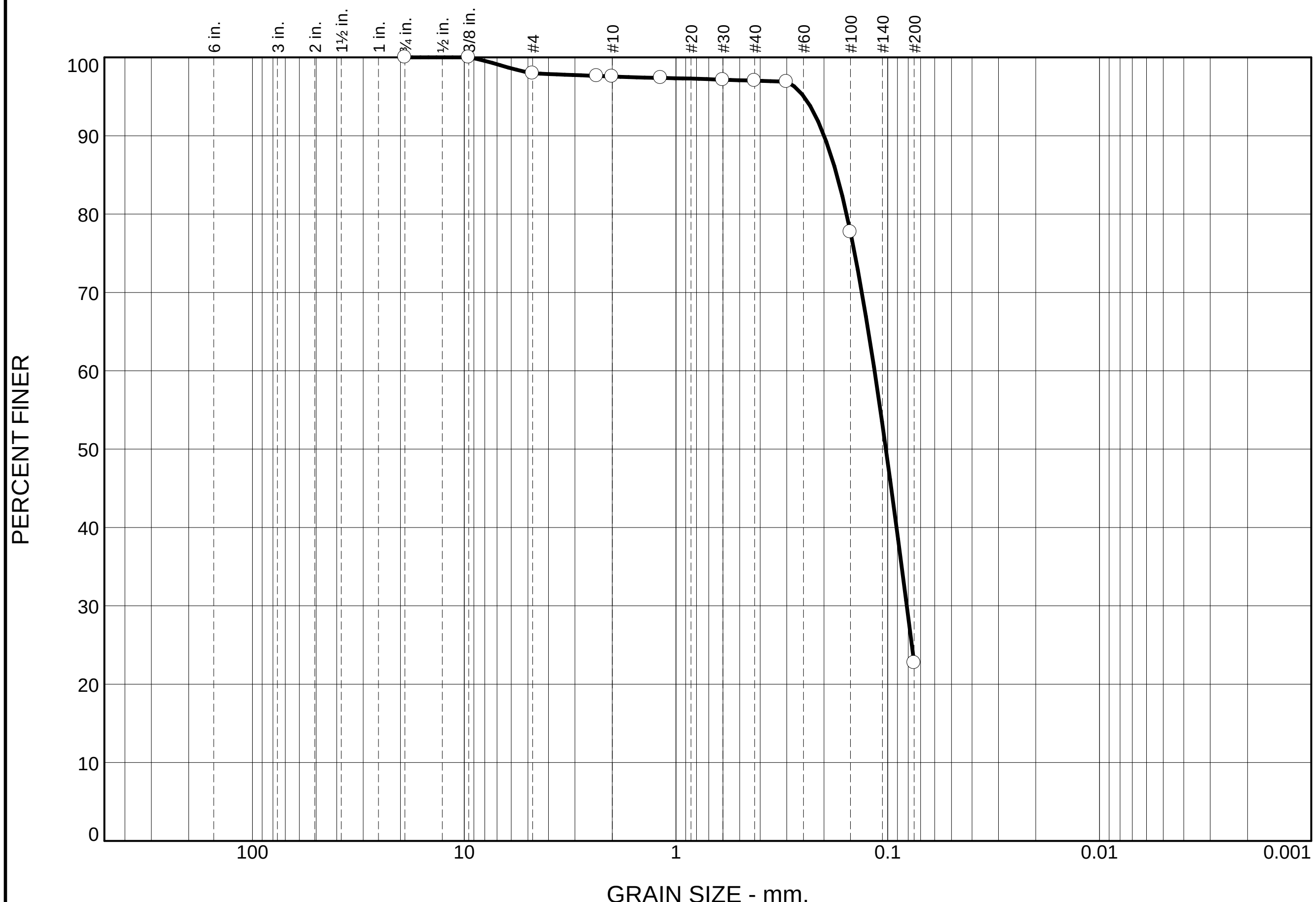
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.1	0.4	91.4	91.9			8.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1003	0.1206	0.1336	0.1533	0.1698	0.1859	0.2026	0.2429	0.2560	0.2718	0.2934

Fineness Modulus	C_u	C_c
0.76	2.02	1.16

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.0	0.4	0.6	74.3	22.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1740	0.1155	0.1020	0.0813				

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-115 **Depth:** (13.0-14.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-115
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
208.62	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	4.25	98.0
			#8	4.94	97.6
			#10	5.09	97.6
			#16	5.48	97.4
			#30	5.99	97.1
			#40	6.20	97.0
			#50	6.49	96.9
			#100	46.49	77.7
			#200	161.22	22.7

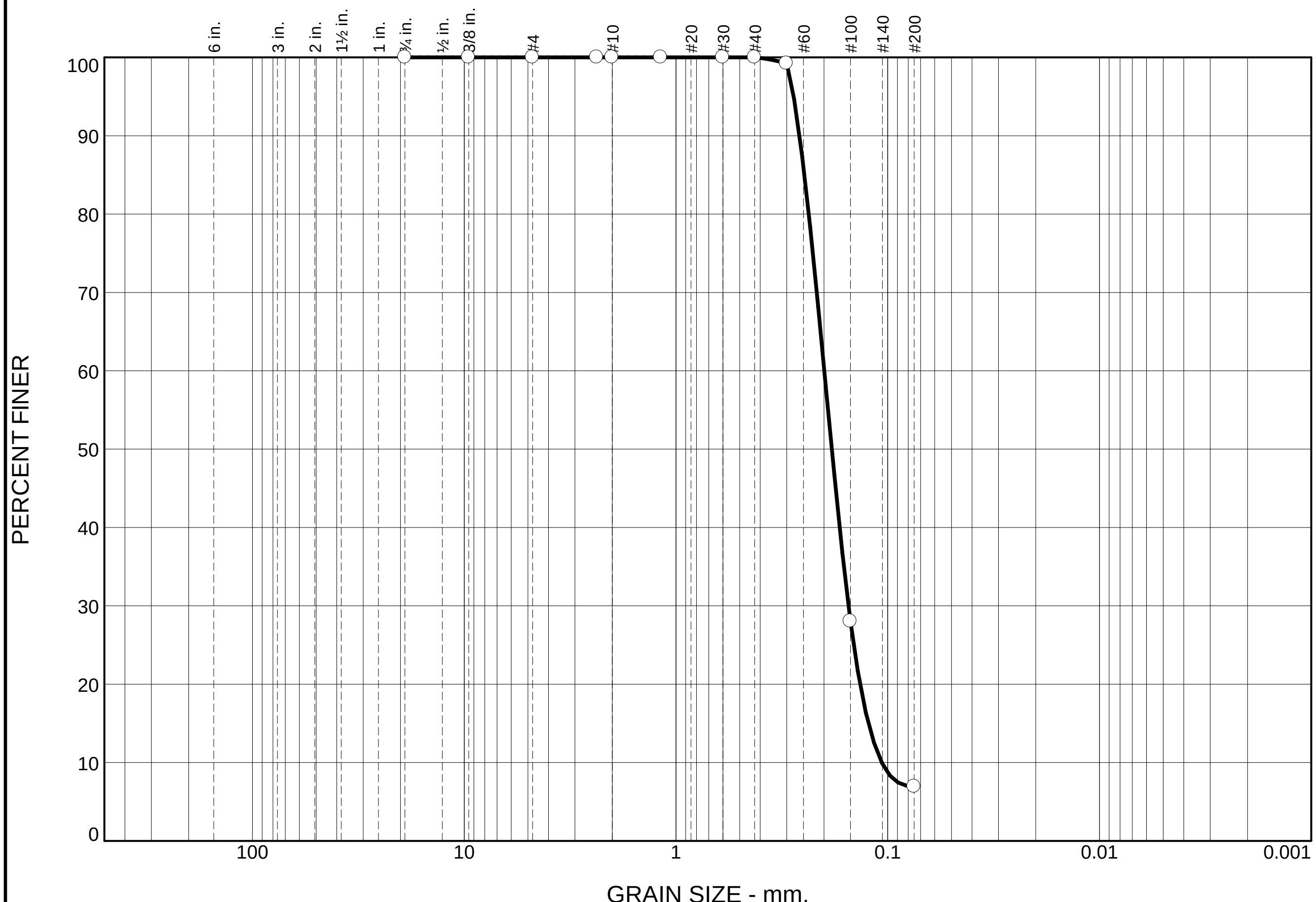
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	2.0	2.0	0.4	0.6	74.3	75.3			22.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0813	0.0909	0.1020	0.1155	0.1565	0.1740	0.1996	0.2487

Fineness Modulus
0.35

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	93.1	6.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2474	0.1992	0.1837	0.1532	0.1233	0.1067	1.10	1.87

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-115 **Depth:** (28.0-29.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-115
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
209.85	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	1.63	99.2
			#100	151.02	28.0
			#200	195.32	6.9

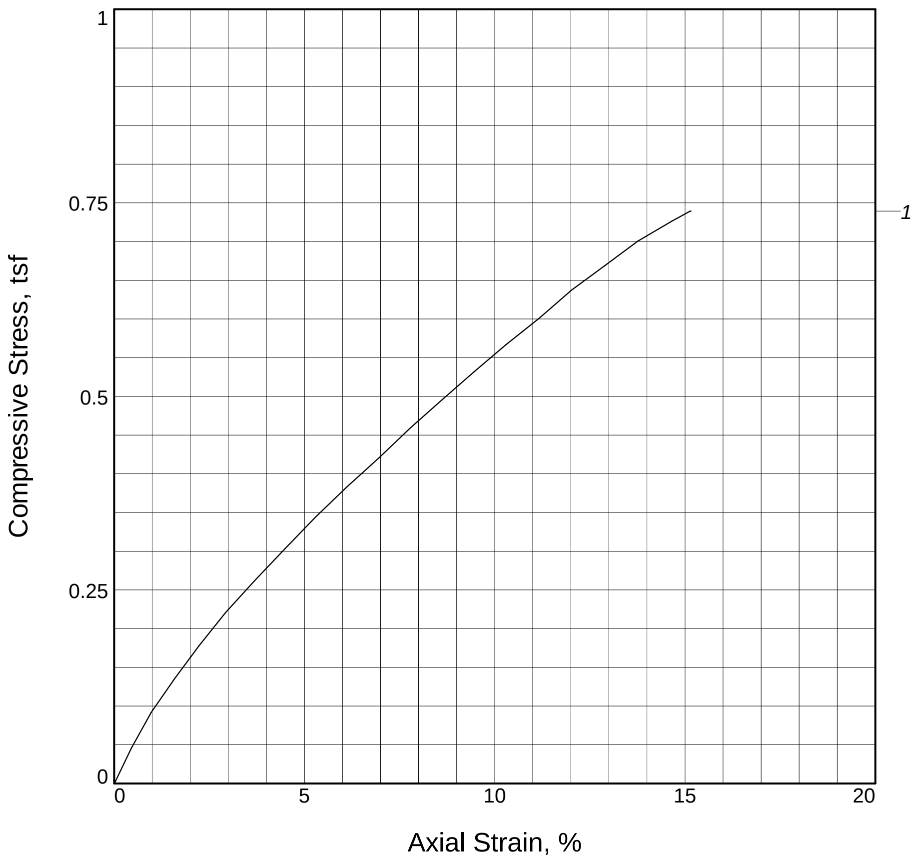
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	93.1	93.1			6.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1067	0.1233	0.1350	0.1532	0.1687	0.1837	0.1992	0.2359	0.2474	0.2610	0.2782

Fineness Modulus	C_u	C_c
0.73	1.87	1.10

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.739			
Undrained shear strength, tsf	0.370			
Failure strain, %	15.1			
Strain rate, %/min.	1.00			
Water content, %	19.3			
Wet density, pcf	124.4			
Dry density, pcf	104.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.76			
Specimen height, in.	5.74			
Height/diameter ratio	2.08			

Description:

LL = 42	**PL =** 16	**PI =** 26	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

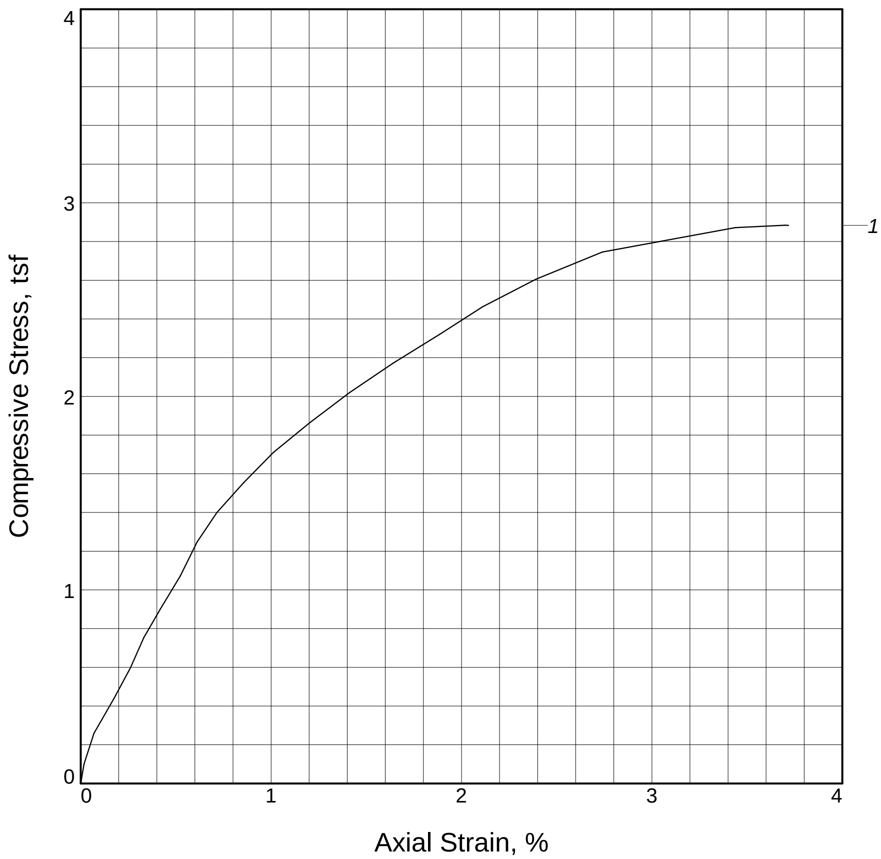
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-101
Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.884			
Undrained shear strength, tsf	1.442			
Failure strain, %	3.7			
Strain rate, %/min.	1.00			
Water content, %	33.0			
Wet density, pcf	121.1			
Dry density, pcf	91.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 70	**PL =** 23	**PI =** 47	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

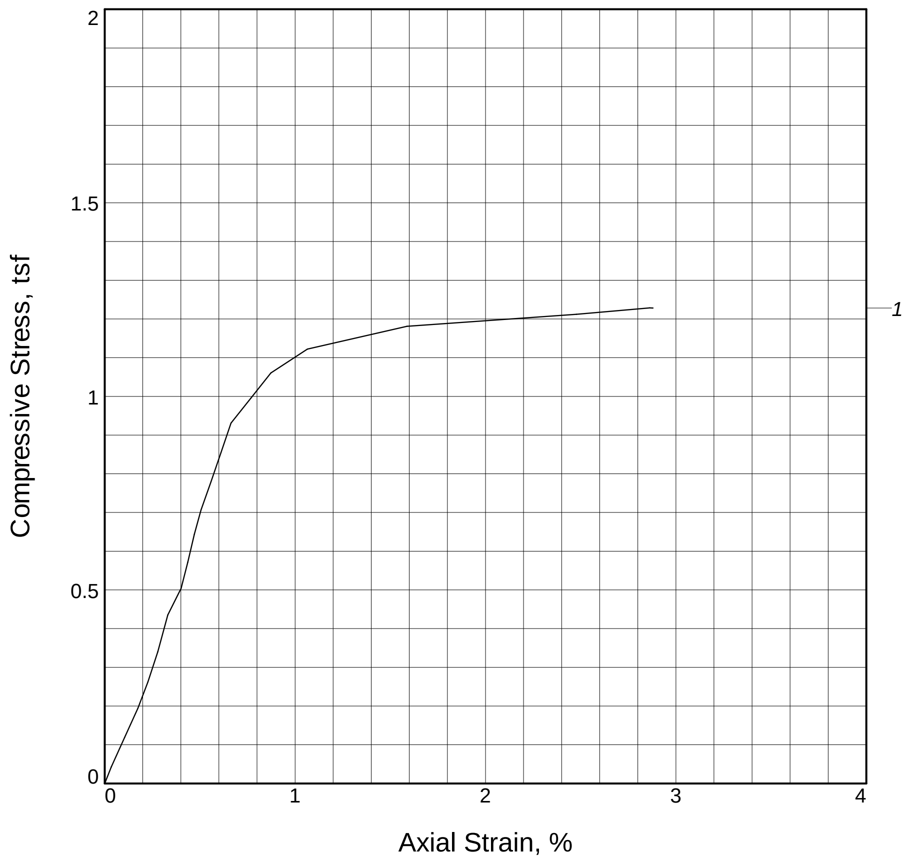
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-101
Depth: (38.0-40.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.228			
Undrained shear strength, tsf	0.614			
Failure strain, %	2.9			
Strain rate, %/min.	1.00			
Water content, %	25.6			
Wet density, pcf	125.3			
Dry density, pcf	99.7			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 62	**PL =** 22	**PI =** 40	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

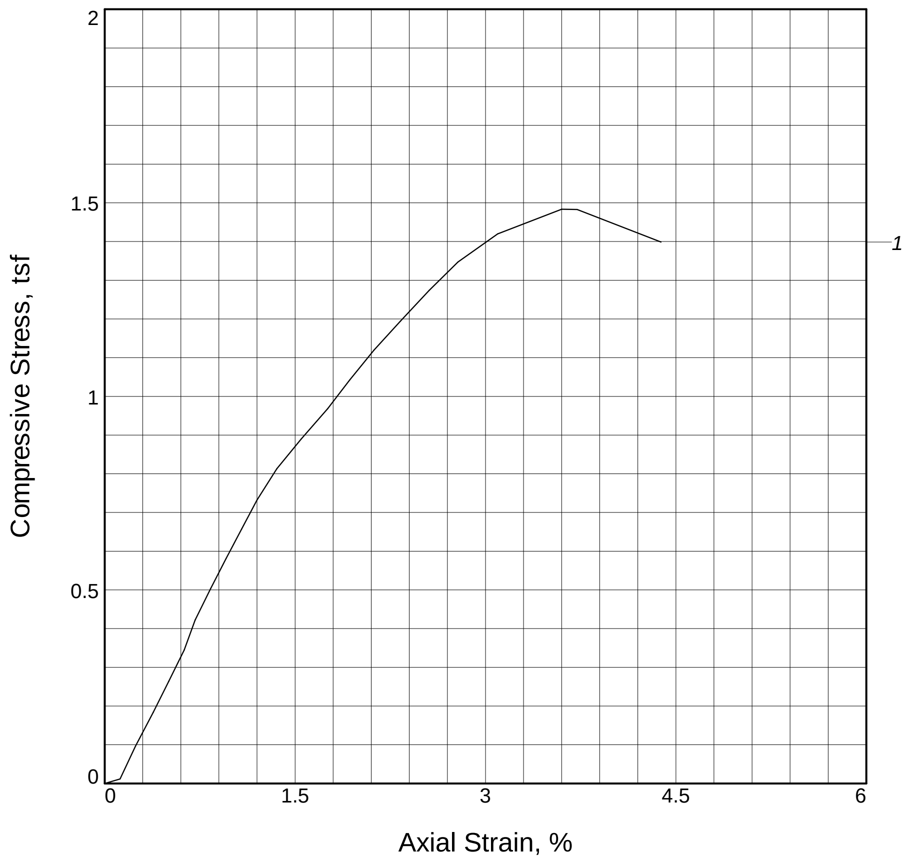
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-103
Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.484			
Undrained shear strength, tsf	0.742			
Failure strain, %	3.6			
Strain rate, %/min.	1.00			
Water content, %	28.8			
Wet density, pcf	122.1			
Dry density, pcf	94.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.75			
Height/diameter ratio	2.04			

Description:

LL = 63	**PL =** 25	**PI =** 38	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

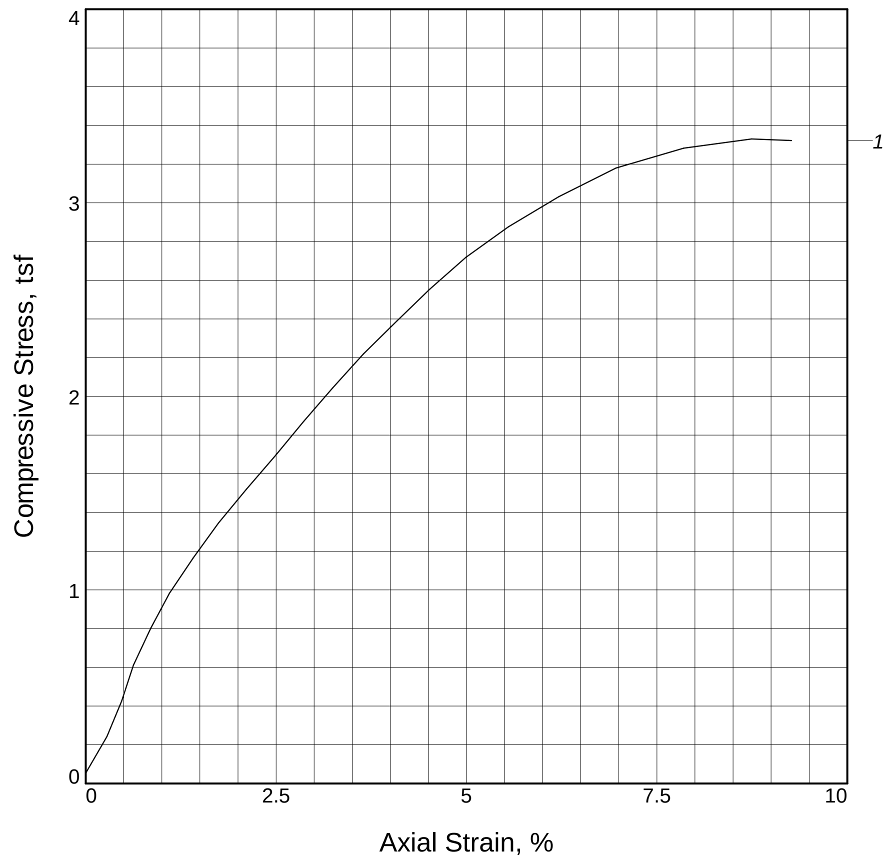
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-104
Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.330			
Undrained shear strength, tsf	1.665			
Failure strain, %	8.7			
Strain rate, %/min.	1.00			
Water content, %	21.9			
Wet density, pcf	131.2			
Dry density, pcf	107.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.78			
Specimen height, in.	5.73			
Height/diameter ratio	2.06			

Description:

LL = 51	**PL =** 20	**PI =** 31	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure ________

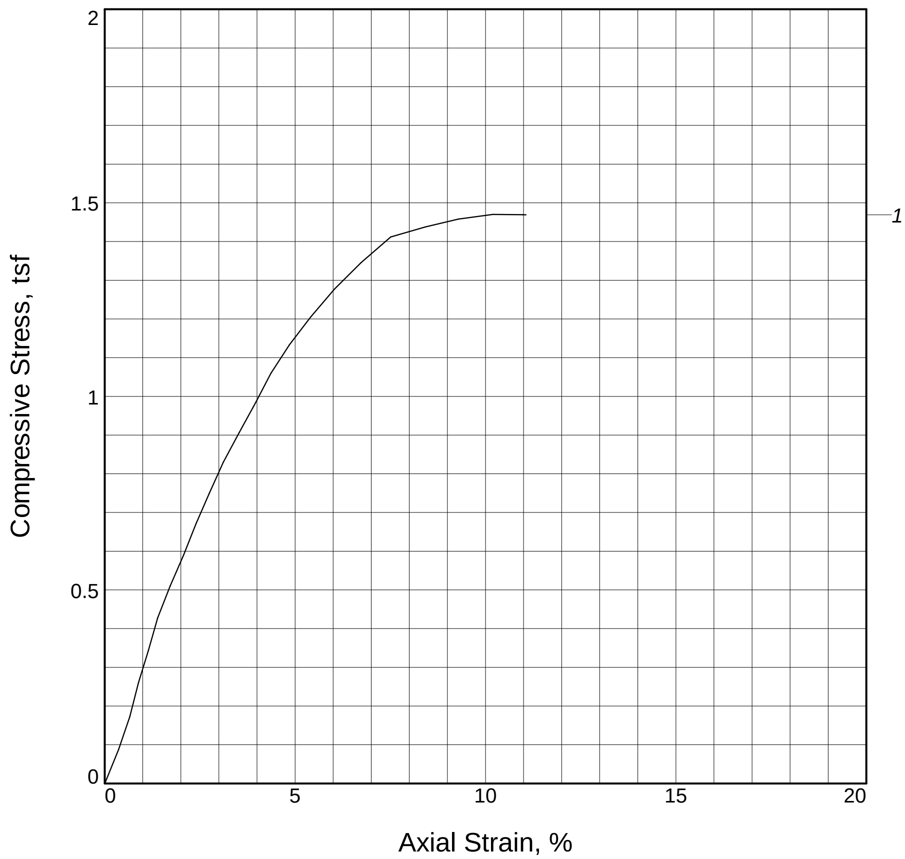
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-105
Depth: (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.470			
Undrained shear strength, tsf	0.735			
Failure strain, %	10.2			
Strain rate, %/min.	1.00			
Water content, %	22.9			
Wet density, pcf	134.4			
Dry density, pcf	109.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.72			
Specimen height, in.	5.75			
Height/diameter ratio	2.11			

Description:

LL = 31	**PL =** 20	**PI =** 11	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

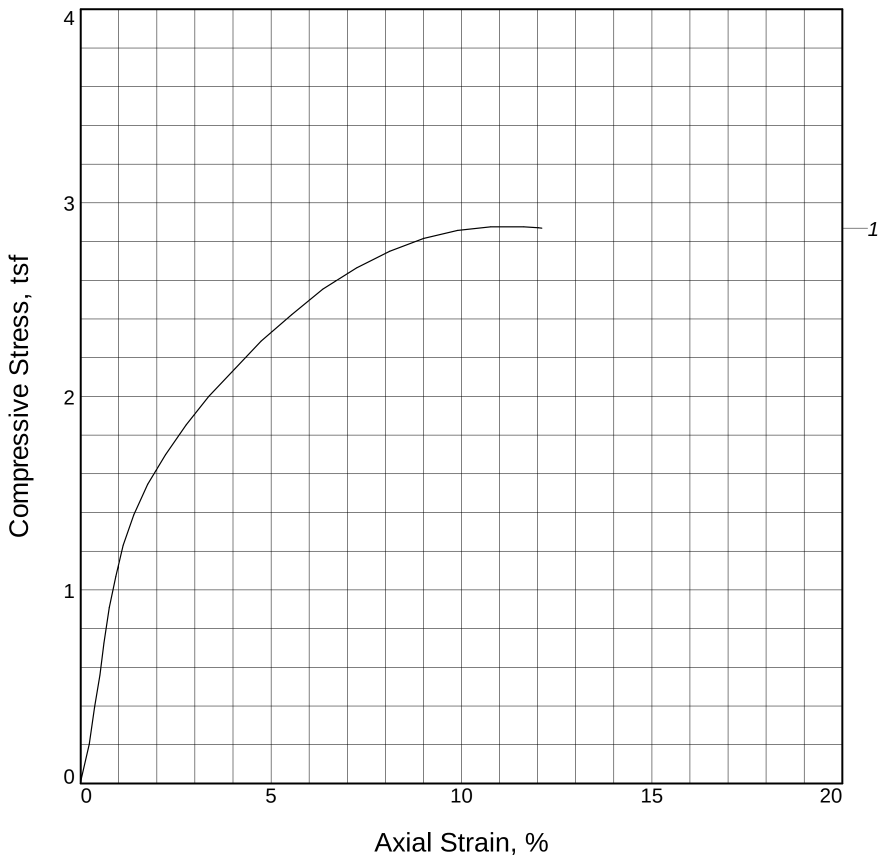
Project: OCR Due Diligence Study

Location: B-106

Depth: (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.876			
Undrained shear strength, tsf	1.438			
Failure strain, %	10.8			
Strain rate, %/min.	1.00			
Water content, %	17.8			
Wet density, pcf	134.0			
Dry density, pcf	113.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.74			
Height/diameter ratio	2.09			

Description:

LL = 55	**PL =** 18	**PI =** 37	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

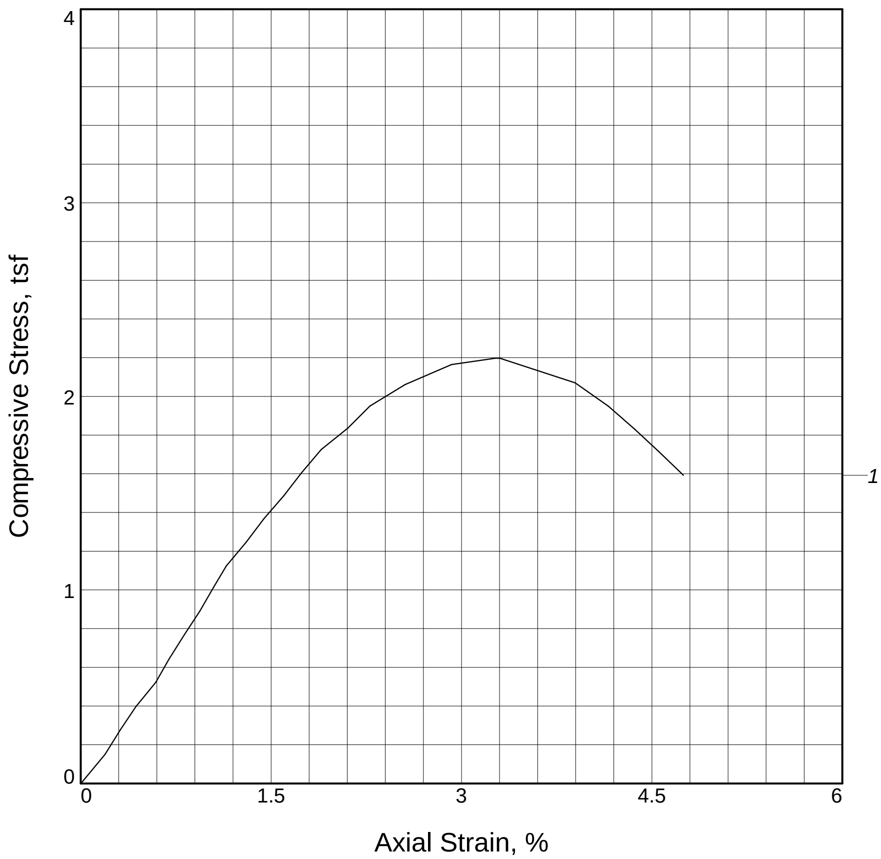
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-107
Depth: (6.0-8.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.197			
Undrained shear strength, tsf	1.099			
Failure strain, %	3.3			
Strain rate, %/min.	1.00			
Water content, %	27.1			
Wet density, pcf	124.3			
Dry density, pcf	97.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.75			
Height/diameter ratio	2.09			

Description:

LL = 67	**PL =** 26	**PI =** 41	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

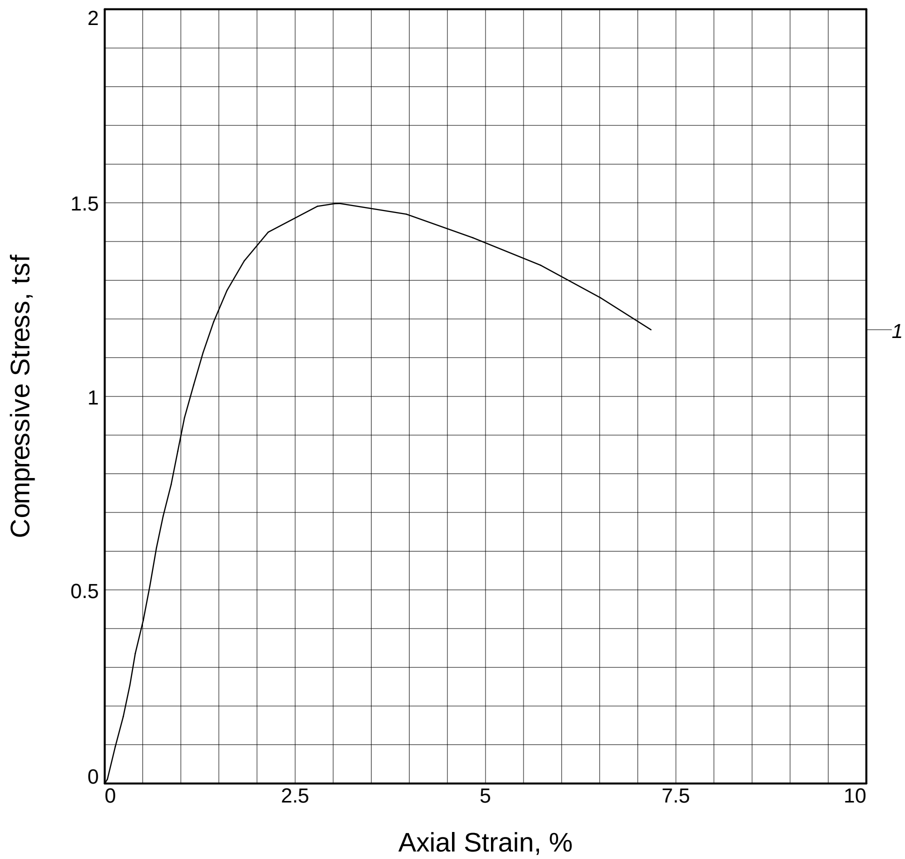
Project: OCR Due Diligence Study

Location: B-107

Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.498			
Undrained shear strength, tsf	0.749			
Failure strain, %	3.1			
Strain rate, %/min.	1.00			
Water content, %	32.9			
Wet density, pcf	120.3			
Dry density, pcf	90.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.73			
Height/diameter ratio	2.09			

Description:

LL = 64	**PL =** 26	**PI =** 38	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

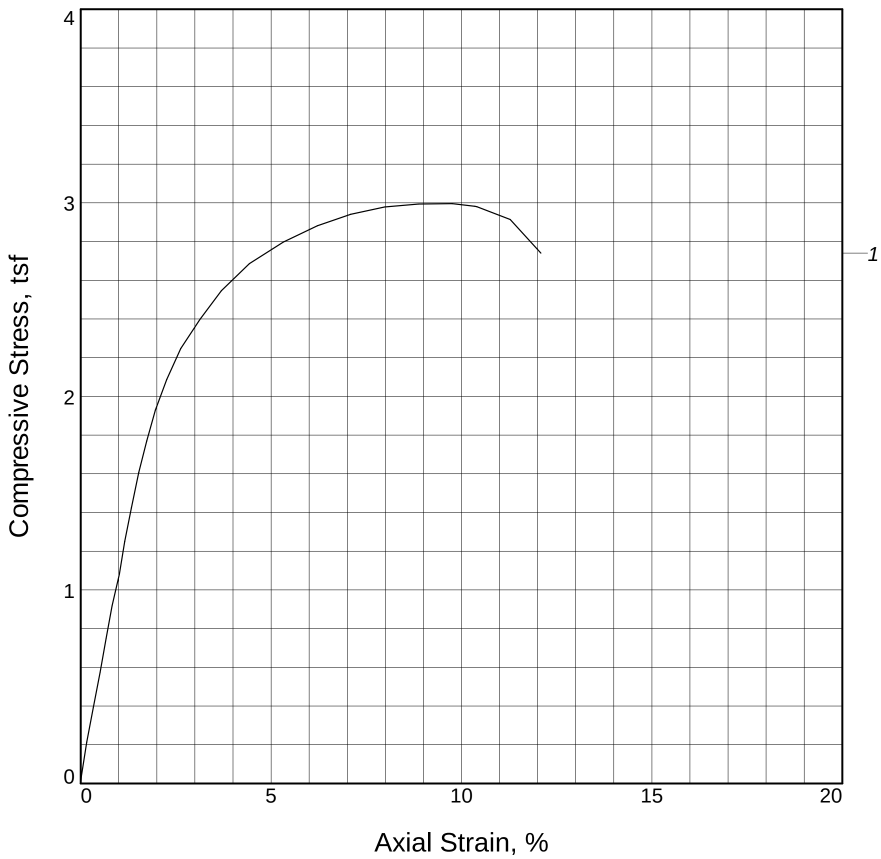
Project: OCR Due Diligence Study

Location: B-108

Depth: (38.0-40.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.996			
Undrained shear strength, tsf	1.498			
Failure strain, %	9.8			
Strain rate, %/min.	1.00			
Water content, %	24.7			
Wet density, pcf	129.9			
Dry density, pcf	104.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.73			
Specimen height, in.	5.71			
Height/diameter ratio	2.09			

Description:

LL = 56	**PL =** 26	**PI =** 30	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

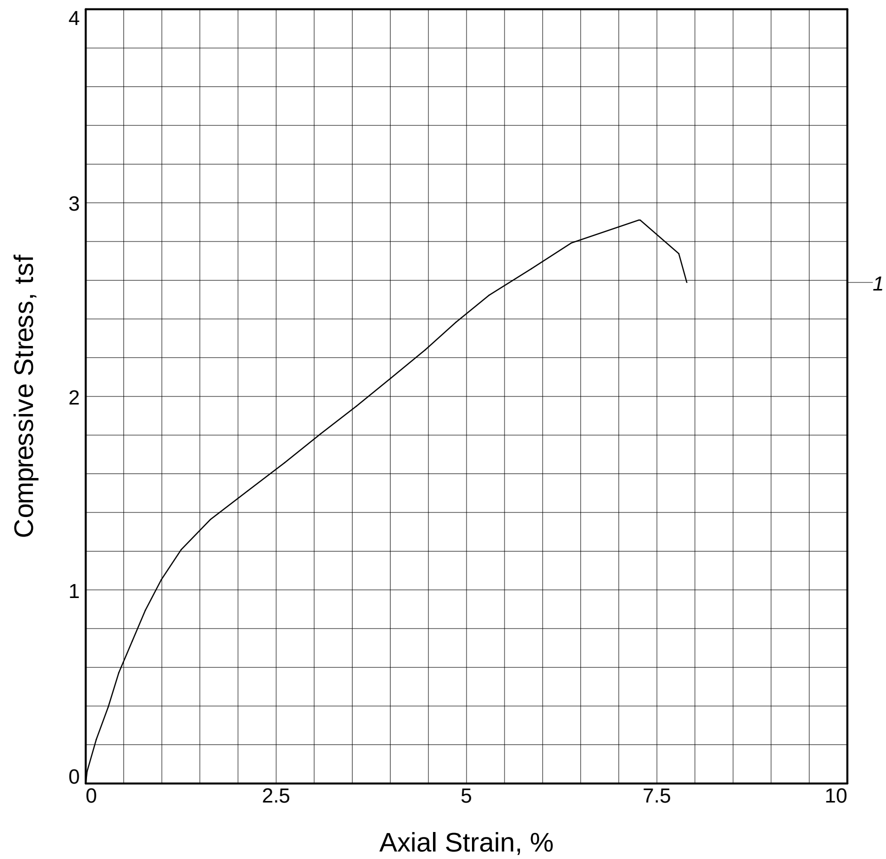
Project: OCR Due Diligence Study

Location: B-109

Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.911			
Undrained shear strength, tsf	1.456			
Failure strain, %	7.3			
Strain rate, %/min.	1.00			
Water content, %	23.8			
Wet density, pcf	122.6			
Dry density, pcf	99.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.81			
Specimen height, in.	5.74			
Height/diameter ratio	2.04			

Description:

LL = 47	**PL =** 20	**PI =** 27	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

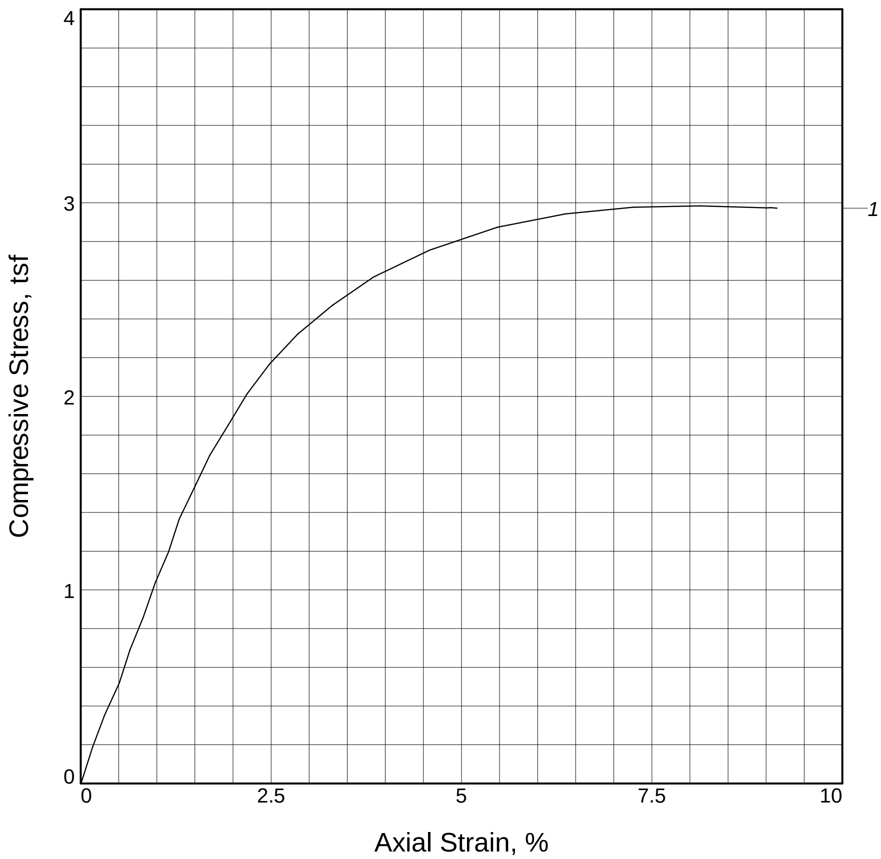
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-109
Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.984			
Undrained shear strength, tsf	1.492			
Failure strain, %	8.1			
Strain rate, %/min.	1.00			
Water content, %	25.8			
Wet density, pcf	128.6			
Dry density, pcf	102.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.72			
Height/diameter ratio	2.09			

Description:

LL = 64	**PL =** 30	**PI =** 34	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

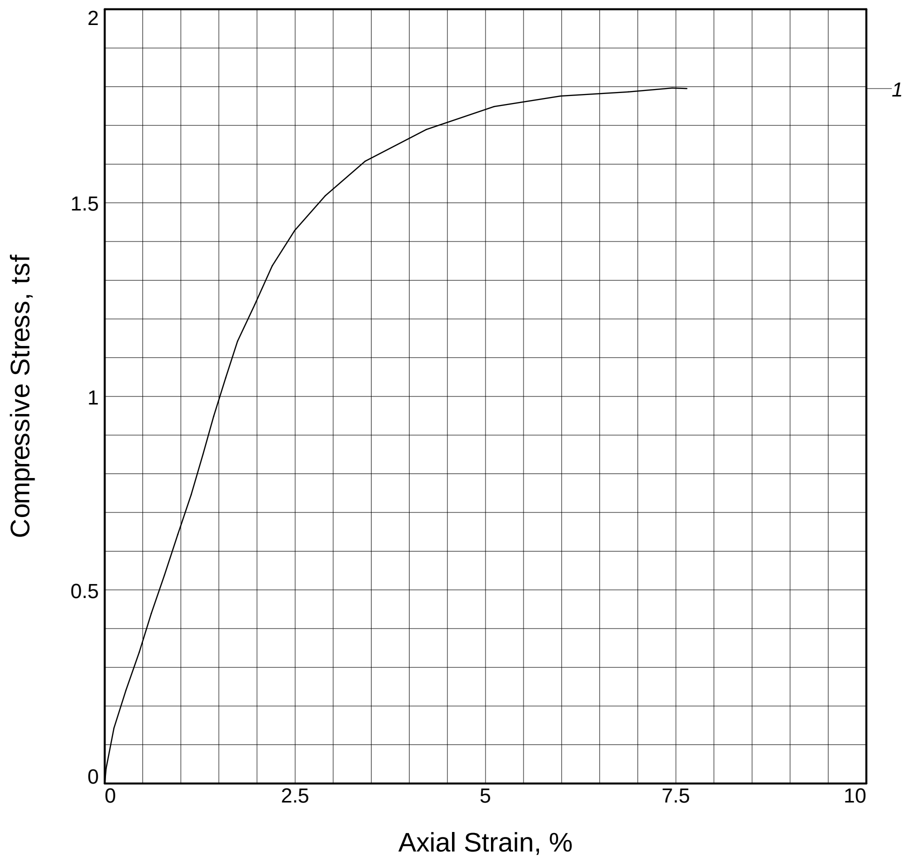
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-110
Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.797			
Undrained shear strength, tsf	0.898			
Failure strain, %	7.5			
Strain rate, %/min.	1.00			
Water content, %	17.2			
Wet density, pcf	132.6			
Dry density, pcf	113.1			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.68			
Specimen height, in.	5.73			
Height/diameter ratio	2.14			

Description:

LL = 72	**PL =** 26	**PI =** 46	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

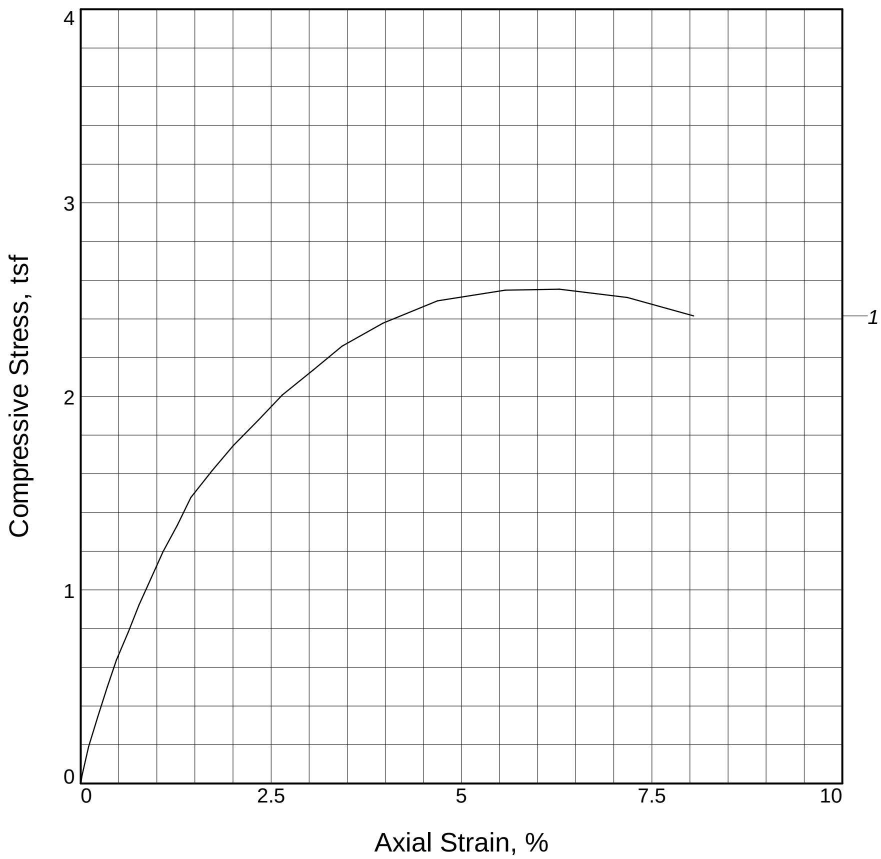
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-111
Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.554			
Undrained shear strength, tsf	1.277			
Failure strain, %	6.3			
Strain rate, %/min.	1.00			
Water content, %	27.1			
Wet density, pcf	127.0			
Dry density, pcf	99.9			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.74			
Height/diameter ratio	2.07			

Description:

LL = 78	**PL =** 33	**PI =** 45	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

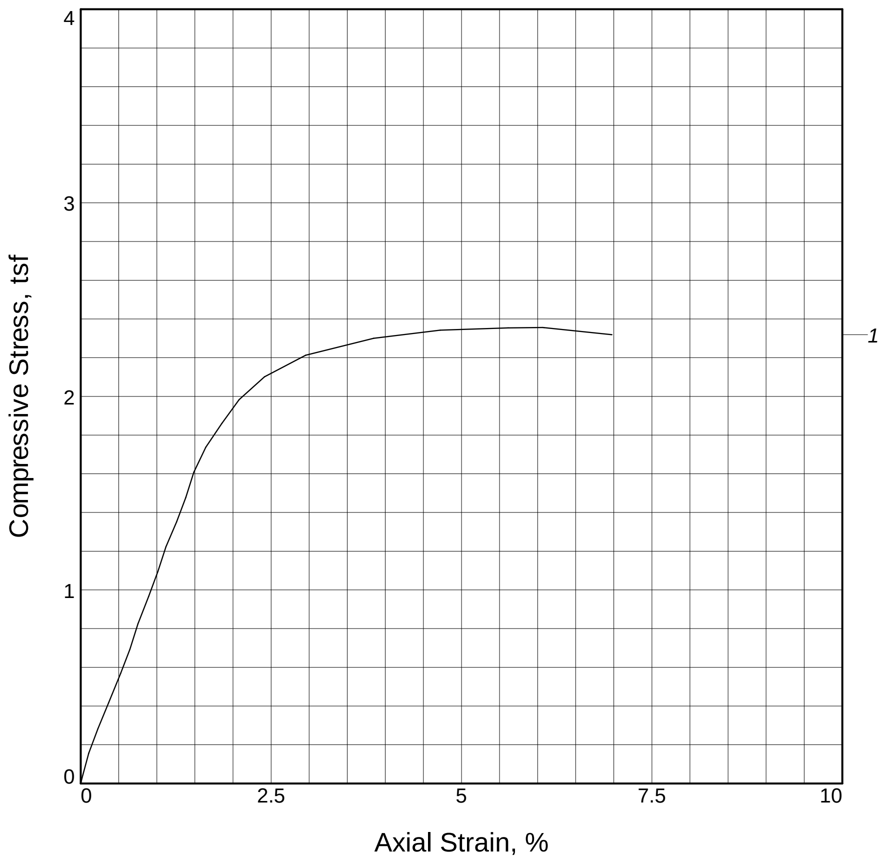
Project: OCR Due Diligence Study

Location: B-111

Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.356			
Undrained shear strength, tsf	1.178			
Failure strain, %	6.1			
Strain rate, %/min.	1.00			
Water content, %	27.7			
Wet density, pcf	123.0			
Dry density, pcf	96.4			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.72			
Height/diameter ratio	2.08			

Description:

LL = 80	**PL =** 35	**PI =** 45	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

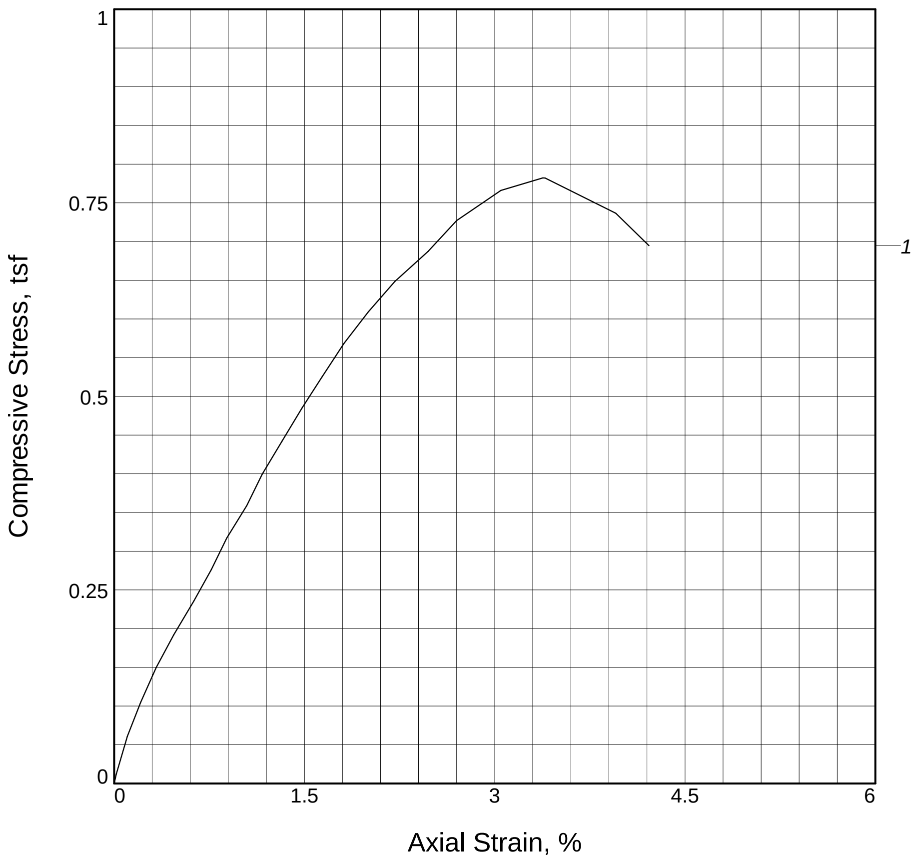
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-112
Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.782			
Undrained shear strength, tsf	0.391			
Failure strain, %	3.4			
Strain rate, %/min.	1.00			
Water content, %	19.9			
Wet density, pcf	132.2			
Dry density, pcf	110.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.74			
Height/diameter ratio	2.09			

Description:

LL = 65	**PL =** 28	**PI =** 37	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

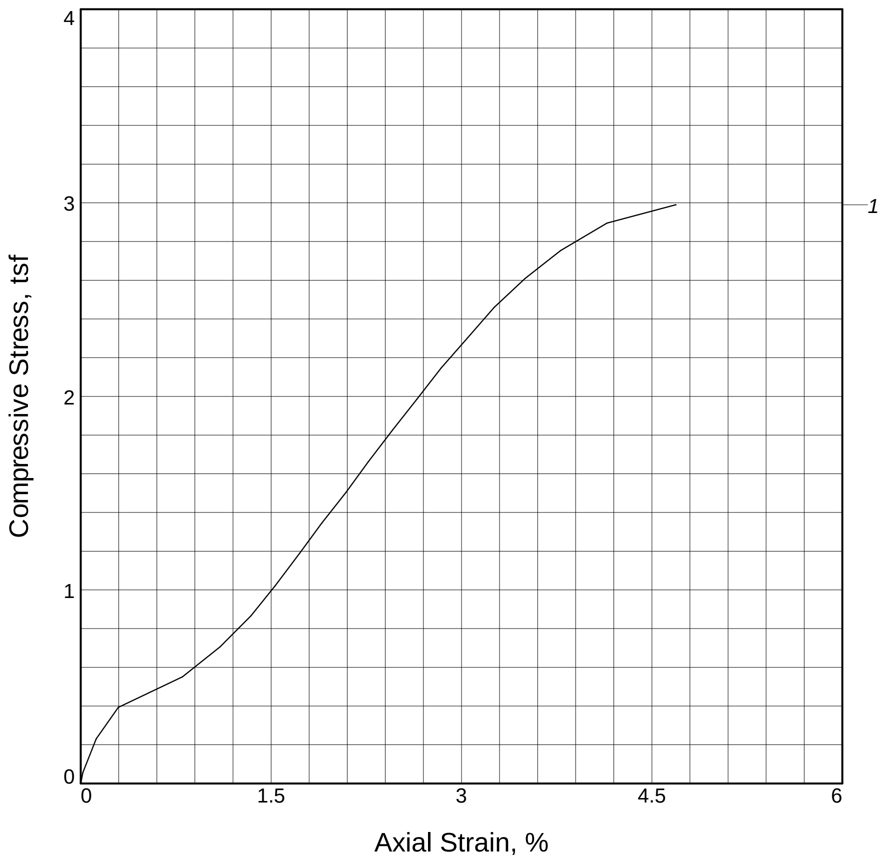
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-112
Depth: (23.0-25.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.989			
Undrained shear strength, tsf	1.495			
Failure strain, %	4.7			
Strain rate, %/min.	1.00			
Water content, %	13.0			
Wet density, pcf	137.4			
Dry density, pcf	121.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.74			
Height/diameter ratio	2.07			

Description:

LL = 44	**PL =** 18	**PI =** 26	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

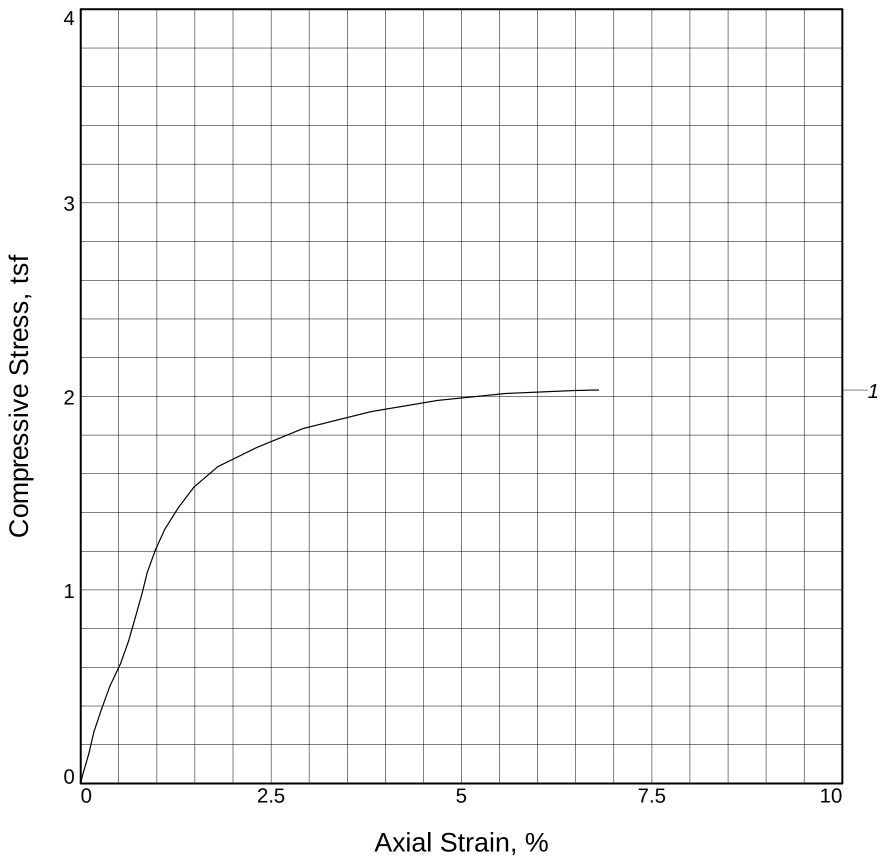
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-113
Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.033			
Undrained shear strength, tsf	1.016			
Failure strain, %	6.7			
Strain rate, %/min.	1.00			
Water content, %	26.3			
Wet density, pcf	124.4			
Dry density, pcf	98.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.79			
Specimen height, in.	5.72			
Height/diameter ratio	2.05			

Description:

LL = 71	**PL =** 31	**PI =** 40	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

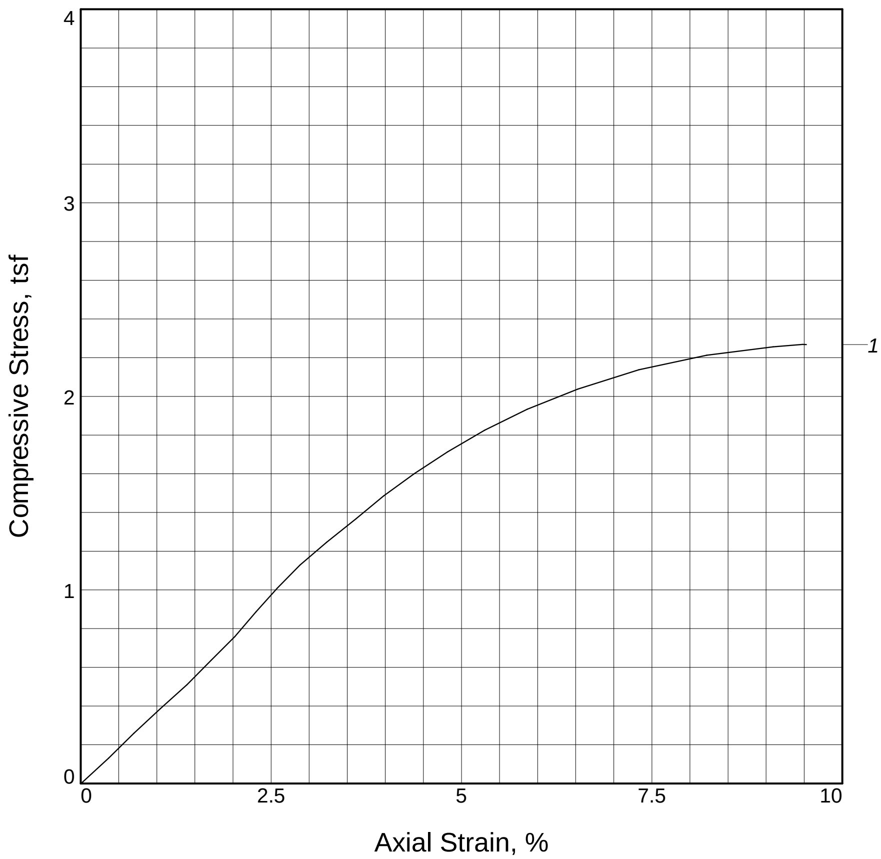
Project: OCR Due Diligence Study

Location: B-114

Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.269			
Undrained shear strength, tsf	1.134			
Failure strain, %	9.5			
Strain rate, %/min.	1.00			
Water content, %	22.2			
Wet density, pcf	124.7			
Dry density, pcf	102.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 58	**PL =** 25	**PI =** 33	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure ________

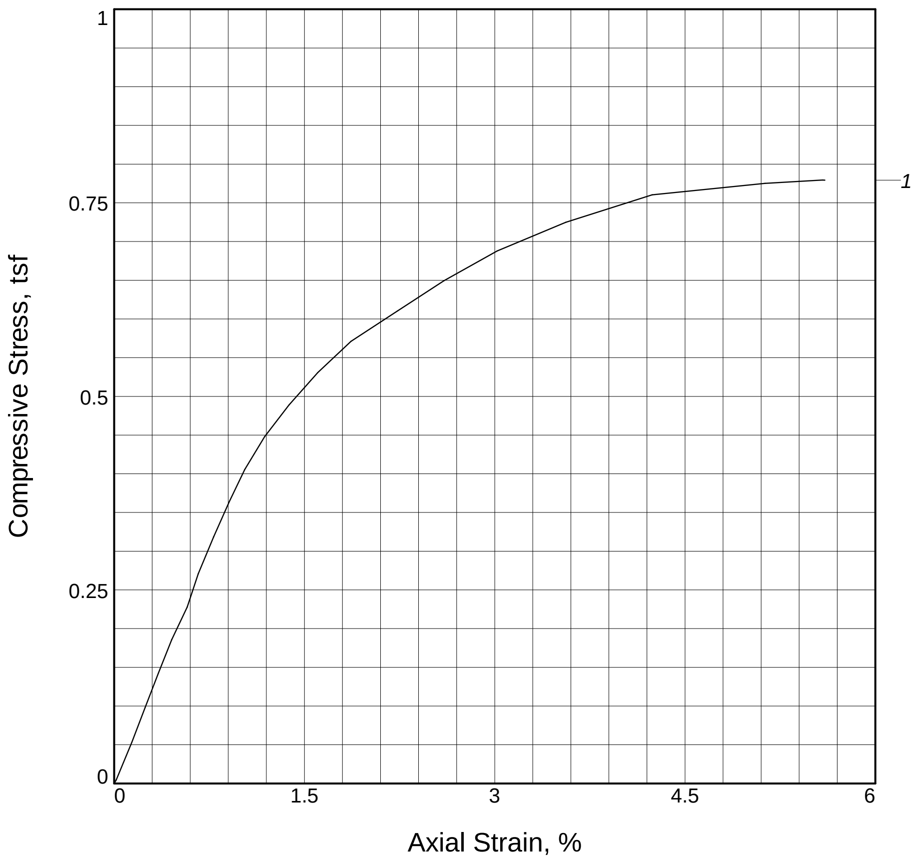
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-114
Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.779			
Undrained shear strength, tsf	0.390			
Failure strain, %	5.6			
Strain rate, %/min.	1.00			
Water content, %	18.3			
Wet density, pcf	131.5			
Dry density, pcf	111.1			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.73			
Height/diameter ratio	2.08			

Description:

LL = 34	**PL =** 13	**PI =** 21	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-104

Depth: (6.0-8.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Appendix D

Crumb Dispersion Test Results

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-101 **Sample No.** 1 **Sample Depth (ft.)** 6.0-8.0

Moisture Content	**2 minutes**		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Boring No. B-103 **Sample No.** 2 **Sample Depth (ft.)** 2.0-4.0

Moisture Content	**2 minutes**		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Boring No. B-103 **Sample No.** 3 **Sample Depth (ft.)** 4.0-6.0

Moisture Content	**2 minutes**		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Boring No. B-103 **Sample No.** 4 **Sample Depth (ft.)** 13.0-15.0

Moisture Content	**2 minutes**		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	3	68	3	67	3	67
Initial Temp(˚F): 69								

Boring No. B-105 **Sample No.** 5 **Sample Depth (ft.)** 6.0-8.0

Moisture Content	**2 minutes**		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-105 **Sample No.** 6 **Sample Depth (ft.)** 8.0-10.0

Moisture Content									
		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-105 **Sample No.** 7 **Sample Depth (ft.)** 13.0-15.0

Moisture Content									
		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	3	68	3	67	4	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 8 **Sample Depth (ft.)** 0-2.0

Moisture Content									
		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 9 **Sample Depth (ft.)** 4.0-6.0

Moisture Content									
		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 10 **Sample Depth (ft.)** 13.0-15.0

Moisture Content									
		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-107 **Sample No.** 11 **Sample Depth (ft.)** 2.0-4.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-107 **Sample No.** 12 **Sample Depth (ft.)** 8.0-10.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-108 **Sample No.** 13 **Sample Depth (ft.)** 2.0-4.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	4	68	4	68	4	67
Initial Temp(˚F):	69								

Boring No. B-108 **Sample No.** 14 **Sample Depth (ft.)** 4.0-6.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-108 **Sample No.** 15 **Sample Depth (ft.)** 8.0-10.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-109 **Sample No.** 16 **Sample Depth (ft.)** 4.0-6.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	4	68	4	67	4	67
Initial Temp(˚F): 69								

Boring No. B-109 **Sample No.** 17 **Sample Depth (ft.)** 6.0-8.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	4	68	4	67	4	67
Initial Temp(˚F): 69								

Boring No. B-109 **Sample No.** 18 **Sample Depth (ft.)** 13.0-15.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Boring No. B-111 **Sample No.** 19 **Sample Depth (ft.)** 2.0-4.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	4	68	4	67	4	67
Initial Temp(˚F): 69								

Boring No. B-111 **Sample No.** 20 **Sample Depth (ft.)** 6.0-8.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube								
Time Started:	1	69	1	68	1	67	1	67
Initial Temp(˚F): 69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-111 **Sample No.** 21 **Sample Depth (ft.)** 8.0-10.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube Time Started: Initial Temp(˚F): 69	1	69	1	67	1	67	1	67

Boring No. B-113 **Sample No.** 22 **Sample Depth (ft.)** 4.0-6.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube Time Started: Initial Temp(˚F): 69	1	69	2	67	2	67	2	67

Boring No. B-114 **Sample No.** 23 **Sample Depth (ft.)** 6.0-8.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube Time Started: Initial Temp(˚F): 69	1	69	1	67	1	66	1	67

Boring No. B-114 **Sample No.** 24 **Sample Depth (ft.)** 8.0-10.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube Time Started: Initial Temp(˚F): 69	1	69	1	67	1	66	2	67

Boring No. B-114 **Sample No.** 25 **Sample Depth (ft.)** 13.0-14.5

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube Time Started: Initial Temp(˚F): 69	1	69	1	67	1	67	1	67

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

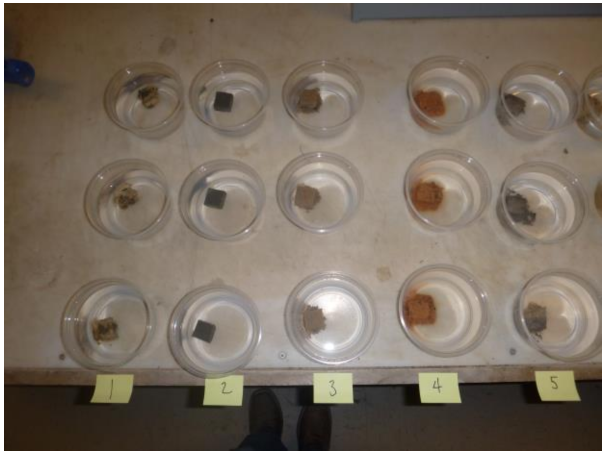
Boring No. B-115 **Sample No.** 26 **Sample Depth (ft.)** 2.0-4.0

Moisture Content								
	2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	4	69	4	67	4	67	4	67
Time Started:								
Initial Temp(˚F): 69								

CRUMB TEST PHOTOGRAPHS

2 min Readings

CRUMB TEST PHOTOGRAPHS



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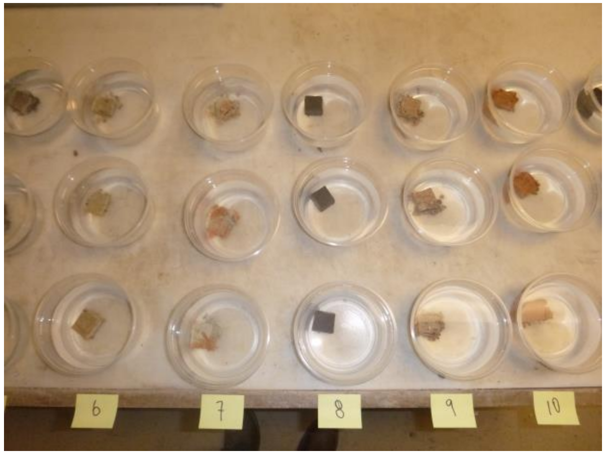

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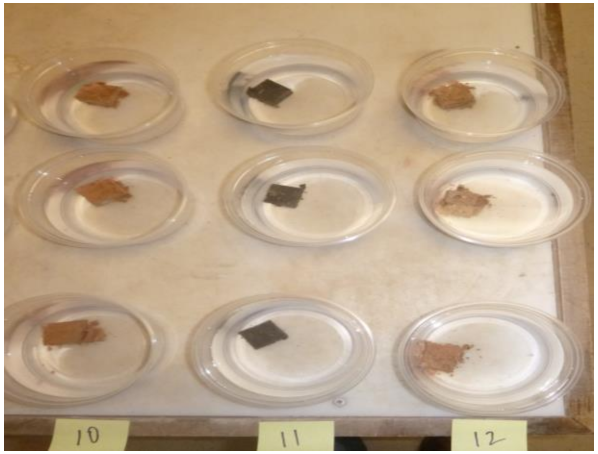

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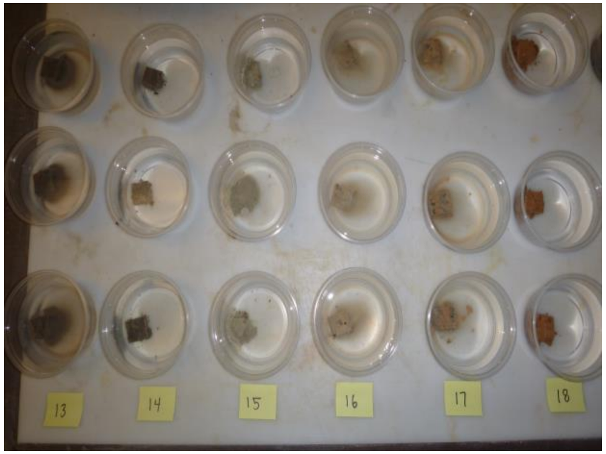
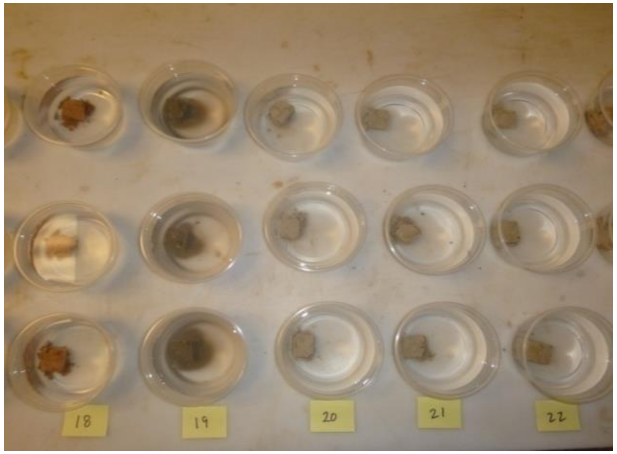


Sample No. 13 to 18 – 2 Min.

CRUMB TEST PHOTOGRAPHS



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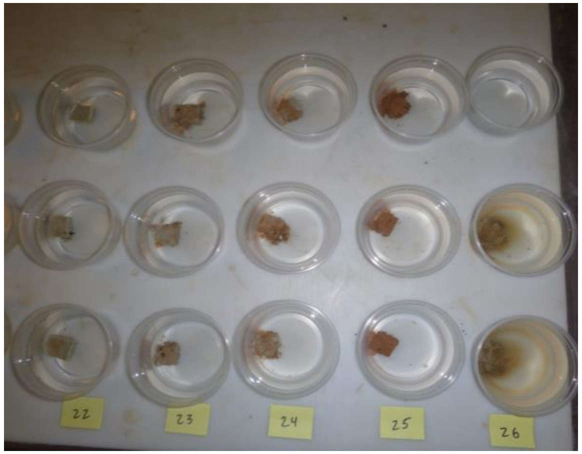
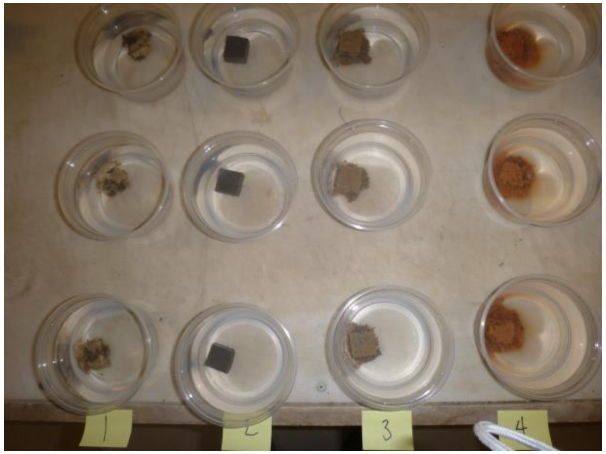


Sample No. 22 to 26 – 2 Min.

1 hour Readings

CRUMB TEST PHOTOGRAPHS



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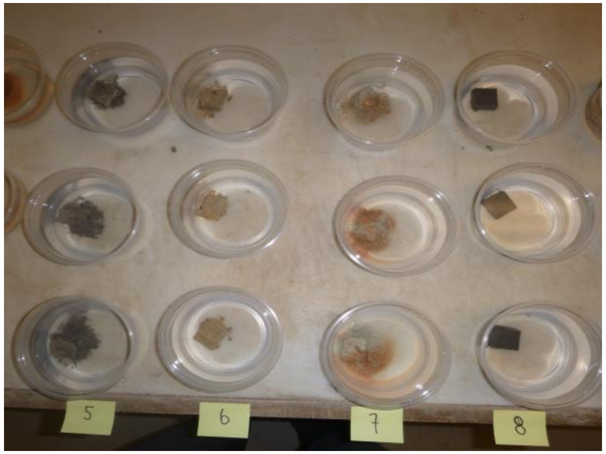

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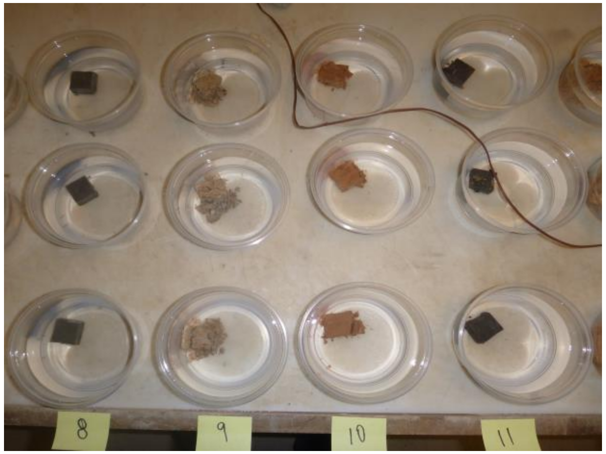
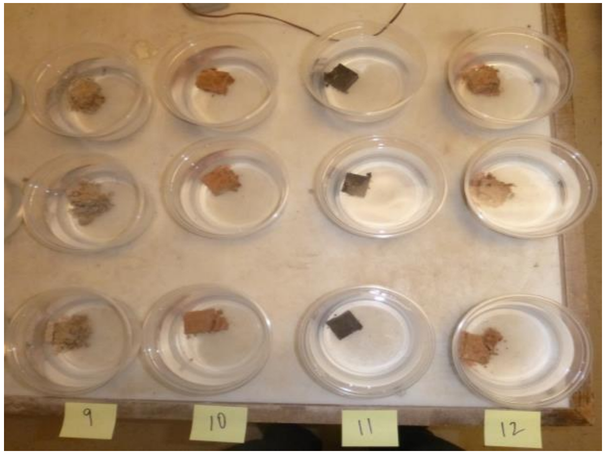
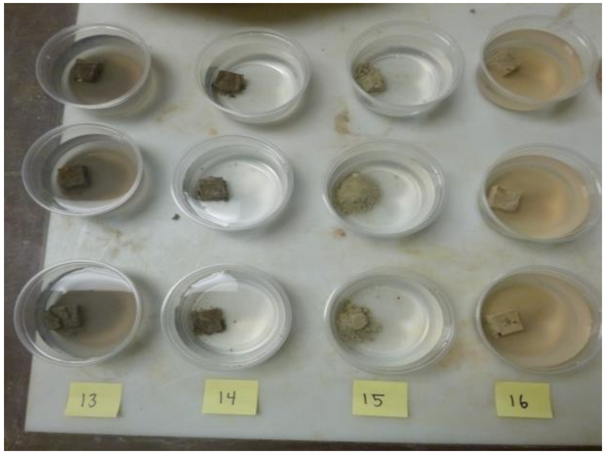


Sample No. 8 to 11 – 1 hour

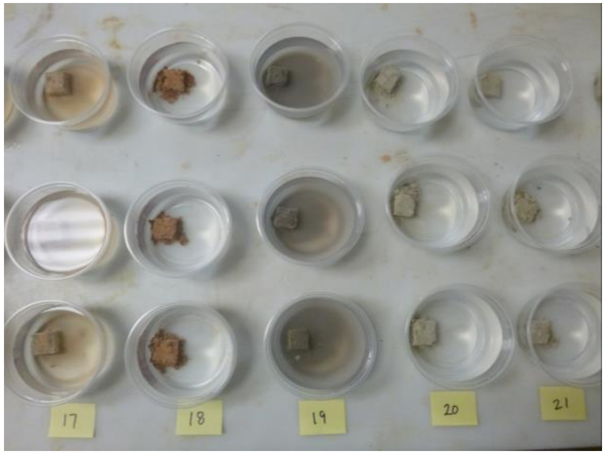


Sample No. 9 to 12 – 1 hour

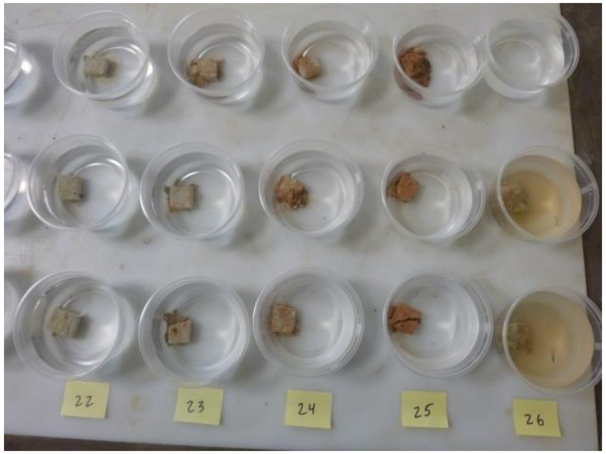
CRUMB TEST PHOTOGRAPHS



Sample No. 13 to 16 – 1 hour



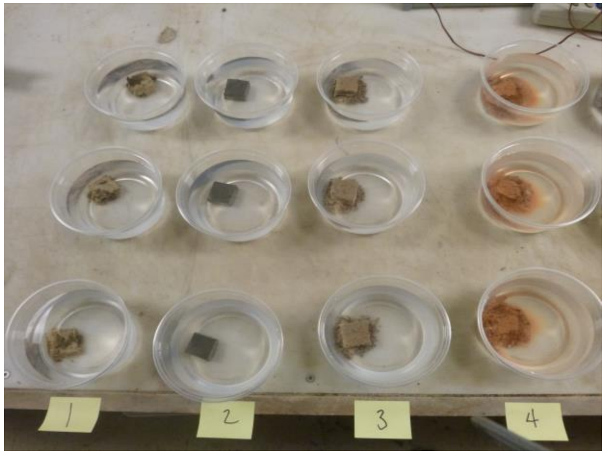
Sample No. 17 to 21 – 1 hour



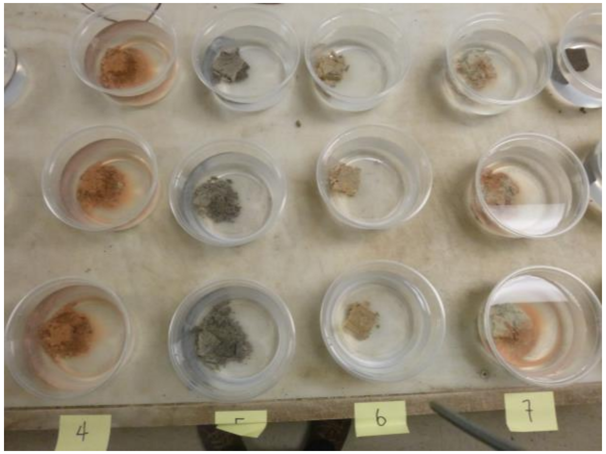
Sample No. 22 to 26 – 1 hour

6 hour Readings

CRUMB TEST PHOTOGRAPHS



Sample No. 1 to 4 – 6 hour



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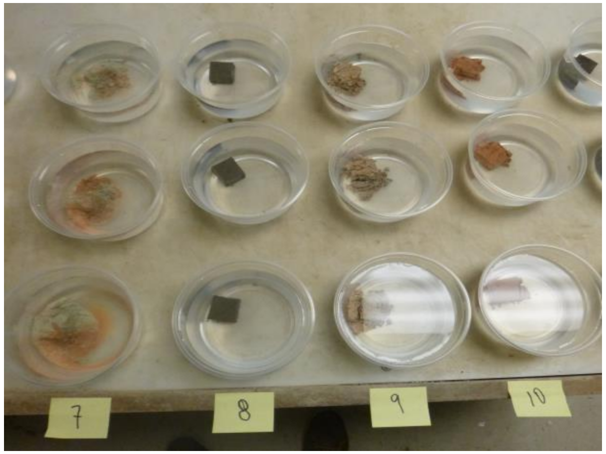
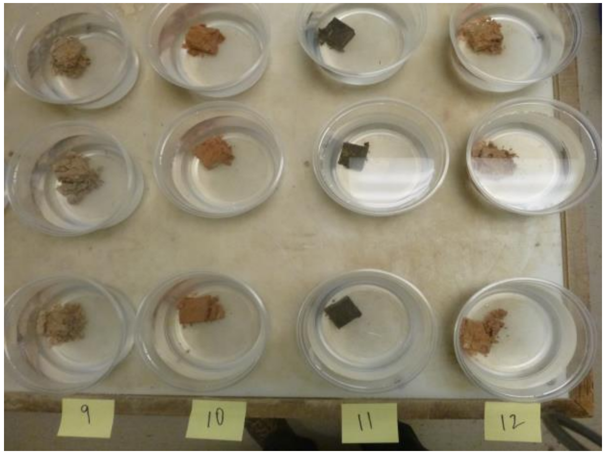
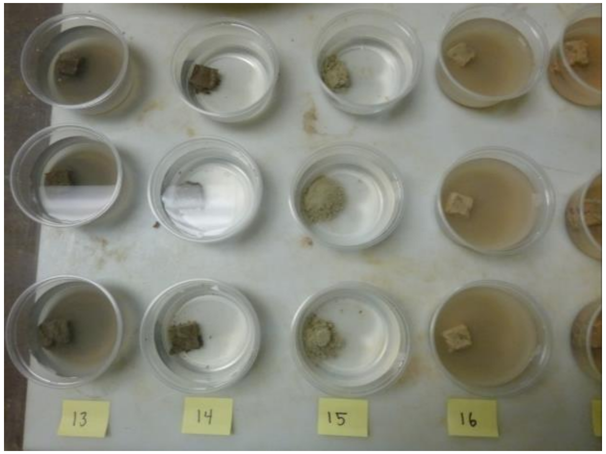


Sample No. 7 to 10 – 6 hour

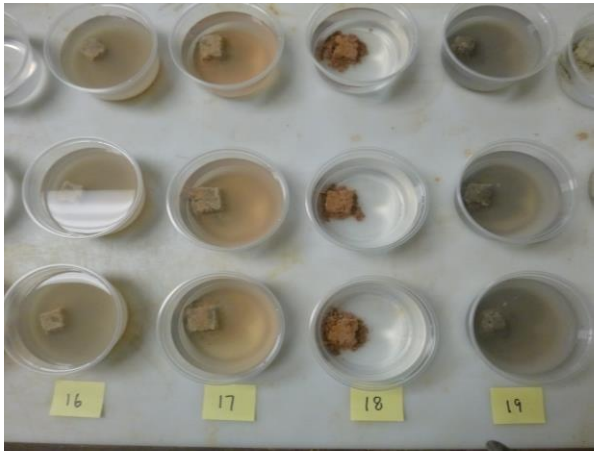


Sample No. 9 to 12 – 6 hour

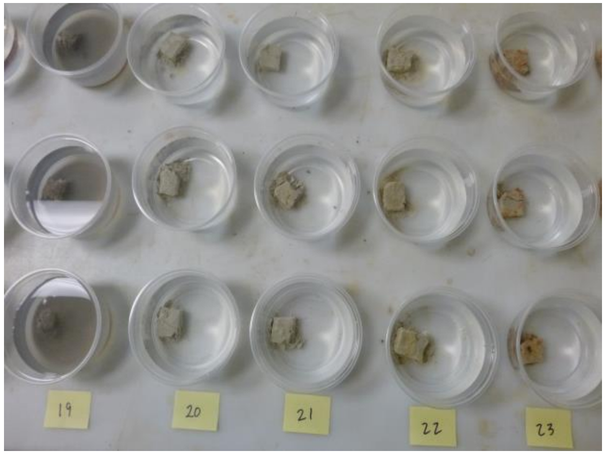
CRUMB TEST PHOTOGRAPHS



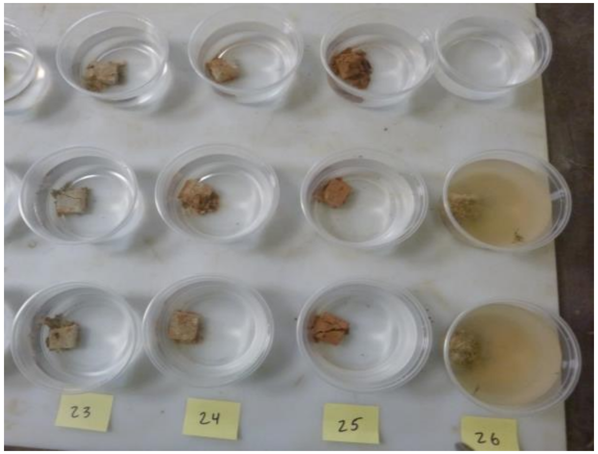
Sample No. 13 to 16 – 6 hour



Sample No. 16 to 19 – 6 hour



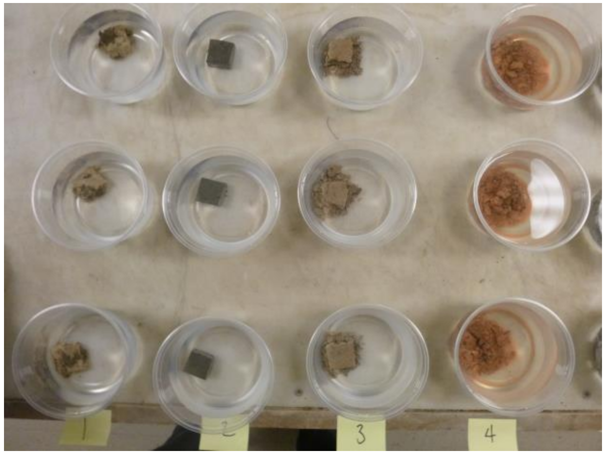
Sample No. 19 to 23 – 6 hour



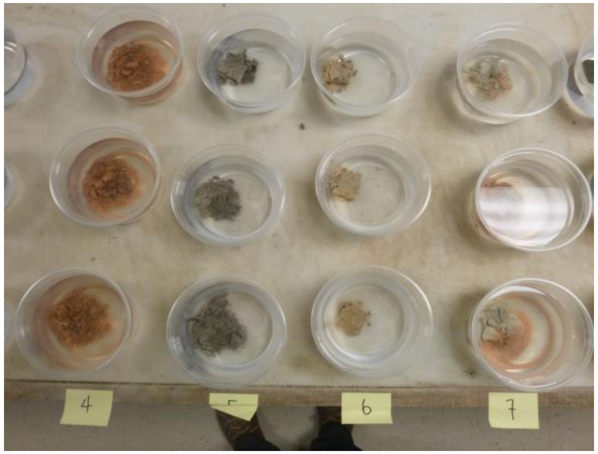
Sample No. 23 to 26 – 6 hour

24 hour Readings

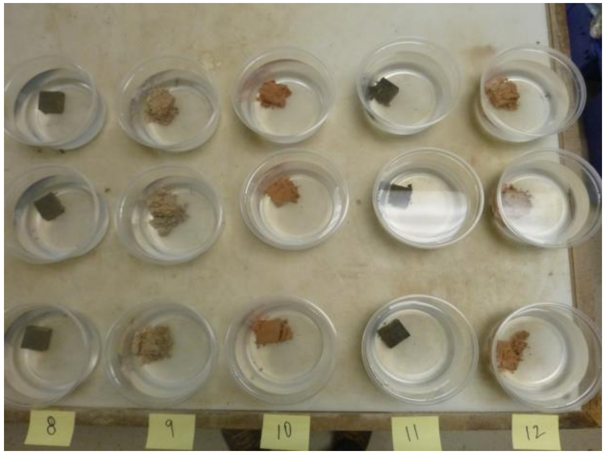
CRUMB TEST PHOTOGRAPHS



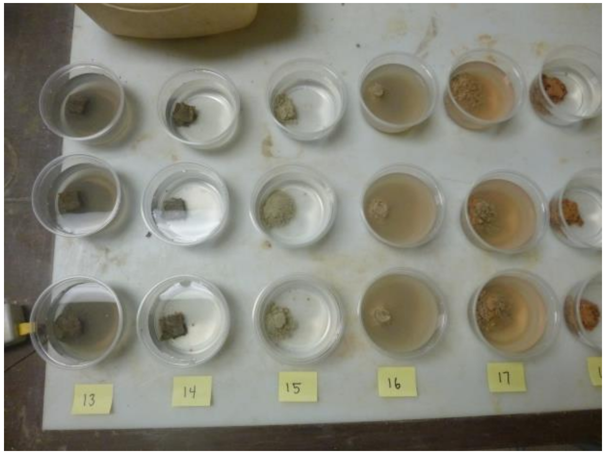
Sample No. 1 to 4 – 24 hour



Sample No. 4 to 7 – 24 hour

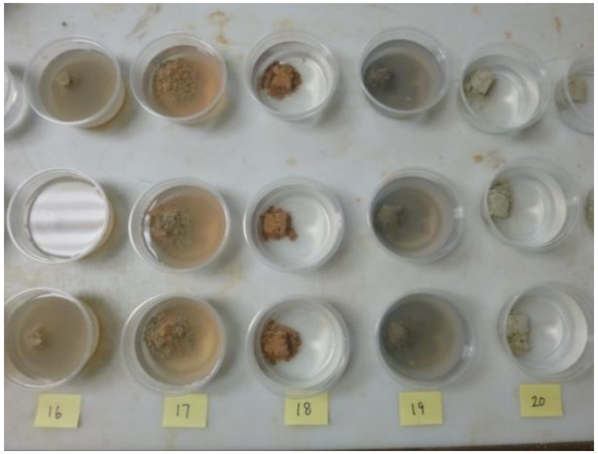


Sample No. 8 to 12 – 24 hour

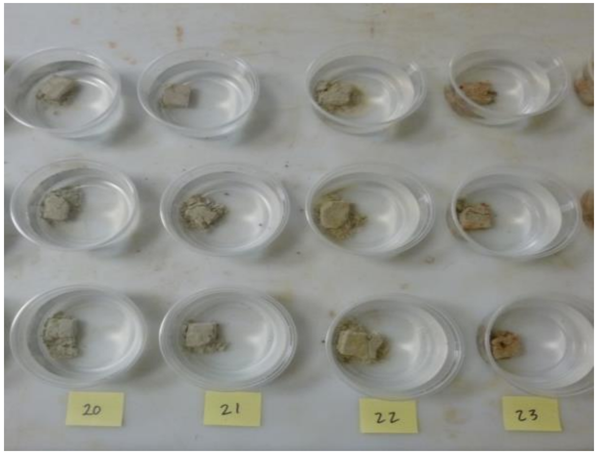


Sample No. 13 to 17 – 24 hour

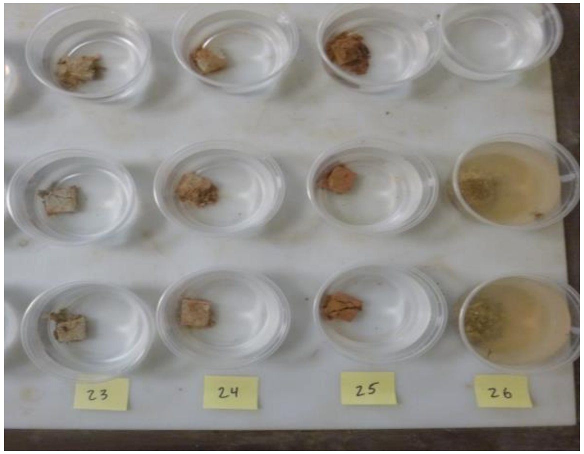
CRUMB TEST PHOTOGRAPHS



Sample No. 16 to 20 – 24 hour



Sample No. 20 to 23 – 24 hour

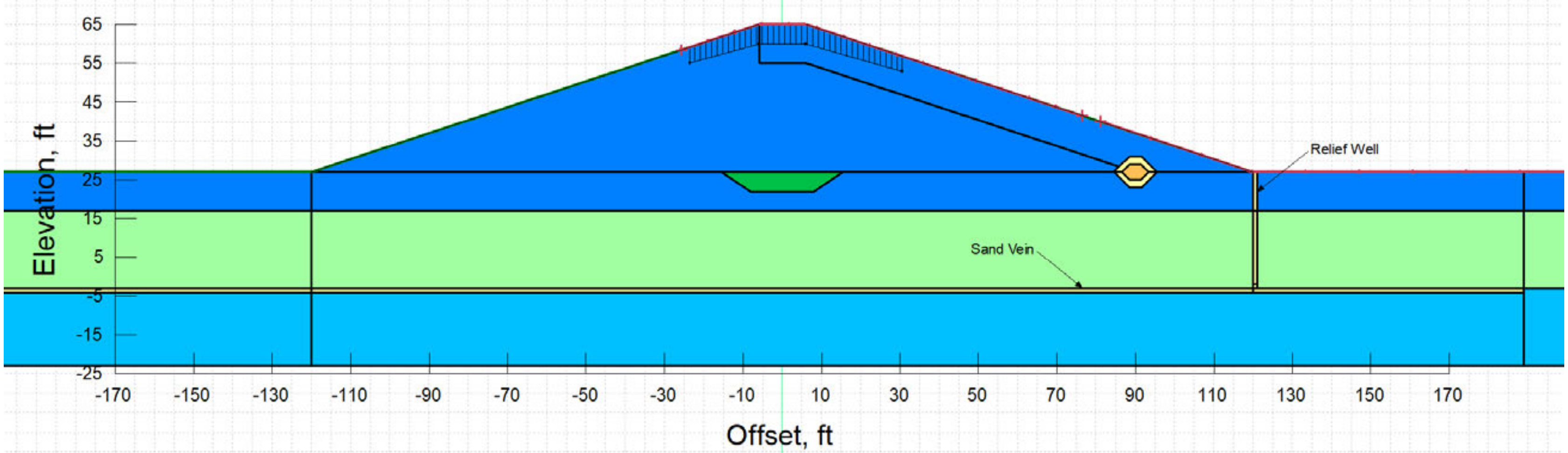


Sample No. 23 to 26 – 24 hour

Appendix E

Seepage and Slope Stability Results

MODEL GEOMETRY



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Sandy Clay	Mohr-Coulomb	125	230	24
	Clay	Mohr-Coulomb	125	230	19
	Clayey Sand	Mohr-Coulomb	125	230	31
	Sand	Mohr-Coulomb	120	0	33
	Gravel	Mohr-Coulomb	120	0	33
	Cut-off	Mohr-Coulomb	125	230	24

FNI PROJECT: LVA17406

DATE: January 12, 2018

PREPARED: SH

FREESE AND NICHOLS

10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TX 77024

Lavaca Navidad River Authority

Proposed Off-Channel Reservoir Due Diligence

Seepage and Slope Stability Analysis

Typical Maximum Embankment Section

PLATE

1

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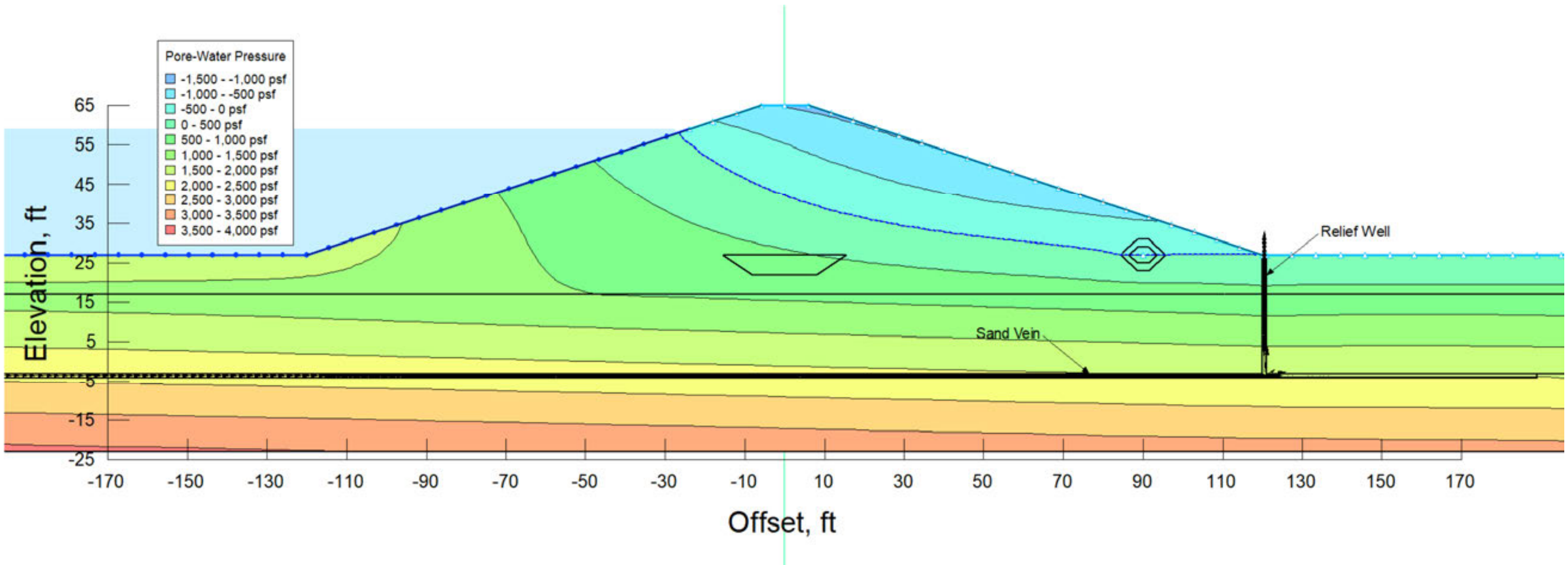
STEADY STATE SEEPAGE ANALYSIS



FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**2**
PREPARED: SH			

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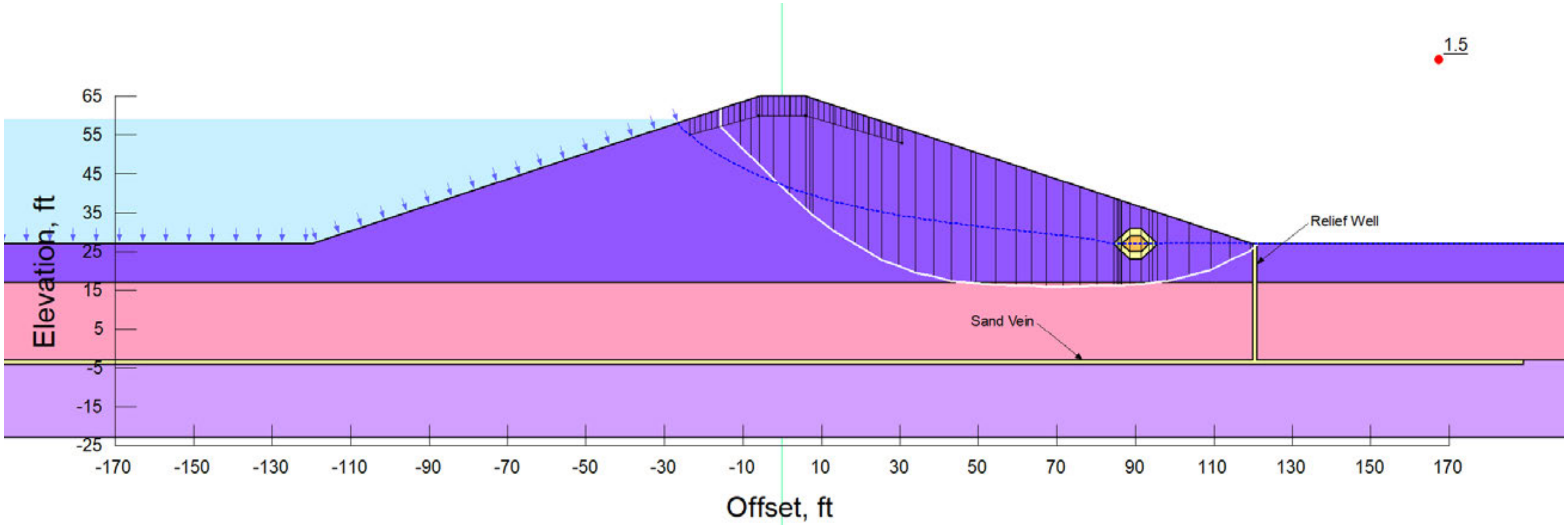
SLOPE STABILITY—END OF CONSTRUCTION SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Top of Layer (psf)	C-Rate of Change ((lbs/ft²)/ft)	C-Maximum (psf)
	Sand	Mohr-Coulomb	120	0	33			
	Sandy Clay Undrained	S=f(depth)	125			500	50	1,000
	Clay Undrained	S=f(depth)	125			1,000	50	1,400
	Clayey Sand Undrained	S=f(depth)	125			1,000	50	1,400
	Gravel	Mohr-Coulomb	120	0	33			

FNI PROJECT:	LVA17406
DATE:	January 12, 2018
PREPARED:	SH

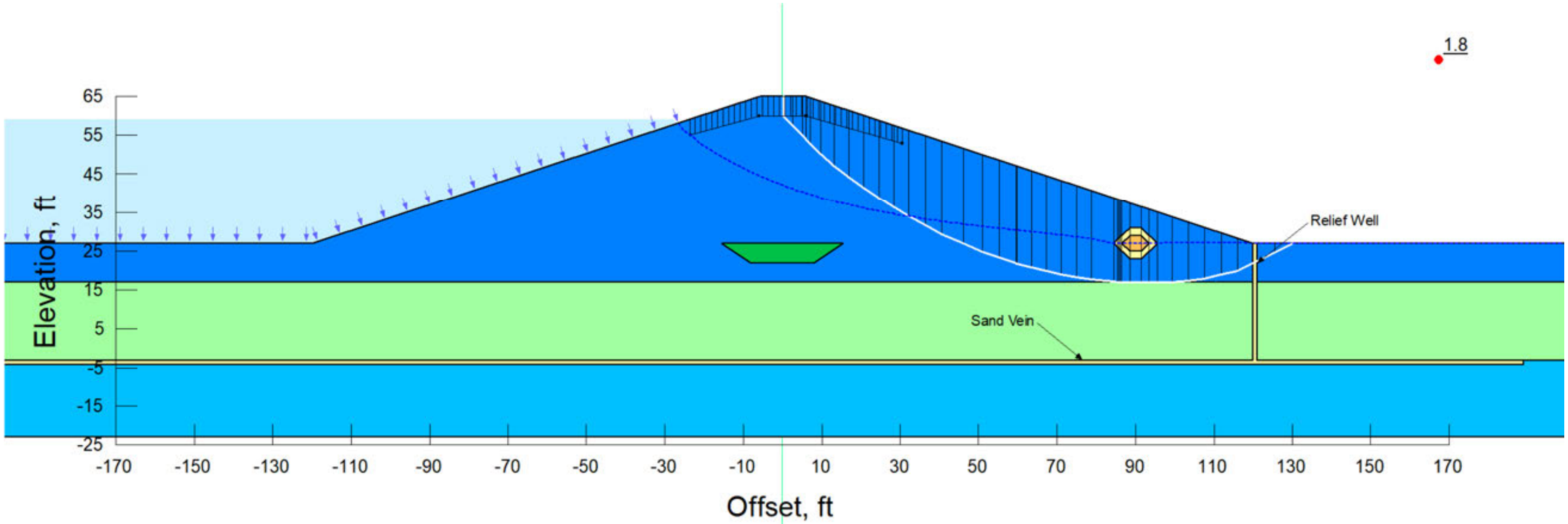
FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TX 77024

Lavaca Navidad River Authority
Proposed Off-Channel Reservoir Due Diligence

Seepage and Slope Stability Analysis
Typical Maximum Embankment Section

PLATE
3

SLOPE STABILITY—STEADY STATE SEEPAGE SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Sandy Clay	Mohr-Coulomb	125	230	24
	Clay	Mohr-Coulomb	125	230	19
	Clayey Sand	Mohr-Coulomb	125	230	31
	Sand	Mohr-Coulomb	120	0	33
	Gravel	Mohr-Coulomb	120	0	33
	Cut-off	Mohr-Coulomb	125	230	24

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**4**
PREPARED: SH			

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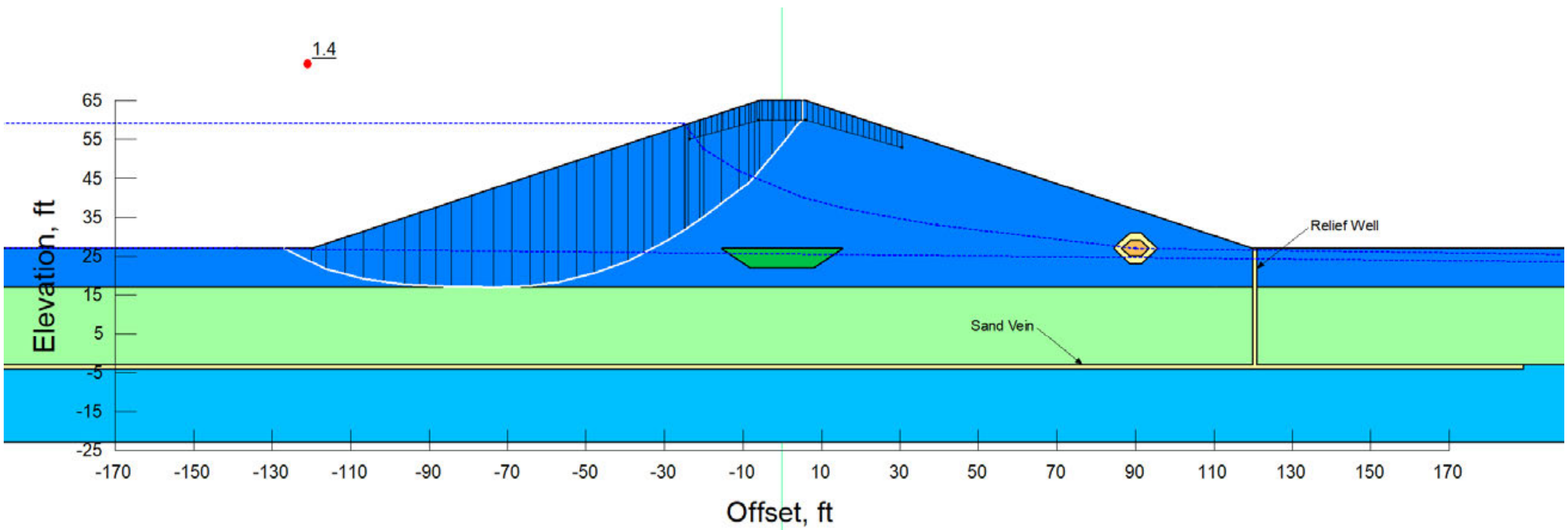
SLOPE STABILITY—RAPID DRAWDOWN SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Cohesion R (psf)	Phi R (°)	Piezometric Line	Piezometric Line After Drawdown
	Sandy Clay	Mohr-Coulomb	125	230	24	1,000	0	1	2
	Clay	Mohr-Coulomb	125	230	19	1,400	0	1	2
	Clayey Sand	Mohr-Coulomb	125	230	31	1,400	0	1	2
	Sand	Mohr-Coulomb	120	0	33	0	0	1	2
	Gravel	Mohr-Coulomb	120	0	33	0	0	1	2
	Cut-off	Mohr-Coulomb	125	230	24	1,000	0	1	2

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE** **5**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	
PREPARED: SH			

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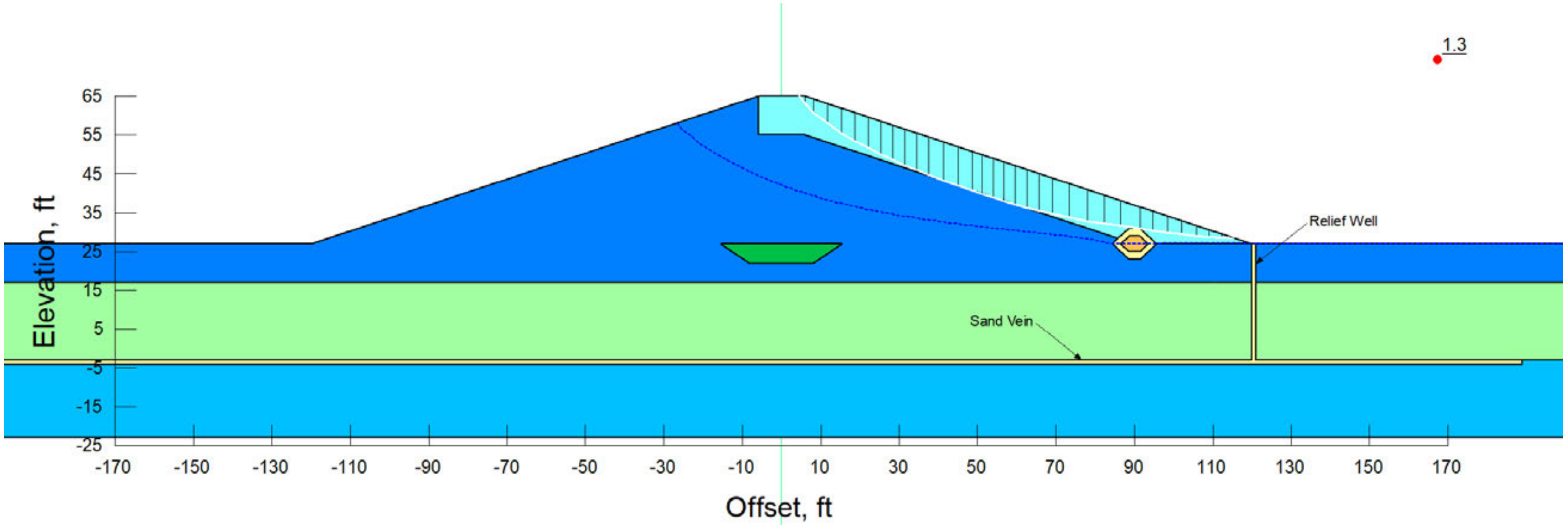
SLOPE STABILITY—FULLY SOFTENED SHEAR STRENGTH SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	B-bar	Add Weight	Strength Function
	Sandy Clay	Mohr-Coulomb	125	230	24	0	No	
	Clay	Mohr-Coulomb	125	230	19	0	No	
	Clayey Sand	Mohr-Coulomb	125	230	31	0	No	
	Sand	Mohr-Coulomb	120	0	33	0	No	
	Clay FSS	Shear/Normal Fn.	125			0.29	Yes	Clay FSS
	Gravel	Mohr-Coulomb	120	0	33	0	No	
	Cut-off	Mohr-Coulomb	125	230	24	0	No	

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**6**
PREPARED: SH			

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RESOLUTION NO. 2017-001

RESOLUTION AUTHORIZING THE GENERAL MANAGER TO MAKE APPLICATION TO TCEQ REGARDING LAVACA-NAVIDAD RIVER AUTHORITY WATER RIGHTS

WHEREAS, the Lavaca-Navidad River Authority (LNRA) was created pursuant to Article XVI, Section 59 of the Texas Constitution, and the laws of the State of Texas, particularly Tex. Laws 1947 Ch. 186, as amended, formerly codified as Article 8280-131, Tex. Civ. Stat., as amended (the Authority Act); and

WHEREAS, LNRA is authorized under the Authority's Act to control, store, preserve, and distribute storm and flood waters, and the waters of the rivers and streams of Jackson County for domestic, municipal, flood control, irrigation, agricultural, mining, and recovery of minerals, hydroelectric power, navigation, recreation, public parks, game preserves, and other useful purposes; and

WHEREAS, LNRA is further authorized under the Authority Act to own, construct, operate, and maintain facilities relating to water supply; and

WHEREAS, LNRA owns water rights on the Navidad and Lavaca Rivers under Certificate of Adjudication No. 16-2095 as amended; and

WHEREAS, the Board of Directors is authorized to appoint a general manager and to prescribe the general manager's duties; and

WHEREAS, Texas Commission on Environmental Quality (TCEQ) Rule 30 Tex. Admin. Code § 295.14 requires a water rights application to be signed by a duly authorized official; and

WHEREAS, 30 Tex. Admin. Code § 295.14 requires written evidence of the individual's authorization in the form of a resolution.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE LAVACA-NAVIDAD RIVER AUTHORITY:

1. The General Manager of LNRA is authorized to prepare, sign and file water rights applications and application amendments with TCEQ including, but not limited to, an application or applications to replace an On-Channel Impoundment on the Lavaca River with an Off-Channel Reservoir and to store and use water diverted from the Lavaca River in existing Lake Texana;

2. The General Manager is authorized take all action necessary, including the retention of sufficient and appropriate engineering, legal, and consulting support to accomplish the water rights application filing and attainment of a permit; and

3. It is officially found, determined, and declared that the meeting at which this Resolution has been read and has been adopted was open to the public and public notice of the time, place, and subject matter of the public business to be considered and acted upon of said meeting, including this Resolution, was given, all as required by the applicable provisions of Chapter 551, Texas Government Code.

PASSED AND APPROVED THIS 19TH DAY OF OCTOBER, 2016.

Ronald J Kubecka

President
Lavaca-Navidad River Authority

ATTEST:

Jerri Parker

Secretary Treasurer
Lavaca-Navidad River Authority

10497 Town and Country Way, Suite 500 + Houston, Texas 77024 + 713-600-6800 + FAX 817-735-7491 www.freese.com

TO: Hal E. Bailey, Jr.

CC: Patrick Brzozowski, P.E.

FROM: Jason Afinowicz, P.E.

SUBJECT: Water Conservation and Management Strategy Alternatives to the Lake Texana Yield Enhancement Project (LTYEP)

DATE: 6/23/2020

PROJECT: Lake Texana Yield Enhancement Project (LVA18507)

The Lavaca-Navidad River Authority (LNRA) owns and operates Lake Texana on the Navidad River in Jackson County. This reservoir is currently authorized under Certificate of Adjudication 16-2095 for the diversion and use of 79,000 acre-feet of water annually for multiple uses, including 4,000 acre-feet dedicated to municipal use. In addition, the reservoir is also permitted for the use of up to 7,500 acre-feet per year on an interruptible basis. Application Number 13728 is intended to provide LNRA, in its ultimate configuration, with an additional firm-yield supply of approximately 30,000 acre-feet per year through a combination of diversions from the Lavaca River, storage in existing Lake Texana, and storage in a proposed off-channel reservoir (OCR). Collectively, this project is known as the Lake Texana Yield Enhancement Project (LTYEP). This new firm yield is expected to increase the current firm yield of Lake Texana by over 35 percent. During the evaluation of this strategy, various other alternatives were also considered to meet identified needs of LNRA's customers.

Demand Management through Water Conservation

The LNRA has been a dedicated advocate of water conservation and within the organization, with its customers, and across the community, promoting conservation education and contractually requiring contract customers to address water efficiency. LNRA adopted their most recent water conservation plan (WCP) in April 2019. Although the plan includes strong measures for water conservation across LNRA's municipal and industrial customers and strict limits on unaccounted-for-water, implementation of these measures are not adequate to offset the potential demand that could be satisfied through the development of the LTYEP project. A summary of the potential benefits of key aspects of the WCP is shown below in **Table *1***.

Table 1 – Comparison of Potential Alternative Water Management Strategies

Customer (Contract Volume)	Conservation Goal	Potential Conservation Savings
City of Corpus Christi (31,440 ac-ft/yr firm)	Reduce demand to 150 gpcd (Based on baseline of 172 gpcd in 2017 SWP)	4,021 ac-ft/yr
	Limit unaccounted-for-water in customer systems to 15% (Baseline of 9% in 2017 Water Loss Audit is already below goal)	0 ac-ft/yr
City of Point Comfort (178 ac-ft/yr)	Reduce demand to 150 gpcd (Baseline of 93 gpcd in 2017 SWP is already below goal)	0 ac-ft/yr
	Limit unaccounted-for-water in customer systems to 15% (Baseline of 13% in 2015 Water Loss Audit is already below goal)	0 ac-ft/yr
LNRA Industrial Customers (42,826 ac-ft/yr)	20% reduction in industrial demand through wastewater reuse/recycling	8,565 ac-ft/yr
LNRA Water Delivery Systems (74,444 ac-ft/yr contracted)	Limit unaccounted-for-water in LNRA system to 10% (No unaccounted-for-water in the LNRA system)	0 ac-ft/yr
Total Potential Conservation Savings		**12,586 ac-ft/yr**

The total of the conservation programs above do not provide adequate reduction in demand to replace the proposed LTYEP project. Furthermore, growth in demands will outpace the rate of conservation, necessitating the development of additional water supplies within the Lavaca River Basin. LNRA industrial customers are financially incentivized to maximize water conservation savings before turning to the development of new water supplies which are more costly than existing sources. Their ongoing interest in securing additional water supplies is indicative of projected future needs that are in excess of those that can be met through conservation and recycling programs, alone.

Alternative Water Management Strategies

The 2017 State Water Plan (SWP) includes a variety of project alternatives for the Lavaca Region. ***Table 2***, below, summarizes these potential strategies in the SWP and how they compare to the LTYEP (identified as the Lavaca Off-Channel Reservoir in the SWP).

Table 2 – Comparison of Potential Alternative Water Management Strategies

Potential Water Management Strategy	Comparison to LTYEP
Drought Management	Recommended strategy for municipalities that are not currently LNRA customers and provides a projected benefit of 87 acre-feet per year within Jackson County by 2070.
Municipal Conservation	No potential yield identified for municipalities in Jackson County, none of which are LNRA customers.
Irrigation Conservation	Intended for irrigation users who are not supplied by LNRA.
Reuse	Intended for the City of El Campo in Wharton County with a potential supply of 560 acre-feet per year.
Lane City Reservoir (Region K)	Intended for irrigation users who are not supplied by LNRA.
Aquifer Storage and Recovery	Estimated yield is limited to 14,163 acre-feet per year and requires appropriation of surface water, similar to LTYEP.
LNRA Desalination	Estimated yield is limited to 6,452 acre-feet per year.
Expanded Use of Groundwater	Intended for irrigation users who are not supplied by LNRA.

The LTYEP strategy, as proposed, represents the only strategy of comparable magnitude to meet the demands of LNRA's current and potential future customers.

Texas Commission on Environmental Quality
TELEPHONE MEMO TO THE FIILE

Call to: Jason Afinowicz	Call from: Hal Bailey, Jr.
Date: June 10, 2020	Project No: WRPERM 13728

Information for File follows:

I received a voicemail on 06/09/2020 from Jason Afinowicz of Freese and Nichols, Inc. requesting to discuss the recent RFI sent to LNRA. I called Mr. Afinowicz back on 06/10/2020. He had some general questions which I answered, and some specific questions regarding the Dam Safety requirements for the project. I suggested that he contact Warren Samuelson directly for clarification on the questions related to the Dam Safety program.

Signed: Hal E. Bailey Jr.

Hal Bailey

From: Jason Afinowicz <[redacted]>
Sent: Wednesday, June 10, 2020 12:40 PM
To: Hal Bailey
Subject: RE: RFI for WRPERM 13278 (LNRA)

Thanks Hal,

Let's go ahead and plan for 3 PM today. You can give me a call at my desk 713.600.6841. Our primary interest is regarding the focus of the dam safety review. When we spoke with Warren last year he indicated that they were not focused on the on-channel impoundment since it is under six feet and we were able to provide him some information on the off-channel that answered his questions on that component. We can certainly provide more detail but just want to make sure we're answering the right question when we do.

Looking forward to talking to you this afternoon,

Jason

Jason D. Afinowicz, P.E.
Associate
Practice Leader, Water Resources

Freese and Nichols, Inc.
10497 Town and Country Way, Suite 500
Houston, Texas 77024
713-600-6841 direct
713-854-1655 mobile

www.freese.com

From: Hal Bailey <Hal.Bailey@tceq.texas.gov>
Sent: June 10, 2020 12:33
To: Jason Afinowicz [redacted]>
Subject: RE: RFI for WRPERM 13278 (LNRA)

Good afternoon Jason,

I will be happy to discuss the RFI with you. I am available this afternoon after 3 PM. Just as an FYI, although I am the project manager for the application, some of the information in the RFI
was requested by other TCEQ staff. It may be necessary for you to speak directly with Warren Samuelson to determine exactly what he needs for his review. We have several different teams
who evaluate the applications and provide the project manager with questions to include in the RFI. As I am working from home, I will have to call you from my cell phone, or you are welcome
to call me. Just let me know your preference.

Thanks,

Hal E. Bailey, Jr.
Natural Resources Specialist II
Water Rights Permitting Team
Water Availability Division
Texas Commission on Environmental Quality
512-239-4615 Hal.Bailey@tceq.texas.gov

From: Jason Afinowicz <[redacted]>
Sent: Wednesday, June 10, 2020 12:00 PM
To: Hal Bailey <Hal.Bailey@tceq.texas.gov>
Subject: RFI for WRPERM 13278 (LNRA)

Good morning Hal,

Sorry I missed your call earlier. This day has been filled with back-to-back meetings. I wanted to propose we set up a time to talk about the RFI if you are available. In particular, I wanted to confirm requirements regarding coordination with the Dam Safety Division. Today, I have availability after 3 PM and tomorrow I am open before 10:30 AM and between 2:00 and 4:00 PM. Please let me know if any of these times would work for you and I will send something out for a call.

Thanks,

Jason

Jason D. Afinowicz, P.E.
Associate
Practice Leader, Water Resources

Freese and Nichols, Inc.
10497 Town and Country Way, Suite 500
Houston, Texas 77024
713-600-6841 direct
713-854-1655 mobile

www.freese.com

Hal Bailey

From: Hal Bailey
Sent: Wednesday, June 3, 2020 5:15 PM
To: [redacted]
Cc: Karen Gregory; Chris Kozlowski; Humberto Galvan
Subject: Lavaca-Navidad River Authority App. No. 13728 Request for Information (RFI)
Attachments: LNRA_13728_RFI_06.03.2020.pdf

Good afternoon Mr. Brzozowski

Attached is an electronic copy of the RFI letter for the Lavaca-Navidad River Authority application no. 13728.

Please provide a response by COB on 07/03/2020. If you need additional time, or have any questions, please let me know.

Sincerely

Hal E. Bailey, Jr.
Natural Resources Specialist II
Water Rights Permitting Team
Water Availability Division
Texas Commission on Environmental Quality
512-239-4615 Hal.Bailey@tceq.texas.gov

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

June 3, 2020

Mr. Patrick Brzozowski, General Manager **VIA E-MAIL**
Lavaca-Navidad River Authority
4631 FM 3131
Edna, Texas 77957

RE: Lavaca-Navidad River Authority
WRPERM 13728
CN604423210, RN111015590
Application No. 13728 for a Water Use Permit
Texas Water Code §§ 11.121,11.042, 11.085, Requiring Mailed and Published Notice
Lavaca River, Lavaca River Basin
Jackson County

Dear Mr. Brzozowski:

This acknowledges receipt, on March 23, 2020, of the referenced application and fees in the amount of $96,262.50 (Receipt Nos. M017404 and M017404B, copies attached).

Additional information and fees are required before the application can be declared administratively complete.

1. Provide written evidence that Mr. Patrick Brzozowski is authorized to sign the application for Lavaca-Navidad River Authority, pursuant to Title 30 Texas Administrative Code (TAC) § 295.14(5), which states:

    If the applicant is a corporation, public district, county, municipality, or other corporate entity, the application shall be signed by a duly authorized official. Written evidence in the form of bylaws, charters, or resolutions which specify the authority of the official to take such action shall be submitted. A corporation may file a corporate affidavit as evidence of the official's authority to sign.

2. Provide a copy of the notices and certified mailing cards sent to each member of the governing body of each county and municipality in which the on-channel reservoir, or any part of the reservoir to be constructed, will be located, pursuant to 30 TAC § 295.42.

Be aware that this Water Use Permit, if granted, may result in annual Water Use Assessment Fees (WUF). For more detailed information on these fees, see the attached *Water Use Assessment Fee: The Annual Fee Associated with Water Rights Permits* fact sheet or contact the Water Quality Monitoring & Assessment Section at (512) 239-3838.

Please provide the requested information by July 3, 2020 or the application may be returned pursuant to 30 TAC § 281.18.

Commission records indicate that as of June 3, 2020, Lavaca-Navidad River Authority has outstanding fees or penalties in the amount of $363.38 within one or more program areas, see attachment. Please remit these fees as soon as possible to facilitate the processing of this application. You may contact Financial Administration at (512) 239-0300 for the latest outstanding balance and more detailed information on the amount owed.

Additional information will also be required in order to complete technical review of the application:

1. Provide data or information that supports the applicant's proposed use of water with consideration of the water conservation goals of the water conservation plan, evaluates conservation as an alternative to the proposed appropriation, and evaluates any other feasible alternative to new water development.

2. Provide additional conceptual details for the proposed dam to the TCEQ Dam Safety Section. Please contact Mr. Warren Samuelson at 512-239-0326 with any questions.

If you have any questions concerning this matter, please contact me via email at hal.bailey@tceq.texas.gov or by telephone at (512) 239-4615.

Sincerely,

Hal E. Bailey, Jr.

Hal E. Bailey, Jr., Project Manager
Water Rights Permitting Team
Water Rights Permitting and Availability Section

Attachments

TCEQ - A/R RECEIPT REPORT BY ACCOUNT NUMBER

TCEQ 27-MAY-20 06:12 PM

Fee Description	Fee Code / Account# / Account Name	Ref#1 / Ref#2 / Paid In By	Check Number / Card Auth. / User Data	CC Type / Tran Code / Rec Code	Slip Key / Document#	Tran Date	Tran Amount
NOTICE FEES-WUP-WATER USE PERM	PTGU	M017404	5186		BS00080717	27-MAY-20	-$47.94
	PTGU		032720	RCUM	J0805059		
	NOTICE FEES WUP WATER USE PERMITS	LAVACA NAVIDAD RIVER AUTHORITY	VACRUZ	CK			

Total (Fee Code): -$47.94

Grand Total: -$47.94

TCEQ - A/R RECEIPT REPORT BY ACCOUNT NUMBER

27-MAY-20 06:21 PM

Fee Description	Fee Code / Account# / Account Name	Ref#1 / Ref#2 / Paid In By	Check Number / Card Auth. / User Data	CC Type / Tran Code / Rec Code	Slip Key / Document#	Tran Date	Tran Amount
WTR USE PERMITS	WUP	M017404B	5186		BS00080718	27-MAY-20	-$96,214.56
	WUP		032720	RCUM	J0805059		
	WATER USE PERMITS	LAVACA NAVIDAD RIVER AUTHORITY	VACRUZ	CK			

Total (Fee Code): -$96,214.56

Grand Total: -$96,214.56

Water Use Assessment Fee (WUF): The Annual Fee Associated with Water Rights Permits

How can this affect me?

You are receiving this notice if you are the owner of a water right permit and you have recently changed your permit. Any change to your permit, including adding an authorized use, changing a diversion point, or a change of ownership, would cause the Water Use Fee assessor to review your permit for billable uses and may (depending on the change) result in you receiving a bill when you previously did not.

What is this fee?

The Water Use Assessment Fee is a fee that is assessed annually on applicable water rights permits. Texas Water Code, Sections 26.0135 & 26.0291 authorizes the TCEQ to establish fees to recover the reasonable costs of water quality assessment programs from wastewater and water right permit holders. TCEQ rules, 30 Texas Administrative Code (TAC), Sections 21.1-21.4, set out the methodology for assessing water use fees, described below.

Why are you billed?

If you hold a water right and do not fall under an exemption, then you are subject to the Water Use Assessment Fee. Unless the water right is amended to fall under an exemption, you will be billed for this water right on an annual basis.

Amendments can make a water right that was not previously billed now billable. For example, if you amend your water right to add an authorized use you could receive a bill in the year following your amendment.

What are reasons for exemption?

Exemptions are listed in 30 TAC, Section 21.3(c). Exemptions from the Water Use Assessment Fee include: municipal/domestic or industrial water rights directly associated with a facility that is assessed a Consolidated Water Quality Fee; agriculture (irrigation) water rights; non-priority hydroelectric water rights for a facility with a capacity of less than 2 megawatts; consumptive authorization less than 250 acre-feet; and non-consumptive authorization less than 2,500 acre-feet. If you can provide proof of these exemptions, please contact us using the information at the end of this document.

How is the fee assessed?

Fees are based on the annual authorization in the water right, not actual use. The total fee is the sum of the separate fees for each authorized use in each of the following categories for each permit.

The fee rate of **$0.385** per acre-foot per year applies to authorized consumptive use (municipal/domestic, industrial, or mining purposes) if the specified limit is more than 250 acre-feet per year.

The fee rate of **$0.021** per acre-foot per year applies to authorized non-consumptive use (including hydroelectric and some recreation) if the specified limit is more than 2,500 acre-feet per year.

The maximum water use fee for a single permit is $115,000, which may be adjusted annually using the latest Consumer Price Index.

How are diversion amounts distributed amongst uses?

For permits with multiple uses that do not specify the amount per use, the total authorized amount is divided equally among all uses.

Example: 10,000 ac-ft for irrigation, municipal, industrial, and mining
10,000/4 = 2,500 ac-ft per use
Irrigation is exempt; municipal/domestic not billed because wastewater treatment plant that uses the water already pays the Consolidated Water Quality Fee; industrial is billed $962.50 at the consumptive rate for 2,500 ac-ft; mining billed $962.50 at the consumptive rate for 2,500 ac-ft.

Where Do I Get More Information?

For copies of the fee rules (30 TAC, Sections 21.1-21.4), refer to the TCEQ rules from the Texas Administrative Code on the Secretary of State's web site at www.sos.state.tx.us. To learn more about the fee, please visit:

http://www.tceq.state.tx.us/agency/drought/waterfees.html

For billing and account balance information, call the TCEQ's Financial Administration Division, Revenue Section at (512) 239-0344.

If you have any questions about the Water Use Assessment Fee or the rates for your water right, contact the Water Quality Monitoring & Assessment Section at (512) 239-3838, or via email at wateruse@tceq.texas.gov, or write to:

Texas Commission on Environmental Quality
Water Quality Planning Division, MC 234
Water Use Fees
P.O. Box 13087
Austin, TX 78711-3087

Customer Name: LAUREL IND. INC.
Account #: 0500548 Debtcollpath Stage: WHOLD:REFERRED,UNCOL:EXHAUST Calls: NOTES

TOX	SC2612-001	LATE FEE FOR TOX0022762			0022762	10-AUG-06	10-SEP-06	$.69
TOX	SC2701-001	LATE FEE FOR TOX0022762			0022762	11-SEP-06	11-OCT-06	$.69

Total of delinquent transactions (Account): $112.76

Total of delinquent transactions (Customer): $112.76

Customer Name: LAURENCIO H. BRITO
Account #: 22002072 Debtcollpath Stage: Calls: HOLD

RGR	RGR0047727	ASSESSMENT CHARGE		FY19	0961-000	31-OCT-18	30-NOV-18	$6.75
RGR	RGR0047728	AWR CHARGE	AF	FY19	0961-000	31-OCT-18	30-NOV-18	$24.04
RGR	RGR0047728	COLLECTION COST RECOVERY				01-MAR-19	01-MAR-19	$6.01
RGR	RGR0047727	COLLECTION COST RECOVERY				01-MAR-19	01-MAR-19	$12.50
RGR	RGR0047726	COLLECTION COST RECOVERY				01-MAR-19	01-MAR-19	$11.69
RGR	RGR0047725	COLLECTION COST RECOVERY				01-MAR-19	01-MAR-19	$12.50
RGR	RGR0050542	ASSESSMENT CHARGE		FY20	0960-000	31-OCT-19	30-NOV-19	$50.00
RGR	RGR0050543	AWR CHARGE	AF	FY20	0960-000	31-OCT-19	30-NOV-19	$47.75
RGR	RGR0050544	ASSESSMENT CHARGE		FY20	0961-000	31-OCT-19	30-NOV-19	$50.00
RGR	RGR0050545	AWR CHARGE	AF	FY20	0961-000	31-OCT-19	30-NOV-19	$24.56

Total of delinquent transactions (Account): $245.80

Total of delinquent transactions (Customer): $245.80

Customer Name: LAURIE MITCHELL
Account #: 0803928H Debtcollpath Stage: WHOLD:REFERRED Calls: NAMECHNG

WMS	WMS0044328	MUN TRAN SLDG FEE GALS		FY19	23928	31-JUL-19	31-AUG-19	$35.88
WMS	SC00247207	LATE FEE - SEP 2019				10-SEP-19	10-SEP-19	$12.50
WMS	SC00248312	LATE FEE - OCT 2019				10-OCT-19	10-OCT-19	$12.50
WMS	SC00249517	LATE FEE - NOV 2019				10-NOV-19	10-NOV-19	$1.62
WMS	SC00251077	LATE FEE - DEC 2019				10-DEC-19	10-DEC-19	$1.62
WMS	SC00253073	LATE FEE - JAN 2020				10-JAN-20	10-JAN-20	$.20
WMS	SC00255287	LATE FEE - JAN 2020				10-JAN-20	10-JAN-20	$.20
WMS	SC00256841	LATE FEE - MAR 2020				10-MAR-20	10-MAR-20	$.20

Total of delinquent transactions (Account): $64.72

Total of delinquent transactions (Customer): $64.72

Customer Name: LAUROB PROPERTIES, LLC
Account #: 22504063 Debtcollpath Stage: Calls:

STX	STX0044812	AWR CHARGE	AF	FY20	1953-601-0	31-OCT-19	30-NOV-19	$.47

Total of delinquent transactions (Account): $.47

Total of delinquent transactions (Customer): $.47

Customer Name: LAVACA-NAVIDAD RIVER AUTHORITY
Account #: 89961130 Debtcollpath Stage: Calls: HOLD

RAF	RAF0005146	REGULATORY ASMT	FY19		P1130	31-JAN-20	29-FEB-20	$363.38

Total of delinquent transactions (Account): $363.38

Total of delinquent transactions (Customer): $363.38

Customer Name: LAVENDER CLEANERS INC
Account #: 24006759 Debtcollpath Stage: Calls:

DCR	DCR0225388	DRY CLEAN REG FEE 1		FY20Q	DCR12196	31-MAR-20	30-APR-20	$625.00

Total of delinquent transactions (Account): $625.00

Total of delinquent transactions (Customer): $625.00

Hal Bailey

From: Karen Gregory <[redacted]>
Sent: Thursday, May 7, 2020 2:57 PM
To: Hal Bailey
Subject: Re: LNRA Water Rights Application No. 13728 (Lake Texana Enhanced Yield Project)

Thank you!

Karen Gregory
Deputy General Manager - Administration
Lavaca-Navidad River Authority
P. O. Box 429
4631 FM 3131
Edna, TX 77957
361.782.5229 office
361.781.2129 cell

From: Hal Bailey <Hal.Bailey@tceq.texas.gov>
Sent: Thursday, May 7, 2020 2:20 PM
To: Karen Gregory <[redacted]>
Subject: RE: LNRA Water Rights Application No. 13728 (Lake Texana Enhanced Yield Project)

Good afternoon Ms. Gregory,

Thank you for the clarification. No action is needed on your part. I didn't see the $112.50 for the bed and banks authorization at the bottom of the
fee calculation page. The amount submitted by LNRA is correct for this application. Notice fees will be calculated separately.

Thank you for your prompt response.

Best Regards,

Hal E. Bailey, Jr.
Natural Resources Specialist II
Water Rights Permitting Team
Water Availability Division
Texas Commission on Environmental Quality
512-239-4615 Hal.Bailey@tceq.texas.gov

From: Karen Gregory [redacted]>
Sent: Thursday, May 7, 2020 1:41 PM
To: Hal Bailey <Hal.Bailey@tceq.texas.gov>
Subject: Fw: LNRA Water Rights Application No. 13728 (Lake Texana Enhanced Yield Project)

Good afternoon:

In response to your email below to Patrick Brzozowski -

Yes, the $96,262.50 payment, check #5186, was for the LNRA Water Rights Application No. 13728 (Lake Texana Enhanced Yield Project). That is the amount we were advised by Freese and Nichols to send to TCEQ. I am not sure why we have a different amount.

Please advise if we need to reissue or need additional information.

Respectfully,

Karen Gregory

Deputy General Manager - Administration
Lavaca-Navidad River Authority
P. O. Box 429
4631 FM 3131
Edna, TX 77957
361.782.5229 office
361.781.2129 cell

Manage Conserve Protect LNRA LAVACA-NAVIDAD RIVER AUTHORITY

From: Hal Bailey <Hal.Bailey@tceq.texas.gov>
Sent: Wednesday, May 6, 2020 5:13 PM
To: Patrick Brzozowski
Subject: LNRA Water Rights Application No. 13728 (Lake Texana Enhanced Yield Project)

Good afternoon Patrick,

I was reviewing the water rights permit application recently submitted by LNRA for the Lake Texana Enhanced Yield Project. On Worksheet 8.0, the fees were
calculated as $96,160; however, when I received the receipt from the TCEQ Cashier's Office, it showed a payment of $96,262.50, paid by check no. 5186. Can you
verify that check no. 5186 is for this application? I wasn't sure if LNRA has submitted more than one application, so I want to make sure we credit the payment to
to the correct application.

Thank you,

Hal E. Bailey, Jr.
Natural Resources Specialist II
Water Rights Permitting Team
Water Availability Division
Texas Commission on Environmental Quality
512-239-4615 Hal.Bailey@tceq.texas.gov

Hal Bailey

From: Amy Settemeyer
Sent: Wednesday, May 6, 2020 12:52 PM
To: Hal Bailey
Cc: Chris Kozlowski
Subject: FW: LNRA
Attachments: 09-05-19 Gregory Email to TCEQ-LNRA Water Conservation Plan.pdf

Hal – this came in last week. It has not been distributed to staff to my knowledge.

Thanks.
Amy

From: Emily Rogers [redacted]>
Sent: Friday, May 1, 2020 4:32 PM
To: Amy Settemeyer <amy.settemeyer@tceq.texas.gov>; Sarah Henderson <sarah.henderson@tceq.texas.gov>
Subject: RE: LNRA

Amy and Sarah, here is what we think you need regarding the plans. Let me know if you need anything else.

Have a great weekend!

Emily Willms Rogers | Managing Partner | Bickerstaff Heath Delgado Acosta LLP
3711 S. Mo-Pac | Building One | Suite 300 | Austin, TX | 78746
Main Office Phone 512.472.8021 | Direct Line 512.404.7790
Cell Phone 512.517.9899 | Fax 512.320.5638

[redacted] | www.bickerstaff.com

Bickerstaff
Heath Delgado Acosta LLP

Austin | El Paso | Houston

Cynthia Alvarez

From:	Karen Gregory
Sent:	Thursday, September 5, 2019 4:06 PM
To:	Cynthia Alvarez
Subject:	Fw: LNRA Water Conservation Plan
Attachments:	Water Conservation_Drought Contingency Review.pdf

Karen Gregory
Deputy General Manager - Administration
Lavaca-Navidad River Authority
P. O. Box 429
4631 FM 3131
Edna, TX 77957
361.782.5229 office
361.781.2129 cell

LNRA
LAVACA-NAVIDAD RIVER AUTHORITY

From: Karen Gregory
Sent: Thursday, September 5, 2019 2:49 PM
To: trent.jennings@tceq.texas.gov <trent.jennings@tceq.texas.gov>
Cc: Doug Anders <[redacted]>
Subject: LNRA Water Conservation Plan

Good afternoon Mr. Jennings:

In response to your email to Doug Anders regarding LNRA's Water Conservation Plan components, I have attached the minutes from LNRA's Board of Directors meeting of July 17, 2019 indicating approval of LNRA's Water Conservation Plan and Drought Contingency Plan.

A copy of the WCP and DCP were made available to the Lavaca Regional Water Planning Group (Region P), at their most recent meeting on August 19, 2019.

Please let me know if you need additional information or have questions.

Sincerely,

Karen Gregory
Deputy General Manager - Administration

Lavaca-Navidad River Authority

Minutes of July 17, 2019
Board Meeting

A meeting of the Lavaca-Navidad River Authority Board of Directors was held on Wednesday, July 17, 2019 at 7:30 a.m. in the Board Meeting Room of the Lavaca Navidad River Authority Office Complex, 4631 FM 3131, located approximately seven (7) miles east of Edna, Jackson County, Texas off FM 3131. Board members present were President Kubecka, Directors Adelman, Johs, Martin, Sachtleben, Steffek, and Taylor, and LNRA Staff: Brzozowski, Anders, Gregory, Janak, Martin, Pearson, Hartl, Sklar, and Crenshaw. Also present was Bill Dugat of Bickerstaff Heath Delgado Acosta LLP, Mike Rivet of Formosa Plastics Corporation, and Telishia Malone of the Jackson County Herald Tribune.

President Kubecka called the meeting to order.

Public Comments

There were no public comments.

General Manager's Report

Brzozowski reported on the following:

- General Manager's Quarterly Report as of June 30, 2019
- Watermasters Meeting July 9, 2019
- Community Education Center Groundbreaking – 9:30 a.m. Today at Site

Consent Agenda

President Kubecka called for questions or comments to the Consent Agenda items as follows:

1. Consider approval of Board meeting minutes of June 26, 2019 and July 10, 2019 and act as necessary.
2. Consider acceptance of June 2019 financial statements and act as necessary.
3. Consider approval of invoices for payment and act as necessary.
4. Consider approval of Investment Report as of June 30, 2019 and act as necessary.
5. Consider approval of budget amendments and act as necessary.

Gregory briefed the Board on the activity of investments as reported on the Quarterly Investment Report as of June 30, 2019. TexPool investments earned an average rate of 2.40% for the quarter. The Board was presented a copy of the quarterly report for their review.

Director Adelman moved to approve the Consent Agenda items 1-5 as presented. Director Martin seconded the motion. Motion passed.

Regular Agenda

LNRA Water Conservation and Drought Contingency Plans

Brzozowski briefed the Board on the most recently revised LNRA Water Conservation and Drought Contingency Plans (April 2019). As required, copies have been submitted to Texas Commission on Environmental Quality (TCEQ). A copy was presented to the Board for their review.

Director Taylor moved to approve the LNRA Water Conservation and Drought Contingency Plans (April 2019) as presented. Director Johs seconded the motion. Motion passed.

Briefing on LNRA Employment

Brzozowski briefed the Board on the LNRA Employee Information Manual, IX, Employment. The Board discussed the current policy of employing relatives and how the relationships might affect the LNRA. Management will clarify the specifics of hiring relatives, while complying with State nepotism laws, and ask the Board to consider proposed revisions to the policy at the August Board meeting.

No action was taken by the Board.

LNRA Strategic Resource Management Plan

Brzozowski briefed the Board on the LNRA Strategic Resource Management Plan as revised and approved in September 2016. It was the consensus of the Board that a workshop be scheduled for review and possible revisions to the Plan.

LNRA's Employee Retirement Benefits and Employer Contribution Rates

LNRA's retirement plan is with the Texas County & District Retirement System (TCDRS). The Board was presented a copy of the funding projections for 2019-2020 and program benefit information.

Brzozowski briefed the Board on the Lavaca-Navidad River Authority's employer contribution rate to TCDRS. TCDRS requires that participating employers review and confirm their benefit plans on an annual basis.

The calculated employer contribution rate for 2020 is 8.07%. LNRA Management recommends continuing contributing at the optional higher elected rate of 15% for 2020.

Director Martin moved to approve the Lavaca-Navidad River Authority's employer contribution rate to Texas County District Retirement System of 15%. Director Adelman seconded the motion. Motion passed.

Agreement between LNRA and U.S. Geological Survey

Brzozowski briefed the Board on the proposed standard joint-funding agreement between LNRA and U.S. Geological Survey (USGS) for surface-water and water-quality data collection activities for the period from October 1, 2019 to September 30, 2020. LNRA will contribute budgeted funds of $85,776 and USGS will contribute $29,810 to cover the cost of the necessary field and analytical work related to the agreement for a total of $115,586. The Board was presented a copy of the agreement for their review. Funds are budgeted for FY 2020.

Director Johs moved to approve the agreement between LNRA and USGS as presented. Director Taylor seconded the motion. Motion passed.

Briefing on Lake Texana Yield Enhancement Project

The Board meeting recessed at 8:55 a.m. and reconvened at 9:30 a.m. at Texana Park, 46 Park Road 1, for the LNRA Community Education Center groundbreaking. The meeting adjourned at 10:32 a.m.

Ronald S Kubecka

Ronald Kubecka
President

Terri Parker

Terri Parker
Secretary-Treasurer

Board Regional

Reply all Delete Junk Block ···

LNRA WCP missing components

TJ Trent Jennings <trent.jennings@tceq.texas.gov>

Tue 7/2/2019 9:03 AM
Doug Anders; Trent Jennings <trent.jennings@tceq.texas.gov>

Hi Doug,

As we discussed this morning, LNRA is missing two components in its water conservation plan (WCP) which are listed below:

1. Documentation of coordination with the regional water planning groups for the service area of the wholesale water supplier in order to ensure consistency with the appropriate approved regional water plans. **(Provide a copy of the letter/email showing you sent a copy of the WCP to your regional water planning group or you can email a statement stating that you have or will provide a copy).**

2. Means for implementation and enforcement, evidenced by a copy of the ordinance, rule, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and a description of the authority by which the water supplier will implement and enforce the conservation plan. **(Provide a copy of the official adoption of the WCP.)**

Please contact me if you have any questions or need assistance.

Thanks,

Trent Jennings
Water Availability Division
Texas Commission on Environmental Quality
Tel: 512-239-6857

8-19-19 - * The LNRA Water Conservation & Drought Contingency Plans were discussed & copies were distributed to Lavaca Regional Water Planning Group (Region P) members

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

TCEQ WATER RIGHTS PERMITTING APPLICATION

ADMINISTRATIVE INFORMATION CHECKLIST

Complete and submit this checklist for each application. See Instructions Page. 5.

APPLICANT(S): Lavaca-Navidad River Authority (LNRA)

Indicate whether the following items are included in your application by writing either Y (for yes) or N (for no) next to each item (all items are not required for every application).

Y/N	
Y	**Administrative Information Report**
N	Additional Co-Applicant Information
N	Additional Co-Applicant Signature Pages
Y	Written Evidence of Signature Authority
Y	**Technical Information Report**
Y	USGS Map (or equivalent)
Y	Map Showing Project Details
Y	Original Photographs
Y	Water Availability Analysis
Y	**Worksheet 1.0**
N	Recorded Deeds for Irrigated Land
N	Consent For Irrigation Land
Y	**Worksheet 1.1**
N	Addendum to Worksheet 1.1
N	**Worksheet 1.2**
N	Addendum to Worksheet 1.2
Y	**Worksheet 2.0**
Y	Additional W.S 2.0 for Each Reservoir
Y	Dam Safety Documents
Y	Notice(s) to Governing Bodies
N	Recorded Deeds for Inundated Land
N	Consent For Inundation Land

Y/N	
Y	**Worksheet 3.0**
Y	Additional W.S 3.0 for each Point
N	Recorded Deeds for Diversion Points
N	Consent For Diversion Access
Y	**Worksheet 4.0**
N	TPDES Permit(s)
N	WWTP Discharge Data
N	24-hour Pump Test
N	Groundwater Well Permit
N	Signed Water Supply Contract
Y	**Worksheet 4.1**
Y	**Worksheet 5.0**
Y	Addendum to Worksheet 5.0
Y	**Worksheet 6.0**
Y	Water Conservation Plan(s)
Y	Drought Contingency Plan(s)
Y	Documentation of Adoption
Y	**Worksheet 7.0**
Y	Accounting Plan
Y	**Worksheet 8.0**
Y	Fees

For Commission Use Only:
Proposed/Current Water Right Number: ____________
Basin: ___________________ Watermaster area Y/N: ___________

ADMINISTRATIVE INFORMATION REPORT

The following information **is required** for **all** new applications and amendments.

******Applicants are strongly encouraged to schedule a pre-application meeting with TCEQ Staff to discuss Applicant's needs prior to submitting an application. Call the Water Rights Permitting Team to schedule a meeting at* (512) 239-4691.**

1. TYPE OF APPLICATION (Instructions, Page. 6)

Indicate, by marking X, next to the following authorizations you are seeking.

__X__ New Appropriation of State Water

_____ Amendment to a Water Right *

__X__ Bed and Banks

****If you are seeking an amendment to an existing water rights authorization, you must be the owner of record of the authorization. If the name of the Applicant in Section 2, does not match the name of the current owner(s) of record for the permit or certificate or if any of the co-owners is not included as an applicant in this amendment request, your application could be returned. If you or a co-applicant are a new owner, but ownership is not reflected in the records of the TCEQ, submit a change of ownership request (Form TCEQ-10204) prior to submitting the application for an amendment. See Instructions page. 6. Please note that an amendment application may be returned, and the Applicant may resubmit once the change of ownership is complete.***

Please summarize the authorizations or amendments you are seeking in the space below or attach a narrative description entitled "Summary of Request."

Please see Section 2.1 Summary of Request in the Supplemental Report.

2. APPLICANT INFORMATION (Instructions, Page. 6)

a. Applicant

Indicate the number of Applicants/Co-Applicants 1
(Include a copy of this section for each Co-Applicant, if any)

What is the Full Legal Name of the individual or entity (applicant) applying for this permit?

Lavaca-Navidad River Authority (LNRA)

(If the Applicant is an entity, the legal name must be spelled exactly as filed with the Texas Secretary of State, County, or in the legal documents forming the entity.)

If the applicant is currently a customer with the TCEQ, what is the Customer Number (CN)? You may search for your CN on the TCEQ website at http://www15.tceq.texas.gov/crpub/index.cfm?fuseaction=cust.CustSearch

CN : CN604423210 (leave blank if you do not yet have a CN).

What is the name and title of the person or persons signing the application? Unless an application is signed by an individual applicant, the person or persons must submit written evidence that they meet the signatory requirements in *30 TAC § 295.14*.

First/Last Name: Patrick Brzozowski

Title: General Manager

Have you provided written evidence meeting the signatory requirements in 30 TAC § 295.14, as an attachment to this application? Yes

What is the applicant's mailing address as recognized by the US Postal Service (USPS)? You may verify the address on the USPS website at https://tools.usps.com/go/ZipLookupAction!input.action.

Name: Lavaca-Navidad River Auth

Mailing Address: 4631 FM3131

City: Edna State: TX ZIP Code: 77957

Indicate an X next to the type of Applicant:

____Individual	____Sole Proprietorship-D.B.A.
____Partnership	____Corporation
____Trust	____Estate
____Federal Government	____State Government
____County Government	____City Government
____Other Government	X Other Conservation and Reclamation District

For Corporations or Limited Partnerships, provide:
State Franchise Tax ID Number: N/A SOS Charter (filing) Number: N/A

3. APPLICATION CONTACT INFORMATION (Instructions, Page. 9)

If the TCEQ needs additional information during the review of the application, who should be contacted? Applicant may submit their own contact information if Applicant wishes to be the point of contact.

First and Last Name: Patrick Brzozowski

Title: General Manager

Organization Name: Lavaca-Navidad River Auth

Mailing Address: 4631 FM3131

City: Edna State: TX ZIP Code: 77957

Phone No.: 361-782-5229 Extension:

Fax No.: 361-782-5310 E-mail Address: [redacted]

4. WATER RIGHT CONSOLIDATED CONTACT INFORMATION (Instructions, Page. 9)

This section applies only if there are multiple Owners of the same authorization. Unless otherwise requested, Co-Owners will each receive future correspondence from the Commission regarding this water right (after a permit has been issued), such as notices and water use reports. Multiple copies will be sent to the same address if Co-Owners share the same address. Complete this section if there will be multiple owners and **all** owners agree to let one owner receive correspondence from the Commission. Leave this section blank if you would like all future notices to be sent to the address of each of the applicants listed in section 2 above.

I/We authorize all future notices be received on my/our behalf at the following:

First and Last Name: N/A

Title: N/A

Organization Name: N/A

Mailing Address: N/A

City: N/A State: N/A ZIP Code: N/A

Phone No.: N/A Extension: N/A

Fax No.: N/A E-mail Address: N/A

5. MISCELLANEOUS INFORMATION (Instructions, Page. 9)

a. The application will not be processed unless all delinquent fees and/or penalties owed to the TCEQ or the Office of the Attorney General on behalf of the TCEQ are paid in accordance with the Delinquent Fee and Penalty Protocol by all applicants/co-applicants. If you need assistance determining whether you owe delinquent penalties or fees, please call the Water Rights Permitting Team at (512) 239-4691, prior to submitting your application.

1. Does Applicant or Co-Applicant owe any fees to the TCEQ? **Yes / No** No

   If **yes**, provide the following information:
   Account number: N/A Amount past due: N/A

2. Does Applicant or Co-Applicant owe any penalties to the TCEQ? **Yes / No** No

   If **yes**, please provide the following information:
   Enforcement order number: N/A Amount past due: N/A

b. If the Applicant is a taxable entity (corporation or limited partnership), the Applicant must be in good standing with the Comptroller or the right of the entity to transact business in the State may be forfeited. See Texas Tax Code, Subchapter F. Applicant's may check their status with the Comptroller at https://mycpa.cpa.state.tx.us/coa/

   Is the Applicant or Co-Applicant in good standing with the Comptroller? **Yes / No** Yes

c. The commission will not grant an application for a water right unless the applicant has submitted all Texas Water Development Board (TWDB) surveys of groundwater and surface water use – if required. See TWC §16.012(m) and 30 TAC § 297.41(a)(5).

Applicant has submitted all required TWDB surveys of groundwater and surface water? **Yes / No** Yes

6. SIGNATURE PAGE (Instructions, Page. 11)

Applicant:

I, Patrick Brzozowski   General Manager
(Typed or printed name)   (Title)

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I further certify that I am authorized under Title 30 Texas Administrative Code §295.14 to sign and submit this document and I have submitted written evidence of my signature authority.

Signature: ______________ Date: 03/23/20
(Use blue ink)

Subscribed and Sworn to before me by the said

on this 23rd day of March, 20 20.

My commission expires on the 10th day of September, 20 20.

Karen Gregory
Notary Public   [SEAL]

Jackson
County, Texas

KAREN GREGORY
NOTARY PUBLIC
STATE OF TEXAS
ID # 2864528
My Comm. Expires 09-10-2020

If the Application includes Co-Applicants, each Applicant and Co-Applicant must submit an original, separate signature page

TECHNICAL INFORMATION REPORT
WATER RIGHTS PERMITTING

This Report is required for applications for new or amended water rights. Based on the Applicant's responses below, Applicants are directed to submit additional Worksheets (provided herein). A completed Administrative Information Report is also required for each application.

Applicants are strongly encouraged to schedule a pre-application meeting with TCEQ Permitting Staff to discuss Applicant's needs and to confirm information necessary for an application prior to submitting such application. Please call Water Availability Division at (512) 239-4691 to schedule a meeting. Applicant attended a pre-application meeting with TCEQ Staff for this Application? **Y / N** Y (If yes, date : 02/06/2020).

1. New or Additional Appropriations of State Water. Texas Water Code (TWC) § 11.121 (Instructions, Page. 12)

State Water is: *The water of the ordinary flow, underflow, and tides of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico, and the storm water, floodwater, and rainwater of every river, natural stream, canyon, ravine, depression, and watershed in the state. TWC § 11.021.*

a. Applicant requests a new appropriation (diversion or impoundment) of State Water? **Y / N** Y

b. Applicant requests an amendment to an existing water right requesting an increase in the appropriation of State Water or an increase of the overall or maximum combined diversion rate? **Y / N** N (If yes, indicate the Certificate or Permit number: N/A)

If Applicant answered yes to (a) or (b) above, does Applicant also wish to be considered for a term permit pursuant to TWC § 11.1381? N **Y / N**

c. Applicant requests to extend an existing Term authorization or to make the right permanent? **Y / N** N (If yes, indicate the Term Certificate or Permit number: N/A)

If Applicant answered yes to (a), (b) or (c), the following worksheets and documents are required:

- **Worksheet 1.0 – Quantity, Purpose, and Place of Use Information Worksheet**
- **Worksheet 2.0 - Impoundment/Dam Information Worksheet** (submit one worksheet for each impoundment or reservoir requested in the application)
- **Worksheet 3.0 - Diversion Point Information Worksheet** (submit one worksheet for each diversion point and/or one worksheet for the upstream limit and one worksheet for the downstream limit of each diversion reach requested in the application)
- **Worksheet 5.0 – Environmental Information Worksheet**
- **Worksheet 6.0 – Water Conservation Information Worksheet**
- **Worksheet 7.0 – Accounting Plan Information Worksheet**
- **Worksheet 8.0 – Calculation of Fees**
- **Fees calculated on Worksheet 8.0** – see instructions **Page. 34.**
- **Maps** – See instructions **Page. 15.**
- **Photographs** - See instructions **Page. 30.**

Additionally, if Applicant wishes to submit an alternate source of water for the project/authorization, see Section 3, Page 3 for Bed and Banks Authorizations (Alternate sources may include groundwater, imported water, contract water or other sources).

Additional Documents and Worksheets may be required (see within).

2. Amendments to Water Rights. TWC § 11.122 (Instructions, Page. 12)

This section should be completed if Applicant owns an existing water right and Applicant requests to amend the water right. ***If Applicant is not currently the Owner of Record in the TCEQ Records, Applicant must submit a Change of Ownership Application (TCEQ-10204) prior to submitting the amendment Application or provide consent from the current owner to make the requested amendment.*** **See instructions page. 6.**

Water Right (Certificate or Permit) number you are requesting to amend: N/A

Applicant requests to sever and combine existing water rights from one or more Permits or Certificates into another Permit or Certificate? **Y / N** N (if yes, complete chart below):

List of water rights to sever	Combine into this ONE water right
N/A	N/A

a. Applicant requests an amendment to an existing water right to increase the amount of the appropriation of State Water (diversion and/or impoundment)? **Y / N** N

If yes, application is a new appropriation for the increased amount, complete ***Section 1 of this Report (PAGE. 1) regarding New or Additional Appropriations of State Water****.*

b. Applicant requests to amend existing Term authorization to extend the term or make the water right permanent (remove conditions restricting water right to a term of years)? **Y / N** N

If yes, application is a new appropriation for the entire amount, complete ***Section 1 of this Report (PAGE. 1) regarding New or Additional Appropriations of State Water****.*

c. Applicant requests an amendment to change the purpose or place of use or to add an additional purpose or place of use to an existing Permit or Certificate? **Y / N** N
If yes, submit:

- **Worksheet 1.0 – Quantity, Purpose, and Place of Use Information Worksheet**
- **Worksheet 1.2 - Notice: "Marshall Criteria"**

d. Applicant requests to change: diversion point(s); or reach(es); or diversion rate? **Y / N** N

If yes, submit: **Worksheet 3.0 - Diversion Point Information Worksheet** (submit one worksheet for each diversion point or one worksheet for the upstream limit and one worksheet for the downstream limit of each diversion reach)

e. Applicant requests amendment to add or modify an impoundment, reservoir, or dam? **Y / N** N

If yes, submit: **Worksheet 2.0 - Impoundment/Dam Information Worksheet** (submit one worksheet for each impoundment or reservoir)

f. Other - Applicant requests to change any provision of an authorization not mentioned above? **Y / N** N *If yes, call the Water Availability Division at (512) 239-4691 to discuss.*

Additionally, all amendments require:

- **Worksheet 8.0 – Calculation of Fees; and Fees calculated – see instructions Page.34**
- **Maps – See instructions Page. 15.**
- **Additional Documents and Worksheets may be required (see within).**

3. Bed and Banks. TWC § 11.042 (Instructions, Page 13)

a. Pursuant to contract, Applicant requests authorization to convey, stored or conserved water to the place of use or diversion point of purchaser(s) using the bed and banks of a watercourse? TWC § 11.042(a). **Y/N** N

If yes, submit a signed copy of the Water Supply Contract pursuant to 30 TAC §§ 295.101 and 297.101. Further, if the underlying Permit or Authorization upon which the Contract is based does not authorize Purchaser's requested Quantity, Purpose or Place of Use, or Purchaser's diversion point(s), then either:

1. *Purchaser must submit the worksheets required under Section 1 above with the Contract Water identified as an alternate source; or*
2. *Seller must amend its underlying water right under Section 2.*

b. Applicant requests to convey water imported into the state from a source located wholly outside the state using the bed and banks of a watercourse? TWC § 11.042(a-1). **Y / N** N

If yes, submit: worksheets 1.0, 2.0, 3.0, 4.0, 5.0, 7.0, 8.0, Maps and fees from the list below.

c. Applicant requests to convey Applicant's own return flows derived from privately owned groundwater using the bed and banks of a watercourse? TWC § 11.042(b). **Y / N** N

If yes, submit: worksheets 1.0, 2.0, 3.0, 4.0, 5.0, 7.0, 8.0, Maps, and fees from the list below.

d. Applicant requests to convey Applicant's own return flows derived from surface water using the bed and banks of a watercourse? TWC § 11.042(c). **Y / N** N

If yes, submit: worksheets 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, Maps, and fees from the list below.

****Please note, if Applicant requests the reuse of return flows belonging to others, the Applicant will need to submit the worksheets and documents under Section 1 above, as the application will be treated as a new appropriation subject to termination upon direct or indirect reuse by the return flow discharger/owner.***

e. Applicant requests to convey water from any other source, other than (a)-(d) above, using the bed and banks of a watercourse? TWC § 11.042(c). **Y / N** Y

If yes, submit: worksheets 1.0, 2.0, 3.0, 4.0, 5.0, 7.0, 8.0, Maps, and fees from the list below.

Worksheets and information:

- **Worksheet 1.0 – Quantity, Purpose, and Place of Use Information Worksheet**
- **Worksheet 2.0 - Impoundment/Dam Information Worksheet** (submit one worksheet for each impoundment or reservoir owned by the applicant through which water will be conveyed or diverted)
- **Worksheet 3.0 - Diversion Point Information Worksheet** (submit one worksheet for the downstream limit of each diversion reach for the proposed conveyances)
- **Worksheet 4.0 – Discharge Information Worksheet** (for each discharge point)
- **Worksheet 5.0 – Environmental Information Worksheet**
- **Worksheet 6.0 – Water Conservation Information Worksheet**
- **Worksheet 7.0 – Accounting Plan Information Worksheet**
- **Worksheet 8.0 – Calculation of Fees; and Fees calculated – see instructions Page. 34**
- **Maps** – See instructions **Page. 15.**
- **Additional Documents and Worksheets may be required (see within).**

4. General Information, Response Required for all Water Right Applications (Instructions, Page 15)

a. Provide information describing how this application addresses a water supply need in a manner that is consistent with the state water plan or the applicable approved regional water plan for any area in which the proposed appropriation is located or, in the alternative, describe conditions that warrant a waiver of this requirement (*not required for applications to use groundwater-based return flows*). Include citations or page numbers for the State and Regional Water Plans, if applicable. Provide the information in the space below or submit a supplemental sheet entitled "Addendum Regarding the State and Regional Water Plans":

This project is included in the 2016 Region L and Lavaca Regional Water Plans and the 2017 State Water Plan as the Lavaca Off-Channel Reservoir. The project is described in detail on page 5-5 and a technical memorandum in Appendix 5B of the Lavaca Regional Water Plan, in Section 5.2.40 of the Region L Regional Water Plan, and within the DB22 database for the 2017 State Water Plan.

b. Did the Applicant perform its own Water Availability Analysis? **Y / N** Y

If the Applicant performed its own Water Availability Analysis, provide electronic copies of any modeling files and reports.

c. Does the application include required Maps? (Instructions **Page. 15**) **Y / N** Y

WORKSHEET 1.0
Quantity, Purpose and Place of Use

1. New Authorizations (Instructions, Page. 16)

Submit the following information regarding quantity, purpose and place of use for requests for new or additional appropriations of State Water or Bed and Banks authorizations:

Quantity (acre-feet) (*Include losses for Bed and Banks*)	**State Water Source (River Basin) or Alternate Source** **each alternate source (and new appropriation based on return flows of others) also requires completion of Worksheet 4.0*	**Purpose(s) of Use**	**Place(s) of Use** **requests to move state water out of basin also require completion of Worksheet 1.1 Interbasin Transfer*
96,022	Lavaca River Basin	Municipal, Industrial, Mining	Calhoun, Jackson, Matagorda, Wharton and Victoria Counties in the Lavaca River Basin, and the Colorado-Lavaca and the Lavaca-Guadalupe Coastal Basins
240	Lavaca River Basin	On-channel storage	Jackson County
50,000	Lavaca River Basin	Off-channel storage	Jackson County

96,022 Total amount of water (in acre-feet) to be used annually (*include losses for Bed and Banks applications*)

If the Purpose of Use is Agricultural/Irrigation for any amount of water, provide:

1. Location Information Regarding the Lands to be Irrigated
   i) Applicant proposes to irrigate a total of N/A acres in any one year. This acreage is all of or part of a larger tract(s) which is described in a supplement attached to this application and contains a total of N/A acres in N/A County, TX.
   ii) Location of land to be irrigated: In the N/A Original Survey No. N/A, Abstract No. N/A.
   A copy of the deed(s) or other acceptable instrument describing the overall tract(s) with the recording information from the county records must be submitted. Applicant's name must match deeds.
   If the Applicant is not currently the sole owner of the lands to be irrigated, Applicant must submit documentation evidencing consent or other documentation supporting Applicant's right to use the land described.

   Water Rights for Irrigation may be appurtenant to the land irrigated and convey with the land unless reserved in the conveyance. 30 TAC § 297.81.

2. Amendments - Purpose or Place of Use (Instructions, Page. 12)

a. Complete this section for each requested amendment changing, adding, or removing Purpose(s) or Place(s) of Use, complete the following:

Quantity (acre-feet)	Existing Purpose(s) of Use	Proposed Purpose(s) of Use*	Existing Place(s) of Use	Proposed Place(s) of Use**
N/A	N/A	N/A	N/A	N/A

**If the request is to add additional purpose(s) of use, include the existing and new purposes of use under "Proposed Purpose(s) of Use."*

***If the request is to add additional place(s) of use, include the existing and new places of use under "Proposed Place(s) of Use."*

Changes to the purpose of use in the Rio Grande Basin may require conversion. 30 TAC § 303.43.

b. For any request which adds Agricultural purpose of use or changes the place of use for Agricultural rights, provide the following location information regarding the lands to be irrigated:

i) Applicant proposes to irrigate a total of N/A acres in any one year. This acreage is all of or part of a larger tract(s) which is described in a supplement attached to this application and contains a total of N/A acres in N/A County, TX.

ii) Location of land to be irrigated: In the N/A Original Survey No. N/A, Abstract No. N/A.

A copy of the deed(s) describing the overall tract(s) with the recording information from the county records must be submitted. Applicant's name must match deeds. If the Applicant is not currently the sole owner of the lands to be irrigated, Applicant must submit documentation evidencing consent or other legal right for Applicant to use the land described.

Water Rights for Irrigation may be appurtenant to the land irrigated and convey with the land unless reserved in the conveyance. 30 TAC § 297.81.

c. Submit Worksheet 1.1, Interbasin Transfers, for any request to change the place of use which moves State Water to another river basin.

d. See Worksheet 1.2, Marshall Criteria, and submit if required.

e. See Worksheet 6.0, Water Conservation/Drought Contingency, and submit if required.

WORKSHEET 1.1
INTERBASIN TRANSFERS, TWC § 11.085

Submit this worksheet for an application for a new or amended water right which requests to transfer State Water from its river basin of origin to use in a different river basin. A river basin is defined and designated by the Texas Water Development Board by rule pursuant to TWC § 16.051.

Applicant requests to transfer State Water to another river basin within the State? **Y / N**

1. Interbasin Transfer Request (Instructions, Page. 20)

a. Provide the Basin of Origin. Lavaca River Basin

b. Provide the quantity of water to be transferred (acre-feet). 96,022

c. Provide the Basin(s) and count(y/ies) where use will occur in the space below:

Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins; Calhoun, Jackson, Matagorda, Victoria, and Wharton Counties

2. Exemptions (Instructions, Page. 20), TWC § 11.085(v)

Certain interbasin transfers are exempt from further requirements. Answer the following:

a. The proposed transfer, which in combination with any existing transfers, totals less than 3,000 acre-feet of water per annum from the same water right. **Y/N** N

b. The proposed transfer is from a basin to an adjoining coastal basin? **Y/N** Y

c. The proposed transfer from the part of the geographic area of a county or municipality, or the part of the retail service area of a retail public utility as defined by Section 13.002, that is within the basin of origin for use in that part of the geographic area of the county or municipality, or that contiguous part of the retail service area of the utility, not within the basin of origin? **Y/N** N

d. The proposed transfer is for water that is imported from a source located wholly outside the boundaries of Texas, except water that is imported from a source located in the United Mexican States? **Y/N** N

3. Interbasin Transfer Requirements (Instructions, Page. 20)

For each Interbasin Transfer request that is not exempt under any of the exemptions listed above Section 2, provide the following information in a supplemental attachment titled “Addendum to Worksheet 1.1, Interbasin Transfer”:

a. the contract price of the water to be transferred (if applicable) (also include a copy of the contract or adopted rate for contract water);

b. a statement of each general category of proposed use of the water to be transferred and a detailed description of the proposed uses and users under each category;

c. the cost of diverting, conveying, distributing, and supplying the water to, and treating the water for, the proposed users (example - expert plans and/or reports documents may be provided to show the cost);

d. describe the need for the water in the basin of origin and in the proposed receiving basin based on the period for which the water supply is requested, but not to exceed 50 years (the need can be identified in the most recently approved regional water plans. The state and regional water plans are available for download at this website: (http://www.twdb.texas.gov/waterplanning/swp/index.asp);

e. address the factors identified in the applicable most recently approved regional water plans which address the following:

    (i) the availability of feasible and practicable alternative supplies in the receiving basin to the water proposed for transfer;

    (ii) the amount and purposes of use in the receiving basin for which water is needed;

    (iii) proposed methods and efforts by the receiving basin to avoid waste and implement water conservation and drought contingency measures;

    (iv) proposed methods and efforts by the receiving basin to put the water proposed for transfer to beneficial use;

    (v) the projected economic impact that is reasonably expected to occur in each basin as a result of the transfer; and

    (vi) the projected impacts of the proposed transfer that are reasonably expected to occur on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries that must be assessed under Sections 11.147, 11.150, and 11.152 in each basin *(if applicable)*. If the water sought to be transferred is currently authorized to be used under an existing permit, certified filing, or certificate of adjudication, such impacts shall only be considered in relation to that portion of the permit, certified filing, or certificate of adjudication proposed for transfer and shall be based on historical uses of the permit, certified filing, or certificate of adjudication for which amendment is sought;

(f) proposed mitigation or compensation, if any, to the basin of origin by the applicant; and

(g) the continued need to use the water for the purposes authorized under the existing Permit, Certified Filing, or Certificate of Adjudication, if an amendment to an existing water right is sought.

WORKSHEET 1.2
NOTICE. "THE MARSHALL CRITERIA"

This worksheet assists the Commission in determining notice required for certain **amendments** that do not already have a specific notice requirement in a rule for that type of amendment, and *that do not change the amount of water to be taken or the diversion rate*. The worksheet provides information that Applicant **is required** to submit for such amendments which include changes in use, changes in place of use, or other non-substantive changes in a water right (such as certain amendments to special conditions or changes to off-channel storage). These criteria address whether the proposed amendment will impact other water right holders or the on-stream environment beyond and irrespective of the fact that the water right can be used to its full authorized amount.

*This worksheet is **not required for Applications in the Rio Grande Basin** requesting changes in the purpose of use, rate of diversion, point of diversion, and place of use for water rights held in and transferred within and between the mainstems of the Lower Rio Grande, Middle Rio Grande, and Amistad Reservoir. See 30 TAC § 303.42.*

*This worksheet is **not required for amendments which are only changing or adding diversion points, or request only a bed and banks authorization or an IBT authorization**. However, Applicants may wish to submit the Marshall Criteria to ensure that the administrative record includes information supporting each of these criteria*

1. The "Marshall Criteria" (Instructions, Page. 21)

Submit responses on a supplemental attachment titled "Marshall Criteria" in a manner that conforms to the paragraphs (a) – (g) below:

a. Administrative Requirements and Fees. Confirm whether application meets the administrative requirements for an amendment to a water use permit pursuant to TWC Chapter 11 and Title 30 Texas Administrative Code (TAC) Chapters 281, 295, and 297. An amendment application should include, but is not limited to, a sworn application, maps, completed conservation plan, fees, etc.

b. Beneficial Use. Discuss how proposed amendment is a beneficial use of the water as defined in TWC § 11.002 and listed in TWC § 11.023. Identify the specific proposed use of the water (e.g., road construction, hydrostatic testing, etc.) for which the amendment is requested.

c. Public Welfare. Explain how proposed amendment is not detrimental to the public welfare. Consider any public welfare matters that might be relevant to a decision on the application. Examples could include concerns related to the well-being of humans and the environment.

d. Groundwater Effects. Discuss effects of proposed amendment on groundwater or groundwater recharge.

e. State Water Plan. Describe how proposed amendment addresses a water supply need in a manner that is consistent with the state water plan or the applicable approved regional water plan for any area in which the proposed appropriation is located or, in the alternative, describe conditions that warrant a waiver of this requirement. The state and regional water plans are available for download at: http://www.twdb.texas.gov/waterplanning/swp/index.asp.

f. Waste Avoidance. Provide evidence that reasonable diligence will be used to avoid waste and achieve water conservation as defined in TWC § 11.002. Examples of evidence could include, but are not limited to, a water conservation plan or, if required, a drought contingency plan, meeting the requirements of 30 TAC Chapter 288.

g. Impacts on Water Rights or On-stream Environment. Explain how proposed amendment will not impact other water right holders or the on-stream environment beyond and irrespective of the fact that the water right can be used to its full authorized amount.

WORKSHEET 2.0 Diversion Structure
Impoundment/Dam Information

This worksheet **is required** for any impoundment, reservoir and/or dam. Submit an additional Worksheet 2.0 for each impoundment or reservoir requested in this application.

If there is more than one structure, the numbering/naming of structures should be consistent throughout the application and on any supplemental documents (e.g. maps).

1. Storage Information (Instructions, Page. 21)

a. Official USGS name of reservoir, if applicable: N/A

b. Provide amount of water (in acre-feet) impounded by structure at normal maximum operating level: 240 acre-feet.

c. The impoundment is on-channel x or off-channel ______ (mark one)

1. Applicant has verified on-channel or off-channel determination by contacting Surface Water Availability Team at (512) 239-4691? **Y / N** Y
2. If on-channel, will the structure have the ability to pass all State Water inflows that Applicant does not have authorization to impound? **Y / N** Y

d. Is the impoundment structure already constructed? **Y / N** N

i. For already constructed **on-channel** structures:

1. Date of Construction: N/A
2. Was it constructed to be an exempt structure under TWC § 11.142? **Y / N** N/A
   a. If Yes, is Applicant requesting to proceed under TWC § 11.143? **Y / N** N/A
   b. If No, has the structure been issued a notice of violation by TCEQ? **Y / N** N/A
3. Is it a U.S. Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service (SCS)) floodwater-retarding structure? **Y / N** N/A
   a. If yes, provide the Site No. N/A and watershed project name N/A;
   b. Authorization to close "ports" in the service spillway requested? **Y / N** N/A

ii. For **any** proposed new structures or modifications to structures:

1. Applicant **must** contact TCEQ Dam Safety Section at (512) 239-0326, *prior to submitting an Application.* Applicant has contacted the TCEQ Dam Safety Section regarding the submission requirements of 30 TAC, Ch. 299? **Y / N** Y
   Provide the date and the name of the Staff Person 08/21/2019, W. Samuelson
2. As a result of Applicant's consultation with the TCEQ Dam Safety Section, TCEQ has confirmed that:
   a. No additional dam safety documents required with the Application. **Y / N** Y
   b. Plans (with engineer's seal) for the structure required. **Y / N** N
   c. Engineer's signed and sealed hazard classification required. **Y / N** N
   d. Engineer's statement that structure complies with 30 TAC, Ch. 299 Rules required. **Y / N** N

3. Applicants **shall** give notice by certified mail to each member of the governing body of each county and municipality in which the reservoir, or any part of the reservoir to be constructed, will be located. (30 TAC § 295.42). Applicant must submit a copy of all the notices and certified mailing cards with this Application. Notices and cards are included? **Y / N** N

iii. Additional information required for **on-channel** storage:

1. Surface area (in acres) of on-channel reservoir at normal maximum operating level: To be determined .

2. Based on the Application information provided, Staff will calculate the drainage area above the on-channel dam or reservoir. If Applicant wishes to also calculate the drainage area they may do so at their option.
Applicant has calculated the drainage area. **Y/N** N
If yes, the drainage area is_____________sq. miles.
(*If assistance is needed, call the Surface Water Availability Team prior to submitting the application, (512) 239-4691).*

2. Structure Location (Instructions, Page. 23)

a. On Watercourse (if on-channel) (USGS name): Lavaca River

b. Zip Code: 77957

c. In the Francis F. Wells, Ramos Musquiz Original Survey No., N/A Abstract No. 78, 59, Jackson County, Texas.

* ***A copy of the deed(s) with the recording information from the county records must be submitted describing the tract(s) that include the structure and all lands to be inundated.***

*****If the Applicant is not currently the sole owner of the land on which the structure is or will be built and sole owner of all lands to be inundated, Applicant must submit documentation evidencing consent or other documentation supporting Applicant's right to use the land described.***

d. A point on the centerline of the dam (on-channel) or anywhere within the impoundment (off-channel) is:

Between Latitude 28.887744 ˚N, Longitude 96.618490 ˚W and
Latitude 28.876220 ˚N, Longitude 96.611804 ˚W.

****Provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places***

di. Indicate the method used to calculate the location (examples: Handheld GPS Device, GIS, Mapping Program): Google Earth

dii. Map submitted which clearly identifies the Impoundment, dam (where applicable), and the lands to be inundated. See instructions Page. 15. **Y / N** N – location not yet determined

WORKSHEET 3.0
DIVERSION POINT (OR DIVERSION REACH) INFORMATION

This worksheet **is required** for each diversion point or diversion reach. Submit one Worksheet 3.0 for **each** diversion point and two Worksheets for **each** diversion reach (one for the upstream limit and one for the downstream limit of each diversion reach).

The numbering of any points or reach limits should be consistent throughout the application and on supplemental documents (e.g. maps).

1. Diversion Information (Instructions, Page. 24)

a. This Worksheet is to add new (select 1 of 3 below):

1. N/A__________ Diversion Point No.
2. A__________ Upstream Limit of Diversion Reach No.
3. N/A__________Downstream Limit of Diversion Reach No.

b. Maximum Rate of Diversion for **this new point** 309.4______cfs (cubic feet per second) or 138,889______gpm (gallons per minute)

c. Does this point share a diversion rate with other points? **Y / N** Y
*If yes, submit Maximum **Combined** Rate of Diversion for all points/reaches* 309.4__________cfs or 138,889____ gpm

d. For amendments, is Applicant seeking to increase combined diversion rate? **Y / N** N/A

*** An increase in diversion rate is considered a new appropriation and would require completion of Section 1, New or Additional Appropriation of State Water.*

e. Check (√) the appropriate box to indicate diversion location and indicate whether the diversion location is existing or proposed):

Check one		**Write: Existing or Proposed**
	Directly from stream	
X	From an on-channel reservoir	Proposed
	From a stream to an on-channel reservoir	
	Other method (explain fully, use additional sheets if necessary)	

f. Based on the Application information provided, Staff will calculate the drainage area above the diversion point (or reach limit). If Applicant wishes to also calculate the drainage area, you may do so at their option.

Applicant has calculated the drainage area. **Y / N** N

If yes, the drainage area is_____________sq. miles.
(*If assistance is needed, call the Surface Water Availability Team at (512) 239-4691, prior to submitting application*)

2. Diversion Location (Instructions, Page 25)

a. On watercourse (USGS name): Lavaca River

b. Zip Code: 77957

c. Location of point: In the Francis F. Wells Original Survey No. N/A, Abstract No. 78, Jackson County, Texas.

A copy of the deed(s) with the recording information from the county records must be submitted describing tract(s) that include the diversion structure. For diversion reaches, the Commission cannot grant an Applicant access to property that the Applicant does not own or have consent or a legal right to access, the Applicant will be required to provide deeds, or consent, or other documents supporting a legal right to use the specific points when specific diversion points within the reach are utilized. Other documents may include, but are not limited to: a recorded easement, a land lease, a contract, or a citation to the Applicant's right to exercise eminent domain to acquire access.

d. Point is at:
Latitude 28.887744 ˚N, Longitude 96.618490 ˚W.
Provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places

e. Indicate the method used to calculate the location (examples: Handheld GPS Device, GIS, Mapping Program): Google Earth

f. Map submitted must clearly identify each diversion point and/or reach. See instructions Page. 38.

g. If the Plan of Diversion is complicated and not readily discernable from looking at the map, attach additional sheets that fully explain the plan of diversion.

Diversion from somewhere in reach between Diversion Point A and Diversion Point B

WORKSHEET 3.0
DIVERSION POINT (OR DIVERSION REACH) INFORMATION

This worksheet **is required** for each diversion point or diversion reach. Submit one Worksheet 3.0 for **each** diversion point and two Worksheets for **each** diversion reach (one for the upstream limit and one for the downstream limit of each diversion reach).

The numbering of any points or reach limits should be consistent throughout the application and on supplemental documents (e.g. maps).

1. Diversion Information (Instructions, Page. 24)

a. This Worksheet is to add new (select 1 of 3 below):

1. N/A________ Diversion Point No.
2. N/A_______ Upstream Limit of Diversion Reach No.
3. B___________ Downstream Limit of Diversion Reach No.

b. Maximum Rate of Diversion for **this new point** 309.4______cfs (cubic feet per second) or 138,889_____gpm (gallons per minute)

c. Does this point share a diversion rate with other points? **Y / N** Y
*If yes, submit Maximum **Combined** Rate of Diversion for all points/reaches* 309.4___________cfs or 138,889____gpm

d. For amendments, is Applicant seeking to increase combined diversion rate? **Y / N** N/A

*** An increase in diversion rate is considered a new appropriation and would require completion of Section 1, New or Additional Appropriation of State Water.*

e. Check (√) the appropriate box to indicate diversion location and indicate whether the diversion location is existing or proposed):

Check one		**Write: Existing or Proposed**
	Directly from stream	
X	From an on-channel reservoir	Proposed
	From a stream to an on-channel reservoir	
	Other method (explain fully, use additional sheets if necessary)	

f. Based on the Application information provided, Staff will calculate the drainage area above the diversion point (or reach limit). If Applicant wishes to also calculate the drainage area, you may do so at their option.

Applicant has calculated the drainage area. **Y / N** N

If yes, the drainage area is_____________sq. miles.
(*If assistance is needed, call the Surface Water Availability Team at (512) 239-4691, prior to submitting application*)

2. Diversion Location (Instructions, Page 25)

a. On watercourse (USGS name): Lavaca River

b. Zip Code: 77957

c. Location of point: In the Francis F. Wells Original Survey No. N/A, Abstract No. 78, Jackson County, Texas.

A copy of the deed(s) with the recording information from the county records must be submitted describing tract(s) that include the diversion structure. For diversion reaches, the Commission cannot grant an Applicant access to property that the Applicant does not own or have consent or a legal right to access, the Applicant will be required to provide deeds, or consent, or other documents supporting a legal right to use the specific points when specific diversion points within the reach are utilized. Other documents may include, but are not limited to: a recorded easement, a land lease, a contract, or a citation to the Applicant's right to exercise eminent domain to acquire access.

d. Point is at:
Latitude 28.876220 °N, Longitude 96.611804 °W.
Provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places

e. Indicate the method used to calculate the location (examples: Handheld GPS Device, GIS, Mapping Program): Google Earth

f. Map submitted must clearly identify each diversion point and/or reach. See instructions Page. 38.

g. If the Plan of Diversion is complicated and not readily discernable from looking at the map, attach additional sheets that fully explain the plan of diversion.

Diversion from somewhere in reach between Diversion Point A and Diversion Point B

WORKSHEET 3.0
DIVERSION POINT (OR DIVERSION REACH) INFORMATION

This worksheet **is required** for each diversion point or diversion reach. Submit one Worksheet 3.0 for **each** diversion point and two Worksheets for **each** diversion reach (one for the upstream limit and one for the downstream limit of each diversion reach).

The numbering of any points or reach limits should be consistent throughout the application and on supplemental documents (e.g. maps).

1. Diversion Information (Instructions, Page. 24)

a. This Worksheet is to add new (select 1 of 3 below):

1. C__________Diversion Point No.
2. N/A________ Upstream Limit of Diversion Reach No.
3. N/A__________Downstream Limit of Diversion Reach No.

b. Maximum Rate of Diversion for **this new point** 660________cfs (cubic feet per second) or 296,229____gpm (gallons per minute)

c. Does this point share a diversion rate with other points? **Y / N** Y
*If yes, submit Maximum **Combined** Rate of Diversion for all points/reaches* 660____________cfs or 296,229____ gpm

d. For amendments, is Applicant seeking to increase combined diversion rate? **Y / N** N/A

*** An increase in diversion rate is considered a new appropriation and would require completion of Section 1, New or Additional Appropriation of State Water.*

e. Check (√) the appropriate box to indicate diversion location and indicate whether the diversion location is existing or proposed):

Check one		Write: Existing or Proposed
	Directly from stream	
X	From an on-channel reservoir	Existing
	From a stream to an on-channel reservoir	
	Other method (explain fully, use additional sheets if necessary)	

f. Based on the Application information provided, Staff will calculate the drainage area above the diversion point (or reach limit). If Applicant wishes to also calculate the drainage area, you may do so at their option.

Applicant has calculated the drainage area. **Y / N** N

If yes, the drainage area is_____________sq. miles.
(*If assistance is needed, call the Surface Water Availability Team at (512) 239-4691, prior to submitting application*)

2. Diversion Location (Instructions, Page 25)

a. On watercourse (USGS name): Navidad River/perimeter of Lake Texana

b. Zip Code: 77957, 77962, 77971

c. Location of point: In the P. Scott Original Survey No. N/A, Abstract No. 69, Jackson County, Texas.

A copy of the deed(s) with the recording information from the county records must be submitted describing tract(s) that include the diversion structure. For diversion reaches, the Commission cannot grant an Applicant access to property that the Applicant does not own or have consent or a legal right to access, the Applicant will be required to provide deeds, or consent, or other documents supporting a legal right to use the specific points when specific diversion points within the reach are utilized. Other documents may include, but are not limited to: a recorded easement, a land lease, a contract, or a citation to the Applicant's right to exercise eminent domain to acquire access.

d. Point is at:

Latitude 28.889524 ˚N, Longitude 96.578802 ˚W.

Provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places

e. Indicate the method used to calculate the location (examples: Handheld GPS Device, GIS, Mapping Program): Google Earth

f. Map submitted must clearly identify each diversion point and/or reach. See instructions Page. 38.

g. If the Plan of Diversion is complicated and not readily discernable from looking at the map, attach additional sheets that fully explain the plan of diversion.

Diversion from perimeter of Lake Texana. Location is on centerline of dam.

WORKSHEET 4.0
DISCHARGE INFORMATION

This worksheet required for any requested authorization to discharge water into a State Watercourse for conveyance and later withdrawal or in-place use. Worksheet 4.1 is also required for each Discharge point location requested. **Instructions Page. 26.** ***Applicant is responsible for obtaining any separate water quality authorizations which may be required and for insuring compliance with TWC, Chapter 26 or any other applicable law.***

a. The purpose of use for the water being discharged will be Municipal, Industrial, Mining.

b. Provide the amount of water that will be lost to transportation, evaporation, seepage, channel or other associated carriage losses ------- % and explain the method of calculation: Evaporation losses for water stored in Lake Texana will be determined in Accounting Plan. Other losses are expected to be minimal.

Is the source of the discharged water return flows? **Y / N** N If yes, provide the following information: N/A

1. The TPDES Permit Number(s). N/A (attach a copy of the **current** TPDES permit(s))

2. Applicant is the owner/holder of each TPDES permit listed above? **Y / N** N/A

PLEASE NOTE: If Applicant is not the discharger of the return flows, the application should be submitted under Section 1, New or Additional Appropriation of State Water, as a request for a new appropriation of state water. If Applicant is the discharger, then the application should be submitted under Section 3, Bed and Banks.

3. Monthly WWTP discharge data for the past 5 years in electronic format. (Attach and label as "Supplement to Worksheet 4.0").

4. The percentage of return flows from groundwater N/A, surface water N/A

5. If any percentage is surface water, provide the base water right number(s) N/A.

c. Is the source of the water being discharged groundwater? **Y / N** N If yes, provide the following information: N/A

1. Source aquifer(s) from which water will be pumped: N/A

2. Any 24 hour pump test for the well if one has been conducted. If the well has not been constructed, provide production information for wells in the same aquifer in the area of the application. See http://www.twdb.texas.gov/groundwater/data/gwdbrpt.asp. Additionally, provide well numbers or identifiers N/A.

3. Indicate how the groundwater will be conveyed to the stream or reservoir. N/A

4. A copy of the groundwater well permit if it is located in a Groundwater Conservation District (GCD) or evidence that a groundwater well permit is not required.

ci. Is the source of the water being discharged a surface water supply contract? **Y / N** N
If yes, provide the signed contract(s).

cii. Identify any other source of the water Surface water from the Lavaca River or overdraft water from the Navidad River.

WORKSHEET 4.1
DISCHARGE POINT INFORMATION

This worksheet is required for **each** discharge point. Submit one Worksheet 4.1 for each discharge point. If there is more than one discharge point, the numbering of the points should be consistent throughout the application and on any supplemental documents (e.g. maps). **Instructions, Page 27.**

For water discharged at this location provide:

a. The amount of water that will be discharged at this point is 96,022 acre-feet per year. The discharged amount should include the amount needed for use and to compensate for any losses.

b. Water will be discharged at this point at a maximum rate of 309.4 cfs or 138,889 gpm.

c. Name of Watercourse as shown on Official USGS maps: Lake Texana

d. Zip Code: 77957, 77962, 77971

f. Location of point: In the P. Scott Original Survey No. N/A, Abstract No. 69, Jackson County, Texas.

g. Point is at:

Latitude 28.889524 ˚N, Longitude 96.578802 ˚W.

**Provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places*

h. Indicate the method used to calculate the discharge point location (examples: Handheld GPS Device, GIS, Mapping Program): Google Earth

Map submitted must clearly identify each discharge point. See instructions Page. 15.

WORKSHEET 5.0
ENVIRONMENTAL INFORMATION

This worksheet is required for new appropriations of water in the Canadian, Red, Sulphur, and Cypress Creek Basins. The worksheet is also required in all basins for: requests to change a diversion point, applications using an alternate source of water, and bed and banks applications. **Instructions, Page 28.**

1. New Appropriations of Water (Canadian, Red, Sulphur, and Cypress Creek Basins only) and Changes in Diversion Point(s)

Description of the Water Body at each Diversion Point or Dam Location. (Provide an Environmental Information Sheet for each location),

a. Identify the appropriate description of the water body.

☐ Stream

☐ Reservoir

Average depth of the entire water body, in feet: ______________________________

☐ Other, specify: n/a - SB3 basin

b. Flow characteristics

If a stream, was checked above, provide the following. For new diversion locations, check one of the following that best characterize the area downstream of the diversion (check one).

☐ Intermittent – dry for at least one week during most years

☐ Intermittent with Perennial Pools – enduring pools

☐ Perennial – normally flowing

Check the method used to characterize the area downstream of the new diversion location.

☐ USGS flow records

☐ Historical observation by adjacent landowners

☐ Personal observation

☐ Other, specify: ____

c. Waterbody aesthetics

Check one of the following that best describes the aesthetics of the stream segments affected by the application and the area surrounding those stream segments.

☐ Wilderness: outstanding natural beauty; usually wooded or unpastured area; water clarity exceptional

☐ Natural Area: trees and/or native vegetation common; some development evident (from fields, pastures, dwellings); water clarity discolored

☐ Common Setting: not offensive; developed but uncluttered; water may be colored or turbid

☐ Offensive: stream does not enhance aesthetics; cluttered; highly developed; dumping areas; water discolored

d. Waterbody Recreational Uses

Are there any known recreational uses of the stream segments affected by the application?

☐ Primary contact recreation (swimming or direct contact with water)

☐ Secondary contact recreation (fishing, canoeing, or limited contact with water)

☐ Non-contact recreation

Submit the following information in a Supplemental Attachment, labeled Addendum to Worksheet 5.0:

1. Photographs of the stream at the diversion point or dam location. Photographs should be in color and show the proposed point or reservoir and upstream and downstream views of the stream, including riparian vegetation along the banks. Include a description of each photograph and reference the photograph to the map submitted with the application indicating the location of the photograph and the direction of the shot.
2. Measures the applicant will take to avoid impingement and entrainment of aquatic organisms (ex. Screens on the new diversion structure).
3. If the application includes a proposed reservoir, also include:
   i. A brief description of the area that will be inundated by the reservoir.
   ii. If a United States Army Corps of Engineers (USACE) 404 permit is required, provide the project number and USACE project manager.
   iii. A description of how any impacts to wetland habitat, if any, will be mitigated if the reservoir is greater than 5,000 acre-feet.

2. Alternate Sources of Water and/or Bed and Banks Applications

For all bed and banks applications:

a. Indicate the measures the applicant will take to avoid impingement and entrainment of aquatic organisms (ex. Screens on the new diversion structure).

b. An assessment of the adequacy of the quantity and quality of flows remaining after the proposed diversion to meet instream uses and bay and estuary freshwater inflow requirements.

If the alternate source is treated return flows, provide the TPDES permit number _N/A_____________

If groundwater is the alternate source, or groundwater or other surface water will be discharged into a watercourse provide:

a. Reasonably current water chemistry information including but not limited to the following parameters in the table below. Additional parameters may be requested if there is a specific water quality concern associated with the aquifer from which water is withdrawn. If data for onsite wells are unavailable; historical data collected from similar sized wells drawing water from the same aquifer may be provided. However, onsite data may still be required when it becomes available. Provide the well number or well identifier. Complete the information below for each well and provide the Well Number or identifier.

Lavaca River near Edna 12524

Parameter	Average Conc.	Max Conc.	No. of Samples	Sample Type	Sample Date/Time
Sulfate, mg/L	18 mg/L as SO4	74.5 mg/L as SO4	205	Routine monitoring	9/24/68 – 10/29/18
Chloride, mg/L	55.8 mg/L as Cl	460 mg/L as cl	227	Routine monitoring	9/24/68 - 10/29/18
Total Dissolved Solids, mg/L	469.3 mg/L (Sum of Constituents)	1,140 mg/L (Sum of Constituents)	10	Routine monitoring	11/17/1981- 4/24/1986
pH, standard units	8	9	343	Routine monitoring	2/23/1972 - 12/18/2018
Temperature*, degrees Celsius	22.0 C	31.8 C	400	Routine monitoring	9/24/1968 - 12/18/2018

* Temperature must be measured onsite at the time the groundwater sample is collected.

b. If groundwater will be used, provide the depth of the well _N/A_____ and the name of the aquifer from which water is withdrawn _N/A_________________________.

WORKSHEET 6.0
Water Conservation/Drought Contingency Plans

This form is intended to assist applicants in determining whether a Water Conservation Plan and/or Drought Contingency Plans is required and to specify the requirements for plans. **Instructions, Page 31.**

The TCEQ has developed guidance and model plans to help applicants prepare plans. Applicants may use the model plan with pertinent information filled in. For assistance submitting a plan call the Resource Protection Team (Water Conservation staff) at 512-239-4691, or e-mail wras@tceq.texas.gov. The model plans can also be downloaded from the TCEQ webpage. ***Please use the most up-to-date plan documents available on the webpage.***

1. Water Conservation Plans

a. The following applications must include a completed Water Conservation Plan (30 TAC § 295.9) for each use specified in 30 TAC, Chapter 288 (municipal, industrial or mining, agriculture – including irrigation, wholesale):

1. Request for a new appropriation or use of State Water.
2. Request to amend water right to increase appropriation of State Water.
3. Request to amend water right to extend a term.
4. Request to amend water right to change a place of use.
   **does not apply to a request to expand irrigation acreage to adjacent tracts.*
5. Request to amend water right to change the purpose of use.
   **applicant need only address new uses.*
6. Request for bed and banks under TWC § 11.042(c), when the source water is State Water
   **including return flows, contract water, or other State Water.*

b. If Applicant is requesting any authorization in section (1)(a) above, indicate each use for which Applicant is submitting a Water Conservation Plan as an attachment:

1. _____Municipal Use. See 30 TAC § 288.2. **
2. _____Industrial or Mining Use. See 30 TAC § 288.3.
3. _____Agricultural Use, including irrigation. See 30 TAC § 288.4.
4. __X__Wholesale Water Suppliers. See 30 TAC § 288.5. **

If Applicant is a water supplier, Applicant must also submit documentation of adoption of the plan. Documentation may include an ordinance, resolution, or tariff, etc. See 30 TAC §§ 288.2(a)(1)(J)(i) and 288.5(1)(H). Applicant has submitted such documentation with each water conservation plan? **Y / N Y

c. Water conservation plans submitted with an application must also include data and information which: supports applicant's proposed use with consideration of the plan's water conservation goals; evaluates conservation as an alternative to the proposed

appropriation; and evaluates any other feasible alternative to new water development. See 30 TAC § 288.7.
Applicant has included this information in each applicable plan? **Y / N** Y

2. Drought Contingency Plans

a. A drought contingency plan is also required for the following entities if Applicant is requesting any of the authorizations in section (1) (a) above – indicate each that applies:

1. _____Municipal Uses by public water suppliers. See 30 TAC § 288.20.

2. _____Irrigation Use/ Irrigation water suppliers. See 30 TAC § 288.21.

3. __X__Wholesale Water Suppliers. See 30 TAC § 288.22.

b. If Applicant must submit a plan under section 2(a) above, Applicant has also submitted documentation of adoption of drought contingency plan (*ordinance, resolution, or tariff, etc. See 30 TAC § 288.30*) **Y / N** Y

WORKSHEET 7.0
ACCOUNTING PLAN INFORMATION WORKSHEET

The following information provides guidance on when an Accounting Plan may be required for certain applications and if so, what information should be provided. An accounting plan can either be very simple such as keeping records of gage flows, discharges, and diversions; or, more complex depending on the requests in the application. Contact the Surface Water Availability Team at 512-239-4691 for information about accounting plan requirements, if any, for your application. **Instructions, Page 34.**

1. Is Accounting Plan Required

Accounting Plans are generally required:

- For applications that request authorization to divert large amounts of water from a single point where multiple diversion rates, priority dates, and water rights can also divert from that point;
- For applications for new major water supply reservoirs;
- For applications that amend a water right where an accounting plan is already required, if the amendment would require changes to the accounting plan;
- For applications with complex environmental flow requirements;
- For applications with an alternate source of water where the water is conveyed and diverted; and
- For reuse applications.

2. Accounting Plan Requirements

a. A **text file** that includes:

1. an introduction explaining the water rights and what they authorize;
2. an explanation of the fields in the accounting plan spreadsheet including how they are calculated and the source of the data;
3. for accounting plans that include multiple priority dates and authorizations, a section that discusses how water is accounted for by priority date and which water is subject to a priority call by whom; and
4. Should provide a summary of all sources of water.

b. A **spreadsheet** that includes:

1. Basic daily data such as diversions, deliveries, compliance with any instream flow requirements, return flows discharged and diverted and reservoir content;
2. Method for accounting for inflows if needed;
3. Reporting of all water use from all authorizations, both existing and proposed;
4. An accounting for all sources of water;
5. An accounting of water by priority date;
6. For bed and banks applications, the accounting plan must track the discharged water from the point of delivery to the final point of diversion;
7. Accounting for conveyance losses;
8. Evaporation losses if the water will be stored in or transported through a reservoir. Include changes in evaporation losses and a method for measuring reservoir content resulting from the discharge of additional water into the reservoir;
9. An accounting for spills of other water added to the reservoir; and
10. Calculation of the amount of drawdown resulting from diversion by junior rights or diversions of other water discharged into and then stored in the reservoir.

WORKSHEET 8.0
CALCULATION OF FEES

This worksheet is for calculating required application fees. Applications are not Administratively Complete until all required fees are received. **Instructions, Page. 34**

1. NEW APPROPRIATION

	Description	Amount ($)
Filing Fee	Circle fee correlating to the total amount of water* requested for any new appropriation and/or impoundment. Amount should match total on Worksheet 1, Section 1. Enter corresponding fee under **Amount ($).** In Acre-Feet a. Less than 100 $100.00 b. 100 - 5,000 $250.00 c. 5,001 - 10,000 $500.00 d. 10,001 - 250,000 $1,000.00 e. More than 250,000 $2,000.00	$1,000.00
Recording Fee		$25.00
Agriculture Use Fee	*Only for those with an Irrigation Use.* Multiply 50¢ x N/A Number of acres that will be irrigated with State Water. **	$0.00
Use Fee	*Required for all Use Types, **excluding Irrigation Use.*** Multiply $1.00 x see report Maximum annual diversion of State Water in acre- feet. **	$70,000.00
Recreational Storage Fee	*Only for those with Recreational Storage.* Multiply $1.00 x N/A acre-feet of in-place Recreational Use State Water to be stored at normal max operating level.	$0.00
Storage Fee	*Only for those with Storage, **excluding Recreational Storage.*** Multiply 50¢ x 50,250 acre-feet of State Water to be stored at normal max operating level.	$25,125.00
Mailed Notice	Cost of mailed notice to all water rights in the basin. Contact Staff to determine the amount (512) 239-4691.	TBD
	TOTAL	$ 96,150.00

2. AMENDMENT *OR* SEVER AND COMBINE

	Description	Amount ($)
Filing Fee	Amendment: $100	
	OR Sever and Combine: $100 x___of water rights to combine	
Recording Fee		$12.50
Mailed Notice	Additional notice fee to be determined once application is submitted.	
	TOTAL INCLUDED	$ 0

3. BED AND BANKS

	Description	Amount ($)
Filing Fee		$100.00
Recording Fee		$12.50
Mailed Notice	Additional notice fee to be determined once application is submitted.	
	TOTAL INCLUDED	$ 112.50

Innovative approaches
Practical results
Outstanding service

LAKE TEXANA YIELD ENHANCEMENT PROJECT SUPPLEMENTAL REPORT

Prepared for:

Lavaca-Navidad River Authority

March 20, 2020

Prepared by:

FREESE AND NICHOLS, INC.
10497 Town and Country Way, Suite 600
Houston, Texas 77024
713-600-6800

Innovative approaches
Practical results
Outstanding service

LAKE TEXANA YIELD ENHANCEMENT PROJECT SUPPLEMENTAL REPORT

Prepared for:

Lavaca-Navidad River Authority

STATE OF TEXAS
JASON D. AFINOWICZ
100102
LICENSED
PROFESSIONAL ENGINEER

2020/03/23

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

Prepared by:

FREESE AND NICHOLS, INC.
10497 Town and Country Way, Suite 600
Houston, Texas 77024
713-600-6800

LVA18507

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APPENDICES

1.0 INTRODUCTION

This report is a supplement to the Texas Commission on Environmental Quality (TCEQ) forms for a new water rights application by the Lavaca-Navidad River Authority (LNRA) for the Lake Texana Yield Enhancement Project (LTYEP). LNRA is seeking a new appropriation from the Lavaca River which will be implemented in two phases. In Phase I, water from the Lavaca River will be stored in the existing Lake Texana. Phase II adds off-channel storage. The information contained in this report adds more detail on the information in the forms, as well as other information that is required for the application. **Section 2.0** contains supplemental information for Form 10214b, Administrative Information Report. Included in this section is a description of the application and information regarding the applicant (LNRA). **Section 3.0** includes supplemental data for Form 10214c, the Technical Information Report. This section includes information for bed and banks delivery and supplemental environmental information, as well as other information.

2.0 ADMINISTRATIVE INFORMATION REPORT - SUPPLEMENTAL

2.1 SUMMARY OF REQUEST

With this water right application, the Lavaca-Navidad River Authority (LNRA) is seeking a Texas water right for the Lake Texana Enhanced Yield Project (LTYEP). This project seeks to create additional supply for LNRA by supplementing existing supplies from Lake Texana with diversions from the Lavaca River and construction of a new off-channel reservoir. The project will be built in two phases. The first phase (Phase I) is storage of Lavaca River water in Lake Texana. The second phase (Phase II) is adding an off-channel reservoir to the project.

Specific authorizations include:

- A new appropriation to:
  - Divert up to 96,022 acre-feet per year from a reach of the Lavaca River between Diversion Point A (28.887744 N 96.618490 W) and Diversion Point B (28.876220 N 96.611804 W) in Jackson County at a maximum diversion rate of 309.4 cfs (200 MGD).
  - Construct and maintain a dam of less than or equal to six feet in height that will impound up to 240 acre-feet in an on-channel diversion reservoir within that reach.
  - Temporarily store the water in the existing Lake Texana for subsequent re-diversion and use at a maximum combined diversion rate of 660 cfs.

  - Store water in a new 50,000 acre-foot off-channel reservoir in Jackson County in the Lavaca-Colorado Coastal Basin for subsequent re-diversion and use.
  - Use the re-diverted water for municipal, industrial, and mining purposes in Calhoun, Jackson, Matagorda, Wharton and Victoria Counties in the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin.
- Use of the bed-and-banks of Lake Texana to convey the water diverted from the Lavaca River and discharged at a point on the perimeter of Lake Texana to the two existing diversion structures on Lake Texana or any other future diversion point on the perimeter of Lake Texana.
- When Lake Texana is full and spilling, spills from Lake Texana exceed the Bay and Estuary Release Schedule in CoA 16-2095B 4.A.1 and CoA 16-2095D Special Condition 5.A., and water could have been diverted from the Lavaca River because environmental flows at the Lavaca River near Edna (USGS 08164000) have been satisfied, an equivalent amount of the water that would have been diverted from the Lavaca River can be diverted from Lake Texana, as long as those diversions do not cause spills to drop below the required Bay and Estuary Release schedule.
- Reuse of the Lavaca River diversions discharged into the waters of the state. Prior to the diversion and use of return flows LNRA will apply and be granted an amendment to identify specific points of discharge and diversion.
- Abandon the authorizations in Certificate of Adjudication 16-2095, as amended (CoA 16-2095) associated with the proposed Stage 2 reservoir, contingent upon the authorization for the new appropriation and bed-and-banks transfer listed above.
- Temporary use of 1,500 acre-feet of water from the Lavaca River, Navidad River, or Keller Creek for use during construction of the pump station, diversion structure, and off-channel reservoir.

Figure 2-1 is a general location map of the project.

Diversion from the Lavaca River will be subject to environmental flow criteria in 30 TAC §298.330(e)(15) the Lavaca River near Edna (USGS 08164000). This measurement point is upstream of the proposed diversion. A discussion of the application of the criteria may be found in **Section 3.9.1**. The applicant also seeks recognition that water transferred from the Lavaca River into Lake Texana is not considered as naturally occurring inflows into Lake Texana and are not subject to bypass to meet the Lake Texana Bay and Estuary Release schedule.

LNRA seeks the ability to overdraft Lake Texana under the following conditions:

- Lake Texana is full and spilling,
- Outflows through Palmetto Bend Dam meet or exceed the bay and estuary freshwater inflow requirements found in the Lake Texana water right (see Table **2-1**), and

- Water could have been diverted from the Lavaca River because environmental flows at the Lavaca River near Edna gage have been satisfied.

This request for overdraft in lieu of pumping is designed to eliminate the need to pump water when there are excess flows. It is a one-to-one exchange of flows. Since the confluence of the Lavaca and Navidad River are very close to both the Lavaca River diversion and Palmetto Bend Dam, the flows reaching the bay will not be affected. This operational flexibility not only allows LNRA to save pumping costs, but it also reduces the need for the electricity to pump the water, reducing the project's carbon footprint. Diversions from Lake Texana will be limited to the flows that would have been pumped from the Lavaca River. The overdraft diversions will be limited by the use of the water for subsequent diversion, either for direct use by LNRA customers or storage in the off-channel reservoir, and by the maximum diversion rates from the Lavaca River and from Lake Texana.

Temporary use of water during construction will not be subject to environmental flow criteria. Diversions for this purpose will be small and intermittent and will have minimal impact on instream uses or bay and estuary needs.

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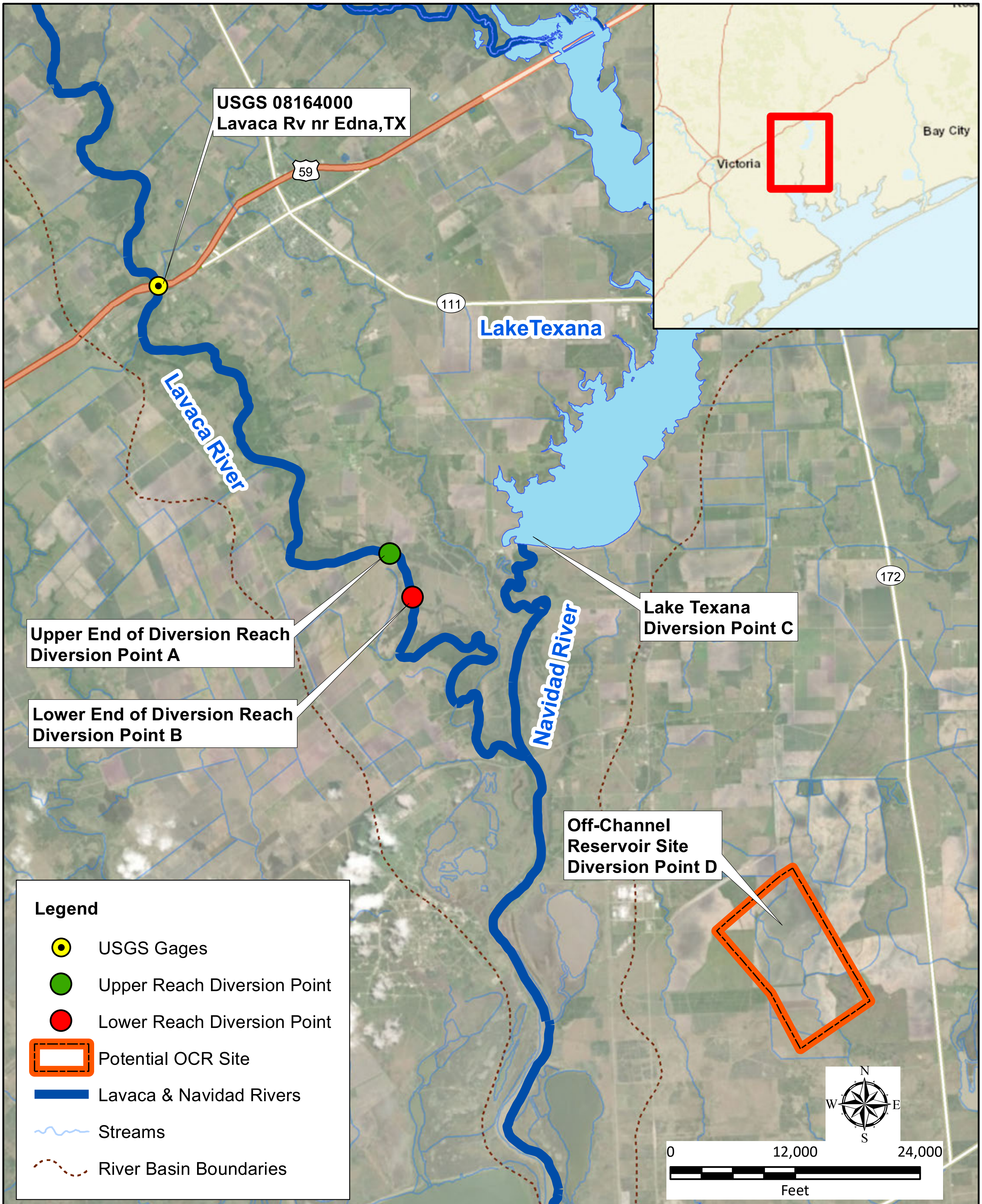

FNI PROJECT NO. LVA18507	FREESE AND NICHOLS, INC.	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE
DATE CREATED Date: 12/3/2019	10497 TOWN AND COUNTRY WAY, SUITE 600		
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central	HOUSTON, TEXAS 77024	**Location Map**	2-1
FILE NAME Name: Figure_1-1	OFFICE: 713-600-6800		
PREPARED BY DML	FAX: 713-600-6801		

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2.2 APPLICANT INFORMATION

LNRA is a conservation and reclamation district created pursuant to Article XVI, Section 59 of the Texas Constitution[1]. The mission of LNRA is to manage, conserve, and protect the natural resources of the Lavaca Basin in a responsible manner that provides opportunities for growth and benefits the public[2]. LNRA's main offices are located near Edna, Texas. LNRA customers include the City of Corpus Christi, Formosa Plastics Corporation, Texas, Inteplast Group Corporation, the City of Point Comfort, and the Calhoun County Navigation District.

LNRA currently obtains water from Lake Texana, which is located on the Navidad River in Jackson County. Palmetto Bend Dam, which impounds Lake Texana, is located four miles upstream of the confluence of the Lavaca and Navidad Rivers. Lake Texana currently impounds 161,085 acre-feet with a surface area of 9,727 acres at its conservation elevation of 44.0 feet msl[3]. The reservoir was completed in May 1980 and filled on May 6, 1982.

Lake Texana is authorized by Certificate of Adjudication 16-2095, as amended (CoA 16-2095). A copy of the certificate may be found in **Appendix 2A**. The Lake Texana authorizations include:

- Impoundment of 170,300 acre-feet with a priority date of May 15, 1972;
- Use of 75,000 acre-feet per year for multiple purposes with a priority date of May 15, 1972;
- Use of 4,000 acre-feet per year for municipal purposes with a priority date of May 24, 1982;
- Use of 7,500 acre-feet per year for municipal and industrial purposes when Lake Texana is above elevation 43 feet and bay and estuary release schedules are met (Interruptible Water) with a priority date of July 1, 2002;
- Interbasin transfer of up to 46,590 acre-feet per year of the 75,000 acre-feet of water authorized for multiple purposes into the Lavaca-Guadalupe Coastal Basin, the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, the Guadalupe River Basin and the San Antonio River Basin; and

[1] Lavaca-Navidad River Authority: Water Management Plan for Lake Texana and Palmetto Bend Stage 2 Dam and Reservoir on Lavaca River, March 2008.
[2] Lavaca-Navidad River Authority, http://www.lnra.org/home
[3] Texas Water Development Board: Volumetric Survey of Lake Texana, prepared for the Lavaca-Navidad River Authority in cooperation with the U.S. Army Corps of Engineers, April 2001.

- Interbasin transfer of up to 7,500 acre-feet per year of the above-mentioned Interruptible Water into the Nueces River Basin, the San Antonio river Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin.

CoA 16-2095 includes a schedule for release of inflows for maintenance of the Lavaca-Matagorda Bay and Estuary System, as shown in **Table 2-1**. The schedule has two tiers which vary based on the storage in the reservoir. These releases are limited to the natural inflow into the reservoir and excludes supplies imported from out of the basin unless those flows are imported to avoid impairment of the Lake Texana water right.

Table 2-1: Lake Texana Bay and Estuary Release Schedule

(values in cfs)

Month	Storage of 78.18% or more	Storage less than 78.18%
Jan	84.5	5
Feb	142.4	5
Mar	86.8	5
Apr	806.8	5
May	1,169.3	5
Jun	1,191.4	5
Jul	126.5	5
Aug	265.7	5
Sep	1,027.3	5
Oct	708.3	5
Nov	68.3	5
Dec	79.3	5

The original Palmetto Bend project was conceived in two phases, with one impoundment on the Navidad River (Stage 1) and a second adjacent impoundment on the Lavaca River (Stage 2). Both stages are authorized in CoA 16-2095, but only Stage 1, now called Lake Texana, has been built. The Stage 2 authorizations include:

- Impoundment of 93,340 acre-feet with a priority date of May 15, 1972;
- Use of 7,150 acre-feet per year for municipal purposes and 22,850 acre-feet per year for industrial purposes with a priority date of May 15, 1972;

- Use of at least 18,122 acre-feet per year for maintenance of the Lavaca-Matagorda Bay and Estuary System with a priority date of October 6, 1993.

LNRA seeks to abandon the Stage 2 authorizations once the authorizations for the proposed Lavaca River diversion, storage in Lake Texana, and off-channel reservoir have been granted. Specific sections of the water right that need to be deleted include:

Original Certificate

1. Impoundment – delete references to impoundment in Stage 2
2. Use B.

Amendment A

1. Impoundment, delete references to Stage 2 reservoir
2. Use B.
5. Special Condition C., delete references to Stage 2

Amendment B

1. Use B.
2. Priority B.
4. Bay and Estuary Release Schedule B.
5. Special Condition c) and d) remove reference to Stage 2.

Amendment D

First paragraph page 6, delete references to Stage 2

Amendment E

1. Priority Date A, delete reference to Stage 2 reservoir
2. Priority Date B

3.0 TECHNICAL INFORMATION REPORT - SUPPLEMENTAL

LNRA is applying for a new appropriation of water and bed and banks authorization to convey water. It is seeking abandon the CoA 16-2095 authorizations for Stage 2 once the new appropriation has been granted. Based on our understanding, the application requires the following worksheets:

Worksheet 1.0 – Quantity, Purpose, and Place of Use Information Worksheet

Worksheet 2.0 – Impoundment/Dam Information Worksheet for channel dam

Worksheet 3.0a – Diversion Point Information Worksheet for the upstream end (Diversion Point A) of the diversion reach on the Lavaca River

Worksheet 3.0b – Diversion Point Information Worksheet for the downstream end (Diversion Point B) of the diversion reach on the Lavaca River

Worksheet 3.0c – Diversion Point Information Worksheet for re-diversion of Lavaca River water from the perimeter of Lake Texana (Diversion Point C)

Worksheet 4.0 – Discharge Information Worksheet

Worksheet 4.0a – Discharge Information Worksheet for discharge of Lavaca River water into Lake Texana

Worksheet 5.0 – Environmental Information Worksheet

Worksheet 6.0 – Water Conservation Information Worksheet

Worksheet 7.0 – Accounting Plan Information Worksheet

Worksheet 8.0 – Calculation of Fees

Required maps are in **Appendix 3A** of this report

Photographs are in **Appendix 3B** of this report.

3.1 CONSISTENCY WITH REGIONAL WATER PLANS

The LTYEP is included in the 2016 Region L and Lavaca (Region P) Regional water plans and the 2017 State Water Plan as the Lavaca Off-Channel Reservoir. Excerpts from the Lavaca and Region L plans may be found in **Appendix 3C**.

3.2 WATER AVAILABILITY ANALYSIS

A memo describing the water availability analysis, including a no injury calculation and impacts on bay and estuary flows, is in **Appendix 3D**. An electronic version of the modified Lavaca Water Availability Model including the LTYEP is included with the application.

3.3 MAPS

Maps of the proposed LTYEP project may be found in **Appendix 3A**. The maps include diversion reaches, discharge points, and the location of the proposed off-channel reservoir.

3.4 WORKSHEET 1.1 - INTERBASIN TRANSFERS

The water from this project is proposed to be used in the Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins, which are adjacent to the Lavaca Basin. Thus, the interbasin transfer is exempt under TWC § 11.085(v)(3).

3.5 WORKSHEET 1.2 - THE MARSHALL CRITERIA

The Marshall Criteria only apply to amendments. This application is for a new authorization, plus abandonment of parts of CoA 16-2095. It is our understanding that these criteria do not apply.

3.6 WORKSHEET 2.0 - PROPOSED IMPOUNDMENTS

There are two proposed impoundments associated with the application:

- A small on-channel diversion impoundment of approximately 240 acre-feet, located within the proposed diversion reach. The final location has not been determined at this time. This diversion impoundment is designed to maintain enough water depth for the pump station to operate. The impoundment will be entirely within channel and will have almost the same surface area as the free-flowing river. The impounding structure will be designed to pass all inflows when the pumps are not operating, as well as flows needed for senior water rights or environmental purposes.
- An off-channel reservoir impounded by a ring levee. **Figure 3-1** shows the site where the off-channel reservoir will be located. The final footprint of the structure has not been determined at this time – it is likely that the off-channel reservoir will not occupy the entire site. This ring levee

will not impound state water other than the Lavaca River water pumped into the reservoir. Any streams in the area will be routed around the reservoir.

Table 3-1 shows the survey data and coordinates for the two impoundments. All locations are in Jackson County. The on-channel reservoir will be located on the boundary of the Francis F. Wells and Ramos Musquiz surveys, which is the Lavaca River. The off-channel reservoir will be located within the property shown in **Figure 3-1,** which is located in several surveys. The coordinates **Table 3-1** are located in the I.& G.N. No. 30 Abstract 171 survey.

Table 3-1: Impoundment Location Data

Location	Survey Information	Lat-Long
On-Channel Reservoir	Francis F. Wells A-78 Ramos Musquiz A-59	Between 28.887744 N 96.618490 W and 28.876220 N 96.611804 W
Off-Channel Reservoir	I.&G.N. RR Co No. 26 A-155 David A. Hoffman A-33 I.&G.N. RR Co No. 27 A-167 I.&G.N. RR Co No. 28 A-169 I.&G.N. RR Co No. 30 A-171 I.&G.N RR Co No. 29 A-170 James Morgan A-56 James Pierce A-250	28.777535 N 96.497558 W

Preliminary engineering and geotechnical information regarding the off-channel reservoir may be found in **Appendix 3E**.

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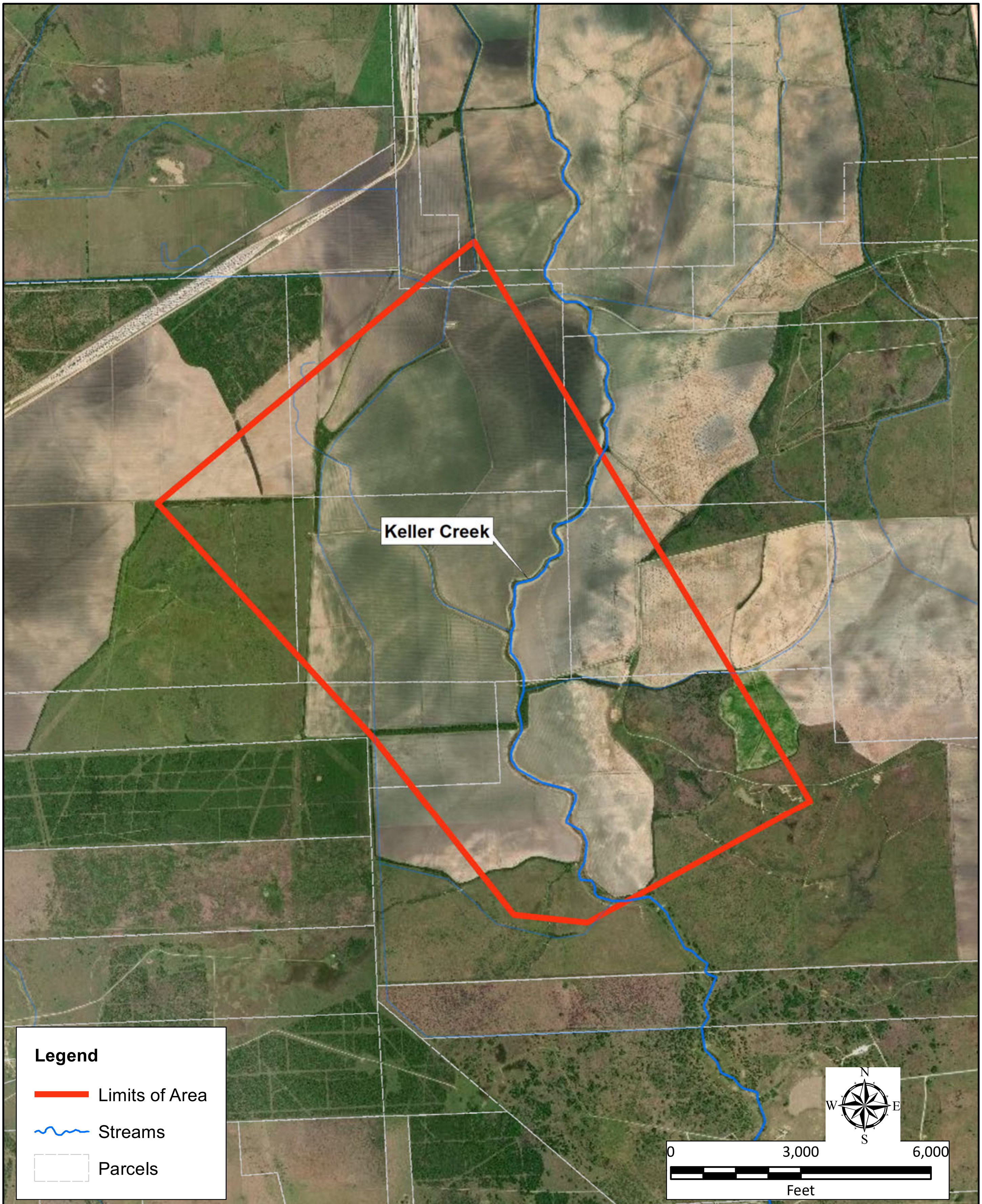

FN PROJECT NO. LVA18507 DATE CREATED Date: 11/25/2019 DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central FILE NAME Name: Figure_2-1 PREPARED BY DML	FREESE AND NICHOLS FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project **Off-Channel Reservoir Site**	FIGURE 3-1

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3.7 WORKSHEET 3.0 - DIVERSION POINT (OR DIVERSION REACH) INFORMATION

There are three diversion points associated with the application:

- A diversion pump station on the Lavaca River within the diversion reach shown in **Figure 3-2** at a maximum diversion rate of 309.4 cfs (200 MGD). The upper and lower ends of this reach are labeled as Diversion Point A and Diversion Point B, respectively. The pump station will be located within the reach defined by these two points. The exact location of the pump station has not been determined at this time.

- Diversion of water conveyed using the bed and banks of Lake Texana, either from the existing diversion locations authorized in CoA 16-2095 (**Figure 3-3**) or from anywhere else on the perimeter of the reservoir (**Figure 3-4**). The diversion from the perimeter of Lake Texana, which includes the existing diversion points, is referred to as Diversion Point C. The location of the diversion point, by TCEQ convention, is on the center line of the dam. The maximum combined diversion rate for the Lavaca River water and other Lake Texana authorizations is 660 cfs.

Per TCEQ guidance, a diversion worksheet for diversions from the off-channel reservoir is not required.

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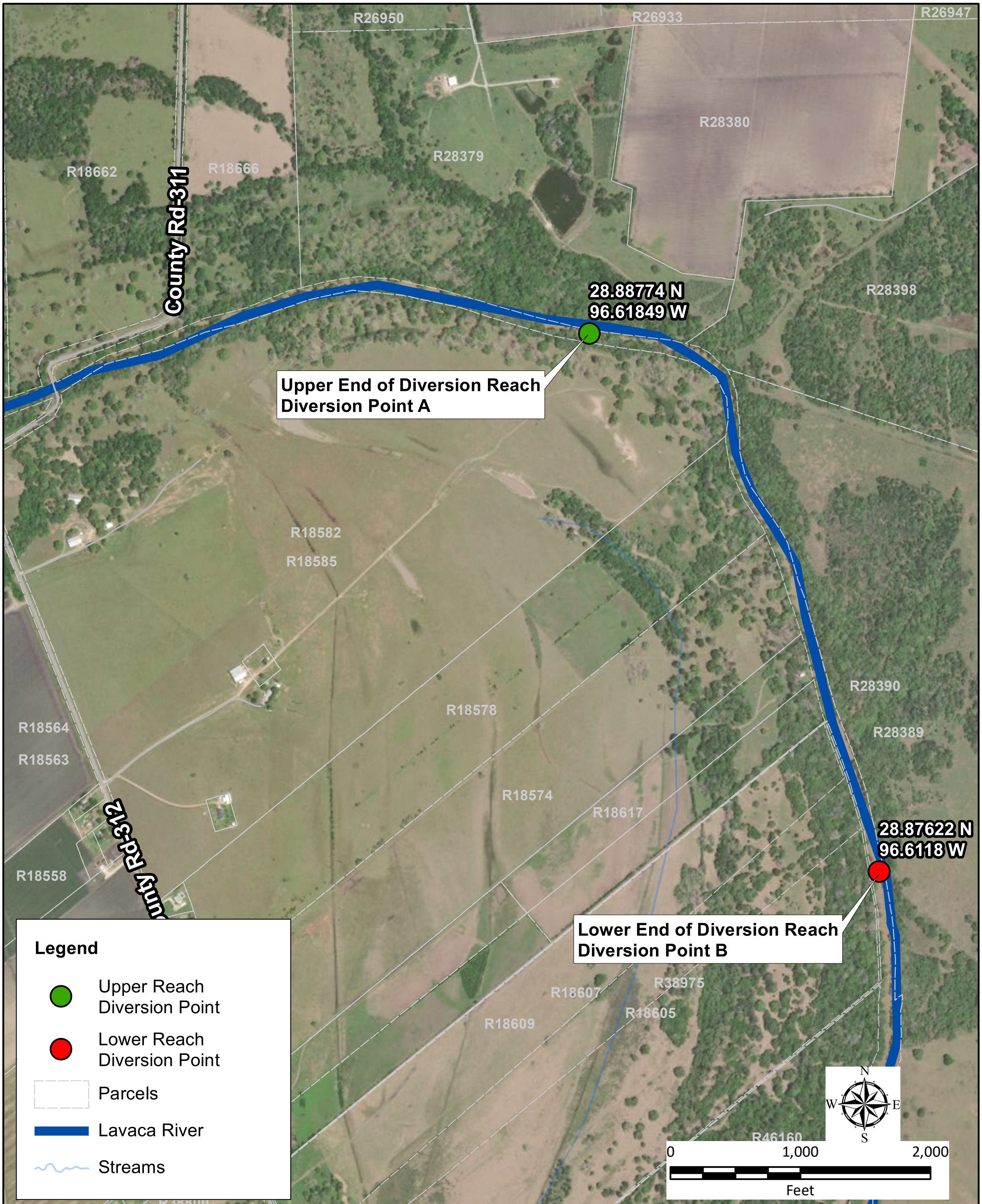

FNI PROJECT NO. LVA18507

DATE CREATED Date: 12/3/2019

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central

FILE NAME Name: Figure_2-2

PREPARED BY DML

FREESE AND NICHOLS, INC.
10497 TOWN AND
COUNTRY WAY, SUITE 600
HOUSTON, TEXAS 77024
OFFICE: 713-600-6800
FAX: 713-600-6801

Lavaca Navidad River Authority

Texana Yield Enhancement Project

Lavaca Diversion Reach

FIGURE

3-2

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FNI PROJECT NO. LVA18507 DATE CREATED Date: 12/3/2019 DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central FILE NAME Name: Figure_2-3 PREPARED BY DML	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project **Perimeter of Lake Texana And Existing Diversion Points**	FIGURE 3-3

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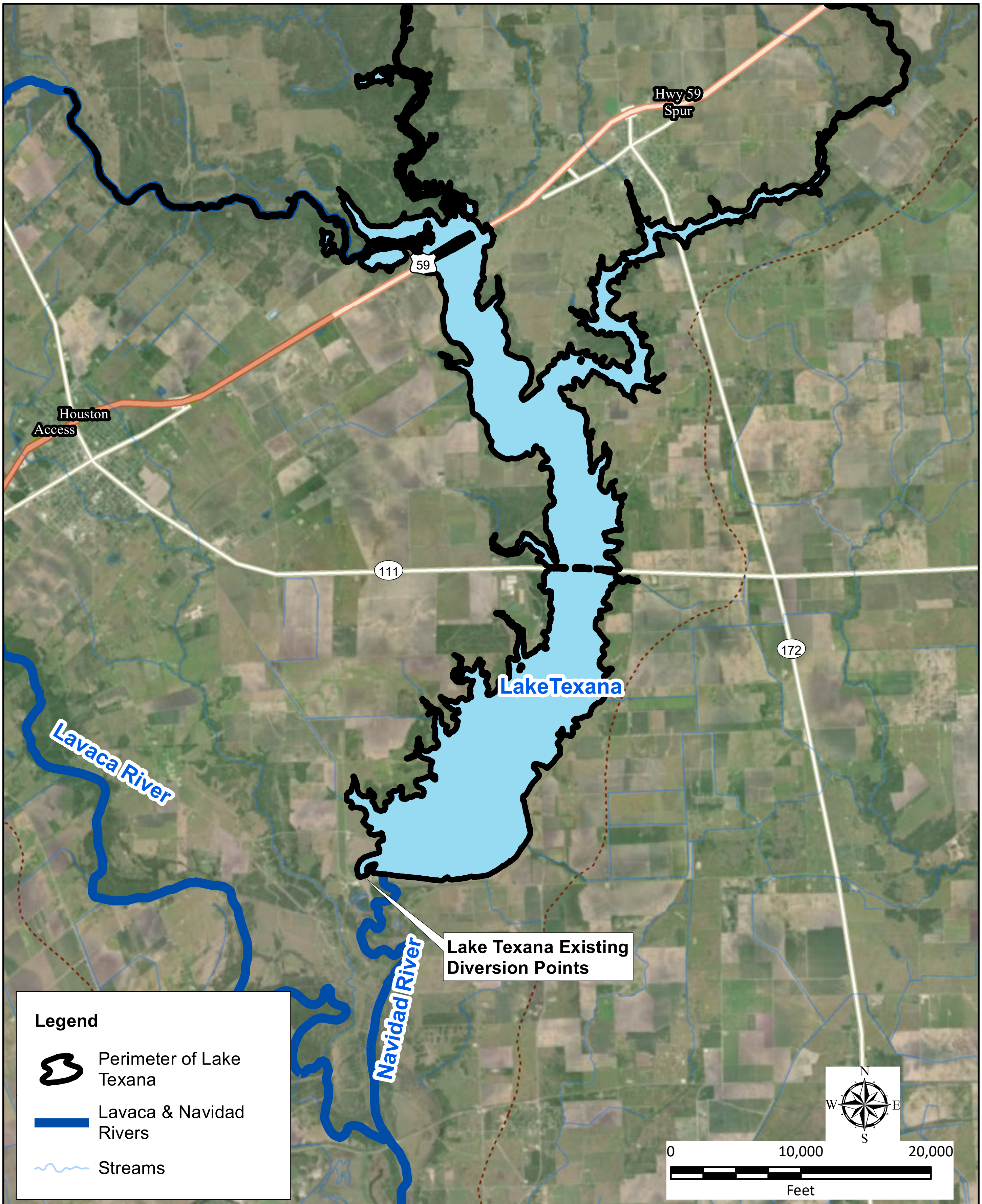

FNI PROJECT NO. LVA18507	FREESE AND NICHOLS, INC.	Lavaca Navidad River Authority	FIGURE
DATE CREATED Date: 12/3/2019	10497 TOWN AND COUNTRY WAY, SUITE 600	Texana Yield Enhancement Project	3-4
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central	HOUSTON, TEXAS 77024	**Perimeter of Lake Texana (Diversion Point C)**	
FILE NAME Name: Figure_2-4	OFFICE: 713-600-6800		
PREPARED BY DML	FAX: 713-600-6801		

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3.8 WORKSHEET 4.0 - DISCHARGE INFORMATION

Diversions from the Lavaca River will be discharged into Lake Texana. The discharge location will be on the perimeter of the reservoir. The exact location has not been determined at this time. Since the discharge will be directly into the reservoir and not into a tributary of the reservoir, there will be no channel losses. Losses will be minimal for water that is immediately diverted on the same day from Lake Texana. Lavaca River water that is stored in Lake Texana for subsequent diversion at a later time will be subject to evaporative losses that will be tracked in the Accounting Plan (see **Appendix 3H**).

According to TCEQ, a discharge worksheet is not required for discharges into the off-channel reservoir.

3.9 WORKSHEET 5.0 - ENVIRONMENTAL INFORMATION

The Lavaca River basin is an SB3 basin, so Worksheet 5.0 Environmental information is not required for the new appropriations from the Lavaca River. However, supplemental information regarding environmental flows and other environmental information that may be useful for the application may be found in **Section 3.9.1**. Worksheet 5.0 is required for the bed and banks delivery using Lake Texana, so **Section 3.9.2** contains the required Supplemental Attachment Addendum for the bed and banks.

LNRA has conducted additional environmental studies in anticipation of filing for Federal permits. These studies are available to TCEQ on request.

3.9.1 Supplemental Environmental Information for Lavaca River Diversions

3.9.1.1. Environmental Flow Standards

Diversions from the Lavaca River will be subject to the environmental flow standards found in 30 TAC §298 Subchapter D. The proposed measurement point is the United States Geological Survey Gage 08164000, Lavaca River near Edna, which is located upstream of the diversion reach. However, it appears that the Summer Average and Wet Base Flow criteria are switched in the TAC. We propose using the standards shown in **Table 3-2**. The switched criteria are indicated by an asterisk.

Table 3-2: Environmental Flow Standards – Lavaca River near Edna

<table>
<tr><th>Season</th><th>Hydrologic Condition</th><th>Subsistence Flow (cfs)</th><th>Base Flow (cfs)</th><th>Small Seasonal Pulse (2 per Season)</th><th>Large Seasonal Pulse (1 per Season)</th><th>Annual Pulse</th></tr>
<tr><td rowspan="4">Winter</td><td>Severe</td><td>8.5</td><td>30</td><td rowspan="4">Trigger:
2,000 cfs
Volume:
8,000 ac-ft
Duration:
6 days</td><td rowspan="4">Trigger:
4,500 cfs
Volume:
18,400 ac-ft
Duration:
7 days</td><td rowspan="16">Trigger:
4,500 cfs
Volume:
18,400 ac-ft
Duration:
7 days</td></tr>
<tr><td>Dry</td><td>N/A</td><td>30</td></tr>
<tr><td>Average</td><td>N/A</td><td>55</td></tr>
<tr><td>Wet</td><td>N/A</td><td>94</td></tr>
<tr><td rowspan="4">Spring</td><td>Severe</td><td>10.0</td><td>30</td><td rowspan="4">Trigger:
4,500 cfs
Volume:
18,400 ac-ft
Duration:
7 days</td><td rowspan="4">Trigger:
4,500 cfs
Volume:
18,400 ac-ft
Duration:
7 days</td></tr>
<tr><td>Dry</td><td>N/A</td><td>30</td></tr>
<tr><td>Average</td><td>N/A</td><td>55</td></tr>
<tr><td>Wet</td><td>N/A</td><td>94</td></tr>
<tr><td rowspan="4">Summer</td><td>Severe</td><td>1.3</td><td>20</td><td rowspan="4">Trigger:
88 cfs
Volume:
370 ac-ft
Duration:
4 days</td><td rowspan="4">Trigger:
420 cfs
Volume:
1,800 ac-ft
Duration:
6 days</td></tr>
<tr><td>Dry</td><td>N/A</td><td>20</td></tr>
<tr><td>Average</td><td>N/A</td><td>33*</td></tr>
<tr><td>Wet</td><td>N/A</td><td>48*</td></tr>
<tr><td rowspan="4">Fall</td><td>Severe</td><td>1.2</td><td>20</td><td rowspan="4">Trigger:
1,600 cfs
Volume:
6,100 ac-ft
Duration:
6 days</td><td rowspan="4">Trigger:
4,500 cfs
Volume:
18,00 ac-ft
Duration:
6 days</td></tr>
<tr><td>Dry</td><td>N/A</td><td>20</td></tr>
<tr><td>Average</td><td>N/A</td><td>33</td></tr>
<tr><td>Wet</td><td>N/A</td><td>58</td></tr>
</table>

* The Summer Average and Wet Criteria appear to be switched in the TAC. We have assumed that the smaller value applies during Average conditions and the larger value applies during Wet conditions.

Since the measurement point is upstream of the diversion, the proposed operation to meet criteria will be as follows:

- Average flows are the average Edna gage flow in the previous 24 hours.
- If average flows are less than the applicable base or subsistence flow, no diversions will be made.
- If average flows are greater than the applicable base or subsistence flow, the diversion rates will not be in excess of the difference between the average streamflow at the gage and the applicable base or subsistence flow.
- When average flows exceed the pulse flow trigger level and the required number of pulses has not been achieved for the current season, diversions will cease until either the volume or duration criteria have been met.

- Diversion rates will not change more often that once every 24 hours except when average flows are approaching the applicable base or subsistence criteria, in which case diversion rates will not change more often that once every 12 hours.

3.9.1.2. Bay and Estuary Achievement

Table 3-3 compares modeled annual achievement frequency of the adopted bay and estuary criteria, with the proposed application (Phase I and Phase II) and with only current water rights (Baseline). In most cases, the proposed application increases achievement frequency of the criteria compared to currently authorized water rights. Other achievement levels are the same. There are no criteria where the proposed project is less than the Baseline. The Baseline condition includes the proposed Stage 2 because it is currently authorized and included in the water availability model. Both Phase I and Phase II assumes abandonment of Stage 2 authorizations.

Table 3-3: Comparison of Bay and Estuary Achievement – Baseline, Phase I and Phase II

Inflow Regime	Goal (Full Year)	Baseline (with Stage 2)			
		Full Year	Spring	Fall	Intervening
Subsistence	96%	80.7%	93.0%	84.2%	94.7%
Base Dry	82%	61.4%	80.7%	70.2%	84.2%
Base Average	46%	29.8%	71.9%	49.1%	64.9%
Base Wet	28%	21.1%	61.4%	40.4%	50.9%
Inflow Regime	**Goal (Full Year)**	**Store in Texana (Phase I)**			
		Full Year	**Spring**	**Fall**	**Intervening**
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	35.1%	71.9%	52.6%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%
Inflow Regime	**Goal (Full Year)**	**Store in OCR and Texana (Phase II)**			
		Full Year	**Spring**	**Fall**	**Intervening**
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	33.3%	71.9%	50.9%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%

The off-channel reservoir will be located on approximately 3,000 acres presently owned by the Formosa Corporation shown in **Figure 3-1**. The final proposed off-channel reservoir footprint will be determined during final design with consideration given to environmental and other factors.

The off-channel site is transected by Keller Creek, which flows into Keller Bay. Keller Creek will likely need to be relocated around the impounding structure when the Off-Channel Reservoir is constructed.

3.9.2 Addendum to Worksheet 5.0 - Lake Texana Bed and Banks

3.9.2.1. Measures to Avoid Impingement and Entrainment

The intake on the Lavaca River is exempt from the requirements of Section 316b of the Clean Water Act because of municipal use for the proposed diversion. Best practices for the pump station design include a velocity of 0.5 feet/second. Future diversion facilities from Lake Texana, if built, will have the same features as the intake on the Lavaca River.

3.9.2.2. Quantity and Quality of Remaining Flows

This section contains an assessment of the adequacy of the quantity and quality of flows remaining after the proposed diversion to meet instream uses and bay and estuary freshwater inflow requirements. Diversions from the Lavaca River will be subject to the adopted environmental flow standards shown in **Table 3-2**. According to 30 TAC §298.310, these flow standards maintain the existing sound ecological environment. **Table 3-3** shows that the Bay and Estuary standards will be met at least as frequently, and in most cases more frequently with the new authorizations compared to the Baseline conditions.

Table 3-4 compares flow statistics for the outflows from Lake Texana and the flows at the mouth of the Lavaca River from the Baseline (without project) and Full Project (Phase II). Note that the changes in Lake Texana outflows are relatively small and mostly positive. The change in overall flow at the mouth of the Lavaca River shows slightly increased flows with the project when flows are less than the median, but somewhat lower flows with the project for higher flows. Overall, the change in average flows is small. More detailed comparisons may be found in **Appendix 3F**.

Table 3-4: Comparison of Flow Statistics With and Without New Authorization
(Values in acre-feet per month)

Statistic	Texana Outflows			Flows at Mouth		
	Baseline	Full Project	Change	Baseline	Full Project	Change
Minimum	0	0	0	0	0	0
10%	297	297	0	365	928	562
25%	323	1,782	1,459	1,979	4,001	2,022
50%	7,778	7,778	0	9,782	12,043	2,261
75%	39,300	39,316	16	56,404	54,415	-1,989
90%	117,275	117,275	0	181,673	179,298	-2,374
Maximum	615,204	615,590	386	1,083,995	1,089,674	5,679
Average	38,164	38,531	367	57,974	58,837	862

Figure 3-5 includes "box and whiskers" plots comparing water quality data for selected parameters from the Lavaca River near Edna gage (TCEQ Station ID 12524) to Lake Texana (TCEQ Station ID 15381). The Edna gage is upstream of the proposed diversion but should be representative of the water quality in the diversion reach. Dissolved Oxygen, pH, and water temperature are very similar for the two sources. Specific conductance, alkalinity and chloride are higher in the river. Nitrate is somewhat higher in the reservoir, although the average value and range of values is similar for the two sources.

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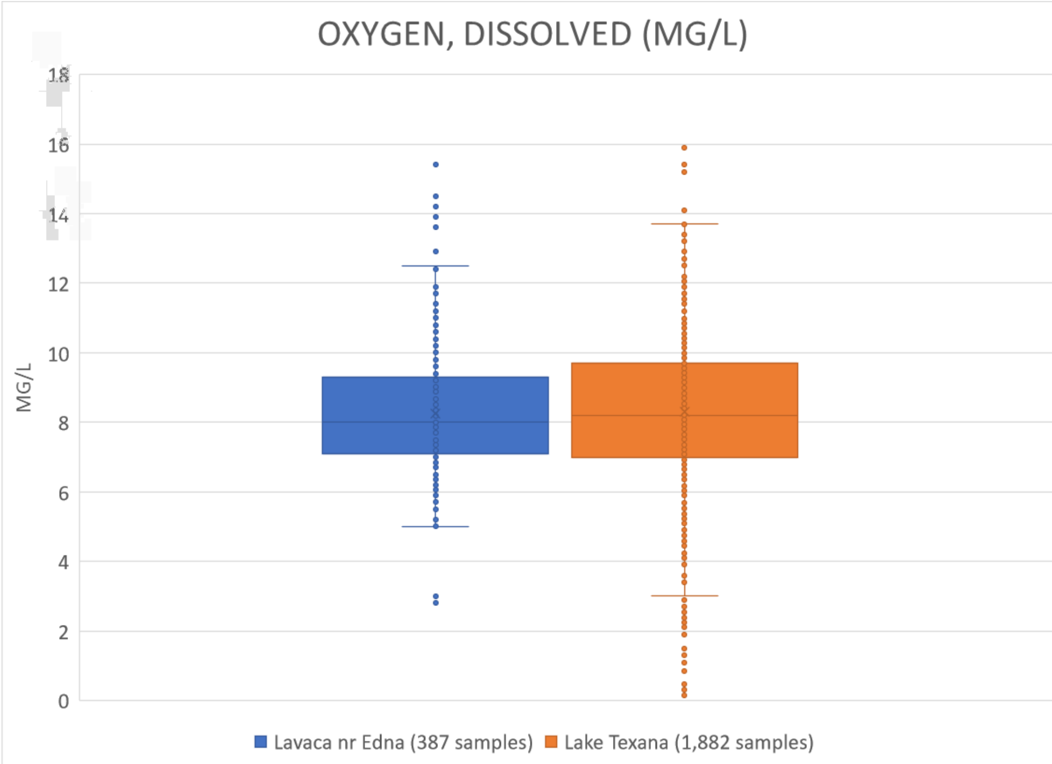
Figure 3-5: Comparison of Water Quality Data for the Lavaca River nr Edna and Lake Texana



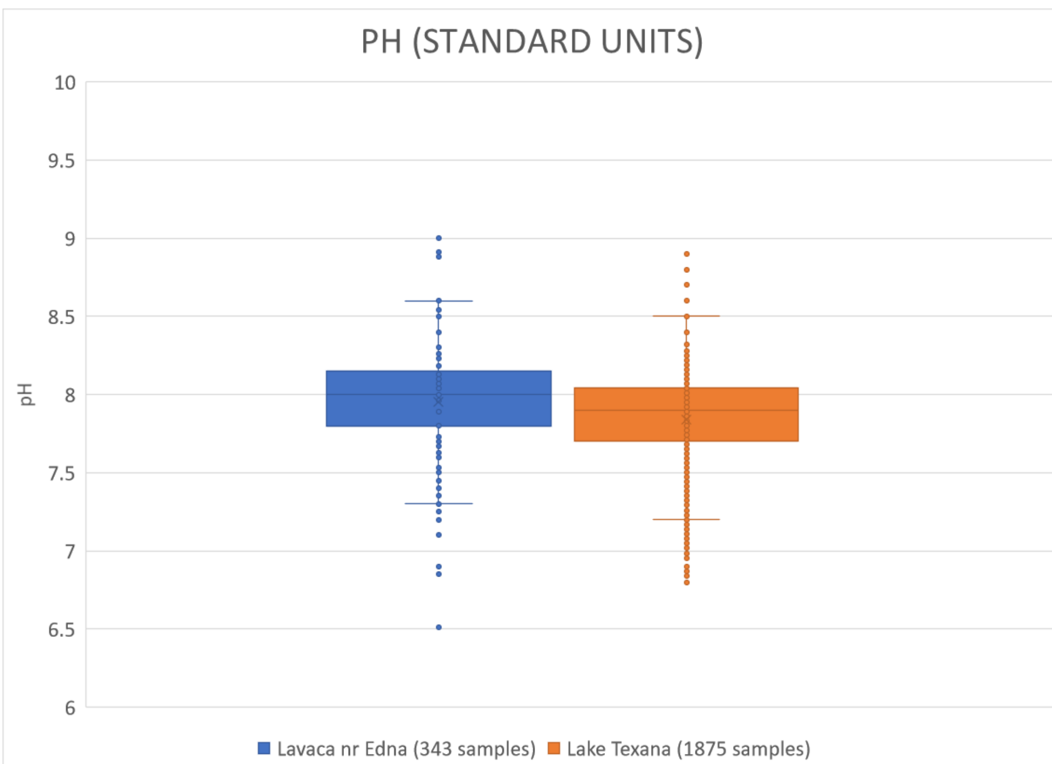
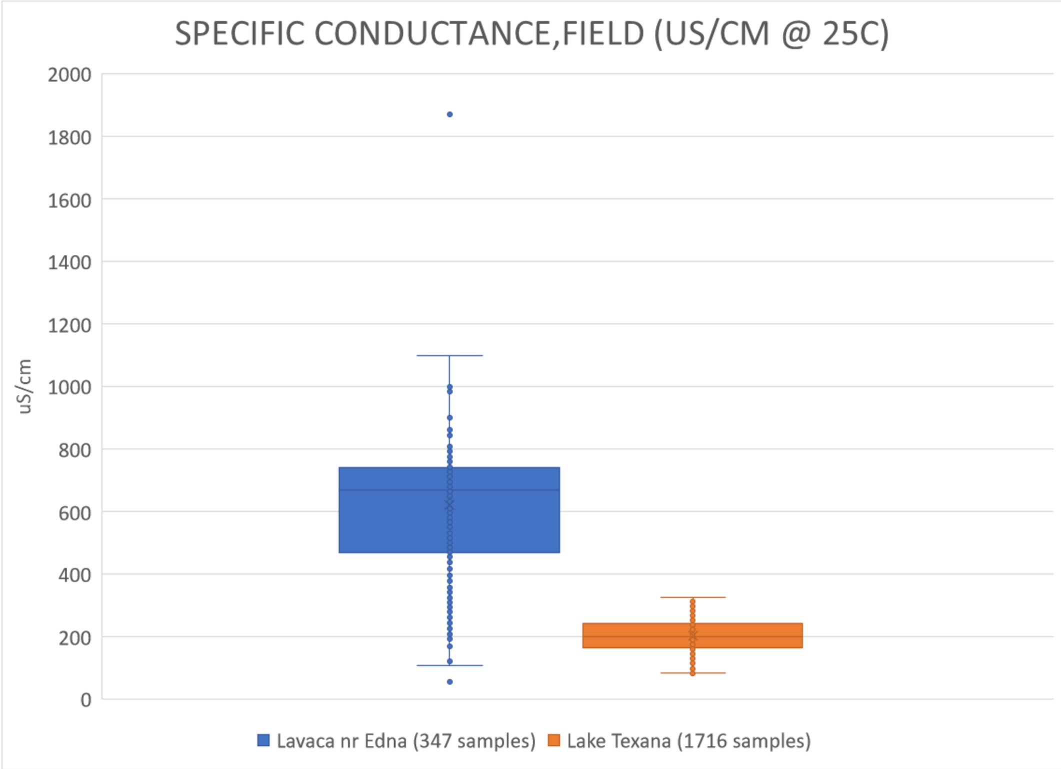


Figure 3-5: Comparison of Water Quality Data for the Lavaca River nr Edna and Lake Texana (continued)



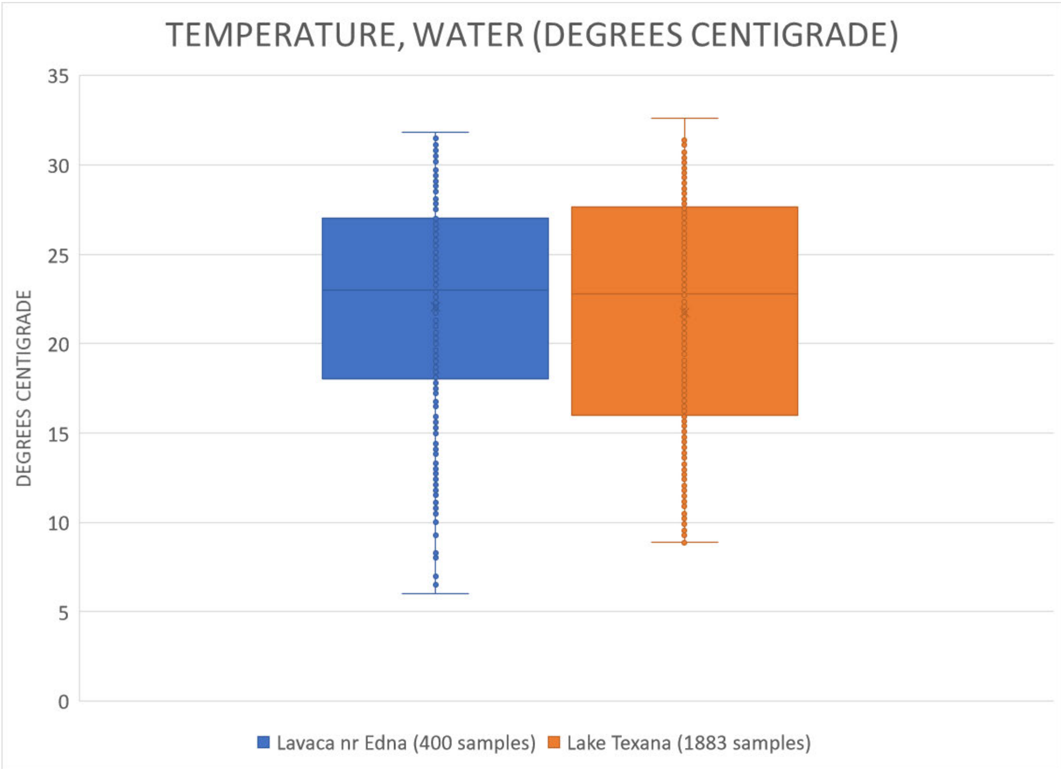
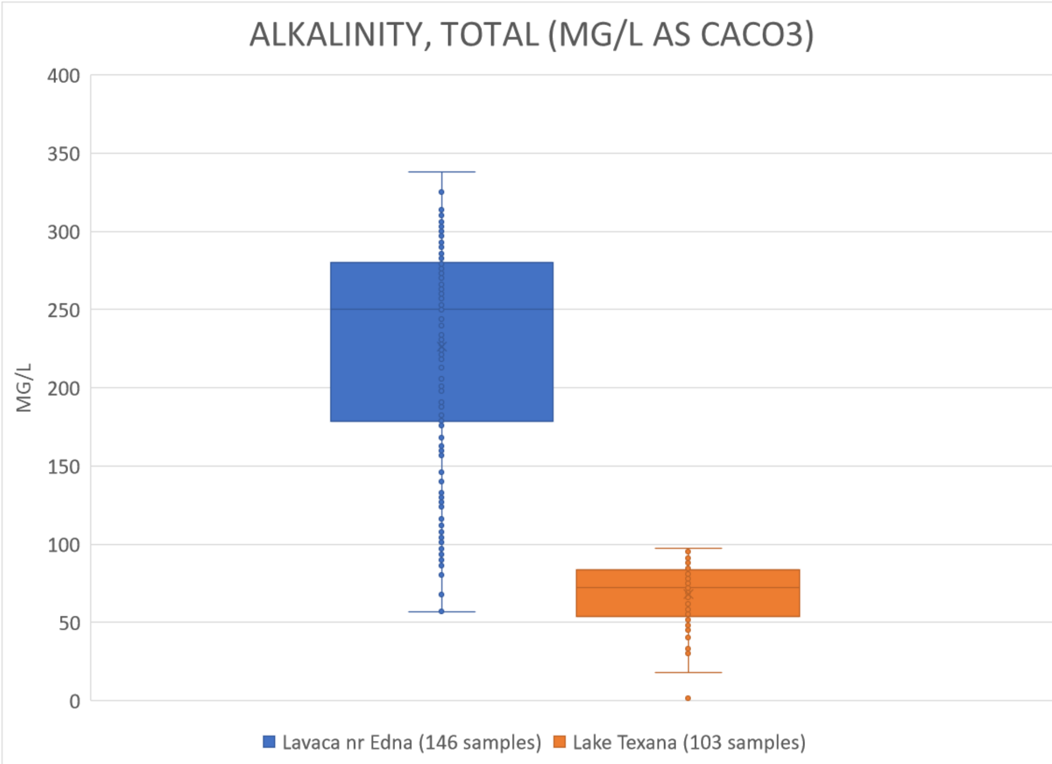


Figure 3-5: Comparison of Water Quality Data for the Lavaca River nr Edna and Lake Texana (continued)



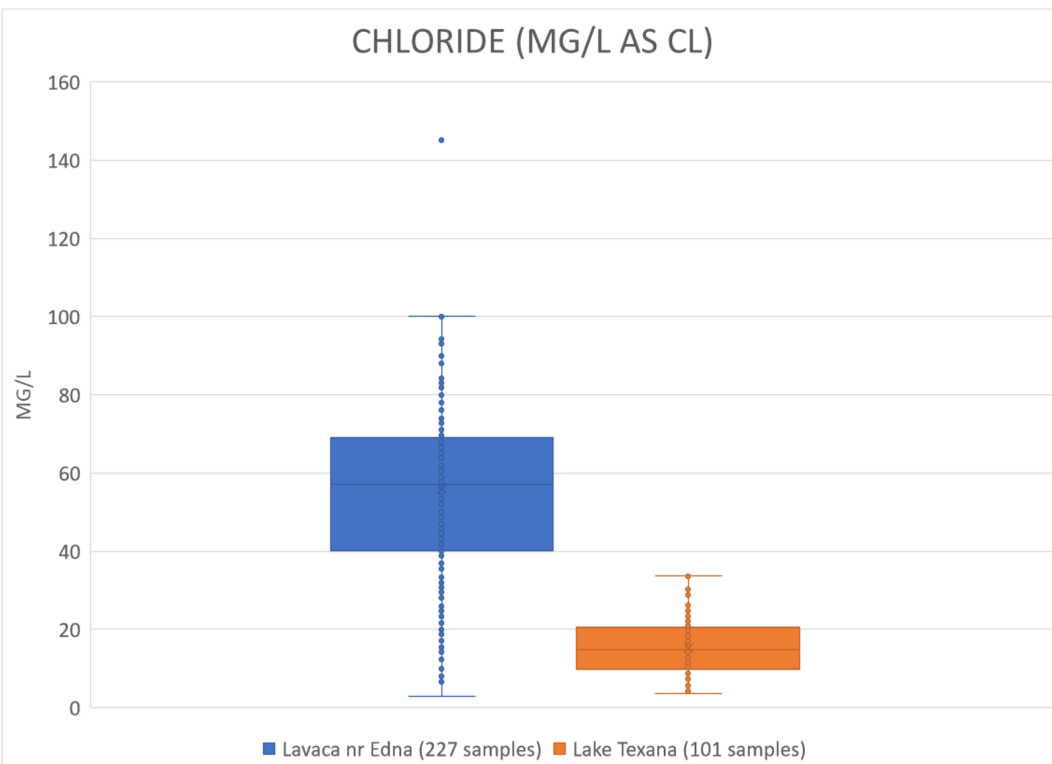
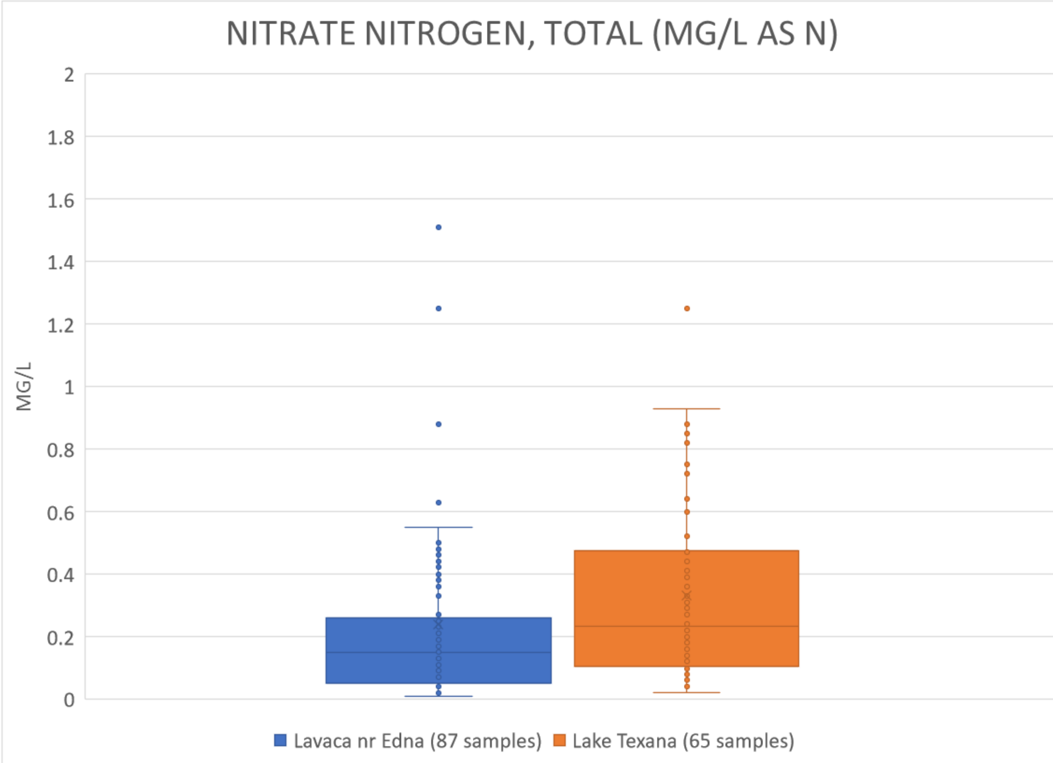
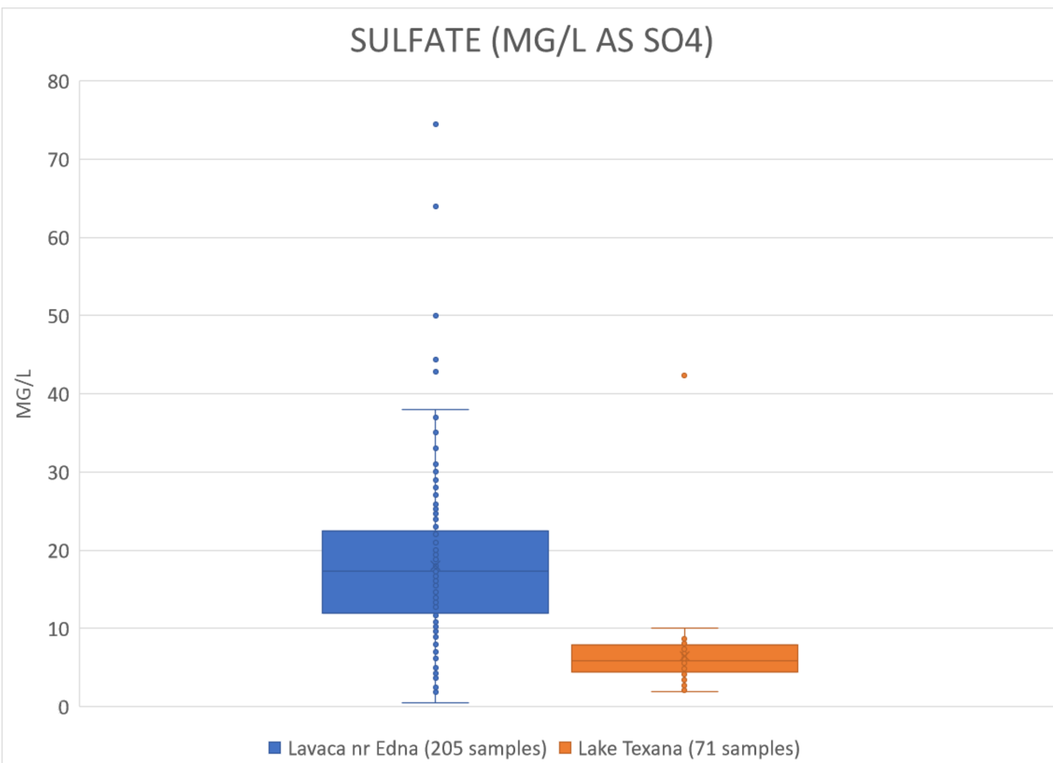


Figure 3-5: Comparison of Water Quality Data for the Lavaca River nr Edna and Lake Texana (continued)





3.10 WORKSHEET 6.0 - WATER CONSERVATION AND DROUGHT CONTINGENCY PLANS

Appendix 3G contains the latest LNRA Water Conservation and Drought Contingency Plan.

3.11 WORKSHEET 7.0 - ACCOUNTING PLAN

Appendix 3H contains the Accounting Plan.

3.12 WORKSHEET 8.0 - CALCULATION OF FEES

Worksheet 8.0 contains calculation of the fees for the new appropriation and bed-and-banks fees, less notice which will be determined by TCEQ. The application is multi-purpose. The maximum diversion from the Lavaca River is 96,022 acre-feet per year. At $1.00 per acre-foot, that would be $96,022, which exceeds the maximum of $50,000 for one use. The quantity of municipal and domestic and mining has not been established, so these fees are set at the maximum for other uses of $10,000 each. Recreational use of stored water in Lake Texana is already authorized under CoA 16-2095. No additional recreational use is sought, so no fee is included.

Including fees for Bed and Banks, the total fees are $96,262.50.

Table 3-5: Calculated Fees

New Appropriation		
Description	**Amount**	**Notes**
Filing Fee	$1,000.00	
Recording Fee	$25.00	
Use fee (industrial)	$50,000.00	Maximum one use fee
Use fee (municipal & domestic)	$10,000.00	Assuming maximum fee for additional use
Use fee (mining)	$10,000.00	Assuming maximum fee for additional use
Recreational storage fee	$0.00	Recreation already authorized in CoA 16-2095 (Lake Texana)
Storage Fee	$25,125.00	$0.50 x 50,000 acre-feet of storage
Mailed Notice	$0.00	To be determined by TCEQ
Total for New Appropriation	*$96,150.00*	
Bed and Banks		
Bed and Banks filing fee	$100.00	
Bed and Banks recording fee	$12.50	
Total Bed and Banks	*$112.50*	
Total Application Fees	*$96,262.50*	

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APPENDIX 2A
Certificate of Adjudication 16-2095

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 16-2095

OWNERS: Texas Water Development Board
c/o Executive Director
P. O. Box 13087
Austin, TX 78711

Lavaca-Navidad River Authority
c/o General Manager
Box 429
Edna, TX 77957

COUNTY: Jackson

PRIORITY DATE: May 15, 1972

WATERCOURSE: Navidad River and Lavaca River

BASIN: Lavaca River

WHEREAS, by final decree of the 155th District Court of Fayette County, in Cause No. 13,102, In Re: The Adjudication of Water Rights in the Lavaca River Basin and a portion of the Lavaca-Guadalupe Coastal Basin, dated March 5, 1981, a right was recognized under Permit 2776A (Application 3032A) authorizing the Texas Water Development Board and the Lavaca-Navidad River Authority to appropriate waters of the State of Texas as set forth below;

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Lavaca River Basin is issued to the Texas Water Development Board and the Lavaca-Navidad River Authority, subject to the following terms and conditions:

1. IMPOUNDMENT

Owners are authorized to construct and maintain a dam with Station 129 + 60 on the centerline, being a point common to the Stage 1 and Stage 2 dams, bearing N 71°27'W, 3333 feet from the northwest corner of the Stephen F. Austin Survey, Abstract 5, Jackson County, Texas, and to impound therein in Stage 1 reservoir not to exceed 170,300 acre-feet of water on the Navidad River and to impound therein in Stage 2 reservoir not to exceed 115,040 acre-feet of water on the Lavaca River.

2. USE

A. Owners are authorized to use from impoundment Stage 1 not to exceed 75,000 acre-feet of water per annum as follows:

(1) Owner Lavaca-Navidad River Authority is authorized to divert and use 7595 acre-feet of water per annum for municipal uses and 24,405 acre-feet of water per annum for industrial uses.

(2) Owner Texas Water Development Board is authorized to divert and use 10,231 acre-feet of water per annum for municipal uses and 32,769 acre-feet of water per annum for industrial uses.

B. Upon completion of the Stage 2 dam and reservoir on the Lavaca River, owner Texas Water Development Board is authorized to divert and use an additional 30,000 acre-feet of water per annum, of which 7150 acre-feet shall be for municipal uses, and 22,850 acre-feet for industrial uses.

C. Owners are authorized to use all impounded waters for recreational purposes and for construction and maintenance of the dams authorized.

2. DIVERSION

A. Location:
(1) At a point on the west bank of the service spillway of Stage 1 dam which is N 69°W, 2850 feet from the northwest corner of the S. F. Austin Survey, Abstract 5, Jackson County, Texas.

(2) At a point on the east bank of the service spillway of Stage 1 dam which is N 61°W, 2500 feet from the northwest corner of the S. F. Austin Survey, Abstract 5, Jackson County, Texas.

B. Maximum Combined Rate: 330 cfs (148,000 gpm).

3. PRIORITY

The time priority of owners' right is May 15, 1972.

The locations of pertinent features related to this certificate are shown on Pages 7 and 8 of the Lavaca River Certificates of Adjudication Maps, copies of which are located in the offices of the Texas Department of Water Resources and the office of the County Clerk.

This certificate of adjudication is issued subject to all terms, conditions and provisions provided for in the final decree of the 155th District Court of Fayette County, in Cause No. 13,102, In Re: The Adjudication of Water Rights in the Lavaca River Basin and a portion of the Lavaca-Guadalupe Coastal Basin, dated March 5, 1981, and supersedes all rights of the owner asserted in that cause.

This certificate of adjudication is issued subject to senior and superior water rights in the Lavaca River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Department of Water Resources and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

This water right is appurtenant to the above-described land within which irrigation is authorized, unless and until severed from the land. A transfer of any portion of the above-described land includes, unless otherwise specified, that portion of the water right which is appurtenant to the transferred land at the time of the transaction.

Texas Water Commission

Felix McDonald

Felix McDonald, Chairman

DATE ISSUED:

JUL 3 1981

ATTEST:

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

TEXAS DEPARTMENT OF WATER RESOURCES

TEXAS WATER COMMISSION

AN ORDER Amending and Correcting
Certificate of Adjudication
No. 16-2095

On November 1, 1984, came on to be considered before the Texas Water Commission the request of Texas Water Development Board (Board) and Lavaca-Navidad River Authority (Authority), holders of Certificate of Adjudication No. 16-2095, to temporarily amend said certificate. The application was made pursuant to Texas Water Code §§11.122 and 11.085. The following were admitted as parties: the Texas Water Development Board, Lavaca-Navidad River Authority, the Executive Director and the Public Interest Advocate of the Texas Department of Water Resources and the Lone Star Chapter of the Sierra Club.

On November 7, 1984, came on to be considered before the Texas Water Commission, pursuant to Section 11.323(b) of the Texas Water Code and 31 TAC Section 307.4 of the Rules of the Texas Department of Water Resources, the correction of Certificate of Adjudication No. 16-2095 to state more accurately provisions in the certificate and to correct errors inadvertently made in the preparation of the certificate.

After considering these matters, the Commission makes the following findings of fact and conclusions of law:

FINDINGS OF FACT

1. Certificate of Adjudication No. 16-2095 was issued to the Texas Water Development Board and the Lavaca-Navidad River Authority by the Texas Water Commission on July 3, 1981, and authorized the certificate holders to maintain a dam creating a 170,300 acre-foot reservoir (Stage I) on the Navidad River, and a dam creating a 93,340 acre-foot reservoir (Stage II) on the Lavaca River. The Board is authorized to use 30,000 acre-feet from Stage II. The Board and Authority are authorized to use 75,000 acre-feet from Stage I as

follows: Texas Water Development Board, 10,231 acre-feet for municipal and 32,769 acre-feet for industrial purposes; Lavaca-Navidad River Authority, 7595 acre-feet for municipal purposes and 24,405 acre-feet for industrial purposes. The reservoir also is authorized for recreational purposes.

2. The Texas Water Development Board and Lavaca-Navidad River Authority submitted an application on September 28, 1984 to amend Certificate of Adjudication No. 16-2095 to authorize, for a three-year period, (1) the conversion of 8,000 acre-feet of water per annum from industrial to municipal purposes from the Board's share of the diversion from Stage I of the reservoir; and (2) the transbasin diversion under §11.085, Texas Water Code, of 18,231 acre-feet of the municipal water authorized under the certificate from the Lavaca River Basin to the service area of the City of Corpus Christi, Texas, in the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins. Water will be diverted pursuant to the diversion point and diversion rate authorizations currently in the certificate. At the end of the three-year period, applicants request that the 8,000 acre-feet per year of municipal water authorized by this application revert back to industrial use; and the transbasin diversion authorization expire.

3. Having determined that the application was in proper form and that required fees had been submitted, the Commission accepted the application for filing on October 1, 1984.

4. Due notice was given to the Secretary of State.

5. On October 5, 1984 notice of the November 1, 1984 hearing on the application was transmitted by first-class mail, postage prepaid, to all holders of certified filings, permits and claims of water rights and to all navigation districts in the Lavaca River Basin, the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins.

6. Notice of the November 1, 1984 hearing was published in the Edna Herald and the Ganado Tribune on October 11 and 18, 1984.

7. Notice of the Commission's consideration on November 7, 1984 of the proposed corrections to the certificate was given on October 15, 1984 by first-class mail, postage pre-paid, to the Board and the Authority, the water rights holders; the Executive Director of the Texas Department of Water Resources; the Public Interest Advocate of the Texas Department of Water Resources; and all parties to the previous proceeding on this water right.

8. The Board and the Authority seek the amendment to the certificate in order to supply the City of Corpus Christi with water during times of shortage. The City of Corpus Christi has experienced drought conditions which have forced rationing and have left the City with limited stores of water. The City anticipates purchase of approximately 18,231 acre-feet of water per year, and more if it is available, from Lake Texana.

9. The City will use the water to serve its citizens and customers, located in the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins.

10. The water will be transmitted to Corpus Christi first via existing pipeline from Lake Texana. Said pipeline intersects a natural gas pipeline, which the City is negotiating to use to further transport the water to the Nueces River above the diversion facilities of the City.

11. Water from the Board's share of the reservoir will be sold to City of Corpus Christi since the indebtedness of the Board is required to be repaid before that of the Authority pursuant to the agreements between the Board, Authority and United States.

12. Amendment of the certificate of adjudication is required to allow the Board sufficient municipal water to supply the City and to allow the transbasin diversion on a

temporary, interim basis of said water outside the present service area of Lake Texana, consisting of the Lavaca River Basin and the Lavaca-Guadalupe and Colorado-Lavaca Coastal Basins.

13. A surplus of water is expected to exist in the Lavaca River Basin, over and above the needs of the basin itself during the ensuing 50-year period, to satisfy the requested transbasin diversion on a temporary, interim basis.

14. The transfer, on a temporary, interim basis, of water from the Lavaca River Basin to the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins will not harm or prejudice any person, property or right within the Lavaca River Basin.

15. Errors were inadvertently made in the preparation of the Certificate, issued on July 3, 1981, which omitted the following conclusions, authorizations, terms and conditions set forth in the Final Determination of Claims of Water Rights in the Lavaca River Basin and a Portion of the Lavaca-Guadalupe Coastal Basin, issued by the Texas Water Commission on June 4, 1980, and affirmed by the 155th Judicial District Court of Fayette County, Texas by Decree dated January 14, 1981 (as corrected nunc pro tunc on March 5, 1981) in Cause No. 13,102:

a. Conclusions 4 and 11, inclusive, set forth on Page 20 of the Final Determination;

b. Provisions in Permit No. 2776 which (1) authorize the diversion and use of water from Lake Texana for use within the adjacent Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins; and (2) specify that the water right is subject to all superior and senior water rights in the Lavaca River Basin and, as may be determined by the Commission, to the release of water for the maintenance of the Lavaca-Matagorda Bay and Estuary System.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS WATER COMMISSION THAT:

1. The application for amendment to Certificate of Adjudication No. 16-2095 of the Texas Water Development Board and Lavaca-Navidad River Authority be granted in accordance with the terms and conditions contained in the attached certificate, as follows:

(a) In lieu of the previous authorizations to the Texas Water Development Board from Stage I, the Texas Water Development Board is authorized to divert and use 18,231 acre-feet of water per annum for municipal uses and 24,769 acre-feet per annum for industrial uses.

(b) At the end of three years from the date of issuance of this amendment, the authorization for the Texas Water Development Board's use from Stage I shall revert back to the uses authorized prior to this amendment, to wit: 10,231 acre-feet per annum for municipal purposes and 32,769 acre-feet for industrial purposes.

(c) Certificate holders are authorized to divert from the Lavaca River Basin 18,231 acre-feet of water per year to be used in the service area of City of Corpus Christi in the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins. This authorization shall expire three years from date of issuance of this amendment.

2. Certificate of Adjudication No. 16-2095 be corrected to include the following inadvertently omitted conclusions, authorizations, terms and conditions set forth in the <u>Final Determination of Claims of Water Rights in the Lavaca River Basin and a Portion of the Lavaca-Guadalupe Coastal Basin</u>, issued by the Texas Water Commission on June 4, 1980, and affirmed by the 155th Judicial District Court of Fayette County, Texas by Decree dated January 14, 1981 (as corrected nunc pro tunc on March 5, 1981) in Cause No. 13,102, in accordance with the attached certificate:

CONCLUSIONS OF LAW

1. The Commission has jurisdiction to consider the application for amendment to the certificate for a change in the purpose of use and for a transbasin diversion on a temporary, interim basin; and, to correct the certificate to state more accurately provisions in the certificate and to correct errors inadvertently made in the preparation of the certificate.

2. The application for amendment is complete and conforms to the requirements of the Texas Water Code and rules of the Texas Department of Water Resources.

3. The municipal use of water requested in the application is a beneficial use of state water.

4. The requirements of §11.085, Texas Water Code, and 31 TAC §303.33 have been met, and a transbasin diversion on a temporary, interim basis should be allowed.

5. The requirements of §11.323(b) of the Texas Water Code and 31 TAC §307.4 have been met and a correction to the certificate should be made.

6. The Final Determination of Claims of Water Rights in the Lavaca River Basin and a Portion of the Lavaca-Guadalupe Coastal Basin, issued by the Texas Water Commission on June 4, 1980, and affirmed by the 155th Judicial District Court of Fayette County, Texas by Decree dated January 14, 1981 (as corrected nunc pro tunc on March 5, 1981) in Cause No. 13,102 continued in full force and effect all of the terms and conditions stated in Permit No. 2776 and its amendments except for irrelevent and immaterial terms and conditions.

7. The provisions of Permit No. 2776 set forth in Finding of Fact No. 15.b. are not irrelevent or immaterial and thus continued in full force and effect as a result of the Final Determination.

a. Conclusions 4 and 11, inclusive, set forth on Page 20 of the Final Determination;

b. Provisions in Permit No. 2776 which (1) authorize the diversion and use of water from Lake Texana for use within the adjacent Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins; and (2) specify that the water right is subject to all superior and senior water rights in the Lavaca River Basin and, as may be determined by the Commission, to the release of water for the maintenance of the Lavaca-Matagorda Bay and Estuary System.

3. The Chief Clerk of the Commission is directed to forward a certified copy of this order to the parties to these proceedings and, subject to the filing of motions for rehearing, to issue the attached certificate and forward the same to the County Clerk of Jackson County for recordation.

Signed this the 13th day of November, 1984.

TEXAS WATER COMMISSION

Paul Hopkins

Paul Hopkins, Chairman

Lee B.M. Biggart

Lee B. M. Biggart, Commissioner

Ralph Roming

Ralph Roming, Commissioner

ATTEST:

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

CORRECTED/AMENDED
CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 16-2095A

OWNERS: Texas Water Development Board
c/o Executive Director
Texas Department of Water Resources
P. O. Box 13087
Austin, Texas 78711

Lavaca-Navidad River Authority
c/o General Manager
Box 429
Edna, Texas 77957

Code A
provider part
expires
1-13-88

COUNTY: Jackson

PRIORITY DATE: May 15, 1972

WATERCOURSES: Navidad River and Lavaca River

BASIN: Lavaca River

WHEREAS, by final decree of the 155th District Court of Fayette County, in Cause No. 13,102, In Re: The Adjudication of Water Rights in the Lavaca River Basin and a portion of the Lavaca-Guadalupe Coastal Basin, dated January 14, 1981, and as corrected nunc pro tunc on March 5, 1981, a right was recognized under Permit 2776A (Application 3032A) authorizing the Texas Water Development Board and the Lavaca-Navidad River Authority to appropriate waters of the State of Texas as set forth below; and

WHEREAS, through Permit No. 2776B issued to the Lavaca-Navidad River Authority on February 24, 1981, the Texas Water Commission approved the location and combined 660 cfs capacity of two facilities to divert water from the Stage 1 reservoir, but authorized a maximum combined diversion rate of only 330 cfs for the facilities;

WHEREAS, on November 1, 1984, the Texas Water Commission granted an amendment to this certificate of adjudication authorizing a temporary change in purpose of use and a transbasin diversion of water on a three-year, interim basis from the Lavaca River Basin to the service area of the City of Corpus Christi, Texas, in the Nueces River Basin and the San Antonio-Nueces and Nueces-Rio Grande Coastal Basins, finding that such transbasin diversion on a temporary interim basis will not harm or prejudice any person, property or right within the Lavaca River Basin and that a surplus of water is expected to exist in the Lavaca River Basin over and above the needs of the basin itself during the ensuing 50-year period, to satisfy the transbasin diversion on a temporary, interim basis;

WHEREAS, pursuant to Texas Department of Water Resources Rule 31 TAC §307.4 and §11.323(b) of the Texas Water Code, the Texas Water Commission on November 7, 1984 corrected this certificate of adjudication to state more accurately provisions in the certificate and to correct errors inadvertently made in the preparation of the certificate;

NOW, THEREFORE, this amendment to certificate of adjudication No. 16-2095, as corrected, is issued to the Texas Water Development Board and the Lavaca-Navidad River Authority, subject to the following terms and conditions:

1. IMPOUNDMENT

Owners are authorized to impound water in a 170,300 acre-foot capacity reservoir (Stage 1 reservoir) on the Navidad River and in a 93,340 acre-foot capacity reservoir (Stage 2 reservoir) on the Lavaca River. Station 129+60 on the centerline, being a point common to the Stage 1 and Stage 2 Dams, bears N 71°27'W, 3333 feet from the northwest corner of the Stephen F. Austin Survey, Abstract No. 5, Jackson County, Texas.

2. USE

A. Upon completion of the Stage 1 dam and reservoir on the Navidad River, and based on Lavaca-Navidad River Authority's share of 42.67% and Texas Water Development Board's share of 57.33% in the estimated non-federal cost of the project as set forth in an amendment contract between the Board and the Authority dated January 7, 1976, and an amended federal contract dated January 9, 1976, owners are authorized to divert and use not to exceed 75,000 acre-feet of water per annum as follows:

(1) Owner Lavaca-Navidad River Authority is authorized to divert and use 7595 acre-feet of water per annum for municipal purposes and 24,405 acre-feet of water per annum for industrial purposes; and

(2) Owner Texas Water Development Board is authorized to divert and use 10,231 acre-feet of water per annum for municipal purposes and 32,769 acre-feet of water per annum for industrial purposes. Provided, however, that for a period not exceeding three years from the date of issuance of this amendment, owner Texas Water Development Board is authorized:
(a) To divert and use not to exceed 18,231 acre-feet of water per annum for municipal purposes and 24,769 acre-feet of water per annum for industrial purposes, in lieu of the above-authorized diversion and use; and
(b) To divert and transfer the 18,231 acre-feet of water per annum for municipal purposes from the Lavaca River Basin to the service area of the City of Corpus Christi in the Nueces River Basin and San Antonio-Nueces and Nueces-Rio Grande Coastal Basins.
At the end of the three-year period, the authorization for the Texas Water Development Board's diversion and use from the Stage 1 reservoir shall revert back to the above prior purposes and corresponding amounts of water.

B. Upon completion of the Stage 2 dam and reservoir on the Lavaca River, owner Texas Water Development Board is authorized to divert and use an additional 30,000 acre-feet of water per annum, of which 7150 acre-feet shall be for municipal purposes, and 22,850 acre-feet for industrial purposes.

C. Owners are authorized to use all impounded waters for recreational purposes and for construction and maintenance of the dams authorized.

3. DIVERSION

A. Location:
(1) At a point on the west bank of the service spillway of the Stage 1 dam which is N 69°W, 2850 feet from the northwest corner of the S. F. Austin Survey, Abstract 5, Jackson County, Texas.

(2) At a point on the east bank of the service spillway of the Stage 1 dam which is N 61°W, 2500 feet from the northwest corner of the S. F. Austin Survey, Abstract 5, Jackson County, Texas.

B. Maximum Combined Rate: 330 cfs (148,000 gpm) The approved diversion facilities have a combined maximum diversion capacity of 660 cfs. Any combined diversion rate in excess of 330 cfs, however, is not authorized by this certificate and shall require further authorization from the Commission.

4. PRIORITY

The time priority of the authorizations herein is May 15, 1972.

5. SPECIAL CONDITIONS

A. None of the waters authorized to be used under this certificate of adjudication shall be diverted and used until owners have furnished the Commission specific information as to the location and capacity of diversion facilities and have had such facilities approved by the Commission.

B. No water shall be diverted and used by any party other than the Texas Water Development Board or the Lavaca-Navidad River Authority until there has been compliance with Department rules regarding diversion and use of water pursuant to a contract.

C. Prior to the completion of the Stage 2 dam and reservoir, owners' rights to the diversion and use of State water shall be limited to the respective quantities of water hereinabove set forth as authorized to be diverted from Stage 1; provided, that nothing herein shall prevent owners from contracting for the sale of the total authorized diversion, said sale being contingent upon the completion of the Stage 2 dam and reservoir project.

D. Until the Texas Water Development Board has provided for the sale and/or use of all waters authorized to be diverted from this project in the manner prescribed, the Commission may, upon application and proper order, authorize and order the release of State water for any beneficial purpose, including releases of water for research purposes in the Lavaca-Matagorda Bay and Estuary System.

E. Owners shall install and maintain a continuous lake level measuring device for each reservoir authorized herein and maintain the following daily records:

(1) Reservoir content;
(2) Diversions from each reservoir; and
(3) Discharges through the dam.

All records shall be compiled monthly and reported to the Department annually and at other times on request.

F. Owners shall survey and monument an appropriate number of sediment ranges in each reservoir prior to impoundment of water. Drawings showing the location and profile of each range will be submitted to the Department along with a revised elevation-area-capacity table based on the surveyed ranges.

G. Revised elevation-area-capacity tables based on new sediment surveys conducted at 10-year intervals following initial filling of each reservoir shall be submitted to the Department.

H. The authorized diversions by owner Lavaca-Navidad River Authority are subject to and shall be limited proportionately by the Authority's contribution of a portion of the total cost of developing the water-supply yield of Stage 1 of the Palmetto Bend Dam and Reservoir Project as specified in an amendment contract dated January 7, 1976, entered into by and between the Texas Water Development Board and Lavaca-Navidad River Authority and an amended federal contract dated January 9, 1976, relating to joint participation in the development of the Palmetto Bend Dam and Reservoir Project. Reassignment of the authorized diversion of 75,000 acre-feet of water per annum shall be made between owners by the Commission on its own motion hereafter on the basis of proportionate sharing in the project cost.

I. Subject to the terms and conditions in this certificate,

5. SPECIAL CONDITIONS

A. None of the waters authorized to be used under this certificate of adjudication shall be diverted and used until owners have furnished the Commission specific information as to the location and capacity of diversion facilities and have had such facilities approved by the Commission.

B. No water shall be diverted and used by any party other than the Texas Water Development Board or the Lavaca-Navidad River Authority until there has been compliance with Department rules regarding diversion and use of water pursuant to a contract.

C. Prior to the completion of the Stage 2 dam and reservoir, owners' rights to the diversion and use of State water shall be limited to the respective quantities of water hereinabove set forth as authorized to be diverted from Stage 1; provided, that nothing herein shall prevent owners from contracting for the sale of the total authorized diversion, said sale being contingent upon the completion of the Stage 2 dam and reservoir project.

D. Until the Texas Water Development Board has provided for the sale and/or use of all waters authorized to be diverted from this project in the manner prescribed, the Commission may, upon application and proper order, authorize and order the release of State water for any beneficial purpose, including releases of water for research purposes in the Lavaca-Matagorda Bay and Estuary System.

E. Owners shall install and maintain a continuous lake level measuring device for each reservoir authorized herein and maintain the following daily records:

(1) Reservoir content;
(2) Diversions from each reservoir; and
(3) Discharges through the dam.

All records shall be compiled monthly and reported to the Department annually and at other times on request.

F. Owners shall survey and monument an appropriate number of sediment ranges in each reservoir prior to impoundment of water. Drawings showing the location and profile of each range will be submitted to the Department along with a revised elevation-area-capacity table based on the surveyed ranges.

G. Revised elevation-area-capacity tables based on new sediment surveys conducted at 10-year intervals following initial filling of each reservoir shall be submitted to the Department.

H. The authorized diversions by owner Lavaca-Navidad River Authority are subject to and shall be limited proportionately by the Authority's contribution of a portion of the total cost of developing the water-supply yield of Stage 1 of the Palmetto Bend Dam and Reservoir Project as specified in an amendment contract dated January 7, 1976, entered into by and between the Texas Water Development Board and Lavaca-Navidad River Authority and an amended federal contract dated January 9, 1976, relating to joint participation in the development of the Palmetto Bend Dam and Reservoir Project. Reassignment of the authorized diversion of 75,000 acre-feet of water per annum shall be made between owners by the Commission on its own motion hereafter on the basis of proportionate sharing in the project cost.

I. Subject to the terms and conditions in this certificate, owners are authorized to transfer to, and divert and use within the Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins water herein authorized to be appropriated.

This certificate of adjudication is issued subject to all superior and senior water rights in the Lavaca River Basin and, as may be determined by the Commission, to the release of water for the maintenance of the Lavaca-Matagorda Bay and Estuary System.

The locations of pertinent features related to this certificate are shown on Pages 11 and 12 of the Lavaca River Certificates of Adjudication Maps, copies of which are located in the offices of the Texas Department of Water Resources and the office of the County Clerk.

This certificate of adjudication is issued subject to all terms, conditions and provisions provided for in the final decree of the 155th District Court of Fayette County, in Cause No. 13,102, In Re: The Adjudication of Water Rights in the Lavaca River Basin and a portion of the Lavaca-Guadalupe Coastal Basin, dated January 14, 1981 and as corrected nunc pro tunc on March 5, 1981, and supersedes all rights of the owner asserted in that cause.

This certificate of adjudication is issued subject to the Rules of the Texas Department of Water Resources and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

Texas Water Commission

Paul Hopkins

Paul Hopkins, Chairman

DATE ISSUED:
January 14, 1985

ATTEST:

Mary Ann Hefner

Mary Ann Hefner, Chief Clerk

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO
CERTIFICATE OF ADJUDICATION NO. 16-2095

CERTIFICATE OF ADJUDICATION: 16-2095B

OWNERS:
Texas Water Development Board
c/o Executive Administrator
P.O. Box 13231
Austin, Texas 78711

Lavaca Navidad River Authority
c/o General Manager
Box 429
Edna, Texas 77957

COUNTY: Jackson

PRIORITY DATES:
May 24, 1982, and October 6, 1993

WATERCOURSES: Lavaca River and
Navidad River

BASIN: Lavaca Basin

WHEREAS, Lavaca-Navidad River Authority (LNRA) and Texas Water Development Board (TWDB) have filed Application 16-2095B and requested amendments of Certificate of Adjudication No. 16-2095, as amended, to appropriate the entire firm yield of the Stage 1 and Stage 2 reservoirs authorized by this certificate of adjudication, and to quantify existing requirements that water be released or passed through to satisfy freshwater inflow needs of the downstream bay and estuary system;

WHEREAS, the Commission finds that it has jurisdiction to hear both Application 16-2095B and the previous application to amend Certificate of Adjudication No. 16-2095 which is the application subject to Cause No. 361,294 remanded from the District Court of Travis County, Texas;

WHEREAS, all parties to the contested case hearing have settled and resolved all matters in dispute and recommend that the application be granted as reflected by this amendment;

WHEREAS, the Commission finds that the entire remaining firm yield of Lake Texana (Stage 1) is 79,000 acre-feet per year;

WHEREAS, the Commission finds that releases for the bay and estuary system specified by this amendment could impact the firm yield of Lake Texana (Stage 1) by reducing it by up to 4,500 acre-feet per year, from 79,000 acre-feet per year to 74,500 acre-feet per year;

WHEREAS, the Commission finds that the entire remaining firm yield of Stage 2 is 48,122 acre-feet per year;

WHEREAS, the District Court of Travis County has remanded LNRA and TWDB's May 24, 1982 application to the Commission for consideration of whether changed circumstances may now exist that demonstrate the need for the additional appropriation requested by such application;

WHEREAS, issuance of this amendment to Certificate of Adjudication No. 16-2095 effectively resolves all matters of dispute in Cause Nos. 361,294 and 374,305, Lavaca-Navidad River Authority v. Texas Department of Water Resources, and the applicants waive and abandon all contested matters in those proceedings, subject to the issuance and legal effectiveness of this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095 is issued to Texas Water Development Board and Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

A. Owners are authorized to use from the impoundment of Lake Texana (impoundment Stage 1) an additional 4,000 af/yr, as follows:

(1) Owner LNRA is authorized to use 406 af/yr for municipal purposes and 1301 af/yr for industrial purposes;

(2) Owner TWDB is authorized to use 546 af/yr for municipal purposes and 1747 af/yr for industrial purposes.

B. Upon completion of the Stage 2 dam and reservoir on the Lavaca River, owner Texas Water Development Board is authorized to use an additional amount of 18,122 af/yr, for a total or 48,122 af/yr, of which up to 7,150 af/yr shall be for municipal purposes, up to 22,850 af/yr shall be for industrial purposes, and at least 18,122 af/yr shall be for the maintenance of the Lavaca-Matagorda Bay and Estuary System. The entire Stage 2 appropriation remains subject to release of water for the maintenance of the bay and estuary system until a release schedule is developed pursuant to the provisions of Section 4.B. of this certificate of adjudication.

2. PRIORITY

A. The time priority for the additional 4,000 af/yr appropriation for Lake Texana is May 24, 1982.

B. The time priority for the additional 18,122 af/yr appropriation for Stage 2 is October 6, 1993.

3. WATER CONSERVATION

A. Within 120 days of issuance of the amended certificate, LNRA shall submit a written response to the following staff recommendations regarding the technical review of LNRA's water conservation plan:

1. The conservation plan needs to be revised to address all of the minimum requirements of 30 TAC Ch. 288, specifically:

a) The water conservation plan should be adopted by the LNRA Board and integrated into LNRA operations and management.

b) A requirement must be added in wholesale contracts so that each successive wholesaler implements water conservation measures in accordance with 30 TAC Ch. 288. For long term contracts already signed, compliance with this provision should be sought voluntarily or this provision should be added at the first available opportunity.

2. Conservation goals and strategies need to be evaluated as to effectiveness for the water users. Goals need to be set based upon an engineering analysis and the technical potential to achieve those goals.

B. Within 180 days of issuance of the amended certificate, LNRA shall revise and implement the "Water Conservation Plan" dated May, 1991. Any subsequent plan used by LNRA shall provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water or prevent the pollution of water, so that a water supply is made available for future use or alternative uses. Such plan shall include a requirement in every wholesale water supply contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement water conservation measures. If the customer intends to resell the water, then the contract for the resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water will be required to implement water conservation measures.

4. BAY AND ESTUARY RELEASE SCHEDULE

A. The first full paragraph on page 4 of Certificate of Adjudication 16-2095 is amended to provide, with respect to Lake Texana (Stage 1), as follows: This certificate of adjudication is issued subject to all superior and senior water rights in the Lavaca River and to the release of water from Stage 1 for the maintenance of Lavaca-Matagorda Bay and Estuary System as follows:

1. When 78.18% or more of the reservoirs's capacity contains stored inflows, all inflows into the reservoir up to the historical monthly median flow during the months of January (84.5 cfs), February (142.4 cfs), March (86.8 cfs), July (126.5 cfs), November (68.3 cfs), and December (79.3 cfs), and all inflows up to the historical monthly average flow of the months of April (806.8 cfs), May (1,169.3 cfs), June (1,191.4 cfs), August (265.7 cfs), September (1,027.3 cfs), and October (708.3 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

2. When less than 78.18% of the reservoir's capacity contains stored inflows, all inflows up to the annual median daily flow for the drought period January 1954 through December 1956 (5 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

As used in this provision, the term "inflows" refers to naturally occurring in-basin inflows. It does not include water supplies imported from out of the basin, unless those supplies are imported by a junior permittee upstream of Lake Texana for the purpose of replacing naturally occurring in-basin inflows in order to avoid impairment of water rights granted pursuant to Certificate of Adjudication 16-2095, as amended, including required freshwater inflows.

Lavaca-Navidad River Authority, Texas Water Development Board, and Texas Parks and Wildlife Department shall cooperate in developing operating procedures to implement the release schedule and provide such procedures to the TNRCC for review and approval as part of the Water Management Plan. Such procedures shall in part assist in the determination of when priority calls on water can be made by the certificate holder on a daily, monthly, or other appropriate schedule. Additional gages needed to measure inflows and outflows in connection with the release schedule shall be installed within one year following LNRA's issue of "Texana Bonds" to finance acquisition of TWDB's interest. LNRA shall notify the TNRCC in writing of the issuance of such bonds not later than thirty (30) days from date of issuance.

B. The Stage 2 appropriation for municipal and industrial uses remains subject to the release of water for maintenance of the Lavaca-Matagorda Bay and Estuary System as follows:

> Prior to commencement of construction of Stage 2, or any diversion of water appropriated under the Stage 2 portion of this Certificate of Adjudication, upon the joint recommendation of Lavaca-Navidad River Authority, Texas Water Development Board, and Texas Parks and Wildlife Department, LNRA and/or TWDB shall submit an application to TNRCC to establish a schedule for the release of fresh water inflows from Stage 2 for the maintenance of the Lavaca-Matagorda Bay and Estuary System. In establishing the Stage 2 release schedule, TNRCC may consider, upon the motion of any party, modification of the Stage 1 release schedule set forth herein; provided, however, the applicant(s) shall retain the right to withdraw its application without prejudice at any time prior to the final decision by the Commission and shall pay reasonable costs incurred by protesting parties. In the event that the application to set the release schedule for Stage 2 is withdrawn, the Stage 1 release schedule shall remain unchanged from the release schedule specified in Section 4.A of this certificate of adjudication.

5. SPECIAL CONDITION:

Within 36 months of issuance of this amendment, LNRA shall submit to the TNRCC, following appropriate public involvement, a water management plan pursuant to Texas Water Code section 11.173(b). Such plan shall address:

a) the potential of water conservation and reuse to enhance existing water supplies and the potential impact of such practices on the timing of construction of Stage 2;

b) a drought management plan in accordance with 30 TAC section 288.2(a)(1)(H);

c) an assessment of environmental water needs (i.e., instream needs, water quality, aquatic and wildlife habitat, and beneficial inflows to affected bays and estuaries) and potential responses to address such needs, particularly as related to Stage 2. Such assessment shall be done in coordination with the Clean Rivers Program (Texas Water Code section 26.0135) and studies performed pursuant to Texas Water Code section 16.058; and,

d) the management of water supply, including planning and timing of construction of Stage 2. This may include the incorporation of integrated resource planning principles where water supply and demand management options are identified, analyzed, and compared so that the most cost-effective and environmentally sensitive strategies are pursued.

This Amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as herein amended.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owners agree to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and the right of continual supervision of State water resources exercised by the Commission.

Issue Date: DEC 16 1994

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

John Hall

John Hall, Chairman

ATTEST:

Gloria A. Vasquez

Gloria A. Vasquez, Chief Clerk

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO CERTIFICATE OF ADJUDICATION

APPLICATION NO. 16-2095C   CERTIFICATE NO. 16-2095C   TYPE: §11.122 and 11.085

Owners: Lavaca-Navidad River Authority, c/o General Manager
P.O. Box 429, Edna, Texas 77957

Texas Water Development Board, c/o Executive Administrator
P.O. Box 13231, Austin, Texas 78711

Filed: December 27, 1995   Purposes: Municipal and Industrial

Counties: Aransas, Atascosa, Bee, Duval, Jackson, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio

Watercourse: Navidad River, tributary of the Lavaca River

Watersheds: Lavaca River Basin, Colorado-Lavaca Coastal Basin, Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces River Basin, Nueces-Rio Grande Coastal Basin, Guadalupe River Basin and San Antonio River Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, includes authorization for the Lavaca-Navidad River Authority and the Texas Water Development Board to impound water in a 170,300 acre-foot capacity reservoir (referred to as Stage 1 reservoir or Lake Texana) on the Navidad River in Jackson County for recreational use; and

WHEREAS, the certificate, as amended, also includes authorization for the owners to divert and use from the lake not to exceed 18,778 acre-feet of water per annum for municipal purposes and 60,222 acre-feet of water per annum for industrial purposes in the Lavaca River Basin, the Colorado-Lavaca Coastal Basin and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, the Lavaca-Navidad River Authority owns a 42.67% interest in the certificate, as amended, and the Texas Water Development Board owns a 57.33% interest in the certificate, as amended; and

WHEREAS, the impoundment authorization, the authorization to divert and use 17,826 acre-feet of water per annum from the lake for municipal purposes and to divert and use 57,174 acre-feet of water per annum from the lake for industrial purposes has a time priority of May 15, 1972; and

WHEREAS, authorization to divert and use 952 acre-feet of water per annum for municipal purposes from the lake and to divert and use 3048 acre-feet of water per annum from the lake for industrial purposes has a time priority of May 24, 1982; and

WHEREAS, the applicants seek (without a change in their current ownership interests in the water right) to amend Certificate of Adjudication No. 16-2095, as amended, to:

1) reallocate use of the total of 79,000 acre-feet of water per year from the lake as follows: 46,518 acre-feet for municipal use and 32,482 acre-feet for industrial use (with 4000 acre-feet of the 46,518 acre-feet to be used for municipal purposes having a time priority of May 24, 1982 and the remainder of the water having a time priority of May 15, 1972);

2) authorize transport of not to exceed 46,590 acre-feet of water per annum of the referenced 79,000 acre-feet of water for use in Aransas, Atascosa, Bee, Duval, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio Counties which include land in the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, the Lavaca-Guadalupe Coastal Basin, the Guadalupe River Basin and the San Antonio River Basin (the 46,590 acre-feet of water requested to be transported per annum includes 46,340 acre-feet of the 46,518 acre-feet per year requested for municipal use and 250 acre-feet of the 32,482 acre-feet per year requested for industrial use); and

3) maintain a continuing right to reclaim for use 10,400 acre-feet of the aforesaid 46,590 acre-feet per annum in the future for use within the basins currently authorized in the certificate;

WHEREAS, the Texas Natural Resource Conservation Commission finds that jurisdiction over the application is established; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Natural Resource Conservation Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, as amended, is issued to the Lavaca-Navidad River Authority and the Texas Water Development Board subject to the following terms and conditions:

1. USE

   a. In lieu of the authorization currently included in Certificate No. 16-2095, as amended, to divert and use from Lake Texana not to exceed 18,778 acre-feet of water per annum for municipal use and not to exceed 60,222 acre-feet of water per annum for industrial use, owners are authorized to divert and use from Lake Texana not to exceed 46,518 acre-feet of water per annum for municipal use and 32,482 acre-feet of water per annum for industrial use.

   b. Owners are authorized to transport not to exceed 46,590 acre-feet of water per annum of the 79,000 acre-feet of water per annum authorized for diversion from the lake for use in Aransas, Atascosa, Bee, Duval, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio Counties, which include land in the Lavaca-Guadalupe Coastal Basin, the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, the Guadalupe River Basin and the San Antonio River Basin.

2. WATER CONSERVATION

   Owners shall maintain a water conservation plan that shall provide for the utilization of those practices, techniques and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plan shall include a requirement in every wholesale water supply contract entered into, on or after the issue date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement water conservation measures. If the customer intends to resell the water, then the contract for the resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water will be required to implement water conservation measures.

3. SPECIAL CONDITION

Owners shall have the right to reclaim for use not to exceed 10,400 acre-feet of the 46,590 acre-feet of water per annum referred to in Paragraph 1.b. of this amendment in the future for use within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin and the Lavaca-Guadalupe Coastal Basin.

4. TIME PRIORITIES

The time priority of 4000 acre-feet of the 46,518 acre-feet per annum authorized for municipal use in this amendment is May 24, 1982. The time priority of the remaining 75,000 acre-feet of water per annum included in this amendment is May 15, 1972.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owners agree to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

For the Commission

DATE ISSUED: OCT 21 1996

ATTEST:

Mamie M. Black

Mamie M. Black, Acting Chief Clerk

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO A
CERTIFICATE OF ADJUDICATION

APPLICATION NO. 16-2095D CERTIFICATE NO. 16-2095D TYPES §11.122 and 11.085

Owner:	Lavaca-Navidad River Authority	Address:	P.O. Box 429 Edna, Texas 77957
Filed:	July 1, 2002	Granted:	FEB 21 2003
Purpose:	Municipal and Industrial	County:	Jackson
Watercourse:	Lake Texana on the Navidad River	Watershed:	Lavaca River Basin, Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and San Antonio-Nueces Coastal Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, authorizes the Lavaca-Navidad River Authority (LNRA) to impound 170,300 acre-feet of water in the Stage 1 reservoir (Lake Texana) on the Navidad River, Lavaca River Basin, Jackson County, to divert and use not to exceed 79,000 acre-feet of water as follows:

A. 42,518 acre-feet of water per annum for municipal use and 32,482 acre-feet of water per annum for industrial use with a priority date of May 15, 1972, and

B. 4,000 acre-feet of water per annum for municipal use with a priority date of May 24, 1982; and

WHEREAS, LNRA is also authorized to transport not to exceed 46,590 acre-feet of water per annum (46,340 acre-feet for municipal use and 250 acre-feet for industrial use) out of the 79,000 acre-feet of water for use in thirteen (13) counties in the Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces-Rio Grande Coastal Basin, Nueces River Basin, Guadalupe River Basin, and the San Antonio River Basin; and

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, contains a special condition authorizing LNRA the right to reclaim for use not to exceed 10,400 acre-feet of water per annum out of that 46,590 acre-feet of water for use within the Lavaca River Basin, Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, upon completion of the Stage 2 dam, LNRA is also authorized to impound 93,340 acre-feet of water in the Stage 2 reservoir on the Lavaca River, Lavaca River Basin, Jackson County and to divert and use not to exceed 48,122 acre-feet of water as follows:

A. 7,150 acre-feet of water per annum for municipal use and 22,850 acre-feet of water per annum for industrial use with a priority date of May 15, 1972, and

B. at least 18,122 acre-feet of water per annum shall be for the maintenance of the Lavaca-Matagorda Bay and Estuary System with a priority date of October 6, 1993; and

WHEREAS, releases for the bay and estuary system could impact the firm yield of Lake Texana (Stage 1) by reducing it by up to 4,500 acre-feet per year, from 79,000 acre-feet per year to 74,500 acre-feet per year; and

WHEREAS, the entire Stage 2 appropriation remains subject to release of water for the maintenance of the bay and estuary system until a release schedule is developed; and

WHEREAS, LNRA is also authorized to use all impounded waters for recreational use and construction and maintenance of the dams; and

WHEREAS, the applicant LNRA seeks authorization to divert an additional 7,500 acre-feet of water per annum from Lake Texana on an interruptible basis and an interbasin transfer authorization for the 7,500 acre-feet of water for multiple purposes (municipal and industrial use) from the Lavaca River Basin for use in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin; and

WHEREAS, no changes to the current bay and estuary release schedule are requested, and no other requests for amendments are being made in this application; and

WHEREAS, the additional 7,500 acre-feet of water for use on an interruptible basis will be junior in priority to existing water rights in the Lavaca River Basin; and

WHEREAS, this application is subject to the Texas Coastal Management Program (CMP) and must be consistent with the CMP goals and policies; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, no one protested the granting of this application; and

WHEREAS, the Commission finds that the detriments to the basin of origin during the proposed transfer period are less than the benefits to the receiving basin during the proposed transfer period; and

WHEREAS, the Commission finds that the applicant for the interbasin transfer has prepared a drought contingency plan and has developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant; and

WHEREAS, the Commission finds that this permit will not be detrimental to the public welfare; and

WHEREAS, the Executive Director recommends several special conditions for the protection of instream uses and senior water rights; and

WHEREAS, the Texas Commission on Environmental Quality finds that the issuance of the permit is consistent with the goals and policies of the Texas Coastal Management Program; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment; and

WHEREAS, the South Texas Watermaster has jurisdiction over this water right;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, as amended, designated as Certificate of Adjudication No. 16-2095D, is issued to the Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

In addition to the previous authorization, the owner is authorized to divert 7,500 acre-feet of water per annum from Lake Texana on an interruptible basis and an interbasin transfer authorization for the 7,500 acre-feet of water for multiple purposes (municipal and industrial use) from the Lavaca River Basin for use in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin.

2. DIVERSION

A. Location:

i. At a point on the west bank of the service spillway of the Stage 1 dam which is N69°W, 2850 feet from the northwest corner of the S.F. Austin Survey, Abstract 5, Jackson County, Texas.

ii. At a point on the east bank of the service spillway of the Stage 1 dam which is N61°W, 2500 feet from the northwest corner of the S.F. Austin Survey, Abstract 5, Jackson County, Texas.

B. Maximum combined diversion rate: 330 cfs (148,000 gpm).

3. CONSERVATION

A. Owner shall implement a water conservation plan that provides for the utilization of those practices, techniques and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

B. The owner shall develop minimum standards for content of water conservation plans for all of its customers. In order to achieve the stated goal for municipal water use, these plans shall identify each customer utility's technical potential for water conservation savings.

C. The owner shall provide technical assistance as necessary to ensure completion of all customers' conservation plans by 2007.

D. The owner shall update its conservation plan every five years in accordance with 30 TAC 288, beginning in 2007. Conservation goals for the five-year period shall include both a per-capita water use goal for the LNRA service area and strategies to achieve that goal that are consistent with the current, approved Regional and State Water Plans.

E. The owner shall as part of its ongoing public education program, provide to customers, local and regional news media, and TCEQ:

i. A progress report stating the goal(s) of the previous five years and quantitative measurements of conservation achieved, based on five years' water use data; and

ii. LNRA's conservation goals for the next five years.

F. The owner shall ensure that customers implement conservation-oriented water rates such as uniform or increasing-block rates, and/or seasonal rates, but not flat or decreasing-block rates through all contracts entered into or renewed following the approval of this amendment.

4. TIME PRIORITY

The time priority for this amendment is July 1, 2002.

5. SPECIAL CONDITIONS

A. The pass-through requirements for freshwater inflows to the Lavaca-Matagorda Bay and Estuary system shall be fully satisfied prior to diversion of the 7,500 acre-feet of water and are described as follows:

When 78.18% or more of the reservoir's capacity contains stored inflows, all inflows into the reservoir up to the historical monthly median flow during the months of January (84.5 cfs), February (142.4 cfs), March (86.8 cfs), July (126.5 cfs), November (68.3 cfs), and December (79.3 cfs), and all inflows up to the historical monthly average flow of the months of April (806.8 cfs), May (1,169.3 cfs), June (1,191.4 cfs), August (265.7 cfs), September (1,027.3 cfs), and October (708.3 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

B. The diversion of the additional 7,500 acre-feet of water and the previously authorized 4,500 acre-feet of water per annum on an interruptible basis shall be limited to those times that the lake level is at or above 43 feet msl.

C. The owner shall install and maintain a measuring device approved by the Commission that will be used to measure and account for the amount of water diverted from Lake Texana, and Owner shall allow representatives of the Texas Commission on Environmental Quality (South Texas Watermaster) reasonable access to the property in inspect the measuring device. If owner diverts water prior to installation of the referenced marker, this amendment shall expire and become null and void.

D. Prior to the diversion of water authorized herein, owner shall contact the South Texas Watermaster.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as specifically amended herein. The owner is still obligated to the condition that should the owner initiate plans of construction for Stage 2 reservoir or the diversion of water under Stage 2 appropriation, the Commission may consider a modified freshwater release schedule which may include an intermediate trigger for a more gradual reduction of freshwater releases from the Lake Texana project (Stage 1 and 2) for bay and estuary purposes.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment. All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY

Margaret Hoffman

For the Commission

Date issued: FEB 21 2003

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 16-2095E — TYPE §§ 11.122, 11.042

Owner:	Lavaca-Navidad River Authority	Address:	P.O. Box 429 Edna, Texas 77957
Filed:	July 7, 2015	Granted:	August 31, 2015
Purposes:	Agricultural, Industrial, Municipal, Domestic, Mining, and Recreational	County:	Aransas, Atascosa, Bee, Duval, Jim Wells, Jackson, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun, and Refugio
Watercourse:	Navidad River, tributary of Lavaca River, and Lavaca River	Watershed:	Guadalupe River Basin, Lavaca River Basin, Nueces River Basin, San Antonio River Basin, Colorado-Lavaca Coastal Basin, Lavaca-Guadalupe Coastal Basin, Nueces-Rio Grande Coastal Basin, and San Antonio-Nueces Coastal Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, authorize the Lavaca-Navidad River Authority, Owner, to impound 170,300 acre-feet of water in the Stage 1 reservoir (Lake Texana) on the Navidad River, tributary of the Lavaca River, Lavaca River Basin, in Jackson County, to divert and use not to exceed 79,000 acre-feet of water per year at a maximum combined diversion rate of 330 cfs (148,000 gpm) as follows:

A. 42,518 acre-feet of water per year for municipal purpose and 32,482 acre feet of water per year for industrial purpose with a priority date of May 15, 1972;

B. 4,000 acre-feet of water per year for municipal purpose with a priority date of May 24, 1982; and

WHEREAS, Owner is also authorized to transport not to exceed 46,590 acre-feet of water per year (46,340 acre-feet for municipal purposes and 250 acre-feet for industrial purposes) out of the 79,000 acre-feet of water for use in thirteen (13) counties in the Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces-Rio Grande Coastal Basin, Nueces River Basin, Guadalupe River Basin, and the San Antonio River Basin; and

WHEREAS, Owner is authorized the right to reclaim for use not to exceed 10,400 acre-feet of water out of that 46,590 acre-feet of water per year for use within the Lavaca River Basin, Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, upon completion of the Stage 2 dam, the Owner is also authorized to impound 93,340 acre-feet of water in the Stage 2 reservoir on the Lavaca River, Lavaca River Basin, Jackson County and to divert and use not to exceed 48,122 acre-feet of water as follows and subject to special conditions:

A. 7,150 acre-feet of water per year for municipal purpose and 22,850 acre-feet of water per year for industrial purpose with a priority date of May 15, 1972;

B. at least 18,122 acre-feet of water per year shall be for the maintenance of the Lavaca Matagorda Bay and Estuary System with a priority date of October 6, 1993; and

WHEREAS, Owner is also authorized to use all impounded waters for recreational purposes and construction and maintenance of the dams; and

WHEREAS, Owner is also authorized to divert and use an additional 7,500 acre-feet of interruptible water per year for municipal and industrial purposes in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin; and

WHEREAS, Owner seeks to add authorization to divert anywhere along the perimeter of Lake Texana (Stage 1 reservoir) located on the Navidad River, Lavaca River Basin; and

WHEREAS, Owner seeks to add municipal, industrial, agricultural, domestic, mining, and recreational purposes to the authorized 79,000 acre-foot portion of water; and

WHEREAS, Owner seeks modification to the Special Condition in Certificate No. 16-2095C to read "Owners shall have the right to cease transporting 10,400 acre-feet of the 46,590 acre-feet of water per annum referred to in paragraph 1.b. of Certificate of Adjudication No. 16-2095C and to use that water within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin"; and

WHEREAS, this application is subject to the Texas Coastal Management Program (CMP) and must be consistent with the CMP goals and policies; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, this amendment, if granted, is subject to requirements and orders of the South Texas Watermaster; and

WHEREAS, the Executive Director recommends that special conditions should be included in the amendment; and

WHEREAS, no requests for a contested case hearing were received for this application; and

WHEREAS, the Texas Commission on Environmental Quality finds that the issuance of this amendment is consistent with the goals and policies of the Texas CMP; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, designated Certificate of Adjudication No. 16-2095E, is issued to Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

In addition to the previous authorizations, Owner is also authorized to divert and use the authorized 79,000 acre-foot portion of water per year for municipal, industrial, agricultural, domestic, mining, and recreational purposes in its fifteen counties (Aransas, Atascosa, Bee, Duval, Jim Wells, Jackson, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun, and Refugio Counties).

2. DIVERSION

In addition to the previous authorizations, Owner is also authorized to divert from the perimeter of Lake Texana (Stage 1 reservoir) in Jackson County.

3. PRIORITY DATE

A. The time priority of 30,000 acre-feet from Stage 2 reservoir and 75,000 acre-feet from Stage 1 reservoir is May 15, 1972.

B. The time priority of 18,122 acre-feet from Stage 2 reservoir is October 6, 1993.

C. The time priority of 4,000 acre-feet from Stage 1 reservoir is May 24, 1982.

D. The time priority of 7,500 acre-feet from Stage 1 reservoir is July 1, 2002.

4. SPECIAL CONDITIONS

A. In lieu of the Special Condition described in Certificate of Adjudication No. 16-2095C, the Owner shall have the right to cease transporting up to 10,400 acre-feet of the 46,590 acre-feet of water per year referred to in Paragraph 1. USE b. of Certificate of Adjudication No. 16-2095C and to use that water within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin.

B. In order to minimize entrainment and impingement of aquatic organisms, the Owner shall utilize screens on any new diversion structures.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

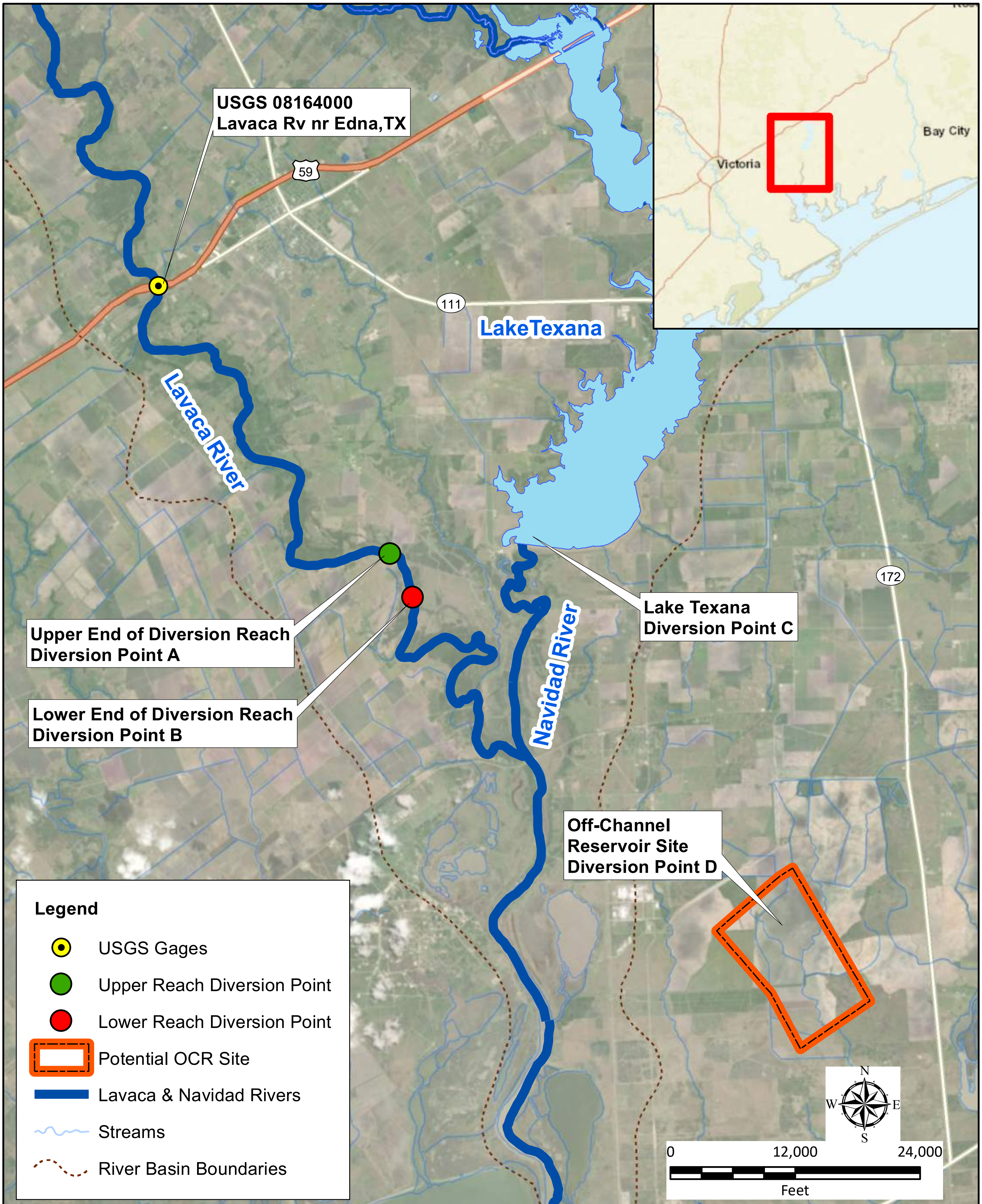
This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

For the Commission

ISSUED: August 31, 2015

APPENDIX 3A
Maps

Appendix 3A - Maps



FNI PROJECT NO. LVA18507 DATE CREATED Date: 12/3/2019 DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central FILE NAME Name: Figure_1-1 PREPARED BY DML	FREESE AND NICHOLS FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project **Location Map**	FIGURE 1

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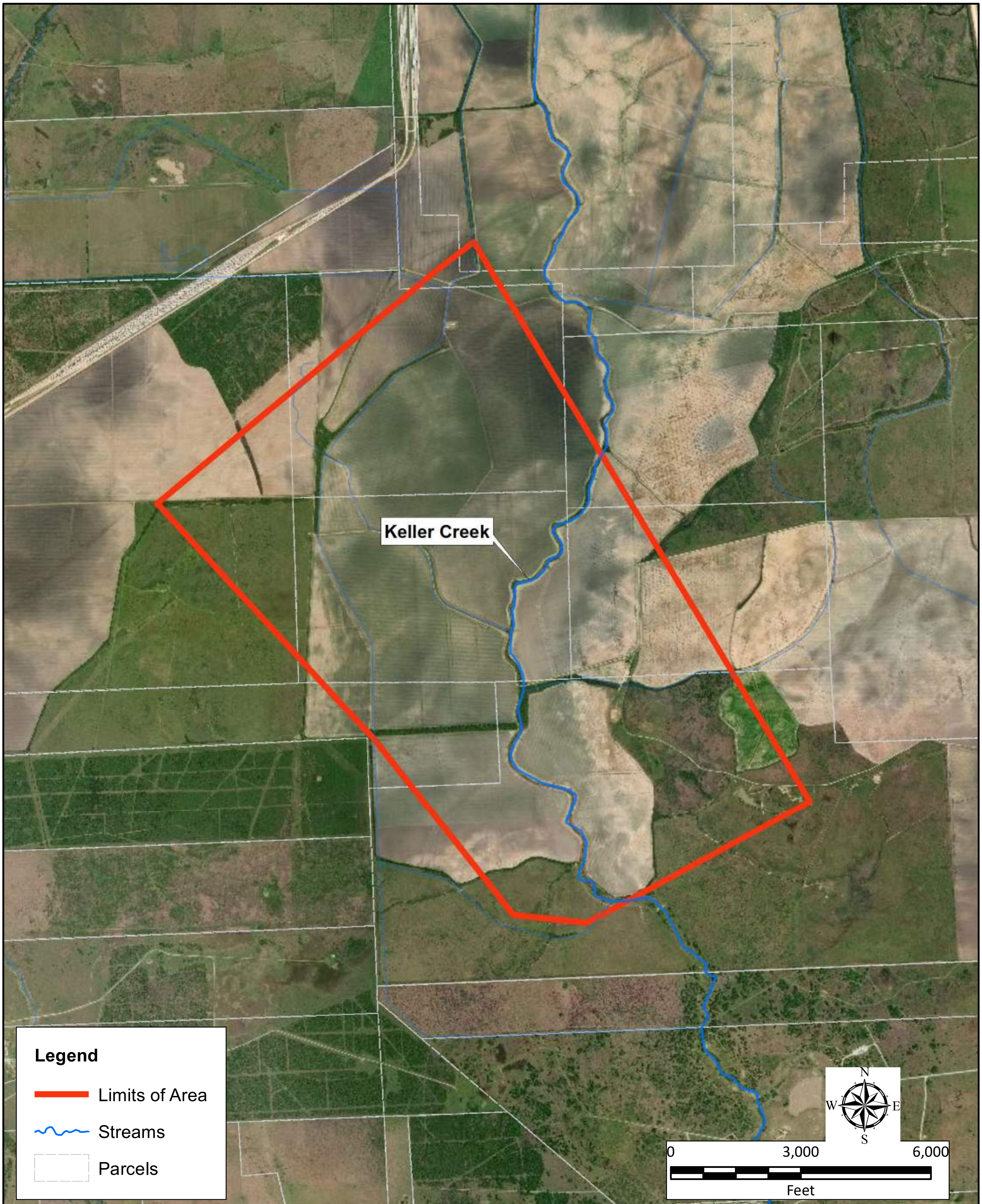
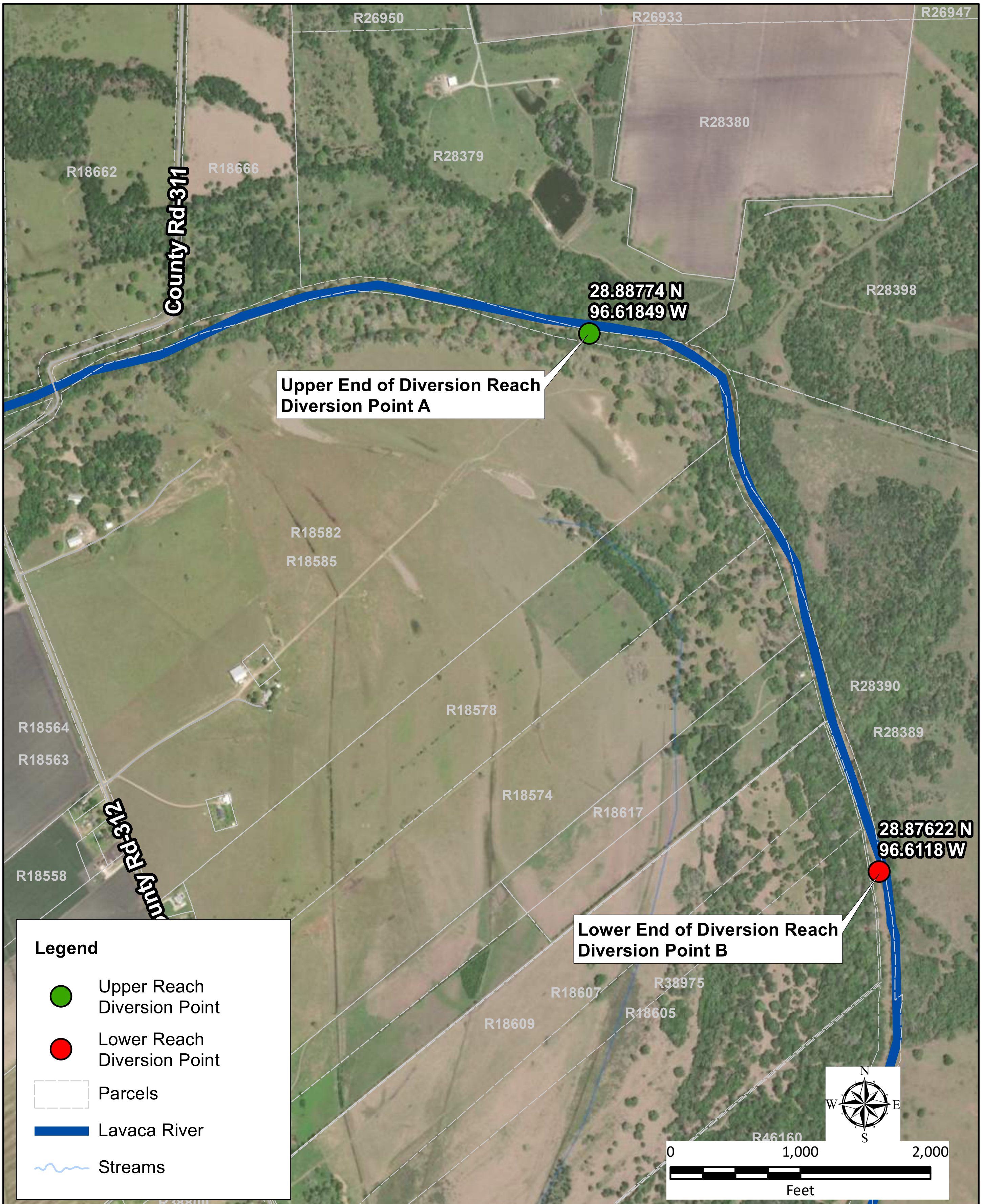


FN PROJECT NO. LVA18507	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE 2
DATE CREATED Date: 11/25/2019			
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central		**Off-Channel Reservoir Site**	
FILE NAME Name: Figure_2-1			
PREPARED BY DML			



FNI PROJECT NO. LVA18507	FREESE AND NICHOLS	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE 3
DATE CREATED Date: 12/3/2019	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	**Lavaca Diversion Reach**	
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central			
FILE NAME Name: Figure_2-2			
PREPARED BY DML			

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FNI PROJECT NO. LVA18507 DATE CREATED Date: 12/3/2019 DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central FILE NAME Name: Figure_2-3 PREPARED BY DML	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project **Perimeter of Lake Texana And Existing Diversion Points**	FIGURE 4

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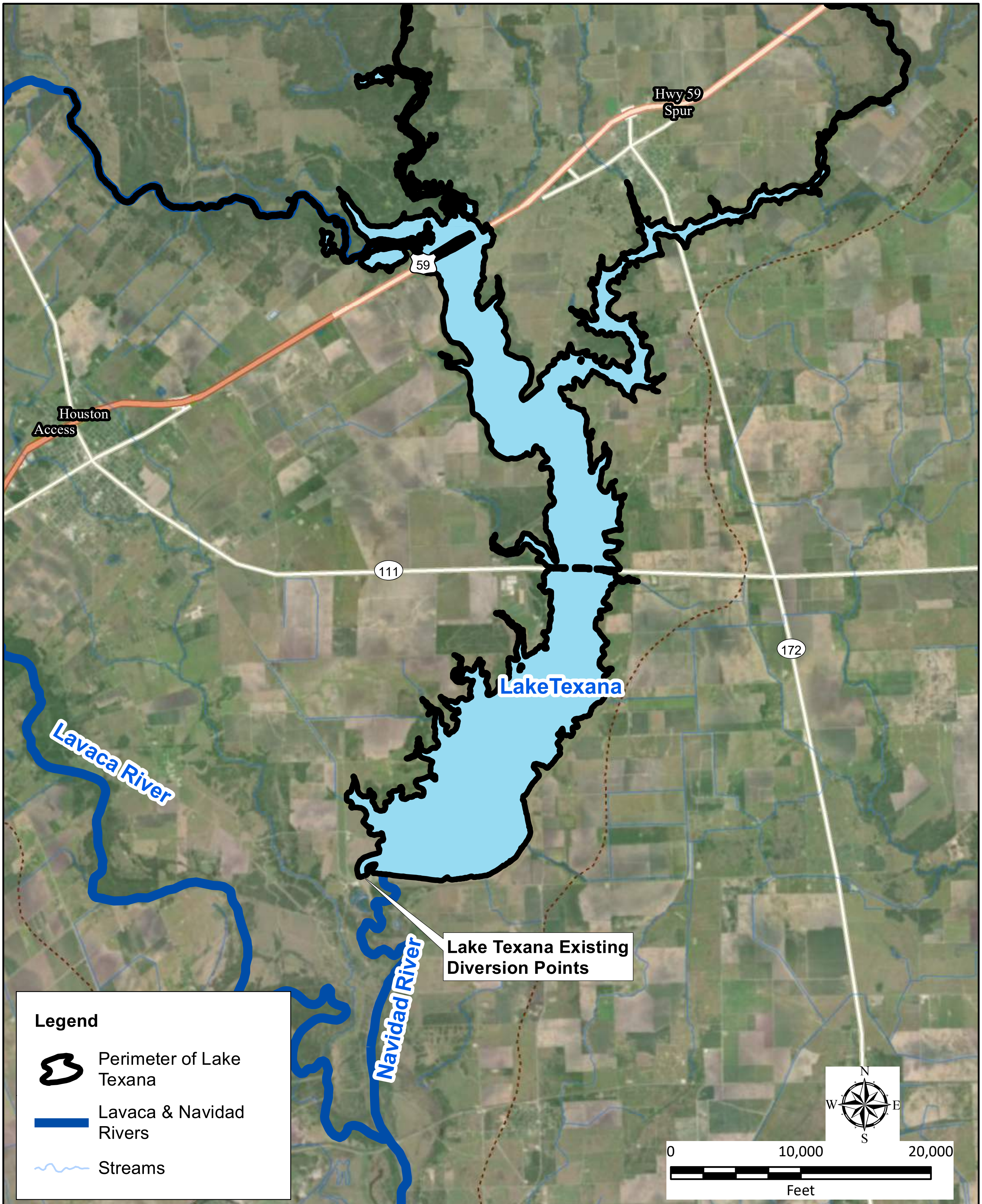

FNI PROJECT NO. LVA18507	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE 5
DATE CREATED Date: 12/3/2019		**Perimeter of Lake Texana (Diversion Point C)**	
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central			
FILE NAME Name: Figure_2-4			
PREPARED BY DML			

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APPENDIX 3B
Photographs

Appendix 3B-1 – Diversion Reach Photographs

Figure 1 – Field Reconnaissance Photos

Photo 1. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing downstream (approximately south).

Photo 2. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing upstream (approximately north).

Photo 3. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing left bank (approximately east).

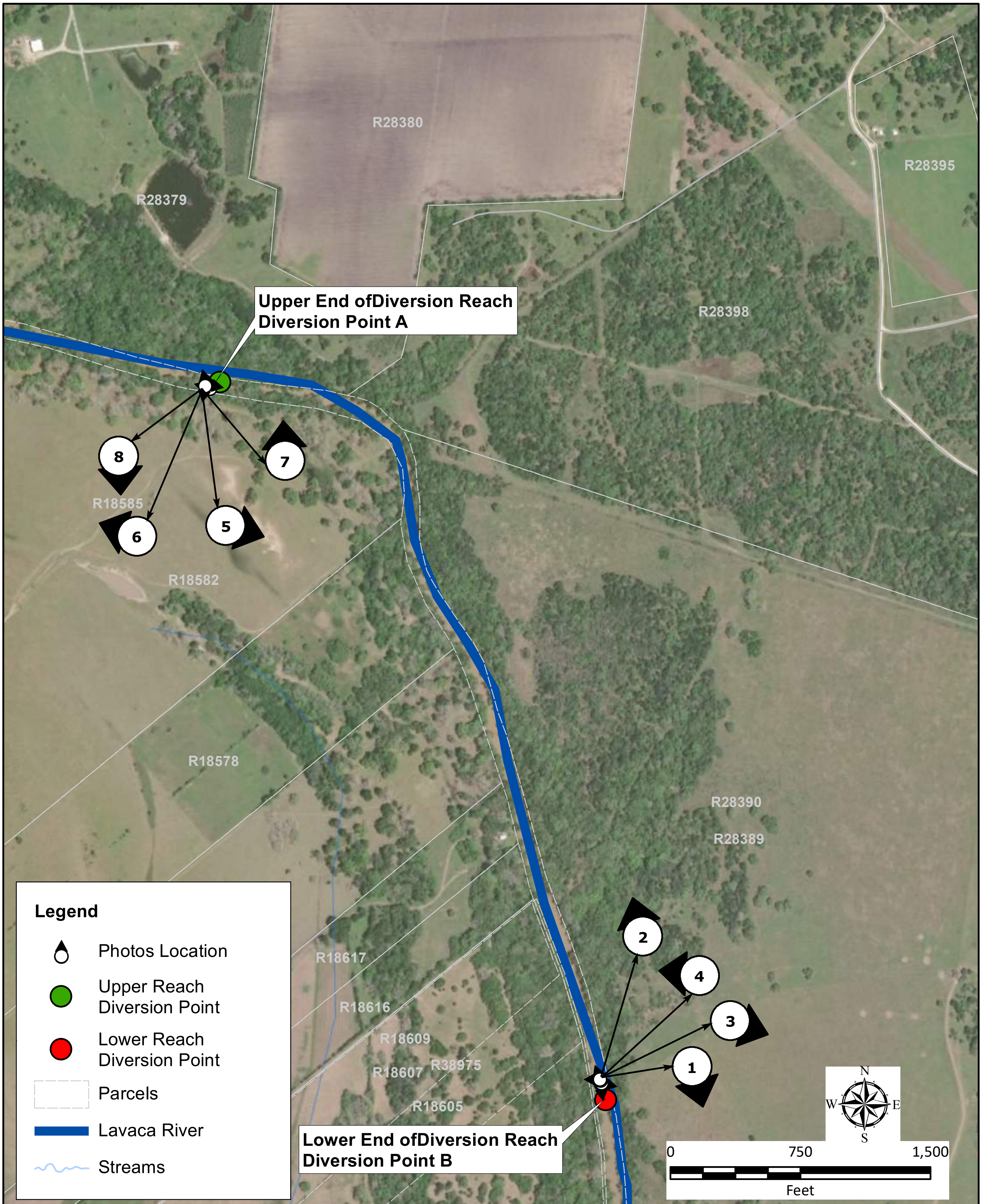
Photo 4. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing right bank (approximately west).

Photo 5. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing downstream (approximately east).

Photo 6. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing upstream (approximately west).

Photo 7. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing left bank (approximately north).

Photo 8. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing right bank (approximately south).



FNI PROJECT NO. LVA18507	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE 1
DATE CREATED Date: 12/3/2019			
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central		**Field Reconnaissance Photos**	
FILE NAME Name: Figure_A-x1			
PREPARED BY DML			

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Photo 1. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing downstream (approximately south).

Photo 2. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing upstream (approximately north).

Photo 3. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing left bank (approximately east).

Photo 4. Typical conditions of the downstream end of the proposed river reach (Diversion Point B) facing right bank (approximately west).

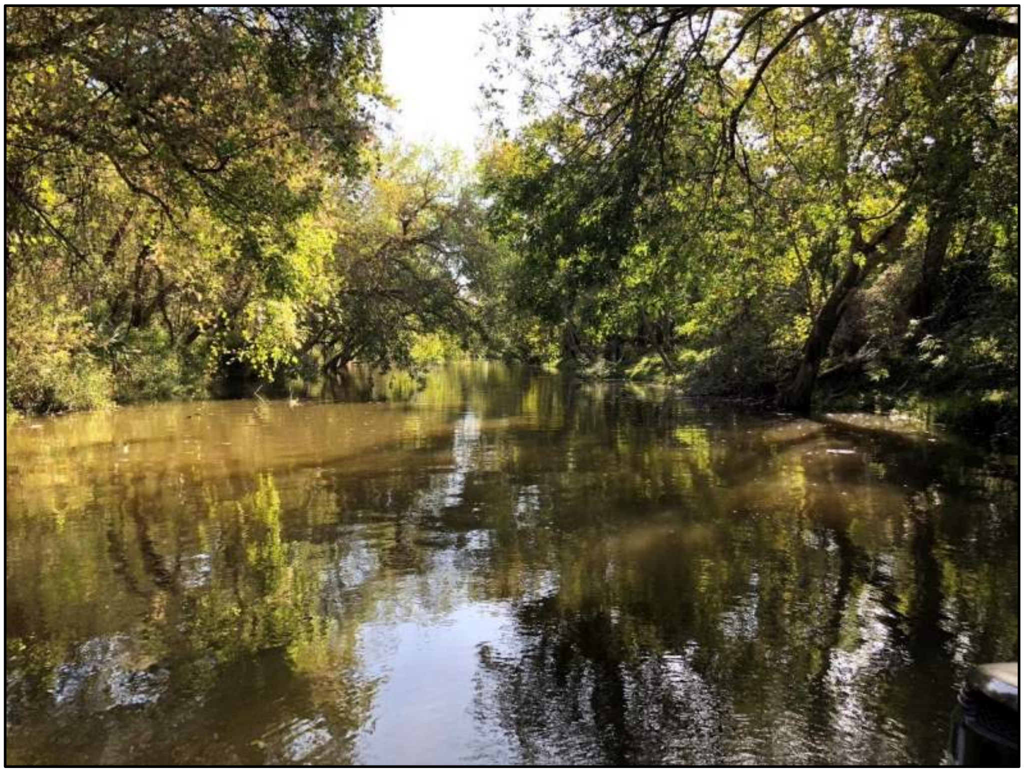


Photo 5. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing downstream (approximately east).

Photo 6. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing upstream (approximately west).

Photo 7. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing left bank (approximately north).

Photo 8. Typical conditions of the upstream end of the proposed river reach (Diversion Point A) facing right bank (approximately south).

Appendix 3B-2 – Off-Channel Reservoir (OCR) Site Photographs

Figure 2 Environmental Memorandum Photos

Photo 1: Typical row crop field (facing north) within proposed project area

Photo 2: Typical pasture (facing north) within proposed project area

Photo 3: Stream 1, Keller Creek, facing downstream

Photo 4: WET2 facing north.

Photo 5: Ditch 1 facing upstream.

Photo 6: Ditch 7 facing downstream.

Photo 7: Ditch 11 facing downstream.

Photo 8: Ditch 17 facing upstream.

Photo 9: Pond 1 facing north.

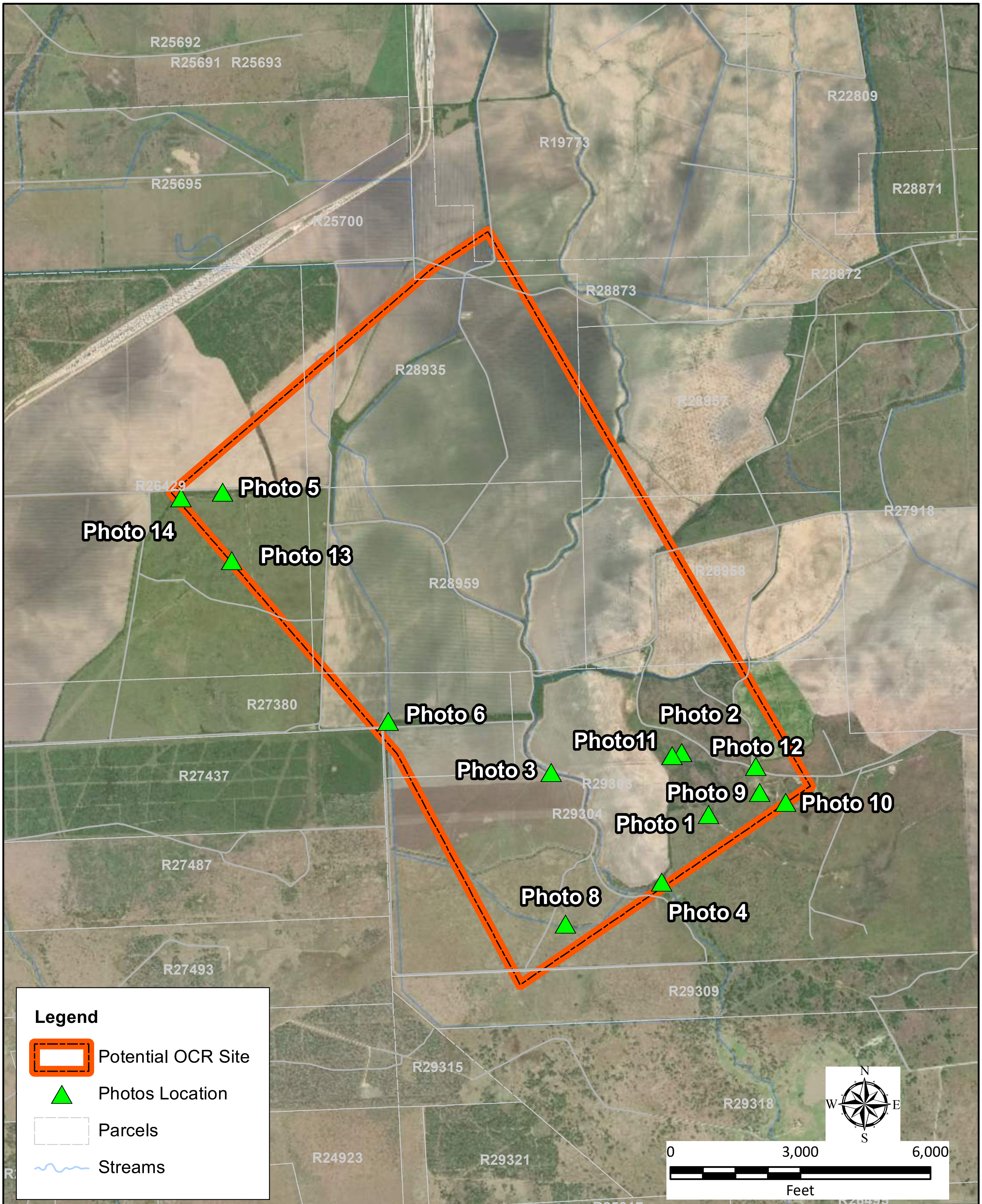
Photo 10: Pond 2 facing east.

Photo 11: Wet 3 facing north.

Photo 12: Wet 5 facing north. A good representation of a sedge meadow (*Cyperus spp.*).

Photo 13: Wet 17 facing east. A good representation of upland species encroachment.

Photo 14: Wet 21 facing east. A good representation of a linear wetland.



FNI PROJECT NO. LVA18507	FREESE AND NICHOLS, INC. 10497 TOWN AND COUNTRY WAY, SUITE 600 HOUSTON, TEXAS 77024 OFFICE: 713-600-6800 FAX: 713-600-6801	Lavaca Navidad River Authority Texana Yield Enhancement Project	FIGURE
DATE CREATED Date: 11/25/2019			
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central		**Environmental Memorandum Photos**	2
FILE NAME Name: Figure_A-x2			
PREPARED BY DML			

Date Saved: 11/25/2019 8:10:13 AM Path: H:\WR_PLANNING\Final_Exhibits\WaterRightsApplication\Figure_A-x2.mxd

Photo 1: Typical row crop field (facing north) within proposed project area

Photo 2: Typical pasture (facing north) within proposed project area

Photo 3: Stream 1, Keller Creek, facing downstream

Photo 4: WET2 facing north.

Photo 5: Ditch 1 facing upstream.

Photo 6: Ditch 7 facing downstream.

Photo 7: Ditch 11 facing downstream.

Photo 8: Ditch 17 facing upstream.

Photo 9: Pond 1 facing north.

Photo 10: Pond 2 facing east.

Photo 11: Wet 3 facing north.

Photo 12: Wet 5 facing north. A good representation of a sedge meadow (*Cyperus spp.*).

Photo 13: Wet 17 facing east. A good representation of upland species encroachment.

Photo 14: Wet 21 facing east. A good representation of a linear wetland.

APPENDIX 3C
Excerpts from the Lavaca and Region L Water Plans

Lavaca Regional Water Planning Area
Potential Management Strategies for Meeting Shortages

Strategy	**Lavaca River Off-Channel Reservoir**
Identified WUG/WWP	LNRA
Shortage Amount	Region L Manufacturing – 10,000 AF Other potential existing and future customers of LNRA within Region P
Supply Quantity	Project firm yield is 16,963 AFY. Project yield based on 25,000 acre-feet of off-channel storage and 200 MGD diversion capacity on the Lavaca River. New TCEQ environmental flow standards are met.
Water Source	Lavaca River
Quality	No change in treated water quality to end user
Reliability	100 percent
Cost ($/acre-foot)	Project cost is $177,485,000, with unit cost of $867. Capital costs taken from 2011 Study and updated to September 2013 $. TWDB Costing tool used to calculate other associated costs. Facilities would include approximately 25,000 acre-feet of off-channel storage, a 200 MGD raw water intake and pump station on the Lavaca River, a 10 MGD raw water delivery pump station at the off –channel reservoir, and associated pipelines and appurtenances to pump water from the Lavaca River and deliver to the East and West Pump Stations at Palmetto Bend Reservoir.

Environmental Impacts

Approximately 1,200 acres of agricultural land would be inundated to accommodate the 25,000 acre-feet of off-channel reservoir. However, the new reservoir would also provide some additional habitat to the area. A schedule for freshwater releases will be established during permitting of the project. New TCEQ environmental flow standards are met.

Impacts on other Water Resources of the State

Stress on the groundwater in the area would be reduced. The freshwater release schedule, to be established during permitting, will minimize impacts to other water resources.

Impacts on Threats to Agriculture and other Natural Resources of the State

The proposed off-channel reservoir scenarios would have a marginal impact on local agricultural activities. Siting of the project and inundation of the off-channel reservoir would remove approximately 1,200 acres of agricultural land from production but would have minimal influence given the large quantity of agricultural land in the area. The construction of an off-channel reservoir will provide wildlife habitat. See Chapter 1 for list of rare, threatened, and endangered species in the region.

Socioeconomic Impacts of not meeting Needs

See Costs above and Appendix 6A of Final Adopted 2016 Lavaca Regional Water Plan

5.1.3.1 Lavaca Off-Channel Reservoir

The Lavaca-Navidad River Authority (LNRA) has considered multiple scenarios for construction of new reservoir storage, including both on- and off-channel reservoirs. The *Lavaca River Water Supply Project Feasibility Study*, completed in 2011 by Freese & Nichols, Inc., compared a variety of these configuration options and recommended the most feasible scenarios for implementation including either the West Off-Channel Reservoir Project or the East Off-Channel Reservoir Project Alternative B. LNRA's Strategic Resource Management Plan (revised 2013) includes the development of an off-channel option as the preferred approach. A summary of the strategy is provided in this Plan. Additional details regarding the strategy scenarios can be found in the above-mentioned *Lavaca River Water Supply Project Feasibility Study*.

In both cases of the West Off-Channel and East Off-Channel B Reservoirs, the minimum facility requirements would include the storage reservoir and associated pump stations to deliver water from the river to the 25,000 acre-foot reservoir. Diversion points and conceptual level pipeline alignments are different in each scenario. Two pump stations are required for both off-channel alternatives, including a Lavaca River diversion pump station to divert flows and an off-channel reservoir pump station to deliver raw water to the existing LNRA East Delivery System pipeline.

The associated pump station would turn on when there is sufficient storage in the off-channel reservoir and when there is sufficient depth of water covering the inlet pipe. The amount of water pumped is limited primarily to flow conditions in the river and would likely be restricted to short-duration, high flow events. Thus the associated river pump would be required to pump at significantly high rates in order to capture flood flows. A diversion dam to increase the in-channel storage and optimize pumping opportunities is also considered in the scenarios in order to increase firm yield. A relatively small amount of in-channel storage could increase the project yield at minimal cost compared to the cost of increasing the size of the off-channel reservoir in order to store more water.

The West Off-Channel Reservoir project includes a diversion dam structure (North Diversion Dam) on the Lavaca River, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the West Off-Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the West Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

The East Off-Channel Reservoir Alternative B project utilizes an alternative diversion dam on the Lavaca River referred to as the South Diversion, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the East Off-Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the East Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

The site location for the recommended version of this strategy is the East Alternative B site. *Section 5.1.5.2*.describes the alternative version of the strategy, where the site location is identified as the West location.

Firm Yield

The firm yield of the Lavaca Off-Channel Reservoir project was analyzed, using an unmodified version of the TCEQ Lavaca River WAM Run 3, to have no negative impacts to the freshwater inflows to Lavaca Bay, as dictated by the latest TCEQ environmental flow standards, adopted August 2012. Additions and changes to the Base Lavaca WAM to create the strategy analysis are in *Appendix 5F*.

The firm yield of the reservoir was determined to be approximately 16,963 acre-feet/year. This firm yield would increase LNRA's supply as a wholesale water provider. A portion of the yield is identified to meet existing manufacturing water needs in Region L, Calhoun County. The remaining yield would be available to meet potential water needs for municipal, industrial, or other water users within the Lavaca Region, as needed. Water losses associated with evaporation from the reservoir are included in the modeling analysis. Water losses from the transmission pipeline are considered negligible.

Opinion of Probable Costs

Costs for the construction of the off-channel reservoir scenarios are provided in the attached Appendix. Costs assumed the more expensive East Off-Channel Alternative B, which is within approximately 10% of the cost of the West Off-Channel scenario. The costs were taken from the *Lavaca River Water Supply Project Feasibility Study,* and the costs were converted from December 2010 to September 2013. Actual costs could vary significantly due to project implementation requirements. Construction costs were estimated to be $123.2 million, with total capital costs being approximately $177.5 million. Annual costs were determined to be $14.7 million, with a unit cost of $867. The TWDB Costing Tool Cost Summary is provided in *Appendix 5D*.

Issues and Considerations

The off-channel reservoir alternatives minimize challenges to implementation as compared to the on-channel scenario. Water rights, land acquisition, and relocation of infrastructure are considerations in the feasibility of this strategy. The evaluation of this strategy assumes that a new water right permit would be obtained for the project. As such, the TCEQ-adopted, Senate Bill 3-developed environmental flow standards, effective August 30, 2012, would need to be met in order for TCEQ to approve the permit.

Environmental Impacts

The proposed off-channel reservoir scenarios would have substantially less impacts on valuable habitat than the considered on-channel reservoir option. In the off-channel scenarios, some habitat would be altered or lost as a result of temporary flooding and the area impacted would be smaller than that of the on-channel reservoir. The impact of the proposed off-channel reservoir scenarios appears to have minimal or no impact on threatened and endangered species.

Since the *Lavaca River Water Supply Project Feasibility Study (Study),* completed in 2011, the TCEQ has adopted new environmental flow standards that apply to new or amended water rights permits.

These standards were not included as part of the 2011 *Study* analysis, so a re-evaluation of the potential firm yield was completed using the new standards for the 2016 Lavaca Regional Water Plan.

The proposed location of the off-channel reservoir is such that it is downstream of all TCEQ adopted environmental flow standard instream flow measurement points along the Lavaca River. The only TCEQ standard that needs to be met is the Bay and Estuary Freshwater Inflow standards for the Lavaca Bay System. The Standards are identified in the table below. Projects requiring new water rights permits shall not cause or contribute to an impairment of the inflow regimes described below.

Table 5-1 Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay System

Inflow Regime	Spring Inflow Quantity (af)	Fall Inflow Quantity (af)	Intervening Inflow Quantity (af)	Annual Strategy Frequency
Subsistence	13,500	9,600	6,900	96%
Base Dry	55,080	39,168	28,152	82%
Base Average	127,980	91,080	65,412	46%
Base Wet	223,650	158,976	114,264	28%

af=acre feet

The Lavaca off-channel reservoir project was modeled so that the model incorporating the strategy either met or exceeded the required annual strategy frequency for each seasonal period; or if the Base Lavaca WAM did not meet the required annual strategy frequency, then the strategy model did not decrease it further. The frequency attainment results are shown below for the Base WAM and the Strategy WAM, respectively.

Table 5-2 Comparison of WAM Results for the Lavaca Off-Channel Reservoir

Base WAM Results

	Subsistence		Base Dry		Base Avg		Base Wet	
Onset Period	Count	%	Count	%	Count	%	Count	%
Springtime	51	89%	45	79%	38	67%	25	44%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	39	68%

Lavaca OCR Results

	Subsistence		Base Dry		Base Avg		Base Wet	
Onset Period	Count	%	Count	%	Count	%	Count	%
Springtime	51	89%	45	79%	37	65%	24	42%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	38	67%

As a result of developing a reservoir to capture and store flow from the river, up to 25,000 ac-ft/yr would be diverted to storage in any given year. Additionally, the new reservoir could provide up to 1,200 acres of new waterfowl habitat.

Impacts to Agriculture

The proposed off-channel reservoir scenarios would have a marginal impact on local agricultural activities. Siting of the project and inundation of the off-channel reservoir would remove approximately 1,200 acres of agricultural land from production but would have minimal influence given the large quantity of agricultural land in the area.

Impacts to Navigation

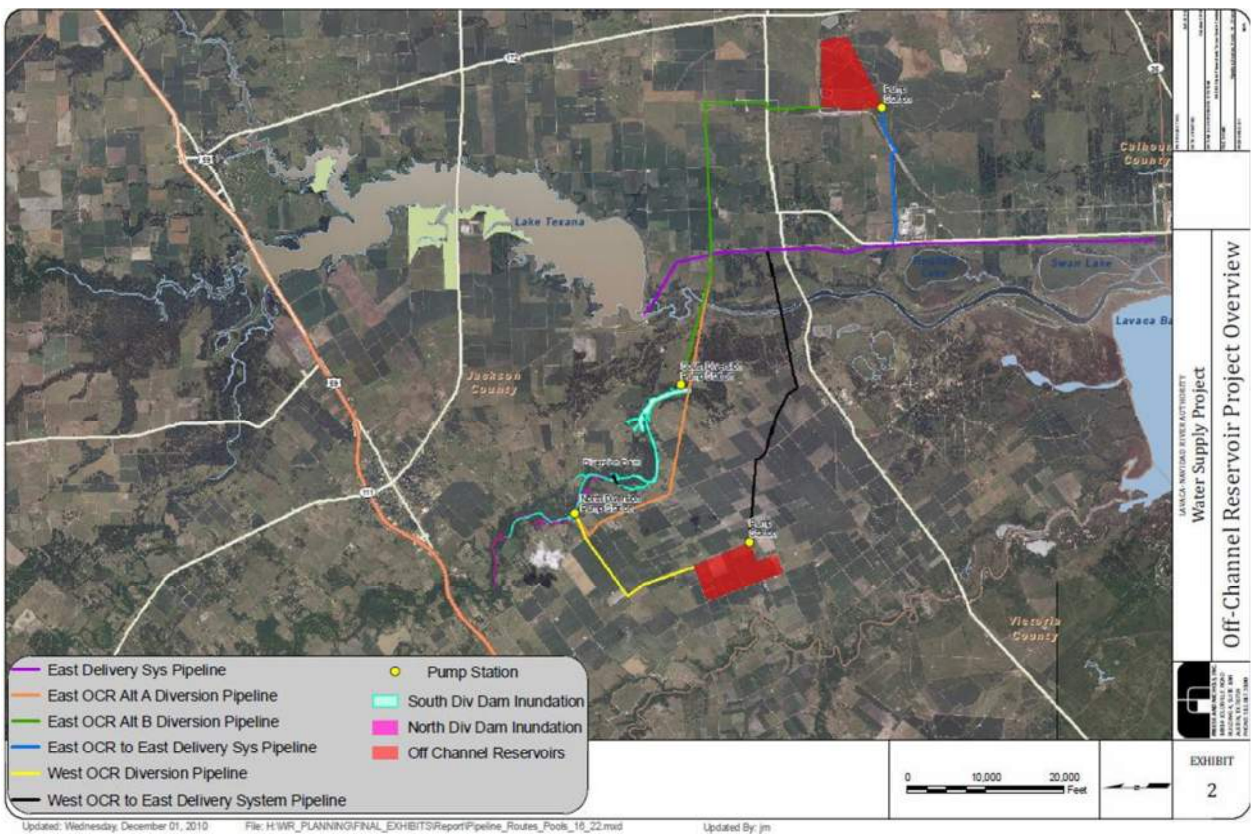
The proposed off-channel reservoir scenarios would have no impact on navigation. Any diversion dam structure would need to consider navigation impacts.

5.2.40 Lavaca River Off-Channel Reservoir

5.2.40.1 Description of Water Management Strategy

The Lavaca-Navidad River Authority (LNRA) has considered multiple scenarios for construction of new reservoir storage, including both on- and off-channel reservoirs. The Lavaca River Water Supply Project Feasibility Study, completed in 2011 by Freese & Nichols, Inc., compared a variety of these configuration options, as shown in Figure 5.2.40-1 below, and recommended the most feasible scenarios for implementation including either the West Off-Channel Reservoir Project or the East Off-Channel Reservoir Project Alternative B. LNRA's Strategic Resource Management Plan (revised 2013) includes the development of an off-channel option as the preferred approach. A summary of the strategy is provided in this Plan. Additional details regarding the strategy scenarios can be found in the above-mentioned Lavaca River Water Supply Project Feasibility Study.

Figure 5.2.40-1 Off-Channel Reservoir Project Overview



In both cases of the West Off-Channel and East Off-Channel B Reservoirs, the minimum facility requirements would include the storage reservoir and associated pump stations to deliver water from the river to the reservoir. Diversion points and conceptual level pipeline alignments are different in each scenario and shown in Figure 5.2.40-1 above. Two pump stations are required for both off-channel alternatives, including a Lavaca River diversion pump station to divert flows and an off-channel reservoir pump station to deliver raw water to the existing LNRA East Delivery System pipeline.

The associated pump station would turn on when there is sufficient storage in the off-channel reservoir and when there is sufficient depth of water covering the inlet pipe. The amount of water pumped is limited primarily to flow conditions in the river and would likely be restricted to short-duration, high flow events. Thus the associated river pump would be required to pump at significantly high rates in order to capture flood flows. A diversion dam to increase the in channel storage and optimize pumping opportunities is also considered in the scenarios in order to increase firm yield. A relatively small amount of in-channel storage could increase the project yield at minimal cost compared to the cost of increasing the size of the off-channel reservoir in order to store more water.

The West Off-Channel Reservoir project includes a diversion dam structure (North Diversion Dam) on the Lavaca River, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the West Off-Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the West Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

The East Off-Channel Reservoir Alternative B project utilizes an alternative diversion dam on the Lavaca River referred to as the South Diversion, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the East Off- Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the East Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

5.2.40.2 Available Yield

The firm yield of the Lavaca Off-Channel Reservoir project was analyzed, using an unmodified version of the Lavaca River WAM Run 3, to have no negative impacts to the freshwater inflows to Lavaca Bay, as dictated by the latest TCEQ environmental flow standards, adopted August 2012. Additions and changes to the Base Lavaca WAM to create the strategy analysis are in the Attachment.

The firm yield of the reservoir was determined to be approximately 16,963 ac-ft/yr. This firm yield would increase LNRA's supply as a wholesale water provider. 10,000 acft/yr of the yield is identified to meet existing manufacturing water needs in Region L, Calhoun County. The remaining yield would be available to meet potential water needs for municipal, industrial, or other water users in Region P (Jackson County), Region L, or Region N.

The proposed location of the off-channel reservoir is such that it is downstream of all TCEQ adopted environmental flow standard instream flow measurement points along the Lavaca River. The only TCEQ standard that needs to be met is the Bay and Estuary Freshwater Inflow standards for the Lavaca Bay System. The Standards are identified in Table 5.2.40-1. Projects requiring new water rights permits shall not cause or contribute to an impairment of the inflow regimes described below.

Table 5.2.40-1 Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay System

Inflow Regime	Spring Inflow Quantity (ac-ft)	Fall Inflow Quantity (ac-ft)	Intervening Inflow Quantity (ac-ft)	Annual Strategy Frequency
Subsistence	13,500	9,600	6,900	96%
Base Dry	55,080	39,168	28,152	82%
Base Average	127,980	91,080	65,412	46%
Base Wet	223,650	158,976	114,264	28%

The Lavaca off-channel reservoir project was modeled so that the model incorporating the strategy either met or exceeded the required annual strategy frequency for each seasonal period; or if the Base Lavaca WAM did not meet the required annual strategy frequency, then the strategy model did not decrease it further. The frequency attainment results are shown in Table 5.2.40-2 for the Base WAM and the Strategy WAM, respectively.

Table 5.2.40-2 Base WAM and Lavaca OCR Results

Onset Period	Subsistence		Base Dry		Base Avg.		Base Wet	
	Count	%	Count	%	Count	%	Count	%
Base WAM Results								
Springtime	51	89%	45	79%	38	67%	25	44%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	39	68%
Lavaca OCR Results								
Springtime	51	89%	45	79%	37	65%	24	42%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	38	67%

5.2.40.3 Environmental Issues

The Lavaca OCR project involves the building of an approximately 1,019 acre OCR about six miles southwest of Lake Texana in Jackson County. The purpose of this OCR is to store excess river water which is available during high flow events via an intake and pipeline from the Lavaca River. The stored water would then be transferred via a pipeline from the OCR to the existing LNRA East Delivery System pipeline to serve area needs and stabilize an otherwise interruptible water source.

The proposed Lavaca River OCR and associated pipeline routes are situated within the Western Gulf Coastal Plain Ecoregion, in an area designated as the Northern Humid Gulf Costal Prairies.[1] Deltaic sands, silts, and clays underlie much of this area, which occurs on a gently sloping coastal plain. The original vegetation within this region included primarily grasslands with a few clusters of oaks (*Quercus* spp.) or maritime woodlands. Historically dominant grassland species include little bluestem (*Schizachyrium scoparium*), yellow Indiangrass (*Sorghastrum nutans*), brownseed paspalum (*Paspalum plicatulum*), gulf muhly (*Muhlenbergia capillaris*), and switchgrass (*Panicum virgatum*). The majority of this region is currently utilized as cropland, rangeland, pasture, or urban land, with woodlands occurring only as remnant riparian strips.[2] Construction of the off-channel reservoir is planned within an area normally used for agriculture; however the pipeline and pump station construction may include the clearing and removal of some areas of riparian vegetation along the Lavaca River and areas southwest of Lake Texana. Therefore, the proposed off-channel reservoir would have a marginal impact on local agricultural activities. Siting of the project and inundation of the off-channel reservoir would remove approximately 1,200 acres of agricultural land from production, but would have minimal influence given the large quantity of agricultural land in the area.

The project also occurs within an area known as the Texan Biotic Province.[3] Mammals typical of this province include the Virginia opossum (*Didelphis virginiana*), fox squirrel (*Sciurus niger*), fulvous harvest mouse (*Reithrodontomys fulvescens*), and swamp rabbit (*Sylvilagus aquaticus*). Typical anuran species within this area include the Gulf Coast toad (*Bufo valliceps*), green treefrog (*Hyla cinerea*), bullfrog (*Rana catesbeiana),* and eastern narrowmouth toad (*Microhylla carolinensis*).

In addition, the Lavaca River location where the new diversion pipeline to the Lavaca River OCR originates is listed by the Texas Parks and Wildlife Department (TPWD) as occurring within an Ecologically Significant Stream Segment, a designation which signifies areas of unique ecological value.

Table 5.2.40-3 lists nine federally-listed endangered or threatened wildlife and plant species, 22 state-listed endangered and threatened wildlife and plant species, and additional state and federal species of concern that may occur in Jackson County. Information found within this table originates from the county lists of rare species provided by the TPWD online in their "Annotated County Lists of Rare Species."

Inclusion in Table 5.2.40-3 does not mean that a species will occur within the project area, but only acknowledges the potential of its occurrence in Jackson County. In addition to the county list, the TPWD Natural Diversity Database (NDD) was reviewed for known occurrences of listed species within or near the project area.

Listed species may have habitat requirements or preferences that suggest they could be present within the project area. However, the presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report. Surveys for protected species

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[1] Griffith, G.E., Bryce, S.A., Omernik, J.M., Comstock, J.A., Rogers, A.C., Harrison, B., Hatch, S.L., and Bezanson, D., 2004, Ecoregions of Texas (color poster with map, descriptive text, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:2,3000,000).
[2] Gould, F. W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[3] Blair, W. Frank, "The Biotic Provinces of Texas," Texas Journal of Science 2(1):93-117, 1950.

should be conducted within the proposed construction corridors where preliminary evidence reveals preferred habitat or indicates their potential presence.

Table 5.2.40-3 Endangered, Threatened, and Species of Concern for Jackson County

Common Name	***Scientific Name***	***Summary of Habitat Preference***	***Listing Entity***		***Potential Occurrence in County***
			USFWS	***TPWD***	
Birds					
Peregrine Falcon	*Falco peregrinus*	Two subspecies, listing statuses differ; see *anatum* and *tundrius* descriptions below.	DL	T	Possible Migrant
American Peregrine Falcon	*Falco peregrinus anatum*	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucoephalus*	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Brown pelican	*Pelecanus occidentalis*	*Largely coastal and near shore areas.*	DL		Resident
Henslow's Sparrow	*Ammodramus henslowii*	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Reddish Egret	*Egretta rufescens*	Resident of Texas Gulf coast.		T	Resident
Snowy Plover	*Charadrius alexandrines*	Potential migrant, winters along coast			Migrant
Sooty Tern	*Sterna fuscata*	Usually flies or hovers over water.		T	Resident
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	Wintering migrant along the Texas Gulf Coast.			Migrant
Sprague's Pipit	*Anthus spragueii*	Migrant found in Texas only during winter. Strongly tied to native upland prairie, locally common in coastal grasslands.	C		Possible Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	Open grasslands, especially prairie, plains and savanna			Resident
White-faced Ibis	*Plegadis chihi*	Prefers freshwater marshes.		T	Resident
White-tailed hawk	*Buteo albicaudatus*	Found near the coast on prairies, cordgrass flats, and scrub-live oak.		T	Resident
Whooping Crane	*Grus americana*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria Americana*	Forages in prairie ponds, ditches, and shallow standing water, formerly nested in TX.		T	Migrant
Fishes					

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
			USFWS	TPWD	
American eel	*Anguilla rostrata*	Coastal waterways below reservoirs to gulf.			Resident
Smalltooth sawfish	*Pristis pectinata*	Young found very close to shore in muddy and sandy bottoms, adults occur in various habitat types.	LE	E	Resident
Mammals					
Louisiana black bear	*Ursus americanus luteolus*	Possible transient; bottomland hardwoods and forested areas.	LT	T	Possible Transient
Plains spotted skunk	*Spilogale putorius interrupta*	Found in open fields, prairies and croplands.			Resident
Red wolf	*Canis rufus*	Extirpated species formerly known throughout the eastern half of Texas.	LE	E	Extirpated
West Indian manatee	*Trichechus manatus*	Aquatic herbivore found in the gulf and bay system	LE	E	Possible Migrant
Mollusks					
Texas fatmucket	*Lampsilis bracteata*	Found in streams and rivers on sand, mud, and gravel substrates in the Colorado and Guadalupe river basins; intolerant of impoundments.	C	T	Resident
Reptiles					
Green sea turtle	*Chelonia mydas*	Gulf and bay systems.	LT	T	Resident
Gulf saltmarsh snake	*Nerodia clarkia*	Found on saline flats.			Resident
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Found in gulf and bay systems.	LE	E	Resident
Loggerhead sea turtle	*Caretta caretta*	Gulf and bay systems for juveniles, ocean for adults.	LT	T	Resident
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	Found in coastal marshes and tidal flats.			Resident
Texas horned lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands.		T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	Mixed hardwood scrub on sandy soils.		T	Resident
Texas tortoise	*Gopherus berlandieri*	Open brush w/ grass understory.		T	Resident
Timber/Canebrake rattlesnake	*Crotalus horridus*	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident
Plants					
Shinner's sunflower	*Helianthus occidentalis ssp. Plantagineus*	Found on prairies on the Coastal Plain			Resident
Threeflower broomweed	*Thurovia triflora*	Endemic: near coast.			Resident
Welder machaeranthera	*Psilactis heterocarpa*	Texas endemic found on grasslands.			Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
E, T=State Listed Endangered/Threatened

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
			USFWS	TPWD	
Blank = Considered rare, but no regulatory listing status					
Source: TPWD, Annotated County List of Rare Species, Jackson County (updated 6/1/2012).					

The Migratory Bird Treaty Act protects most bird species, including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds. Migratory bird pathways, stopover habitats, wintering areas, and breeding areas may occur within and adjacent to the project area, and may be associated with wetlands, ponds, shorelines, riparian corridors, fallow fields and grasslands areas. Although construction of the proposed off-channel reservoir could remove some habitats utilized by certain migratory bird species, it would create additional habitats for others.

Two bird species federally or state listed as endangered are included in the project area county. These include the interior least tern (*Sterna antillarum athalassos*), and whooping crane (*Grus americana*). The interior least tern and whooping crane are seasonal migrants which could pass through the project area. The interior least tern typically nests on bare or sparsely vegetated areas associated with streams or lakes, such as sand and gravel bars, beaches, islands, and salt flats. The main whooping crane flock nests in Canada and migrates annually to their wintering grounds in and around the Aransas National Wildlife Refuge near Rockport on the Texas coast. Whooping cranes occasionally utilize wetlands as an incidental rest stop during this migration.

Avian species listed by the State of Texas as threatened include the peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), reddish egret (*Egretta rufescens*), sooty tern (*Sterna fuscata*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), and wood stork (*Mycteria Americana*). The reddish egret, sooty tern and white-faced ibis are resident bird species within the project area. The peregrine falcon, bald eagle, snowy plover, southeastern snowy plover, and wood stork are migratory species which may occur infrequently within the project area. The peregrine falcon includes two subspecies which migrate across the state from more northern breeding areas in the U.S. and Canada to winter along the coast. The majority of nesting bald eagle pairs currently reported are found along major rivers and near reservoirs in Texas. Bald eagles are opportunistic predators, feeding primarily on fish captured in the shallow water of both lakes and streams or scavenged food sources. These birds may utilize tall trees near perennial water as roosting or nesting sites. Bald eagles are documented by the NDD in areas near Lake Texana.

Many of the listed species found within the project area, such as the Texas Tortoise (*Gopherus berlandieri*), Texas scarlet snake (*Cemophora coccinea lineri*), and timber/canebrake rattlesnake (*Crotalus horridus* are dependent on shrubland or riparian habitats which should be avoided wherever possible. The NDD indicates that the Texas diamondback terrapin (*Malaclemys terrapin littoralis)* has been documented near the mouth of the Lavaca River where it empties into the Lavaca Bay. This reptilian species of concern prefers a habitat which consists of coastal marshes and tidal flats.

Destruction of potential habitat has been minimized by the selection of an OCR project area which lies within previously disturbed areas of cropland. No designated critical habitat areas occur within the project area.[4] Care should be taken to ensure minimum impacts from construction to the existing riparian and wetland areas located along the Lavaca River and below Lake Texana. It is not anticipated that this project will have any permanent adverse effect on any state or federally listed threatened or endangered species or their designated critical habitat.

Habitat studies and surveys for protected species and cultural resources may need to be conducted at the proposed off channel site, and along the pipeline routes. Specific project features, such as pipelines, and off-channel reservoirs generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites. Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operation on sensitive resources.

Potential wetland impacts are expected to primarily include the raw water pipeline crossing of the Lavaca River and wetland areas which occur south of Lake Texana. These impacts can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are four small cemeteries and two historical markers which occur within or near the area proposed for the construction of the pipeline routes between the OCR and Lake Texana. Avoidance of these areas should be possible through appropriate siting of the project pipelines.

[4] USFWS. Critical Habitat Portal. Accessed online at http://ecos.fws.gov/crithab/ on January 15, 2014.

5.2.40.4 Engineering and Costing

Costs for the construction of the off-channel reservoir scenarios are provided in Table 5.2.40-4 Costs assumed the more expensive East Off-Channel Alternative B, which is within approximately 10% of the cost of the West Off-Channel scenario. The costs were taken from the Lavaca River Water Supply Project Feasibility Study, and the costs were converted from December 2010 to September 2013. Actual costs could vary significantly due to project implementation requirements. The costs do not include water treatment or raw water purchase.

Table 5.2.40-4 Cost Estimate Summary for Lavaca OCR

Item	***Estimated Costs for Facilities***
CAPITAL COST	
Dam and Reservoir (Conservation Pool acft, acres)	$63,002,000
Pump Stations	$21,454,000
Parallel pipe from Alice to Ben Bolt	$2,928,000
Transmission Pipeline (18 in dia., 2 miles)	$35,829,000
TOTAL COST OF FACILITIES	**$123,213,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$41,470,000
Environmental & Archaeology Studies and Mitigation	$3,523,000
Land Acquisition and Surveying (0 acres)	$3,276,000
Interest During Construction (4% for 1 years with a 1% ROI)	$6,003,000
TOTAL COST OF PROJECT	**$186,564,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$6,918,000
Reservoir Debt Service (5.5 percent, 40 years)	$5,909,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$867,000
Dam and Reservoir (1.5% of Cost of Facilities)	$945,000
Pumping Energy Costs (727,187 kW-hr @ 0.09 $/kW-hr)	$65,000
TOTAL ANNUAL COST	**$14,704,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	16,963
Annual Cost of Water ($ per acft)	$867
Annual Cost of Water ($ per 1,000 gallons)	$2.66

5.2.40.5 Implementation Issues

The off-channel reservoir alternatives minimize challenges to implementation as compared to the on-channel scenario. Water rights, land acquisition, and relocation of infrastructure are considerations in the feasibility of this strategy. The evaluation of this strategy assumes that a new water right permit would be obtained for the project. As such, the TCEQ-adopted, Senate Bill 3-developed environmental flow standards, effective August 30, 2012, would need to be met in order for TCEQ to approve the permit.

Water Rights and Permit Modification

Under Certificates of Adjudication No. 16-2095, 16-2095A, 16-2095B, 16-2095C, and 16-2095D, LNRA is authorized to impound and divert water in the Lavaca and Navidad River basins for municipal, industrial, and recreational uses. These permits allow the use of water from two separate reservoirs, one on the Navidad River (existing Palmetto Bend Dam/Lake Texana) and one on the Lavaca River (proposed Palmetto Bend Stage II).

LNRA is authorized to impound up to 170,300 acft of water in Lake Texana on the Navidad River and an additional 93,340 acft in the proposed Palmetto Bend Stage II reservoir on the Lavaca River. LNRA is authorized to divert and use up to 79,000 acft from Lake Texana for municipal and industrial uses and an additional 36,000 acft (not including bay and estuary maintenance flows) from Palmetto Bend Stage II reservoir for municipal and industrial uses. Diversions are currently limited by location to two points on Lake Texana (East and West Delivery System Pump Stations) and by rate to up to 330 cfs total from Lake Texana. The impoundment and diversions of water each have a priority date of May 15, 1972.

In addition to the permit limitations specified above, the impoundment and diversion of water from Lake Texana is further subject to a bay and estuary release schedule. Inflows into Lake Texana are subject to release from Lake Texana as a function of both reservoir capacity and season. The existing permits further specify that prior to commencement of construction of Palmetto Bend Stage II reservoir, or any diversion of water from Stage II reservoir, upon the joint recommendation of LNRA, TWDB, and Texas Parks and Wildlife Department (TPWD), LNRA shall submit an application to the TCEQ to establish a schedule for the release of freshwater inflows from Stage II reservoir. In establishing the Stage II release schedule, the TCEQ may consider the modification to the Lake Texana release schedule. LNRA shall retain the right to withdraw its application at any time prior to any final decision by the TCEQ and upon withdrawal; the Lake Texana release schedule shall remain unchanged.

The existing water rights permits for Lake Texana and Stage II reservoirs would need to be modified to incorporate changes associated with the proposed Lavaca River Off-Channel Reservoir project. These modifications may include an additional diversion point on the Lavaca River, the impoundment of water in an off-channel reservoir as opposed to the currently permitted on-channel Stage II reservoir, likely changes in the amounts and distribution currently permitted for industrial and municipal uses, potential addition of agricultural use, and a proposed bay and estuary (i.e., pass through) schedule for the proposed Lavaca River Off-Channel Reservoir project.

It should be noted that these changes in conditions to the existing permit would likely require a major permit modification and require public notification. In addition, it should also be noted that any of these permit modifications, and specifically the required bay and estuary release schedule, could potentially reduce the project yield from the existing Lake Texana and/or the proposed Lavaca River Off-Channel Reservoir project.

APPENDIX 3D
Water Availability Analysis

MEMORANDUM

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TO: File

CC:

FROM: Jon S. Albright

SUBJECT: Water Availability Modeling for LTYEP

DATE: 3/19/2020

PROJECT: LVA18507

Introduction

This memorandum describes the water availability analysis for the proposed Lake Texana Yield Enhancement Project (LTYEP). The modeling includes three scenarios:

- A Baseline scenario which includes existing permanent water rights, including the authorized but not built Stage 2 reservoir at the location specified in Certificate of Adjudication 16-2095 (CoA 16-2095), as amended,
- Phase I which adds diversions from the Lavaca River stored in Lake Texana and removes the Stage 2 modeling, and
- Phase II which includes storage of diversions from the Lavaca River in a 50,000 acre-foot Off-Channel Reservoir (OCR) and Lake Texana.

The Phase I and Phase II models were used to determine the additional yield made available by the LTYEP. The Baseline scenario was used as a comparison point for the Phase I and Phase II scenarios for achievement of adopted Bay and Estuary freshwater inflow standards.

The modeling uses a version of the Lavaca Water Availability Model (Lavaca WAM) full authorization scenario with proposed changes to the Lake Texana and Stage 2 modeling described in the March 29, 2016 Memorandum to Kathy Alexander, TCEQ *Proposed Revisions to Lavaca and Lavaca-Guadalupe WAMs*. The latest modeling takes an alternative approach to modeling the adopted environmental flow standards that directly uses the modeled storage in Lake Texana and uses new instream flow modeling capabilities recently incorporated into WRAP. The specific modifications are included in **Attachment A** of this memorandum.

The model does not include the overdraft in lieu of pumping because the overdraft is a one to one exchange between Lavaca and Navidad water.

Water Availability Analysis

The Phase I model models the LTYEP using these steps:

1. Determine the available flow at the Lavaca near Edna gage, which is the proposed measurement point for environmental flows for the LTYEP project.

2. Divert 200 MGD from the proposed diversion reach, limited to the available flow at the Edna gage. This gives a conservative estimate of available flows at the project site because it ignores intervening flow between the measurement point and the diversion site.
3. Divert the additional yield from Lake Texana using the diverted water plus previously stored water. The additional yield comes from both the Lavaca River diversions and unused storage in Lake Texana. (The Baseline model has unused storage at the end of the critical drought, which partially contributes to the additional yield available from the project.)
4. Fill empty storage in Lake Texana with the diverted flows not used for the additional yield.
5. Return unused Lavaca River diversions to the river at the diversion point.

Phase II is similar, but it adds the OCR. The Phase II model uses the following steps:

1. Determine the available flow at the Lavaca near Edna gage, which is the proposed measurement point for environmental flows for the LTYEP project.
2. Divert 200 MGD from the proposed diversion reach, limited to the available flow at the Edna gage. This gives a conservative estimate of available flows at the project site since it ignores intervening flows between the measurement point and the diversion point.
3. Divert the additional yield from the OCR using the diverted water and water previously stored in the OCR. Fill empty storage in the OCR with unused Lavaca River diversions.
4. Fill Lake Texana storage with any Lavaca River diversions not used at the OCR.
5. Back up shortages from the OCR diversions from Lake Texana.
6. Return unused Lavaca River diversions to the river at the diversion point.

Table 1 shows the firm yield and the maximum diversion from the Lavaca River for each scenario.

Table 1: Yield Analysis

Scenario	Firm Yield (ac-ft/yr)	Maximum Diversion from Lavaca River (ac-ft/yr)
Phase I Store in Texana	23,500	78,318
Phase II OCR and Store in Texana	30,600	96,022

Table 2 compares the annual depletions from the Lavaca River for the Baseline (current water rights), to Phase I and Phase II of the LTYEP. The Baseline depletions are the Stage 2 reservoir depletions for water use and filling storage. They do not include the 18,122 acre-feet per year bay and estuary diversion, which is returned to the river. The Phase I and Phase II depletions are only for the LTYEP. In most years the depletions from the Lavaca River made by the LTYEP are less than the depletions for Stage 2.

Table 2: Comparison of Annual Depletions from the Lavaca River

(Values in acre-feet per year)

Year	Stage 2 Depletions	Phase I Depletions	Phase II Depletions
1940	46,664	24,315	34,413
1941	41,112	21,865	28,930
1942	39,679	33,895	41,548
1943	49,815	25,842	29,779
1944	44,808	25,383	37,367
1945	32,554	12,694	20,719
1946	53,830	40,427	53,743
1947	29,021	29,036	30,393
1948	46,453	29,881	30,135
1949	66,970	28,828	47,855
1950	24,218	6,228	8,732
1951	36,641	19,306	19,306
1952	86,627	45,872	55,351
1953	45,208	25,065	38,725
1954	11,694	4,896	5,378
1955	79,414	46,968	46,968
1956	4,102	972	972
1957	98,479	47,709	96,022
1958	39,107	27,221	35,093
1959	42,166	38,033	51,301
1960	38,791	23,469	31,046
1961	44,903	24,304	33,080
1962	45,101	42,880	42,880
1963	24,429	13,418	14,465
1964	54,073	30,881	30,881
1965	60,850	31,450	91,869
1966	31,727	15,857	18,612
1967	56,221	30,025	45,385
1968	39,248	29,572	38,990
1969	43,910	24,019	28,920
1970	42,164	29,040	46,713
1971	49,440	31,345	41,646
1972	41,572	21,210	24,398
1973	42,474	36,789	49,676
1974	42,806	48,443	47,617
1975	41,092	32,106	35,961
1976	34,324	78,318	81,143
1977	43,673	36,197	37,135
1978	45,327	23,925	50,411
1979	42,584	35,011	43,024

Table 2 (continued)

Year	Stage 2 Depletions	Phase I Depletions	Phase II Depletions
1980	29,362	16,587	22,348
1981	57,834	34,250	52,724
1982	48,237	27,046	39,071
1983	43,768	38,708	46,470
1984	49,767	11,558	9,324
1985	42,036	42,955	65,592
1986	40,218	23,106	33,749
1987	40,662	23,373	28,591
1988	26,029	7,364	7,364
1989	34,080	10,160	8,407
1990	26,362	12,847	12,842
1991	87,761	46,041	74,563
1992	44,516	23,321	41,762
1993	41,290	16,557	26,664
1994	58,349	28,730	47,022
1995	36,251	38,624	40,813
1996	51,334	28,882	27,494
Average	44,581	28,119	37,393
Min	4,102	972	972
Max	98,479	78,318	96,022

Table 3 shows the adopted Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay system. The flow quantities in this table are the sum of the flows from the Lavaca River, which is modeled by the Lavaca WAM, and Garcitas Creek, which is modeled in the Lavaca-Guadalupe WAM. The Spring Inflow Quantity is the maximum flow from the Lavaca River and Garcitas Creek that occurs during any period of three consecutive months beginning in February, March, April, or May. In other words, the modeled flows are summed over the months of February through April, March through May, April through June, and May through July. The maximum volume of flow from these four windows is the Spring Inflow Quantity for that year. Similarly, the Fall Inflow Quantity is the maximum three-month sum over any period of three consecutive months beginning in August, September, or October. The Intervening Inflow Quantity is the sum of flows for the remaining six months that were not included in the Fall Inflow or Spring Inflow Quantities for that year.

Table 3: Bay and Estuary Freshwater Inflow Criteria

Inflow Regime	Goal Attainment Frequency	Spring Inflow Quantity (ac-ft)	Fall Inflow Quantity (ac-ft)	Intervening Inflow Quantity (ac-ft)
Subsistence	96%	13,500	9,600	6,900
Base Dry	82%	55,080	39,168	28,152
Base Average	46%	127,980	91,080	65,412
Base Wet	28%	223,650	158,976	114,264

Table 4 is a comparison of the modeled Bay and Estuary Freshwater Inflow achievement for the three scenarios. The Baseline (with Stage 2) is the frequency with current water rights, including the proposed Stage 2. The Phase I and Phase II inflows assume replacement of the Stage 2 project with the LTYEP. Note that the achievement is as good or better with the proposed project compared to current water rights.

Table 4: Comparison of Modeled Bay and Estuary Freshwater Inflow Achievement

Inflow Regime	Goal (Full Year)	Baseline (with Stage 2)			
		Full Year	Spring	Fall	Intervening
Subsistence	96%	80.7%	93.0%	84.2%	94.7%
Base Dry	82%	61.4%	80.7%	70.2%	84.2%
Base Average	46%	29.8%	71.9%	49.1%	64.9%
Base Wet	28%	21.1%	61.4%	40.4%	50.9%
Inflow Regime	**Goal (Full Year)**	**Store in Texana (Phase I)**			
		Full Year	**Spring**	**Fall**	**Intervening**
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	35.1%	71.9%	52.6%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%
Inflow Regime	**Goal (Full Year)**	**Store in OCR and Texana (Phase II)**			
		Full Year	**Spring**	**Fall**	**Intervening**
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	33.3%	71.9%	50.9%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%

Table 5 shows the annual freshwater inflows from the three modeling scenarios. Flows that are greater than the Base Wet criteria are shaded in blue, flows that are greater than the Base Average criteria but less than the Base Wet are shaded green. Flows that are less than the Base Dry criteria but more than the Subsistence criteria are shaded orange. Flows that are less than the Subsistence criteria are shaded pink. This table shows that on average the flows into the bay are greater with the new project compared to existing permits.

Table 5: Comparison of Bay and Estuary Freshwater Inflow Regime Levels
(values in acre-feet per year)

Year	Baseline			Phase I			Phase II		
	Spring	Fall	Intervening	Spring	Fall	Intervening	Spring	Fall	Intervening
1940	679,165	1,187,126	36,546	688,536	1,194,781	41,280	681,982	1,191,641	41,216
1941	1,134,166	133,235	639,515	1,136,516	139,482	650,079	1,135,730	136,982	646,299
1942	244,995	73,910	215,209	246,461	68,884	226,517	244,610	68,884	218,537
1943	68,406	55,426	54,126	72,148	74,012	64,495	68,212	73,775	65,335
1944	525,657	63,659	297,898	528,840	68,393	308,829	528,582	66,136	299,266
1945	242,705	47,434	110,204	244,863	51,291	121,969	236,543	51,912	121,969
1946	321,072	619,573	302,401	321,598	622,889	317,317	313,715	621,418	307,689
1947	172,545	8,355	190,571	159,239	12,972	202,765	157,059	20,166	202,357
1948	206,966	6,435	29,558	204,729	7,268	45,653	202,904	7,268	50,463
1949	230,683	246,080	33,509	246,964	252,973	59,438	227,026	250,818	50,507
1950	104,811	5,897	70,958	115,029	6,685	75,865	115,029	6,685	74,162
1951	13,870	9,434	6,182	17,578	18,695	8,592	17,578	18,695	8,592
1952	235,943	71,188	12,894	259,691	88,328	18,043	252,399	80,428	17,793
1953	142,786	96,620	29,933	147,512	103,851	40,970	134,277	103,851	36,005
1954	6,323	5,409	4,152	10,031	5,504	6,334	10,031	5,504	5,866
1955	53,979	9,808	22,513	67,921	14,329	45,515	57,703	14,329	45,515
1956	2,673	6,264	2,636	3,640	6,959	3,250	3,640	6,959	3,250
1957	435,979	626,792	33,651	453,928	634,132	59,534	430,488	613,851	59,534
1958	233,862	78,332	255,950	236,805	79,521	265,917	236,780	79,357	256,492
1959	585,071	181,549	177,017	587,715	180,365	192,972	580,399	173,885	192,134
1960	415,920	893,389	305,054	422,978	891,213	315,426	413,792	890,274	317,974
1961	422,853	690,773	570,598	427,189	695,114	583,030	423,693	692,147	580,887
1962	161,904	10,753	38,739	141,090	20,954	57,743	141,090	20,954	57,743
1963	39,643	7,508	12,140	39,280	10,117	28,881	38,229	10,117	28,881
1964	17,550	24,943	14,410	21,202	34,517	21,113	22,023	34,517	21,113
1965	454,525	211,548	203,447	446,919	227,245	229,334	437,081	220,789	199,844
1966	352,105	37,408	141,963	356,496	40,935	148,142	355,446	41,380	146,436
1967	5,564	478,896	11,901	9,484	494,813	16,995	9,484	479,344	16,995
1968	869,486	60,866	426,475	881,114	65,359	426,169	878,246	63,823	419,978
1969	695,881	42,317	293,281	700,465	47,637	302,359	698,856	47,114	299,679
1970	376,498	193,271	152,467	381,045	210,078	151,219	376,598	206,751	143,963
1971	7,670	404,819	130,376	13,055	416,408	136,368	13,055	401,736	135,254
1972	677,819	42,097	202,683	683,004	44,819	214,799	682,274	44,819	212,491
1973	1,608,175	510,263	295,321	1,611,562	511,534	304,559	1,610,327	510,653	293,696
1974	304,688	582,367	350,319	287,719	594,813	372,266	291,896	582,084	371,830
1975	534,420	87,828	150,797	531,402	93,780	164,000	529,513	93,071	161,352
1976	338,147	638,449	53,192	303,205	649,469	80,161	303,205	647,130	75,161
1977	388,959	11,103	199,134	392,945	22,137	195,527	391,376	22,137	195,173
1978	90,801	646,747	90,208	89,543	658,807	107,963	79,020	653,136	105,468
1979	878,066	322,569	629,187	870,936	335,004	639,107	868,672	332,636	637,146

Table 5 (continued)

Year	Baseline			Phase I			Phase II		
	Spring	Fall	Intervening		Spring	Fall	Intervening		Spring
1980	213,392	12,569	258,522	212,321	17,397	266,260	209,411	19,927	266,339
1981	654,060	883,780	75,605	665,460	889,781	85,903	645,580	887,425	85,291
1982	644,891	227,889	114,187	650,685	234,230	122,435	649,523	226,619	120,386
1983	436,894	435,736	253,370	443,133	446,123	261,630	442,386	442,800	256,205
1984	42,232	153,069	100,954	48,949	176,861	105,645	51,347	176,730	106,890
1985	650,631	262,022	202,386	645,590	274,325	200,822	631,046	267,946	196,448
1986	198,076	269,861	40,988	199,127	274,128	51,183	193,479	269,506	51,183
1987	875,019	149,805	281,370	876,052	155,819	291,334	873,788	154,441	289,762
1988	41,328	1,742	23,118	46,429	2,910	31,517	46,429	2,910	32,917
1989	103,531	2,672	67,634	109,076	2,784	84,442	110,370	2,784	84,552
1990	86,652	15,752	38,795	94,273	16,828	40,611	94,273	16,628	41,277
1991	495,983	372,382	219,848	505,391	381,565	245,994	497,345	364,198	241,632
1992	1,603,580	86,277	1,152,860	1,609,126	91,336	1,163,270	1,608,514	89,905	1,146,872
1993	1,435,280	45,676	377,067	1,441,311	51,588	389,485	1,439,749	51,588	381,001
1994	341,589	1,364,457	72,697	348,566	1,376,797	82,270	336,010	1,371,160	82,172
1995	339,868	37,210	199,809	346,049	42,416	202,443	342,301	42,416	202,107
1996	33,692	106,789	33,557	37,085	116,912	40,399	37,116	118,283	40,399
Average	394,369	243,125	180,875	397,176	249,963	191,511	393,109	247,235	188,587
Min	2,673	1,742	2,636	3,640	2,784	3,250	3,640	2,784	3,250
Max	1,608,175	1,364,457	1,152,860	1,611,562	1,376,797	1,163,270	1,610,327	1,371,160	1,146,872

Greater than Base Wet
Between Base Wet and Base Average
Between Base Average and Base Dry
Between Base Dry and Subsistence
Less than Subsistence

The modeled flows in **Table 5** include flows from Garcitas Creek from the Lavaca-Guadalupe WAM. These flows are the same for all scenarios and are included in **Attachment B**.

No Injury Analysis

Table 6 compares the Volume Reliability for non-LNRA water rights for the three scenarios. There are 32 water rights that are more reliable with Phase I, and 31 water rights that are more reliable with Phase II. The increase in reliability is primarily due to the cancelation of the Stage 2 authorizations, which makes upstream junior water rights more reliable. The proposed LTYEP authorizations will be junior to those existing authorizations. Other water rights that are slightly more reliable are the water rights that are upstream of Lake Texana that are cut off when Lake Texana is below 43 feet msl (drought Index 3 in the Lavaca WAM). No water rights are less reliable with the proposed project.

Table 6: Comparison of Volume Reliabilities for Non-LNRA Water Rights

Water Right ID	Baseline	Phase I	Phase II	Change Baseline to Phase I	Change Baseline to Phase II
2078_1	95.73%	95.73%	95.73%	0.00%	0.00%
61602088	89.96%	89.96%	89.96%	0.00%	0.00%
61602082	63.80%	63.80%	63.80%	0.00%	0.00%
2078_2	94.22%	94.22%	94.22%	0.00%	0.00%
61602080	59.04%	59.04%	59.04%	0.00%	0.00%
61602099	97.61%	97.61%	97.61%	0.00%	0.00%
2098_1	96.94%	96.94%	96.94%	0.00%	0.00%
61602100	95.59%	95.59%	95.59%	0.00%	0.00%
61602097	94.53%	94.53%	94.53%	0.00%	0.00%
61602101	94.43%	94.43%	94.43%	0.00%	0.00%
61602092	64.18%	64.18%	64.18%	0.00%	0.00%
61602087	98.83%	98.83%	98.83%	0.00%	0.00%
2083_1	66.51%	66.51%	66.51%	0.00%	0.00%
2077_1	91.83%	91.83%	91.83%	0.00%	0.00%
61602084	72.06%	72.06%	72.06%	0.00%	0.00%
2094_1	82.98%	82.98%	82.98%	0.00%	0.00%
2094_2	82.98%	82.98%	82.98%	0.00%	0.00%
61602091	88.89%	88.89%	88.89%	0.00%	0.00%
61602075	98.20%	98.20%	98.20%	0.00%	0.00%
61602081	56.23%	56.23%	56.23%	0.00%	0.00%
2086_1	54.42%	54.42%	54.42%	0.00%	0.00%
61602090	86.04%	86.04%	86.04%	0.00%	0.00%
2077_2	86.78%	86.78%	86.78%	0.00%	0.00%
2096_1	95.05%	95.05%	95.05%	0.00%	0.00%
2085_1	84.51%	84.51%	84.51%	0.00%	0.00%
61602093	83.49%	83.49%	83.49%	0.00%	0.00%
61602089	78.65%	78.65%	78.65%	0.00%	0.00%
2083_2	59.65%	59.65%	59.65%	0.00%	0.00%
C2095_1	100.00%	100.00%	100.00%	0.00%	0.00%
11603665	26.24%	30.01%	26.88%	3.77%	0.64%
11603725	26.24%	29.37%	26.88%	3.13%	0.64%
11603727	25.64%	27.60%	26.27%	1.96%	0.63%
3876_1	25.37%	26.92%	26.02%	1.55%	0.65%
3876_2	0.58%	1.43%	0.58%	0.85%	0.00%
3836_1	24.50%	25.40%	25.14%	0.90%	0.64%
3910_1	32.42%	34.20%	33.17%	1.78%	0.75%
3905_1	32.12%	33.90%	32.87%	1.78%	0.75%
11603906	40.29%	44.09%	41.17%	3.80%	0.88%
11603904	24.22%	26.04%	24.86%	1.82%	0.64%
11603908	25.05%	27.49%	25.69%	2.44%	0.64%

Table 6 (continued)

Water Right ID	Baseline	Phase I	Phase II	Change Baseline to Phase I	Change Baseline to Phase II
11603909	37.90%	38.76%	38.67%	0.86%	0.77%
3907_1	23.64%	24.45%	24.28%	0.81%	0.64%
3907_2	23.56%	24.20%	24.18%	0.64%	0.62%
11603903	24.53%	28.24%	25.17%	3.71%	0.64%
3911_1	4.31%	4.38%	4.37%	0.07%	0.06%
3912_1	57.13%	62.83%	57.77%	5.70%	0.64%
2098_2	46.85%	86.70%	86.70%	39.85%	39.85%
3978_1	63.70%	91.45%	91.45%	27.75%	27.75%
11604102	14.39%	17.51%	15.95%	3.12%	1.56%
4085_1	13.21%	16.07%	14.51%	2.86%	1.30%
11604252	13.64%	15.65%	14.09%	2.01%	0.45%
11604241	21.95%	24.67%	22.79%	2.72%	0.84%
5168_1	13.33%	15.34%	13.78%	2.01%	0.45%
5168_2	38.59%	40.20%	39.47%	1.61%	0.88%
5263_1	12.09%	14.95%	13.39%	2.86%	1.30%
5370_1	32.66%	38.86%	33.65%	6.20%	0.99%
5584_1	44.11%	96.95%	96.95%	52.84%	52.84%
5584_2	43.40%	99.39%	99.39%	55.99%	55.99%
5584_5	99.42%	99.42%	99.42%	0.00%	0.00%
5595_1	13.13%	16.07%	14.51%	2.94%	1.38%
5706_1	13.23%	16.36%	14.80%	3.13%	1.57%
5579_1	11.59%	14.57%	12.90%	2.98%	1.31%

Attachment A: Modifications to WRAP Code

Modifications to the Lavaca WAM WRAP code include:

- Revised modeling of the adopted environmental flow standards for the Lavaca Basin using new capabilities of WRAP,
- Modeling of the proposed LTYEP project, and
- Changes to the Lavaca WAM as previously provided to TCEQ in March 2016, excluding changes suggested for environmental flows.

The changes to the WRAP code for Lake Texana and Stage 2 proposed in 2016 are summarized in this appendix for reference.

Environmental Flow Standards

The modeling of the environmental flow standards has been replaced with code that uses the new HC and ES Records in WRAP. Although these records seem to be oriented toward the daily WRAP model, they do function in the monthly model and result in considerably less code than current methods. They also allow for more direct application of reservoir storage as a method for setting hydrologic condition, although the model logic does not seem to anticipate the use of both storage and flow as a basis for setting the condition. The method for determining monthly pulse flow targets is the same as that employed in previous monthly models – the monthly flow volume is based on the pulse volume and duration plus the applicable base flow for the remaining days of the month. However, unlike previous versions the model does not calculate the monthly pulse targets within the model – it is done externally. A future improvement would be to incorporate this calculation within the WRAP code.

The code in this memo is only for the Lavaca River near Edna gage. However, this technique was applied at all of the adopted flow measurement points.

Base Flow Targets

Define artificial control points *FKLE01* and *FKLE02* used in the hydrologic condition calculations.

```
CPFKLE01     OUT                        2     NONE    NONE                    1    0          9999999
CPFKLE02     OUT                        2     NONE    NONE                    1    0          9999999
```

Use a Type 8 water right and a TO record to get the end-of-month storage in Lake Texana in the previous timestep. This will be used to determine dry, average and wet conditions.

```
**   Use a type 8 water right to get the previous month's storage in Lake Texana
WR GS300                20110301   8                                     TexStor   LavEd
TO    -4                                      TEXANA
```

Using a combination of IF, HC, and ES Records at artificial control point *FKLE01*, set a flag that signifies that you are in Dry (code 200), Average (code 300) or Wet (code 400) conditions. These codes, which are based on Lake Texana storage, apply at all measurement points. The codes for Severe (code 0) and Subsistence (code 100), which are dependent on flow, are set later in the process at each individual gage. The HC Record uses the storage values from *TexStor* to select one of the four base flow conditions on the following ES Records. Conditions are evaluated in March, July, September and December. The values entered on the ES Records convert to approximately the condition codes (i.e. 0, 200, 300 or 400) when converted from cfs to acre-feet per month.

```
**  Record code for dry, average, wet conditions based on Texana storage
**   This will be the same for all SB3 IF calculations
IFFKLE01      -9        20110301   2                    IF_other   LavEd
HC GS300   1  WR       M   J S  D       0  132439  160929  170299      -9              //          TexStor
ES BASE1       0       0       0       0       0       0       0       0       0       0       0       0
ES BASE2   3.253   3.601   3.253   3.361   3.253   3.361   3.253   3.253   3.361   3.253   3.361   3.253
ES BASE3   4.879   5.402   4.879   5.042   4.879   5.042   4.879   4.879   5.042   4.879   5.042   4.879
ES BASE4   6.505   7.202   6.505   6.722   6.505   6.722   6.505   6.505   6.722   6.505   6.722   6.505
```

The next step is to determine the Dry or Severe flow target, if applicable. For this example, we are showing the target for the Lavaca River near Edna gage (USGS 08164000). Dry or Severe conditions can vary at different measurement points and can vary month-by-month within a season.

Using IF and ES Records at artificial control point *FKLE02* sets the Dry flow target of 30 or 20 cfs. The program will calculate targets in acre-feet per month, taking into account the number of days in the month, including leap years.

```
**  Monthly dry/severe flow target for Edna
IFFKLE02      -9        20110301   2                  LE_IF_dry   LavEd
ES BASE       30      30      30      30      30      30      20      20      20      20      20      30
```

Divide the actual regulated flow at *GS300* (the Lavaca near Edna gage) by the monthly Dry flow targets set in *LE_IF_dry*.

```
**  Divide regulated flow by monthly dry/severe target
WR GS300          XMONTH20110301   8                              LE_SEVTRIGGER   LavEd
TO     2             ADD                GS300                              CONT
TO    13             DIV                                     LE_IF_dry
```

Using a Type 8 water right, set a monthly target equal to 100 (the Severe code) if *LE_SEVTRIGGER* is greater than 1 (i.e. flows are greater than the Dry flow target of 20 or 30 cfs), or 0 (the Subsistence code) if *LE_SEVTRIGGER* is less than 1 (i.e. flows are less than 20 or 30 cfs).

```
**  If SEVTRIGGER is greater than 1, use severe code (100), otherwise it is subsistence code (0)
WR GS300     100  XMONTH20110301   8                                     LE_sub   LavEd
TO    13             LIM       1  999999                 LE_SEVTRIGGER
```

Set the final hydrologic condition code as the maximum of the value calculated in *LE_sub* and *IF_other*.

```
**  Set hydrologic condition code for Lavaca near Edna
WR GS300                20110301   8                                 LE_hc_code   LavEd
TO    13             SET                                      LE_sub     CONT
TO    13             MAX                                    IF_other
```

Now that the hydrologic condition codes have been set (i.e. 0 for Subsistence, 100 for Severe, 200 for Dry, 300 for Average and 400 for Wet), the base flows can be set at the measurement point. Since the values for dry average and wet codes are not exactly equal to the codes, the values that set the base flow condition are set so that subsistence is triggered if the code is greater than or equal to 0 but less than 20, severe is triggered if the code is greater than or equal to 20 but less than 120, and so on. Note that the values for the base flows are entered in cfs. The program will calculate monthly targets in acre-feet per month, taking into account the number of days in each month, including leap years.

```
** Set base flow triggers using condition codes
IFLEBASE      -9        20110301   2                  LEBASEFIN   LavEd
HC GS300   1  WR                      0      20     120     220     320      -9                //     LE_hc_code
** Lavaca River nr Edna sub and base flows
ES BASE1     8.5     8.5    10.0    10.0    10.0    10.0     1.3     1.3     1.2     1.2     1.2     8.5
ES BASE2    30.0    30.0    30.0    30.0    30.0    30.0    20.0    20.0    20.0    20.0    20.0    30.0
```

```
ES BASE3    30.0    30.0    30.0    30.0    30.0    30.0    20.0    20.0    20.0    20.0    20.0    30.0
ES BASE4    55.0    55.0    55.0    55.0    55.0    55.0    33.0    33.0    33.0    33.0    33.0    55.0
ES BASE5    94.0    94.0    94.0    94.0    94.0    94.0    48.0    48.0    58.0    58.0    58.0    94.0
```

Pulse Flow Targets

The new pulse flow records do not automatically account for the base flows that occur during the rest of the month, so the pulse flow volumes cannot be directly input into the program. Like the previous methods for inputting pulses, the pulse volume plus the base flow volume for the rest of the month must be calculated and input into the WRAP code. For the new WRAP instream flow records, the monthly volumes must be converted into daily average volumes. The pulse flow calculations for the Lavaca near Edna gage are shown in **Table A-1**.

Note that for these calculations we are assuming a non-leap year (28 days in February). Since the new WRAP code respects leap years, the monthly values will be off slightly in February of leap years. This was determined not to be critical to the flow calculations, since pulses are not engaged every February.

Also note that for the Annual and Large pulses, during Severe conditions the Subsistence flow could never apply. If one of those pulses occur, the average flow in the month would necessarily be higher than the Dry target flow. This is also true for the Small pulses except for the Summer season. A small pulse could occur in July or August and the average flow over the month would be less than the Dry base flow - the average flow of 7.15 cfs with a pulse is less than the Dry base flow of 20 cfs. This requires special handling in the code, setting the Summer Season separately.

Table A-1: Monthly Pulse Flow Target Calculations

Annual Pulse (1 per year)

						Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Feb	Winter	28	18,400	9,277	7	8.5	178.5	9,455	337.68	30	630	9,907	353.81	55	1,155	10,432	372.56	94	1,974	11,251	401.81
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	18,400	9,277	7	1.3	31.2	9,308	300.25	20	480	9,757	314.73	33	792	10,069	324.8	48	1,152	10,429	336.41
Aug	Summer	31	18,400	9,277	7	1.3	31.2	9,308	300.25	20	480	9,757	314.73	33	792	10,069	324.8	48	1,152	10,429	336.41
Sep	Fall	30	18,400	9,277	7	1.2	27.6	9,304	310.14	20	460	9,737	324.56	33	759	10,036	334.52	58	1,334	10,611	353.69
Oct	Fall	31	18,400	9,277	7	1.2	28.8	9,305	300.18	20	480	9,757	314.73	33	792	10,069	324.8	58	1,392	10,669	344.15
Nov	Fall	30	18,400	9,277	7	1.2	27.6	9,304	310.14	20	460	9,737	324.56	33	759	10,036	334.52	58	1,334	10,611	353.69
Dec	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02

Large Pulse (1 per season)

						Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Feb	Winter	28	18,400	9,277	7	8.5	178.5	9,455	337.68	30	630	9,907	353.81	55	1,155	10,432	372.56	94	1,974	11,251	401.81
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	1,800	908	6	1.3	32.5	940	30.32	20	500	1,408	45.4	33	825	1,733	55.89	48	1,200	2,108	67.98
Aug	Summer	31	1,800	908	6	1.3	32.5	940	30.32	20	500	1,408	45.4	33	825	1,733	55.89	48	1,200	2,108	67.98
Sep	Fall	30	18,000	9,075	6	1.2	28.8	9,104	303.46	20	480	9,555	318.5	33	792	9,867	328.9	58	1,392	10,467	348.9
Oct	Fall	31	18,000	9,075	6	1.2	30	9,105	293.71	20	500	9,575	308.87	33	825	9,900	319.35	58	1,450	10,525	339.52
Nov	Fall	30	18,000	9,075	6	1.2	28.8	9,104	303.46	20	480	9,555	318.5	33	792	9,867	328.9	58	1,392	10,467	348.9
Dec	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02

Table (continued)

Small Pulse (2 per season)

Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
						Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	8,000	4,033	6	8.5	212.5	4,246	136.96	30	750	4,783	154.3	55	1,375	5,408	174.46	94	2,350	6,383	205.91
Feb	Winter	28	8,000	4,033	6	8.5	187	4,220	150.73	30	660	4,693	167.62	55	1,210	5,243	187.26	94	2,068	6,101	217.9
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	370	187	4	1.3	35.1	222	**7.15**	20	540	727	23.44	33	891	1,078	34.76	48	1,296	1,483	47.82
Aug	Summer	31	370	187	4	1.3	35.1	222	**7.15**	20	540	727	23.44	33	891	1,078	34.76	48	1,296	1,483	47.82
Sep	Fall	30	6,100	3,075	6	1.2	28.8	3,104	103.47	20	480	3,555	118.51	33	792	3,867	128.91	58	1,392	4,467	148.91
Oct	Fall	31	6,100	3,075	6	1.2	30	3,105	100.17	20	500	3,575	115.34	33	825	3,900	125.82	58	1,450	4,525	145.98
Nov	Fall	30	6,100	3,075	6	1.2	28.8	3,104	103.47	20	480	3,555	118.51	33	792	3,867	128.91	58	1,392	4,467	148.91
Dec	Winter	31	8,000	4,033	6	8.5	212.5	4,246	136.96	30	750	4,783	154.3	55	1,375	5,408	174.46	94	2,350	6,383	205.91

In the WRAP code, we first set the Annual pulse using a combination of IF, HC and ES Records. Since we are never in Severe conditions, the monthly flow targets can be set directly by the storage in Lake Texana recorded in *TexStor*. The hydrologic condition codes used for the base flows are not used because only one pulse occurs during a year.

```
**  Annual pulse
IFLEAPUL      -9        20110301   2                    LEannPul   LavEd
HCLEAPUL   1  WR      M   J S  D       0  132439  160929  170299      -9         //               TexStor
** Lavaca River nr Edna annual pulse
ES HA 11  322.47  353.81  322.47  332.22  322.47  332.22  314.73  314.73  324.56  314.73  324.56  322.47
ES HA 12  322.47  353.81  322.47  332.22  322.47  332.22  314.73  314.73  324.56  314.73  324.56  322.47
ES HA 13  341.83  372.56  341.83  351.39  341.83  351.39  324.80  324.80  334.52  324.80  334.52  341.83
ES HA 14  372.02  401.81  372.02  381.29  372.02  381.29  336.41  336.41  353.69  344.15  353.69  372.02
```

The Large pulse is similar to the annual pulse – it can never occur during subsistence conditions and can be set by storage in Lake Texana. The hydrologic condition codes used for the base flows are not used because only one pulse occurs during a season.

```
IFLELPUL      -9        20110301   2                    LElrgPul   LavEd
HCLELPUL   1  WR      M   J S  D       0  132439  160929  170299      -9        //               TexStor
** Lavaca River nr Edna large pulse
ES HS 11  322.47  353.81  322.47  332.22  322.47  332.22   45.40   45.40  318.50  308.87  318.50  322.47
ES HS 12  322.47  353.81  322.47  332.22  322.47  332.22   45.40   45.40  318.50  308.87  318.50  322.47
ES HS 13  341.83  372.56  341.83  351.39  341.83  351.39   55.89   55.89  328.90  319.35  328.90  341.83
ES HS 14  372.02  401.81  372.02  381.29  372.02  381.29   67.98   67.98  348.90  339.52  348.90  372.02
```

The Small pulses can also be set directly by storage in Lake Texana except for in the Summer when it could occur during subsistence conditions. The first set of code sets the Small pulses for every season except the Summer.

```
IFLESPUL      -9        20110301   2                    LEsmlPul   LavEd
HCLESPUL   1  WR      M   J S  D       0  132439  160929  170299      -9         //                    TexStor
** Lavaca River nr Edna small pulse rest of year
ES HS 21  154.30  167.62  322.47  332.22  322.47  332.22       0       0  118.51  115.34  118.51  154.30
ES HS 22  154.30  167.62  322.47  332.22  322.47  332.22       0       0  118.51  115.34  118.51  154.30
ES HS 23  174.46  187.26  341.83  351.39  341.83  351.39       0       0  128.91  125.82  128.91  174.46
ES HS 24  205.91  217.90  372.02  381.29  372.02  381.29       0       0  148.91  145.98  148.91  205.91
```

The summer pulse is set using the hydrologic condition codes calculated by *LE_hc_code*. This code only works because there are only two months in the Summer season – July and August – and the method assumes that only one pulse can occur in any given month. The hydrologic condition codes do not work with the seasonal calculations in the ES Records.

```
IFLESPUL     -99        20110301   2                  LEsmlPul2   LavEd
HC GS300   1  WR                       0      20     120     220     320      -9              //    LE_hc_code
** Lavaca River nr Edna small pulse summer only
ES HS 21       0       0       0       0       0       0    7.15    7.15       0       0       0       0
ES HS 22       0       0       0       0       0       0   23.44   23.44       0       0       0       0
ES HS 23       0       0       0       0       0       0   23.44   23.44       0       0       0       0
ES HS 24       0       0       0       0       0       0   34.76   34.76       0       0       0       0
ES HS 25       0       0       0       0       0       0   47.82   47.82       0       0       0       0
```

Modeling Lake Texana

The code modeling the existing authorizations in Lake Texana is modified to include a PX 3 Record so that the additional yield due to the LTYEP does not change the appropriation at the current priority dates.

```
**  FNI change for LTYEP - add PX3
WRDV221A   74500      TA19720515   1   1                                 C2095_1  texana
WSTEXANA  160930
PX     3
**
**   500 ac-ft at from original authorization, set to 2002 priority to reflect subordination
**
WRDV221A    1680    INTW20020701   1   1     1.0    NOUT       2      72_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                    500
PX     3
**
**  4,000 ac-ft from 1982 authorization, set to 2002 priority to reflect subordination
**
WRDV221A   13440    INTW20020701   1   1     1.0    NOUT       2      82_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                   4000
PX     3
**
**  7,500 ac-ft from Amendment D.
**
WRDV221A   26880    INTW20020701   1   1     1.0    NOUT       2      02_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                   7500
PX     3
**
** FINAL FILLUP FOR LAKE TEXANA
WRDV221A       0        20020701   1                                  REFILL  texana  TEXANA
WSTEXANA  170300
PX     3
```

Modeling the LTYEP

The diversion from the Lavaca River is assumed to be at the same location as the Stage 2 reservoir, which is near the upper end of the diversion reach. However, control point *STG_II*, the Stage 2 control point, included 25.77 square miles of the drainage area of Dry Creek, which is a tributary of the Lavaca River between the Lavaca River and Lake Texana. Dry Creek would have been impounded by the Stage 2 dam. However, since the confluence with the Lavaca River is downstream of the diversion reach it is not included in the modeling for the LTYEP. The control points *STG_II* and *S2RF* are defined as follows:

```
**CP DV211   CB220                       7           GS300      -2
CP DV211  STG_II                       7           GS300      -2
CPSTG_II    S2RF                       7           GS300      -2
CP  S2RF   CB220                       7           GS300      -2
```

Control point *TWW217* is on Dry Creek and is no longer part of the drainage area upstream of control point *STG_II*.

```
CPTWW217   CB220                       7           GS300      -1
**CPTWW217  STG_II                       7           GS300      -1
```

The following changes were made to the .dis file:

```
FDSTG_II   EP000       1   GS300  WGS800   GS500
FD  S2RF   EP000       1   GS300  WGS800   GS500
```

```
**WPSTG_II  865.00                     1.0
WPSTG_II  839.23                     1.0
```

```
WP  S2RF  839.23                     1.0
**WP  S2RF  865.00                     1.0
**
```

Comment out all code associated with Stage 2.

```
**WRSTG_II    7150       119720515   1   1    0.00                        61602095_3 stage_2
**WSSTAGE2   93340
**WRSTG_II   22850       219720515   1   1    0.00                        61602095_4 stage_2
**WSSTAGE2   93340
**WRSTG_II   18122  BAYES119931006   1   1     1.0                            2095_5 stage_2
**PX     3
```

All diversions for the LTYEP occur only in the second simulation. This prevents Lake Texana from filling storage emptied by the new diversions from being refilled at a senior priority date.

Define artificial control point *HOLD* and control point *OCRLOC*. *HOLD* will serve as a place to temporarily hold flows diverted from the Lavaca River, and *OCRLOC* is the location for the off-channel reservoir. Both control points have zero flow. Evaporation is repeated from control point *GS300*. This is the same evaporation used for Lake Texana.

```
CP  HOLD     OUT                     2    ZERO    ZERO
CPOCRLOC     OUT                     2    ZERO   GS300
```

Since the measurement point for environmental flows is upstream, the first step records the available flow at the Lavaca near Edna gage (*GS300*) using a Type 8 WR Record. This will serve as a limit on diversions downstream. It ignores any incremental flow between *GS300* and the diversion point. However, this flow is small and should not make a significant contribution to water supply for the LTYEP.

```
**  See what the available flow is at GS300, Lavaca at Edna
WR GS300               20200000   8                                    ASF_LE  texana   LTYEP
TO     3
```

Fill the channel dam, limited to available flow at *GS300*. The channel dam is assumed to be at the same location as Stage 2. At this time storage and volume curves for the storage is not available, so the generic relationship for smaller storage in the Lavaca WAM is used.

```
WRSTG_II               20200000   1   1                           FillChanDam  texana   LTYEP
WS CHDAM     240    1.00   0.727    0.00
LO    13            SET                                      ASF_LE
PX     2
```

Divert the available flow less channel dam depletions, limited to 200 MGD. Store in artificial control point *HOLD*. Note that stored water in the channel dam is assumed to not be available for diversion. The storage in the channel dam is intended to provide enough head for pumping and is not a source of stored water.

```
WRSTG_II  224200   MONTH20200000   1   1     1.0    HOLD             Divert_LE  texana   LTYEP
LO    13            SET                                      ASF_LE
LO     6            SUB                                 FillChanDam
PX     2
```

Storage in Lake Texana Only (Phase I)

For Phase I, Lake Texana is the only place to use the diverted water. For this step, fill Lake Texana with water from artificial control point *HOLD* and take additional yield from the reservoir.

```
WRDV221A   23500      TA20200000   1                                 LTYEP_tex  texana   LTYEP
WSTEXANA  170300
```

```
SO                          HOLD
PX     2
```

Return unused water to the river.

```
WR  HOLD                20200000   1   1     1.0  STG_II             return_hold  texana   LTYEP
TO     2
PX     2
```

Storage of Water in Off-Channel Reservoir and Lake Texana (Phase II)

In Phase II, diverted water is first used to fill the off-channel reservoir and meet demands there.

```
WROCRLOC   30600      TA20200000   1                                   LTYEP_OCR  texana   LTYEP
WSLAVOCR   50000
SO                          HOLD
PX     2
```

Fill Lake Texana with left over water and back up any shortages at the off-channel reservoir.

```
WRDV221A       0      TA20200000   1                                   LTYEP_tex  texana   LTYEP
WSTEXANA  170300
BU                     LTYEP_OCR
SO                          HOLD
PX     2
```

Finally, return any unused water back to the river.

```
WR  HOLD                20200000   1   1     1.0  STG_II             return_hold  texana   LTYEP
TO     2
PX     2
```

Previously Proposed Modifications

The modifications proposed in 2016 include:

- Changing the storage and area tables (SV and SA Records) to use the original storage characteristics, consistent with the assumptions used in other Full Authorization WAM models. The storage and area tables were obtained from computer runs by the Texas Department of Water Resources (TDWR) associated with the original permit. These runs were found in FNI files from that time. The original Lavaca WAM used the year 2000 survey by the Texas Water Development Board.

- Addition of a primary control point at the mouth of the Lavaca River. This change corrects for flow inconsistencies associated with negative incremental flows downstream of the gaged primary control points.

- Placing Stage 2 at the location authorized in CoA 16-2095. The previous version of the WAM had Stage 2 at a more likely site upstream of the authorized location. However, the water right was never amended to include that location. To be consistent with the water right Stage 2 should be at its originally proposed location.

Lake Texana SV and SA Records

The TDWR SV and SA records are:

```
SVTEXANA       0     480    2950    9190   21420   40060   64210   94790  132820  170300  180840
SATEXANA       0     190     790    1700    3190    4270    5390    6840    8370   10370   10880
```

This change required modifications to the WS Record associated with water right ID *2095_1*. This water right models the non-interruptible portion of Lake Texana, with a maximum storage at elevation 43 feet.

```
WRDV221A   74500      TA19720515   1   1                                 C2095_1 TEXANA1
WSTEXANA  160930
```

DI Records for drought index 3 also needed adjustment to correspond with the changed SV Records.

```
** DROUGHT INDEX RECORDS water rights that have the 43 ft msl restriction.
DI     3   0   1  TEXANA
IS     6       0   10000  100000  160930  160931  170300
IP             0       0       0       0     100     100
```

New Control Point at Mouth of Lavaca River

The original Lavaca WAM uses flows at control point *GS500* (USGS Gage 08164500, Navidad River near Ganado) to estimate flows at control point *EP000*, the mouth of the Lavaca River. As a result, in approximately 26 percent of the months the naturalized flow at the mouth was less than the combined naturalized flow from the upstream primary control points *GS500, GS300* (USGS Gage 08164000, Lavaca River near Edna) and *WGS800* (USGS Gage 08164503, West Mustang Creek near Ganado). Because the naturalized flow calculation for *EP000* is solely based on *GS500*, whenever flow at *GS500* is zero, flow at *EP000* is also modeled as zero even though there are flows shown from the Lavaca River and West Mustang Creek. It does not seem reasonable to assume that these flows are lost prior to entering the bay. These observations indicate that the naturalized flow methodology applied for *EP000* in the existing model is not a reliable approach.

The proposed approach calculated new naturalized flows at *EP000* using the total flow at *GS500, GS300,* and *WGS800* multiplied by the ratio of the drainage areas found in the DIS file (2,322.46 divided by 822.05 + 1058.52+ 167.53 equals 1.134). This is consistent with the method used by WRAP to calculate naturalized flows at secondary control points between primary control points. This is also consistent with a number of other WAMs which have synthetic flows at the outlet point of the model.

The following proposed code changes implement the new naturalized flows at the mouth.

1. A modified CP record changes EP000 from a secondary to a primary control point.

```
CP EP000     OUT                     1           GS300       0
```

2. The following IN records were added to the INF file.

```
IN EP000    1940  2090.7 26948.5  5332.9  3707.4  7929.7 23720.6639742.9  7358.4  4238.2 41153.7728331.6347518.9
IN EP000    1941119749.2 72502.6221902.4269463.5438255.8291206.0139189.6 51369.0 18366.7 67584.4 65360.1 25033.9
IN EP000    1942 10873.5 14823.0 15068.6174049.1 15590.5 13164.0221570.7 14218.5 43974.3 15073.0 25871.1 15765.1
IN EP000    1943 30324.2 10251.7 59369.1  9478.6 30296.5 16451.4 24444.6  9659.1  7135.7  5978.3 50465.5 76706.4
IN EP000    1944192479.2 43633.8307243.9 19213.7178756.1 20630.3 11070.0  7742.1 36672.3  7857.2 33994.9 81711.6
IN EP000    1945 82422.6 27362.0 20095.6210268.9 11194.8 15455.9  9637.9 43345.7 12651.5 16381.5  5450.9 17978.3
IN EP000    1946 48893.2115426.4 69399.5 28169.3 71036.8234881.2 34622.0 88200.0226323.3184951.0145143.6 32193.2
IN EP000    1947154774.4 16801.3 38700.4 26285.7110784.0  8516.0  9493.2  8734.9  7708.8  3264.7  8773.4 19871.8
IN EP000    1948 24928.4 55144.5 45498.8  9122.1151905.6  6450.6 12879.7   803.1  9609.7  2468.3  4834.1  2689.3
IN EP000    1949  5213.7 53345.4 28429.2218539.8 29374.6  6545.3 17822.1 15598.8 11826.1191600.5 11652.3105499.5
IN EP000    1950 45526.4 34829.1  7269.0 27761.3 11201.0 75919.3  6830.1   342.3  8421.1  2466.8  2947.3  2123.8
IN EP000    1951  1693.2  2992.1  6635.2  4229.2  3836.5 86156.3  2251.9     0.0 36705.4  9784.6  4859.0  2814.3
IN EP000    1952  1272.4 10829.9  5277.3 88717.3219581.3 33196.6  4978.0  1466.3  7287.6  1879.6 52075.0 87359.8
IN EP000    1953 12117.8 13125.6  5145.4  6476.6161518.8  2339.5  6572.5 53183.7 75035.9  5872.3  5267.8  7810.6
IN EP000    1954  1952.6  2317.7  1726.7  7664.9 12569.4   261.3  1796.8   206.7  1351.5  2709.7  2318.0   696.7
```

```
IN EP000    1955  1514.7103160.7  1690.8  5037.7 99206.5 19019.4  2756.9 15006.1 20370.2 14653.6  2335.8   887.7
IN EP000    1956   872.8  8022.8   640.3  2882.3  2916.2     0.0  3186.9     0.0    73.4   765.9  2341.3  6614.9
IN EP000    1957     0.9 14443.7122317.2250494.9140918.8126944.7  3055.9   171.3 45338.0358842.1207530.9 19566.8
IN EP000    1958135682.4188849.9 23429.6 12069.5 68970.9  2500.0 20515.6  1000.7 70343.1 38097.8 21122.1 42542.4
IN EP000    1959 22238.7238171.0 17788.6305689.5 61885.7 76755.8 11524.5 22639.8 18217.5 92510.7 66779.8 65386.0
IN EP000    1960 59319.2 65915.7 16462.4 27904.0 38350.7349034.7 60992.7138141.0 22064.1482953.4181637.3132192.7
IN EP000    1961198123.5292766.8 27028.5 18377.4 15580.0285187.3126135.2 11538.7464724.2 21677.3160588.1 17203.4
IN EP000    1962 15002.3 16393.5 11177.0 90558.7 21379.0 43665.1 18479.3  1535.0 27730.0  8287.5  5637.8 19793.0
IN EP000    1963 26036.7 43530.2  6719.4  4849.4  8537.3  6686.5 27990.2   402.1  1914.7  2698.9 11397.9 20413.1
IN EP000    1964  5777.1 26369.1 18700.1  8928.6  5252.2 53428.0  6460.8  2753.1 48196.4 13189.9  6901.4  2766.0
IN EP000    1965 90378.1123659.3 10040.4 11646.4315458.4 98309.8 11985.0  2479.3 11670.5 26637.4171274.1 61713.6
IN EP000    1966 37240.7 72822.2 38400.9111372.3193786.9 43374.0 23390.3 17586.8 13956.1  8786.1  4237.3  3521.2
IN EP000    1967  4355.9  3486.5  3476.6 14801.6 11547.7  1248.3  4021.8 19288.6394597.4143305.0 13450.2  6288.0
IN EP000    1968305217.7 29962.2 29329.6 36123.0255916.9518567.1 59057.9  8982.4 29754.6 22864.0 18104.6 54656.8
IN EP000    1969 31532.4222380.2146490.6224752.8269762.7 17396.5  6318.4  2849.1 17209.1 26800.1 16911.4 58847.9
IN EP000    1970 58130.4 10424.1109639.7 18254.2246297.4 70845.1 19730.1  4315.2107681.7126512.2 10030.1  5474.8
IN EP000    1971  4215.4  6386.1  4739.3  7928.5  8050.4  6141.6  4443.0 93715.6243004.1103831.3 11636.5116313.2
IN EP000    1972 65627.5107044.4 36413.9 11194.7546948.0 79854.1 32928.9 19686.1 15013.3 10059.1 10215.5  5319.6
IN EP000    1973 19070.7 40148.1209229.9478659.4 92606.4965679.3 72542.7 41403.8130105.4300523.6 51277.0 23646.9
IN EP000    1974245445.4 36674.6 22707.2 34417.9110405.7126901.7 14974.3 23001.3407122.6 34066.7169927.2 65183.6
IN EP000    1975 36303.3 28911.2 13747.2 90101.3326517.0124750.9 80591.8 26107.5 26662.0 17822.1  9016.7 61034.4
IN EP000    1976  7298.4  6679.1  7103.1 81499.4128432.6 76227.6 66206.3  3237.2  9048.0113943.6 61646.5409538.6
IN EP000    1977 58199.4179226.4 22486.5197443.5 33108.4 74756.9 17937.5  2904.3  6001.7  6004.2 38806.0  5296.4
IN EP000    1978 73279.9 46725.7 12182.9 37054.7  2787.8 39600.0 15851.0  1189.7504590.6 22795.3 33865.3 16854.2
IN EP000    1979328344.8154065.5 78472.6222374.2379935.2155362.5 36208.6  8068.9270814.4  6017.8  8093.1 11959.2
IN EP000    1980214429.4 37071.7 11002.6 10382.5154725.0  7463.9 13796.8  2121.1  9100.2 33266.1  5917.1  8184.3
IN EP000    1981  9053.4  6998.0 11409.7 35901.3 68242.0416622.0 76587.9 58141.3476075.5 81384.2347454.1 26581.1
IN EP000    1982  9603.4 82802.1 25832.0 27558.2520352.9 19251.3 20748.4  1958.7  7943.3 12730.0192815.5 16414.4
IN EP000    1983 73316.0205624.4185353.8 34821.1 62308.9 16195.3111186.2 13388.4130033.5179570.7116676.8  7270.5
IN EP000    1984 73694.9 28969.0 22098.1 16338.4 13780.0 14631.0 20879.0  4491.0  1289.5209596.7 20092.9 15504.7
IN EP000    1985 97135.0 62613.3199652.5311015.9 43615.0 22521.4 38716.4 11019.5 16835.8 34831.3234181.9 53999.4
IN EP000    1986  5231.9  7476.6  2692.6 11351.7 13537.6222155.7 18822.5  6647.8 20944.3 46198.1 35759.8205256.1
IN EP000    1987 62688.7147733.4 46920.7 16782.0 70739.9641075.9 54200.7  9430.1  5010.2  1650.7 92411.3 88231.4
IN EP000    1988 10869.3  2616.8 23180.7 24584.8 18234.0 13524.9 23770.9  7784.3    95.3 14043.5  1834.1 12217.9
IN EP000    1989111586.8 17773.5 12246.6  5264.7130619.7 14957.8  7438.9  2644.6     0.0  4063.1  5210.9   361.1
IN EP000    1990  3278.0 31669.1 65935.9 51452.6 33591.2    26.9 25582.4  3156.9 13740.7 11035.7  1594.6    22.5
IN EP000    1991171119.6 61208.7 16555.0302089.4 34939.3 37368.7 48253.2  8537.6 33876.8  2490.7  6802.8376359.2
IN EP000    1992334581.3883200.3133695.2419298.4456711.8246171.7 31863.9  9491.1  9644.1  8018.2 68756.1 61189.6
IN EP000    1993 80669.9124668.1125973.9110964.4451581.3674427.7 44156.1 21405.6  2708.0 29939.2  6379.5 43800.5
IN EP000    1994  9577.9  2141.5 38242.6 40219.6237854.3 73967.3 12097.1 27520.4 20486.4 1147303 14445.0116565.0
IN EP000    1995129152.6  9865.1202807.3 46508.2124490.0 27104.2 48545.2 18165.1 10761.5   686.2 17050.8 66300.2
IN EP000    1996  8009.8  3691.9 10633.4  9639.6 13425.4 68185.9 17246.4 15949.2 99096.7  1835.9 15087.5 19054.0
```

3. The following records were changed in the DIS file.

On Lavaca:

```
FD 20955   EP000       1   GS300  WGS800   GS500
FD CB220   EP000       1   GS300  WGS800   GS500
FD DV211   EP000       1   GS300  WGS800   GS500
FD DV212   EP000       1   GS300  WGS800   GS500
FD DV213   EP000       1   GS300  WGS800   GS500
FD DV214   EP000       1   GS300  WGS800   GS500
FD DV215   EP000       1   GS300  WGS800   GS500
FD DV216   EP000       1   GS300  WGS800   GS500
FD WQ002   EP000       1   GS300  WGS800   GS500
```

On Navidad:

```
FD CB230   EP000       2  WGS800   GS500   GS300
FDDV221A   EP000       2  WGS800   GS500   GS300
FDDV221B   EP000       2  WGS800   GS500   GS300
FDRSRTRN   EP000       2  WGS800   GS500   GS300
FD WQ004   EP000       2  WGS800   GS500   GS300
```

Below confluence of Lavaca and Navidad:

```
FD CB210   EP000       3   GS300  WGS800   GS500
FD DV201   EP000       3   GS300  WGS800   GS500
FD GS100   EP000       3   GS300  WGS800   GS500
FD GS200   EP000       3   GS300  WGS800   GS500
FD WQ001   EP000       3   GS300  WGS800   GS500
FD WQ003   EP000       3   GS300  WGS800   GS500
```

Revisions to Modeling of Lake Texana Interruptible Diversions

The 12,000 acre-feet per year of interruptible supply from Lake Texana consists of three separate authorizations:

- 500 acre-feet per year from the original 75,000 acre-feet per year authorized from Lake Texana in the unamended certificate with a priority date of May 15, 1972. Amendment D changed this supply to interruptible because the implementation of bay and estuary pass-through requirements in Amendment B reduced the firm yield of the reservoir from 79,000 acre-feet per year to 74,500 acre-feet per year. So 500 acre-feet per year of the original authorization was changed to interruptible. It appears that the priority date of this authorization was not changed.
- 4,000 acre-feet per year authorized in Amendment B with a priority date of May 24, 1982. This is the remaining 4,000 acre-feet per year of the 4,500 acre-foot total reduction in firm yield mentioned in the previous bullet. Amendment D makes this interruptible without changing the priority date.
- 7,500 acre-feet per year authorized in Amendment D with a priority date of July 1, 2002.

According to Special Condition 5.B. of Amendment D, the 12,000 acre-feet of the interruptible water can only be diverted when the lake level is above 43 feet. The upper tier of the bay and estuary pass-through requirements must be met at all times for interruptible water to be diverted, as specified in Bay and Estuary Release Schedule 4.A.1 of Amendment B and repeated in Special Condition 5.A. of Amendment D.

In the current TCEQ WAM, the interruptible authorization is modeled as a single 12,000 acre-feet per year diverted at a July 2, 2002 priority date. The reason for the change in the priority date of the authorization is not documented, but it may be due to the implementation of the LNRA Water Management Plan and the 1996 *Compromise Settlement Agreement* between LNRA and upstream water right holders, which is included in the Water Management Plan. The compromise agreement allows upstream diverters to take water when Lake Texana is above 43 feet. Changing the priority date allows the upstream diverters to take water when Texana is above 43 feet but below 170,300 acre-feet. The proposed modifications to the interruptible code split out the three authorizations so that their origin can be clearly linked to the water rights. The junior priority date of all authorizations has been maintained, but it has been changed to the July 1, 2002 date found in Amendment D.

Two other revisions have been proposed for the interruptible modeling. The first uses the annual diversion limit in Field 10 of the SO Record to limit annual diversions rather than diverting more water than needed to a dummy control point and returning unused water to the reservoir. The annual diversion limit option was not available when the Lavaca WAM was developed. The proposed technique is simpler and more robust than the previous version. The second change uses a pattern that allows more water to be diverted in the last three months of the year if interruptible targets have not been met earlier in the year. The annual limits on the SO record prevent over-use of water.

Like the previous modeling, the 43-foot limit is established by making storage below 43 feet inactive (Field 7 of the WS Record) and bay and estuary limits are implemented using a drought index tied to 78.18 percent of the storage in Lake Texana.

The following changes were made to the model code:

1. A new UC record was added to set monthly interruptible diversion targets. A monthly limit of 2,880 ac-ft has been retained from the old model for the first nine months of the year. This has been increased for the last three months so that the full amount of interruptible water may be diverted if it was not available earlier in the year.

```
UC  INTW     288     288     288     288     288     288
UC           288     288     288     480     480     480
```

2. The 500 ac-ft/yr of interruptible water originating from firm authorization in the original permit is modeled using the following code. Please note that a separate water right record that fills Lake Texana at the 2002 priority date has been commented out because the proposed revisions no longer rely on diverting more water from the reservoir than is needed to meet interruptible targets. The annual diversion target is set to divert 120 ac-ft/month during the first nine months of the year and 200 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 500 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero target to zero.

```
**   500 ac-ft at from original authorization, set to 2002 priority to reflect subordination
**
WRDV221A    1680    INTW20020701   1   1     1.0    NOUT       2      72_INTERUP          TEXANA
WSTEXANA  170300                          160930
SO                                                                   500
PX     3
```

3. The 4,000 ac-ft/yr of interruptible water authorized by Amendment B is modeled using the following code. The annual diversion target is set to divert 960 ac-ft/month during the first nine months of the year and 1,600 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 4,000 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero.

```
**  4,000 ac-ft from 1982 authorization, set to 2002 priority to reflect subordination
**
WRDV221A   13440    INTW20020701   1   1     1.0    NOUT       2      82_INTERUP          TEXANA
WSTEXANA  170300                          160930
SO                                                                  4000
PX     3
```

4. The following code models the 7,500 ac-ft/yr of interruptible water authorized in Amendment D. The annual diversion target is set to divert 1,920 ac-ft/month during the first nine months of the year and 3,200 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 7,500 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from

dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero.

```
**  7,500 ac-ft from Amendment D.
**
WRDV221A   26880    INTW20020701   1   1     1.0    NOUT       2      02_INTERUP          TEXANA
WSTEXANA  170300                          160930
SO                                                                    7500
PX     3
```

Revisions to Stage 2 Location and SVSA Records

In the existing Lavaca WAM, Stage 2 of the Palmetto Bend project does not appear to be modeled at the location or capacity authorized in COA 16-2095, as amended. The location description in the permit states that "Station 129+60 on the centerline, being a point common to the Stage 1 and Stage 2 Dams, bears N 71°27'W, 3333 feet from the northwest corner of the Stephen F. Austin Survey, Abstract No. 5, Jackson Co. Texas." This point is at the tip of the blue arrow in **Figure A-1**, approximately where the proposed Stage 2 dam intersects the existing Stage 1 dam. **Figure A-1** also shows the proposed location of the Stage 2 dam from the 1963 report *Plan of Development for Palmetto Bend Project Texas*. The existing WAM has Stage 2 modeled at control point WQ002, also shown on **Figure A-1**, which is upstream of the location described in the permit. COA 16-2095A authorizes the storage of 93,340 ac-ft in Stage 2. In the existing WAM, the storage for the project is 62,454 ac-ft. The storage in the existing WAM appears to be the location and storage for an alternative version of Stage 2 described in the 1991 report *Cost Update for Palmetto Bend Stage 2 and Yield Enhancement Alternative for Lake Texana and Palmetto Bend Stage 2*. FNI was unable to find any indication that the permit was amended to reflect either the upstream location or the reduced storage.

In order to model Stage 2 as described and authorized in COA 16-2095, FNI proposes:

- Adding a new control point STG_II where the dam described in the 1963 Report intersects the Lavaca River
- Moving the location of the dam to the new control point
- Using the storage-area relationship found in the 1963 Report.

The Stage 2 dam, as proposed in the 1963 Report, would also impound water flowing down Dry Creek, a tributary located between the Lavaca and Navidad Rivers. The dam is upstream of the confluence of Dry Creek and the Navidad River, cutting off a portion of the Dry Creek drainage area. The drainage area for the new control point STG_II includes the portion of the Dry Creek drainage area above the dam.

FNI estimated the drainage area of control point STG_II to be 865 square miles based on the incremental drainage area between control point DV211 and the dam (including the Dry Creek drainage area above the dam). This is less than the 929 square miles in the 1963 Report. The 1963 Report also has a drainage area of 887 square miles for the Lavaca River near Edna, TX (USGS Gage 08164000). This was the gage drainage area reported by the USGS at the time. The USGS subsequently revised the gage drainage area to 817 square miles. The Lavaca WAM has a drainage area of 822.0499 square miles for the Edna gage (control point GS300). Applying the delta between the Lavaca WAM drainage area for GS300 (822 square miles) and the Edna gage drainage area in the 1963 Report (887 square miles) to the Stage 2 drainage area in the 1963

Report (929 square miles) results in a drainage area of 864 square miles; this is very close to the recommended drainage area of 865 square miles.

Figure A-1: Model Stage 2 Reservoir Location

In order to implement the proposed changes, the following revisions were made to the model:

1. A new control point (STG_II) was added to the DAT file.

```
**  FNI change - add new control point for Stage 2 authorized location
**CP DV211   CB220                       7           GS300      -2
CP DV211  STG_II                       7           GS300      -2
CPSTG_II   CB220                       7           GS300      -2
**  FNI change - this control point is above Stage 2 authorized location
**CPTWW217   CB220                       7           GS300      -1
CPTWW217  STG_II                       7           GS300      -1
**  end FNI change
```

2. Associated revisions were also made to the DIS file. Note that this code assumes a primary control point at EP000.

```
** new control point STG_II for authorized location
FDSTG_II   EP000       1   GS300  WGS800   GS500

**  FNI change - new control point at authorized location for Stage 2
WPSTG_II  865.00                     1.0
```

3. Modeling of diversion and storage was revised. The only changes to the existing code for these records are the control point and the storage amount.

```
**  FNI change - move to authorized location at new control point STG_II and store full amount
authorized in water right
**
WRSTG_II    7150       119720515   1   1    0.00                      61602095_3 TEXANA2
WSSTAGE2   93340
**
WRSTG_II   22850       219720515   1   1    0.00                      61602095_4 TEXANA2
WSSTAGE2   93340
**
WRSTG_II   18122  BAYES119931006   1   1     1.0   20955                  2095_5
**
```

New SV and SA records for the downstream location from the 1963 Report were added.

```
**  FNI change
**  Stage 2 SVSA from 1963 Definite Plan Report Palmetto Bend Project Texas
**  elev       0       5      10      15      20      25      30      35      40      44      47
50
SVSTAGE2       0     133     563    1388    4168   11301   24320   43358   68338   93344  116279
147046
SASTAGE2       0      53     119     211     901    1952    3256    4359    5633    6870    8420
11234
**
```

Table B-1: Modeled Bay Inflows from Garcitas Creek
(values in acre-feet per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	824	5,630	851	560	1,445	3,598	85,166	1,455	740	7,378	88,158	42,020	237,826
1941	17,460	11,366	35,582	32,346	91,565	61,381	31,112	5,011	2,245	6,545	6,293	3,841	304,748
1942	2,384	2,745	2,010	23,411	2,949	2,292	37,553	1,475	7,170	4,795	2,235	3,198	92,216
1943	3,077	2,321	5,510	1,446	3,723	4,677	199	1,372	886	3,526	3,414	9,434	39,586
1944	19,558	5,558	34,575	3,204	26,815	4,663	0	1,227	5,285	3,710	2,606	5,424	112,625
1945	10,695	3,530	3,359	15,644	1,937	4,572	0	1,065	387	3,872	505	2,292	47,858
1946	2,675	12,363	6,423	2,639	5,402	25,104	4,670	18,516	41,671	35,228	16,992	5,776	177,460
1947	18,246	3,727	5,442	4,204	19,080	2,741	0	635	391	3,298	879	2,583	61,225
1948	2,031	5,144	4,082	1,014	38,989	2,805	0	240	436	3,143	309	1,870	60,064
1949	1,357	4,993	1,853	26,592	5,021	2,498	185	2,143	835	11,712	943	12,205	70,338
1950	3,574	3,357	1,106	2,723	2,641	4,615	0	101	120	2,998	100	1,741	23,076
1951	726	1,324	468	349	495	10,062	0	0	3,559	3,541	313	1,815	22,651
1952	617	1,788	587	5,925	42,463	6,558	0	440	372	2,974	7,339	10,846	79,908
1953	1,711	2,248	813	1,194	22,255	1,487	0	5,856	2,797	3,468	414	1,875	44,117
1954	761	1,219	270	2,060	2,321	876	0	61	129	2,912	0	1,478	12,088
1955	578	15,717	363	743	22,659	3,883	0	3,782	1,043	2,990	10	1,588	53,357
1956	460	1,343	122	62	384	718	0	0	0	2,896	0	2,262	8,247
1957	303	2,802	11,805	36,346	14,928	9,696	0	50	4,260	46,452	29,699	4,381	160,723
1958	19,135	27,984	4,357	1,823	12,507	1,587	0	299	9,868	8,113	1,660	4,297	91,630
1959	1,998	27,581	2,726	33,867	11,030	4,769	0	1,732	1,842	8,928	5,955	5,597	106,025
1960	5,558	6,166	2,127	2,806	2,826	32,797	11,375	16,500	1,939	85,968	21,834	15,894	205,791
1961	27,111	27,109	4,272	2,811	3,081	41,255	21,112	2,023	53,173	6,472	28,128	4,516	221,063
1962	3,002	3,107	1,873	15,784	3,186	7,625	843	460	3,865	4,218	861	2,930	47,755
1963	2,639	8,166	1,260	696	1,075	1,531	3,572	119	106	2,995	450	2,411	25,022
1964	1,325	2,637	2,307	1,791	1,083	9,263	0	594	4,874	3,814	221	1,829	29,738
1965	17,069	23,863	2,142	1,714	53,166	20,770	0	744	460	4,872	20,973	8,236	154,009
1966	3,772	7,517	3,935	14,804	23,951	4,815	1,451	1,067	841	3,310	430	2,000	67,894
1967	995	1,402	663	1,803	1,319	1,027	0	406	48,334	22,113	2,106	2,591	82,759
1968	28,417	4,540	4,318	5,452	44,596	58,340	9,820	1,503	2,747	3,905	1,185	6,378	171,202
1969	3,482	26,693	19,042	35,785	46,711	3,976	0	855	1,264	5,692	1,599	8,684	153,782
1970	7,905	2,572	9,639	1,951	40,993	13,491	203	0	10,580	3,798	183	165	91,480
1971	163	82	175	191	47	5,188	1,076	1,715	53,829	36,219	2,524	11,550	112,759
1972	15,451	5,121	419	202	68,574	1,050	5,167	8,743	627	523	893	319	107,087
1973	2,453	12,583	5,433	48,167	1,951	79,098	1,081	1,043	12,309	39,243	1,597	904	205,862
1974	6,858	1,196	846	394	33,948	21,554	967	1,146	20,027	919	14,364	8,026	110,245
1975	3,234	719	531	329	33,131	10,211	3,277	777	1,851	636	500	49,659	104,855
1976	1,680	539	700	28,211	39,129	2,838	6,682	480	9,638	31,593	17,130	62,326	200,946
1977	9,874	23,464	1,854	4,837	1,067	36,030	961	554	1,155	2,705	3,556	853	86,911
1978	5,201	11,282	658	3,227	735	12,935	177	86	180,536	1,590	1,926	865	219,217
1979	47,195	22,355	2,146	14,666	118,651	24,595	8,647	1,060	77,100	2,507	1,022	908	320,852

Table B-1 (continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	29,899	4,295	1,073	747	72,229	1,022	74	24	1,433	1,813	278	199	113,088
1981	505	301	320	329	13,400	169,853	7,012	633	537	4,707	16,035	659	214,290
1982	515	18,070	2,496	2,371	112,935	1,573	244	0	199	4,446	66,627	5,627	215,103
1983	2,444	25,067	15,522	1,084	782	207	50,676	4,060	5,641	37,991	12,027	1,082	156,582
1984	12,745	4,205	970	527	975	182	25	138	249	8,210	2,570	2,194	32,988
1985	12,461	5,742	47,916	65,130	2,995	2,459	6,950	474	353	1,473	1,316	1,498	148,768
1986	1,004	448	342	328	2,307	18,510	226	0	232	4,224	1,771	37,254	66,646
1987	11,388	21,957	4,133	502	2,529	166,884	4,365	606	1,070	576	17,435	5,472	236,919
1988	1,417	626	568	743	607	29	67	0	0	57	53	121	4,289
1989	4,711	1,890	150	120	8	0	50	0	0	5	2	6	6,943
1990	8	29	1,723	3,650	327	0	28,635	699	1,054	64	45	17	36,252
1991	16,208	14,135	3,530	150,328	1,904	573	9,622	703	3,910	935	1,285	45,556	248,690
1992	52,136	123,417	4,021	84,023	68,135	20,084	962	497	594	234	2,535	1,494	358,132
1993	8,446	14,693	37,944	7,536	94,839	155,426	2,478	315	254	340	495	419	323,183
1994	719	595	12,703	812	35,531	1,628	212	596	6,861	164,343	1,588	7,740	233,326
1995	13,093	623	13,463	1,526	1,390	2,683	174	256	620	108	1,663	3,447	39,047
1996	535	177	118	64	5	7,959	304	3,317	19,960	368	172	272	33,251

APPENDIX 3E
Geotechnical Investigation and Preliminary Engineering Analysis of Off-Channel Reservoir

TECHNICAL MEMORANDUM

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TO: Pat Brzozowski, P.E.

CC: Michael Reedy, P.E.

FROM: Tony Bosecker, P.E. and Shawn Hutcherson, P.E.

SUBJECT: Geotechnical Investigation and Preliminary Engineering Analysis

DATE: March 1, 2018

PROJECT: LVA17406 – Proposed Off-Channel Reservoir Due Diligence

STATE OF TEXAS
TONY BOSECKER
80158
REGISTERED
PROFESSIONAL ENGINEER

03/01/2018
Freese and Nichols, Inc.
Texas Registered Engineering
Firm F-2144

PROJECT DESCRIPTION

This technical memorandum summarizes the results of the geotechnical investigation performed for the proposed Off-Channel Reservoir (OCR) Due Diligence Study and provides preliminary engineering analysis for OCR development. This work was provided under Freese and Nichols, Inc. (FNI) project number LVA17406, authorized by the contract with Lavaca Navidad River Authority.

The geotechnical investigation and subsequent preliminary engineering analysis were conducted to aid in the evaluation of an approximate 2,500-acre site, owned by Formosa, proposed as an OCR site. The recommendations in this study are according to the following scope of services:

- Select locations for up to fifteen (15) exploratory borings (grid with boring spacing of about 4,000) at the site for identification and evaluation of subsurface materials. All borings will be drilled to a maximum depth of 50 feet.

- Laboratory testing shall be performed on samples obtained from the borings to determine soil classification and pertinent engineering properties of the subsurface materials.

- Develop assessment of subsurface conditions and soil properties indicated by the field and laboratory work and the implications for design.

- Perform preliminary seepage analysis using generalized hydraulic conductivity values based on gradation tests and industry accepted correlations based on soil classification. The seepage analysis will be performed for one typical cross section.

- Perform preliminary slope stability analysis using shear strength parameters based on soil classifications and industry accepted correlations. Results of global stability analyses (rotational failure) and pertinent analysis output figures displaying the failure surface, calculated factor of safety, and water surface elevations for one representative cross section will be provided.

- Develop assessment of expected construction related issues.

- Develop up to four potential configurations using up to two cells that provide the desired storage.
- Adjust the potential configurations to accommodate yield and environmental constraints.
- Develop a typical section, including erosion protection, cutoff and minimum slopes.
- Evaluate the potential for on-site borrow material.
- Develop a proposed inlet and outlet structure configuration that would be typical for the identified configurations.
- Perform Preliminary Design Flood Analysis and maximum wave calculations to determine a minimum overflow spillway and needed freeboard.
- Based on further analysis and evaluations regarding permitting issues, select a final configuration for further development.

This technical memorandum has been prepared based on our current knowledge and understanding of the proposed project. Changes in the configuration or location of the proposed OCR, as described in this document, may require modification of the recommendations contained in this technical memorandum. This memorandum presents the results of the geotechnical investigation and preliminary engineering analysis in a direct and abbreviated manner and is not intended to serve as a detailed report.

Pertinent project details are summarized in Table 1.

Table 1 – Project Summary

Project Location:	Jackson County, Texas – 2 miles west of Highway 172, 7 miles SE of LNRA's Palmetto Bend dam and 2 miles east of the Formosa Plant
Proposed Improvements:	Evaluate an approximate 2,500-acre site, currently owned by Formosa, as a future location for an Off-Channel Reservoir

SUBSURFACE EXPLORATION AND LABORATORY TESTING

The subsurface exploration for the proposed OCR Due Diligence Study consisted of drilling fifteen (15) exploratory core borings each to a depth of 50 feet. The borings were drilled between September 27, 2017 and October 6, 2017 and the boring locations are presented on the Boring Location Map included with this memorandum.

The borings were drilled by Terracon using a Dietrich D-50 track-mounted drill rig. Zack Ready of Geoscience Consultants International supervised the drilling and logged the borings. The borings were drilled using continuous flight augers and rotary wash methods to the terminal depth of 50 feet below ground surface. Push tubes and a split-spoon sampler were used to collect samples within the borings. The split-spoon sampler was used in conjunction with the Standard Penetration Test (STP). The borings were observed for indications of subsurface water

entry during drilling and were checked for accumulated water before being backfilled with bentonite chips and topped with soil cuttings.
Laboratory testing was performed on selected samples by Gorrondona and Associates, Inc. Testing was performed to allow for material classification according to the Unified Soil Classification System (USCS) and to evaluate pertinent engineering properties of the materials. These tests included moisture content, unit dry weight, Atterberg limits, percentage passing a No. 200 Sieve, grain size analysis, unconfined compression tests and crumb dispersion tests. The results of these tests are presented on the boring logs (See Appendix B) and in Appendix C – Laboratory Test Results.

The boring logs were prepared from the field logs and represent a generalized interpretation of the stratigraphy encountered within each boring based on field descriptions, *in situ* testing, and laboratory test results. Stratigraphy lines shown on the logs correspond to the approximate boundary between strata. *In situ*, this transition can be, and often is, gradual. The boring logs are included with this memorandum along with a key to the symbols and terms used on the logs.

GENERALIZED SUBSURFACE CONDITIONS

GEOLOGY

The approximate 3,000-acre site is located within the Beaumont geologic formation, either in areas predominantly in clay or areas predominantly in sand. The predominantly clay portion of the Beaumont formation consists of "dominantly clay and mud of low permeability" (Bureau of Economic Geology, Geologic Map of Texas, 1992 (University of Texas at Austin)). Specifically, the formation consists of light- to dark-gray and bluish- to greenish-gray clay and silt, intermixed and interbedded; contains beds and lenses of fine sand, decayed organic matter, and many buried organic-rich, oxidized soil(?) zones that contain calcareous and ferruginous nodules. Very light gray to very light yellowish-gray sediment cemented by calcium carbonate is present in varied forms, veins, laminar zones, burrows, root casts, nodules. Locally, small gypsum crystals are present. Plastic and compressible clay and mud were deposited in flood basins, coastal lakes, and former stream channels on a deltaic plain" (from Moore and Wermund, 1993a, 1993b).

The predominantly clay portion of the Beaumont formation consists of "yellowish- to brownish-gray, locally reddish orange, very fine to fine quartz sand, silt, and minor fine gravel, intermixed and interbedded. It includes stream channel, point-bar, cravasse-splay, and natural levee ridge deposits, and clayey fill in abandoned channels. It forms poorly defined meander-belt ridges and pimple mounds aligned approximately normal to coast and 1-2 m higher than surrounding interdistributary silt and clay. Channel fill is dark-brown to brownish-dark-gray, laminated clay and silt, organic -rich. The formation includes marine delta-front sand, lagoonal clay, and near-shore marine sand beneath and landward of bays along the coast" (from Moore and Wermund, 1993a, 1993b).

STRATIGRAPHY

The site stratigraphy varies across the site but is composed primarily of sandy lean (CL) and fat (CH) clays, clayey sands (SC) and sands (SP). Stiff to hard clays generally overlie very loose to dense sands with alternating clays and sands of variable thicknesses beneath the sands. The upper clays (CL and CH) are dark brown and brown near the surface and transition to light brown, reddish brown and light gray with depth. Atterberg limits tests performed on the upper clays resulted in liquid limits ranging from 29 to 79 and plasticity indices ranging from 10 to 49 with percentages passing a No. 200 Sieve ranging from 51 to 100 percent. The sands beneath the upper clays were light brown and reddish brown. The sands had percentages passing a No. 200 Sieve ranging from 6 to 34 percent.

A summary of the generalized stratigraphy is provided in the table below. The ranges contain the limits within the designated stratigraphy. Reference to the boring logs should be made for more details specific to the materials and subsurface transitions observed within each boring.

Table 2 – Generalized Stratigraphy

Stratum	Depth Range	Description
1	0-50	Dark brown to light brown, reddish brown and light gray, stiff to hard, **LEAN (CL) and FAT (CH) CLAY**; 29$\leq$LL$\leq$79, 10$\leq$PI$\leq$49, 51$\leq$P200$\leq$100
2	6-38	Light brown and reddish brown, very loose to very dense, **CLAYEY SANDS (SC) and SANDS (SP)**
3	18-50	Yellowish brown, reddish brown and light gray, medium stiff to hard, **LEAN (CL) and FAT (CH) CLAY**; and light to dark brown, reddish and yellowish brown, loose to very dense **CLAYEY SANDS (SC) and SANDS (SP)**

GROUNDWATER

The borings were advanced using techniques that allow for direct and indirect observations of seepage and groundwater during drilling operations. The borings were advanced with continuous flight augers and used rotary wash drilling techniques which require water for drilling fluid. Observations for seepage and groundwater were made in all of the borings before the introduction of drilling fluids.

Groundwater was encountered in all of the borings except for one (B-105). During drilling, groundwater was encountered at depths ranging from 10.8 feet to 28 feet below ground surface (bgs). The observations are only indicative of conditions at the time and place indicated. A groundwater study has not been performed for this project, and long-term observations would be necessary to evaluate the groundwater levels and fluctuations. The occurrence of groundwater can vary due to many factors, including seasonal changes, site topography, surface runoff, the layering and permeability of subsurface strata, water levels in waterways, etc. Groundwater at this site will likely be influenced by seasonal flows within Keller Creek channel that runs through the site.

GEOTECHNICAL ANALYSIS AND DISCUSSION

EMBANKMENT DESIGN

Two footprints for the OCR were evaluated. The smaller footprint is located north and west of Keller Creek (refer to Figure 2) and attempts to avoid or minimize potential mitigation requirements. The larger footprint (refer to Figure 3) generally encompasses most of the subject property, but it will require mitigation due to rerouting of Keller Creek and existing wetlands on the site (especially south and east of Keller Creek). Storage volumes were developed based on a firm yield analysis prepared by FNI and included in a separate memorandum.

Several different embankment configurations were evaluated for the different storage volumes developed. These configurations included varied slope angles for both the upstream and downstream side of the embankment. These included the following: (1) 4H:1V upstream and downstream; (2) 3.5H:1V upstream and 4H:1V downstream; (3) 3.5H:1V upstream and downstream; (4) 3H:1V upstream and 3.5H:1V downstream; (5) 3H:1V upstream and downstream. Using these different configurations along with different storage volumes (3 for the smaller footprint and 3 for the larger footprint), calculations were performed to determine dam height. Wave runup calculations were performed for these alternatives to determine the amount of freeboard needed for each footprint. A discussion on wave runup is included in a later section of this memorandum. Based on these factors, a cut (excavation) and fill (compacted fill) balance was performed to optimize the use of the onsite soil as fill material for the embankment. Refer to Table 3 for a summary of the different scenarios.

TABLE 3

LNRA OFF CHANNEL RESERVOIR - SMALL FOOTPRINT (~1440 ACRES)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
30,284	54.8	47.8	28.3	26.5	4H:1V both	5,129,043	4,605,376	11,000
30,284	54.9	47.9	28.4	26.5	3.5H:1V up; 4H:1V down	4,972,530	4,409,966	65,000
30,284	55	48	28.5	26.5	3.5H:1V both	4,816,343	4,211,093	124,000
30,284	55.2	48.2	28.7	26.5	3H:1V up; 3.5H:1V down	4,503,968	4,035,706	18,000
30,284	55.3	48.3	28.8	26.5	3H:1V both	4,347,781	3,828,124	85,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
40,378	60.1	53.1	27.1	33.0	4H:1V both	7,184,209	6,459,495	6,000
40,378	60.2	53.2	27.2	33.0	3.5H:1V up; 4H:1V down	7,004,106	6,165,550	138,000
40,378	60.4	53.4	27.4	33.0	3.5H:1V both	6,648,617	5,901,317	82,000
40,378	60.6	53.6	27.6	33.0	3H:1V up; 3.5H:1V down	6,297,195	5,628,785	39,000
40,378	60.8	53.8	27.8	33.0	3H:1V both	5,948,539	5,347,868	6,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
50,007	65.2	58.2	26.0	39.2	4H:1V both	9,477,887	8,543,937	(14,000)
50,007	65.3	58.3	26.1	39.2	3.5H:1V up; 4H:1V down	9,254,832	8,136,407	193,000
50,007	65.5	58.5	26.3	39.2	3.5H:1V both	8,822,550	7,762,921	177,000
50,007	65.7	58.7	26.5	39.2	3H:1V up; 3.5H:1V down	8,397,590	7,379,691	178,000
50,007	66	59	26.8	39.2	3H:1V both	7,775,769	7,020,973	(23,000)

LNRA OFF CHANNEL RESERVOIR - LARGE FOOTPRINT (~2500 ACRES)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
50,133	54.4	45.6	30	24.4	4H:1V both	5,444,270	4,964,357	(65,000)
50,133	54.4	45.9	30	24.4	3.5H:1V up; 4H:1V down	5,444,270	4,722,860	177,000
50,133	54.5	46	30.1	24.4	3.5H:1V both	5,163,476	4,512,885	134,000
50,133	54.6	46.1	30.2	24.4	3H:1V up; 3.5H:1V down	4,889,949	4,299,086	102,000
50,133	54.7	46.2	30.3	24.4	3H:1V both	4,616,713	4,081,440	74,000

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
60,222	57.2	48.7	29.6	27.6	4H:1V both	6,776,150	6,005,637	93,000
60,222	57.3	48.8	29.7	27.6	3.5H:1V up; 4H:1V down	6,438,965	5,742,972	52,000
60,222	57.4	48.9	29.8	27.6	3.5H:1V both	6,106,140	5,476,041	19,000
60,222	57.5	49	29.9	27.6	3H:1V up; 3.5H:1V down	5,774,769	5,204,819	(8,000)
60,222	57.6	49.1	30	27.6	3H:1V both	5,444,270	4,929,283	(29,000)

Storage Volume (ac-ft)	Top of Dam Elevation	Normal Pool	Bottom Elevation	Dam Height	Slopes	Excavation	Compacted Fill	Borrow
75,357	61.4	52.9	29	32.4	4H:1V both	8,877,160	7,756,918	233,000
75,357	61.5	53	29.1	32.4	3.5H:1V up; 4H:1V down	8,516,721	7,400,436	265,000
75,357	61.7	53.2	29.3	32.4	3.5H:1V both	7,808,051	7,078,650	(51,000)
75,357	61.8	53.3	29.4	32.4	3H:1V up; 3.5H:1V down	7,458,368	6,709,821	3,000
75,357	61.9	53.4	29.5	32.4	3H:1V both	7,114,206	6,335,984	67,000

Depending on which footprint is selected and what storage volume is used, the embankment height will range from 24 to 39 feet and will be about 25 feet wide at the crest. The embankment will have 3H:1V side slopes on both the interior and exterior slopes (see Figure 4). Embankment slope angles are governed by soil cement construction issues on the interior slopes and maintenance (mowing and potential surface slides) on the exterior slopes in addition to the global stability of the embankment.

The embankment should consist of compacted earth fill, soil cement for slope protection on the interior slopes, and a toe drain constructed within the base of the embankment about 30 feet from the downstream toe. The toe drain will have periodic outlets along the downstream toe of the embankment.

The toe drain system will consist of a 4-foot by 4-foot thick clean gravel surrounded by a 3-foot thick filter sand. At periodic locations, the toe drain will discharge via a 12-inch diameter HDPE or PVC pipe to a concrete discharge structure located at the downstream toe. The concrete structures will discharge into perimeter drainage channels.

A ramp will be constructed on the inside of the reservoir to provide access for maintenance and cleaning. A 2-foot layer of soil cement will be placed on the ramp and interior slopes of the reservoir to provide slope protection from wave action and protection during maintenance and cleaning.

The exterior slopes of the reservoir will be grassed.

CONSTRUCTION MATERIALS

The proposed reservoir site will use onsite materials to balance the cut and fill requirements. Depending on the storage volume and the footprint selected, up to 3 feet will be excavated from the interior of the reservoir to construct the embankment. Soils consisting of lean (CL) to fat (CH) clays, and to a lesser extent clayey sand (SC) material, were found in the upper 3 feet across the site. These materials are suitable for use in the embankment. A homogeneous embankment is recommended, although utilizing the leaner clays and clayey sands when possible in the outer portions (shell) of the embankment will help reduce potential surface slides due to dessication cracking.

Granular material for the soil cement and toe drain system should be obtained from an offsite source since these types of materials are not readily available onsite.

ANALYSIS OF LABORATORY DATA

Data from the laboratory tests performed on samples collected during the field investigation were analyzed to develop generalized conditions across the proposed site. The purpose of these averages is to determine if soil types available during excavation will be suitable embankment material for design. The coarse analysis evaluated average values for each of five rows of borings, with each row containing three borings. For each row, test results were averaged across the three borings, in 10-foot depth intervals. Table 4 presents the averaged values. A legend for the abbreviated field and laboratory tests provided in Table 4 are as follows:

- dd – dry density (pcf)
- -200 – percent passing the #200 sieve
- LL – liquid limit
- PL – plastic limit
- PI – plasticity index
- Qu – unconfined compression test (tsf)
- N – blows per foot
- HP – hand penetrometer (tsf)

Table 4: Average Test Results across Proposed Site

Borings 101-103

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	104	72	45	19	26	0.7	11	3.0
10-20	100	53	62	22	40	1.2	10	2.8
20-30	-	86	67	23	44	-	11	2.8
30-40	91	-	70	23	47	2.9	14	4.1
40-50	-	99	49	19	30	-	9	3.0

Borings 104-106

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	111	84	41	18	23	0.8	9	2.7
10-20	109	65	41	20	21	2.4	12	2.8
20-30	95	75	44	23	22	1.5	16	1.9
30-40	-	92	53	20	33	-	12	3.5
40-50	-	-	-	-	-	-	11	2.7

Borings 107-109

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	114	84	47	17	30	2.9	-	3.7
10-20	104	56	56	26	30	3.0	16	3.3
20-30	-	56	-	-	-	-	23	0.8
30-40	96	91	59	24	35	2.2	-	2.8
40-50	-	-	-	-	-	-	63	1.9

Borings 110-112

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	113	72	57	21	37	1.8	8	3.1
10-20	96	56	80	35	45	2.4	20	3.0
20-30	106	100	68	30	38	1.9	11	3.8
30-40	99	69	57	25	32	2.6	7	3.8
40-50	-	-	-	-	-	-	3	2.2

Borings 113-115

Depth	Avg. dd	Avg. -200	Avg. LL	Avg. PL	Avg. PI	Avg. Qu	Avg. N	Avg. HP
0-10	122	76	47	18	29	3.0	23	3.6
10-20	99	44	71	31	40	2.0	11	2.5
20-30	102	67	43	22	21	2.7	31	4.1
30-40	-	98	60	26	34	-	35	3.1
40-50	-	-	-	-	-	-	-	2.7

The data indicates that conditions are relatively similar across the site, with primarily fine-grained soil in the upper 10 feet, a zone of sandy clay and clayey sand from 10 to 20 feet, and then generally increasing in fines content with depth below 20 feet.

DISPERSIVE SOILS

Crumb dispersion tests were performed on 26 soil samples to determine if the clays onsite are dispersive in nature. Dispersive clays have different properties from normal clays because their electrochemical makeup is different. The presence of dispersive clays in an embankment can lead to piping (erosion) failures.

The test results performed on selected samples of the clay soils at the site are included in Appendix D and here as follows: Six of the samples tested were determined to be highly dispersive (Grade 4), one sample was classified as dispersive (Grade 3), two were classified as slightly dispersive (Grade 2) and 17 (Grade 1) were considered to be non-dispersive. About 25 percent of the samples tested were classified as dispersive or highly dispersive. It is anticipated that soils for the embankment will be obtained onsite within the upper four feet of the surface. Eleven of the 26 samples that were tested were from soils that were within the upper 4 feet. Of those eleven samples tested, four samples were classified as highly dispersive. While not desirable, dispersive soils can be used in the construction of the embankment provided they are encapsulated with non-dispersive soils. Dispersive soils should not be exposed on the slopes or within three feet of the surface of the embankment. A larger concern with respect to dispersive soils at the site is in the bottom of the unlined reservoir. If the dispersive soils are widespread across the proposed bottom of the OCR, a slurry trench (3-foot to 5-foot wide and 40-50 feet deep) constructed beneath the embankment could effectively cut off potential piping (erosion) failures due to dispersive soils.

GEOTECHNICAL DESIGN PARAMETERS

Geotechnical parameters were developed for use in seepage and slope stability analyses. Estimated parameters are based on the general characteristics of sampled materials, as no hydraulic conductivity and shear strength testing was performed during this study.

Seepage Parameters

The embankment material will be sourced from the upper few feet of soil across the site. This material ranges in percent fines from 35% to 98%, with an average of 78% across the site. The index value for liquid limit for this material ranges from 29 to 79, with an average of 47. The plasticity index values range from 10 to 49, with an average of 29. The average values suggest a borderline material between lean and fat clay. Based on this data, a horizontal hydraulic conductivity equal to 3.0E-07 cm/sec (9.8E-09 ft/sec) is selected based on the clay material, and then increased 100% to 6.0E-07 cm/sec (2.0E-08 ft/sec) to account for the 20+% sand content. An anisotropy Kv/Kh value of 0.25 is assumed.

Some clay zones within the foundation were found to have fines contents of 90% or greater. A horizontal hydraulic conductivity of 3.0E-07 (9.8E-09 ft/sec) is estimated for the foundation clay material, with an anisotropy of 0.25 assumed.

Clayey/silty sand zones with greater than 13% fines are assumed to have a horizontal hydraulic conductivity of 1.0E-05 cm/sec (3.3E-07 ft/sec), with an anisotropy Kv/Kh ratio of 0.25.

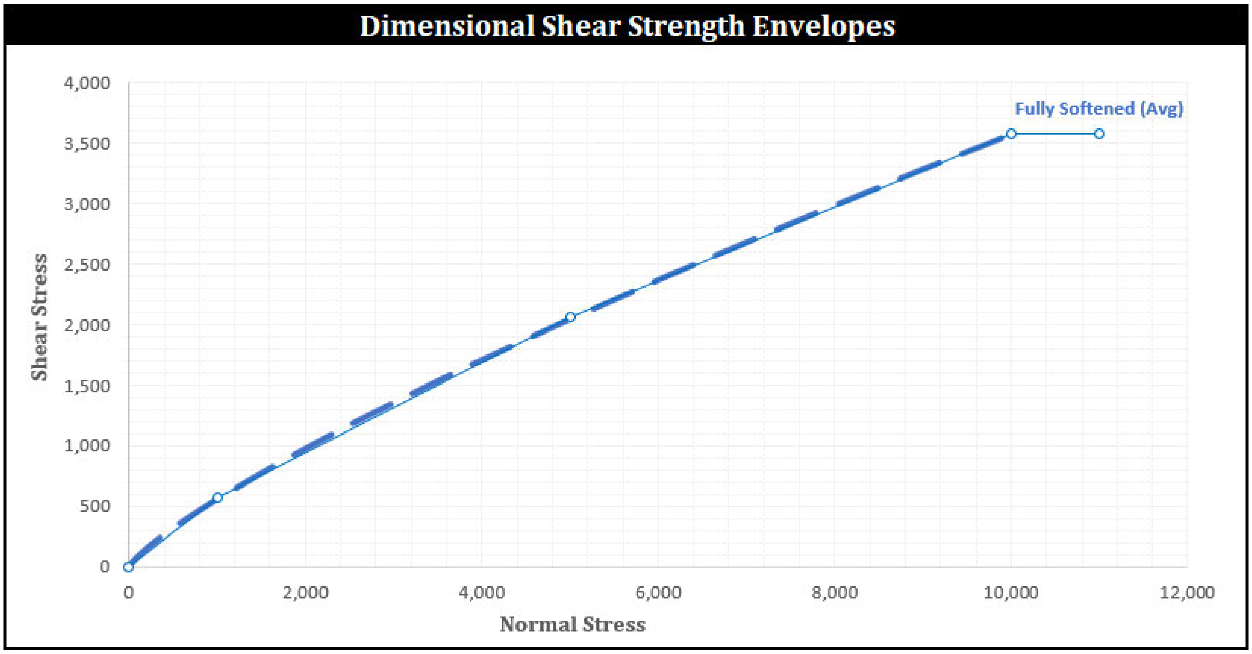
For sand zones with less than 13% fines, data from particle size analyses performed on samples collected during the site investigation were used with the Kozeny-Carmen method for estimating hydraulic conductivity. An average vertical hydraulic conductivity of 4.8E-03 cm/sec (1.6E-04 ft/sec) is estimated. An anisotropy of 0.5 is assumed, resulting in an estimated horizontal hydraulic conductivity of 9.6E-03 cm/sec (3.2E-04 ft/sec).

Shear Strength Parameters

At the conceptual design level, the only shear strength testing performed in the laboratory consisted of unconfined compression strength tests (UCS) on cohesive material. The UCS results provide an estimate of undrained shear strength of fine-grained collected samples. Testing performed in the field consisted of Standard Penetration Tests and hand penetrometers. SPT data can be used to estimate insitu density of coarse-grained materials and correlated drained strength values. Hand penetrometer data is used to determine the consistency of fine-grained collected samples, which can be helpful identifying areas of weak and highly compressible soil.
The UCS test results ranged from 0.7 to 3.3 tsf, with an average of 2.1 tsf. A UCS value of 1.4 tsf is selected as representative for the fine-grained foundation material, resulting in an undrained shear strength of 1400 psf. The hand penetrometer results range from 0.75 to 4.5+ tsf, indicating foundation consistency ranging from stiff to hard.

The SPT test results ranged from 4 to 63 blows per foot within the materials classified as poorly graded sand, and an average value of 22. A correlation developed by Peck was used to estimate drained shear strength based on the blow count value. The correlation shows a range of secant friction angles from 30 to 36 degrees for blow counts between 10 and 30. A secant friction angle value of 33 degrees is selected as representative for initial stability modeling.

For the fine-grained embankment and foundation soils, a typical peak strength envelope of 24 degrees and 230 psf cohesion is selected as representative. This envelope is consistent with the values published in NAVFAC 1986 for an intermediate CH/CL material. The undrained shear strength of the embankment material is assumed to be 1000 psf, consistent with a medium stiff to stiff clay. Given the moderate to high plasticity of the clay on-site, and related capacity for shrinking and swelling, fully softened shear strength (FSS) parameters have also been estimated. The FSS can be used to analyze a slope for susceptibility to shallow slides, which are typically 5 to 6 feet in depth. These potential shallow slides are considered a maintenance issue if addressed in a timely manner. The FSS parameters were estimated using the correlation developed by Castellanos 2016. The correlation uses the measured liquid limit, plasticity index, and clay fraction for a material to estimate a fully softened shear strength envelope represented by a power curve function. For this estimation, the average of the maximum and the mean values for each parameter were used to represent the 75th percentile value, weighting the strength envelope towards the lower bound strength envelope. The values used were: liquid limit of 63, plasticity index of 39, and an estimated clay fraction of 47%. The resulting FSS envelope is presented in Figure A, and an equivalent piece-wise function using Mohr-Coulomb parameters presented in Figure B.



All Stress Units:	PSF	All Angle Units:	DEGREES

Figure A: Fully Softened Shear Strength Envelope

Piece-Wise Function M-C Values

Description:		FSS, Average	
Normal Stress Range		φ'	c'
0	1,000	29.7	0.0
1,000	5,000	20.3	218.7
5,000	10,000	17.0	531.8
10,000	11,000	0.0	3583.9

Figure B: Fully Softened Shear Strength Envelope using Mohr-Coulomb Piece-Wise Function

For the clayey sand foundation soils, a typical peak strength envelope of 31 degrees and 230 psf cohesion is selected as representative. This envelope is consistent with the values published in NAVFAC 1986 for an SC material.

<u>Summary of Selected Geotechnical Parameters</u>

Table 5 summarizes the parameters discussed for seepage and slope stability analyses.

Table 5: Preliminary Design Parameters

Material	Unit Weight	Drained Strength		Undrained Strength		Hydraulic Conductivity	
	g (pcf)	φ' (deg)	c' (psf)	φ (deg)	c (psf)	k (ft/sec)	K_v/K_h
Sandy Clay, embankment	125	24	230	0	1000	2.0E-08	0.25

Table 5: Preliminary Design Parameters (cont.)

Sandy Clay, foundation	125	24	230	0	1400	2.0E-08	0.25
Clay	125	19	230	0	1400	9.8E-09	0.25
Clayey Sand	125	31	230	0	1400	3.3E-07	0.25
Sand	120	33	0	-	-	3.2E-04	0.50

SEEPAGE ANALYSIS

A finite element model was developed to evaluate seepage conditions using the SEEP/W module within GeoStudio 2016. A maximum embankment height of 38 feet was analyzed. Steady state seepage was evaluated with normal pool at elevation 59 feet, crest elevation at EL 65 feet, upstream and downstream toe of slope at EL 27 feet, and an initial groundwater surface at EL 17 feet. Based on data from the field investigation, the foundation materials between 10 and 30 feet below existing ground surface vary between clay, sandy clay, clayey sand and poorly graded sand. Various scenarios were evaluated to determine how different combinations of each of these materials affect developed pore pressures. It was found that the condition where a vein of sand within the foundation, which extends below the reservoir and under the embankment, but is unable to daylight downstream, presents the most critical state regarding location and magnitude of pore pressures. The sand vein is capable of developing high pore pressures below the embankment and downstream toe. After determining the critical condition, different design elements were added to the embankment and foundation in an attempt to mitigate against the predicted pore pressures. The design elements evaluated included cut-off trenches, drainage trenches, embankment vertical and horizontal filters, toe drain, and downstream relief wells. The toe drain appears to manage seepage through the embankment provided that relief wells were included and controlled the pressures within the foundation sand vein. A relief well consists of a pipe that is installed in a vertical borehole and backfilled with sand or gravel. The pipe (usually 4 inches in diameter or greater made of stainless steel) consists of a lower screened section and a solid section above. In order for the relief wells to be effective, they must penetrate the sand vein. The pipe is a conduit for release of the pressure by passive means (i.e. no pumping). While the toe drains and relief wells are not directly connected, they may share the same discharge structure depending on the spacing of the toe drains and relief wells. Layers of sand were noted in the bore logs as deep as 48 feet. Given these depths, relief wells are likely to be a cost effective and practical method for controlling the foundation pressures. The relief well system and the toe drain are not connected hydraulically but may share a discharge structure.

Without the downstream relief wells, the risk of uplift and blowout of the downstream toe of slope increases significantly. This is in addition to a decrease in stability of the downstream slope. Uplift and blowout of the downstream toe could lead to backwards piping of foundation materials and eventual uncontrolled release of the reservoir.

SLOPE STABILITY ANALYSIS

A limit equilibrium model was developed to evaluate slope stability using the SLOPE/W module within GeoStudio 2016. Each scenario utilized the Spencer method to calculate the factor of safety. Pore pressures developed in the seepage analysis were utilized in the slope stability analyses. When appropriate, tension cracks were introduced to the model to prevent tensile force from developing within the soil, and the tension cracks were conservatively assumed to be 100% filled with water. Four scenarios were evaluated for slope stability: End of Construction (EOC), Steady State Seepage (SSS), Rapid Drawdown (RDD), and Fully Softened (FSS).

The EOC scenario evaluates the embankment and foundation at the end of construction and during first filling of the reservoir. Low permeability soils in the foundation are assumed to have not undergone consolidation due to the increased loading of the constructed embankment, and the low permeability soils in the embankment have not yet consolidated under their self-weight. Unconsolidated-undrained (UU) shear strengths are assigned to the low permeability soils. The relatively high permeability soils (sand) are assigned drained shear strength parameters. Pore pressures are only accounted for within the high permeability soils, while pore pressures are accounted for in the UU shear strength of the low permeability soils.

The SSS scenario evaluates the embankment and foundation under long-term conditions, assuming a steady-state seepage flow regime develops through the embankment. This assumption is conservative for a pump storage reservoir if water levels fluctuate regularly. Drained shear strengths are assigned to all soils, and pore pressures from the seepage analysis are accounted for within all soils.

The RDD scenario evaluates the upstream embankment slope for the condition where the reservoir is lowered at a rate faster than the embankment soils can dissipate developed pore pressures. The staged undrained strength method developed by Duncan, Wright and Wong was utilized to analyze the RDD scenario. This method evaluates the slope using drained strengths and consolidated-undrained strengths after drawdown to determine the limiting condition (lowest factor of safety). The pore pressures from the steady state seepage analysis were utilized to develop the initial pore pressure condition, prior to drawdown.

The FSS scenario evaluates the downstream slope when moderate to high plasticity soils are used to construct an embankment. These soils are susceptible to large volume changes between periods of wet and dry weather. Repeated volume change cycles have the effect of reducing slope stability over time. The reduced soil shear strength due to this weathering effect is referred to as “fully softened”. Fully softened shear strength is applied to the upper 10 feet of the embankment and above the SSS phreatic surface, the zone typically influenced by the weathering effects. Shallow slides associated with the FSS scenario are typically triggered after an intense rainfall event that follows an extend period of dry weather. To simulate the pore pressures developed during the rainfall event, a pore pressure coefficient of 0.29 was used, which is based on past experience with similar projects. The pore pressure coefficient method simply estimates the pore pressure at a specific point by multiplying the total overburden stress at that point by the pore pressure coefficient.

The side slopes of the embankment were set at 3.5 horizontal to 1 vertical during the first model run. Factors of safety for EOC, SSS and RDD scenarios were in excess of the minimum values required by TCEQ Dam Safety program for new dams. TCEQ does not have a minimum for the FSS scenario. The side slopes were then analyzed at 3 horizontal to 1 vertical (3H:1V), and again, all factors of safety exceed the TCEQ required minimum values. Slopes steeper than 3H:1V can present difficulties during maintenance operations, and increase the risk of shallow side development. No slopes steeper than 3H:1V were analyzed. A summary of the calculated factors of safety for each scenario are present in Table 6. Figures illustrating the model results are provided in Appendix E.

Table 6: Slope Stability Factor of Safety Summary

Scenario	**Slope Stability Factor of Safety (3H:1V)**	
	Calculated FOS	**TCEQ Req. Minimum**
EOC	1.5	1.25
SSS	1.8	1.5
RDD	1.4	1.2

Table 6: Slope Stability Factor of Safety Summary (cont.)

FSS	1.30	-

FREEBOARD CALCULATIONS

The necessary freeboard for the reservoir was calculated by comparing the maximum wave height with runup from a design level wind with the Probable Maximum Flood (PMF) level combined with a strong wind. Since there are not any governing criteria from the TCEQ or other entities with regard to selection of wind speed, the design level wind is based on historical maximum wind speeds recorded for the area, which is equivalent to a Category I hurricane. The process finds a critical sustained wind speed that can be maintained long enough to generate full wave heights for the given fetch and depth of the reservoir. For the smaller reservoir, the fetch is 1.5 miles and the calculated maximum wind speed is 72.7 mph sustained for 19.5 minutes. This would generate a wave height of 3.9 feet. Considering the potential setup and runup, this correlates to maximum height of 5.9 feet. This would correlate to a minimum of six feet of freeboard.

The PMF is equivalent to the Probable Maximum Precipitation (PMP) since the drainage area is simply the reservoir area itself. For this part of the state, the PMP is 49 inches. Typical procedures would assume wind speeds of half the maximum described above. This would generate a maximum wave height of 2.9 feet. Combining the PMF with the wave height would suggest a freeboard of seven feet for the smaller reservoir.

For the larger reservoir, which has a fetch of 2.3 miles, a similar process provided a maximum wave height of 8.3 feet, compared to a PMF of 49 inches plus a wave height of 3.9 feet. In this case the wave height controls and a freeboard of 8.5 feet would be suggested.

SLOPE PROTECTION

Soil cement will be utilized for wave protection on the upstream slope. The downstream slopes of the embankment will be protected with grass. A grassed slope should be kept mowed and maintained to prevent the growth of trees that can damage the embankment.

HYDRAULIC STRUCTURES

The proposed reservoir was reviewed in multiple configurations, but each configuration will each have the same three hydraulic structures incorporated to control inflow water pumped into the reservoir, releases piped out, and possible overflows if the storage level rises too high, for the safety of the structure.

The configuration of the inlet piping was based on the assumption of a 300 MGD pumping facility with a maximum flow velocity in the pipe of 6 fps. This would suggest a 120-inch pipeline from the diversion point through the inlet into the reservoir. This would be a pipe under the embankment that would turn up and into the reservoir, as shown in Figure 5. The final capacity of the diversion pumping station is not set, so changes in the assumed rate will affect the size of the inlet pipe needed. A 120-inch diameter pipe is considered a maximum practical size for such piping and an increase in the capacity would likely mean the use of dual pipes.

The configuration of the outlet piping was based on the assumption of a 75 MGD release capacity, also with a maximum flow velocity in the pipe of 6 fps. This would suggest a 60-inch pipeline through the outlet of the reservoir. This would also be a pipe under the embankment that would be at the lowest point in the reservoir, as shown in Figure 6, and then drain to the release point selected on the river. The flows would then be picked up by downstream users. The final capacity of the outlet piping is not set, so changes in the assumed rate will affect the size of the pipe needed.

The third hydraulic structure is an emergency overflow. This would be a low spot in the embankment, generally set 2 or 3 feet above the maximum operating pool level. If, due to malfunction or operator error, the maximum inflow is maintained above the maximum operating pool level, the emergency overflow capacity would be set to allow this same flowrate to be released without risking an overtopping of the embankment. A fifty-foot-wide overflow would provide the 300 MGD capacity with a little more than 2 feet of depth over the weir. The weir would be covered with soil cement and a discharge channel from the overflow down into a natural drainage channel away from the embankment would also be constructed of soil cement. If this was set at 2 to 3 feet above the maximum operating level, then there would still be more than 2 to 3 feet of freeboard above that maximum flow level, preventing any possible overtopping of the embankment due to these issues. This overflow channel would also provide some small discharge during an extreme rainfall event, possibly reducing the needed freeboard slightly. This contribution was not considered in the freeboard calculations due to the level of unknowns, but should be identified during the final design.

CONCLUSIONS

- Suitable soils are available onsite for embankment construction.
- Balance of cut and fill earthwork quantities can be achieved for both the small and large footprint.
- Due to an underlying sand layer beneath the reservoir and proposed embankment, uplift pressures are significant enough to potentially cause blowout and instability of the downstream toe.
- Uplift pressures can be reduced and minimum safety factors (TCEQ minimum requirements) can be met for both uplift and slope stability through the use of relief wells and a toe drain near the downstream toe.
- 3H:1V side slopes for both upstream and downstream slope are suitable provided relief wells and a toe drain are installed.
- Approximately 35 percent of the soil samples that were taken from the upper four feet of the surface tested as highly dispersive. The dispersive soils may be used, if needed, as part of the embankment provided they are encapsulated with at least 3 feet of non-dispersive soil.
- A larger concern with respect to dispersive soils at the site is in the bottom of the unlined reservoir. If the dispersive soils are widespread across the proposed bottom of the OCR, a slurry trench (3-foot to 5-foot wide and 40-50 feet deep) constructed beneath the embankment could effectively cut off potential piping (erosion) failures due to dispersive soils.
- Freeboard height required due to maximum wave runup is 6 feet for the small footprint and 8.5 feet for the large footprint.
- Based on a 300 MGD pumping facility with a maximum flow velocity of 6 fps, a 120-inch diameter inlet pipe would be needed to carry the flow.

- Based on a 75 MGD release capacity and a maximum flow velocity of 6 fps, a 60-inch diameter outlet pipe will be needed.
- A 50-foot wide emergency overflow will provide the 300 MGD capacity with a little more than 2 feet of depth over the weir.
- Based on this preliminary study, this site is feasible for development of an Off-Channel Reservoir.

LIMITATIONS

This memorandum was prepared specifically for use by Lavaca-Navidad River Authority (LNRA) and Freese and Nichols, Inc. for this particular project and shall not be used for other projects or purposes. This work was performed in a manner consistent with the level of care and skill ordinarily exercised by other members of the engineering profession practicing in the same locality, under similar conditions, and at the date the services were provided. Freese and Nichols, Inc. makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The information and opinions contained in this memorandum are based on field observations, subsurface explorations, laboratory tests, seepage and slope stability analyses and present knowledge of the proposed project. It is possible that soil or groundwater conditions could vary between or beyond the points explored. Paragraphs, statements, test results, boring logs, figures, etc., should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the purpose of this memorandum.

- **END OF MEMORANDUM -**

Appendix A – Figures

Appendix B – Boring Logs and Boring Log Legend & Nomenclature

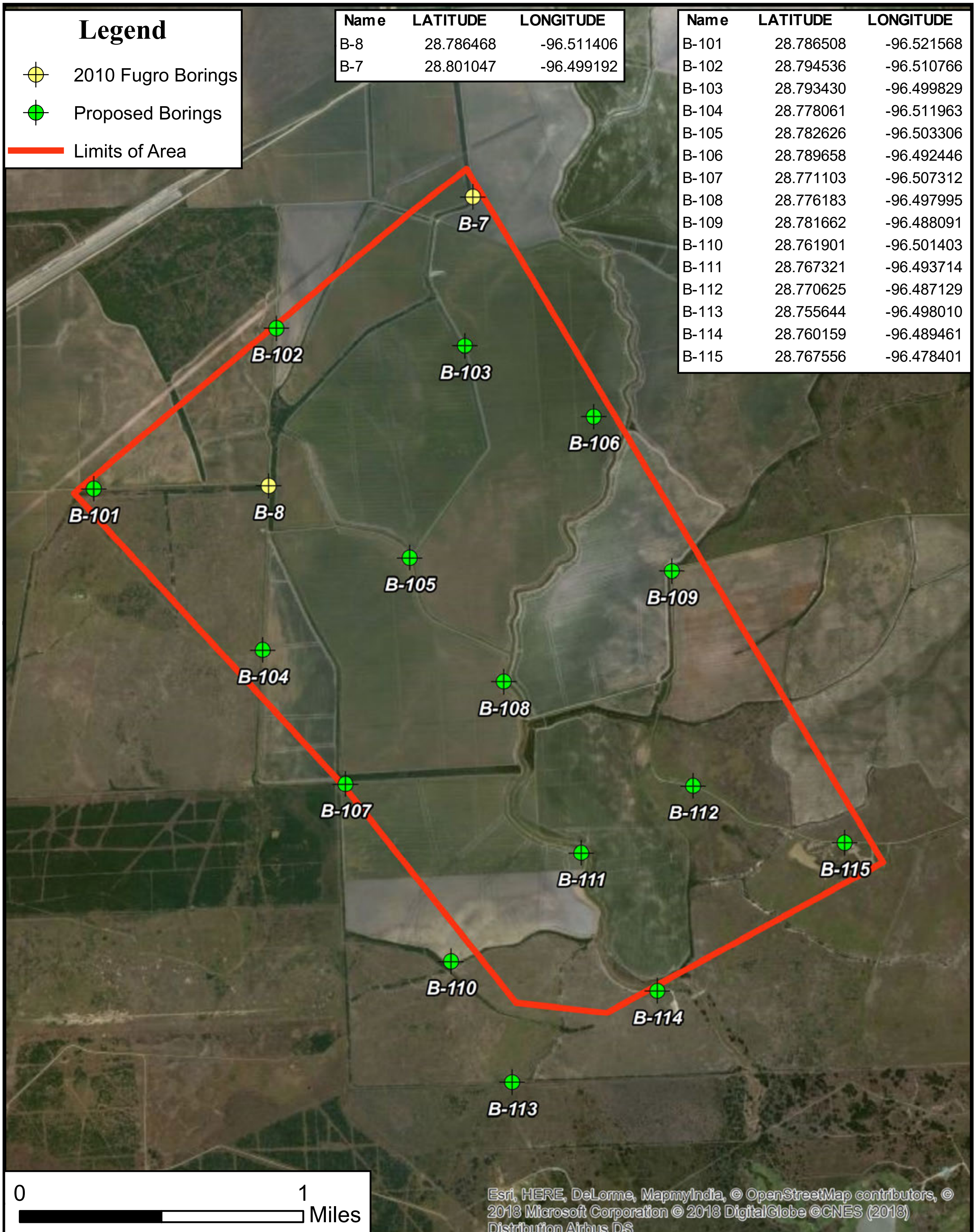
Appendix C – Laboratory Testing Results

Appendix D - Crumb Dispersion Test Results

Appendix E – Seepage and Slope Stability Results

Appendix A

Figures



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B-7	28.801047	-96.499192

Name	LATITUDE	LONGITUDE
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B-102	28.794536	-96.510766
B-103	28.793430	-96.499829
B-104	28.778061	-96.511963
B-105	28.782626	-96.503306
B-106	28.789658	-96.492446
B-107	28.771103	-96.507312
B-108	28.776183	-96.497995
B-109	28.781662	-96.488091
B-110	28.761901	-96.501403
B-111	28.767321	-96.493714
B-112	28.770625	-96.487129
B-113	28.755644	-96.498010
B-114	28.760159	-96.489461
B-115	28.767556	-96.478401

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Lavaca Navidad River Authority
OCR Due Diligence Study

Boring Location Plan

FN JOB NO	LVA17406
FILE	OCR Lavaca.mxd
DATE	2/14/2018
SCALE	1:30,000
DESIGNED	Tony Bosecker
DRAFTED	MPT

1
FIGURE

FREESE AND NICHOLS

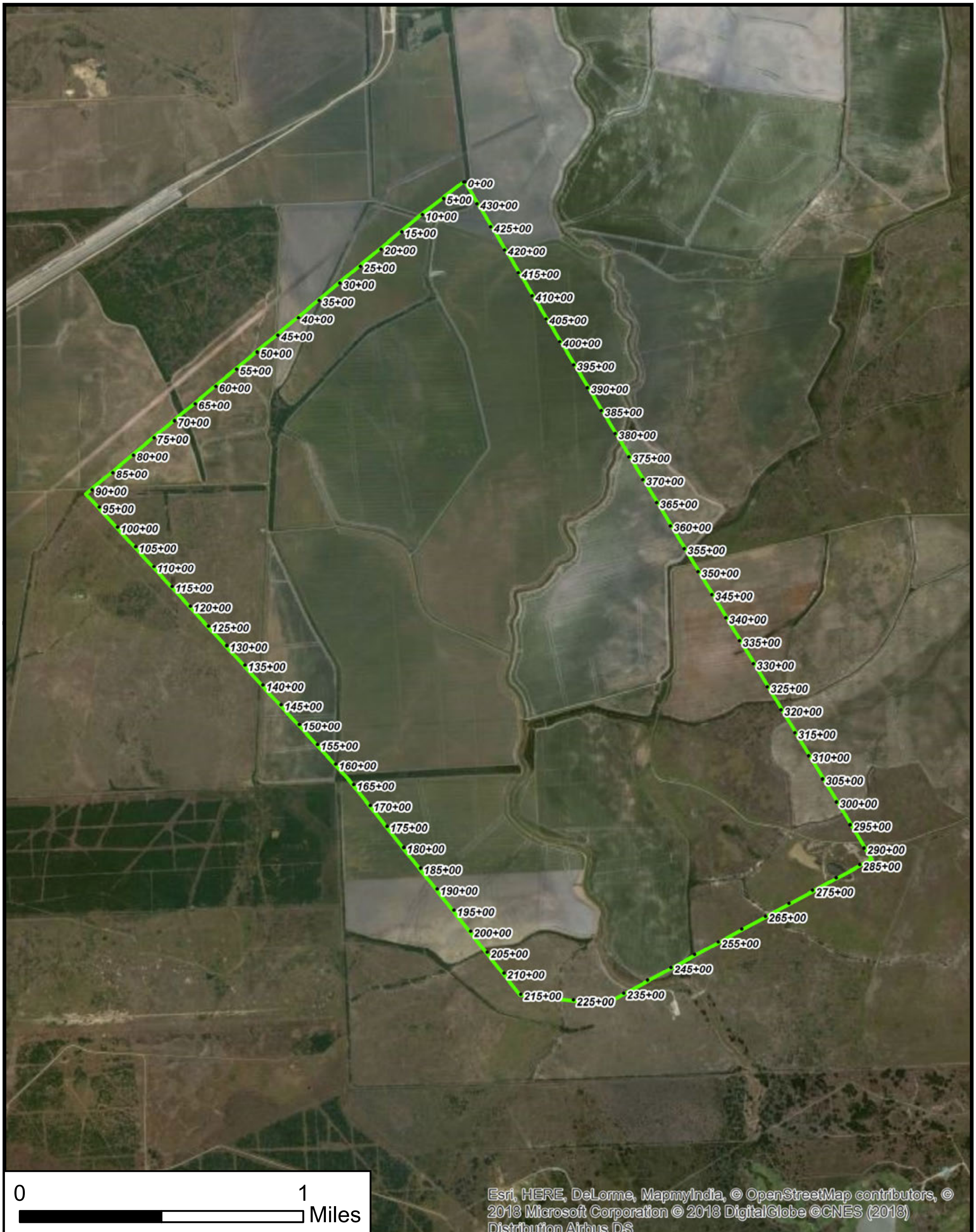
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

Lavaca Navidad River Authority
OCR Due Diligence Study

Small Footprint (1450 acres +/-)

FN JOB NO	LVA17406
FILE	OCR Lavaca.mxd
DATE	2/14/2018
SCALE	1:30,000
DESIGNED	Tony Bosecker
DRAFTED	MPT

FIGURE 2



FREESE AND NICHOLS

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Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

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Lavaca Navidad River Authority
OCR Due Diligence Study

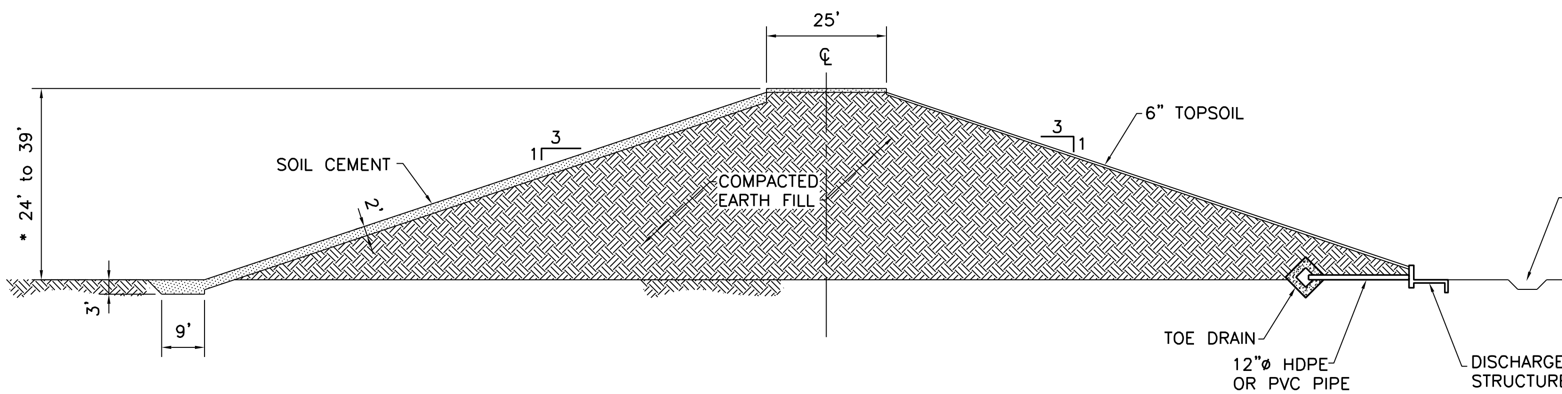
Large Footprint (2500 acres +/-)

FN JOB NO	LVA17406
FILE	OCR Lavaca.mxd
DATE	2/14/2018
SCALE	1:30,000
DESIGNED	Tony Bosecker
DRAFTED	MPT

3

FIGURE

N:\WRD\report\FIG 4.dwg LAYOUT: LAYOUT
Jan 16, 2018 - 4:30pm LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



* DAM HEIGHT VARIES DEPENDING ON STORAGE VOLUME AND RESERVOIR FOOTPRINT

TYPICAL EMBANKMENT SECTION
1"=20'

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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

PROPOSED OCR DUE DILIGENCE

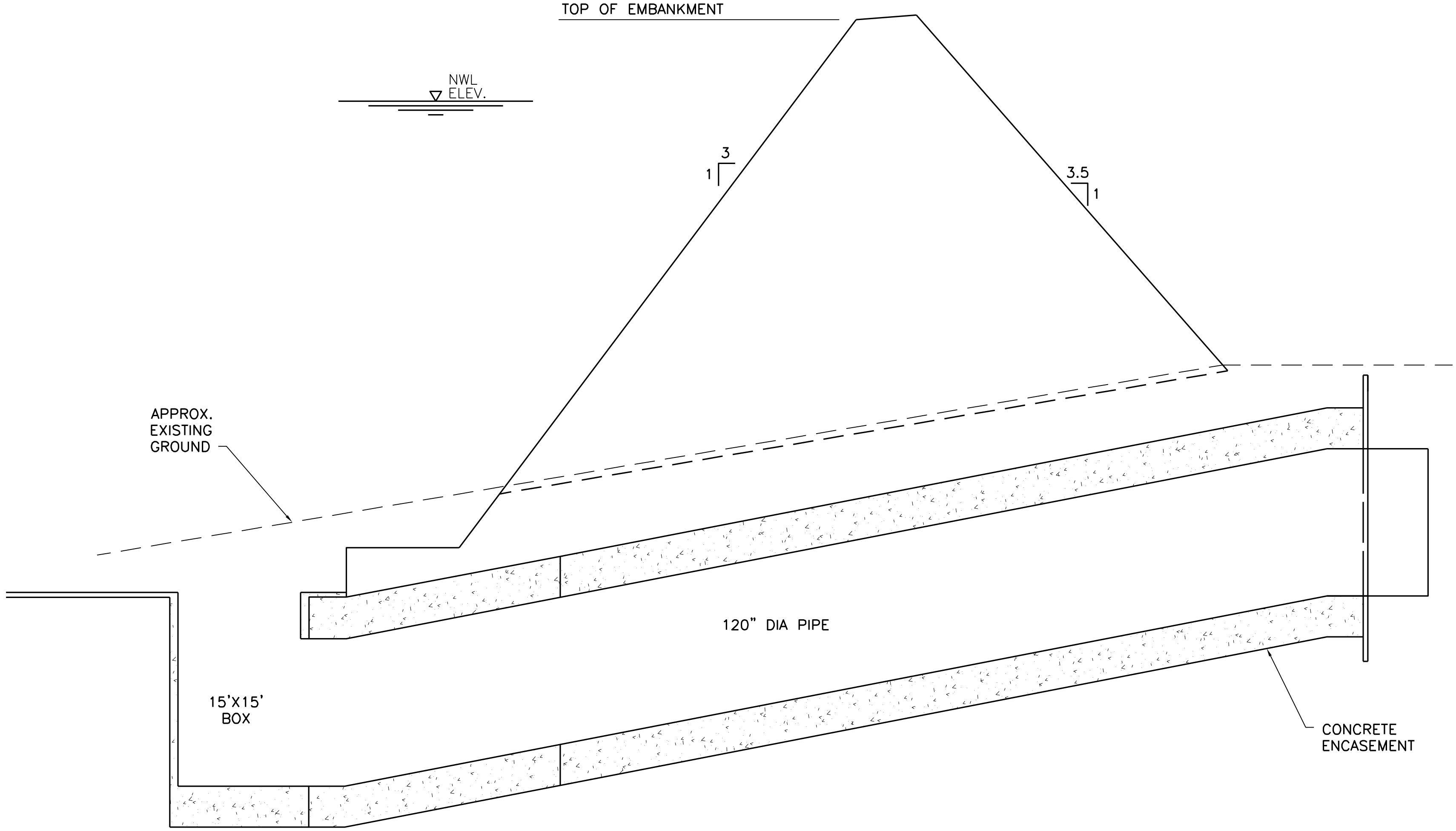
EMBANKMENT SECTION - TYPICAL

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	DAB
DRAFTED	MLP
FILE	FIG 4.dwg
FIGURE	4

Freese and Nichols, Inc.
Texas Registered
Engineering Firm F-2144

Date: Jan 16, 2018 - 4:30pm User: mlp File: N:\WRD\report\FIG 4.dwg

N:\WRD\report\FIG X.dwg LAYOUT: LAYOUT (2)
Jan 17, 2018 - 9:38am LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



Date: Jan 17, 2018 - 9:38am User: mlp File: N:\WRD\report\FIG X.dwg

FREESE AND NICHOLS
4055 International Plaza, Suite 200
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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

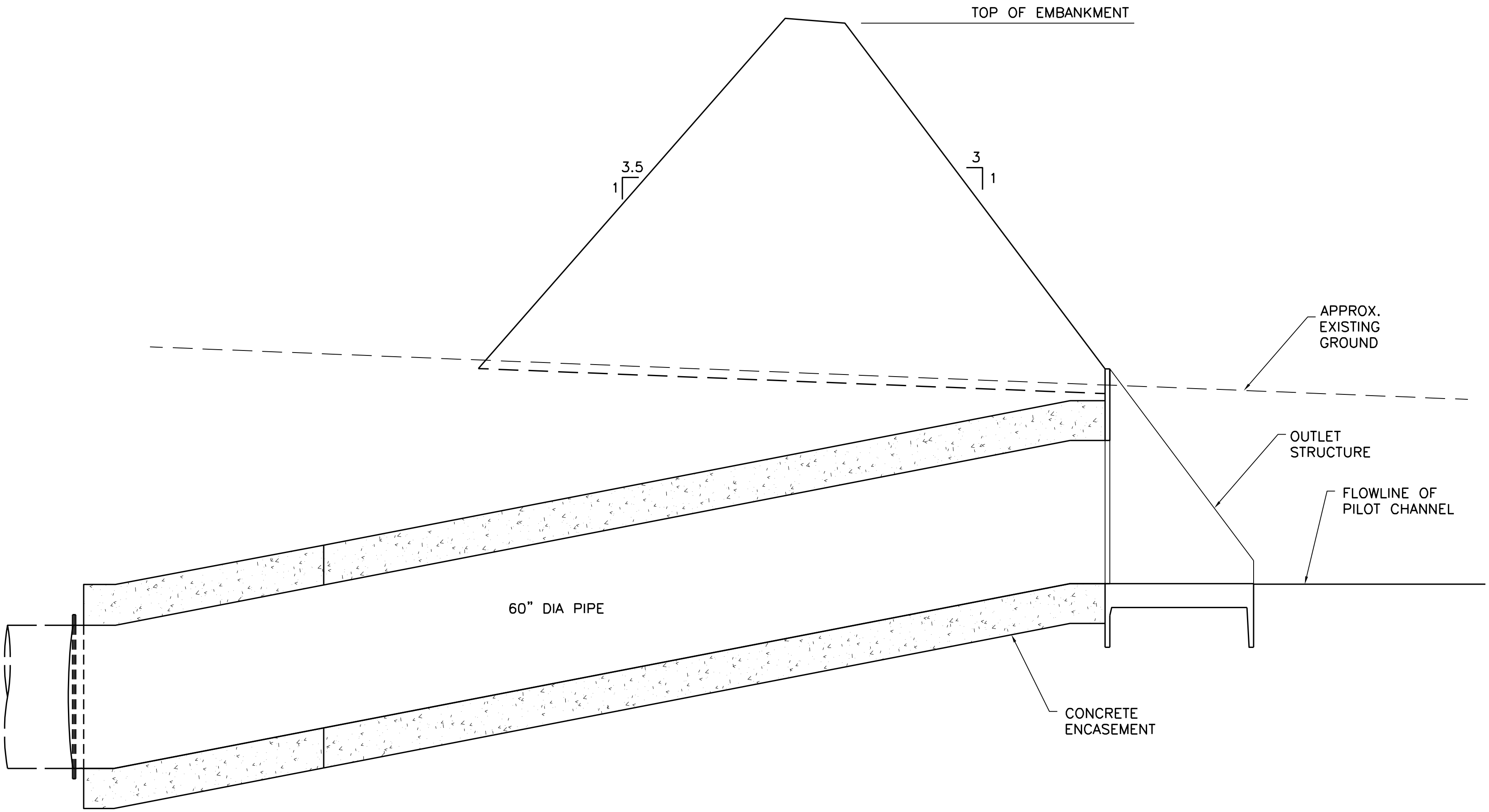
PROPOSED OCR DUE DILIGENCE

INLET PROFILE

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	JLR
DRAFTED	MLP
FILE	FIG X.dwg
FIGURE	5

Freese and Nichols, Inc.
Texas Registered
Engineering Firm F-2144

N:\WRD\report\FIG X.dwg LAYOUT: LAYOUT
Jan 17, 2018 - 9:38am LTS: 1 PSLTS: 1 TWIST:
REFERENCES: N:\STANDARD\8LBORDER.dwg



Date: Jan 17, 2018 - 9:38am User: mlp File: N:\WRD\report\FIG X.dwg

FREESE AND NICHOLS
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LAVACA-NAVIDAD RIVER AUTHORITY (LVA)

PROPOSED OCR DUE DILIGENCE

OUTLET PROFILE

F&N JOB NO.	LVA17406
DATE	JAN 2018
SCALE	AS SHOWN
DESIGNED	JLR
DRAFTED	MLP
FILE	FIG X.dwg
FIGURE	6

Freese and Nichols, Inc.
Texas Registered
Engineering Firm F-2144

Appendix B

Boring Logs and Boring Log Legend & Nomenclature

LOG OF BORING NO. B-101

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.786508
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.521568
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	31			SANDY LEAN CLAY, brown and dark gray, hard, dry, some silt									
	U-2		4.5 (P)	40				11		75	29	15	14			
5	U-3		4.5 (P)	44			-trace calcareous particles, slightly moist at 4 feet									
	U-4		3.5 (P)	42			6/ LEAN CLAY, light brown, very stiff, moist, trace calcareous particles, with sand									
	U-5		1.75 (P)	54			8/ SANDY LEAN CLAY, light brown and red-brown, mottled, moist, stiff, very fine-grained, with sand (Beaumont Formation)	19	104	71	42	16	26	0.74	15.1	
10						∇										
	U-6		1.5 (P)	46												
15																
	U-7		2.5 (P)	29			18/ SILTY LEAN CLAY, red-brown, very stiff, wet, trace calcareous particles (Beaumont Formation)									
20																
	U-8		4.5 (P)	63			23/ SILTY LEAN CLAY, red-brown, hard, moist, trace calcareous fragments, fragments have trace fossils-root traces (Beaumont Formation)									
25																
	SPT-9	2-4-4 (8)					28/ SILTY SAND, red-brown, loose, wet, trace clay (Beaumont Formation)									

Water Observations:
11.1 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-101

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.786508

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.521568

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SILTY SAND, red-brown, loose, wet, trace clay (Beaumont Formation) *(continued)*									
	SPT-10	6-9-11 (20)					LEAN CLAY, red-brown, very stiff, moist, with sand (Beaumont Formation) 33/									
35																
	U-11		3.75 (P)	88			FAT CLAY, yellow-brown and light gray, very stiff, moist, trace sand lenses, trace fossil fragments (Beaumont Formation) 38/	33	91		70	23	47	2.88	3.7	
40																
	U-12		2.25 (P)	94			LEAN CLAY, yellow-brown and light gray, very stiff, moist, with sand lenses and sandy partings (Beaumont Formation) 43/									
45																
	U-13		0.75 (P)	100			CLAYEY SAND, yellow-brown, wet (Beaumont Formation) 48/									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
11.1 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-102

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.794536
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.510766
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	SPT-1	4-6-8 (14)					SANDY LEAN CLAY, dark brown, stiff to hard, dry, trace red-brown clay seams									
	U-2		4.5 (P)	33				12		51	29	13	16			
5	U-3			52			-sand layer from 4 to 4.5 feet									
	SPT-4	6-6-6 (12)					6/ SAND, light brown and red-brown, medium dense to loose, dry, medium-to-fine-grained (Alluvium)									
	SPT-5	7-5-5 (10)														
10																
						▽										
	SPT-6	2-2-3 (5)						24								
15																
	SPT-7	7-8-6 (14)														
20							19.3/ LEAN CLAY, red-brown, stiff, moist (Beaumont Formation)									
	U-8		1.0 (P)	23			23/ SANDY SILT, light brown, wet, fine-to-medium-grained, medium stiff to stiff (Beaumont Formation)	24		68	NP	NP	NP			
25																
	SPT-9	4-5-8 (13)					28/ FAT CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation)	28		100	67	23	44			

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-102

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.794536

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.510766

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation) *(continued)*									
	U-10			75												
35							CLAYEY SAND, dark brown, moist (Beaumont Formation) 34.5/									
	U-11			83												
40																
							LEAN CLAY, light green-gray, stiff, moist, fine-grained glauconitic sand 43/									
	SPT-12	5-5-6 (11)														
45																
	SPT-13	3-2-4 (6)														
							Total boring depth 49.5 ft.									
50																
55																

Water Observations:
13 ft At time of drilling

Remarks:

LOG OF BORING NO. B-103

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.793430

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.499829

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		2.75 (P)	42			FAT CLAY, dark brown, very stiff, moist, trace sand (Alluvium)									
	U-2		2.75 (P)	44												
5	U-3		2.0 (P)	56			4/ FAT CLAY, light brown, stiff to very stiff, moist, some sand, trace calcareous particles, trace iron staining (Alluvium)	27		91	79	30	49			
							-with sand at 7 feet									
	U-4		1.75 (P)	67			7/ CLAYEY SAND, light brown, moist, fine-grained (Alluvium)									
	U-5		1.75 (P)	69												
10							9.5/ SANDY LEAN CLAY, light brown and light gray, stiff, moist, mottled (Alluvium)									
	U-6		3.5 (P)	75			13/ FAT CLAY, red-brown, very stiff, moist, trace light gray lenses, trace fine-grained sand (Beaumont Formation)									
15																
	U-7		3.5 (P)	100				26	100	99	62	22	40	1.23	2.9	
20																
	U-8			67			23/ CLAYEY SAND, light brown and red-brown, wet, fine-to-medium-grained (Beaumont Formation)									
25							24.8/ SAND, light brown, wet, trace clay (Beaumont Formation)									
	SPT-9	4-5-6 (11)					28/ CLAYEY SAND, red-brown, loose, wet, fine-grained (Beaumont Formation)	28								

Water Observations:
23 ft At time of drilling
14.4 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-103

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/3/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.793430

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.499829

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/3/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, loose, wet, fine-grained (Beaumont Formation) *(continued)*									
	SPT-10	4-3-4 (7)														
35							LEAN CLAY, red-brown, medium stiff, moist, some sand, trace fossils (Beaumont Formation) 34.2/									
	U-11		4.5 (P)	75			LEAN CLAY, red-brown, hard, moist, trace sand, trace iron stain 38/									
40																
	U-12		4.5 (P)	71				18		99	49	19	30			
45																
	U-13		4.5 (P)	79												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
23 ft At time of drilling
14.4 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-104

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.778061

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.511963

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	SPT-1	5-9-6 (15)					LEAN CLAY, light gray and brown, stiff, dry, 3 inch layer of gravel and fossil material on road, with sand (Fill)									
	U-2	5-4-5 (9)					-charcoal fragments at 2.5 feet									
3							SANDY LEAN CLAY, light gray and light brown, very stiff, dry, fine-grained (Alluvium)									
5	U-3		3.0 (P)	33												
	U-4		3.5 (P)	48				18	111	53	34	13	21	0.78	5.6	
8							SANDY LEAN CLAY, light gray, moist, natural (Alluvium)									
	U-5			71												
10																
						▽										
	SPT-6	7-7-10 (17)					-coloring to light brown at 13 feet	20		57						
15																
20							SAND, light brown, medium dense, wet, fine-to-medium grained (Beaumont Formation)									
	SPT-7	3-5-8 (13)														
23							FAT CLAY, red-brown, stiff, moist, trace fine-grained sand (Beaumont Formation)									
	SPT-8	4-6-6 (12)														
25																
	U-9		2.25 (P)	100				29	95	100	63	25	38	1.48	3.6	
29.5																

Water Observations:
11.1 ft At time of drilling

Remarks: 0-15 feet - continuous flight auger; 15-50 feet - rotary wash.
Boring was backfilled with cuttings and bentonite chips upon completion.

LOG OF BORING NO. B-104

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.778061

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.511963

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, moist, fine-to-medium grained (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	75												
35																
	SPT-11	3-3-5 (8)					LEAN CLAY, light green-gray, medium stiff to stiff, moist, glauconitic, highly plastic (Beaumont Formation) 38/									
40																
	U-12		1.75 (P)	100			-2 inch chert fragments and 1/4 inch shell fragments, trace fossils at 43.2 feet									
45																
	U-13		0.75 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
11.1 ft At time of drilling

Remarks:
0-15 feet - continuous flight auger; 15-50 feet - rotary wash.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-105

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.782660

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.503300

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5+ (P)	81			FAT CLAY, dark brown, hard, dry, trace roots and sand									
	U-2		4.5+ (P)	29												
5	U-3		2.5 (P)	40			4/ FAT CLAY, dark brown, very stiff, moist									
	U-4		2.25 (P)	31			-coloring change to light grayish-brown, trace calcareous particles at 6 feet									
	U-5		2.5 (P)	52			8/ FAT CLAY, red-brown and light gray, very stiff, moist, trace calcareous particles (Beaumont Formation)	22		95	61	21	40			
10																
	U-6		3.75 (P)	83			13/ SILTY FAT CLAY, red-brown and light gray, very stiff, moist (Beaumont Formation)	22	108	100	50	20	30	3.33	8.7	
15																
	U-7		3.5 (P)	63												
20																
	U-8			79			23/ CLAYEY SAND, red-brown, moist, very-fine-to fine-grained, medium dense, trace clay and silt (Beaumont Formation)	21			25	20	5			
25																
	U-9		1.5 (P)	100												

Water Observations:
Dry At Time Of Drilling

Remarks: 0-25 feet - continuous flight auger; rotary wash - 25-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-105

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/27/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.782660

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.503300

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/27/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							CLAYEY SAND, red-brown, moist, very-fine-to fine-grained, medium dense, trace clay and silt (Beaumont Formation) *(continued)*									
	SPT-10	6-8-9 (17)														
35																
38							SILTY FAT CLAY, yellow-brown, stiff to hard, moist, trace sand (Beaumont Formation)									
	SPT-11	4-5-6 (11)						24		92	53	20	33			
40																
	SPT-12	4-5-6 (11)														
45																
	U-13		4.5+ (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
Dry At Time Of Drilling

Remarks: 0-25 feet - continuous flight auger; rotary wash - 25-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-106

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/6/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.795140
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.491122
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/6/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		1.0 (P)	33		FAT CLAY, dark brown, medium stiff to stiff, moist, trace silt -grading into light gray below 1 foot									
	U-2		1.5 (P)	44											
4/						LEAN CLAY, red-brown, very stiff, moist, trace iron stain, trace fine-grained sand (Beaumont Formation)									
5	U-3		3.0 (P)	83											
	U-4		2.25 (P)	100			18		96	38	17	21			
8/						SANDY LEAN CLAY, red-brown, moist to wet, stiff, some light gray clayey sand (Beaumont Formation)									
	U-5		1.5 (P)	100			22		94	29	19	10			
10															
13/						SANDY LEAN CLAY, red-brown, stiff, moist, fine-grained (Beaumont Formation)									
	U-6		1.25 (P)	100			23	109	92	31	20	11	1.47	10.2	
15															
18/						SAND, red-brown, loose, wet, fine-to-medium grained, trace clay (Beaumont Formation)									
	SPT-7	1-2-3 (5)													
20															
	SPT-8	3-4-5 (9)													
25															
28/						SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation)									
	SPT-9	15-15-12 (27)													

Water Observations:
13 ft At time of drilling
12.5 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-106

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/6/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.795140
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.491122
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/6/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation) *(continued)*									
35	U-10		3.75 (P)	100			SANDY LEAN CLAY, red-brown, very stiff, moist, glauconitic clay mottling, trace clayey sand seams (Beaumont Formation) 33/									
40	U-11		3.75 (P)	100			-with 2-inch seam and sub-angular gravel fragments, iron staining and trace calcareous particles at 39.5 feet									
45	U-12		1.75 (P)	92			CLAYEY SAND, red-brown, moist (Beaumont Formation) 43/									
50	U-13		4.5+ (P)	83			SANDY CLAY, green-gray and red-brown, hard, dry, iron staining, trace lignite particles (Beaumont Formation) 48/									
							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling
12.5 ft After drilling

Remarks:
0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-107

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.771155

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.507484

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		3.75 (P)	40			FAT CLAY, dark brown, very stiff, dry, trace fine-grained sand (Residual Soil)									
	U-2		2.5 (P)	40												
5	U-3		3.25 (P)	52												
	U-4		3.5 (P)	67			5.5/ FAT CLAY, light gray and red-brown, very stiff, dry, with fine-to-medium grained sand, trace calcareous particles, mottled, trace iron stain (Beaumont Formation)	18	114	82	55	18	37	2.88	10.8	
	U-5		3.5 (P)													
10																
	U-6		2.5 (P)				13/ CLAYEY SAND, red-brown, moist to wet, medium dense, fine-grained (Beaumont Formation)									
15																
	SPT-7	13-15-19 (34)					18/ SAND, brown, dense, wet, fine-to-medium grained, trace clay (Beaumont Formation)									
20																
	SPT-8	12-20-29 (49)														
25																
	U-9			75			28/ FAT CLAY, red-brown, hard to very stiff, dry, trace fine-grained sand (Beaumont Formation)									

Water Observations:
13 ft At time of drilling
12.2 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring backfilled with cutting and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-107

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/4/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.771155

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.507484

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/4/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, hard to very stiff, dry, trace fine-grained sand (Beaumont Formation) *(continued)*									
							-hard at 33 feet									
	U-10		4.25 (P)	65				27	98	100	67	26	41	2.2	3.3	
35																
							-trace gypsum particles and laminations at 38 feet									
	U-11		3.5 (P)	83			-trace glauconitic clay partings at 39 feet									
40																
							LEAN CLAY, light brown and light gray, very stiff, dry, mottled, trace fine-grained sand, trace iron stained sand seams (Beaumont Formation) 43/									
	U-12		2.75 (P)	100												
45																
							-vertical glauconitic clay seams from 48 to 50 feet									
	U-13		2.25 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling
12.2 ft After drilling

Remarks: 0-15 feet - continuous flight auger; rotary wash - 15-50 feet.
Boring backfilled with cutting and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-108

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.776183
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.497995
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/28/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	54			SILTY LEAN CLAY, light gray and light brown, hard, moist, with fine-grained sand									
	U-2		4.5+ (P)	50			2/ LEAN CLAY, dark brown, hard, dry, trace calcareous particles with trace fine-grained sand (Alluvium)	19		84	45	16	29			
							-moist at 4 feet									
5	U-3		3.0 (P)	35												
	U-4		4.5 (P)	83			6/ SANDY LEAN CLAY, light gray and yellow-brown, hard, moist, with fine-grained sand (Alluvium)									
	U-5		2.0 (P)	27			8/ SANDY LEAN CLAY, light gray and yellow-brown, stiff, dry, with fine-grained sand, trace iron staining (Alluvium)	17		79	41	17	24			
10																
	SPT-6	1-1-3 (4)					13/ SAND, light brown, very loose, wet, trace clay									
15																
	SPT-7	3-5-6 (11)					18/ FAT CLAY, red-brown, stiff, wet, trace sand and silt (Beaumont Formation)									
20																
	SPT-8	9-9-10 (19)					23/ SAND, red-brown, medium dense, wet, trace clay (Beaumont Formation)									
25																
	SPT-9	4-5-6 (11)					28/ SANDY LEAN CLAY, red-brown, stiff, wet, trace sand (Beaumont Formation)									

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-108

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.776183

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.497995

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/28/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, red-brown, stiff, wet, trace sand (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	117			33/ LEAN CLAY, red-brown, very stiff, moist, trace calcite crystals, with silt (Beaumont Formation)									
35																
	U-11		1.5 (P)	75			38/ FAT CLAY, light gray and light brown, stiff, trace silt (Beaumont Formation)	33	91	98	64	26	38	1.5	3.1	
40																
	U-12		2.0 (P)	83												
45																
	U-13		0.75 (P)	71			48/ GLAUCONITIC CLAY, green-gray, medium stiff, moist, with glauconitic sands (Beaumont Formation)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
13 ft At time of drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-109

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/2/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.781662

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.488091

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/2/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		3.5 (P)	29			LEAN CLAY, light brown, very stiff, medium-to-fine grained (0.5/) FAT CLAY, dark brown, hard, very stiff, dry to moist, with sand									
	U-2		4.5 (P)	77												
5	U-3		4.5+ (P)	69			-trace fossil fragments at 4 feet									
	U-4		4.5 (P)	52			(5.8/) LEAN CLAY, red-brown and light brown, hard,dry, with sand, very fine-to-fine gravel -coloring to light brown at 5.8 feet									
	U-5		4.5 (P)	40			-some fossil fractures and calcareous particles and nodules from 8.5 to 10 feet	13		92	46	17	29			
10																
	U-6		3.5 (P)	79			(13/) FAT CLAY, red-brown, very stiff,moist, little to no sand, silty (Beaumont Formation)									
15																
							-with fine-grained sand at 18 feet									
	U-7		3.75 (P)	75				25	104	100	56	26	30	3	9.8	
20																
	SPT-8	4-5-8 (13)					(23/) SAND, red-brown, medium dense, fine-to-medium grained, some clay (Beaumont Formation)									
25																
	U-9		0.75 (P)	88			(28/) LEAN CLAY, red-brown, medium stiff, moist, with sand or sand seams and layers 29.5/									

Water Observations:
23 ft At time of drilling
17.4 ft After drilling

Remarks: 0-25 feet - continuous flight auger; rotary wash - 25-49.5 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-109

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/2/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.781662
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.488091
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/2/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, light brown, loose to medium dense, wet (Beaumont Formation) *(continued)*									
33							SANDY LEAN CLAY, red-brown, stiff, moist, mottled with light gray clay, fine-grained (Beaumont Formation)									
	U-10		1.75 (P)	88				24	99	76	47	20	27	2.9	7.3	
35																
38							SAND, light brown, loose, wet, some clay, fine-to-medium grained, with glauconitic sand and calcareous particles (Beaumont Formation)									
	U-11			63												
40																
43							SAND, light brown and red-brown, wet, very dense, fine-to-medium grained, trace clay (Beaumont Formation)									
	SPT-12	13-26-37 (63)														
45																
48							LEAN CLAY, red-brown and green-gray, very stiff, moist, with glauconitic sand, mottled (Beaumont Formation)									
	SPT-13	5-8-12 (20)														
50							Total boring depth 49.5 ft.									
55																

Water Observations:
23 ft At time of drilling
17.4 ft After drilling

Remarks:
0-25 feet - continuous flight auger; rotary wash - 25-49.5 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-110

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.761901

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.501403

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	27			LEAN CLAY, light brown to brown, hard, dry, with fine-grained sand									
	U-2		2.5 (P)	60			2/ SANDY LEAN CLAY, tan and light brown, very stiff, dry, with sand lenses, fine-grained									
5	U-3		4.5 (P)	50			4/ SANDY LEAN CLAY, light brown and light gray, hard, dry -with calcareous particles from 5.7 to 6 feet	17		72	46	17	29			
	U-4		4.5 (P)				6/ CLAYEY SAND, red-brown, medium dense, dry, fine-grained									
	SPT-5	8-7-7 (14)					-red-brown, wet below 8 feet									
10																
	SPT-6	9-11-14 (25)														
15																
	SPT-7	4-6-17 (23)					18/ SAND, light brown, very stiff, wet, trace clay									
20																
	U-8		3.5 (P)	75			23/ FAT CLAY, red-brown, very stiff, moist, fine-grained sand (Beaumont Formation)									
25																
	U-9		3.75 (P)	79				26	102	100	64	30	34	2.98	8.1	

Water Observations:
17 ft At time of drilling
12.1 ft After drilling

Remarks: 0-19.5 feet - continuous flight auger; rotary wash - 19.5-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-110

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.761901

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.501403

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, very stiff, moist, fine-grained sand (Beaumont Formation) *(continued)*									
	U-10		4.5 (P)	92			SANDY LEAN CLAY, light brown, hard, moist, fine-grained, trace iron staining, trace sandy laminations and lenses, trace light clay laminations (Beaumont Formation) 33/	20		71	36	17	19			
35																
							-with increase of light gray clay laminations below 37 feet									
	U-11		4.25 (P)	83												
40																
	U-12		2.5 (P)	100			LEAN CLAY, light brown and light gray, very stiff, moist, mottled, trace sandy partings 43/									
45																
	U-13		2.75 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
17 ft At time of drilling
12.1 ft After drilling

Remarks: 0-19.5 feet - continuous flight auger; rotary wash - 19.5-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

LOG OF BORING NO. B-111

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.767370
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.493600
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	SAMPLE BLOW COUNTS	SAMPLE HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE RECOVERY, %	SAMPLE RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	52			FAT CLAY, dark brown, hard, dry, trace fine-grained sand and calcareous particles (Residual Soil)									
	U-2		4.5 (P)	33												
5	U-3		1.25 (P)	54			4/ FAT CLAY, light gray, stiff, moist, trace calcareous particles and nodules (Residual Soil) -with small calcareous cobbles approximately 4 inches in diameter below 6 feet -transitions into sandy fat clay at 6 feet									
	U-4		2.0 (P)	46				19		85	54	19	35			
	U-5		2.75 (P)	48			8/ FAT CLAY, red-brown and light gray, very stiff, moist, mottled, trace calcareous particles (Beaumont Formation)	17	113	98	72	26	46	1.8	7.5	
10																
	U-6															
15																
							16/ CLAYEY SAND, red-brown, loose, wet (Beaumont Formation)									
	SPT-7	4-6-6 (12)					18/ FAT CLAY, red-brown, stiff, moist, trace light brown very fine-grained sand lenses (Beaumont Formation)									
20																
	SPT-8	3-5-6 (11)						33		100	75	31	44			
25																
	U-9		3.75 (P)	100			28/ SANDY LEAN CLAY, red-brown, very stiff, moist to wet, with very fine-grained sand (Beaumont Formation)									

Water Observations:
10.8 ft Seepage at time of drilling
28 ft 24 hours after drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-111

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/28/2017
Logged By: Z. Ready
Rig Type: D-50 Track
Latitude: 28.767370
Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.493600
Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, red-brown, very stiff, moist to wet, with very fine-grained sand (Beaumont Formation) *(continued)*									
	U-10		3.0 (P)	88			FAT CLAY, red-brown, very stiff, moist (Beaumont Formation) 33/	27	99	100	78	33	45	2.55	6.3	
35							-with sand and trace laminations alternating light gray and light brown at 34.9 feet									
	U-11		3.5 (P)	100												
40																
	U-12		2.0 (P)	100			FAT CLAY, light gray and light brown, stiff to very stiff, moist, mottled, little to no sand, glauconitic (Beaumont Formation) 43/									
45																
	U-13		1.5 (P)	100												
50							Total boring depth 50.0 ft.									
55																

Water Observations:
10.8 ft Seepage at time of drilling
28 ft 24 hours after drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

![Freese and Nichols logo]

LOG OF BORING NO. B-112

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/1/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.770625

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.487129

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/1/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		.25 (P)	42			CLAYEY SAND, light brown, very loose to loose									
	SPT-2	3-4-3 (7)														
5	SPT-3	3-1-4 (5)					3.8/ CLAYEY SAND, tan, loose, wet, with crushed fossil and clay, fine-grained sand (Beaumont Formation)	14		35						
	SPT-4	2-3-4 (7)														
	SPT-5															
10																
	SPT-6	6-9-12 (21)					13/ CLAYEY SAND, light brown and red-brown, medium dense, fine-to-medium grained									
15																
	U-7		3.0 (P)	92			18/ FAT CLAY, red-brown, very stiff to stiff, moist, trace sand, some silt (Beaumont Formation)	28	96	100	80	35	45	2.36	6.1	
20																
	U-8		4.25 (P)	98			-hard to stiff, some sandy layers and lenses below 24 feet	20	110	100	65	28	37	0.78	3.4	
25																
	SPT-9	3-4-6 (10)														

Water Observations:
17 ft At time of drilling

Remarks:
0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-112

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/1/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.770625

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.487129

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/1/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, red-brown, very stiff to stiff, moist, trace sand, some silt (Beaumont Formation) *(continued)*									
35	U-10			88			-light brown to tan, with 2 1/2 inch crushed fossil layer at 33.5 feet -light brown to tan, with 2 1/2 inch crushed fossil layer at 34.5 feet									
40	SPT-11	4-4-3 (7)					CLAYEY SAND, tan, loose, wet, with crushed fossil and clay, fine-grained sand (Beaumont Formation) 38/									
45	SPT-12	5-1-2 (3)					CLAY, light gray, soft, moist , glauconitic (Beaumont Formation) 43/									
	SPT-13															
50							Total boring depth 49.5 ft.									
55																

Water Observations:
17 ft At time of drilling

Remarks:
0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

LOG OF BORING NO. B-113

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.755644

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.498010

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		1.75 (P)	33			SANDY LEAN CLAY, brown, stiff, dry -with trace shell fragments from 0.1 to 0.2 feet									
	U-2		1.75 (P)	33												
5	U-3		4.5 (P)	52			4/ LEAN CLAY, light gray, hard, dry, fossil fragments, mottled with sandy laminations									
	U-4		4.5 (P)	42												
	U-5		4.5 (P)	58				13	122	58	44	18	26	3	4.7	
10																
	SPT-6	5-4-5 (9)					13/ SAND, light brown, loose to very loose, dry, fine-to-medium grained, trace clay									
15						▽										
	SPT-7	1-1-3 (4)					-wet at 18 feet									
20																
	SPT-8	5-7-6 (13)					23/ SANDY LEAN CLAY, light brown, stiff, wet	24		94	27	18	9			
25																
	SPT-9	4-7-9 (16)														

Water Observations:
16 ft At time of drilling

Remarks:
0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-113

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.755644

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.498010

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SANDY LEAN CLAY, light brown, stiff, wet *(continued)*									
	U-10		4.0 (P)	79			33/ FAT CLAY, red-brown, very stiff to hard, moist, fine-grained sand, trace light gray clay seams and laminations (Beaumont Formation)	24		99	64	28	36			
35																
	U-11		3.25 (P)	94			-trace gypsum in sandy laminations from 38 to 40 feet									
40																
	U-12		3.5 (P)	100			43/ LEAN CLAY, light brown and light gray, very stiff, moist, mottled, fine-grained sand (Beaumont Formation)									
45																
	U-13		2.5 (P)	90			48/ FAT CLAY, light green-gray, very stiff, moist, trace light brown laminations, glauconitic (Beaumont Formation)									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
16 ft At time of drilling

Remarks:
0-20 feet - continuous flight auger; rotary wash - 20-50 feet.
Boring was backfilled with cuttings and bentonite chips upon completion.

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

FREESE AND NICHOLS

LOG OF BORING NO. B-114

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/29/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.760159

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.489461

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	63			SANDY LEAN CLAY, light brown, hard, dry, trace roots (Residual Soil)									
	U-2		4.5 (P)	27			3/ FAT CLAY, light gray, hard to very stiff, dry, trace iron staining, glauconitic (Beaumont Formation)									
5	U-3		3.75 (P)	42												
	U-4		3.0 (P)	67			6/ FAT CLAY, red-brown and light gray, very stiff, mist, trace calcareous particles, with sand, mottled (Beaumont Formation)	18		94	55	20	35			
	U-5		1.0 (P)	38			8/ SANDY LEAN CLAY, red-brown, medium stiff, moist (Beaumont Formation)									
10																
	SPT-6	3-4-5 (9)					13/ FAT CLAY, red-brown, stiff to very stiff, light gray mottling, with sand, very fine-grained (Beaumont Formation)									
15																
	U-7		2.5 (P)	100				26	99	100	71	31	40	2.03	6.7	
20																
	U-8		3.75 (P)	88			23/ FAT CLAY, red-brown, very stiff to hard, moist, trace sand lenses (Beaumont Formation)									
25																
	U-9		4.5 (P)	100			28/ FAT CLAY, light gray and red-brown, very stiff, moist, mottled, glauconitic, trace sand (Beaumont Formation)	22	102	100	58	25	33	2.7	9.5	

Water Observations:
28 ft At time of drlling
22.7 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-114

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 9/29/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.760159

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.489461

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 9/29/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							FAT CLAY, light gray and red-brown, very stiff, moist, mottled, glauconitic, trace sand (Beaumont Formation) *(continued)*									
	U-10		2.75 (P)	100												
35																
	U-11		2.5 (P)	88				25		100	62	26	36			
40																
	U-12		2.0 (P)	96			-trace calcareous particles from 43 to 45 feet									
45							-trace fossils (bivalves) at 45 feet									
	U-13		2.25 (P)				-trace sandy lenses from 48 to 50 feet									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
28 ft At time of drlling
22.7 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-115

FREESE AND NICHOLS

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.767556

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.478401

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE: TYPE	BLOW COUNTS	HAND PENE-TROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5 (P)	35			SANDY LEAN CLAY, light brown, hard, dry, medium-to-fine grained									
	U-2		4.5 (P)	27			2/ SANDY LEAN CLAY, brown and orange-brown, hard to very stiff, dry									
5	SPT-3	15-14-16 (30)														
	SPT-4	10-14-8 (22)					-shell fragments and calcareous particles from 6.8 to 7.5 feet	9		74	43	16	27			
	SPT-5	6-6-10 (16)					8/ SAND, red-brown, medium dense, dry, trace calcareous fragments and chert, trace clay									
10																
	SPT-6	10-11-12 (23)					13/ SAND, light brown, medium dense to dense, dry									
15																
	SPT-7	6-4-6 (10)					-red-brown, lean clay seam/layer from 19.4 to 19.5 feet									
20																
	SPT-8	11-23-23 (46)														
25																
	SPT-9	16-21-29 (50)					28/ SAND, light brown, very dense to dense, wet (Beaumont Formation)									

Water Observations:
18 ft At tine of drilling
16.9 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

LOG OF BORING NO. B-115

Project Description: Proposed OCR Due Diligence
Project Location: Edna, Texas
Date Drilling Started: 10/5/2017
Logged By: ZR
Rig Type: D-50 Track
Latitude: 28.767556

Drilling Co.: Terracon
Hammer Type: Automatic
Longitude: -96.478401

Project No.: LVA17406
Phase No.: ****
Date Drilling Completed: 10/5/2017
Drill Method: CFA & Rotary Wash
Elevation:

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
							SAND, light brown, very dense to dense, wet (Beaumont Formation) *(continued)*									
	SPT-10	11-16-19 (35)					-trace clay from 33 to 34.5 feet									
35																
38							FAT CLAY, light brown and yellow-brown, very stiff, dry									
	U-11		3.0 (P)	73			-trace fossil seam from 38.6 to 38.7 feet	26		95	53	23	30			
40																
43	U-12		1.75 (P)	79			LEAN CLAY, yellow-brown, stiff, moist, trace shell fragments and fossil fragments									
45																
48	U-13		4.0 (P)	54			LEAN CLAY, red-brown, hard, moist, trace glauconitic nodules, fine-grained sand									
50							Total boring depth 50.0 ft.									
55																

Water Observations:
18 ft At tine of drilling
16.9 ft After drilling

Remarks:

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual. These logs are subject to the limitations, conclusions, and recommendations in the associated report.

BORING LOG LEGEND AND NOMENCLATURE

Abbreviations		
U – Undisturbed Sample (tube)	SPT – Standard Penetration Test	NT – Not Testable
A – Auger Sample	TCP – Texas Cone Penetration	NP – Non Plastic
CS – Continuous Sample	CFA – Continuous Flight Auger	ATD – At Time of Drilling
C – Rock Core	HSA – Hollow Stem Auger	AD – After Drilling

General Terms

Term	Description
Blow Counts	Results from either the Standard Penetration Test (SPT) or the Texas Cone Penetration (TCP) test.
Recovery	Length of sample or core recovered divided by the total length pushed, driven, or cored (expressed as a %)
Rock Quality Designation (RQD)	Cumulative length of unfractured pieces of core material more than 4 inches in length divided by the total length of material cored (expressed as a percentage)

Consistency of Cohesive Soil

Description	Comp. Strength, tsf	SPT Blows	TCP Blows	Criteria
Very Soft	< 0.25	0 – 2	0 – 8	Sample sags under its own weight and is easily deformed
Soft	≥ 0.25 – < 0.5	> 2 – 4	> 8 – 20	Easily pinched between fingers and remolded with light finger pressure
Medium Stiff	≥ 0.5 – < 1.0	> 4 – 8	N/A for TxDOT	Imprinted easily with fingers and remolded with firm finger pressure
Stiff	≥ 1.0 – < 2.0	> 8 – 15	>20 – 40	Imprinted with strong finger pressure or indented easily with fingernail
Very Stiff	≥ 2.0 – < 4.0	> 15 – 30	> 40 to 80	Light imprint from finger or light indent with fingernail
Hard	≥ 4.0	> 30	>80	Difficult to indent with fingernail

Apparent Density of Cohesionless Soil

Description	SPT Blow Count	Texas Cone Blow Count
Very Loose	0 – 4	0 – 8
Loose	> 4 – 10	> 8 – 20
Medium Dense	> 10 – 30	> 20 to 80
Dense	> 30 – 50	80 to ≥ 5”
Very Dense	> 50	0” to < 5”

Soil Structure

Description	Criteria
Stratified	Alternating layers of varying material/color with layers ≥ 1/4-inch thick
Laminated	Alternating layers of varying material/color with layers < 1/4-inch thick
Fissured	Breaks along definite planes with little resistance
Slickensided	Fracture planes appear polished or glossy; shows movement direction
Blocky	Cohesive soil that can be broken into small, angular lumps
Lensed	Inclusion of small pockets of soil that is different from dominate type
Homogenous	Same color and appearance throughout

Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

Textural Adjectives

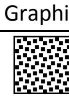
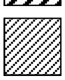
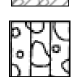
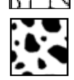
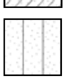
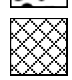
Textural Item	Description
Pit	Pinhole sized openings
Vug	Small openings up to 4 inches in size
Cavity	Opening larger than 4 inches
Honeycomb	Numerous and grouped pits and vugs
Vesicle	Small openings in volcanic rocks

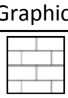
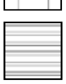
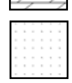
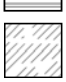
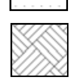
BORING LOG LEGEND AND NOMENCLATURE

Rock Hardness Descriptors			
Grade	Approx. Comp. Strength, tsf	Approx. TCP Range	Field Test
Very Soft	< 10 - 100	>6”	Can be peeled with pocket knife, crumbles under firm blows of geological hammer
Soft	100 - 500	4” - 6”	Can be peeled with pocket knife with difficulty, indented by firm blows of geological hammer
Hard	500 - 1000	1” - 5”	Cannot be peeled with pocket knife, can be fractured by single firm blow of hammer
Very Hard	1000 - 2000	0” - 2”	Specimen requires more than one blow of geological hammer to fracture it
Extremely Hard	> 2000	0”	Specimen requires many blows of geological hammer to fracture it

Degree of Rock Weathering	
Description	Criteria
Unweathered	No evidence of chemical or mechanical alteration
Slightly Weathered	Slight discoloration of surface or discontinuities; < 10% volume altered
Weathered	Discoloring evident; 10 to 50% of volume altered
Highly Weathered	Entire mass discolored; alteration through majority of rock
Decomposed	Rock reduced to soil consistency with some rock-like texture

Rock Bedding Structure	
Description	Criteria
Laminated	< 3/8 inch
Very Thinly Bedded	3/8—1 inch
Thinly Bedded	1 inch—4 inches
Moderately Bedded	4 inches—1 foot
Thickly Bedded	1 foot—3 feet
Very Thickly Bedded	3– 10 feet
Massive	> 10 feet

Soil Column Graphic Symbols*			
Graphic	Represented Soil Types	Graphic	Represented Soil Types
	Fat Clay, Fat Clay with sand, Sandy Fat Clay		Well-Graded Sand or Poorly-Graded Sand; little to no fines
	Lean Clay, Lean Clay with sand, Sandy Lean Clay, Silty Clay		Clayey Gravel, Gravel-Sand-Clay Mixtures
	Inorganic Silt and Organic Silt		Silty Gravel, Gravel-Sand-Silt Mixtures
	Clayey Sand, Clay-Sand Mixtures		Well-Graded Gravel or Poorly-Graded Gravel; little to no fines
	Silty Sands, Sand-Silt Mixtures		Fill with Significant Debris or Deleterious Material

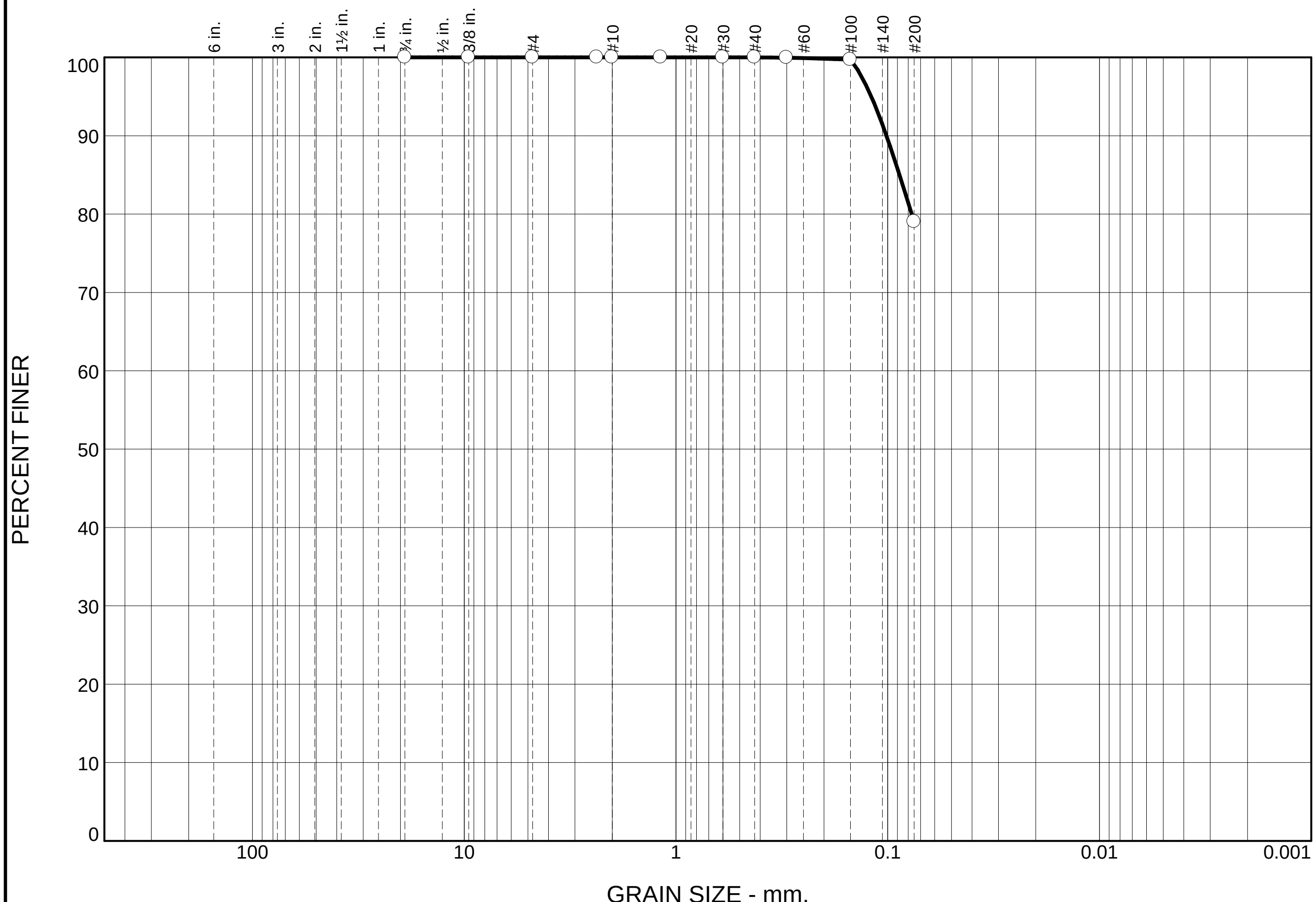
Rock Column Graphic Symbols*			
Graphic	Represented Rock Types	Graphic	Represented Rock Types
	Limestone, Shaly/Marly Limestone, Limestone with Shale		Marl, Marl with Limestone, Marl with Shale
	Shale, Shale with Limestone		Sandstone, Shaly Sandstone, Sandstone with Shale
	Mudstone		Generic Bedrock Symbol

* Combined graphics may be used for dual classifications. Not all graphics represented. Refer to lithology description for soil classification or rock type.

Appendix C

Laboratory Testing Results

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	21.0	79.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0880							

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-101 **Depth:** (28.0-29.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-101
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
211.41	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.10	100.0
			#100	0.61	99.7
			#200	44.37	79.0

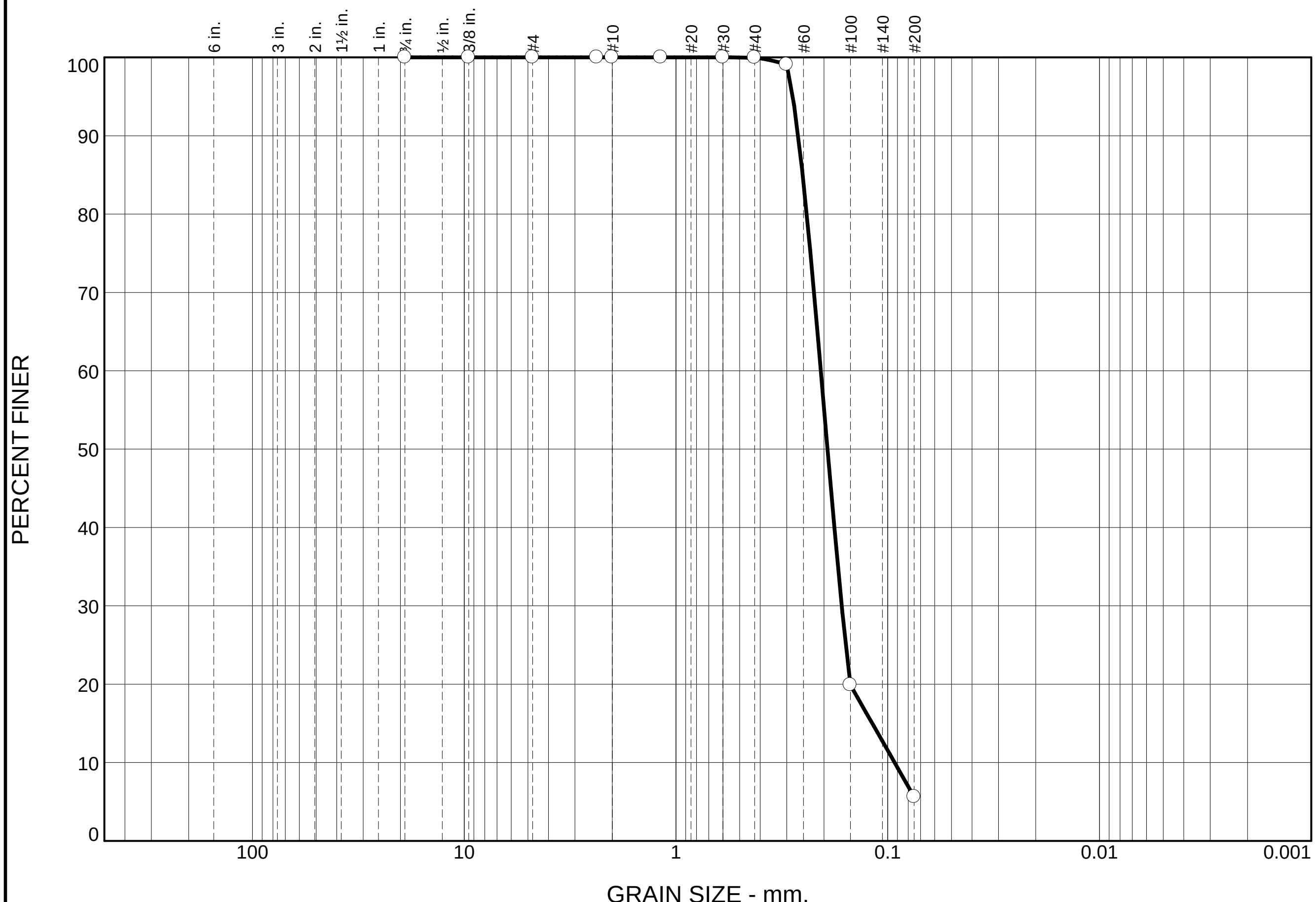
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	21.0	21.0			79.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
								0.0770	0.0880	0.1014	0.1196

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	94.4	5.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2521	0.2069	0.1925	0.1650	0.1183	0.0928	1.42	2.23

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-102 **Depth:** (13.0-14.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-102
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
292.39	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.10	100.0
			#50	2.69	99.1
			#100	234.25	19.9
			#200	275.96	5.6

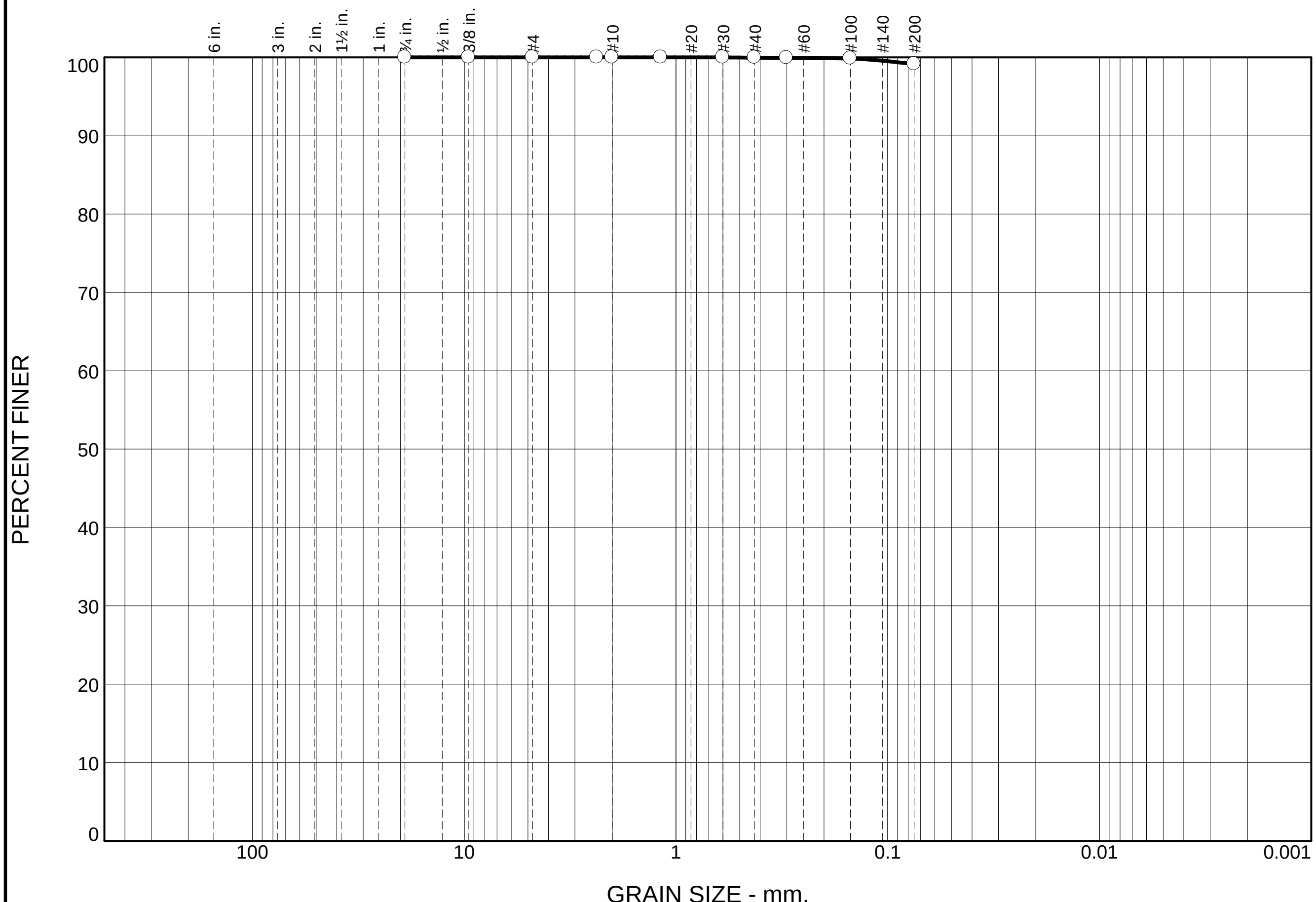
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	94.4	94.4			5.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0928	0.1183	0.1502	0.1650	0.1787	0.1925	0.2069	0.2413	0.2521	0.2648	0.2808

Fineness Modulus	C_u	C_c
0.81	2.23	1.42

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	0.9	99.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-103 **Depth:** (28.0-29.5) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-103
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
151.30	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.06	100.0
			#50	0.11	99.9
			#100	0.21	99.9
			#200	1.29	99.1

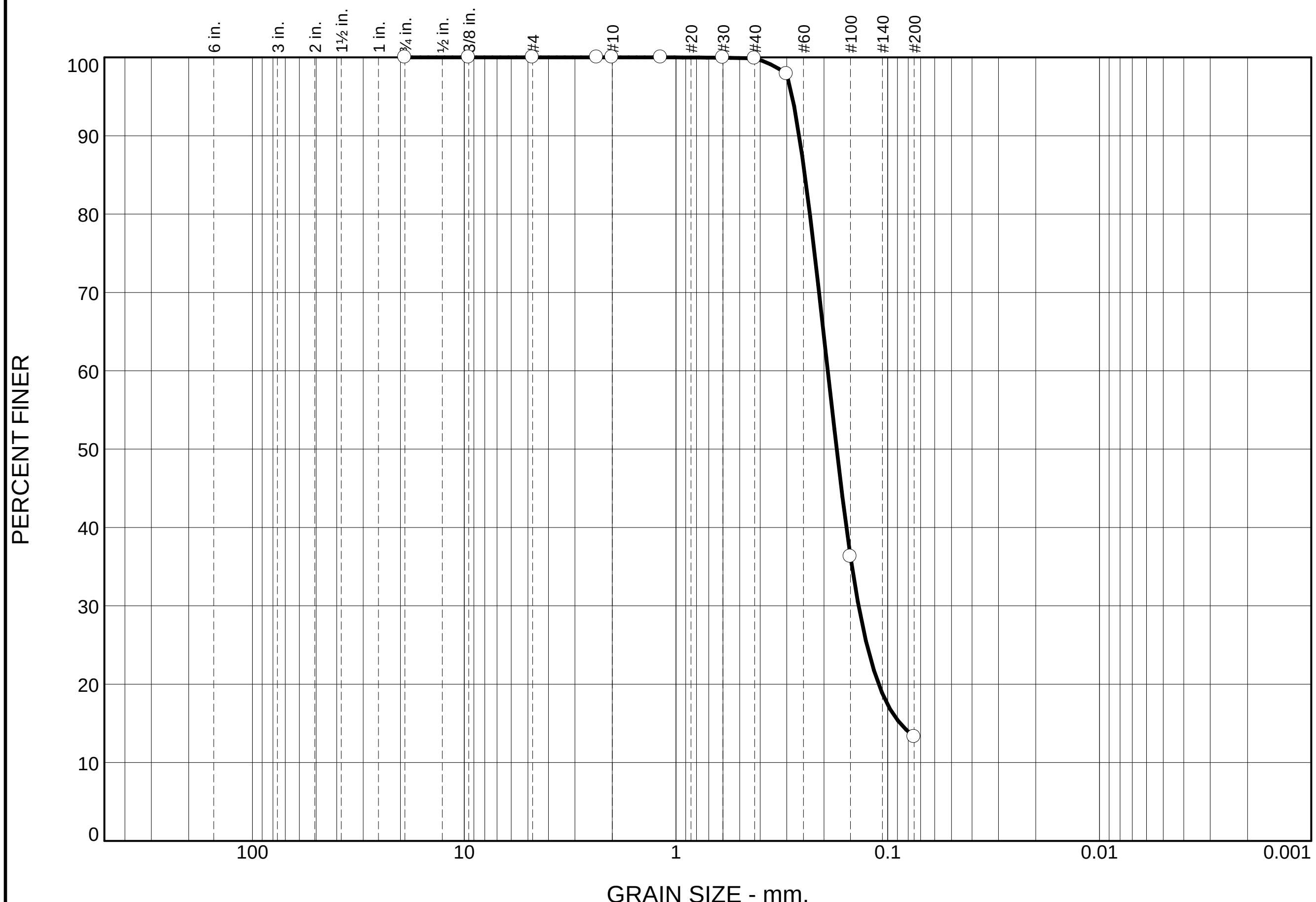
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9			99.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.1	86.6	13.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2463	0.1919	0.1743	0.1372	0.0873			

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-104 **Depth:** (20.0-21.5) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-104
Depth: (20.0-21.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
177.85	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.07	100.0
			#40	0.24	99.9
			#50	3.76	97.9
			#100	113.30	36.3
			#200	154.21	13.3

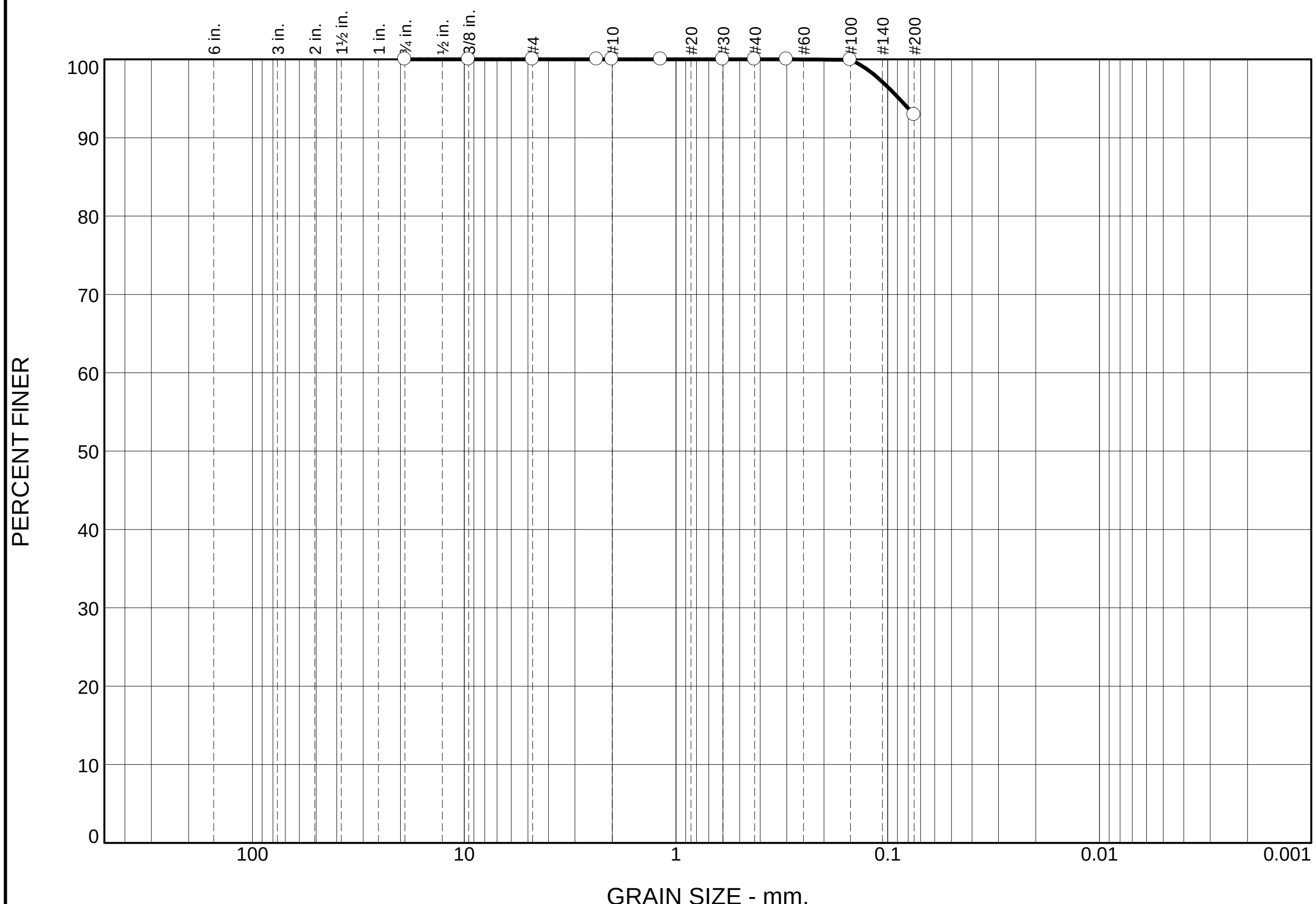
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	86.6	86.7			13.3

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0873	0.1104	0.1372	0.1568	0.1743	0.1919	0.2331	0.2463	0.2619	0.2825

Fineness Modulus
0.66

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	7.1	92.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	25	20								

	Material Description	USCS	AASHTO
○		CL-ML	A-4(3)

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-105 **Depth:** (23.0-25.0) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-105
Depth: (23.0-25.0) ft.
Liquid Limit: 25
Plastic Limit: 20
USCS Classification: CL-ML
AASHTO Classification: A-4(3)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
187.48	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.00	100.0
			#100	0.13	99.9
			#200	13.28	92.9

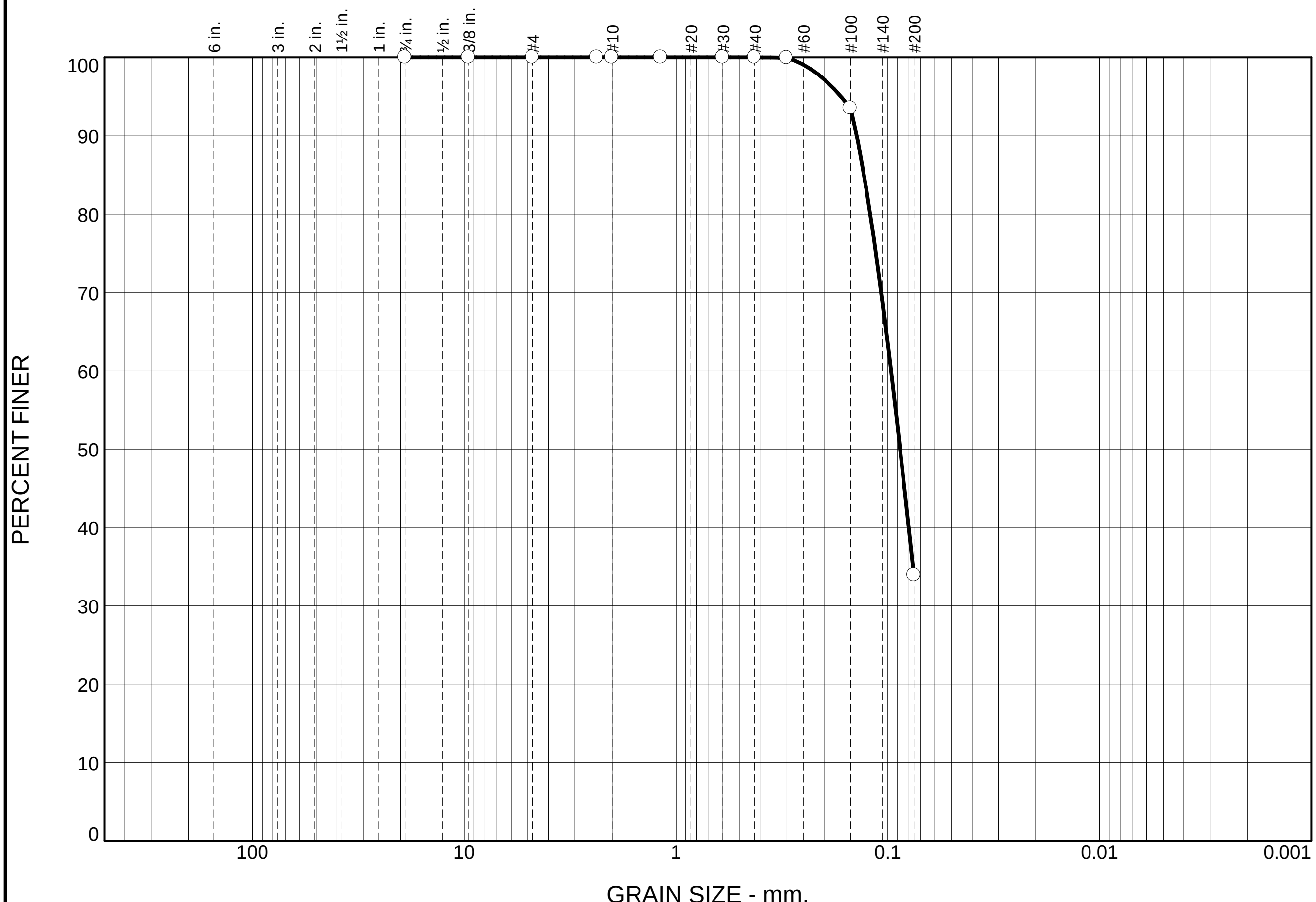
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.1			92.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
											0.0884

Fineness Modulus
0.00

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	66.1	33.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1294	0.0965	0.0874					

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-106 **Depth:** (23.0-24.5) ft.

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Houston, Texas

Remarks:

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-106
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
155.29	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	0.09	99.9
			#100	10.07	93.5
			#200	102.66	33.9

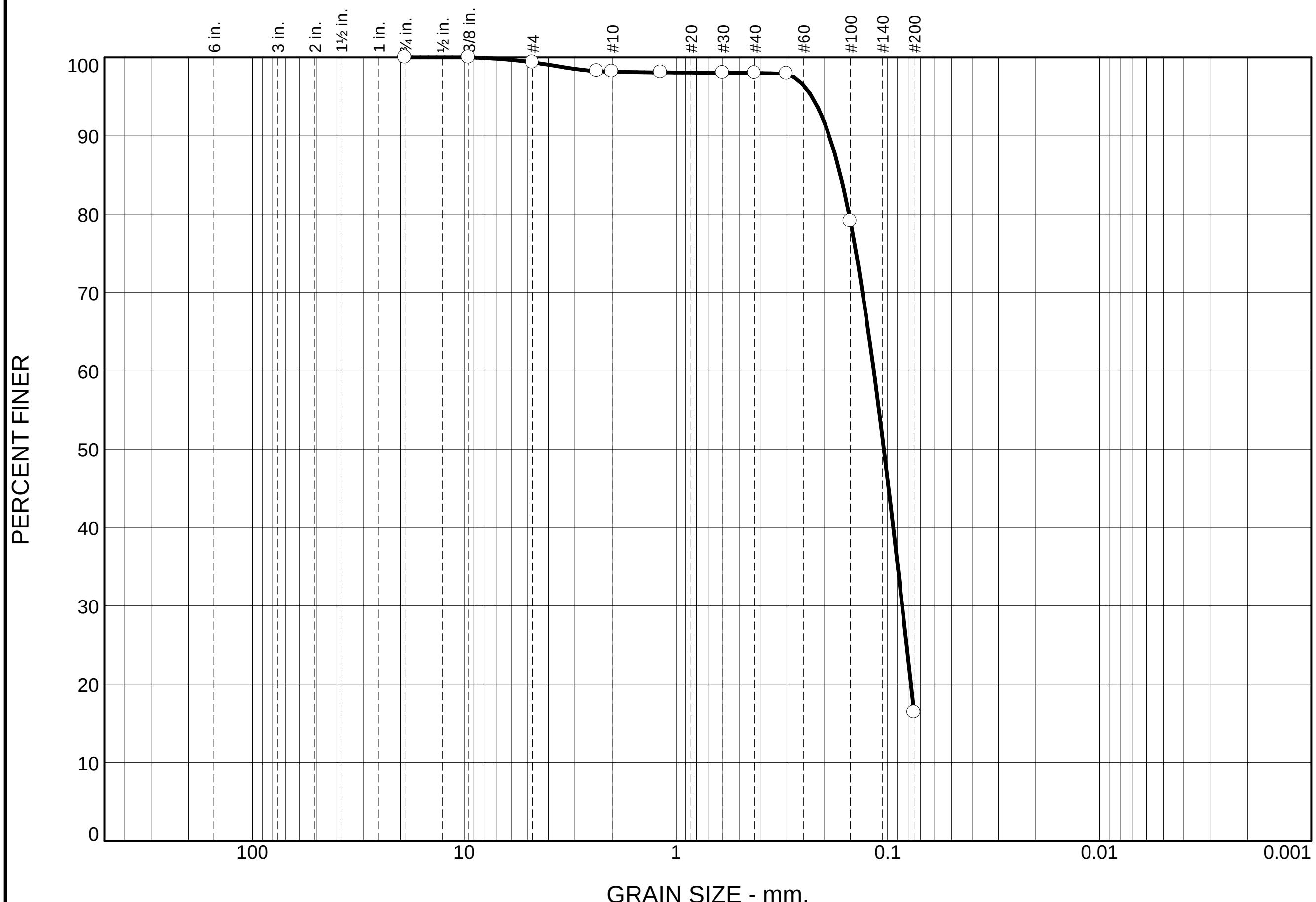
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	66.1	66.1			33.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0794	0.0874	0.0965	0.1209	0.1294	0.1401	0.1663

Fineness Modulus
0.07

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	1.2	0.2	81.6	16.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1672	0.1163	0.1043	0.0854				

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-107 **Depth:** (23.0-24.5) ft.

Remarks:

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Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-107
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
161.36	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	1.02	99.4
			#8	2.82	98.3
			#10	2.93	98.2
			#16	3.09	98.1
			#30	3.17	98.0
			#40	3.22	98.0
			#50	3.38	97.9
			#100	33.69	79.1
			#200	134.89	16.4

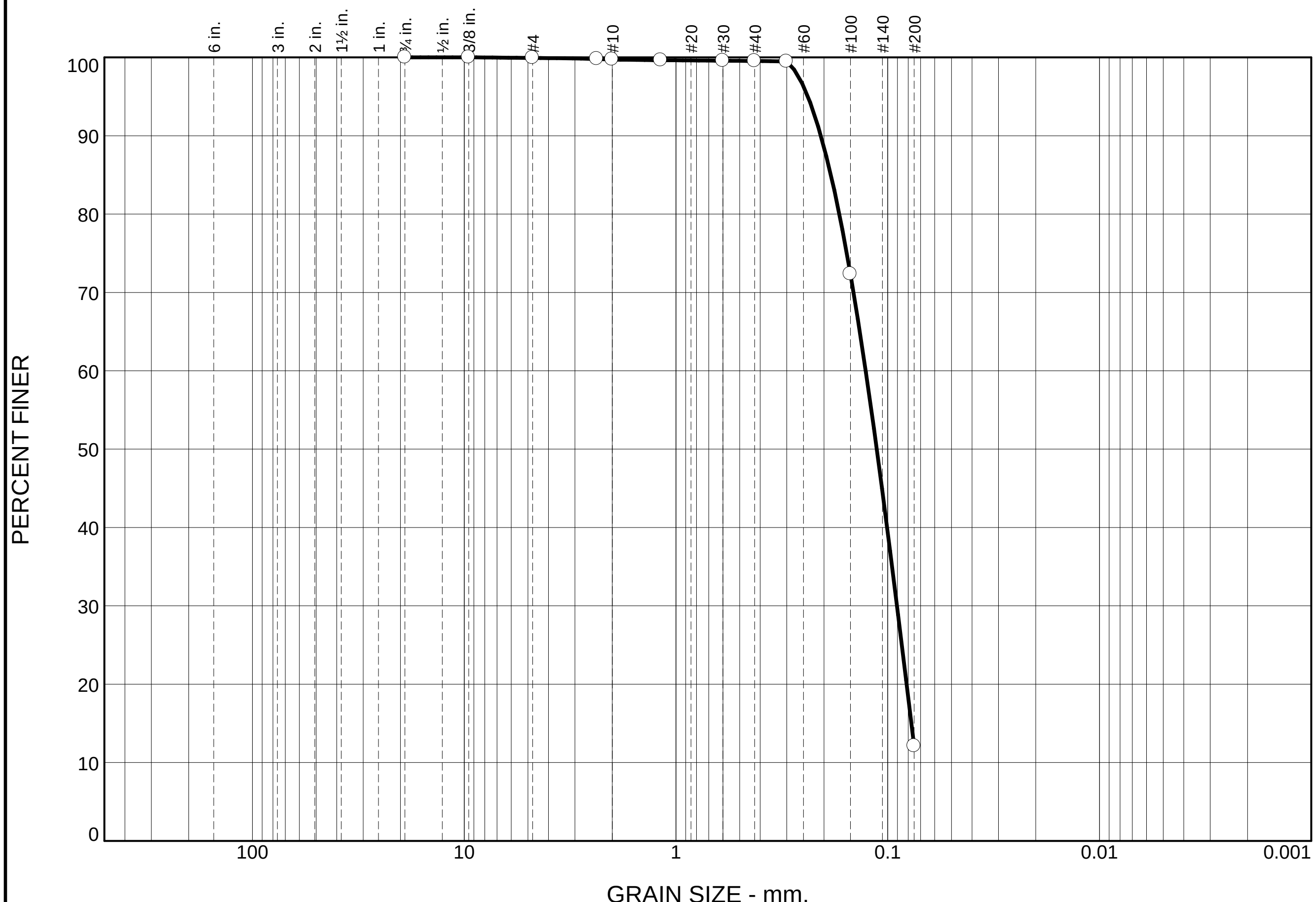
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.6	0.6	1.2	0.2	81.6	83.0			16.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.0776	0.0854	0.0942	0.1043	0.1163	0.1522	0.1672	0.1888	0.2280

Fineness Modulus
0.29

Particle Size Distribution Report



% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
0.0	0.0	0.1	0.2	0.2	87.4	12.1	

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
		0.1856	0.1271	0.1127	0.0904	0.0773			

Material Description	USCS	AASHTO

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-108 **Depth:** (13.0-14.5) ft.

Remarks:

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Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-108
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
182.08	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.13	99.9
			#8	0.38	99.8
			#10	0.50	99.7
			#16	0.66	99.6
			#30	0.77	99.6
			#40	0.83	99.5
			#50	0.97	99.5
			#100	50.36	72.3
			#200	160.03	12.1

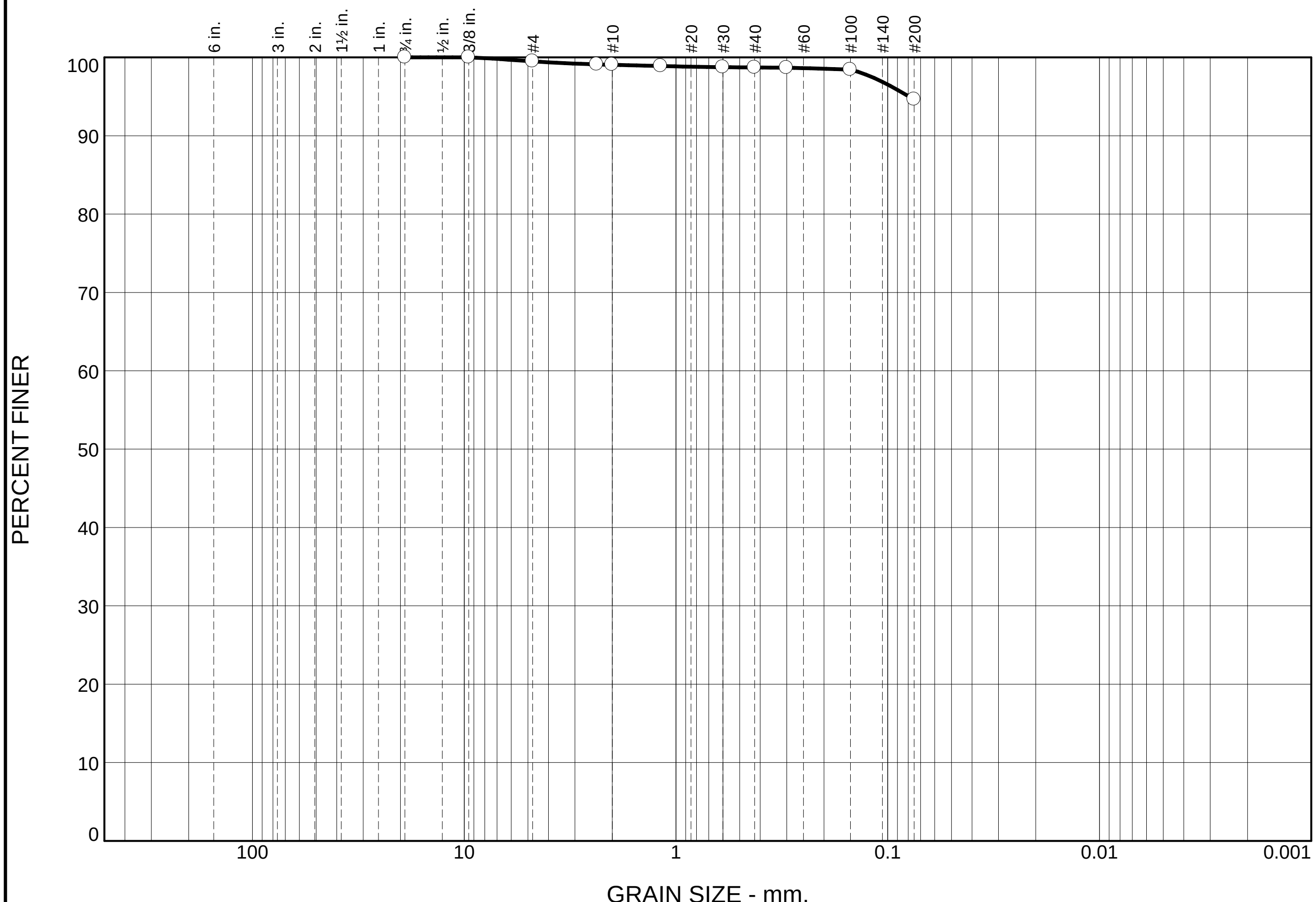
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.1	0.1	0.2	0.2	87.4	87.8			12.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0773	0.0814	0.0904	0.1007	0.1127	0.1271	0.1693	0.1856	0.2069	0.2382

Fineness Modulus
0.29

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.4	0.4	4.1	94.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-109 **Depth:** (23.0-24.5) ft.

Remarks:

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-109
Depth: (23.0-24.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
164.71	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.84	99.5
			#8	1.47	99.1
			#10	1.56	99.1
			#16	1.81	98.9
			#30	2.07	98.7
			#40	2.13	98.7
			#50	2.19	98.7
			#100	2.60	98.4
			#200	8.86	94.6

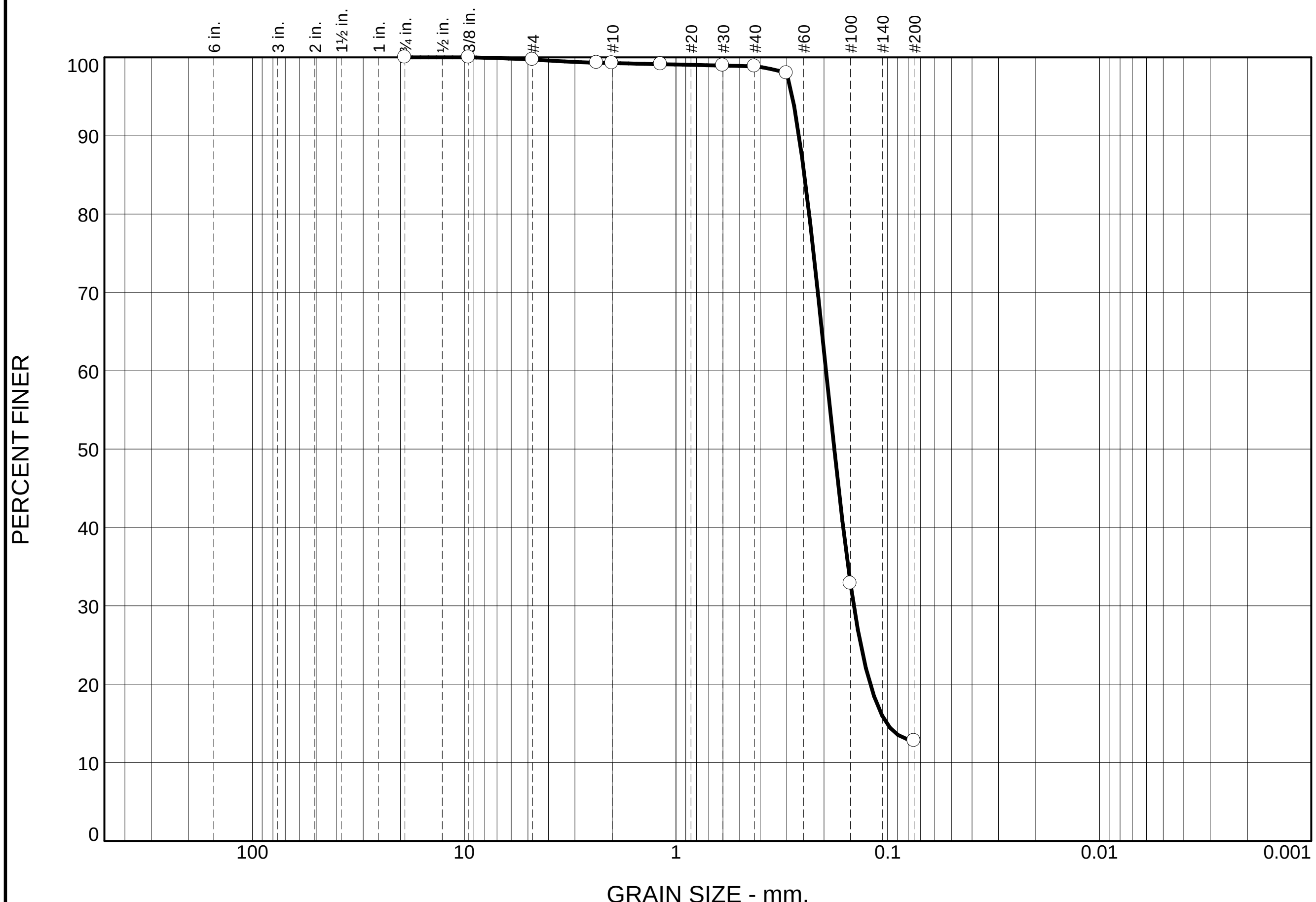
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.5	0.5	0.4	0.4	4.1	4.9			94.6

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
											0.0793

Fineness Modulus
0.07

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.3	0.4	0.4	86.1	12.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2475	0.1955	0.1788	0.1446	0.1011			

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-110 **Depth:** (18.0-19.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-110
Depth: (18.0-19.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
178.12	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.52	99.7
			#8	1.22	99.3
			#10	1.29	99.3
			#16	1.55	99.1
			#30	1.86	99.0
			#40	2.03	98.9
			#50	3.57	98.0
			#100	119.60	32.9
			#200	155.34	12.8

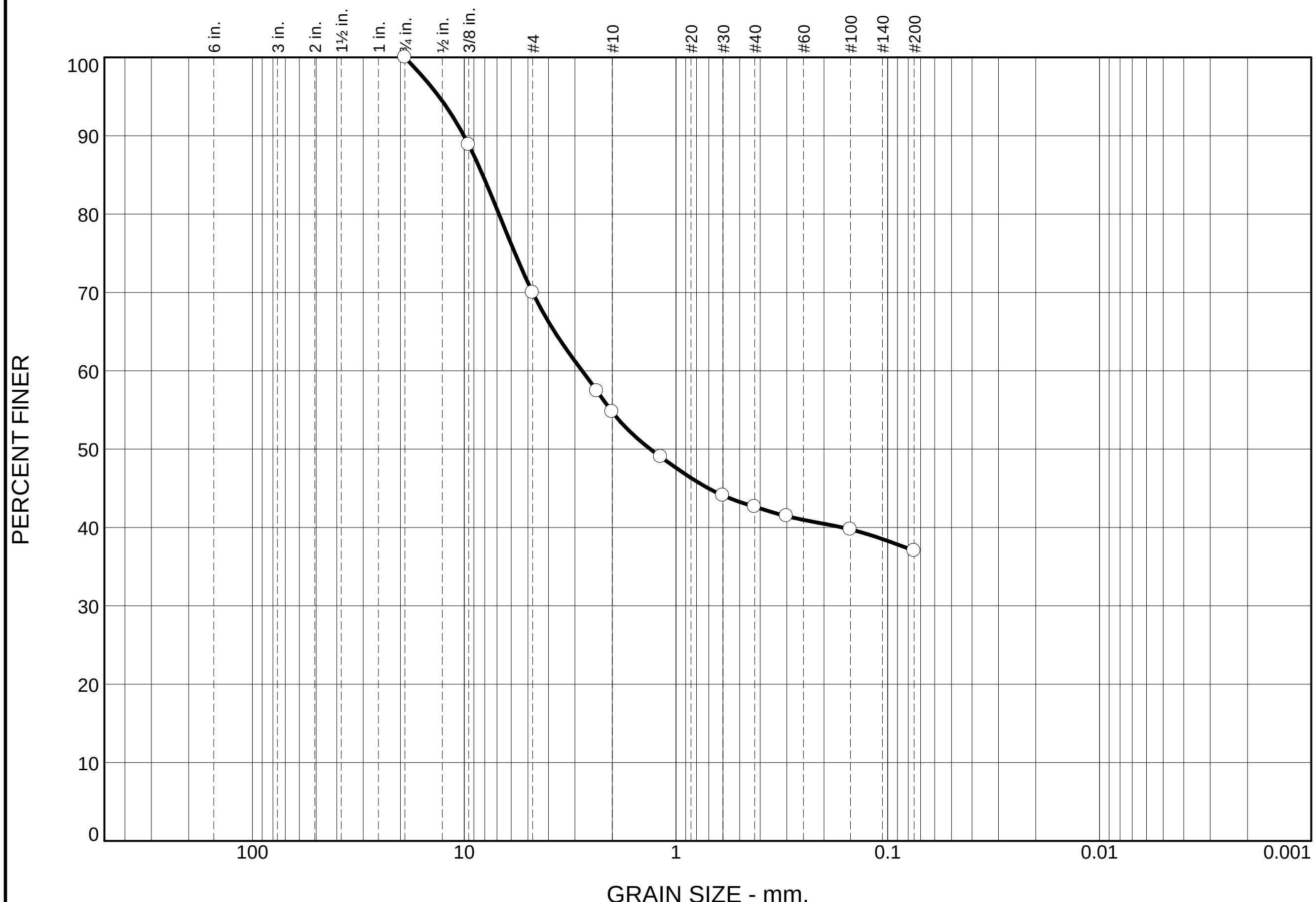
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	0.4	0.4	86.1	86.9			12.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.1011	0.1210	0.1446	0.1624	0.1788	0.1955	0.2349	0.2475	0.2625	0.2822

Fineness Modulus
0.72

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	30.0	15.2	12.2	5.6	37.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			8.1816	2.7755	1.3204					

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-112 **Depth:** (38.0-39.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-112
Depth: (38.0-39.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
166.46	0.00	0.00	0.75"	0.00	100.0
			3/8"	18.55	88.9
			#4	50.00	70.0
			#8	70.88	57.4
			#10	75.32	54.8
			#16	84.87	49.0
			#30	93.08	44.1
			#40	95.47	42.6
			#50	97.47	41.4
			#100	100.28	39.8
			#200	104.81	37.0

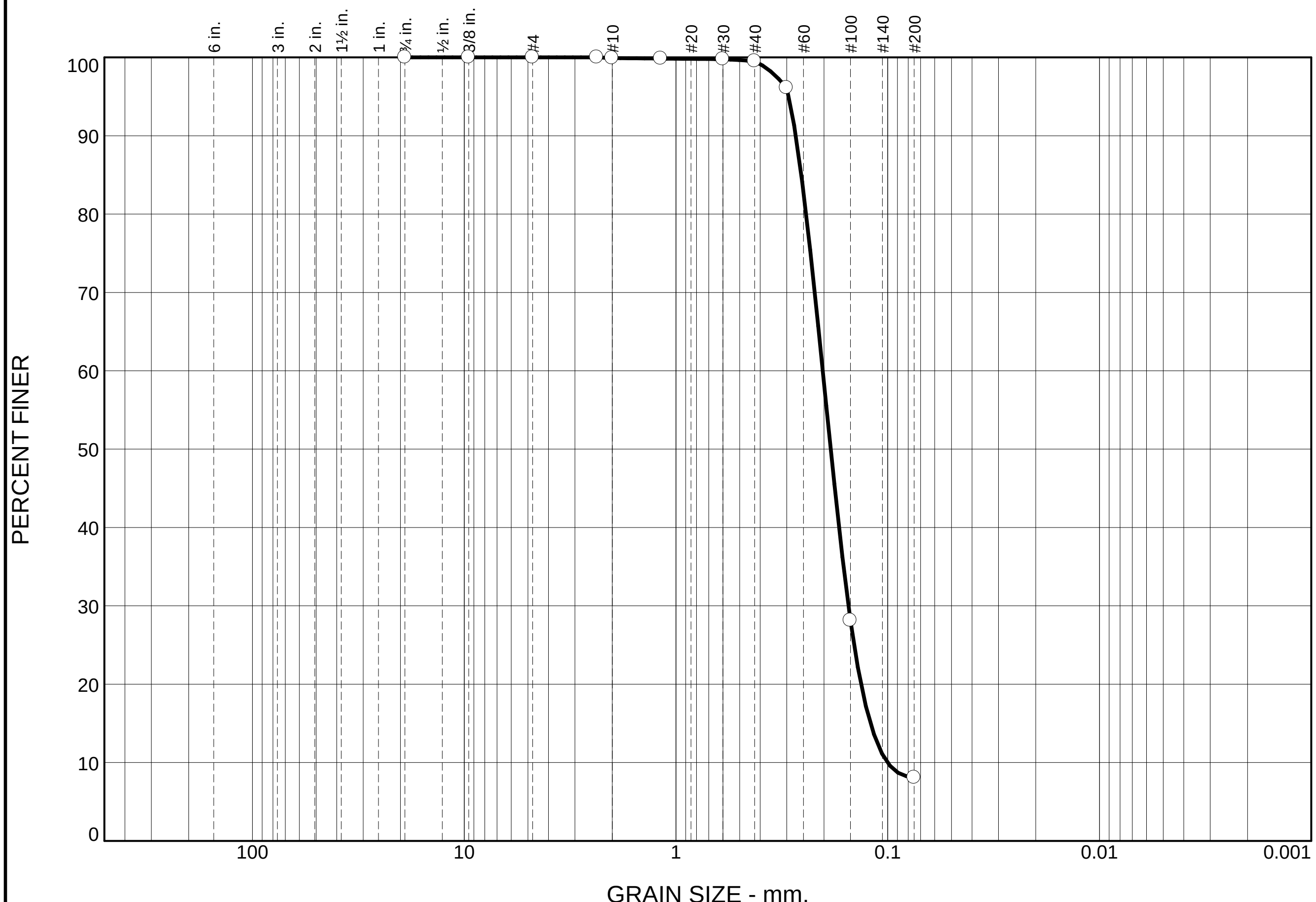
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	30.0	30.0	15.2	12.2	5.6	33.0			37.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.1638	1.3204	2.7755	6.8528	8.1816	10.0207	13.1504

Fineness Modulus
3.09

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.4	91.4	8.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2560	0.2026	0.1859	0.1533	0.1206	0.1003	1.16	2.02

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-113 **Depth:** (18.0-19.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-113
Depth: (18.0-19.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
220.19	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.19	99.9
			#16	0.33	99.9
			#30	0.50	99.8
			#40	1.07	99.5
			#50	8.56	96.1
			#100	158.25	28.1
			#200	202.38	8.1

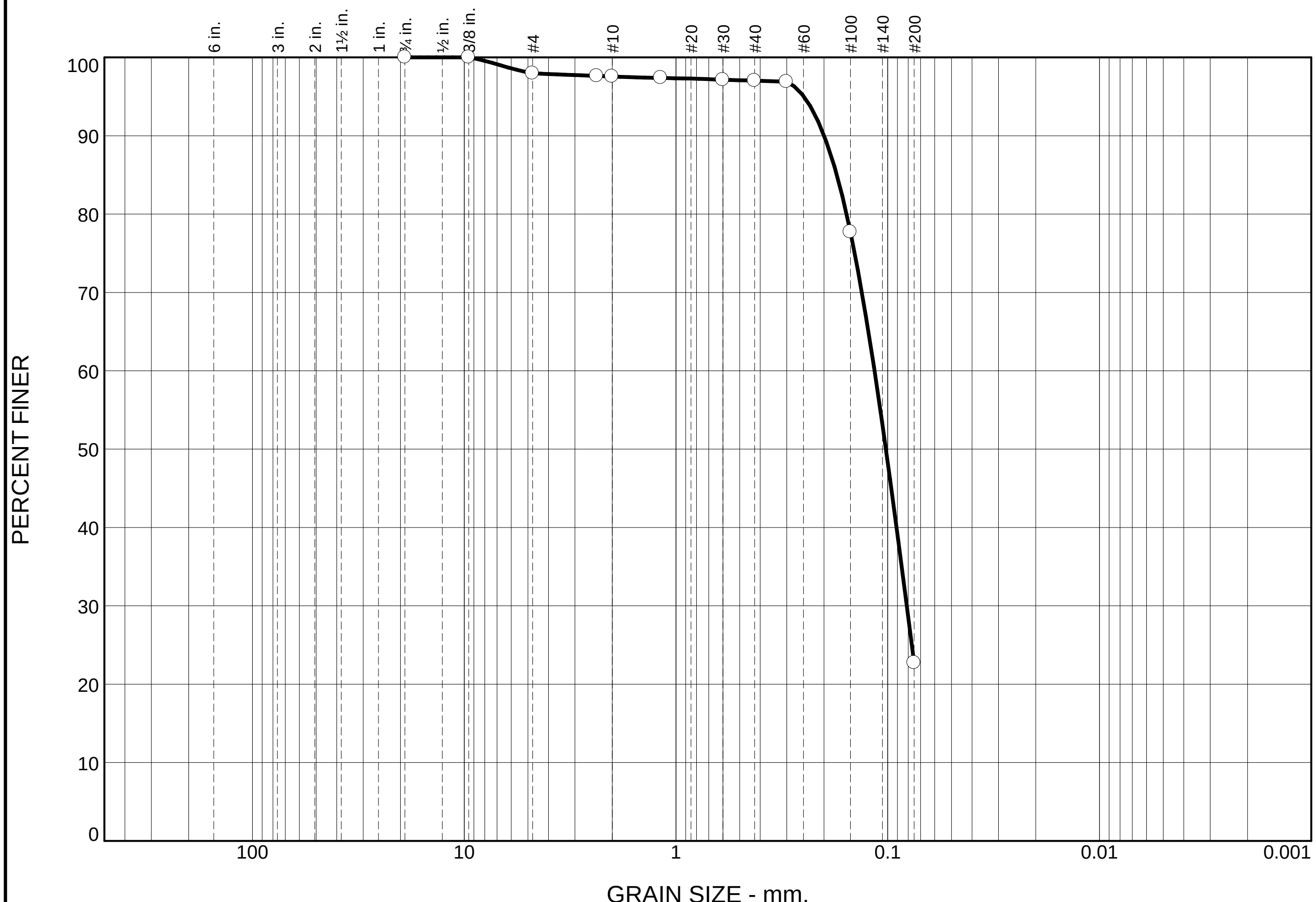
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.1	0.4	91.4	91.9			8.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1003	0.1206	0.1336	0.1533	0.1698	0.1859	0.2026	0.2429	0.2560	0.2718	0.2934

Fineness Modulus	C_u	C_c
0.76	2.02	1.16

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.0	0.4	0.6	74.3	22.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1740	0.1155	0.1020	0.0813				

	Material Description	USCS	AASHTO
○			

Project No. LVA17406 **Client:** Freese and Nichols, Inc.

Project: OCR Due Diligence Study

○ **Location:** B-115 **Depth:** (13.0-14.5) ft.

Remarks:

Gorrondona & Associates, Inc.

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Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-115
Depth: (13.0-14.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
208.62	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	4.25	98.0
			#8	4.94	97.6
			#10	5.09	97.6
			#16	5.48	97.4
			#30	5.99	97.1
			#40	6.20	97.0
			#50	6.49	96.9
			#100	46.49	77.7
			#200	161.22	22.7

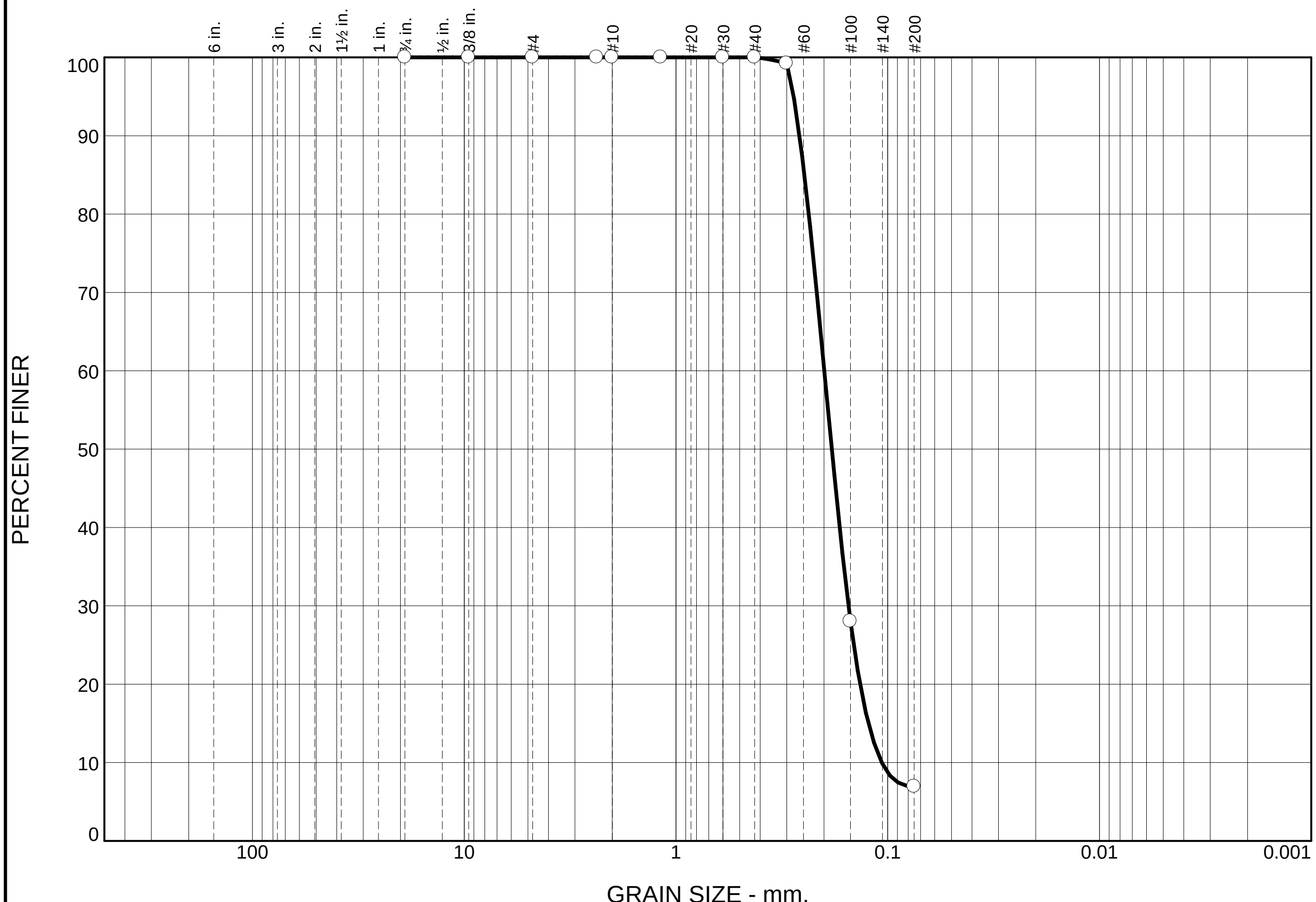
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	2.0	2.0	0.4	0.6	74.3	75.3			22.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0813	0.0909	0.1020	0.1155	0.1565	0.1740	0.1996	0.2487

Fineness Modulus
0.35

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	93.1	6.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2474	0.1992	0.1837	0.1532	0.1233	0.1067	1.10	1.87

Material Description	USCS	AASHTO
○		

Project No. LVA17406 **Client:** Freese and Nichols, Inc.
Project: OCR Due Diligence Study

○ **Location:** B-115 **Depth:** (28.0-29.5) ft.

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/18/2017

Client: Freese and Nichols, Inc.
Project: OCR Due Diligence Study
Project Number: LVA17406
Location: B-115
Depth: (28.0-29.5) ft.

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
209.85	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.00	100.0
			#30	0.00	100.0
			#40	0.00	100.0
			#50	1.63	99.2
			#100	151.02	28.0
			#200	195.32	6.9

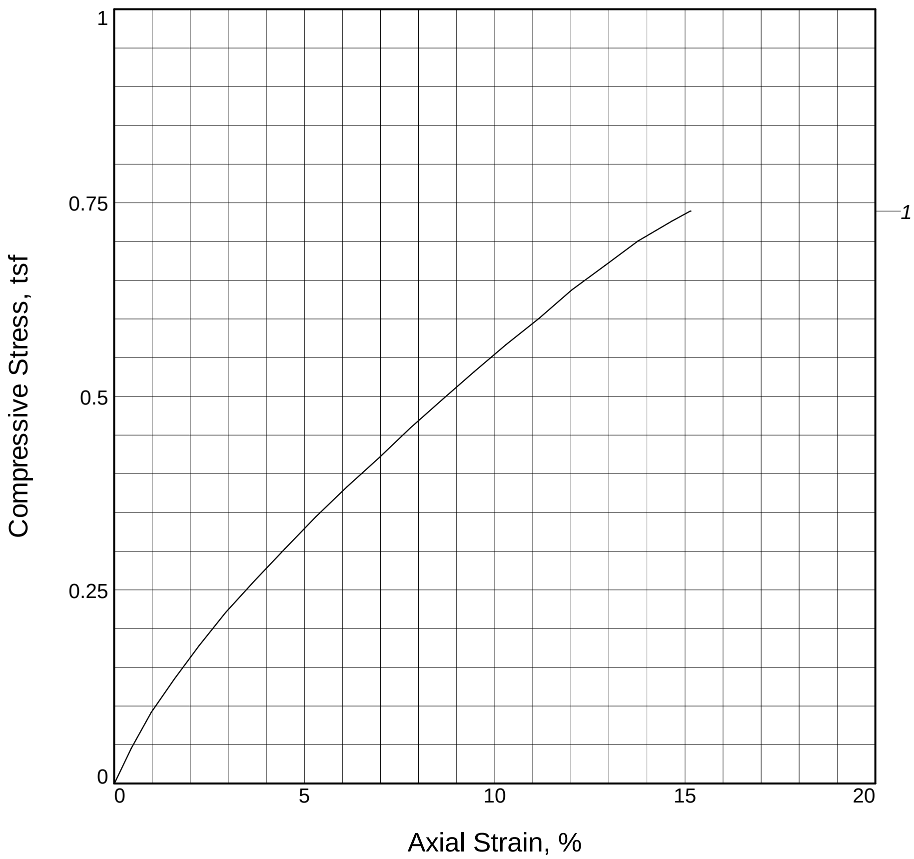
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	93.1	93.1			6.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1067	0.1233	0.1350	0.1532	0.1687	0.1837	0.1992	0.2359	0.2474	0.2610	0.2782

Fineness Modulus	C_u	C_c
0.73	1.87	1.10

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.739			
Undrained shear strength, tsf	0.370			
Failure strain, %	15.1			
Strain rate, %/min.	1.00			
Water content, %	19.3			
Wet density, pcf	124.4			
Dry density, pcf	104.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.76			
Specimen height, in.	5.74			
Height/diameter ratio	2.08			

Description:

LL = 42	**PL =** 16	**PI =** 26	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-101

Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
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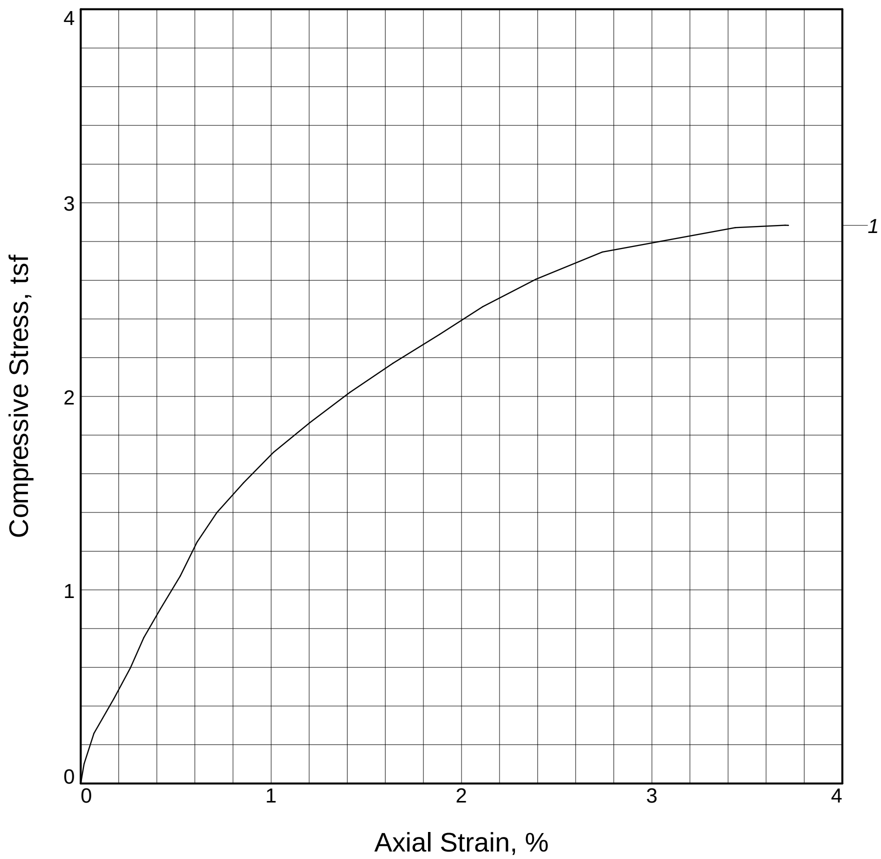
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.884			
Undrained shear strength, tsf	1.442			
Failure strain, %	3.7			
Strain rate, %/min.	1.00			
Water content, %	33.0			
Wet density, pcf	121.1			
Dry density, pcf	91.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 70	**PL =** 23	**PI =** 47	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

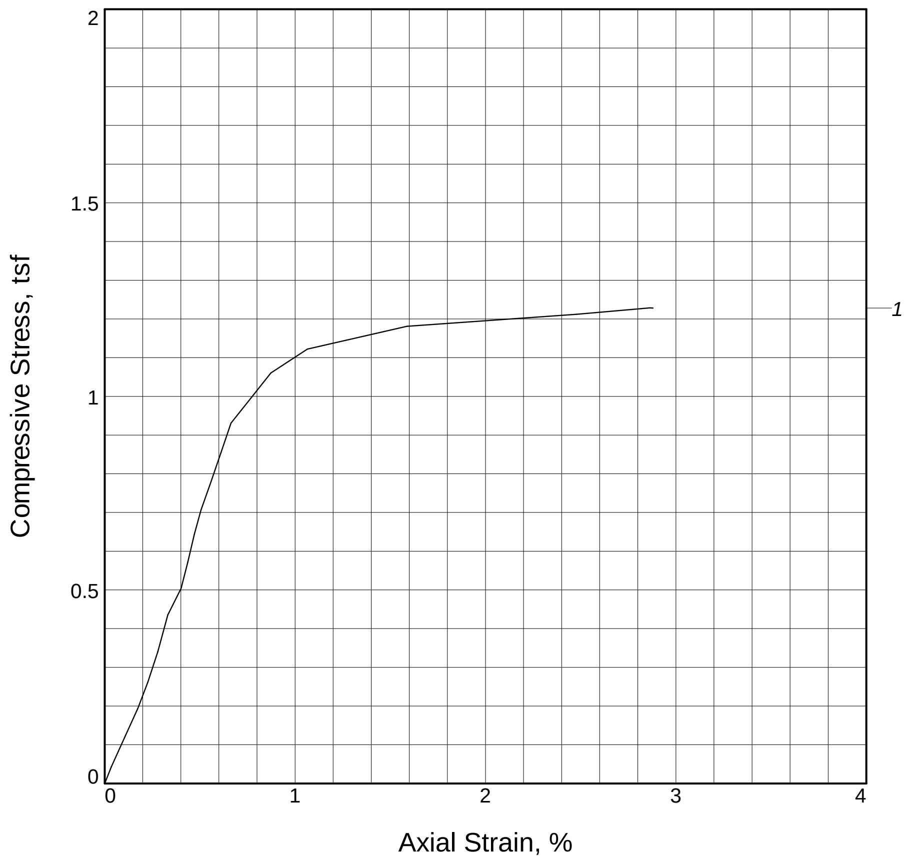
Project: OCR Due Diligence Study

Location: B-101

Depth: (38.0-40.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.228			
Undrained shear strength, tsf	0.614			
Failure strain, %	2.9			
Strain rate, %/min.	1.00			
Water content, %	25.6			
Wet density, pcf	125.3			
Dry density, pcf	99.7			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 62	**PL =** 22	**PI =** 40	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Client: Freese and Nichols, Inc.

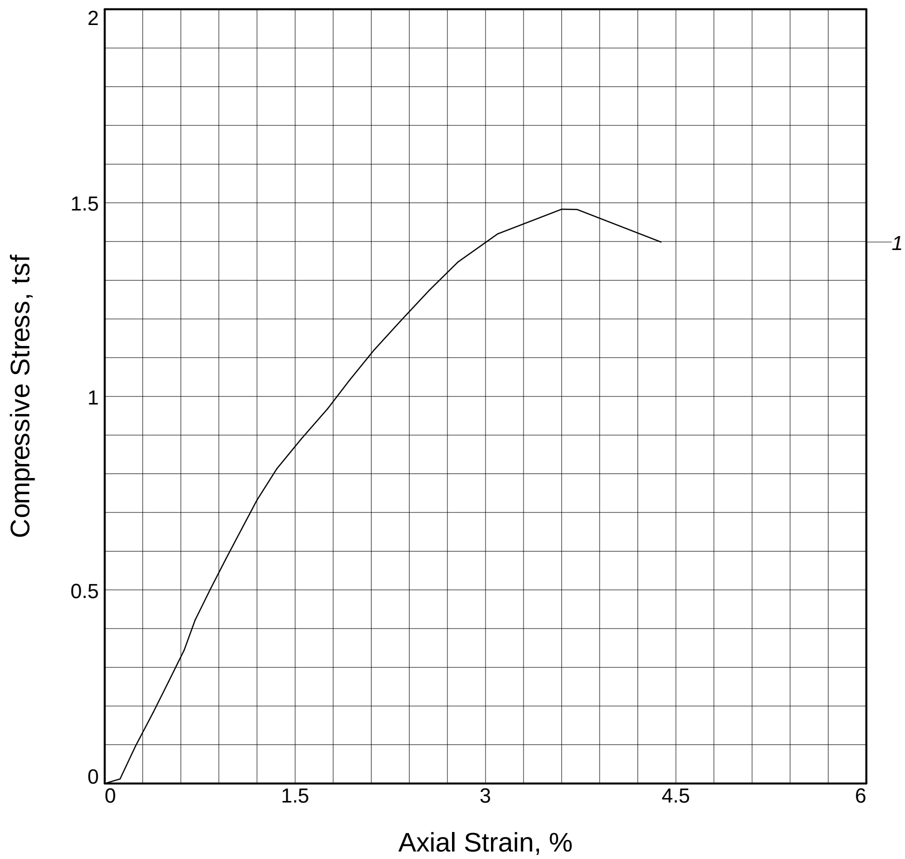
Project: OCR Due Diligence Study

Location: B-103
Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Figure _______

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.484			
Undrained shear strength, tsf	0.742			
Failure strain, %	3.6			
Strain rate, %/min.	1.00			
Water content, %	28.8			
Wet density, pcf	122.1			
Dry density, pcf	94.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.75			
Height/diameter ratio	2.04			

Description:

LL = 63	**PL =** 25	**PI =** 38	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-104

Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
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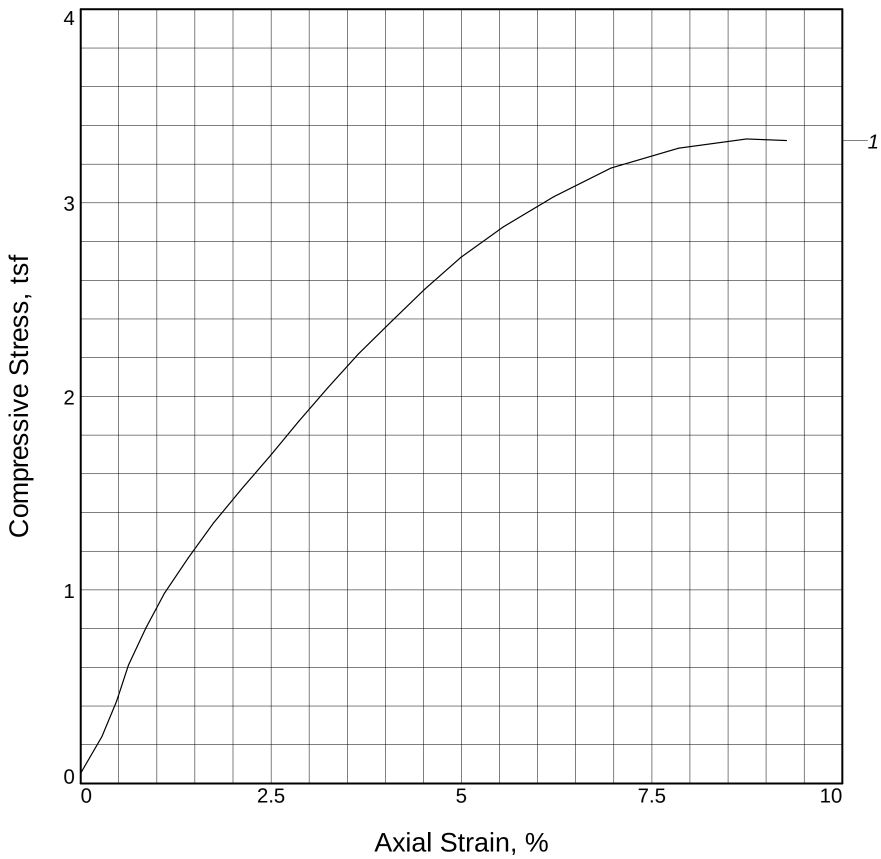
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.330			
Undrained shear strength, tsf	1.665			
Failure strain, %	8.7			
Strain rate, %/min.	1.00			
Water content, %	21.9			
Wet density, pcf	131.2			
Dry density, pcf	107.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.78			
Specimen height, in.	5.73			
Height/diameter ratio	2.06			

Description:

LL = 51	**PL =** 20	**PI =** 31	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-105
Depth: (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST
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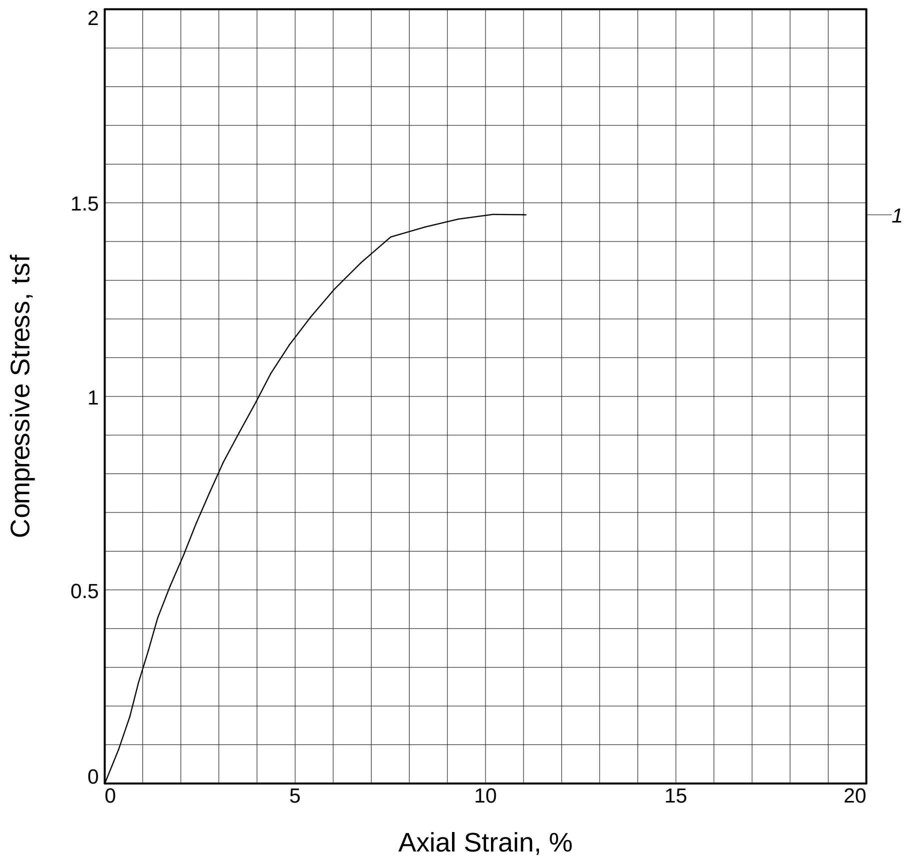
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.470			
Undrained shear strength, tsf	0.735			
Failure strain, %	10.2			
Strain rate, %/min.	1.00			
Water content, %	22.9			
Wet density, pcf	134.4			
Dry density, pcf	109.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.72			
Specimen height, in.	5.75			
Height/diameter ratio	2.11			

Description:

LL = 31	**PL =** 20	**PI =** 11	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-106
Depth: (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST
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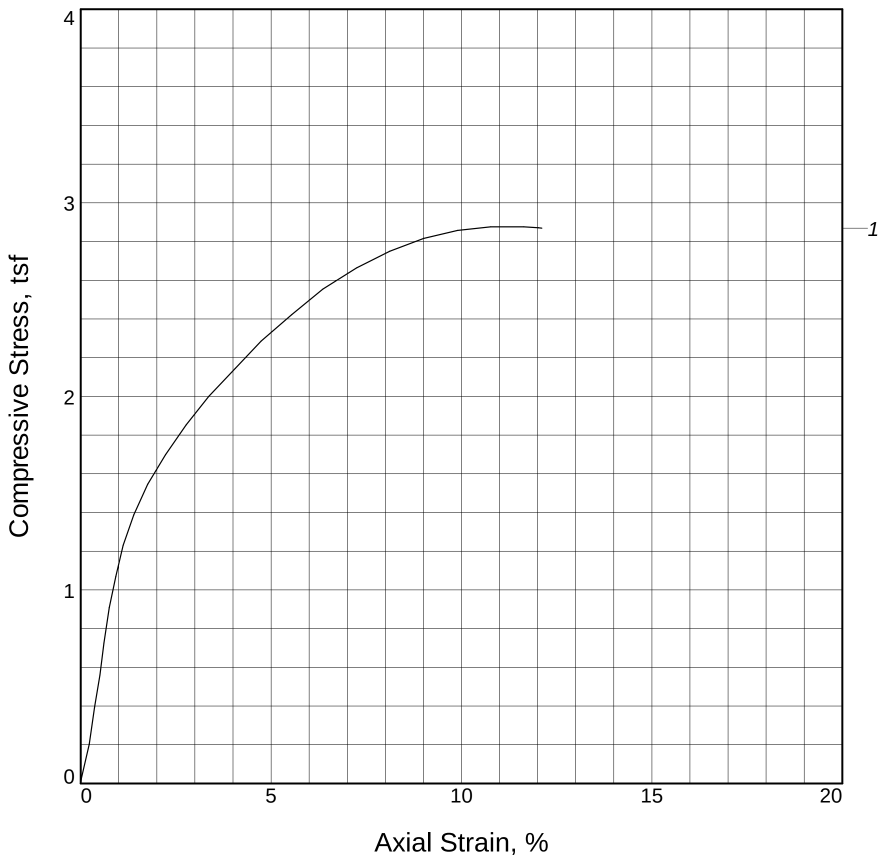
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.876			
Undrained shear strength, tsf	1.438			
Failure strain, %	10.8			
Strain rate, %/min.	1.00			
Water content, %	17.8			
Wet density, pcf	134.0			
Dry density, pcf	113.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.74			
Height/diameter ratio	2.09			

Description:

LL = 55	**PL =** 18	**PI =** 37	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

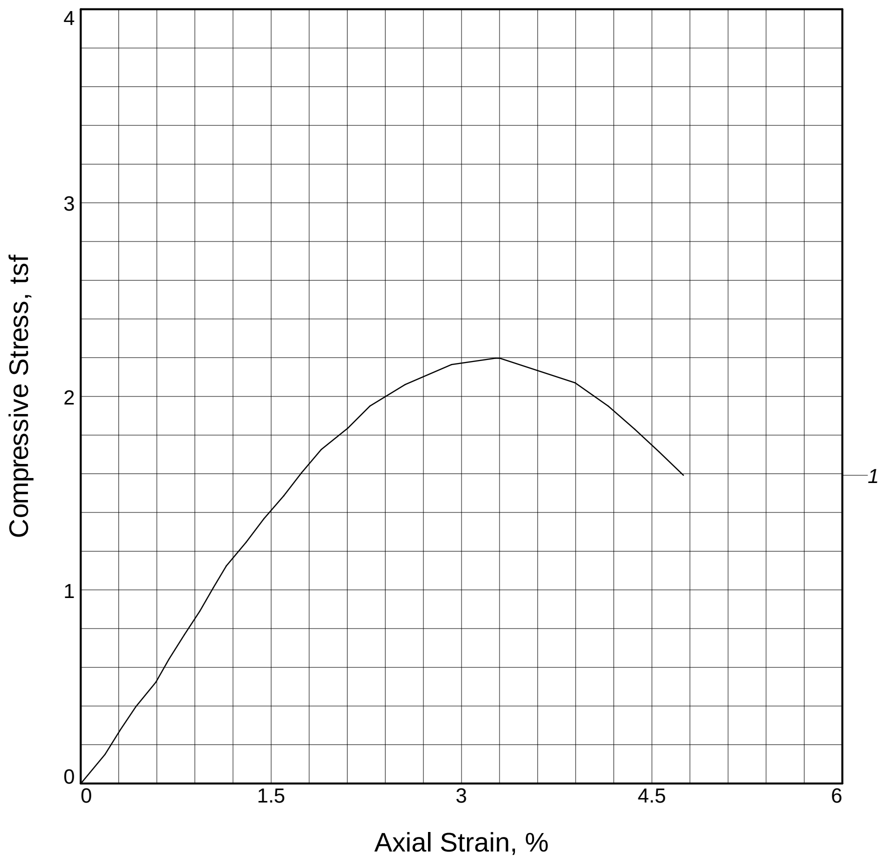
Project: OCR Due Diligence Study

Location: B-107

Depth: (6.0-8.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.197			
Undrained shear strength, tsf	1.099			
Failure strain, %	3.3			
Strain rate, %/min.	1.00			
Water content, %	27.1			
Wet density, pcf	124.3			
Dry density, pcf	97.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.75			
Height/diameter ratio	2.09			

Description:

LL = 67	**PL =** 26	**PI =** 41	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

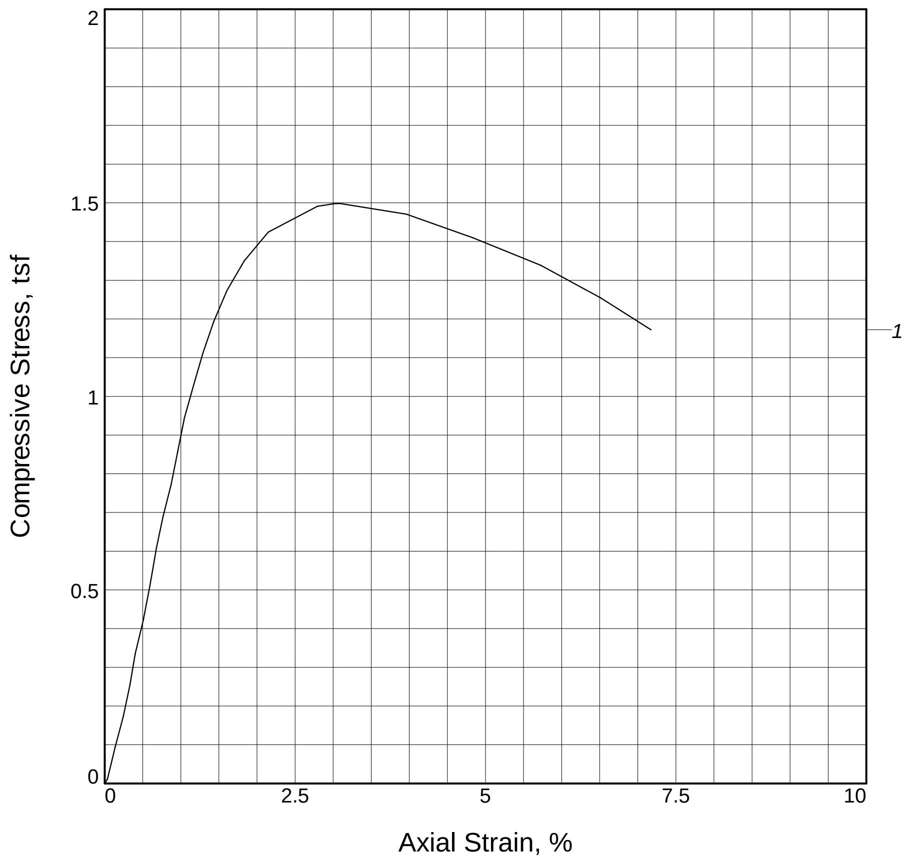
Project: OCR Due Diligence Study

Location: B-107

Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.498			
Undrained shear strength, tsf	0.749			
Failure strain, %	3.1			
Strain rate, %/min.	1.00			
Water content, %	32.9			
Wet density, pcf	120.3			
Dry density, pcf	90.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.73			
Height/diameter ratio	2.09			

Description:

LL = 64	**PL =** 26	**PI =** 38	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-108

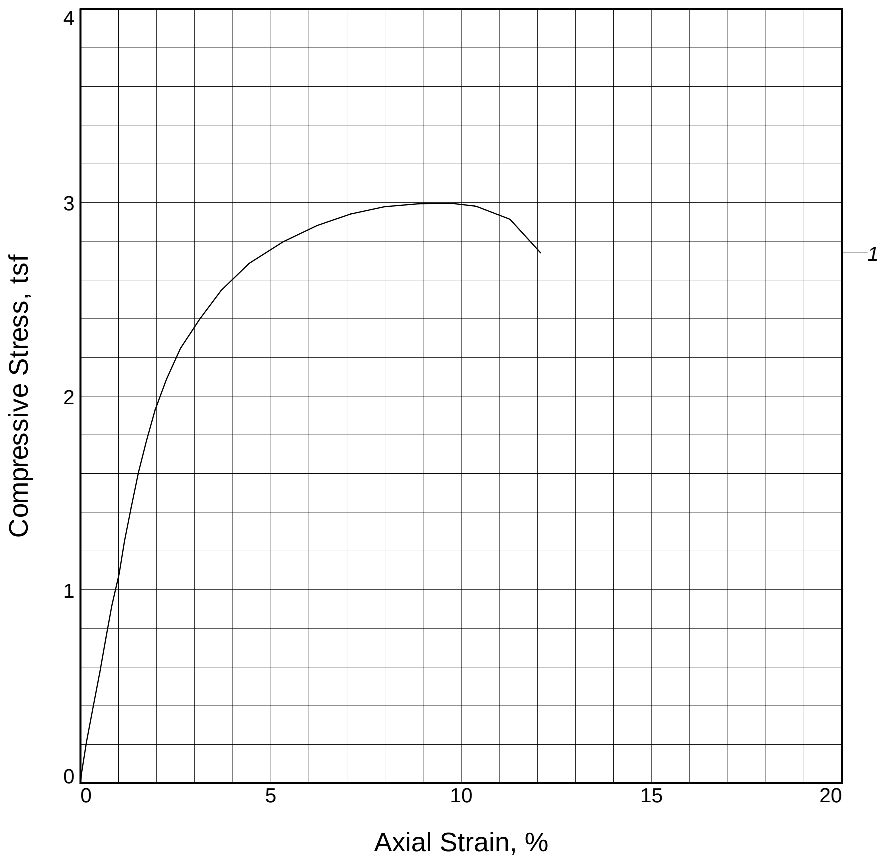
Depth: (38.0-40.0) ft.

UNCONFINED COMPRESSION TEST

Gorrondona & Associates, Inc.

Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.996			
Undrained shear strength, tsf	1.498			
Failure strain, %	9.8			
Strain rate, %/min.	1.00			
Water content, %	24.7			
Wet density, pcf	129.9			
Dry density, pcf	104.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.73			
Specimen height, in.	5.71			
Height/diameter ratio	2.09			

Description:

LL = 56	**PL =** 26	**PI =** 30	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Client: Freese and Nichols, Inc.

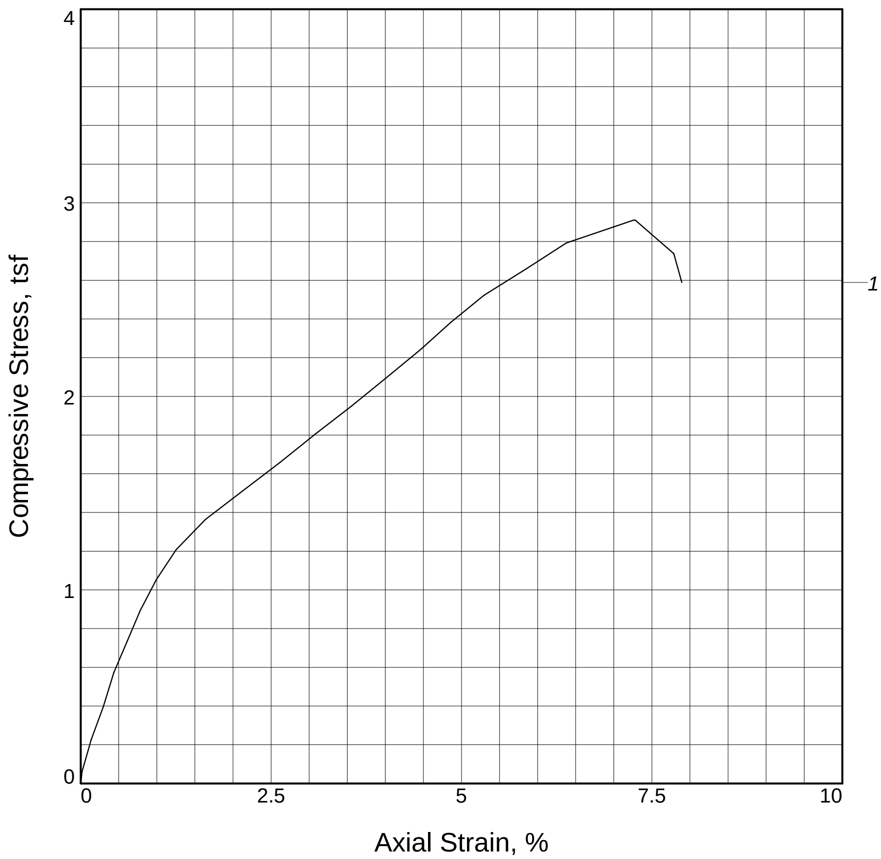
Project: OCR Due Diligence Study

Location: B-109
Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Figure _______

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.911			
Undrained shear strength, tsf	1.456			
Failure strain, %	7.3			
Strain rate, %/min.	1.00			
Water content, %	23.8			
Wet density, pcf	122.6			
Dry density, pcf	99.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.81			
Specimen height, in.	5.74			
Height/diameter ratio	2.04			

Description:

LL = 47	**PL =** 20	**PI =** 27	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

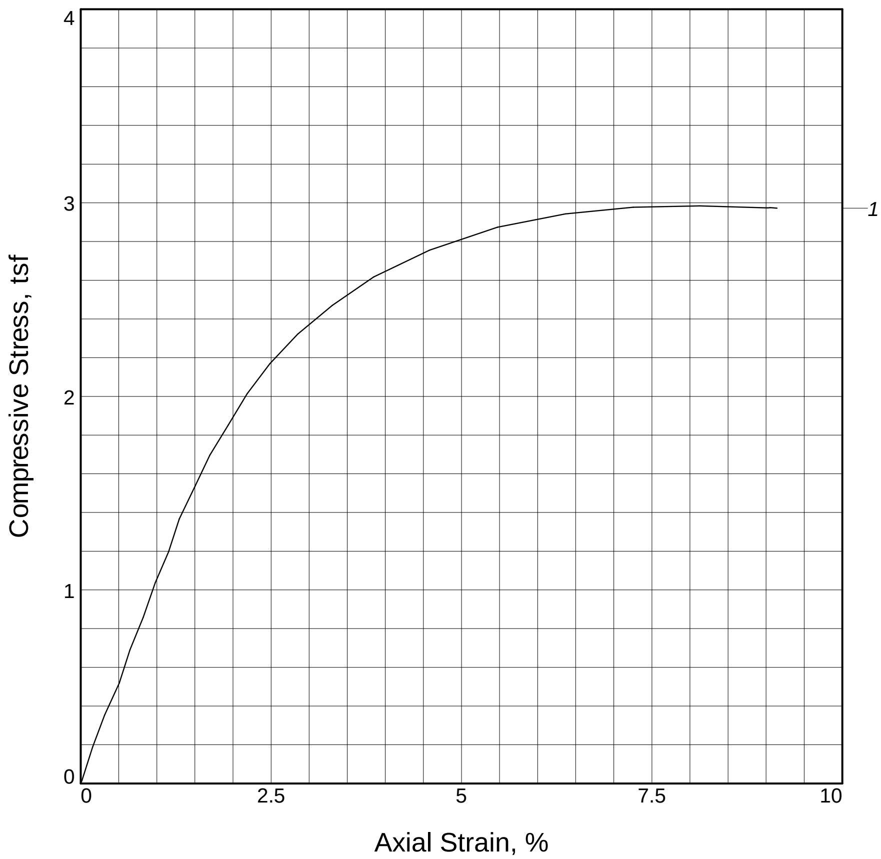
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-109
Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.984			
Undrained shear strength, tsf	1.492			
Failure strain, %	8.1			
Strain rate, %/min.	1.00			
Water content, %	25.8			
Wet density, pcf	128.6			
Dry density, pcf	102.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.72			
Height/diameter ratio	2.09			

Description:

LL = 64	**PL =** 30	**PI =** 34	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:
Remarks:
Bulge Failure

Client: Freese and Nichols, Inc.

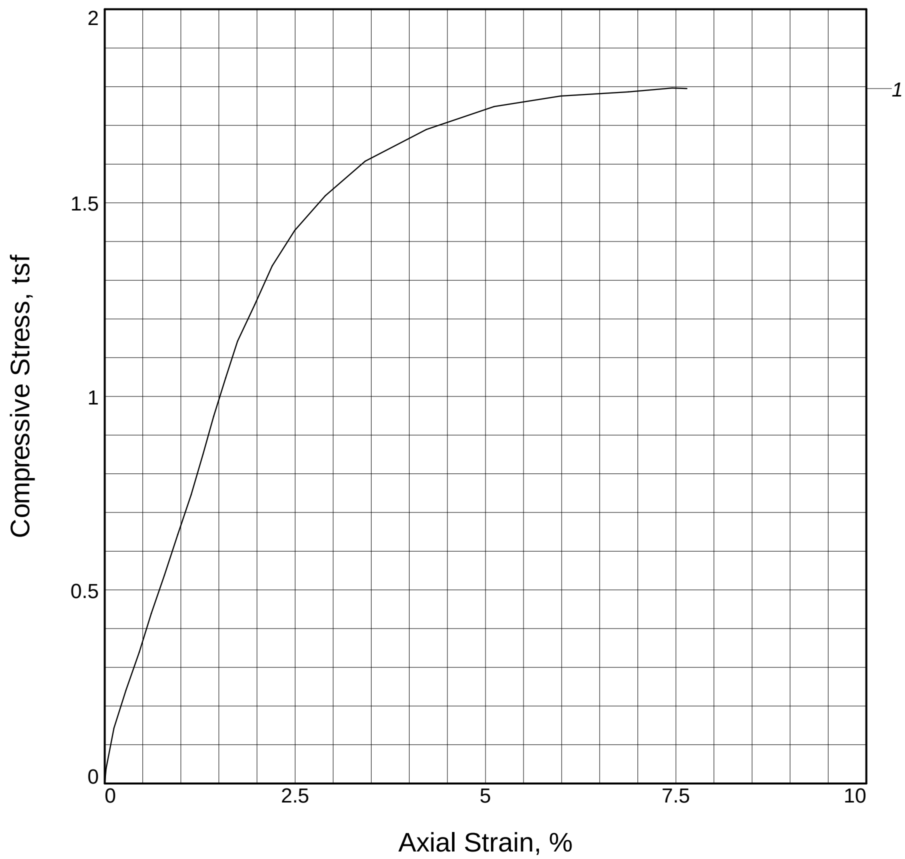
Project: OCR Due Diligence Study

Location: B-110
Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Figure _______

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.797			
Undrained shear strength, tsf	0.898			
Failure strain, %	7.5			
Strain rate, %/min.	1.00			
Water content, %	17.2			
Wet density, pcf	132.6			
Dry density, pcf	113.1			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.68			
Specimen height, in.	5.73			
Height/diameter ratio	2.14			

Description:

LL = 72	**PL =** 26	**PI =** 46	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

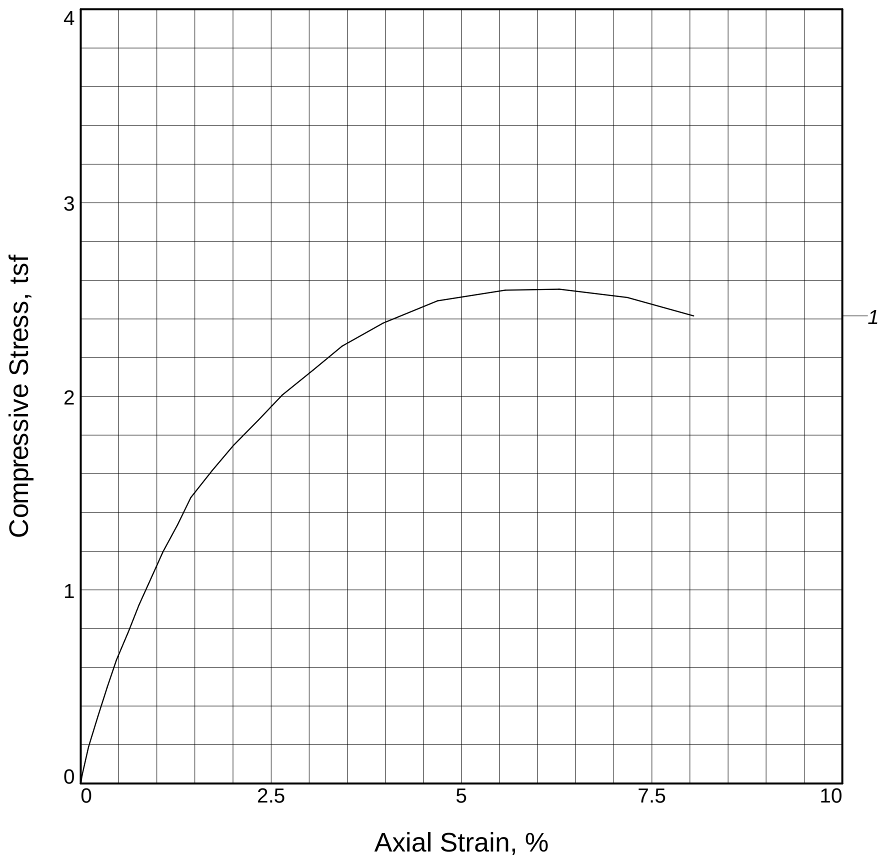
Project: OCR Due Diligence Study

Location: B-111

Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.554			
Undrained shear strength, tsf	1.277			
Failure strain, %	6.3			
Strain rate, %/min.	1.00			
Water content, %	27.1			
Wet density, pcf	127.0			
Dry density, pcf	99.9			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.74			
Height/diameter ratio	2.07			

Description:

LL = 78	**PL =** 33	**PI =** 45	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

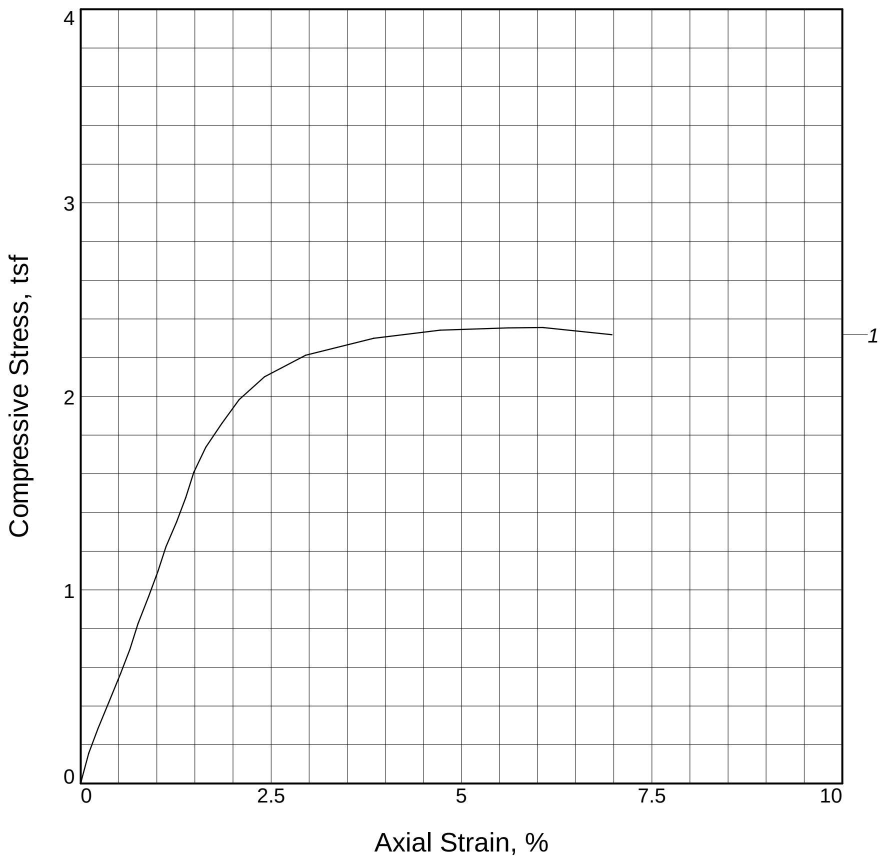
Project: OCR Due Diligence Study

Location: B-111

Depth: (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.356			
Undrained shear strength, tsf	1.178			
Failure strain, %	6.1			
Strain rate, %/min.	1.00			
Water content, %	27.7			
Wet density, pcf	123.0			
Dry density, pcf	96.4			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.72			
Height/diameter ratio	2.08			

Description:

LL = 80	**PL =** 35	**PI =** 45	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

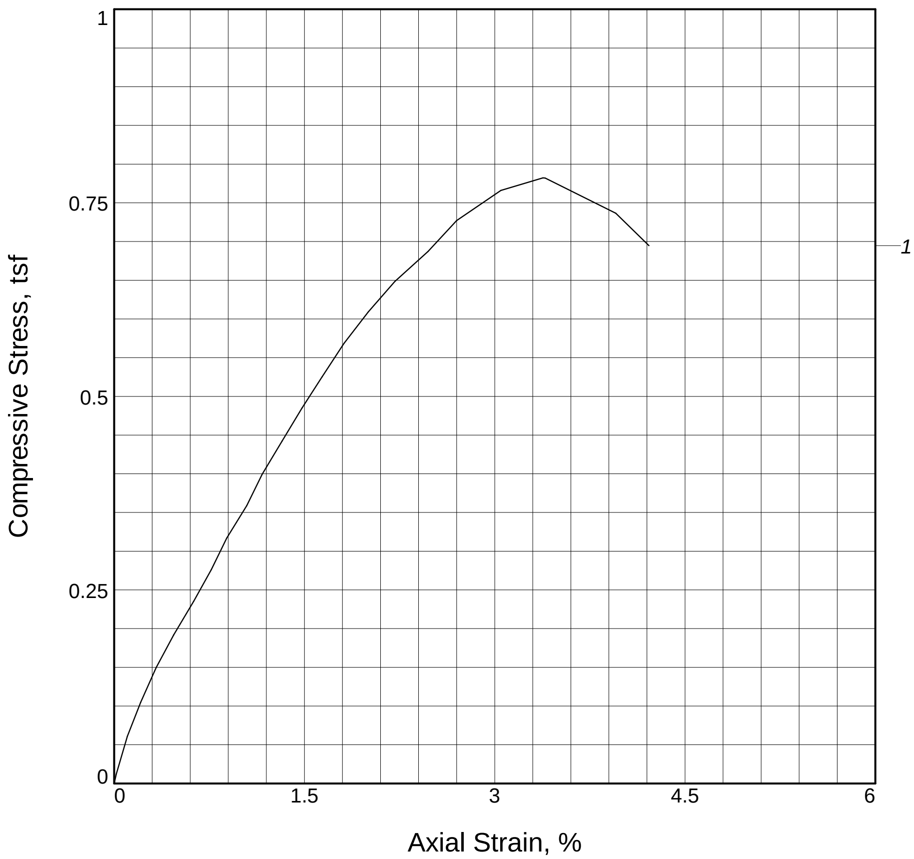
Project: OCR Due Diligence Study

Location: B-112

Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.782			
Undrained shear strength, tsf	0.391			
Failure strain, %	3.4			
Strain rate, %/min.	1.00			
Water content, %	19.9			
Wet density, pcf	132.2			
Dry density, pcf	110.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.74			
Specimen height, in.	5.74			
Height/diameter ratio	2.09			

Description:

LL = 65	**PL =** 28	**PI =** 37	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

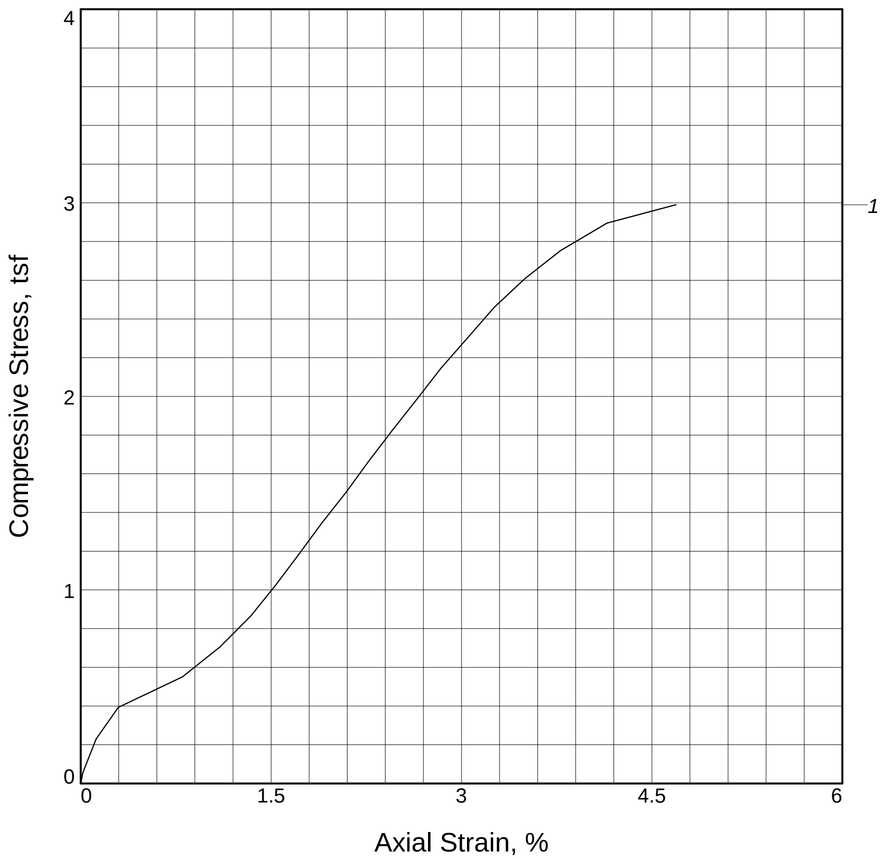
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-112
Depth: (23.0-25.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.989			
Undrained shear strength, tsf	1.495			
Failure strain, %	4.7			
Strain rate, %/min.	1.00			
Water content, %	13.0			
Wet density, pcf	137.4			
Dry density, pcf	121.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.74			
Height/diameter ratio	2.07			

Description:

LL = 44	**PL =** 18	**PI =** 26	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Shear Plane Failure

Figure _______

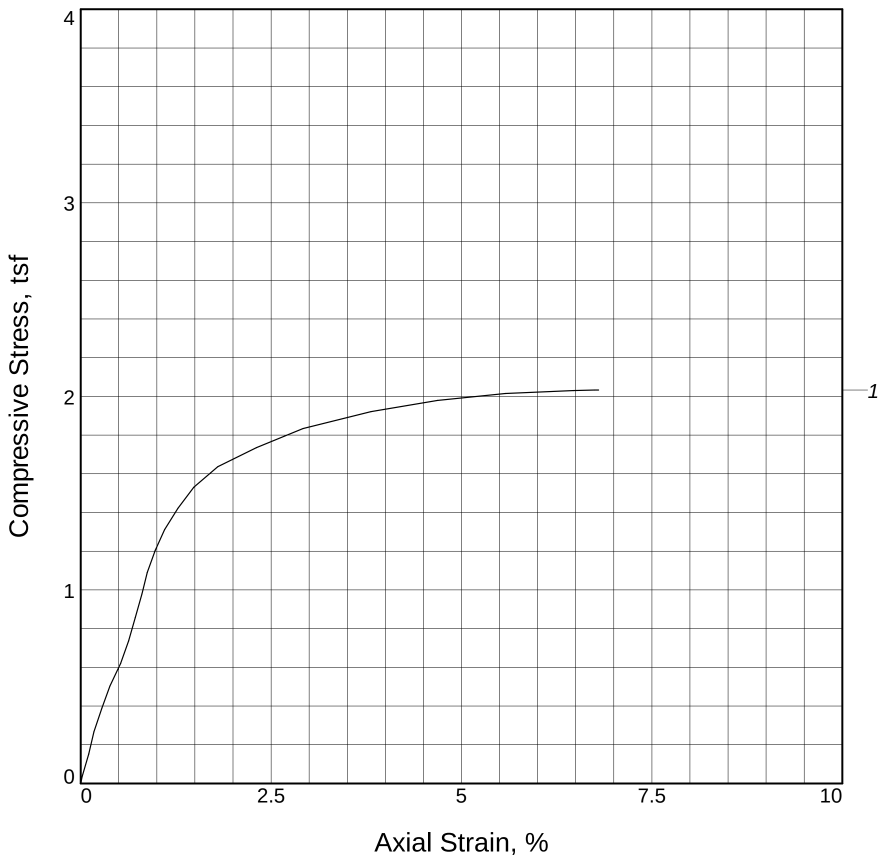
Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-113
Depth: (8.0-10.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.033			
Undrained shear strength, tsf	1.016			
Failure strain, %	6.7			
Strain rate, %/min.	1.00			
Water content, %	26.3			
Wet density, pcf	124.4			
Dry density, pcf	98.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.79			
Specimen height, in.	5.72			
Height/diameter ratio	2.05			

Description:

LL = 71	**PL =** 31	**PI =** 40	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

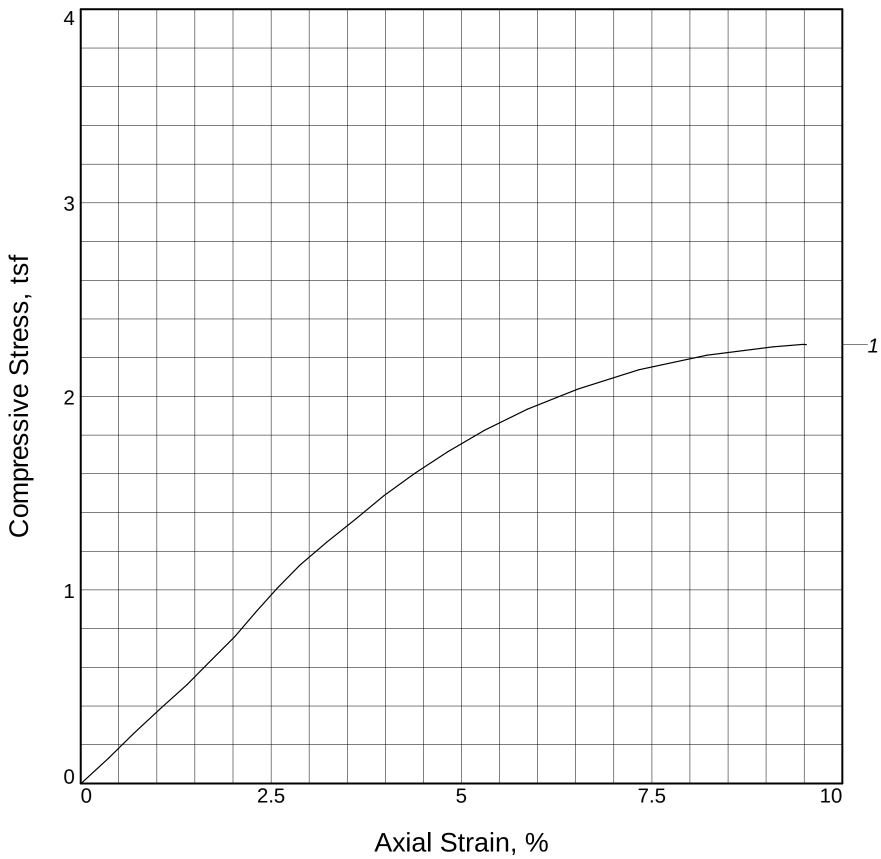
Project: OCR Due Diligence Study

Location: B-114

Depth: (18.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.269			
Undrained shear strength, tsf	1.134			
Failure strain, %	9.5			
Strain rate, %/min.	1.00			
Water content, %	22.2			
Wet density, pcf	124.7			
Dry density, pcf	102.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.82			
Specimen height, in.	5.73			
Height/diameter ratio	2.03			

Description:

LL = 58	**PL =** 25	**PI =** 33	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406

Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

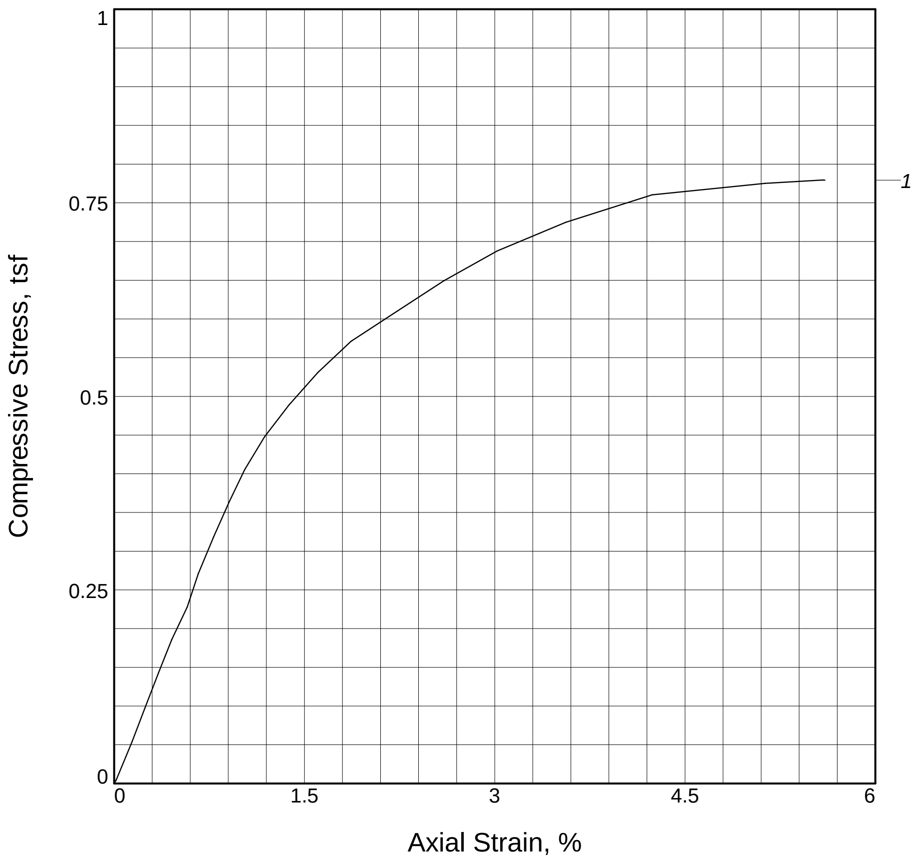
Project: OCR Due Diligence Study

Location: B-114

Depth: (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.779			
Undrained shear strength, tsf	0.390			
Failure strain, %	5.6			
Strain rate, %/min.	1.00			
Water content, %	18.3			
Wet density, pcf	131.5			
Dry density, pcf	111.1			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.73			
Height/diameter ratio	2.08			

Description:

LL = 34	**PL =** 13	**PI =** 21	**GS=**	**Type:** Shelby Tube

Project No.: LVA17406
Date Sampled:

Remarks:
Bulge Failure

Figure _______

Client: Freese and Nichols, Inc.

Project: OCR Due Diligence Study

Location: B-104
Depth: (6.0-8.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Appendix D

Crumb Dispersion Test Results

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-101 **Sample No.** 1 **Sample Depth (ft.)** 6.0-8.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-103 **Sample No.** 2 **Sample Depth (ft.)** 2.0-4.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-103 **Sample No.** 3 **Sample Depth (ft.)** 4.0-6.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-103 **Sample No.** 4 **Sample Depth (ft.)** 13.0-15.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	3	68	3	67	3	67
Initial Temp(˚F):	69								

Boring No. B-105 **Sample No.** 5 **Sample Depth (ft.)** 6.0-8.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	68	1	67	1	67
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-105 **Sample No.** 6 **Sample Depth (ft.)** 8.0-10.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-105 **Sample No.** 7 **Sample Depth (ft.)** 13.0-15.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	3	68	3	67	4	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 8 **Sample Depth (ft.)** 0-2.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 9 **Sample Depth (ft.)** 4.0-6.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-106 **Sample No.** 10 **Sample Depth (ft.)** 13.0-15.0

Moisture Content									
		2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-107 **Sample No.** 11 **Sample Depth (ft.)** 2.0-4.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	1	69	1	68	1	67	1	67
Time Started:								
Initial Temp(˚F): 69								

Boring No. B-107 **Sample No.** 12 **Sample Depth (ft.)** 8.0-10.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	1	69	1	68	1	67	1	67
Time Started:								
Initial Temp(˚F): 69								

Boring No. B-108 **Sample No.** 13 **Sample Depth (ft.)** 2.0-4.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	1	69	4	68	4	68	4	67
Time Started:								
Initial Temp(˚F): 69								

Boring No. B-108 **Sample No.** 14 **Sample Depth (ft.)** 4.0-6.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	1	69	1	68	1	67	1	67
Time Started:								
Initial Temp(˚F): 69								

Boring No. B-108 **Sample No.** 15 **Sample Depth (ft.)** 8.0-10.0

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	1	69	1	68	1	67	1	67
Time Started:								
Initial Temp(˚F): 69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-109 **Sample No.** 16 **Sample Depth (ft.)** 4.0-6.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	4	68	4	67	4	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-109 **Sample No.** 17 **Sample Depth (ft.)** 6.0-8.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	4	68	4	67	4	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-109 **Sample No.** 18 **Sample Depth (ft.)** 13.0-15.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-111 **Sample No.** 19 **Sample Depth (ft.)** 2.0-4.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	4	68	4	67	4	67
Time Started:									
Initial Temp(˚F):	69								

Boring No. B-111 **Sample No.** 20 **Sample Depth (ft.)** 6.0-8.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube		1	69	1	68	1	67	1	67
Time Started:									
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

Boring No. B-111 **Sample No.** 21 **Sample Depth (ft.)** 8.0-10.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	67	1	67	1	67
Initial Temp(˚F):	69								

Boring No. B-113 **Sample No.** 22 **Sample Depth (ft.)** 4.0-6.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	2	67	2	67	2	67
Initial Temp(˚F):	69								

Boring No. B-114 **Sample No.** 23 **Sample Depth (ft.)** 6.0-8.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	67	1	66	1	67
Initial Temp(˚F):	69								

Boring No. B-114 **Sample No.** 24 **Sample Depth (ft.)** 8.0-10.0

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	67	1	66	2	67
Initial Temp(˚F):	69								

Boring No. B-114 **Sample No.** 25 **Sample Depth (ft.)** 13.0-14.5

Moisture Content		2 minutes		1 hour		6 hours		24 hours	
Specimen Type		Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube									
Time Started:		1	69	1	67	1	67	1	67
Initial Temp(˚F):	69								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name OCR Due Diligence Study **Project No.** LVA17406 **Date** 11/30/2017

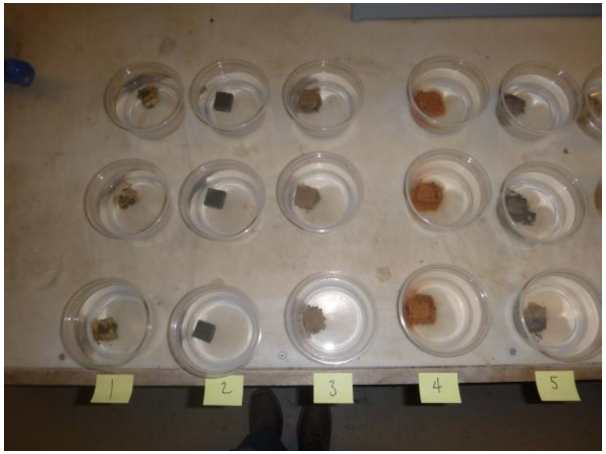
Boring No. B-115 **Sample No.** 26 **Sample Depth (ft.)** 2.0-4.0

Moisture Content								
	2 minutes		**1 hour**		**6 hours**		**24 hours**	
Specimen Type	Grade	˚F	Grade	˚F	Grade	˚F	Grade	˚F
Natural Molded Cube	4	69	4	67	4	67	4	67
Time Started:								
Initial Temp(˚F): 69								

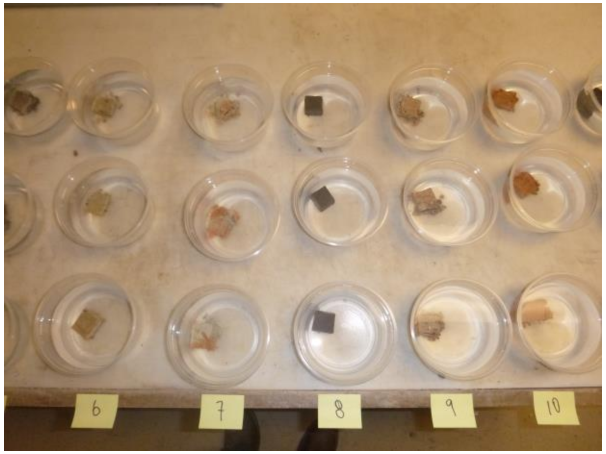
CRUMB TEST PHOTOGRAPHS

2 min Readings

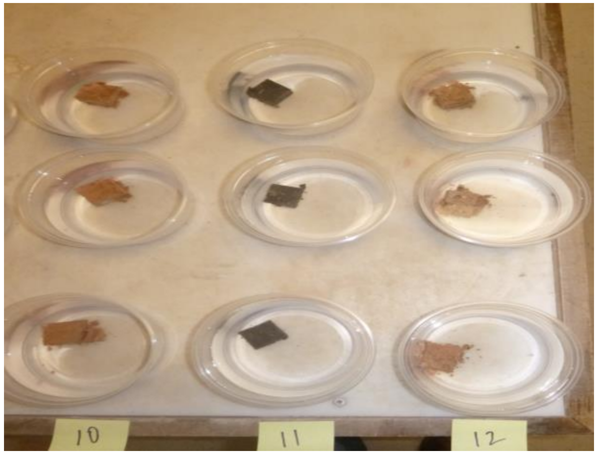
CRUMB TEST PHOTOGRAPHS



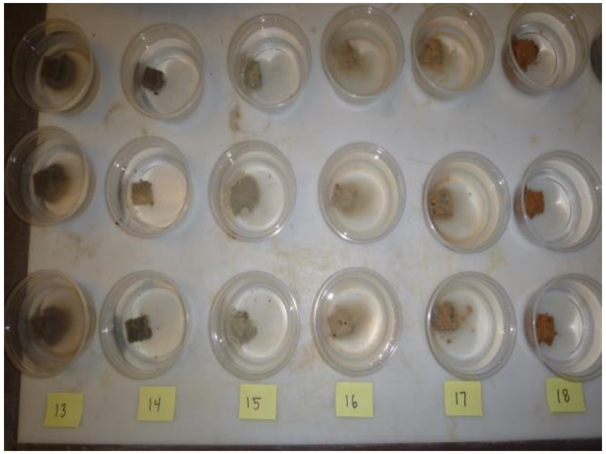
Sample No. 1 to 5 – 2 Min.



Sample No. 6 to 10 – 2 Min.

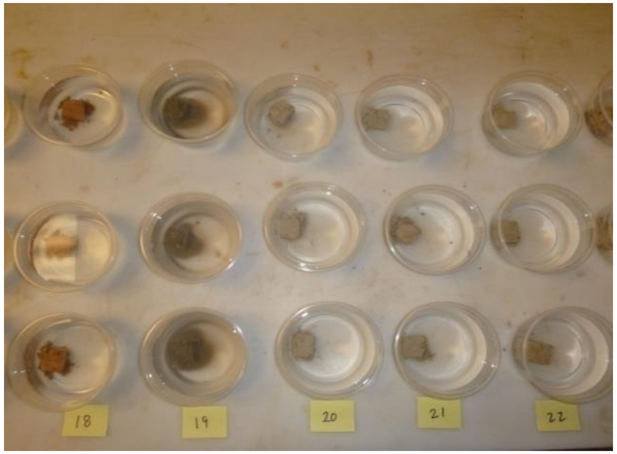


Sample No. 10 to 12 – 2 Min.

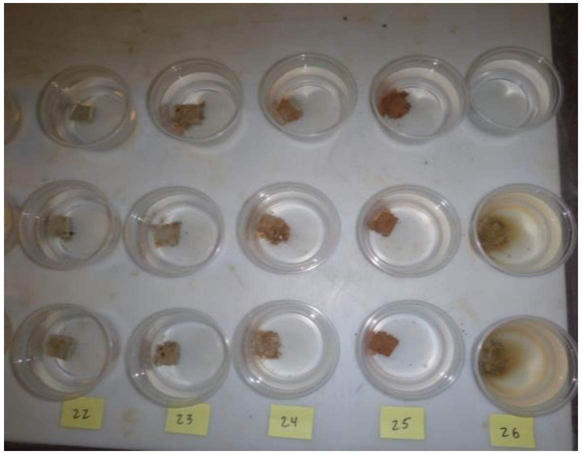


Sample No. 13 to 18 – 2 Min.

CRUMB TEST PHOTOGRAPHS



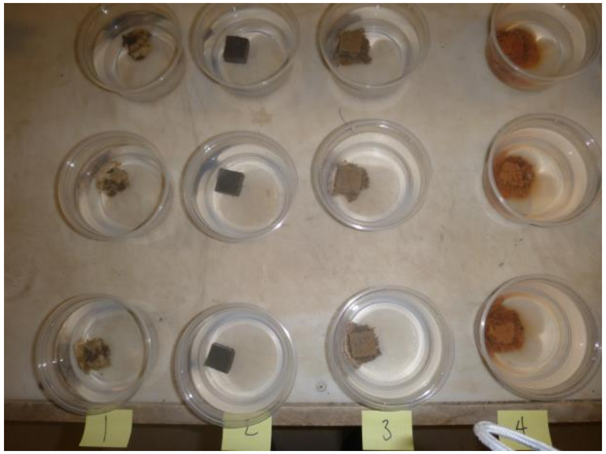
Sample No. 18 to 22 – 2 Min.



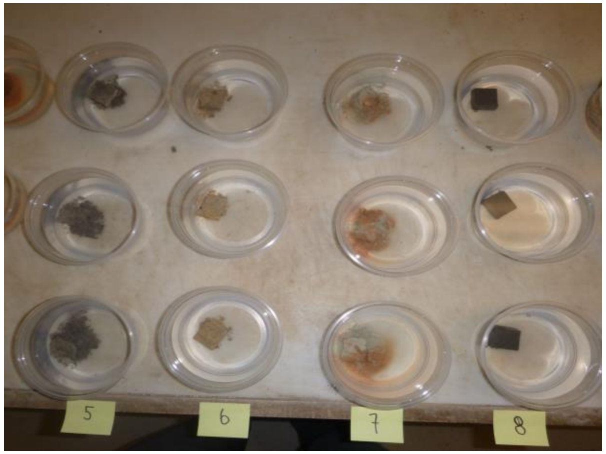
Sample No. 22 to 26 – 2 Min.

1 hour Readings

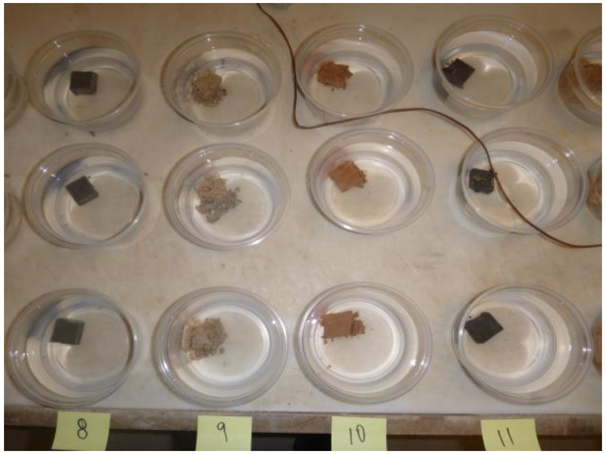
CRUMB TEST PHOTOGRAPHS



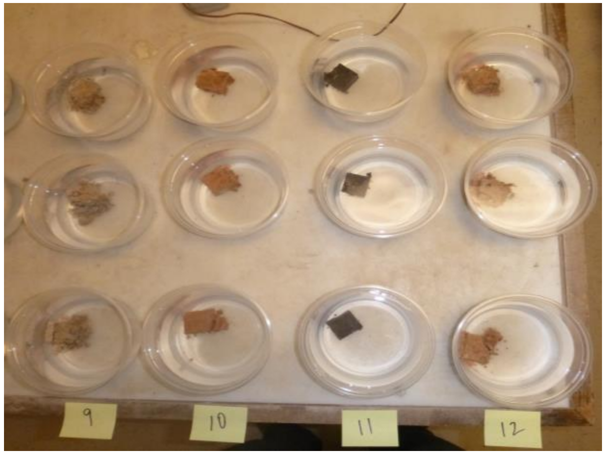
Sample No. 1 to 4 – 1 hour



Sample No. 5 to 8 – 1 hour

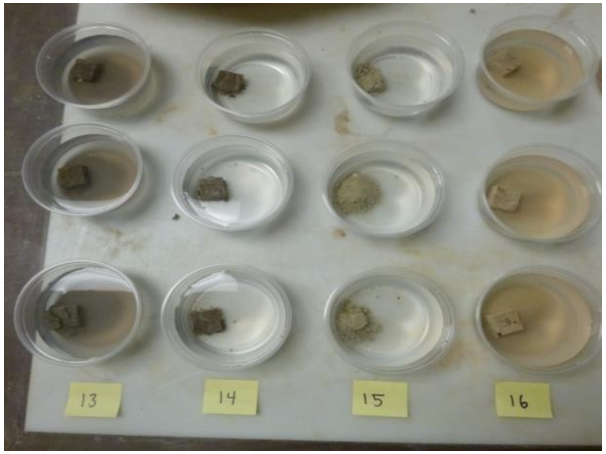


Sample No. 8 to 11 – 1 hour

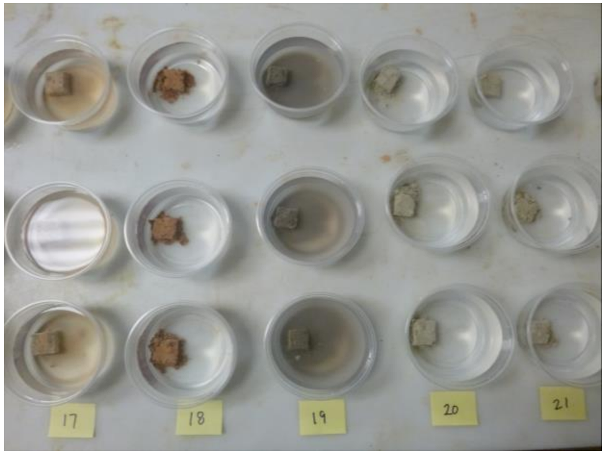


Sample No. 9 to 12 – 1 hour

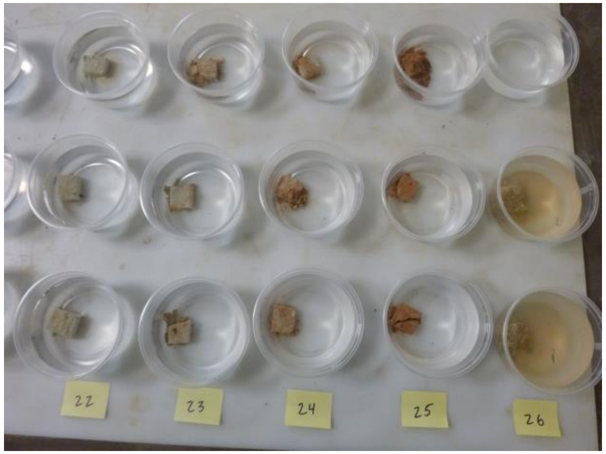
CRUMB TEST PHOTOGRAPHS



Sample No. 13 to 16 – 1 hour



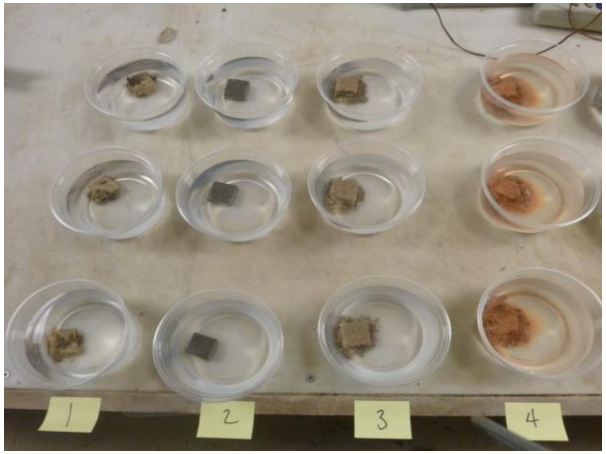
Sample No. 17 to 21 – 1 hour



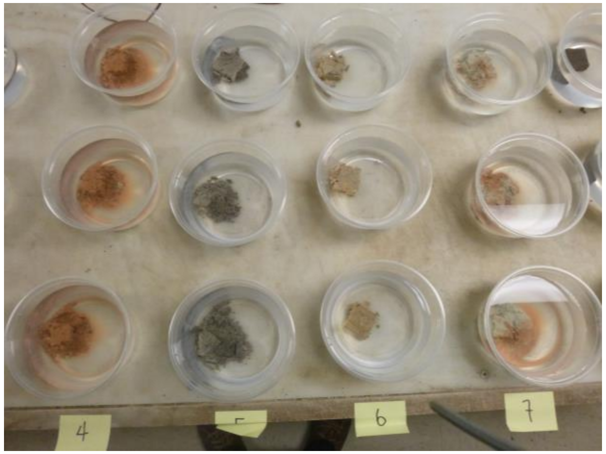
Sample No. 22 to 26 – 1 hour

6 hour Readings

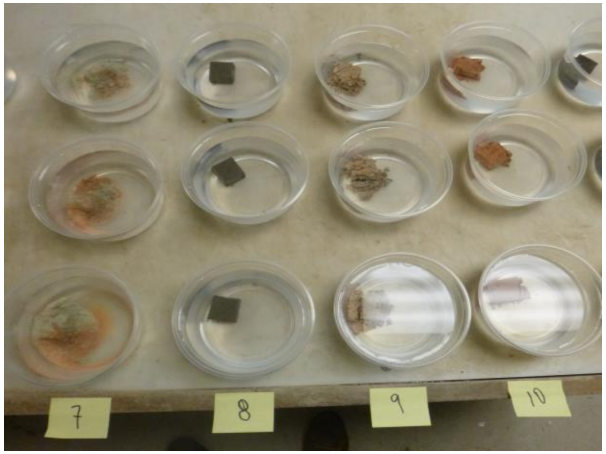
CRUMB TEST PHOTOGRAPHS



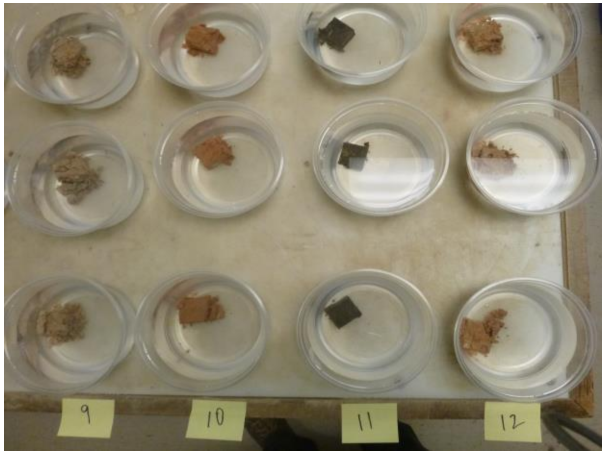
Sample No. 1 to 4 – 6 hour



Sample No. 4 to 7 – 6 hour

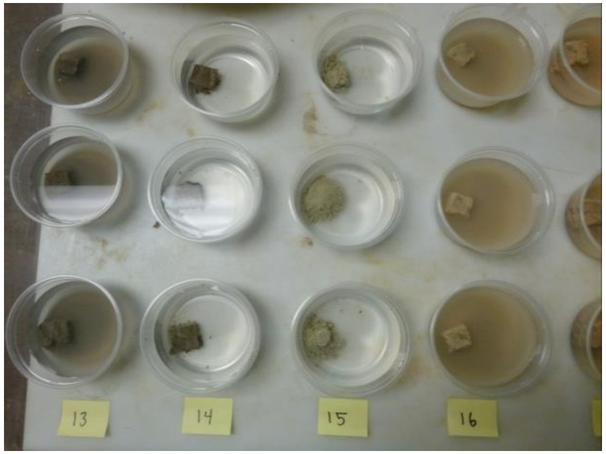


Sample No. 7 to 10 – 6 hour



Sample No. 9 to 12 – 6 hour

CRUMB TEST PHOTOGRAPHS



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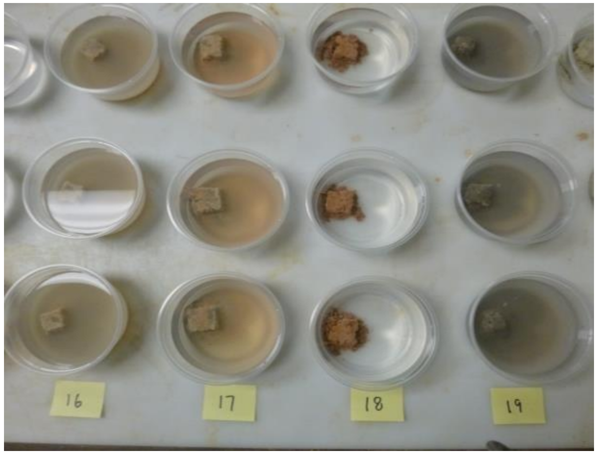

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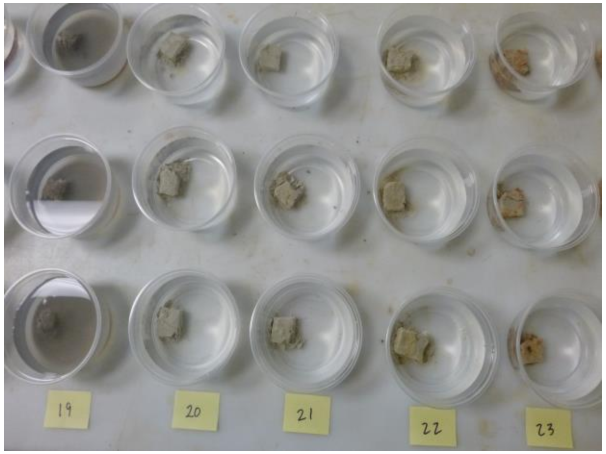
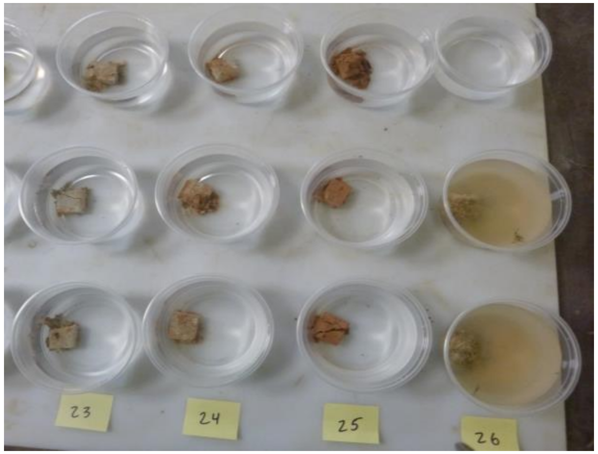


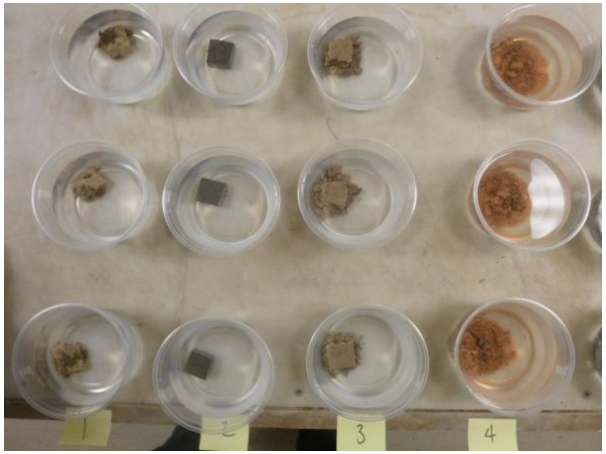
Sample No. 19 to 23 – 6 hour



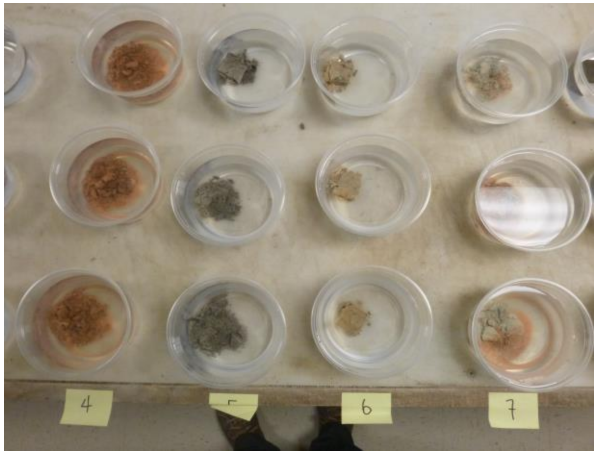
Sample No. 23 to 26 – 6 hour

24 hour Readings

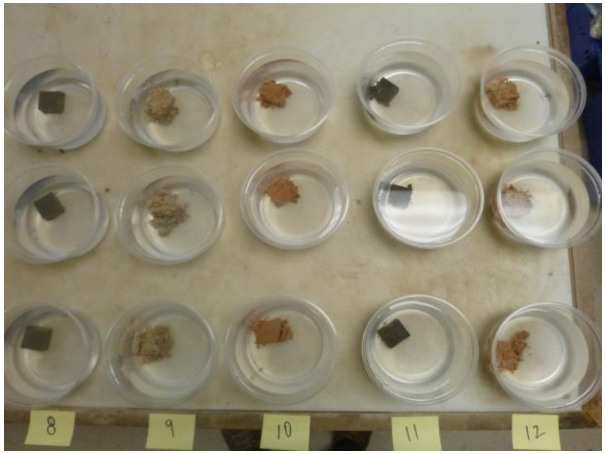
CRUMB TEST PHOTOGRAPHS



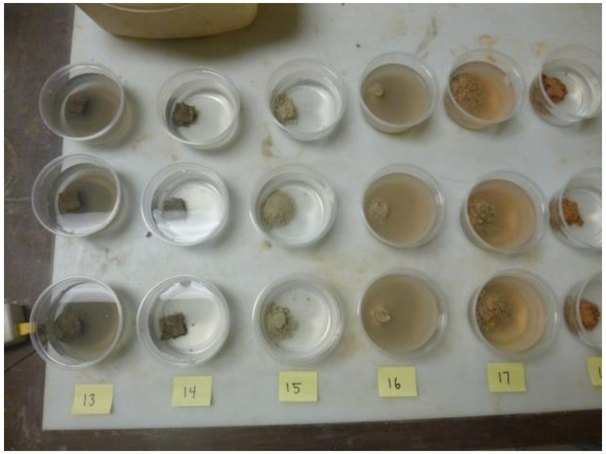
Sample No. 1 to 4 – 24 hour



Sample No. 4 to 7 – 24 hour

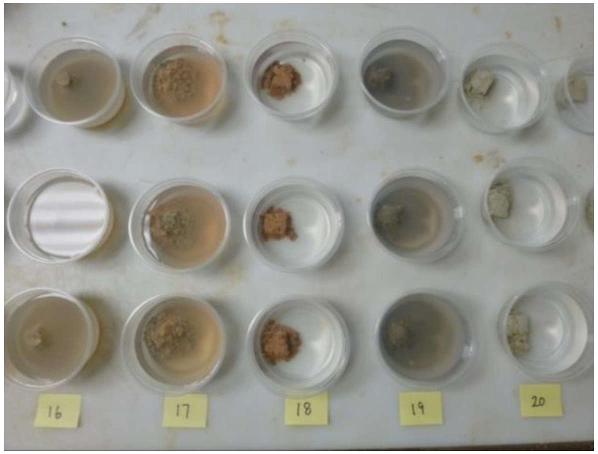


Sample No. 8 to 12 – 24 hour

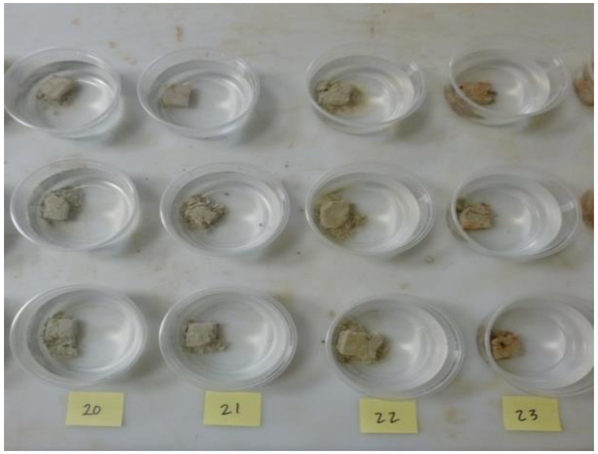


Sample No. 13 to 17 – 24 hour

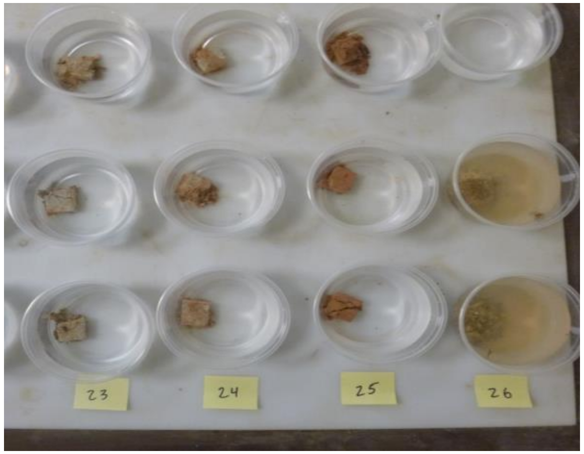
CRUMB TEST PHOTOGRAPHS



Sample No. 16 to 20 – 24 hour



Sample No. 20 to 23 – 24 hour

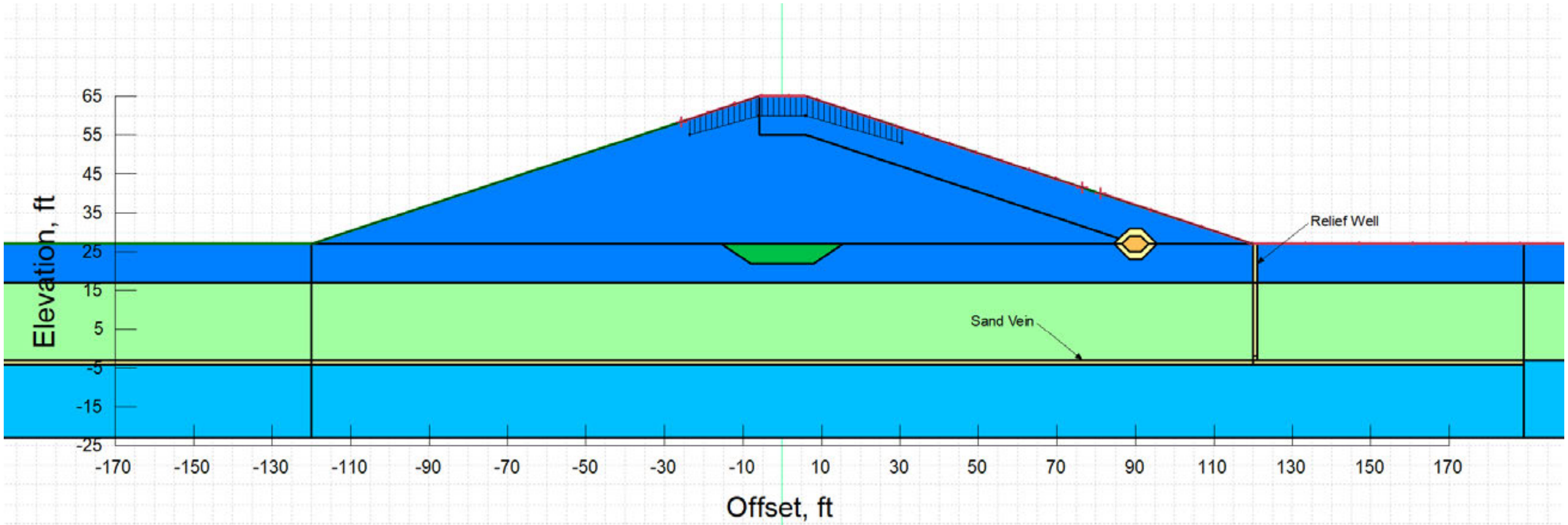


Sample No. 23 to 26 – 24 hour

Appendix E

Seepage and Slope Stability Results

MODEL GEOMETRY



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Sandy Clay	Mohr-Coulomb	125	230	24
	Clay	Mohr-Coulomb	125	230	19
	Clayey Sand	Mohr-Coulomb	125	230	31
	Sand	Mohr-Coulomb	120	0	33
	Gravel	Mohr-Coulomb	120	0	33
	Cut-off	Mohr-Coulomb	125	230	24

FNI PROJECT:	LVA17406
DATE:	January 12, 2018
PREPARED:	SH

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TX 77024

Lavaca Navidad River Authority

Proposed Off-Channel Reservoir Due Diligence

Seepage and Slope Stability Analysis

Typical Maximum Embankment Section

PLATE

1

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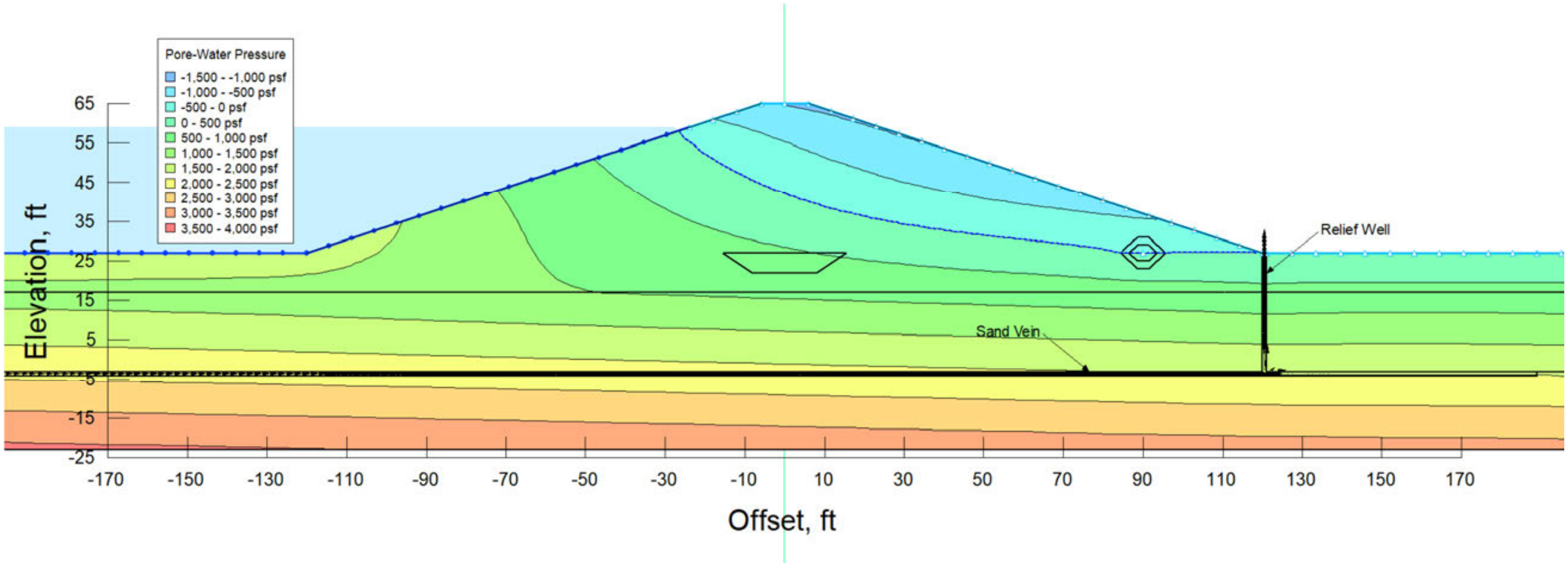
STEADY STATE SEEPAGE ANALYSIS



FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**2**
PREPARED: SH			

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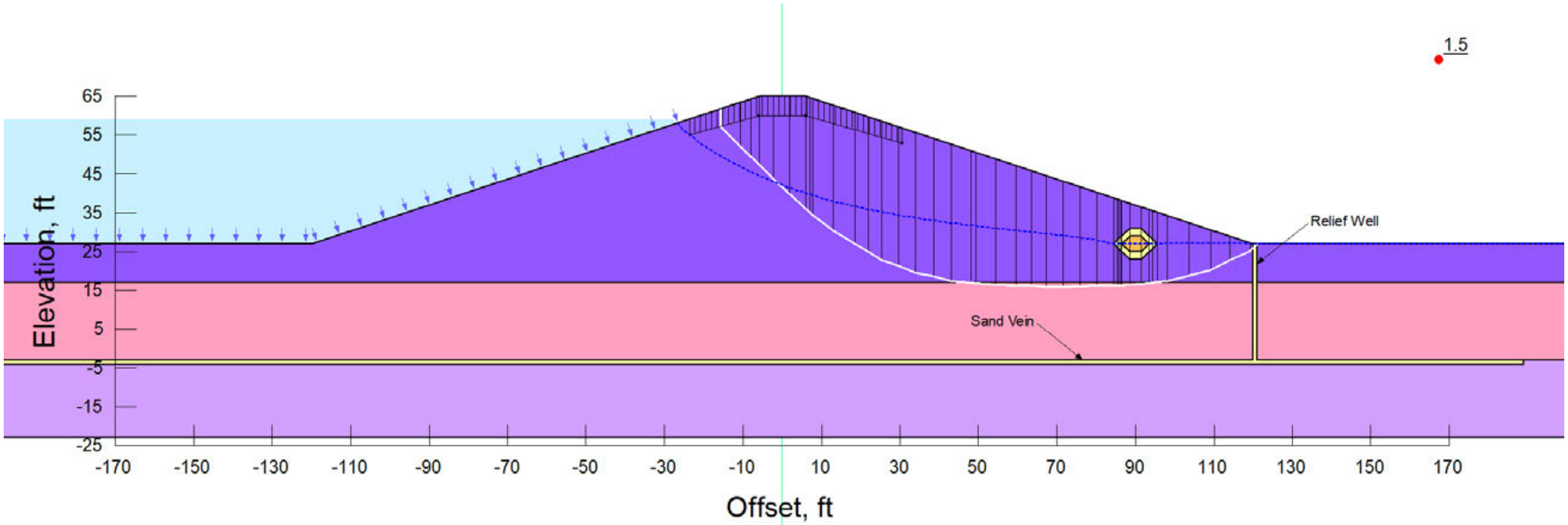
SLOPE STABILITY—END OF CONSTRUCTION SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Top of Layer (psf)	C-Rate of Change ((lbs/ft²)/ft)	C-Maximum (psf)
	Sand	Mohr-Coulomb	120	0	33			
	Sandy Clay Undrained	S=f(depth)	125			500	50	1,000
	Clay Undrained	S=f(depth)	125			1,000	50	1,400
	Clayey Sand Undrained	S=f(depth)	125			1,000	50	1,400
	Gravel	Mohr-Coulomb	120	0	33			

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE** **3**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	
PREPARED: SH			

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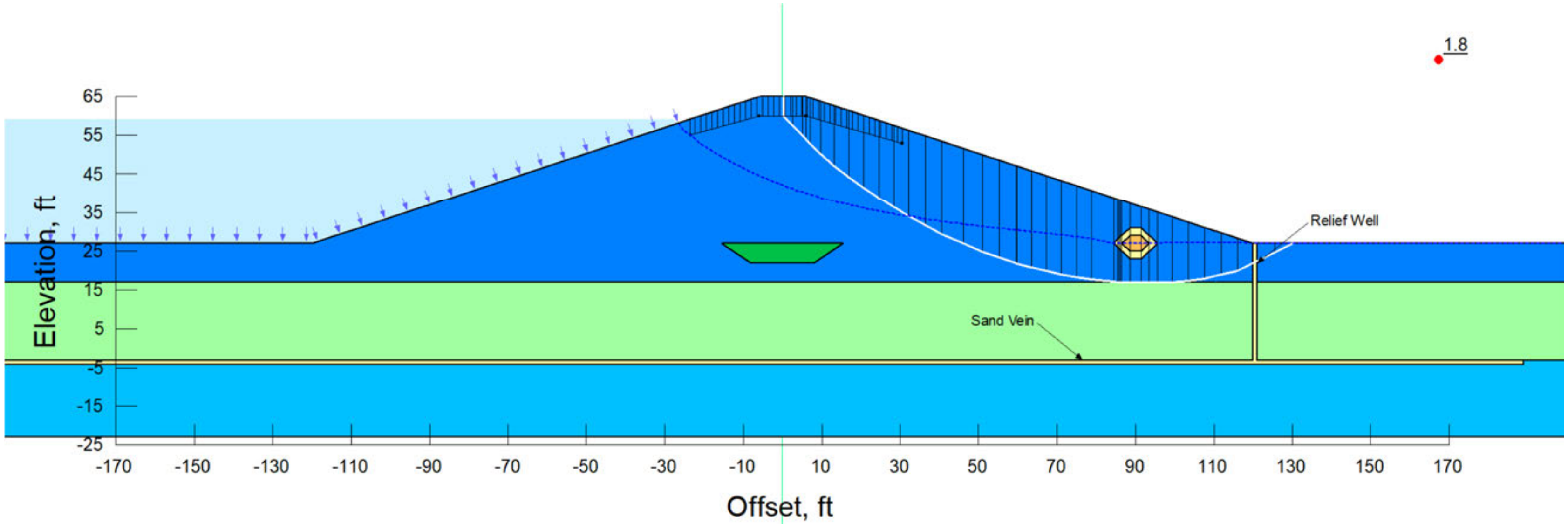
SLOPE STABILITY—STEADY STATE SEEPAGE SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Sandy Clay	Mohr-Coulomb	125	230	24
	Clay	Mohr-Coulomb	125	230	19
	Clayey Sand	Mohr-Coulomb	125	230	31
	Sand	Mohr-Coulomb	120	0	33
	Gravel	Mohr-Coulomb	120	0	33
	Cut-off	Mohr-Coulomb	125	230	24

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**4**
PREPARED: SH			

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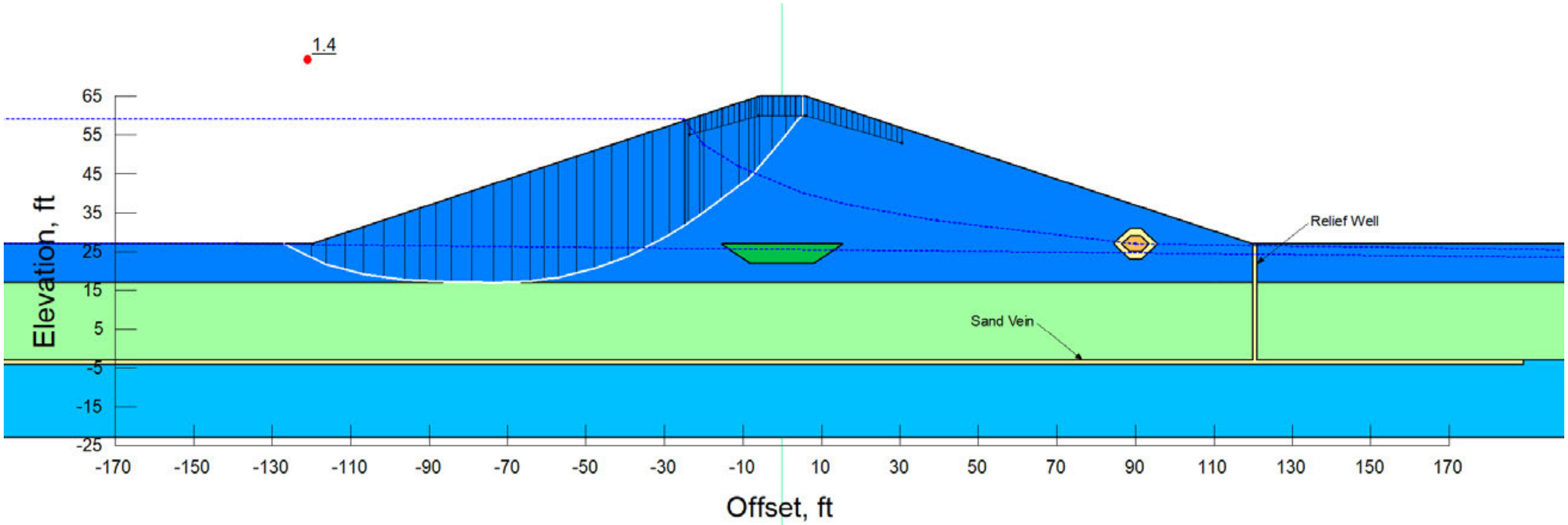
SLOPE STABILITY—RAPID DRAWDOWN SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Cohesion R (psf)	Phi R (°)	Piezometric Line	Piezometric Line After Drawdown
	Sandy Clay	Mohr-Coulomb	125	230	24	1,000	0	1	2
	Clay	Mohr-Coulomb	125	230	19	1,400	0	1	2
	Clayey Sand	Mohr-Coulomb	125	230	31	1,400	0	1	2
	Sand	Mohr-Coulomb	120	0	33	0	0	1	2
	Gravel	Mohr-Coulomb	120	0	33	0	0	1	2
	Cut-off	Mohr-Coulomb	125	230	24	1,000	0	1	2

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**5**
PREPARED: SH			

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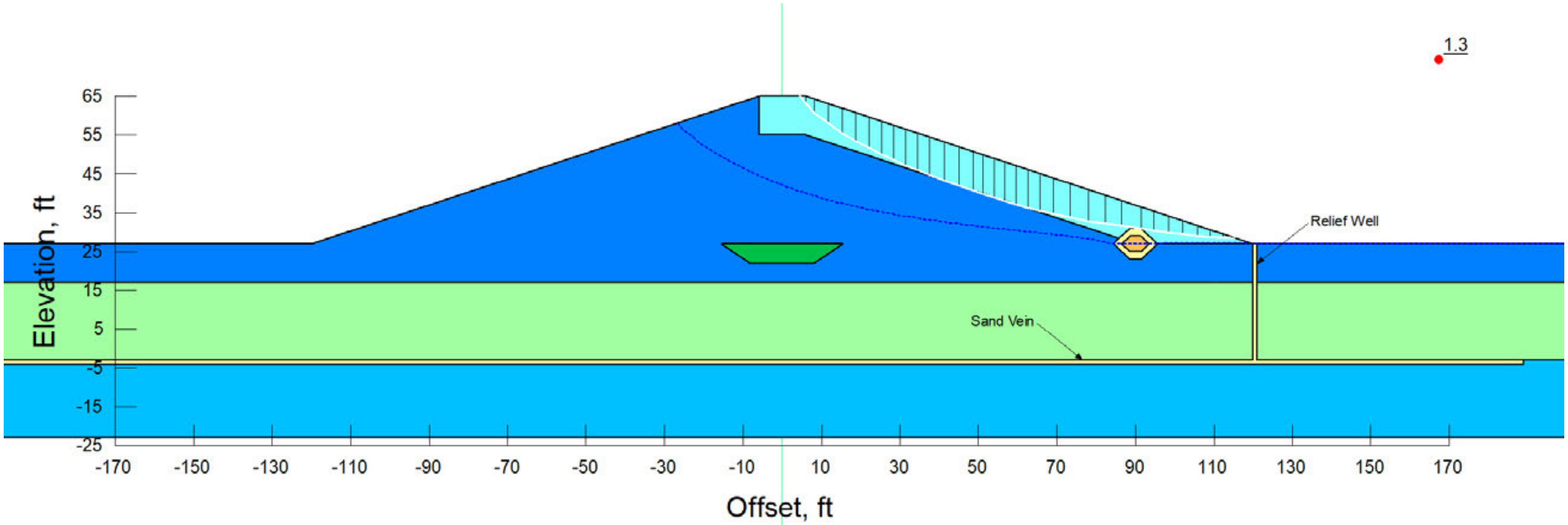
SLOPE STABILITY—FULLY SOFTENED SHEAR STRENGTH SCENARIO



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	B-bar	Add Weight	Strength Function
	Sandy Clay	Mohr-Coulomb	125	230	24	0	No	
	Clay	Mohr-Coulomb	125	230	19	0	No	
	Clayey Sand	Mohr-Coulomb	125	230	31	0	No	
	Sand	Mohr-Coulomb	120	0	33	0	No	
	Clay FSS	Shear/Normal Fn.	125			0.29	Yes	Clay FSS
	Gravel	Mohr-Coulomb	120	0	33	0	No	
	Cut-off	Mohr-Coulomb	125	230	24	0	No	

FNI PROJECT: LVA17406	FREESE AND NICHOLS	Lavaca Navidad River Authority **Proposed Off-Channel Reservoir Due Diligence**	**PLATE**
DATE: January 12, 2018	10497 TOWN AND COUNTRY WAY SUITE 600 HOUSTON, TX 77024	Seepage and Slope Stability Analysis **Typical Maximum Embankment Section**	**6**
PREPARED: SH			

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Jon Albright

From: Warren Samuelson <warren.samuelson@tceq.texas.gov>
Sent: Friday, August 30, 2019 2:20 PM
To: Michael Reedy; pbrzozowski@lnra.org; Jason Afinowicz
Subject: RE: LNRA OCR Technical Memorandum

Mike:

The report is sufficient for the Dam Safety review for the water right permit application.

Thanks for the opportunity to review.

Warren

From: Michael Reedy <MVR@freese.com>
Sent: Wednesday, August 21, 2019 6:31 PM
To: Warren Samuelson <warren.samuelson@tceq.texas.gov>; pbrzozowski@lnra.org; Jason Afinowicz <Jason.Afinowicz@freese.com>
Subject: LNRA OCR Technical Memorandum

Warren,

Thank you again for your time this afternoon. It was really great to talk with you. As we discussed, the attached technical memorandum summarizes the results of the due diligence study that we performed on the proposed Off-Channel Reservoir site that we conducted last year. We would appreciate it if you could review this and let us know if this information would suffice for your offices review of a water right permit application and, if not, what additional information you would need.

Take Care.

Mike

Michael V. Reedy, P.E.
Principal and Vice President
Water Resources Manager

Freese and Nichols, Inc.
10497 Town and Country Way, Suite 500
Houston, Texas 77024
(713) 600-6800

(713) 600-6828 (direct)
(713) 204-0994 (cell)
(713) 600-6801 (fax)

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www.freese.com

APPENDIX 3F
Comparison of Flows

Table 3F-1a
Baseline
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	982	7,908	3,106	1,312	4,255	15,413	307,897	2,130	2,198	27,403	452,204	222,029	1,046,837
1941	68,132	36,295	121,583	173,403	236,001	142,798	86,654	23,078	12,275	43,551	36,241	10,473	990,481
1942	5,196	7,908	5,337	84,619	8,625	8,420	112,561	8,425	25,446	9,344	4,064	4,876	284,822
1943	5,196	6,492	19,072	4,679	20,534	5,825	7,778	5,070	297	297	297	20,253	95,790
1944	135,455	21,641	204,191	9,770	100,142	10,487	4,898	2,864	22,760	297	297	36,912	549,714
1945	47,369	11,513	5,337	150,585	6,425	6,386	4,547	16,337	11,101	13,079	297	297	273,274
1946	5,196	66,449	43,184	19,706	56,361	144,702	7,778	28,593	112,238	83,805	93,487	13,361	674,859
1947	100,893	7,908	5,672	14,159	68,674	3,689	4,409	297	297	297	297	297	206,891
1948	297	7,908	15,383	5,385	70,984	1,575	6,336	73	297	297	297	297	109,131
1949	297	297	5,337	113,382	17,071	2,294	7,778	8,106	297	112,718	4,064	55,494	327,137
1950	26,488	18,260	4,373	19,142	5,077	61,908	2,680	31	297	297	297	297	139,149
1951	297	297	297	297	297	297	297	0	297	297	297	297	3,272
1952	297	297	297	297	102,880	18,059	1,389	134	5,992	297	297	25,655	155,893
1953	5,196	7,908	3,015	2,430	72,033	329	2,870	16,337	61,128	4,085	4,058	297	179,686
1954	297	297	297	297	297	20	297	19	297	297	297	298	3,014
1955	297	297	297	297	297	297	297	297	297	297	297	298	3,569
1956	298	297	298	297	297	0	297	0	25	298	297	297	2,703
1957	0	297	297	93,608	92,761	82,387	875	16	33,446	185,905	124,763	4,876	619,231
1958	81,354	108,116	5,337	6,246	40,800	280	7,778	91	297	22,548	4,064	14,254	291,165
1959	8,245	155,747	5,337	196,848	36,775	62,391	5,041	15,881	297	43,551	31,179	46,941	608,232
1960	36,585	41,324	5,337	19,047	29,936	231,811	25,990	80,120	16,517	228,379	117,233	85,899	918,178
1961	121,663	206,655	5,337	9,919	8,360	157,800	67,361	4,574	300,394	11,170	77,974	4,876	976,082
1962	5,196	7,908	5,337	48,007	13,240	24,905	297	140	297	297	297	297	106,221
1963	297	7,908	3,488	2,070	297	297	297	37	297	297	297	297	15,882
1964	297	297	297	3,331	297	297	2,848	297	297	10,171	4,064	297	22,794
1965	1,913	57,414	4,633	6,063	173,591	50,731	5,654	226	9,986	297	75,216	38,912	424,638
1966	19,875	46,279	16,934	60,849	128,116	30,308	7,778	12,711	11,289	7,304	297	297	342,036
1967	297	297	297	297	297	213	297	297	180,151	73,542	4,064	3,322	263,375
1968	212,822	10,889	7,559	20,617	140,158	366,887	21,422	3,333	22,030	19,213	4,064	13,317	842,312
1969	13,864	142,638	86,635	120,771	157,505	8,993	1,908	260	13,427	297	4,064	4,876	555,238
1970	29,386	6,054	65,225	11,840	138,695	38,864	7,778	648	61,128	79,442	4,064	3,233	446,357
1971	2,147	4,159	2,346	297	297	297	297	297	115,914	65,497	4,064	63,823	259,437
1972	32,433	65,189	9,234	6,083	313,572	50,043	7,778	10,824	11,588	7,302	4,064	3,070	521,182
1973	297	7,908	107,688	293,713	53,093	599,740	21,463	16,337	102,193	176,226	28,821	7,232	1,414,711
1974	159,087	10,583	5,337	26,244	71,897	68,027	7,338	297	256,226	23,806	114,024	39,383	782,249
1975	14,317	8,873	5,337	48,007	185,864	73,980	29,438	16,337	21,046	13,627	4,064	7,520	428,409
1976	4,053	4,041	3,631	45,837	70,900	53,196	297	296	4,607	43,551	6,347	235,223	471,979
1977	26,686	100,662	5,337	118,896	17,201	51,220	7,778	265	297	297	297	2,292	331,229
1978	16,964	27,159	5,260	19,467	216	28,025	7,778	92	251,320	14,239	7,130	4,876	382,527
1979	210,130	93,867	41,451	139,340	200,402	57,530	7,778	2,470	181,627	1,824	4,064	4,876	945,358
1980	147,053	12,375	5,337	5,289	71,897	3,315	7,778	707	297	297	4,064	4,876	263,287
1981	5,196	5,192	297	297	49,497	217,012	26,557	40,424	298,602	57,722	221,123	9,894	931,815
1982	3,212	28,242	5,337	19,167	276,621	8,780	7,778	152	4,117	297	77,251	4,637	435,592
1983	42,282	141,154	117,996	25,433	36,245	9,504	7,778	3,903	94,821	151,352	77,458	3,112	711,038
1984	35,969	11,700	5,337	11,931	8,174	9,495	7,778	3,125	297	117,317	5,793	6,712	223,630
1985	62,542	30,911	140,826	173,087	27,796	14,588	7,778	9,201	13,541	29,877	130,347	37,893	678,386
1986	1,981	3,653	287	8,512	9,650	97,220	7,778	5,468	17,394	37,554	4,064	115,332	308,894
1987	32,468	81,742	16,928	11,714	58,394	298,863	18,944	5,021	2,689	128	39,551	62,975	629,418
1988	5,196	321	5,337	20,507	10,685	7,518	7,778	297	7	297	297	297	58,540
1989	40,592	7,908	5,337	3,115	84,264	10,809	5,035	2,221	0	297	297	152	160,029
1990	297	297	11,487	39,650	26,493	2	7,778	2,470	297	10,552	297	21	99,645
1991	73,566	39,049	5,337	193,783	22,066	28,676	7,778	7,366	29,738	1,698	2,082	180,969	592,108
1992	220,732	537,655	76,337	224,884	275,120	113,420	7,778	6,054	7,302	5,818	23,466	35,710	1,534,276
1993	51,110	90,017	68,362	64,910	282,267	391,401	8,374	16,289	780	26,509	4,064	297	1,004,381
1994	5,196	303	5,337	34,693	108,733	61,741	7,153	16,337	14,264	615,204	4,064	76,472	949,498
1995	78,907	3,467	137,836	8,352	89,978	5,681	13,528	14,215	9,269	53	4,064	26,027	391,378
1996	5,196	2,646	5,337	7,770	12,054	3,418	7,778	8,256	55,630	173	4,064	4,876	117,198

Min	0	297	287	297	216	0	297	0	0	53	297	21	2,703
Max	220,732	537,655	204,191	293,713	313,572	599,740	307,897	80,120	300,394	615,204	452,204	235,223	1,534,276
Average	38,800	40,577	25,400	48,255	71,833	65,652	17,003	7,353	42,092	41,770	32,004	27,228	457,968

5%	297	297	297	297	297	18	297	14	24	169	297	283	3,246
10%	297	297	297	297	297	294	297	36	297	297	297	297	21,411
25%	1,448	3,560	3,560	4,984	8,492	3,367	2,859	263	297	297	297	297	157,961
Median	8,245	7,908	5,337	19,047	40,800	15,413	7,778	2,470	9,986	9,344	4,064	4,876	382,527
75%	49,240	43,801	16,931	62,879	101,511	65,209	7,778	10,013	31,592	43,551	30,000	36,311	676,623
90%	137,775	114,724	109,750	173,150	207,521	219,972	27,134	16,337	180,446	124,124	114,666	78,357	978,962

Table 3F-1b
Phase I - Store in Lake Texana
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	982	7,972	3,106	1,312	4,255	15,413	307,838	2,130	2,198	27,403	453,057	222,029	1,047,695
1941	68,132	36,295	121,583	173,403	236,001	142,798	86,654	23,078	12,275	43,551	36,241	10,473	990,481
1942	5,196	7,908	5,337	84,619	8,625	8,420	112,295	8,425	25,446	9,344	6,893	4,876	287,385
1943	10,959	6,492	19,072	4,679	20,534	5,825	7,778	5,070	297	297	297	23,562	104,862
1944	135,455	21,641	204,191	9,770	98,766	10,487	4,898	2,864	21,972	297	297	39,168	549,807
1945	47,369	11,513	5,337	150,880	6,425	6,386	4,547	16,337	11,101	12,457	297	297	272,948
1946	5,774	66,514	43,184	19,706	56,361	149,816	7,778	28,521	112,239	83,804	93,492	13,337	680,526
1947	100,988	7,908	5,672	14,159	68,674	3,689	4,409	5,459	297	297	297	297	212,148
1948	297	7,908	15,467	5,385	70,984	1,575	6,336	73	297	297	297	297	109,216
1949	297	297	5,337	116,619	17,071	2,294	7,778	8,106	9,228	112,495	4,064	55,548	339,134
1950	26,488	18,260	4,373	19,142	5,077	61,908	1,880	31	297	297	297	297	138,349
1951	297	297	297	297	297	297	297	0	297	297	297	297	3,272
1952	297	297	297	297	102,891	18,059	1,389	134	5,992	297	297	31,770	162,019
1953	5,196	7,908	3,015	2,430	72,033	329	2,870	16,337	61,128	4,085	4,058	4,876	184,264
1954	297	297	297	297	297	20	297	19	297	297	297	298	3,014
1955	297	297	297	297	297	10,515	297	297	297	297	297	298	13,787
1956	298	297	298	297	297	0	297	0	25	298	297	297	2,703
1957	0	297	297	93,608	92,761	82,387	875	16	33,446	185,905	124,763	4,876	619,231
1958	81,354	108,116	5,337	6,246	40,800	280	7,778	91	297	22,548	4,596	17,258	294,701
1959	8,245	155,747	5,337	196,848	36,775	62,391	5,041	15,881	13,067	42,716	33,361	46,941	622,348
1960	36,585	41,324	5,337	19,047	29,936	231,811	25,990	80,120	16,517	228,379	117,233	85,899	918,178
1961	121,663	206,655	5,337	9,919	8,360	157,800	67,361	4,574	300,394	11,170	78,715	4,876	976,824
1962	5,196	7,908	5,337	48,007	13,240	24,905	7,778	140	297	297	297	297	113,701
1963	5,196	7,908	3,488	2,070	5,494	297	297	37	297	297	297	297	25,978
1964	297	297	297	2,510	297	297	2,848	297	297	10,171	4,064	297	21,972
1965	2,079	57,414	4,633	6,063	173,591	50,731	5,654	226	9,986	297	80,156	38,823	429,654
1966	19,871	46,279	16,934	60,849	128,116	30,308	7,778	12,711	11,289	6,859	297	297	341,588
1967	297	297	297	297	297	213	297	297	180,261	73,542	4,064	3,322	263,485
1968	213,090	10,889	7,559	20,617	145,790	366,887	21,422	3,333	22,030	19,213	4,064	13,753	848,648
1969	13,864	142,638	86,635	120,771	157,505	8,993	1,908	260	12,815	297	3,905	5,558	555,149
1970	30,145	6,054	65,794	11,840	138,695	38,864	7,778	648	61,128	85,947	4,064	3,233	454,189
1971	2,147	4,159	2,346	297	297	297	297	297	120,557	65,497	4,064	65,593	265,850
1972	32,433	65,189	9,234	6,083	313,572	50,043	7,778	10,824	11,588	7,302	4,064	2,920	521,032
1973	297	7,908	107,855	293,713	53,093	607,557	21,485	16,338	102,478	176,214	28,826	7,231	1,422,996
1974	158,979	10,583	5,337	26,244	71,897	68,027	7,338	14,091	265,952	23,806	114,024	39,383	805,662
1975	14,317	8,873	5,337	48,007	193,108	73,980	29,438	16,337	21,046	13,627	4,064	7,520	435,653
1976	4,053	4,041	3,631	45,837	70,900	53,196	26,616	296	4,607	43,551	26,240	236,211	519,179
1977	26,686	100,662	5,337	122,615	17,201	51,220	7,778	265	1,768	297	297	2,292	336,419
1978	23,363	27,159	5,260	19,467	216	28,025	7,778	92	251,320	14,239	7,130	6,306	390,357
1979	210,130	93,867	41,451	139,340	200,402	57,530	9,678	2,470	187,618	1,824	4,064	4,876	953,248
1980	147,814	12,375	5,337	5,289	71,897	3,315	7,778	707	297	297	4,064	4,876	264,048
1981	5,196	4,983	297	297	49,497	221,514	26,602	40,463	298,602	57,722	221,123	9,894	936,191
1982	3,212	28,223	5,337	19,167	276,663	8,780	7,778	152	4,117	297	77,251	4,637	435,616
1983	45,885	141,154	117,996	25,433	36,245	9,504	18,280	3,903	100,642	151,352	77,458	3,112	730,965
1984	35,969	11,700	5,337	11,931	8,174	9,495	6,306	3,103	297	117,569	5,814	6,674	222,371
1985	62,621	30,973	140,826	173,087	27,796	14,588	7,899	9,201	13,541	29,877	136,826	37,893	685,128
1986	1,981	3,653	287	8,512	9,127	97,370	7,778	5,468	17,394	37,554	4,064	115,332	308,521
1987	32,468	81,742	16,928	11,714	58,394	298,863	18,944	5,021	2,689	128	39,551	62,970	629,413
1988	5,196	321	5,386	20,507	10,685	7,518	6,329	297	7	297	297	297	57,140
1989	40,688	7,908	5,337	3,115	84,523	10,809	5,035	2,221	0	297	297	152	160,384
1990	297	297	11,487	39,650	26,493	2	7,112	2,436	297	10,464	297	21	98,857
1991	74,023	39,049	5,337	194,687	22,066	28,676	9,332	7,366	29,738	1,698	1,967	181,283	595,223
1992	220,792	537,655	76,337	224,884	275,120	113,420	7,778	6,054	7,302	5,818	23,466	35,710	1,534,337
1993	51,110	90,017	68,362	64,910	282,267	391,401	8,374	16,289	780	26,509	3,891	409	1,004,320
1994	5,196	303	5,436	34,693	108,733	61,741	7,153	16,337	14,264	615,204	4,064	76,472	949,597
1995	78,907	3,467	140,433	8,352	98,789	5,681	19,856	14,215	9,269	53	4,064	26,058	409,143
1996	5,196	2,646	5,337	7,770	11,806	3,608	7,778	8,256	55,630	190	4,064	4,876	117,157

Min	0	297	287	297	216	0	297	0	0	53	297	21	2,703
Max	220,792	537,655	204,191	293,713	313,572	607,557	307,838	80,120	300,394	615,204	453,057	236,211	1,534,337
Average	39,219	40,576	25,463	48,384	72,272	66,143	17,873	7,684	42,941	41,850	32,672	27,662	462,738

5%	297	297	297	297	297	18	297	14	24	184	297	283	3,246
10%	297	297	297	297	297	294	297	36	297	297	297	297	25,177
25%	2,030	3,560	3,560	4,984	8,492	3,649	4,478	263	297	297	297	298	161,201
Median	10,959	7,972	5,337	19,047	40,800	15,413	7,778	3,103	11,101	9,344	4,064	4,876	390,357
75%	49,240	43,801	16,931	62,879	100,840	65,209	9,505	11,767	31,592	43,134	31,093	36,801	682,827
90%	137,927	114,724	109,883	173,150	207,521	223,573	27,181	16,337	181,732	124,325	114,666	78,357	979,555

Table 3F-1c
Change in Flows Baseline to Phase I
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	0	64	0	0	0	0	-58	0	0	0	852	0	858
1941	0	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	0	0	0	0	-265	0	0	0	2,829	0	2,563
1943	5,763	0	0	0	0	0	0	0	0	0	0	3,309	9,072
1944	0	0	0	0	-1,376	0	0	0	-788	0	0	2,257	93
1945	0	0	0	296	0	0	0	0	0	-622	0	0	-326
1946	578	64	0	0	0	5,114	0	-72	1	-1	5	-24	5,666
1947	96	0	0	0	0	0	0	5,162	0	0	0	0	5,257
1948	0	0	85	0	0	0	0	0	0	0	0	0	85
1949	0	0	0	3,236	0	0	0	0	8,931	-223	0	54	11,998
1950	0	0	0	0	0	0	-800	0	0	0	0	0	-800
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	11	0	0	0	0	0	0	6,115	6,126
1953	0	0	0	0	0	0	0	0	0	0	0	4,579	4,579
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	10,218	0	0	0	0	0	0	10,218
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	532	3,004	3,536
1959	0	0	0	0	0	0	0	0	12,769	-835	2,181	0	14,116
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	742	0	742
1962	0	0	0	0	0	0	7,481	0	0	0	0	0	7,481
1963	4,899	0	0	0	5,197	0	0	0	0	0	0	0	10,096
1964	0	0	0	-821	0	0	0	0	0	0	0	0	-821
1965	166	0	0	0	0	0	0	0	0	0	4,940	-90	5,016
1966	-5	0	0	0	0	0	0	0	0	-444	0	0	-449
1967	0	0	0	0	0	0	0	0	110	0	0	0	110
1968	268	0	0	0	5,632	0	0	0	0	0	0	436	6,336
1969	0	0	0	0	0	0	0	0	-612	0	-159	682	-89
1970	759	0	569	0	0	0	0	0	0	6,505	0	0	7,832
1971	0	0	0	0	0	0	0	0	4,643	0	0	1,769	6,412
1972	0	0	0	0	0	0	0	0	0	0	0	-150	-150
1973	0	0	167	0	0	7,817	22	1	285	-11	5	-1	8,285
1974	-107	0	0	0	0	0	0	13,793	9,726	0	0	0	23,412
1975	0	0	0	0	7,244	0	0	0	0	0	0	0	7,244
1976	0	0	0	0	0	0	26,319	0	0	0	19,893	988	47,200
1977	0	0	0	3,720	0	0	0	0	1,470	0	0	0	5,190
1978	6,400	0	0	0	0	0	0	0	0	0	0	1,430	7,830
1979	0	0	0	0	0	0	1,900	0	5,991	0	0	0	7,891
1980	761	0	0	0	0	0	0	0	0	0	0	0	761
1981	0	-209	0	0	0	4,502	44	39	0	0	0	0	4,376
1982	0	-19	0	0	42	0	0	0	0	0	0	0	23
1983	3,603	0	0	0	0	0	10,502	0	5,822	0	0	0	19,926
1984	0	0	0	0	0	0	-1,472	-22	0	251	21	-38	-1,259
1985	80	62	0	0	0	0	121	0	0	0	6,480	0	6,742
1986	0	0	0	0	-523	151	0	0	0	0	0	0	-372
1987	0	0	0	0	0	0	0	0	0	0	0	-5	-5
1988	0	0	49	0	0	0	-1,449	0	0	0	0	0	-1,400
1989	96	0	0	0	259	0	0	0	0	0	0	0	355
1990	0	0	0	0	0	0	-666	-34	0	-89	0	0	-788
1991	457	0	0	904	0	0	1,554	0	0	0	-115	315	3,115
1992	60	0	0	0	0	0	0	0	0	0	0	0	60
1993	0	0	0	0	0	0	0	0	0	0	-173	112	-61
1994	0	0	99	0	0	0	0	0	0	0	0	0	99
1995	0	0	2,597	0	8,810	0	6,328	0	0	0	0	31	17,766
1996	0	0	0	0	-247	190	0	0	0	17	0	0	-40

Min	-107	-209	0	-821	-1,376	0	-1,472	-72	-788	-835	-173	-150	-1,400
Max	6,400	64	2,597	3,720	8,810	10,218	26,319	13,793	12,769	6,505	19,893	6,115	47,200
Average	419	-1	63	129	439	491	869	331	848	80	667	435	4,770

5%	0	-2	0	0	-275	0	-865	-23	-61	-462	-120	-43	-865
10%	0	0	0	0	0	0	-100	0	0	-27	0	-2	-517
25%	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	0	0	0	0	0	0	0	0	0	0	858
75%	30	0	0	0	0	0	0	0	0	0	0	16	7,362
90%	759	0	56	0	86	158	1,623	0	4,879	0	1,118	1,867	12,421

Table 3F-1d
Phase II - Store in OCR and Lake Texana
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	982	7,972	3,106	1,312	4,255	15,413	307,838	2,130	2,198	27,403	452,204	222,029	1,046,843
1941	68,132	36,295	121,583	173,403	236,001	142,798	86,654	23,078	12,275	43,551	36,241	10,473	990,481
1942	5,196	7,908	5,337	84,619	8,625	8,420	112,561	8,425	25,446	9,344	4,108	4,876	284,865
1943	11,081	6,492	19,072	4,679	20,534	5,825	7,778	5,070	297	297	297	20,253	101,675
1944	135,455	21,641	204,191	9,770	100,142	10,487	4,898	2,864	22,760	297	297	36,912	549,714
1945	47,369	11,513	5,337	150,585	6,425	6,386	4,547	16,337	11,101	12,457	297	297	272,653
1946	5,774	66,514	43,184	19,706	56,361	147,073	7,778	28,521	112,239	83,804	93,492	13,337	677,783
1947	100,988	7,908	5,748	14,159	68,674	3,689	4,409	5,459	297	297	297	297	212,224
1948	297	11,179	15,383	5,385	70,984	1,575	6,336	73	297	297	297	297	112,402
1949	297	297	4,680	114,042	17,071	2,294	7,778	8,106	297	112,718	4,064	55,548	327,194
1950	26,488	18,260	4,373	19,142	5,077	61,908	2,680	31	297	297	297	297	139,149
1951	297	297	297	297	297	297	297	0	297	297	297	297	3,272
1952	297	297	297	297	102,880	18,059	1,389	134	5,795	297	297	26,019	156,060
1953	5,196	7,908	3,015	2,430	72,142	329	2,870	16,337	61,128	4,085	4,058	297	179,794
1954	297	297	297	297	297	20	297	19	297	297	297	298	3,014
1955	297	297	297	297	297	297	297	297	297	297	297	298	3,569
1956	298	297	298	297	297	0	297	0	25	298	297	297	2,703
1957	0	297	297	93,608	94,356	85,148	875	16	33,446	186,157	124,777	4,876	623,854
1958	81,458	108,116	5,337	6,246	40,800	280	7,778	91	297	22,548	4,064	14,254	291,269
1959	8,245	155,747	5,337	196,848	36,775	62,391	5,041	15,881	13,067	42,716	31,993	46,941	620,981
1960	36,585	41,324	5,337	19,047	29,936	231,811	25,990	80,120	16,517	228,379	117,233	85,899	918,178
1961	121,663	206,655	5,337	9,919	8,360	157,800	67,361	4,574	300,394	11,170	77,974	4,876	976,082
1962	5,196	7,908	5,337	48,007	13,240	24,905	7,778	140	297	297	297	297	113,701
1963	297	7,908	3,488	2,070	5,494	297	297	37	297	297	297	297	21,079
1964	297	297	297	2,510	297	297	2,100	297	297	9,584	4,044	297	20,618
1965	2,697	57,453	4,633	6,063	173,591	50,731	5,654	226	9,986	297	81,076	38,709	431,118
1966	19,871	46,279	16,934	60,849	128,116	30,308	7,778	12,711	11,289	6,859	297	297	341,588
1967	297	297	297	297	297	213	297	297	180,165	73,647	4,064	3,322	263,494
1968	212,822	10,889	7,559	20,617	145,220	366,887	21,422	3,333	22,030	19,213	4,064	13,317	847,375
1969	13,864	142,638	86,635	120,771	157,505	8,993	1,908	260	12,815	297	4,064	5,409	555,159
1970	29,386	6,054	65,225	11,840	138,695	38,864	7,778	648	61,128	85,721	4,064	3,233	452,636
1971	2,147	4,159	2,346	297	297	297	297	297	115,914	65,497	4,064	64,657	260,271
1972	32,433	65,189	9,234	6,083	313,572	50,043	7,778	10,824	11,588	7,302	3,831	3,070	520,948
1973	297	7,485	108,367	293,713	53,093	607,557	21,435	16,337	102,478	176,214	28,826	7,231	1,423,033
1974	159,061	10,583	5,337	26,244	71,897	68,027	7,338	14,091	259,287	23,806	114,024	39,383	799,078
1975	14,317	8,873	5,337	48,007	191,640	73,980	29,438	16,337	21,046	13,627	4,064	7,576	434,242
1976	4,053	4,041	3,631	45,837	70,900	53,196	26,584	296	4,607	43,551	26,240	235,223	518,158
1977	26,686	100,662	5,337	121,535	17,201	51,220	7,778	265	1,768	297	297	2,292	335,339
1978	20,524	27,159	5,260	19,467	216	28,025	7,778	92	255,784	14,239	7,491	6,018	392,054
1979	210,130	93,867	41,451	139,340	200,402	57,530	9,678	2,470	187,595	1,824	4,064	4,876	953,225
1980	147,110	12,375	5,337	5,289	71,897	3,315	7,778	707	297	297	4,064	4,876	263,344
1981	5,196	5,192	297	297	49,497	217,012	26,557	40,424	298,602	57,722	221,123	9,894	931,815
1982	3,212	28,307	5,337	19,167	277,132	8,780	7,778	152	4,117	297	77,251	4,637	436,167
1983	45,173	141,154	117,996	25,433	36,245	9,504	17,292	3,903	99,221	151,352	77,458	3,112	727,844
1984	35,969	11,700	5,337	11,931	8,174	9,495	6,306	3,103	297	117,569	5,796	6,674	222,352
1985	62,510	30,911	140,910	173,087	27,796	14,588	8,732	9,201	13,541	29,877	135,472	38,073	684,699
1986	1,981	3,653	287	8,512	9,650	97,220	7,778	5,468	17,394	37,554	4,064	115,332	308,894
1987	32,468	81,742	16,928	11,714	58,394	298,863	18,944	5,021	2,689	128	39,551	62,970	629,413
1988	5,196	321	5,386	20,507	10,685	7,518	6,329	297	7	297	297	297	57,140
1989	40,688	7,908	5,337	3,115	84,523	10,809	5,035	2,221	0	297	297	152	160,384
1990	297	297	11,487	39,650	26,493	2	7,112	2,470	297	10,432	297	21	98,859
1991	74,023	39,114	5,348	194,748	22,066	28,676	7,991	7,366	29,738	1,678	1,991	181,213	593,951
1992	220,846	537,655	76,337	224,884	275,120	113,420	7,778	6,054	7,302	5,818	23,466	35,710	1,534,391
1993	51,110	90,017	68,362	64,910	282,267	391,401	8,374	16,289	780	26,509	4,064	297	1,004,381
1994	5,196	303	5,391	34,699	108,890	61,741	7,153	16,337	14,264	615,204	4,064	76,472	949,714
1995	78,907	3,467	139,826	8,352	98,789	5,681	19,856	14,215	9,269	53	4,064	26,058	408,536
1996	5,196	2,646	5,337	7,770	12,054	3,393	7,778	8,256	55,630	173	4,064	4,876	117,172

Min	0	297	287	297	216	0	297	0	0	53	297	21	2,703
Max	220,846	537,655	204,191	293,713	313,572	607,557	307,838	80,120	300,394	615,204	452,204	235,223	1,534,391
Average	39,055	40,632	25,440	48,316	72,315	65,879	17,850	7,684	42,647	41,845	32,562	27,283	461,508

5%	297	297	297	297	297	18	297	14	24	169	297	283	3,246
10%	297	297	297	297	297	294	297	36	297	297	297	297	20,987
25%	1,482	3,560	3,560	4,984	8,492	3,354	4,478	263	297	297	297	297	158,222
Median	11,081	8,873	5,337	19,047	40,800	15,413	7,778	3,103	11,101	9,344	4,064	4,876	392,054
75%	49,240	43,801	16,931	62,879	101,511	65,209	9,205	11,767	31,592	43,134	30,409	36,311	681,241
90%	137,786	114,724	110,292	173,150	207,521	219,972	27,154	16,337	181,651	124,325	114,666	78,357	978,962

Table 3F-1e
Change in Flows Phase I to Phase II
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	0	0	0	0	0	0	0	0	0	0	-852	0	-852
1941	0	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	0	0	0	0	265	0	0	0	-2,785	0	-2,520
1943	123	0	0	0	0	0	0	0	0	0	0	-3,309	-3,187
1944	0	0	0	0	1,376	0	0	0	788	0	0	-2,257	-93
1945	0	0	0	-296	0	0	0	0	0	0	0	0	-296
1946	0	0	0	0	0	-2,743	0	0	0	0	0	0	-2,743
1947	0	0	76	0	0	0	0	0	0	0	0	0	76
1948	0	3,271	-85	0	0	0	0	0	0	0	0	0	3,186
1949	0	0	-657	-2,576	0	0	0	0	-8,931	223	0	0	-11,941
1950	0	0	0	0	0	0	800	0	0	0	0	0	800
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	-11	0	0	0	-197	0	0	-5,751	-5,958
1953	0	0	0	0	109	0	0	0	0	0	0	-4,579	-4,470
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	-10,218	0	0	0	0	0	0	-10,218
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	1,595	2,761	0	0	0	252	15	0	4,623
1958	104	0	0	0	0	0	0	0	0	0	-532	-3,004	-3,432
1959	0	0	0	0	0	0	0	0	0	0	-1,367	0	-1,367
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	-742	0	-742
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	-4,899	0	0	0	0	0	0	0	0	0	0	0	-4,899
1964	0	0	0	0	0	0	-748	0	0	-587	-20	0	-1,355
1965	619	39	0	0	0	0	0	0	0	0	921	-114	1,464
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	-96	105	0	0	9
1968	-268	0	0	0	-570	0	0	0	0	0	0	-436	-1,274
1969	0	0	0	0	0	0	0	0	0	0	159	-149	10
1970	-759	0	-569	0	0	0	0	0	0	-226	0	0	-1,553
1971	0	0	0	0	0	0	0	0	-4,643	0	0	-936	-5,579
1972	0	0	0	0	0	0	0	0	0	0	-233	150	-83
1973	0	-423	511	0	0	0	-49	-1	-1	0	0	0	37
1974	81	0	0	0	0	0	0	0	-6,665	0	0	0	-6,584
1975	0	0	0	0	-1,468	0	0	0	0	0	0	57	-1,411
1976	0	0	0	0	0	0	-33	0	0	0	0	-988	-1,021
1977	0	0	0	-1,080	0	0	0	0	0	0	0	0	-1,080
1978	-2,840	0	0	0	0	0	0	0	4,464	0	360	-288	1,697
1979	0	0	0	0	0	0	0	0	-24	0	0	0	-24
1980	-704	0	0	0	0	0	0	0	0	0	0	0	-704
1981	0	209	0	0	0	-4,502	-44	-39	0	0	0	0	-4,376
1982	0	83	0	0	468	0	0	0	0	0	0	0	551
1983	-712	0	0	0	0	0	-987	0	-1,421	0	0	0	-3,120
1984	0	0	0	0	0	0	0	0	0	0	-18	0	-18
1985	-111	-62	85	0	0	0	833	0	0	0	-1,354	180	-429
1986	0	0	0	0	523	-151	0	0	0	0	0	0	372
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	34	0	-32	0	0	2
1991	0	64	11	61	0	0	-1,342	0	0	-20	25	-71	-1,272
1992	54	0	0	0	0	0	0	0	0	0	0	0	54
1993	0	0	0	0	0	0	0	0	0	0	173	-112	61
1994	0	0	-45	6	156	0	0	0	0	0	0	0	118
1995	0	0	-607	0	0	0	0	0	0	0	0	0	-607
1996	0	0	0	0	247	-216	0	0	0	-17	0	0	15

Min	-4,899	-423	-657	-2,576	-1,468	-10,218	-1,342	-39	-8,931	-587	-2,785	-5,751	-11,941
Max	619	3,271	511	61	1,595	2,761	833	34	4,464	252	921	180	4,623
Average	-163	56	-22	-68	43	-264	-23	0	-293	-5	-110	-379	-1,230

5%	-967	-6	-572	-374	-67	-2,919	-772	0	-4,845	-51	-1,355	-3,436	-6,947
10%	-355	0	-9	0	0	-30	-35	0	-116	-3	-574	-1,242	-5,035
25%	0	0	0	0	0	0	0	0	0	0	0	0	-1,482
Median	0	0	0	0	0	0	0	0	0	0	0	0	-83
75%	0	0	0	0	0	0	0	0	0	0	0	0	9
90%	11	8	0	0	175	0	0	0	0	0	17	0	601

Table 3F-1f
Change in Flows Baseline to Phase II
Lake Texana Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	0	64	0	0	0	0	-58	0	0	0	0	0	6
1941	0	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	0	0	0	0	0	0	0	0	44	0	44
1943	5,885	0	0	0	0	0	0	0	0	0	0	0	5,886
1944	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	-622	0	0	-622
1946	578	64	0	0	0	2,371	0	-72	1	-1	5	-24	2,923
1947	96	0	76	0	0	0	0	5,162	0	0	0	0	5,333
1948	0	3,271	0	0	0	0	0	0	0	0	0	0	3,271
1949	0	0	-657	660	0	0	0	0	0	0	0	54	57
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	-197	0	0	364	168
1953	0	0	0	0	109	0	0	0	0	0	0	0	109
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	1,595	2,761	0	0	0	252	15	0	4,623
1958	104	0	0	0	0	0	0	0	0	0	0	0	104
1959	0	0	0	0	0	0	0	0	12,769	-835	814	0	12,748
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	7,481	0	0	0	0	0	7,481
1963	0	0	0	0	5,197	0	0	0	0	0	0	0	5,197
1964	0	0	0	-821	0	0	-748	0	0	-587	-20	0	-2,176
1965	784	39	0	0	0	0	0	0	0	0	5,861	-204	6,480
1966	-5	0	0	0	0	0	0	0	0	-444	0	0	-449
1967	0	0	0	0	0	0	0	0	14	105	0	0	119
1968	0	0	0	0	5,062	0	0	0	0	0	0	0	5,062
1969	0	0	0	0	0	0	0	0	-612	0	0	533	-79
1970	0	0	0	0	0	0	0	0	0	6,279	0	0	6,279
1971	0	0	0	0	0	0	0	0	0	0	0	833	833
1972	0	0	0	0	0	0	0	0	0	0	-233	0	-234
1973	0	-423	678	0	0	7,817	-28	0	284	-11	5	-1	8,322
1974	-26	0	0	0	0	0	0	13,793	3,061	0	0	0	16,829
1975	0	0	0	0	5,776	0	0	0	0	0	0	57	5,833
1976	0	0	0	0	0	0	26,286	0	0	0	19,893	0	46,179
1977	0	0	0	2,639	0	0	0	0	1,470	0	0	0	4,110
1978	3,560	0	0	0	0	0	0	0	4,464	0	360	1,142	9,527
1979	0	0	0	0	0	0	1,900	0	5,968	0	0	0	7,867
1980	57	0	0	0	0	0	0	0	0	0	0	0	57
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	64	0	0	510	0	0	0	0	0	0	0	575
1983	2,891	0	0	0	0	0	9,514	0	4,401	0	0	0	16,806
1984	0	0	0	0	0	0	-1,472	-22	0	251	3	-38	-1,278
1985	-31	0	85	0	0	0	954	0	0	0	5,125	180	6,313
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	-5	-5
1988	0	0	49	0	0	0	-1,449	0	0	0	0	0	-1,400
1989	96	0	0	0	259	0	0	0	0	0	0	0	355
1990	0	0	0	0	0	0	-666	0	0	-120	0	0	-786
1991	457	64	11	965	0	0	213	0	0	-20	-91	244	1,843
1992	115	0	0	0	0	0	0	0	0	0	0	0	115
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	54	6	156	0	0	0	0	0	0	0	216
1995	0	0	1,990	0	8,810	0	6,328	0	0	0	0	31	17,159
1996	0	0	0	0	0	-26	0	0	0	0	0	0	-26

Min	-31	-423	-657	-821	0	-26	-1,472	-72	-612	-835	-233	-204	-2,176
Max	5,885	3,271	1,990	2,639	8,810	7,817	26,286	13,793	12,769	6,279	19,893	1,142	46,179
Average	255	55	40	61	482	227	847	331	555	75	558	56	3,540

5%	-7	0	0	0	0	0	-818	-2	-20	-590	-27	-25	-1,290
10%	0	0	0	0	0	0	-34	0	0	-40	0	0	-484
25%	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	0	0	0	0	0	0	0	0	0	0	115
75%	0	0	0	0	0	0	0	0	0	0	0	0	5,583
90%	481	44	50	0	727	0	1,143	0	1,788	0	107	193	10,171

Table 3F-2a
Baseline
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	1,028	16,258	3,223	1,393	4,429	15,935	568,592	2,292	2,291	30,434	682,946	336,191	1,665,011
1941	107,435	62,807	210,102	257,439	420,564	270,871	111,138	31,045	14,211	53,174	49,693	13,690	1,602,168
1942	6,477	9,629	6,263	143,638	9,909	8,710	183,581	8,738	39,780	11,953	6,546	6,674	441,898
1943	9,568	6,717	30,411	4,887	22,429	8,628	10,944	5,282	454	429	1,407	37,216	138,372
1944	183,451	32,147	292,743	13,612	154,707	12,644	5,142	3,034	25,189	470	3,628	47,822	774,589
1945	70,576	16,781	11,239	192,152	6,671	7,087	4,759	17,290	11,380	13,439	417	693	352,485
1946	6,271	84,764	58,298	24,529	65,016	198,382	8,539	71,754	215,089	174,780	135,813	22,351	1,065,586
1947	143,572	11,811	16,437	22,193	105,189	3,876	4,618	490	467	369	490	734	310,247
1948	846	9,121	16,383	5,586	140,911	1,716	6,619	91	509	352	404	357	182,895
1949	412	1,471	5,962	169,028	22,226	2,438	8,170	8,449	558	134,642	4,320	82,258	439,934
1950	32,001	22,815	4,533	21,659	5,323	67,850	2,830	39	483	352	362	344	158,590
1951	335	363	443	391	382	2,192	347	0	1,105	513	404	359	6,834
1952	325	536	414	2,248	153,883	24,866	1,498	166	6,152	339	1,443	48,248	240,118
1953	5,463	8,697	3,128	2,572	112,825	380	3,014	17,507	62,779	4,214	4,174	469	225,222
1954	340	348	335	466	574	26	337	23	327	357	348	313	3,796
1955	331	2,566	335	408	24,137	2,149	358	627	745	620	349	317	32,943
1956	317	474	312	361	362	0	368	0	27	314	349	443	3,326
1957	0	615	2,987	151,378	123,572	100,058	942	19	34,444	311,675	200,262	9,746	935,699
1958	126,168	180,219	12,693	6,785	63,000	335	8,229	113	16,657	36,294	5,740	20,281	476,514
1959	9,834	228,359	7,670	284,868	56,036	67,404	5,294	16,379	698	58,371	45,064	57,634	837,612
1960	47,758	54,038	7,351	23,427	31,102	305,020	32,799	120,299	17,084	471,540	172,217	125,936	1,408,572
1961	184,740	278,612	11,791	12,645	8,715	247,124	101,566	4,828	436,586	18,468	147,946	10,140	1,463,160
1962	9,030	10,218	5,665	85,675	13,711	35,924	704	174	907	480	421	733	163,641
1963	870	23,708	3,636	2,176	485	445	913	46	340	357	548	746	34,269
1964	425	877	709	3,528	413	1,472	2,990	358	1,357	10,461	4,216	358	27,164
1965	18,636	118,057	6,033	6,395	282,968	89,512	5,918	281	10,243	883	118,854	57,730	715,512
1966	26,583	63,645	23,573	96,925	177,042	34,568	8,292	13,097	11,596	7,497	391	375	463,583
1967	393	374	374	623	551	241	386	722	271,862	127,218	7,263	3,595	413,602
1968	285,676	18,289	14,829	32,270	229,816	498,099	28,814	3,531	24,902	19,716	4,564	25,118	1,185,625
1969	18,965	212,383	133,245	209,844	251,254	9,488	2,047	323	13,805	887	4,436	21,020	877,697
1970	46,052	8,591	88,671	12,840	222,404	61,180	8,212	743	77,242	97,183	4,285	3,354	630,756
1971	2,239	4,299	2,451	472	475	433	395	18,323	206,534	88,199	5,746	100,542	430,107
1972	54,525	92,185	19,762	6,330	523,440	70,831	8,758	12,764	11,918	7,523	4,289	3,187	815,512
1973	1,058	17,305	177,791	462,916	85,188	930,855	40,877	22,611	118,846	298,236	40,032	12,182	2,207,897
1974	234,719	21,219	9,368	27,942	103,960	116,889	7,667	1,780	359,337	30,805	156,915	56,527	1,127,128
1975	22,667	16,889	7,428	84,033	303,798	102,918	53,643	17,777	22,004	14,019	4,262	18,751	668,190
1976	4,213	4,188	3,787	77,724	123,859	66,386	16,113	367	4,806	101,231	29,287	396,881	828,842
1977	48,065	164,933	13,187	180,683	26,879	65,617	8,173	329	429	430	1,151	2,409	512,285
1978	23,543	36,098	7,793	31,743	278	30,411	8,127	119	429,208	18,049	15,438	7,734	608,538
1979	317,205	142,370	65,127	209,618	362,779	147,758	14,000	2,648	235,743	1,956	4,242	5,525	1,508,971
1980	184,340	24,622	6,474	5,517	127,353	3,479	8,081	754	498	1,029	4,194	5,056	371,396
1981	5,395	5,346	548	1,087	50,998	366,926	45,871	44,225	452,023	76,120	334,358	16,257	1,399,155
1982	6,705	62,035	12,427	22,236	492,425	12,125	8,234	195	4,292	577	136,880	13,731	771,863
1983	55,365	193,522	173,594	28,105	56,643	10,408	60,541	6,948	105,720	167,065	107,293	4,214	969,419
1984	56,560	15,384	8,855	12,291	8,477	9,817	8,237	3,224	326	124,082	6,962	9,051	263,266
1985	85,701	51,316	185,803	294,724	37,739	16,668	13,230	9,444	13,912	30,643	182,663	44,429	966,270
1986	2,196	4,531	346	8,762	9,948	158,221	8,192	5,615	17,855	38,570	4,850	183,193	442,279
1987	50,189	140,137	31,277	12,083	64,763	610,411	26,067	5,228	2,799	164	45,462	80,695	1,069,275
1988	5,435	379	5,847	21,048	11,086	7,816	8,301	469	10	606	338	566	61,900
1989	43,046	8,299	5,606	3,231	87,137	11,138	5,199	2,280	0	387	412	160	166,894
1990	370	994	12,937	40,782	27,232	3	8,341	2,539	600	10,795	333	22	104,947
1991	77,330	40,396	5,701	281,893	28,868	29,498	13,197	7,554	30,483	1,753	2,232	320,620	839,523
1992	324,367	869,874	120,267	401,978	441,627	222,103	8,580	6,263	7,514	5,995	24,978	51,040	2,484,585
1993	68,075	113,317	113,868	93,905	435,157	648,417	11,870	16,760	839	27,167	4,204	1,261	1,534,840
1994	5,407	350	6,178	35,578	203,583	64,458	7,419	16,942	14,715	1,083,995	8,711	98,080	1,545,417
1995	116,904	7,685	179,730	41,924	101,836	19,055	14,596	14,614	9,505	68	4,439	27,485	537,841
1996	5,372	2,727	5,571	7,982	12,349	4,918	8,157	8,606	72,170	2,366	4,396	6,172	140,787

Min	0	348	312	361	278	0	337	0	0	68	333	22	3,326
Max	324,367	869,874	292,743	462,916	523,440	930,855	568,592	120,299	452,023	1,083,995	682,946	396,881	2,484,585
Average	55,173	61,854	37,921	73,448	112,956	101,863	27,190	9,756	60,024	65,256	48,129	42,123	695,694

5%	325	362	335	406	380	24	357	17	25	299	347	298	6,530
10%	339	455	406	593	483	371	393	44	337	352	360	354	34,004
25%	1,627	4,244	3,712	5,202	9,928	3,678	3,816	326	649	496	849	734	204,059
Median	18,636	16,781	7,670	22,193	56,643	19,055	8,192	3,034	11,380	10,461	4,396	9,746	537,841
75%	69,325	63,226	26,992	95,415	154,295	101,488	13,615	12,931	37,112	55,772	42,548	48,035	1,017,503
90%	184,420	182,880	174,433	262,330	374,336	317,402	55,023	19,180	242,966	168,608	159,976	105,620	1,536,955

Table 3F-2b
Phase I - Store in Lake Texana
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	2,081	14,468	5,274	2,413	6,285	18,928	573,114	3,446	3,538	36,148	684,967	336,110	1,686,771
1941	108,471	62,869	211,258	257,630	421,852	271,741	114,115	34,142	16,447	55,250	50,287	17,267	1,621,329
1942	9,906	12,846	7,783	141,979	10,691	10,021	182,955	10,019	34,257	11,170	9,125	8,896	449,647
1943	15,568	9,959	31,655	6,619	23,196	7,558	10,643	6,478	1,754	1,755	9,387	46,496	171,069
1944	181,543	32,894	294,971	15,913	153,361	16,198	5,872	5,545	30,487	1,832	2,858	51,964	793,437
1945	70,534	16,405	11,922	194,003	9,524	11,887	5,463	19,110	12,520	14,337	1,690	2,870	370,264
1946	9,598	90,834	57,822	23,891	62,209	202,354	12,444	72,495	215,613	176,381	137,003	23,701	1,084,345
1947	144,093	13,806	17,905	18,268	94,341	6,588	5,319	6,831	1,327	490	1,837	2,947	313,752
1948	3,151	19,780	22,891	7,311	130,441	2,903	7,383	377	1,403	457	559	929	197,586
1949	1,031	11,763	8,324	185,478	19,695	3,627	10,375	9,755	10,875	139,230	5,720	83,163	489,037
1950	33,144	23,794	7,205	25,631	9,562	69,858	2,511	43	911	457	483	906	174,504
1951	889	888	1,173	1,090	731	4,853	375	0	8,813	1,910	560	934	22,214
1952	872	2,459	1,118	5,446	178,828	20,470	1,946	788	7,058	512	9,452	57,206	286,154
1953	7,531	10,103	5,059	4,249	113,943	810	3,454	20,858	65,334	5,539	5,235	6,101	248,217
1954	1,195	1,032	974	2,165	2,241	29	359	26	646	400	388	326	9,782
1955	844	24,121	973	1,122	27,162	12,353	392	3,273	2,290	951	410	518	74,408
1956	561	1,108	608	398	479	0	619	0	28	324	389	1,088	5,601
1957	0	2,546	25,069	169,641	121,029	102,288	1,109	21	42,312	311,158	200,251	11,448	986,872
1958	125,865	179,860	12,057	10,724	66,057	840	10,484	546	22,075	31,168	6,636	24,301	490,613
1959	12,527	226,870	11,829	284,842	48,528	70,374	7,383	17,816	14,973	53,540	48,143	58,203	855,028
1960	48,408	56,523	9,377	23,221	34,460	305,761	35,758	121,958	20,840	468,155	173,433	125,928	1,423,825
1961	186,075	280,434	13,730	16,028	13,864	244,689	103,188	7,569	439,567	19,125	148,648	11,352	1,484,269
1962	11,235	13,786	7,626	71,214	15,541	27,740	9,052	886	8,450	1,849	1,710	2,943	172,032
1963	8,095	18,977	6,648	3,532	6,822	952	3,306	51	614	467	825	2,969	53,256
1964	1,054	3,088	2,891	4,428	1,109	3,528	3,383	1,072	9,278	11,921	4,409	932	47,094
1965	37,661	116,513	9,985	10,264	279,459	81,547	7,663	1,691	11,540	2,592	133,945	56,628	749,489
1966	27,158	62,984	25,863	98,027	177,959	36,939	10,601	14,440	13,022	8,255	1,468	963	477,680
1967	996	908	1,045	2,454	2,200	279	435	1,661	289,249	127,218	5,793	6,294	438,533
1968	285,000	19,110	17,009	27,445	236,650	499,058	32,650	6,225	24,403	21,355	5,982	26,554	1,201,441
1969	20,168	212,586	134,941	211,126	252,860	14,573	2,689	1,393	14,680	8,461	5,775	17,428	896,679
1970	47,072	8,139	91,243	15,624	221,595	52,818	10,612	2,775	84,418	105,444	5,655	5,467	650,863
1971	3,885	6,347	4,375	1,885	1,255	1,613	786	23,543	211,112	89,990	5,720	102,561	453,072
1972	56,109	93,029	22,793	9,822	521,980	75,247	10,987	12,639	13,364	8,925	5,662	4,980	835,535
1973	2,914	18,840	176,215	464,476	77,076	940,795	44,189	24,705	119,690	296,744	41,951	14,198	2,221,792
1974	234,791	24,166	9,630	30,682	96,976	104,165	9,166	18,035	370,325	32,263	156,916	57,439	1,144,554
1975	23,884	17,841	11,665	74,115	309,365	104,252	56,233	19,922	24,067	16,364	6,387	20,233	684,328
1976	6,193	6,035	5,755	68,677	107,001	57,349	34,179	2,140	6,141	90,462	49,437	398,520	831,889
1977	47,961	166,780	12,019	183,991	23,911	59,122	9,726	1,988	3,179	1,757	8,915	4,351	523,699
1978	30,315	36,519	11,525	26,332	2,078	34,504	8,945	762	438,088	22,240	14,426	11,361	637,096
1979	316,021	143,215	67,494	209,429	363,868	139,728	17,536	5,325	245,516	3,283	5,576	7,205	1,524,195
1980	186,055	25,748	10,499	9,314	118,459	5,780	8,686	1,408	1,834	2,860	5,488	6,759	382,890
1981	7,338	6,761	2,596	3,308	53,695	372,650	48,850	45,345	455,739	75,747	337,016	17,810	1,426,854
1982	9,114	61,027	13,421	25,648	493,723	14,435	10,494	1,249	5,607	2,029	144,420	11,081	792,247
1983	59,484	194,535	174,718	32,208	44,138	14,443	71,588	5,463	113,556	168,425	108,484	7,262	994,304
1984	54,854	18,277	9,605	15,364	11,704	12,643	7,496	3,778	858	145,393	7,812	10,683	298,467
1985	87,572	43,905	186,539	296,357	32,534	18,054	11,342	10,236	15,391	32,503	191,676	45,859	971,969
1986	4,940	7,440	2,232	10,020	11,110	156,853	8,886	6,021	19,410	40,640	6,696	183,543	457,792
1987	51,019	139,385	33,879	15,404	66,628	606,651	28,995	7,930	4,060	1,411	50,338	80,586	1,086,286
1988	8,173	2,594	8,161	23,059	12,858	9,133	9,167	665	79	926	438	1,315	76,568
1989	54,693	10,291	7,669	3,981	91,246	12,482	5,290	2,312	0	466	569	360	189,359
1990	940	2,049	15,993	43,290	29,288	3	8,489	2,545	1,567	10,898	373	22	115,459
1991	100,779	50,834	7,943	278,621	26,453	32,743	13,162	7,659	32,277	2,438	3,427	327,924	884,261
1992	324,984	871,404	122,040	404,220	441,910	224,402	12,332	8,375	8,861	7,359	27,434	52,280	2,505,600
1993	69,514	114,026	115,129	96,028	435,961	651,522	16,982	19,684	2,058	28,937	5,333	4,027	1,559,201
1994	7,428	2,053	8,820	37,878	206,914	65,803	7,993	18,028	16,262	1,095,828	11,695	95,603	1,574,308
1995	117,835	5,530	184,553	34,212	110,905	11,154	23,246	16,587	10,641	672	5,939	30,587	551,861
1996	6,396	3,644	6,893	8,777	12,557	7,436	8,823	11,269	80,516	1,480	5,859	7,492	161,145

Min	0	888	608	398	479	0	359	0	0	324	373	22	5,601
Max	324,984	871,404	294,971	464,476	521,980	940,795	573,114	121,958	455,739	1,095,828	684,967	398,520	2,505,600
Average	57,465	63,574	40,147	74,549	113,092	102,360	29,285	11,384	63,314	66,630	50,369	43,805	715,974

5%	816	1,020	974	1,119	1,071	27	390	19	74	452	389	356	20,971
10%	930	2,053	1,162	2,363	2,175	834	753	49	816	467	474	924	70,177
25%	4,413	6,554	6,771	6,965	12,131	7,012	5,304	1,321	2,734	1,756	2,348	2,958	222,902
Median	20,168	18,840	11,525	23,221	53,695	18,928	9,166	5,545	13,022	10,898	5,939	11,352	551,861
75%	70,024	62,926	28,759	97,028	165,660	103,226	17,259	15,514	38,284	54,395	48,790	52,122	1,039,324
90%	186,059	182,795	175,017	261,828	375,465	319,139	59,304	23,775	254,262	170,016	160,220	107,234	1,562,222

Table 3F-2c
Change in Flows Baseline to Phase I
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	1,053	-1,790	2,051	1,020	1,855	2,994	4,522	1,154	1,246	5,714	2,021	-80	21,760
1941	1,036	62	1,155	192	1,288	870	2,977	3,097	2,236	2,076	594	3,577	19,161
1942	3,429	3,217	1,520	-1,659	782	1,311	-626	1,281	-5,523	-783	2,579	2,222	7,749
1943	6,001	3,241	1,243	1,732	767	-1,070	-301	1,196	1,300	1,327	7,980	9,280	32,697
1944	-1,908	747	2,228	2,300	-1,346	3,553	730	2,511	5,298	1,361	-770	4,142	18,848
1945	-42	-376	683	1,852	2,853	4,800	704	1,819	1,140	897	1,272	2,177	17,779
1946	3,327	6,070	-477	-639	-2,807	3,972	3,904	742	525	1,601	1,190	1,351	18,759
1947	521	1,995	1,468	-3,926	-10,848	2,712	701	6,341	860	120	1,347	2,212	3,505
1948	2,306	10,659	6,507	1,726	-10,470	1,187	764	286	894	106	155	572	14,691
1949	619	10,293	2,362	16,450	-2,531	1,188	2,205	1,306	10,317	4,588	1,400	905	49,103
1950	1,143	979	2,672	3,972	4,239	2,008	-319	4	428	106	120	562	15,914
1951	554	525	729	699	349	2,661	28	0	7,709	1,397	156	575	15,380
1952	546	1,923	704	3,198	24,945	-4,395	448	622	906	173	8,009	8,958	46,037
1953	2,069	1,405	1,932	1,677	1,118	430	440	3,352	2,556	1,325	1,061	5,632	22,995
1954	855	684	639	1,699	1,667	3	22	3	319	43	39	13	5,985
1955	514	21,555	638	713	3,025	10,204	34	2,646	1,545	331	62	201	41,465
1956	244	635	296	37	117	0	252	0	1	9	40	645	2,276
1957	0	1,930	22,082	18,263	-2,543	2,230	167	2	7,868	-516	-11	1,702	51,173
1958	-304	-359	-636	3,939	3,058	505	2,255	432	5,418	-5,125	896	4,020	14,099
1959	2,694	-1,489	4,159	-26	-7,508	2,970	2,089	1,436	14,274	-4,831	3,079	569	17,415
1960	650	2,485	2,026	-206	3,359	740	2,959	1,659	3,756	-3,385	1,216	-7	15,253
1961	1,334	1,821	1,940	3,383	5,149	-2,435	1,622	2,741	2,981	657	703	1,213	21,109
1962	2,205	3,568	1,961	-14,461	1,830	-8,184	8,348	712	7,543	1,369	1,289	2,211	8,391
1963	7,225	-4,731	3,012	1,356	6,336	507	2,393	5	274	110	277	2,222	18,987
1964	629	2,211	2,182	901	696	2,055	393	714	7,921	1,460	194	574	19,929
1965	19,025	-1,544	3,952	3,868	-3,510	-7,965	1,746	1,410	1,297	1,709	15,090	-1,102	33,977
1966	575	-661	2,291	1,102	917	2,371	2,308	1,343	1,426	758	1,078	588	14,097
1967	603	534	671	1,831	1,648	39	50	939	17,387	1	-1,470	2,699	24,932
1968	-676	821	2,181	-4,825	6,834	958	3,836	2,694	-499	1,639	1,418	1,436	15,816
1969	1,202	204	1,696	1,282	1,606	5,085	642	1,070	874	7,574	1,339	-3,592	18,982
1970	1,020	-452	2,572	2,784	-808	-8,361	2,400	2,032	7,176	8,261	1,370	2,113	20,107
1971	1,646	2,048	1,924	1,413	780	1,181	391	5,220	4,578	1,791	-26	2,019	22,966
1972	1,584	843	3,031	3,492	-1,461	4,416	2,229	-126	1,446	1,402	1,373	1,793	20,023
1973	1,856	1,534	-1,576	1,560	-8,112	9,940	3,312	2,095	845	-1,492	1,918	2,016	13,896
1974	72	2,948	262	2,740	-6,985	-12,724	1,498	16,255	10,988	1,458	1	912	17,426
1975	1,217	952	4,238	-9,918	5,566	1,334	2,589	2,145	2,063	2,345	2,125	1,482	16,138
1976	1,980	1,846	1,968	-9,046	-16,858	-9,037	18,066	1,774	1,335	-10,769	20,150	1,639	3,047
1977	-105	1,846	-1,168	3,308	-2,968	-6,495	1,553	1,659	2,749	1,327	7,764	1,943	11,414
1978	6,772	421	3,732	-5,411	1,800	4,094	819	644	8,880	4,191	-1,011	3,627	28,557
1979	-1,185	845	2,367	-189	1,089	-8,030	3,536	2,677	9,773	1,327	1,334	1,679	15,225
1980	1,716	1,126	4,025	3,797	-8,893	2,301	605	654	1,336	1,831	1,294	1,703	11,494
1981	1,942	1,414	2,047	2,221	2,697	5,724	2,979	1,120	3,715	-372	2,658	1,553	27,699
1982	2,409	-1,008	994	3,412	1,298	2,310	2,259	1,054	1,315	1,451	7,540	-2,650	20,384
1983	4,119	1,013	1,124	4,102	-12,505	4,035	11,047	-1,484	7,836	1,360	1,191	3,047	24,885
1984	-1,706	2,893	750	3,074	3,227	2,825	-741	554	532	21,310	850	1,632	35,201
1985	1,871	-7,411	736	1,633	-5,204	1,387	-1,888	792	1,479	1,860	9,013	1,430	5,700
1986	2,744	2,908	1,886	1,258	1,162	-1,368	694	407	1,555	2,070	1,846	350	15,513
1987	830	-752	2,602	3,321	1,865	-3,760	2,928	2,702	1,261	1,247	4,877	-109	17,011
1988	2,738	2,215	2,314	2,012	1,772	1,317	866	196	69	320	100	749	14,668
1989	11,647	1,992	2,063	750	4,109	1,344	92	33	0	79	156	199	22,465
1990	571	1,055	3,056	2,508	2,056	0	149	5	968	103	41	0	10,512
1991	23,449	10,438	2,242	-3,272	-2,415	3,246	-35	105	1,795	685	1,195	7,304	44,737
1992	617	1,530	1,773	2,242	283	2,299	3,753	2,112	1,346	1,364	2,456	1,239	21,015
1993	1,439	710	1,261	2,123	804	3,104	5,112	2,924	1,218	1,770	1,129	2,767	24,361
1994	2,022	1,703	2,642	2,301	3,331	1,345	574	1,086	1,547	11,833	2,984	-2,477	28,891
1995	931	-2,155	4,823	-7,712	9,069	-7,901	8,650	1,973	1,136	603	1,500	3,102	14,020
1996	1,024	917	1,322	795	208	2,518	666	2,663	8,346	-886	1,464	1,320	20,358

Min	-1,908	-7,411	-1,576	-14,461	-16,858	-12,724	-1,888	-1,484	-5,523	-10,769	-1,470	-3,592	2,276
Max	23,449	21,555	22,082	18,263	24,945	10,204	18,066	16,255	17,387	21,310	20,150	9,280	51,173
Average	2,292	1,720	2,226	1,101	137	497	2,095	1,628	3,291	1,373	2,239	1,682	20,280

5%	-1,237	-2,412	-689	-9,133	-11,013	-8,429	-637	-13	-50	-4,860	-794	-2,494	3,459
10%	-145	-1,500	289	-4,943	-8,268	-7,978	-88	2	233	-1,007	-1	-86	7,396
25%	562	312	872	114	-2,473	0	321	420	900	104	156	571	14,384
Median	1,143	1,055	1,961	1,677	1,089	1,334	866	1,154	1,446	1,327	1,272	1,482	18,848
75%	2,255	2,129	2,587	2,929	2,775	2,898	2,943	2,128	5,358	1,739	2,073	2,217	23,678
90%	6,155	4,068	4,052	3,883	5,232	4,493	4,640	2,958	9,059	4,813	7,807	4,045	36,454

Table 3F-2d
Phase II - Store in OCR and Lake Texana
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	2,081	14,468	5,274	2,413	6,285	18,928	566,553	3,446	3,538	36,148	680,767	335,977	1,675,876
1941	107,838	62,463	210,870	257,570	421,356	271,163	112,720	32,645	16,447	55,250	47,742	14,869	1,610,932
1942	9,018	11,560	7,783	140,796	10,691	10,021	180,726	10,019	34,257	11,170	6,340	8,896	441,275
1943	15,691	9,959	28,081	6,619	23,196	7,558	10,643	6,478	1,754	1,755	9,387	43,186	164,308
1944	173,830	32,243	294,379	15,913	153,382	16,198	5,872	5,545	31,275	1,832	2,858	49,707	783,034
1945	70,534	14,284	9,524	189,229	9,524	9,566	5,463	19,110	12,520	14,337	1,690	2,870	358,651
1946	9,598	90,834	49,368	23,891	62,209	198,587	12,444	69,353	215,015	175,789	136,411	22,885	1,066,383
1947	143,685	13,806	16,190	16,780	94,350	5,101	5,319	6,831	1,524	1,436	1,837	2,947	309,805
1948	3,151	23,050	20,598	7,792	130,428	4,391	7,383	377	1,403	457	559	929	200,520
1949	1,031	11,763	7,667	166,200	19,695	3,627	10,375	9,755	1,944	139,453	5,720	79,648	456,880
1950	30,475	23,062	7,205	25,631	9,562	69,858	3,311	43	911	457	483	906	171,902
1951	889	888	1,173	1,090	731	4,853	375	0	8,813	1,910	560	934	22,214
1952	872	2,459	1,118	5,446	171,536	20,470	1,946	788	6,808	434	9,452	49,384	270,712
1953	7,531	10,103	5,059	4,249	100,758	810	3,454	20,858	65,334	5,539	5,235	1,136	230,068
1954	899	861	974	2,165	2,241	29	359	26	646	400	388	326	9,314
1955	844	24,121	973	1,122	27,162	2,135	392	3,273	2,290	951	410	518	64,190
1956	561	1,108	608	398	479	0	619	0	28	324	389	1,088	5,601
1957	0	2,546	25,069	169,641	108,522	91,355	1,109	21	42,312	302,271	196,123	11,448	950,416
1958	119,873	179,740	12,057	10,724	66,057	840	10,484	546	22,075	31,168	6,104	17,821	477,490
1959	10,990	224,515	11,829	283,327	47,562	70,374	7,383	17,816	14,973	53,540	41,743	57,428	841,479
1960	49,714	54,761	9,377	23,221	34,460	301,188	34,261	121,054	20,840	467,619	172,882	125,663	1,415,040
1961	185,422	279,803	12,587	16,028	13,864	241,748	102,181	7,569	437,133	19,125	147,689	11,352	1,474,500
1962	11,235	13,786	7,626	71,214	15,541	27,740	9,052	886	8,450	1,849	1,710	2,943	172,032
1963	3,196	18,977	5,597	3,532	6,822	952	3,306	51	614	467	825	2,969	47,306
1964	1,054	3,088	2,891	4,429	1,109	3,528	2,635	1,003	9,278	11,334	4,389	932	45,669
1965	26,185	100,919	8,413	9,579	277,830	80,274	7,663	1,691	11,540	2,592	126,558	53,868	707,113
1966	27,158	61,326	24,334	97,476	177,238	34,619	11,246	15,136	13,022	8,255	1,468	963	472,242
1967	996	908	1,045	2,454	2,200	279	435	1,661	289,153	111,963	5,793	6,294	423,182
1968	281,568	18,418	16,050	27,445	235,360	498,766	30,887	6,225	24,403	21,355	5,982	25,018	1,191,476
1969	16,985	211,784	134,287	210,677	252,037	14,573	2,689	1,393	14,680	8,461	5,933	17,279	890,779
1970	41,227	8,139	90,674	15,624	218,175	51,280	10,612	2,775	84,418	98,756	5,655	5,467	632,802
1971	3,885	6,347	4,375	1,885	1,255	1,613	786	23,543	197,758	89,234	5,720	101,258	437,660
1972	56,109	91,496	21,588	9,822	521,031	75,247	10,987	12,639	13,364	8,925	5,429	5,130	831,765
1973	2,914	18,416	167,773	464,292	75,701	940,768	42,560	23,473	118,948	297,235	41,012	13,969	2,207,061
1974	233,820	24,166	9,630	30,682	96,976	104,165	9,166	18,035	362,143	32,263	155,957	56,806	1,133,810
1975	22,985	17,109	11,665	74,115	308,136	103,306	54,899	19,922	23,293	15,565	5,614	19,535	676,144
1976	6,193	6,035	5,755	68,677	107,001	57,349	33,241	1,444	6,141	89,070	49,008	397,181	827,095
1977	47,512	165,985	12,019	182,932	23,911	59,122	9,726	1,988	3,179	1,757	8,915	4,351	521,396
1978	25,335	30,714	9,127	24,012	2,078	32,183	8,945	762	436,531	22,240	13,078	11,073	616,079
1979	315,286	142,686	67,494	208,470	363,351	138,496	16,427	5,325	242,910	3,283	5,576	7,205	1,516,510
1980	182,813	24,974	10,499	9,314	115,250	5,780	8,686	1,408	1,834	2,860	5,488	6,759	375,665
1981	7,338	6,970	2,596	3,308	53,695	359,029	47,370	45,306	453,848	75,605	336,261	16,932	1,408,257
1982	9,114	59,741	12,441	25,648	492,345	14,435	10,494	1,249	5,607	2,029	136,279	11,081	780,462
1983	58,119	194,027	174,290	32,208	44,138	14,443	66,887	5,463	112,135	166,722	107,851	7,262	983,544
1984	53,545	18,277	9,605	15,364	11,704	12,643	7,496	3,778	858	145,393	7,794	10,683	297,140
1985	87,461	43,843	170,511	292,614	30,997	16,567	12,176	10,236	15,391	32,503	187,950	46,039	946,288
1986	4,940	7,440	2,232	10,020	11,633	150,747	8,886	6,021	19,410	40,640	6,696	178,408	447,074
1987	50,284	139,326	32,818	15,404	66,628	605,393	27,498	7,930	4,060	1,411	50,338	77,269	1,078,359
1988	8,173	2,594	8,161	23,059	12,858	9,133	9,167	665	79	926	438	1,315	76,568
1989	54,693	10,291	7,669	3,981	91,246	12,482	5,290	2,312	0	466	569	360	189,359
1990	940	2,049	15,993	43,290	29,288	3	8,489	2,578	1,567	10,866	373	22	115,461
1991	100,779	50,898	7,854	270,600	24,916	31,256	11,820	7,659	32,277	2,418	3,451	310,538	854,467
1992	315,642	871,672	121,346	403,571	439,631	223,154	12,332	8,375	8,861	7,359	27,434	48,914	2,488,290
1993	65,230	113,498	114,578	95,170	435,628	650,801	14,790	19,684	2,058	28,937	5,507	3,915	1,549,795
1994	7,428	2,053	8,776	37,884	194,514	65,803	7,993	18,028	16,262	1,089,161	11,695	95,316	1,554,915
1995	117,222	5,530	183,211	33,396	110,286	9,820	23,246	16,587	10,641	672	5,939	30,587	547,137
1996	6,396	3,644	6,893	8,777	12,805	7,221	8,823	11,914	80,516	1,464	5,859	7,492	161,805

Min	0	861	608	398	479	0	359	0	0	324	373	22	5,601
Max	315,642	871,672	294,379	464,292	521,031	940,768	566,553	121,054	453,848	1,089,161	680,767	397,181	2,488,290
Average	56,110	62,904	39,080	73,705	111,884	101,084	28,773	11,275	62,580	65,884	49,532	42,545	705,356

5%	816	906	974	1,119	1,071	27	390	19	74	430	389	356	20,924
10%	897	2,053	1,162	2,363	2,175	834	753	49	816	464	474	924	60,813
25%	3,541	6,659	6,324	7,206	12,254	5,440	5,304	1,321	2,174	1,756	2,348	2,945	215,294
Median	16,985	18,416	9,630	23,221	53,695	18,928	9,166	5,545	13,022	10,866	5,933	11,081	547,137
75%	67,882	61,895	26,575	96,323	162,459	97,331	15,609	15,862	38,284	54,395	44,743	49,149	1,024,964
90%	183,334	182,598	168,320	260,176	374,952	312,756	57,296	23,487	252,159	168,536	159,342	106,139	1,550,819

Table 3F-2e
Change in Flows Phase I to Phase II
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	0	0	0	0	0	0	-6,561	0	0	0	-4,200	-134	-10,895
1941	-633	-406	-388	-61	-496	-578	-1,395	-1,497	0	0	-2,545	-2,398	-10,397
1942	-888	-1,286	0	-1,183	0	0	-2,229	0	0	0	-2,785	0	-8,372
1943	123	0	-3,574	0	0	0	0	0	0	0	0	-3,309	-6,761
1944	-7,713	-651	-592	0	21	0	0	0	788	0	0	-2,257	-10,404
1945	0	-2,120	-2,398	-4,774	0	-2,321	0	0	0	0	0	0	-11,613
1946	0	0	-8,454	0	0	-3,767	0	-3,143	-598	-592	-592	-817	-17,962
1947	-408	0	-1,715	-1,488	9	-1,488	0	0	196	946	0	0	-3,947
1948	0	3,271	-2,292	481	-13	1,488	0	0	0	0	0	0	2,934
1949	0	0	-657	-19,278	0	0	0	0	-8,931	223	0	-3,515	-32,158
1950	-2,668	-733	0	0	0	0	800	0	0	0	0	0	-2,602
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	-7,292	0	0	0	-250	-78	0	-7,822	-15,442
1953	0	0	0	0	-13,185	0	0	0	0	0	0	-4,965	-18,150
1954	-296	-171	0	0	0	0	0	0	0	0	0	0	-467
1955	0	0	0	0	0	-10,218	0	0	0	0	0	0	-10,218
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	-12,508	-10,932	0	0	0	-8,887	-4,128	0	-36,455
1958	-5,991	-120	0	0	0	0	0	0	0	0	-532	-6,480	-13,124
1959	-1,537	-2,355	0	-1,515	-966	0	0	0	0	0	-6,400	-775	-13,549
1960	1,306	-1,762	0	0	0	-4,573	-1,497	-905	0	-536	-551	-265	-8,785
1961	-653	-631	-1,144	0	0	-2,942	-1,007	0	-2,433	0	-959	0	-9,769
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	-4,899	0	-1,051	0	0	0	0	0	0	0	0	0	-5,950
1964	0	0	0	0	0	0	-748	-69	0	-587	-20	0	-1,424
1965	-11,477	-15,594	-1,572	-685	-1,629	-1,273	0	0	0	0	-7,386	-2,760	-42,376
1966	0	-1,657	-1,529	-551	-721	-2,321	645	696	0	0	0	0	-5,438
1967	0	0	0	0	0	0	0	0	-96	-15,255	0	0	-15,351
1968	-3,432	-692	-960	0	-1,291	-292	-1,763	0	0	0	0	-1,536	-9,965
1969	-3,183	-802	-653	-449	-823	0	0	0	0	0	159	-149	-5,900
1970	-5,845	0	-569	0	-3,421	-1,538	0	0	0	-6,688	0	0	-18,060
1971	0	0	0	0	0	0	0	0	-13,354	-755	0	-1,303	-15,413
1972	0	-1,533	-1,205	0	-949	0	0	0	0	0	-233	150	-3,770
1973	0	-423	-8,442	-183	-1,375	-26	-1,629	-1,233	-742	491	-939	-230	-14,731
1974	-971	0	0	0	0	0	0	0	-8,182	0	-959	-633	-10,744
1975	-898	-733	0	0	-1,229	-946	-1,334	0	-774	-799	-774	-698	-8,184
1976	0	0	0	0	0	0	-938	-696	0	-1,393	-428	-1,339	-4,794
1977	-449	-794	0	-1,059	0	0	0	0	0	0	0	0	-2,302
1978	-4,980	-5,805	-2,398	-2,321	0	-2,321	0	0	-1,557	0	-1,349	-288	-21,017
1979	-734	-529	0	-959	-517	-1,232	-1,109	0	-2,606	0	0	0	-7,685
1980	-3,243	-774	0	0	-3,209	0	0	0	0	0	0	0	-7,225
1981	0	209	0	0	0	-13,621	-1,480	-39	-1,891	-142	-755	-878	-18,597
1982	0	-1,286	-980	0	-1,378	0	0	0	0	0	-8,140	0	-11,785
1983	-1,365	-508	-428	0	0	0	-4,701	0	-1,421	-1,703	-633	0	-10,760
1984	-1,309	0	0	0	0	0	0	0	0	0	-18	0	-1,327
1985	-111	-62	-16,028	-3,743	-1,537	-1,488	833	0	0	0	-3,726	180	-25,682
1986	0	0	0	0	523	-6,106	0	0	0	0	0	-5,135	-10,718
1987	-735	-59	-1,062	0	0	-1,258	-1,497	0	0	0	0	-3,316	-7,927
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	34	0	-32	0	0	2
1991	0	64	-89	-8,021	-1,537	-1,488	-1,342	0	0	-20	25	-17,386	-29,794
1992	-9,342	268	-694	-649	-2,278	-1,248	0	0	0	0	0	-3,366	-17,310
1993	-4,284	-529	-551	-858	-333	-721	-2,192	0	0	0	173	-112	-9,406
1994	0	0	-45	6	-12,400	0	0	0	0	-6,667	0	-287	-19,393
1995	-612	0	-1,342	-817	-619	-1,334	0	0	0	0	0	0	-4,724
1996	0	0	0	0	247	-216	0	645	0	-17	0	0	660

Min	-11,477	-15,594	-16,028	-19,278	-13,185	-13,621	-6,561	-3,143	-13,354	-15,255	-8,140	-17,386	-42,376
Max	1,306	3,271	0	481	523	1,488	833	696	788	946	173	180	2,934
Average	-1,355	-670	-1,067	-844	-1,209	-1,276	-511	-109	-734	-745	-837	-1,260	-10,618

5%	-7,876	-2,700	-8,443	-5,099	-12,411	-10,289	-2,477	-1,259	-8,257	-6,908	-6,499	-6,615	-32,587
10%	-5,153	-1,678	-2,398	-1,676	-3,251	-3,928	-1,655	-195	-1,999	-1,455	-3,806	-3,805	-21,950
25%	-1,337	-712	-1,057	-600	-1,097	-1,411	-972	0	0	-26	-694	-1,321	-15,382
Median	0	0	0	0	0	0	0	0	0	0	0	0	-9,769
75%	0	0	0	0	0	0	0	0	0	0	0	0	-3,858
90%	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3F-2f
Change in Flows Baseline to Phase II
Mouth Outflows

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	1,053	-1,790	2,051	1,020	1,855	2,994	-2,039	1,154	1,246	5,714	-2,179	-214	10,865
1941	403	-344	768	131	792	292	1,582	1,600	2,236	2,076	-1,951	1,179	8,764
1942	2,541	1,931	1,520	-2,842	782	1,311	-2,855	1,281	-5,523	-783	-206	2,222	-623
1943	6,123	3,241	-2,331	1,732	767	-1,070	-301	1,196	1,300	1,327	7,980	5,971	25,936
1944	-9,621	96	1,636	2,300	-1,325	3,553	730	2,511	6,085	1,361	-770	1,886	8,444
1945	-42	-2,497	-1,715	-2,923	2,853	2,479	704	1,819	1,140	897	1,272	2,177	6,166
1946	3,327	6,070	-8,931	-639	-2,807	205	3,904	-2,401	-74	1,009	599	534	796
1947	113	1,995	-247	-5,413	-10,839	1,225	701	6,341	1,056	1,066	1,347	2,212	-442
1948	2,306	13,929	4,215	2,206	-10,483	2,674	764	286	894	106	155	572	17,625
1949	619	10,293	1,705	-2,828	-2,531	1,188	2,205	1,306	1,387	4,811	1,400	-2,610	16,946
1950	-1,525	247	2,672	3,972	4,239	2,008	481	4	428	106	120	562	13,312
1951	554	525	729	699	349	2,661	28	0	7,709	1,397	156	575	15,380
1952	546	1,923	704	3,198	17,653	-4,395	448	622	656	95	8,009	1,136	30,594
1953	2,069	1,405	1,932	1,677	-12,067	430	440	3,352	2,556	1,325	1,061	667	4,845
1954	559	512	639	1,699	1,667	3	22	3	319	43	39	13	5,518
1955	514	21,555	638	713	3,025	-14	34	2,646	1,545	331	62	201	31,247
1956	244	635	296	37	117	0	252	0	1	9	40	645	2,276
1957	0	1,930	22,082	18,263	-15,051	-8,703	167	2	7,868	-9,404	-4,139	1,702	14,718
1958	-6,295	-479	-636	3,939	3,058	505	2,255	432	5,418	-5,125	364	-2,460	975
1959	1,156	-3,845	4,159	-1,542	-8,474	2,970	2,089	1,436	14,274	-4,831	-3,321	-206	3,867
1960	1,956	723	2,026	-206	3,359	-3,833	1,462	755	3,756	-3,922	665	-272	6,469
1961	681	1,191	796	3,383	5,149	-5,376	615	2,741	548	657	-257	1,213	11,340
1962	2,205	3,568	1,961	-14,461	1,830	-8,184	8,348	712	7,543	1,369	1,289	2,211	8,391
1963	2,326	-4,731	1,961	1,356	6,336	507	2,393	5	274	110	277	2,222	13,037
1964	629	2,211	2,182	901	696	2,055	-355	645	7,921	873	173	574	18,505
1965	7,548	-17,138	2,380	3,183	-5,139	-9,237	1,746	1,410	1,297	1,709	7,704	-3,862	-8,399
1966	575	-2,318	761	551	196	51	2,953	2,039	1,426	758	1,078	588	8,659
1967	603	534	671	1,831	1,648	39	50	939	17,291	-15,254	-1,470	2,699	9,581
1968	-4,108	129	1,221	-4,825	5,543	666	2,073	2,694	-499	1,639	1,418	-100	5,851
1969	-1,981	-598	1,042	833	783	5,085	642	1,070	874	7,574	1,497	-3,741	13,081
1970	-4,825	-452	2,004	2,784	-4,229	-9,899	2,400	2,032	7,176	1,573	1,370	2,113	2,047
1971	1,646	2,048	1,924	1,413	780	1,181	391	5,220	-8,776	1,035	-26	716	7,553
1972	1,584	-689	1,826	3,492	-2,410	4,416	2,229	-126	1,446	1,402	1,140	1,943	16,253
1973	1,856	1,111	-10,018	1,376	-9,487	9,914	1,684	862	102	-1,001	979	1,786	-835
1974	-899	2,948	262	2,740	-6,985	-12,724	1,498	16,255	2,806	1,458	-958	279	6,681
1975	318	219	4,238	-9,918	4,338	388	1,255	2,145	1,289	1,546	1,351	784	7,954
1976	1,980	1,846	1,968	-9,046	-16,858	-9,037	17,128	1,078	1,335	-12,162	19,721	300	-1,747
1977	-554	1,052	-1,168	2,249	-2,968	-6,495	1,553	1,659	2,749	1,327	7,764	1,943	9,111
1978	1,793	-5,384	1,334	-7,732	1,800	1,773	819	644	7,324	4,191	-2,360	3,339	7,540
1979	-1,919	316	2,367	-1,148	572	-9,262	2,427	2,677	7,167	1,327	1,334	1,679	7,539
1980	-1,527	352	4,025	3,797	-12,102	2,301	605	654	1,336	1,831	1,294	1,703	4,269
1981	1,942	1,624	2,047	2,221	2,697	-7,897	1,499	1,081	1,825	-515	1,903	675	9,102
1982	2,409	-2,294	14	3,412	-80	2,310	2,259	1,054	1,315	1,451	-601	-2,650	8,599
1983	2,753	505	696	4,102	-12,505	4,035	6,346	-1,484	6,415	-343	558	3,047	14,125
1984	-3,015	2,893	750	3,074	3,227	2,825	-741	554	532	21,310	832	1,632	33,874
1985	1,760	-7,473	-15,292	-2,110	-6,742	-101	-1,054	792	1,479	1,860	5,288	1,610	-19,982
1986	2,744	2,908	1,886	1,258	1,685	-7,474	694	407	1,555	2,070	1,846	-4,785	4,795
1987	95	-811	1,540	3,321	1,865	-5,018	1,431	2,702	1,261	1,247	4,877	-3,425	9,084
1988	2,738	2,215	2,314	2,012	1,772	1,317	866	196	69	320	100	749	14,668
1989	11,647	1,992	2,063	750	4,109	1,344	92	33	0	79	156	199	22,465
1990	571	1,055	3,056	2,508	2,056	0	149	39	968	71	41	0	10,514
1991	23,449	10,503	2,153	-11,293	-3,952	1,758	-1,377	105	1,795	665	1,220	-10,083	14,943
1992	-8,725	1,798	1,079	1,593	-1,996	1,051	3,753	2,112	1,346	1,364	2,456	-2,126	3,705
1993	-2,845	181	710	1,265	471	2,383	2,920	2,924	1,218	1,770	1,303	2,655	14,955
1994	2,022	1,703	2,598	2,306	-9,069	1,345	574	1,086	1,547	5,167	2,984	-2,764	9,498
1995	319	-2,155	3,481	-8,528	8,450	-9,235	8,650	1,973	1,136	603	1,500	3,102	9,296
1996	1,024	917	1,322	795	455	2,303	666	3,308	8,346	-903	1,464	1,320	21,017

Min	-9,621	-17,138	-15,292	-14,461	-16,858	-12,724	-2,855	-2,401	-8,776	-15,254	-4,139	-10,083	-19,982
Max	23,449	21,555	22,082	18,263	17,653	9,914	17,128	16,255	17,291	21,310	19,721	5,971	33,874
Average	937	1,050	1,159	257	-1,072	-779	1,583	1,519	2,556	628	1,403	422	9,662

5%	-6,538	-5,593	-9,039	-10,055	-12,759	-9,326	-1,443	-262	-1,002	-9,680	-2,456	-3,954	-2,412
10%	-3,233	-2,766	-1,277	-7,891	-11,084	-9,077	-433	2	1	-4,104	-1,566	-2,896	-478
25%	-21	-465	683	-893	-4,090	-4,114	209	347	765	75	40	-50	4,820
Median	619	723	1,540	1,356	696	507	764	1,078	1,336	1,035	979	675	8,764
75%	2,045	1,994	2,108	2,624	2,376	2,302	2,217	2,075	3,281	1,559	1,441	1,914	14,693
90%	2,868	4,068	3,590	3,553	4,500	3,106	3,783	3,001	7,741	4,315	5,771	2,664	21,307

APPENDIX 3G
Water Conservation Plan

LAVACA-NAVIDAD RIVER AUTHORITY

WATER CONSERVATION PLAN

APRIL 2019

LAVACA-NAVIDAD RIVER AUTHORITY

WATER CONSERVATION PLAN

APRIL 2019

PLAN OVERVIEW

1.0 INTRODUCTION

The Lavaca-Navidad River Authority (LNRA) is a conservation and reclamation district of the State of Texas, created in August 1959. LNRA is a body politic and corporate created and existing pursuant to Article XVI, Section 59 of the Texas Constitution and a series of acts formerly compiled as Article 8280-131, Vernon's Annotated Texas Civil Statutes (the "Act"), and is authorized and empowered under the Texas Constitution and the Act for the purposes of controlling, storing, preserving, and distributing the waters of the storm and flood waters and the waters of rivers and streams of Jackson County, Texas, for domestic, municipal, flood control, irrigation, agricultural, mining and recovery of minerals, hydroelectric power, navigation, recreation and pleasure, public parks, game preserves, and other useful purposes. LNRA is the only wholesale water provider in the Lavaca Basin. Protecting and improving the quality of the available water resources of the Lavaca River Basin for beneficial use by the public is also an important function of LNRA.

As shown in Figure 1, the boundaries of LNRA are coextensive with the boundaries of Jackson County, Texas

2.0 BASIN POPULATION

The Texas Water Development Board's (TWDB) 2011 Regional Water Plan Population Projections for 2000-2060 for Region P show an estimated population of 49,491 in year 2010 and an estimated population of 49,663 in year 2060. Population centers in the Lavaca River Basin include the Cities of Edna, Ganado, Hallettsville, Yoakum, Shiner, Schulenburg, and Moulton. See Table 1 showing population projections as collected as part of the Region P's efforts.

Although not located within the geographical boundary of the Lavaca River Basin, the City of Corpus Christi and Point Comfort are LNRA customers and receive water from Lake Texana. The City of Corpus Christi serves a seven (7) county area owned by the City.

3.0 CURRENT WATER USES

Lake Texana, with a conservation storage capacity of approximately 163,506 acre-feet, is the only major surface water reservoir in the Lavaca River Basin. The LNRA holds a water rights permit from the Texas Commission on Environmental Quality (TCEQ), which provides for a 74,500 acre-feet per year firm yield for Lake Texana and up to 12,000 acre-feet per year of interruptible water available for sale/use. In accordance with Certificates of Adjudication 16-2095E, the purposes for which this water is permitted are all beneficial uses. Other permit holders in the Lavaca River Basin have run-of-the-river rights and are permitted to divert up to approximately 63,000 acre-feet of stream flows annually for irrigation purposes. These rights are issued directly from TCEQ and are not administered through LNRA.

Historical record of water use in the Lavaca River Basin indicates the majority of water usage is for agricultural use, primarily irrigation. Irrigation water supplies within the Lavaca River Basin include groundwater, water rights permits from the Navidad and Lavaca Rivers, and water delivered from the Colorado River by the Lower Colorado River Authority's Garwood Irrigation District as irrigation water. Municipal and industrial water users in the Lavaca River Basin, not supplied by the LNRA, utilize groundwater as their primary water supply. See Table 2 showing projected water use in the Lavaca River Basin.

3.1 Municipal Water Use

Municipal water users include residences, commercial establishments, public offices, industries and institutions as defined by the rules of the TCEQ. As of 2019, the LNRA has raw water supply contracts with two municipal water customers, the City of Point Comfort (178 ac-ft/yr.) and the City of Corpus Christi (31,440 ac-ft/yr. Firm; 5,000 ac-ft/yr. Temporary; and 12,000 ac-ft/yr. interruptible).

The LNRA contracted with the City of Point Comfort in December 1994, to provide and deliver 168 acre-feet of raw water per year, which was amended in October 1996, for a total contracted diversion from Lake Texana of 178 acre- feet per year. In October 2001, Formosa Plastics Corporation changed the delivery point of 178 acre-feet per year from Formosa to the City of Point Comfort giving the City a total of 356 acre-feet per year available for treatment. Deliveries of treated water to Point Comfort residences, businesses and industry began in February 1995. The City of Point Comfort assumed operations of the treatment plant on December14, 2012.

In December 1993, the LNRA contracted with the City of Corpus Christi (the "CCC") to provide and deliver 31,440 acre-feet per year of raw water on a permanent basis for their ten-county service area and 10,400 acre-feet per year on a temporary basis until such water is needed to supply demand in Jackson County. As part of the delivery system project, the LNRA constructed an intake pumping station near Edna, which it owns and operates, adjacent to Lake Texana. In July 2001, LNRA contracted with the CCC to provide up to 4,500 ac-ft/yr of water for use on an interruptible basis. In July 2003, the contract was amended to increase the interruptible water amount up to 12,000 ac-ft/yr. The CCC currently obtains raw water from Choke Canyon Reservoir, Lake Corpus Christi, and Lake Texana (firm and interruptible supplies). The CCC uses the interruptible supply from Lake Texana first when possible, in increments as available. This interruptible supply is available approximately 87% of the time. The CCC serves a significant industrial demand along its port area, and the scarcity of water available to the CCC in past years has driven these industries to a high level of conservation for them to continue to operate during periods of shortage. The CCC also encourages the use of reclaimed water but has not promoted this effort as aggressively as other cities because of return flow requirements to the Nueces River Estuary included in the Certificate of Adjudication issued for the construction of the Choke Canyon Dam and Reservoir. On January 7, 1999, the CCC finalized its purchase of 35,000 acre-feet/year of water from the Garwood Irrigation Company by obtaining a water right authorizing the CCC to divert the water from the Colorado River. In April, 2014 the CCC started construction of a pumping plant at Bay City on the Colorado River along with a 41 mile pipeline (Mary Rhodes Phase II) from Bay City to the West Pump Station (WPS) at LNRA. They also constructed a 6,000 MG storage tank at the WPS. On May 25, 2016 the CCC started pumping water from the Colorado River to the WPS where it enters the West Delivery Pumping Plant which sends the water on to the CCC via the existing Mary Rhodes Phase I pipeline.

In 2018, LNRA recalled 5,400 acre-feet of water from CCC. Currently LNRA is contracted with the CCC to provide and deliver 31,440 acre-feet per year of raw water on a permanent basis for their ten-county service area and 5,000 acre-feet per year on a temporary basis until such water is needed to supply demand in Jackson County.

3.2 Industrial Water Use

Industrial water uses include chemical processing, manufacturing and steam electric power generation as defined by the rules of the TCEQ. Currently, LNRA has raw water supply contracts with three industrial water customers, Formosa Plastics Corporation (30,800 ac-ft/yr.), Inteplast Corporation (1,032 ac-ft/yr.), and Calhoun County Navigation District (594 ac-ft/yr.).

In May 1980, the LNRA contracted with Formosa Plastics Corporation to provide and deliver 5,000 acre-feet of water annually. The contract also called for the construction of a 15 mile, 36-inch pipeline and associated pumping plant. In April 1990, the LNRA again contracted with Formosa Plastics Corporation, for the construction of a 54-inch pipeline and together with the existing 36-inch pipeline, LNRA has the capacity to provide and deliver to Formosa Plastic Corporation 30,800 acre-feet of water annually. In July 2007, the contract was amended adding an additional 800 acre-feet of water bring the total volume to 30,800 acre-feet. Formosa Plastics was using approximately 80% percent of its contract allocation of 30,800 acre-feet per year. Formosa has implemented a highly successful program of water conservation through water reuse. Plant process water at Formosa Plastics is reused until the Total Dissolved Solids (TDS) concentration exceeds the plant process requirements. At this point, the process water is treated and discharged; and additional makeup water is introduced into the recycle stream. This has been highly successful for them, for instance, in 2017, Formosa used approximately 71.63% of its contract allocation of 30,800 acre-feet per year while increasing water use within the plant. In 2018, LNRA recalled 5,400 acre-feet of water from CCC and on January 11, 2018 sold this water to Formosa Plastics Corporation for use in their expansion plant currently under construction in Jackson County. Currently LNRA is contracted with Formosa Plastics Corporation to provide and deliver 36,022 acre-feet of water.

In October 1992, the LNRA contracted with Inteplast Corporation to provide and deliver 2000 acre-feet of water annually, which was reduced to 1,832 acre-feet annually in October 1994 and reduced a second time in July 2007 to the present volume of 1032 acre-feet. Inteplast Corporation also has a significant water reuse program. Like other industrial customers, process water is recycled and reused by Inteplast until the TDS concentration increases to an unacceptable level for process use and it becomes more cost effective to clean and discharge the waste stream.

In May 1995, the LNRA contracted with the Calhoun County Navigation District (CCND) for the purchase of 410 acre-feet annually, which was amended to 594 acre-feet annually in August 1996.

CCND are not utilizing their contracted industrial water allocations and does not have a water delivery system constructed from Lake Texana. As a result, there is no existing water conservation plan for CCND and will only be required by LNRA when they begin taking their contract water.

In September 1996, the LNRA contracted with the Central Power and Light Company for the purchase of 56 acre-feet of water annually. In February 2005, the contract was terminated with the sale of the plant and cancellation of the water supply contract by the new owner. LNRA therefore has 56 acre-feet of firm water available for sale and use.

Currently, there is no demand for electric power generation water supply in the Lavaca River Basin.

3.3 Irrigation Water Use

The Lavaca River Basin is primarily a rural area having a large agricultural base. Total irrigation water usage of the agricultural industry for year 2010 has been projected as 217,846 acre-feet and is assumed to carry throughout the planning horizon. Major irrigated crops include rice, cotton, corn, milo, soybeans and turf grass. The primary irrigated crop in the basin is rice, using approximately 224,500 acre-feet of water annually, with approximately 90% percent being produced from groundwater sources.

3.4 Other Water Uses

Mining and livestock uses account for approximately 5,000 acre-feet of water annually, accounting for approximately two percent of the annual water use in the Lavaca River Basin.

4.0 WATER USES BY LNRA CUSTOMERS

Except for 56 acre-feet of water which is available for sale and use, all the permitted water of Lake Texana is under contract. LNRA has water supply contracts with the City of Corpus Christi (31,440 acre-feet/year on a permanent basis and 5,000 acre-feet/year on a temporary basis), Formosa Plastics Corporation (36,200 acre-feet/year), Inteplast Corporation (1,032 acre-feet/year), the Calhoun County Navigation District (594 acre-feet/year), and the City of Point Comfort (178 acre-feet/year) totaling 74,444 acre-feet per year. The remaining 4,500 acre-feet per year yield is reserved to cover the mandated releases for bay and estuarine needs. However, in those years when a surplus of water exists and all bay and estuary requirements are satisfied, an additional diversion up to 4,500 acre-feet per year may be available for sale on an interruptible basis. As indicated above, LNRA and the City of Corpus Christi have entered into a contract wherein LNRA will sell and make available to Corpus Christi, up to 12,000 acre-feet of water per year, for use by the City of Corpus Christi on an interruptible basis. The CCC can also use 35,000 acre-feet per year from the Colorado River as available.

5.0 CURRENT WATER SUPPLY

The primary surface water supplies in the Lavaca River Basin are the Lavaca River, the Navidad River, and Lake Texana. Currently, Lake Texana, located on the Navidad River, is the main surface water supply for LNRA. Lake Texana was designed to ensure that a dependable water supply existed to support water requirements inherent with industrial and urban growth in the coastal region. LNRA's water right permit also allows from a second impoundment on the Lavaca River. LNRA is currently pursuing an alternative approach to the authorized on demand impoundment on the Lavaca River to instead allow the water to be pumped into Lake Texana and/or an Off-Channel Reservoir.

To better manage the water resources of the area, the LNRA has developed an updated *Water Resource Management Plan* for Lake Texana and LNRA's water rights on the Lavaca River to establish policies and guidelines for water resource management. This Water Conservation Plan and LNRA's Drought Contingency Plan have been made a part of the LNRA's *Water Resource Management Plan* as an appendix.

Groundwater supplies in the Lavaca River Basin are produced from the Carrizo and Gulf Coast Aquifers. The Gulf Coast Aquifer is the predominant groundwater source in the LNRA area, supplying more than 95% percent of the total water usage in the region. The largest single use of groundwater in the area is for irrigation purposes.

Currently, the Lavaca River Basin water supply is adequate for a variety of consumptive uses; however, water conservation is necessary to extend the usability of the existing supply.

6.0 OVERVIEW

Consistent with TCEQ regulations, all LNRA water customers are required by their respective water sales contract to prepare and submit Water Conservation and Drought Contingency Plans to the TCEQ. The LNRA recommends that its customers develop plans consistent with the LNRA Water Conservation Plan and trigger conditions as established in the LNRA Drought Contingency Plan.

The LNRA Water Conservation Plan provides its customers and communities with essential water conservation information, regulations and services. The plan will be reviewed every five years or less and updated based upon developments in the Lavaca River Basin and the LNRA service area.

The following sections discuss water conservation programs for LNRA water customers, the operation of Lake Texana, the LNRA Water Management Plan, and the LNRA Drought Contingency Plan.

Table 1: Population Projections for Region P
Source: Texas Water Development Board 2012 Regional Water Plan Population Projection for 2010-2060 Region P

WATER USER GROUP	COUNTY NAME	P2010	P2020	P2030	P2040	P2050	P2060	Region Split Pop. 2)	County Split Pop. 3)
COUNTY-OTHER	JACKSON	7,029	7,491	7,778	7,943	8,006	8,008		
EDNA	JACKSON	6,331	6,773	7,048	7,206	7,266	7,267		
GANADO	JACKSON	2,081	2,251	2,357	2,418	2,441	2,441		
	JACKSON Total	15,441	16,515	17,183	17,567	17,713	17,716		
COUNTY-OTHER	LAVACA	10,012	10,002	9,728	9,244	8,684	8,041		
HALLETTS-VILLE	LAVACA	2,289	2,287	2,224	2,114	1,985	1,839		
MOULTON	LAVACA	921	920	895	851	799	740		
SHINER	LAVACA	2,020	2,018	1,963	1,866	1,753	1,623		
YOAKUM	LAVACA	3,508	3,504	3,409	3,239	3,043	2,818	P	P
	LAVACA Total	18,750	18,731	18,219	17,314	16,264	15,061		
COUNTY-OTHER	WHARTON	3,725	3,937	4,074	4,153	4,155	4,111	P	
EL CAMPO	WHARTON	11,575	12,236	12,662	12,906	12,912	12,775		
	WHARTON Total	15,300	16,173	16,736	17,059	17,067	16,886	P	
	REGION P TOTAL	49,491	51,419	52,138	51,940	51,044	49,663		

1) The year 2012 population for cities and county totals are from the 2010 Census. For utilities, TWDB staff estimated the population served by the utility in 2000. Some of the 2012 population estimates for utilities were revised by the Regional Water Planning Groups. The County-Other population was derived by summing all of the city and utility population within a county and subtracting it from the county total population.

2) If "P" is present in this column, the Water User Group (WUG) is located in more than one Region and the projections listed in the row represent only the WUG's population projections within that particular Region, not the WUG's total population projections. If the "P" is present for a county total entry, then the county has been split by Regional boundaries and the projections listed in the row represent only the county's populations within the particular Region, not the county's total population projections.

3) If "P" is present in this column, the Water User Group (WUG) is located in more than one county and the projections listed in the row represent only the WUG's population projections within that particular county, not the WUG's total population projections.

Table 2: Projected Water Use for Region P

Water Use Category	D2010	D2020	D2030	D2040	D2050	D2060
Municipal*	7,215	7,305	7,258	7,115	6,989	6,892
Manufacturing	1,089	1,162	1,223	1,281	1,331	1,425
Mining	164	172	177	182	188	192
Steam-Electric	0	0	0	0	0	0
Livestock	3,499	3,499	3,499	3,499	3,499	3,499
Irrigation	217,846	217,846	217,846	217,846	217,846	217,846
Region P Subtotal	229,813	229,984	230,003	229,923	229,853	229,854
Bays and Estuaries (Lake Texana)	4,500	4,500	4,500	4,500	4,500	4,500
Region P Total	**234,313**	**234,484**	**234,503**	**234,423**	**234,353**	**234,354**

* Municipal figures include County-Other water demands based on population projections. Below normal rainfall with expected conservation is the primary water use scenario.

WATER CONSERVATION PLAN

1.0 INTRODUCTION

The objective of the Water Conservation Plan is to produce a permanent reduction in the quantity of water required through the implementation of efficient water supply and water use practices, and not elimination of use.

2.0 WATER CONSERVATION GOALS

The Water Conservation Plan for the Lavaca River Basin is consistent with LNRA's goals for water conservation and resource management. LNRA will provide technical assistance for water conservation and drought management for both municipal and industrial water users in the Lavaca River Basin.

The LNRA has both municipal and industrial water conservation target goals for their wholesale customers where appropriate which include:

1. Per capita water use of 150 gpcd for the year 2020 for its service area and maintain this through 2025. The basis for this goal is the projected per capita water demands developed by the TWDB for the most current State Water Plan. The per capita water demands are the total projected municipal water use within LNRA service area divided by the population within the service area and do not represent per capita water demand for a specific entity.

2. Limiting unaccounted-for-water from the customer's water distribution systems to no more than 15 percent of the volume of water delivered for the year 2020 and maintains unaccounted-for-water at no more than 15% through the year 2025.

3. Limiting unaccounted-for-water from the LNRA's water delivery systems to no more than 10 percent of the volume of water delivered to their wholesale customers for the year 2020 and maintain unaccounted-for-water at no more than 10% through the year 2025.

4. Reducing industrial water consumption 20% through the implementation and increased use of wastewater reuse/recycle programs for the year 2020 and maintain such reduction through the year 2025.

5. Providing all wholesale customers advice and assistance in preparing their individual Water Conservation Plans (the LNRA will review, comment, and provide sources of useful information).

6. Assisting the Region P Regional Water Planning Group in completing/implementing the Lavaca Regional Water Plan.

7. Pass-through water conservation goals, including where appropriate, target per capita water use, maximum acceptable unaccounted-for-water and a time frame for achieving these

goals and specific quantifiable 5-year and 10-year goals, will be required as a part of each wholesale water customer's contract with the LNRA upon modification or extension.

2.1 Water Conservation Methods

The LNRA does not own or control any of the internal distributions systems of its wholesale water customers; therefore, the LNRA cannot mandate customer conservation methods. Each wholesale customer employs Best Management Practices (BMPs) to ensure the maximum economic benefit will be realized for their business and/or individual retail water customers. The LNRA does lend its full support to its customers in their conservation plans and has included the methods listed in those plans for achieving conservation goals.

Methods to be employed for achieving the customer's stated water conservation goals include leak detection and repair programs, plumbing and landscape ordinances, public education programs, cost-based water rate structures, and reuse/recycling of wastewater and greywater.

2.2 Unaccounted-for-Water

Measures to determine and control unaccounted-for-water should include:

1. Metering water from fire hydrants used for construction purposes on a temporary basis.

2. The Fire Department should report to the Water Department estimated flow times from fire hydrants either during fires or as part of the hydrants testing program.

3. Water Department crews should provide timely responses to leaks and estimate the volume of water lost.

4. Water Department crews should estimate the volume of water discharged as part of a main-flushing program.

5. When retail water accounts are closed, water service is currently turned off at the meter. If it is anticipated that the building will be vacant for an extended period or if there is evidence of unauthorized water use, the meter should be removed.

2.3 Plumbing and Landscape Ordinances

Plumbing and landscape ordinances that promote water conservation should be implemented. Examples include:

1. Requiring water saving plumbing fixtures for all new construction.

2. Requiring the use of drip irrigation systems in certain circumstances, such as any irrigation system designed to irrigate vegetation located within the following areas - in the right-of-way (ROW) between the curb and sidewalk; within five feet of the paved surface of the ROW where there is no sidewalk; narrow strips of vegetation less than five feet wide

between the sidewalk or curb and the parking lot; narrow strips of vegetation less than five feet wide within a parking lot; any median or traffic island which is less than five feet wide.

3. Requiring the use of Xeriscaping and drought tolerant plant species in commercial development landscaping.

2.4 Leak Detection and Repairs

Aggressive leak detection and repair programs should be implemented for all water distribution systems. Citizens as well as city employees from other departments should be encouraged to promptly report any leaks. City personnel such as meter readers, solid waste collectors, and street maintenance workers, as well as those from other utility departments (Wastewater, Gas, and Stormwater) that routinely travel throughout a city make the most effective leak detectors. A 24-hour, 365-day dispatching service should be provided to assure rapid response, as well as work crews that are devoted exclusively to repairing leaks. Crews normally assigned to construction of new water mains can, in emergency situations, augment these crews. The leak repair crews should be on duty for two daily eight-hour shifts. The remaining eight hours should have a crew that is on pager call to respond. The city's goal should be to respond to any leak within four hours of it being reported. In order to maintain the integrity of the distribution system, the city should also budget for water main replacement. The operating budget should provide for replacing lines that have a high leak incidence or are the very oldest lines. The capital improvements budget should provide for system replacements and upgrades associated with other improvements such as major street reconstruction projects.

2.5 Education Programs

Educational programs should be implemented to inform retail water customers of the need to conserve water and the available methods for attaining this goal. The three basic components of an educational program are media campaigns, school programs, and public exhibitions. Media campaigns include local TV and radio stations advertisements; handouts mailed to provide information on water conservation issues, such as Xeriscape and simple water conserving tips; printed newspaper and billboard advertisements. Establish a telephone Water Hotline to encourage public access to water conservation information. Customers can utilize a dedicated telephone line to request water conservation kits and other information. Establish school programs to teach children water conservation concepts through various school-related activities. School programs target young water consumers who will hopefully retain a water-use ethic into their adult life. Children also have direct contact with their parents and may have a better opportunity to influence their behavior than traditional advertising campaigns. The City of Corpus Christi currently has the following school programs implemented – "Major Rivers Educational Program", "Water Conservation Fair; Xeriscape – A Water Wise Educational Program", "Toilet Training – It's Not Just for Kids", "Learning to be Water Wise", "The Water Source Book", water-conservation school book covers, and the "Teacher Outreach – Super Saturday workshop". Public Water Conservation Exhibitions should include information booths set up by the city's water conservation department at various public events throughout the year. Staff distributes practical literature on learning to read water meters, xeriscape planning, rainwater harvesting, and other water conservation issues; toilet retrofit kits and low-flow showerheads; and, promotional items such as stickers, beach balls, etc. at these events. Other exhibitions could include the establishment of an educational garden and learning center that teaches the seven principles of Xeriscape and beneficial horticulture practices.

2.6 Conservation-Oriented Water Rate Structures

Conservation-oriented water rate structures should be implemented by the LNRA's wholesale customers for serving their retail customers. There are many ways to design this type of rate structure; however, a common rate scheme has a two-part approach consisting of:

1. A monthly minimum customer charge based on customer class and meter size; and

2. A volume charge based on water usage above the minimum base amount.

2.7 Reclaimed Wastewater Programs

Reclaimed wastewater programs can be established for both municipal and industrial discharges. Municipal water and wastewater treatment plants as well as industrial process plants are well suited to incorporate reclaimed water technology. Currently, two of the LNRA's industrial wholesale customers, Formosa Plastics and Inteplast Corporation, have implemented major water reuse/recycle programs. Formosa Plastics is meeting approximately 30 percent of its current demand with reclaimed process water. The City of Corpus Christi has prepared a long-range plan for reusing effluent from its six wastewater treatment plants within their treatment processes as well as to irrigate the plants' on-site landscaping. This reclaimed water is also used to irrigate golf courses, ballpark complexes, the city landfill, etc. During drought conditions, the City has made reclaimed wastewater effluent available to other water users free of charge. Distribution sites at the treatment plants are established to allow homeowners the opportunity for obtaining treated wastewater for private use. Training and instructions are provided to ensure safe use and handling of the treated wastewater. Few owners take advantage of this service, however, primarily due to the cost of transporting the effluent. It must be noted, however, that the widespread reuse of effluent in the CCC service area is subject to the return flow limitations in the existing Nueces River watershed, so the majority of the reuse must take place with water obtained from the LNRA.

3.0 WATER MEASUREMENT AND ACCOUNTING

LNRA deliveries are made through the LNRA East and West Water Delivery Systems; the East System consists of a 36-inch pipeline and a 54-inch pipeline with the related pumping and metering facilities. Deliveries to the City of Corpus Christi are made from the West Water Delivery System. The West System consists of a 64-inch pipeline with the related pumping and metering facilities. The same procedures are employed to maintain an accounting and leak detection program for water delivered to both the East and West Systems.

The LNRA meters water deliveries at the point of diversion near the Lake Texana spillway, and at the delivery points (Formosa Plastics Corporation, Formosa Plastics Corporation Expansion Plant, Inteplast Incorporated, and the Cities of Point Comfort and Corpus Christi) by time of travel flow meters. These flow meters vary in size from 14 inch to 64 inch. A manifold system for the 36-

inch and 54-inch pipelines provides the connection between the two pipelines. The manifold system is supplied from Lake Texana by three vertical pumps located at the East Water Delivery System stilling well. Each pump is powered by a 300 horsepower electric motor, and together is capable of providing 36,000 gallons/minute to LNRA customers. The East Pumping Plant has the capacity for four pumps which could provide 56,000 gpm.

The West Water Delivery System consists of a single 64 inch, 102-mile pipeline originating at Lake Texana and terminating at the City of Corpus Christi's O.N. Stevens Water Treatment Plant. The conveyance system includes an intake pump station owned by LNRA and two intermediate booster pump stations located at Bloomington and Woodsboro. The intake pump station is currently fitted with six vertical turbine pumps powered by 2 - 820 Hp and 4 - 1250 Hp electric motors. LNRA also owns a chemical injection facility capable of dosing the system for bio-growth, including algae and fresh water mussels. The booster pump stations are fitted with 4 horizontal pumps powered by 4 - 1000 Hp electric motors. The combined capacity of the current system is 55,000 gpm. The ultimate capacity of the delivery system is designed at 72,000 gpm.

The Mary Rhodes Phase II (MRP II) delivery system consists of a single 54 inch, 41-mile pipeline originating at the Bay City Pump Station and terminating at a 6,000-gallon storage tank at LNRA. The conveyance system includes an intake structure, river pump station, sedimentation basins, and a booster pump station. The MRP II system ties in to the Mary Rhodes Phase I pipeline at the existing West Delivery Pump Station at LNRA. The MRP II project is a recommended water management strategy identified in the State Water Plan and the Region N Water Plan for meeting the water needs of the Coastal Bend Region. Corpus Christi takes a long-term approach to water planning and has an excellent record of maximizing the use of its existing water supplies and implementing conservation measures.

4.0 MONITORING AND RECORDS MANAGEMENT

The East Delivery systems flow meters are monitored by radio telemetry which consists of a master control station PLC and remote station PLC's located at each point of delivery. These remote station PLC's transmit data to the master control station PLC, which is interfaced with the LNRA computer system for storage of water delivery records. The master PLC is used to assimilate the transmitted information and control the operation of the water delivery system based on predetermined set points for maintaining the water levels in the receiving ponds. The computer system is comprised of one computer workstation which utilizes a Windows operating system and runs SCADA/database software which handles the reporting.

The West Delivery System is operated in much the same way. First flow meters measure the water. Then the information is stored in PLC's for local processing/control and also stored in a database at the main headquarters for records. This system in not based on radio's but a TCP/IP infrastructure. Overall there are 7 workstations in the West Delivery system and 3 servers. Two servers are for SCADA and one for records/data. All workstations and servers use a Windows based operating system.

Operation and documentation of water deliveries are monitored using computer programs, which generate both daily and monthly water delivery reports. Daily reports include the water quantity initiated at the point of diversion, and the quantity of water distributed to each delivery point. Additionally, the daily reports provide percent meter error information for the day, month, and year. The maximum acceptable unaccounted-for water determined by metering equipment is based on the accuracy of the equipment, which is plus or minus two percent. LNRA calibrates meters on a monthly basis to insure accountability of water. Monthly reports include the amount of water delivered to each delivery point during the month and the year to date totals. Appendix B includes examples of LNRA water delivery accounting reports.

5.0 DELIVERY SYSTEM AUDITING AND LEAK DETECTION

Leak detection of the LNRA water delivery system is monitored by three methods. The first method is by accounting for the amount of water passing the point of diversion against the amount of water being delivered to each delivery point. The second method is to monitor the system when there is no demand for water at the points of delivery to determine if there are losses in the system. The control center computer will also indicate if there is an improper valve closure in the system. The third method is periodic visual inspections of the entire distribution system.

Repairs and down times are minimized for the distribution system by implementation of proper maintenance programs. When minor repairs are necessary, trained on-site personnel accomplish the task with minimum interruption of service. When major equipment repairs require the assistance of outside experts, appropriate actions are taken to ensure minimal customer service disruption.

The East Water Delivery System is protected against power loss by six diesel-powered generators. These generators provide emergency power when standard operating power service has been disrupted. Two inline generators are located at the LNRA pump station that can supply sufficient power for operation of the three existing pumps. As an additional security measure, generators are located at the three distribution points and at the LNRA pipeline control building. These generators ensure continuous power for minimal customer service disruption.

The West Water Delivery System is not protected against primary power loss, however, auxiliary generators are in place to ensure proper operation of the control system to ensure valve closure and control system integrity.

6.0 RESERVOIR SYSTEM OPERATION PLAN

LNRA operates Lake Texana on the Navidad River for municipal and industrial water supply purposes, recreation, fish and wildlife benefits. Since Lake Texana is the only reservoir in the Lavaca River Basin and is operated by the LNRA, the LNRA does not have nor need a reservoir system operation plan.

After extensive biologic and hydrologic studies, the LNRA, Texas Parks and Wildlife Department (TPWD), and the Texas Water Development Board (TWDB) signed an agreement on May 20, 1992 concerning the quantity of water released from Lake Texana to estuaries and Lavaca Bay below the Palmetto Bend Dam. On December 16, 1994, the Texas Natural Resource Conservation Commission (TNRCC), predecessor agency of the TCEQ, amended Certificate of Adjudication No. 16-2095 to incorporate the agreed upon release schedule. Generally, the agreement requires that releases of inflows be made from Lake Texana under normal and abundant water supply conditions to ensure the productivity of estuaries and Lavaca Bay downstream from Lake Texana. Specifically, the agreement and permit requirements are as follows: All inflows into the reservoir up to the historical monthly median flow are released during the months of January through March, July, and November through December; inflows up to the historical average flow are released during the months April through June and August through September; however, if the reservoir contains less than 78.18% of the water storage capacity, only inflows up to the average median daily flow for the historical drought period (5 cubic feet per second) will be released. The agreement is beneficial for Lavaca Bay and provides a reliable water supply from Lake Texana. Appendix A contains a copy of Certificate of Adjudication: 16-2095B.

7.0 CONSERVATION-ORIENTED RATES

The LNRA has two different customer classes. All customers purchasing water from Lake Texana on a firm-yield basis are charged the same base rate. All customers purchasing water from Lake Texana for use on an interruptible basis are charged the same rate which is one-half of the base rate charged all customers using firm yield water.

8.0 CUSTOMER CONSERVATION STRATEGIES

LNRA water customers are required by their water sales contract to prepare and submit Water Conservation and Drought Contingency Plans to the TCEQ. The LNRA recommends that its customers develop plans consistent with the LNRA Water Conservation Plan and trigger conditions as established in the LNRA Drought Contingency Plan.

LNRA also recommends that their customers and the M&I users in the Lavaca River Basin address the eight aspects of water conservation discussed herein, including public information and education, conservation oriented plumbing codes, water conservation retrofit programs, universal metering and meter repair/replacement, water conserving landscaping, leak detection and water audits, and means of implementation and enforcement.

8.1. Public Information and Education

A committee should be appointed by each water supply entity to engage in an ongoing education program. The committee may be responsible for the following:

- Provide qualified individuals to speak at institutions, organizations, and groups throughout the area at regular intervals;
- Conduct or sponsor exhibits on conservation, water saving devices, and other methods to promote water conservation and efficiency;
- Provide and distribute brochures and other materials to area citizens. Materials are available from the Texas Agricultural Extension Service and TWDB;

- Work in cooperation with builders, developers, and governmental agencies to provide exhibits of xeriscape landscaping;
- Work in cooperation with schools to establish an education program, and provide conservation videos, brochures, and teaching aids; and
- Develop welcome packages for new citizens to educate and provide the benefits of conservation and availability of native, water efficient plants, trees, shrubs, and grasses.

8.2 Conservation Oriented Plumbing Code

A conservation oriented plumbing code is recommended to encourage the use of water-conserving plumbing fixtures for residential and commercial construction. Senate Bill 815 enacted by the 73rd Texas Legislature directs the Texas Senate Board of Plumbing Examiners to adopt the Southern Standard Plumbing Code, the Uniform Plumbing Code, and the National Standard Plumbing Code. Questions concerning State of Texas plumbing codes can be answered by the Texas State Board of Plumbing Examiners in Austin, Texas.

The 72nd Texas legislature passed legislation requiring that plumbing fixtures sold in Texas after January 1, 1992 meet the following standards:

(a) Shower Heads: No more that 2.75 gallons per minute at 80 pounds per square inch of pressure.
(b) Lavatory/Sink Faucets and Aerators: No more than 2.2 gallons per minute at 60 pounds per square inch of pressure.
(c) Wall Mounted, Flushometer Toilets: No more than 2.0 gallons per flush.
(d) All Other Toilets: No more than 1.6 gallons per flush.
(e) Urinals: No more than 1.0 gallon per flush.
(f) Drinking Water Fountains: Must be self closing.

The above standards are enforced through requirements placed directly on the manufacturers, importers, and suppliers of new fixtures in Texas and do not necessarily require the amendment of existing plumbing codes. However, LNRA encourages that the above standards be used in city, district, and other entity plumbing codes. Furthermore, LNRA suggests the following requirements be incorporated into city, district, and other entity plumbing codes:

(a) Hot Water Pipes: Hot water lines not in or under a concrete slab should be insulated.
(b) Pressure Reduction Valves: Pressure reduction valves may be installed where system pressures exceed 80 pounds per square inch.
(c) Swimming Pools: Swimming pools should have recirculating filtration equipment.
(d) Automatic Dishwashers: Automatic dishwashers installed in residential dwellings should be a design that uses a maximum of six gallons of water per cycle.
(e) Automatic Clotheswashers: Automatic clotheswashers installed in residential dwellings should be a design that uses a maximum of 14 gallons of water per cycle.

8.3 Water Conservation Retrofit Program

Retrofit of existing plumbing fixtures can be accomplished through the voluntary efforts of individual consumers for their homes and businesses. Adoption of a water conservation plumbing code can provide a gradual upgrading of plumbing fixtures in existing structures. Many water conserving plumbing devices are available at local hardware stores, and can be installed by the consumer. The TWDB provides a list of Water Saving Device Sources to the public. Additional information on retrofitting can be provided through public education.

8.4 Universal Metering and Meter Repair/Replacement

Service connections to water supply utilities and customers should be metered. LNRA recommends the following schedule for testing meters:

1. Production or master meters, test once per year;

2. Meters larger than 1', test once every three years; and

3. Meters 1' or less, test once every 10 years.

8.5 Water Conserving Landscaping

Water conserving landscaping can be initiated through public information and education. Well-designed and properly maintained demonstration landscapes located in highly visible areas should be created to promote the xeriscape concept.

8.6 System Auditing and Leak Detection Program

Leak detection and water audits may be accomplished through the voluntary efforts of each water supplier. Technical assistance may be requested from the TWDB.

8.7 Water Reuse and Recycling

LNRA encourages reusing and recycling water whenever it is found to be fiscally, environmentally, and institutionally practical and prudent.

8.8 Means of Implementation and Enforcement

The Water Conservation Plan should be implemented by water supply utilities. The following methods are suggested:

1. Encourage service tap applicants to utilize water conserving plumbing fixtures. Water utility staff should insure that water saving plumbing devices is being installed in new buildings.

2. Adopt a rate structure that will encourage retrofitting of old plumbing fixtures that are using large amounts of water.

3. Require the water rate structure as a condition for receiving service.

APPENDIX A

Certificate of Adjudication No: 16-2095B
Certificate of Adjudication No: 16-2095C
Certificate of Adjudication No: 16-2095D
Certificate of Adjudication No: 16-2095E

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO CERTIFICATE OF ADJUDICATION NO. 16-2095

CERTIFICATE OF ADJUDICATION: 16-2095B

OWNERS:
Texas Water Development Board
c/o Executive Administrator
P.O. Box 13231
Austin, Texas 78711

Lavaca Navidad River Authority
c/o General Manager
Box 429
Edna, Texas 77957

COUNTY: Jackson

PRIORITY DATES:
May 24, 1982, and October 6, 1993

WATERCOURSES: Lavaca River and Navidad River

BASIN: Lavaca Basin

WHEREAS, Lavaca-Navidad River Authority (LNRA) and Texas Water Development Board (TWDB) have filed Application 16-2095B and requested amendments of Certificate of Adjudication No. 16-2095, as amended, to appropriate the entire firm yield of the Stage 1 and Stage 2 reservoirs authorized by this certificate of adjudication, and to quantify existing requirements that water be released or passed through to satisfy freshwater inflow needs of the downstream bay and estuary system;

WHEREAS, the Commission finds that it has jurisdiction to hear both Application 16-2095B and the previous application to amend Certificate of Adjudication No. 16-2095 which is the application subject to Cause No. 361,294 remanded from the District Court of Travis County, Texas;

WHEREAS, all parties to the contested case hearing have settled and resolved all matters in dispute and recommend that the application be granted as reflected by this amendment;

WHEREAS, the Commission finds that the entire remaining firm yield of Lake Texana (Stage 1) is 79,000 acre-feet per year;

WHEREAS, the Commission finds that releases for the bay and estuary system specified by this amendment could impact the firm yield of Lake Texana (Stage 1) by reducing it by up to 4,500 acre-feet per year, from 79,000 acre-feet per year to 74,500 acre-feet per year;

WHEREAS, the Commission finds that the entire remaining firm yield of Stage 2 is 48,122 acre-feet per year;

WHEREAS, the District Court of Travis County has remanded LNRA and TWDB's May 24, 1982 application to the Commission for consideration of whether changed circumstances may now exist that demonstrate the need for the additional appropriation requested by such application;

WHEREAS, issuance of this amendment to Certificate of Adjudication No. 16-2095 effectively resolves all matters of dispute in Cause Nos. 361,294 and 374,305, Lavaca-Navidad River Authority v. Texas Department of Water Resources, and the applicants waive and abandon all contested matters in those proceedings, subject to the issuance and legal effectiveness of this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095 is issued to Texas Water Development Board and Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

A. Owners are authorized to use from the impoundment of Lake Texana (impoundment Stage 1) an additional 4,000 af/yr, as follows:

(1) Owner LNRA is authorized to use 406 af/yr for municipal purposes and 1301 af/yr for industrial purposes;

(2) Owner TWDB is authorized to use 546 af/yr for municipal purposes and 1747 af/yr for industrial purposes.

B. Upon completion of the Stage 2 dam and reservoir on the Lavaca River, owner Texas Water Development Board is authorized to use an additional amount of 18,122 af/yr, for a total or 48,122 af/yr, of which up to 7,150 af/yr shall be for municipal purposes, up to 22,850 af/yr shall be for industrial purposes, and at least 18,122 af/yr shall be for the maintenance of the Lavaca-Matagorda Bay and Estuary System. The entire Stage 2 appropriation remains subject to release of water for the maintenance of the bay and estuary system until a release schedule is developed pursuant to the provisions of Section 4.B. of this certificate of adjudication.

2. PRIORITY

A. The time priority for the additional 4,000 af/yr appropriation for Lake Texana is May 24, 1982.

B. The time priority for the additional 18,122 af/yr appropriation for Stage 2 is October 6, 1993.

3. WATER CONSERVATION

A. Within 120 days of issuance of the amended certificate, LNRA shall submit a written response to the following staff recommendations regarding the technical review of LNRA's water conservation plan:

1. The conservation plan needs to be revised to address all of the minimum requirements of 30 TAC Ch. 288, specifically:

a) The water conservation plan should be adopted by the LNRA Board and integrated into LNRA operations and management.

b) A requirement must be added in wholesale contracts so that each successive wholesaler implements water conservation measures in accordance with 30 TAC Ch. 288. For long term contracts already signed, compliance with this provision should be sought voluntarily or this provision should be added at the first available opportunity.

2. Conservation goals and strategies need to be evaluated as to effectiveness for the water users. Goals need to be set based upon an engineering analysis and the technical potential to achieve those goals.

B. Within 180 days of issuance of the amended certificate, LNRA shall revise and implement the "Water Conservation Plan" dated May, 1991. Any subsequent plan used by LNRA shall provide for the utilization of those practices, techniques, and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water or prevent the pollution of water, so that a water supply is made available for future use or alternative uses. Such plan shall include a requirement in every wholesale water supply contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement water conservation measures. If the customer intends to resell the water, then the contract for the resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water will be required to implement water conservation measures.

4. BAY AND ESTUARY RELEASE SCHEDULE

A. The first full paragraph on page 4 of Certificate of Adjudication 16-2095 is amended to provide, with respect to Lake Texana (Stage 1), as follows: This certificate of adjudication is issued subject to all superior and senior water rights in the Lavaca River and to the release of water from Stage 1 for the maintenance of Lavaca-Matagorda Bay and Estuary System as follows:

1. When 78.18% or more of the reservoirs's capacity contains stored inflows, all inflows into the reservoir up to the historical monthly median flow during the months of January (84.5 cfs), February (142.4 cfs), March (86.8 cfs), July (126.5 cfs), November (68.3 cfs), and December (79.3 cfs), and all inflows up to the historical monthly average flow of the months of April (806.8 cfs), May (1,169.3 cfs), June (1,191.4 cfs), August (265.7 cfs), September (1,027.3 cfs), and October (708.3 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

2. When less than 78.18% of the reservoir's capacity contains stored inflows, all inflows up to the annual median daily flow for the drought period January 1954 through December 1956 (5 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

As used in this provision, the term "inflows" refers to naturally occurring in-basin inflows. It does not include water supplies imported from out of the basin, unless those supplies are imported by a junior permittee upstream of Lake Texana for the purpose of replacing naturally occurring in-basin inflows in order to avoid impairment of water rights granted pursuant to Certificate of Adjudication 16-2095, as amended, including required freshwater inflows.

Lavaca-Navidad River Authority, Texas Water Development Board, and Texas Parks and Wildlife Department shall cooperate in developing operating procedures to implement the release schedule and provide such procedures to the TNRCC for review and approval as part of the Water Management Plan. Such procedures shall in part assist in the determination of when priority calls on water can be made by the certificate holder on a daily, monthly, or other appropriate schedule. Additional gages needed to measure inflows and outflows in connection with the release schedule shall be installed within one year following LNRA's issue of "Texana Bonds" to finance acquisition of TWDB's interest. LNRA shall notify the TNRCC in writing of the issuance of such bonds not later than thirty (30) days from date of issuance.

B. The Stage 2 appropriation for municipal and industrial uses remains subject to the release of water for maintenance of the Lavaca-Matagorda Bay and Estuary System as follows:

> Prior to commencement of construction of Stage 2, or any diversion of water appropriated under the Stage 2 portion of this Certificate of Adjudication, upon the joint recommendation of Lavaca-Navidad River Authority, Texas Water Development Board, and Texas Parks and Wildlife Department, LNRA and/or TWDB shall submit an application to TNRCC to establish a schedule for the release of fresh water inflows from Stage 2 for the maintenance of the Lavaca-Matagorda Bay and Estuary System. In establishing the Stage 2 release schedule, TNRCC may consider, upon the motion of any party, modification of the Stage 1 release schedule set forth herein; provided, however, the applicant(s) shall retain the right to withdraw its application without prejudice at any time prior to the final decision by the Commission and shall pay reasonable costs incurred by protesting parties. In the event that the application to set the release schedule for Stage 2 is withdrawn, the Stage 1 release schedule shall remain unchanged from the release schedule specified in Section 4.A of this certificate of adjudication.

5. SPECIAL CONDITION:

Within 36 months of issuance of this amendment, LNRA shall submit to the TNRCC, following appropriate public involvement, a water management plan pursuant to Texas Water Code section 11.173(b). Such plan shall address:

a) the potential of water conservation and reuse to enhance existing water supplies and the potential impact of such practices on the timing of construction of Stage 2;

b) a drought management plan in accordance with 30 TAC section 288.2(a)(1)(H);

c) an assessment of environmental water needs (i.e., instream needs, water quality, aquatic and wildlife habitat, and beneficial inflows to affected bays and estuaries) and potential responses to address such needs, particularly as related to Stage 2. Such assessment shall be done in coordination with the Clean Rivers Program (Texas Water Code section 26.0135) and studies performed pursuant to Texas Water Code section 16.058; and,

d) the management of water supply, including planning and timing of construction of Stage 2. This may include the incorporation of integrated resource planning principles where water supply and demand management options are identified, analyzed, and compared so that the most cost-effective and environmentally sensitive strategies are pursued.

This Amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as herein amended.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owners agree to be bound by the terms, conditions, and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and the right of continual supervision of State water resources exercised by the Commission.

Issue Date: DEC 16 1994

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

John Hall

John Hall, Chairman

ATTEST:

Gloria A. Vasquez

Gloria A. Vasquez, Chief Clerk

VOL 47 PAGE 775

9661

Amendment

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

TO

LAVACA NAVIDAD RIVER AUTHORITY

FILED FOR RECORD THIS THE 4th day of
January A.D., 1995 at 1:05 P.M.

Honorable Martha Knapp , County Clerk
Jackson County, Texas

By Barbara Vanecek Deputy
12/19/1994 Barbara Vanecek Fee: $ 17.00

Filed by: LAVACA NAVIDAD RIVER AUTHORITY
BOX 429
EDNA, TEXAS 77957

Return to: LAVACA NAVIDAD RIVER AUTHORITY
BOX 429
EDNA, TEXAS 77957 VOL 47 PAGE 776

Recorded this the 10th Day of January A. D., 1995 At 10:00 A. M.
Honorable Martha Knapp , County Clerk By [illegible] Deputy.

STATE OF TEXAS
COUNTY OF JACKSON

I hereby certify that this instrument was FILED on the date and at the time affixed hereon by me and was duly RECORDED in the Volume and page of the Official Records of Jackson County, Texas as stamped hereon by me.

JAN 10 1995

MARTHA KNAPP COUNTY CLERK
JACKSON COUNTY, TEXAS
BY Dora Gonzales Deputy

Dora Gonzales

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Natural Resource Conservation Commission document, which is filed in the permanent records of the Commission.
Given under my hand and the seal of office on
Mamie M. Black OCT 22 1996
Mamie M. Black, Acting Chief Clerk
Texas Natural Resource
Conservation Commission

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO CERTIFICATE OF ADJUDICATION

APPLICATION NO. 16-2095C   CERTIFICATE NO. 16-2095C   TYPE: §11.122 and 11.085

Owners: Lavaca-Navidad River Authority, c/o General Manager
P.O. Box 429, Edna, Texas 77957

Texas Water Development Board, c/o Executive Administrator
P.O. Box 13231, Austin, Texas 78711

Filed: December 27, 1995   Purposes: Municipal and Industrial

Counties: Aransas, Atascosa, Bee, Duval, Jackson, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio

Watercourse: Navidad River, tributary of the Lavaca River

Watersheds: Lavaca River Basin, Colorado-Lavaca Coastal Basin, Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces River Basin, Nueces-Rio Grande Coastal Basin, Guadalupe River Basin and San Antonio River Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, includes authorization for the Lavaca-Navidad River Authority and the Texas Water Development Board to impound water in a 170,300 acre-foot capacity reservoir (referred to as Stage 1 reservoir or Lake Texana) on the Navidad River in Jackson County for recreational use; and

WHEREAS, the certificate, as amended, also includes authorization for the owners to divert and use from the lake not to exceed 18,778 acre-feet of water per annum for municipal purposes and 60,222 acre-feet of water per annum for industrial purposes in the Lavaca River Basin, the Colorado-Lavaca Coastal Basin and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, the Lavaca-Navidad River Authority owns a 42.67% interest in the certificate, as amended, and the Texas Water Development Board owns a 57.33% interest in the certificate, as amended; and

WHEREAS, the impoundment authorization, the authorization to divert and use 17,826 acre-feet of water per annum from the lake for municipal purposes and to divert and use 57,174 acre-feet of water per annum from the lake for industrial purposes has a time priority of May 15, 1972; and

By________

WHEREAS, authorization to divert and use 952 acre-feet of water per annum for municipal purposes from the lake and to divert and use 3048 acre-feet of water per annum from the lake for industrial purposes has a time priority of May 24, 1982; and

WHEREAS, the applicants seek (without a change in their current ownership interests in the water right) to amend Certificate of Adjudication No. 16-2095, as amended, to:

1) reallocate use of the total of 79,000 acre-feet of water per year from the lake as follows: 46,518 acre-feet for municipal use and 32,482 acre-feet for industrial use (with 4000 acre-feet of the 46,518 acre-feet to be used for municipal purposes having a time priority of May 24, 1982 and the remainder of the water having a time priority of May 15, 1972);

2) authorize transport of not to exceed 46,590 acre-feet of water per annum of the referenced 79,000 acre-feet of water for use in Aransas, Atascosa, Bee, Duval, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio Counties which include land in the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, the Lavaca-Guadalupe Coastal Basin, the Guadalupe River Basin and the San Antonio River Basin (the 46,590 acre-feet of water requested to be transported per annum includes 46,340 acre-feet of the 46,518 acre-feet per year requested for municipal use and 250 acre-feet of the 32,482 acre-feet per year requested for industrial use); and

3) maintain a continuing right to reclaim for use 10,400 acre-feet of the aforesaid 46,590 acre-feet per annum in the future for use within the basins currently authorized in the certificate;

WHEREAS, the Texas Natural Resource Conservation Commission finds that jurisdiction over the application is established; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Natural Resource Conservation Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, as amended, is issued to the Lavaca-Navidad River Authority and the Texas Water Development Board subject to the following terms and conditions:

1. USE

   a. In lieu of the authorization currently included in Certificate No. 16-2095, as amended, to divert and use from Lake Texana not to exceed 18,778 acre-feet of water per annum for municipal use and not to exceed 60,222 acre-feet of water per annum for industrial use, owners are authorized to divert and use from Lake Texana not to exceed 46,518 acre-feet of water per annum for municipal use and 32,482 acre-feet of water per annum for industrial use.

   b. Owners are authorized to transport not to exceed 46,590 acre-feet of water per annum of the 79,000 acre-feet of water per annum authorized for diversion from the lake for use in Aransas, Atascosa, Bee, Duval, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun and Refugio Counties, which include land in the Lavaca-Guadalupe Coastal Basin, the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, the Guadalupe River Basin and the San Antonio River Basin.

2. WATER CONSERVATION

   Owners shall maintain a water conservation plan that shall provide for the utilization of those practices, techniques and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plan shall include a requirement in every wholesale water supply contract entered into, on or after the issue date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement water conservation measures. If the customer intends to resell the water, then the contract for the resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water will be required to implement water conservation measures.

3. SPECIAL CONDITION

Owners shall have the right to reclaim for use not to exceed 10,400 acre-feet of the 46,590 acre-feet of water per annum referred to in Paragraph 1.b. of this amendment in the future for use within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin and the Lavaca-Guadalupe Coastal Basin.

4. TIME PRIORITIES

The time priority of 4000 acre-feet of the 46,518 acre-feet per annum authorized for municipal use in this amendment is May 24, 1982. The time priority of the remaining 75,000 acre-feet of water per annum included in this amendment is May 15, 1972.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owners agree to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION

For the Commission

DATE ISSUED: OCT 21 1996

ATTEST:

Mamie M. Black

Mamie M. Black, Acting Chief Clerk

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO A
CERTIFICATE OF ADJUDICATION

APPLICATION NO. 16-2095D CERTIFICATE NO. 16-2095D TYPES §11.122 and 11.085

Owner:	Lavaca-Navidad River Authority	Address:	P.O. Box 429 Edna, Texas 77957
Filed:	July 1, 2002	Granted:	FEB 21 2003
Purpose:	Municipal and Industrial	County:	Jackson
Watercourse:	Lake Texana on the Navidad River	Watershed:	Lavaca River Basin, Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and San Antonio-Nueces Coastal Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, authorizes the Lavaca-Navidad River Authority (LNRA) to impound 170,300 acre-feet of water in the Stage 1 reservoir (Lake Texana) on the Navidad River, Lavaca River Basin, Jackson County, to divert and use not to exceed 79,000 acre-feet of water as follows:

A. 42,518 acre-feet of water per annum for municipal use and 32,482 acre-feet of water per annum for industrial use with a priority date of May 15, 1972, and

B. 4,000 acre-feet of water per annum for municipal use with a priority date of May 24, 1982; and

WHEREAS, LNRA is also authorized to transport not to exceed 46,590 acre-feet of water per annum (46,340 acre-feet for municipal use and 250 acre-feet for industrial use) out of the 79,000 acre-feet of water for use in thirteen (13) counties in the Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces-Rio Grande Coastal Basin, Nueces River Basin, Guadalupe River Basin, and the San Antonio River Basin; and

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, contains a special condition authorizing LNRA the right to reclaim for use not to exceed 10,400 acre-feet of water per annum out of that 46,590 acre-feet of water for use within the Lavaca River Basin, Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, upon completion of the Stage 2 dam, LNRA is also authorized to impound 93,340 acre-feet of water in the Stage 2 reservoir on the Lavaca River, Lavaca River Basin, Jackson County and to divert and use not to exceed 48,122 acre-feet of water as follows:

A. 7,150 acre-feet of water per annum for municipal use and 22,850 acre-feet of water per annum for industrial use with a priority date of May 15, 1972, and

B. at least 18,122 acre-feet of water per annum shall be for the maintenance of the Lavaca-Matagorda Bay and Estuary System with a priority date of October 6, 1993; and

WHEREAS, releases for the bay and estuary system could impact the firm yield of Lake Texana (Stage 1) by reducing it by up to 4,500 acre-feet per year, from 79,000 acre-feet per year to 74,500 acre-feet per year; and

WHEREAS, the entire Stage 2 appropriation remains subject to release of water for the maintenance of the bay and estuary system until a release schedule is developed; and

WHEREAS, LNRA is also authorized to use all impounded waters for recreational use and construction and maintenance of the dams; and

WHEREAS, the applicant LNRA seeks authorization to divert an additional 7,500 acre-feet of water per annum from Lake Texana on an interruptible basis and an interbasin transfer authorization for the 7,500 acre-feet of water for multiple purposes (municipal and industrial use) from the Lavaca River Basin for use in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin; and

WHEREAS, no changes to the current bay and estuary release schedule are requested, and no other requests for amendments are being made in this application; and

WHEREAS, the additional 7,500 acre-feet of water for use on an interruptible basis will be junior in priority to existing water rights in the Lavaca River Basin; and

WHEREAS, this application is subject to the Texas Coastal Management Program (CMP) and must be consistent with the CMP goals and policies; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, no one protested the granting of this application; and

WHEREAS, the Commission finds that the detriments to the basin of origin during the proposed transfer period are less than the benefits to the receiving basin during the proposed transfer period; and

WHEREAS, the Commission finds that the applicant for the interbasin transfer has prepared a drought contingency plan and has developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant; and

WHEREAS, the Commission finds that this permit will not be detrimental to the public welfare; and

WHEREAS, the Executive Director recommends several special conditions for the protection of instream uses and senior water rights; and

WHEREAS, the Texas Commission on Environmental Quality finds that the issuance of the permit is consistent with the goals and policies of the Texas Coastal Management Program; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment; and

WHEREAS, the South Texas Watermaster has jurisdiction over this water right;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, as amended, designated as Certificate of Adjudication No. 16-2095D, is issued to the Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

In addition to the previous authorization, the owner is authorized to divert 7,500 acre-feet of water per annum from Lake Texana on an interruptible basis and an interbasin transfer authorization for the 7,500 acre-feet of water for multiple purposes (municipal and industrial use) from the Lavaca River Basin for use in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin.

2. DIVERSION

A. Location:

i. At a point on the west bank of the service spillway of the Stage 1 dam which is N69°W, 2850 feet from the northwest corner of the S.F. Austin Survey, Abstract 5, Jackson County, Texas.

ii. At a point on the east bank of the service spillway of the Stage 1 dam which is N61°W, 2500 feet from the northwest corner of the S.F. Austin Survey, Abstract 5, Jackson County, Texas.

B. Maximum combined diversion rate: 330 cfs (148,000 gpm).

3. CONSERVATION

A. Owner shall implement a water conservation plan that provides for the utilization of those practices, techniques and technologies that reduce or maintain the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water, so that a water supply is made available for future or alternative uses. Such plans shall include a requirement that in every wholesale water contract entered into, on or after the effective date of this amendment, including any contract extension or renewal, that each successive wholesale customer develop and implement conservation measures. If the customer intends to resell the water, then the contract for resale of the water must have water conservation requirements so that each successive wholesale customer in the resale of the water be required to implement water conservation measures.

B. The owner shall develop minimum standards for content of water conservation plans for all of its customers. In order to achieve the stated goal for municipal water use, these plans shall identify each customer utility's technical potential for water conservation savings.

C. The owner shall provide technical assistance as necessary to ensure completion of all customers' conservation plans by 2007.

D. The owner shall update its conservation plan every five years in accordance with 30 TAC 288, beginning in 2007. Conservation goals for the five-year period shall include both a per-capita water use goal for the LNRA service area and strategies to achieve that goal that are consistent with the current, approved Regional and State Water Plans.

E. The owner shall as part of its ongoing public education program, provide to customers, local and regional news media, and TCEQ:

i. A progress report stating the goal(s) of the previous five years and quantitative measurements of conservation achieved, based on five years' water use data; and

ii. LNRA's conservation goals for the next five years.

F. The owner shall ensure that customers implement conservation-oriented water rates such as uniform or increasing-block rates, and/or seasonal rates, but not flat or decreasing-block rates through all contracts entered into or renewed following the approval of this amendment.

4. TIME PRIORITY

The time priority for this amendment is July 1, 2002.

5. SPECIAL CONDITIONS

A. The pass-through requirements for freshwater inflows to the Lavaca-Matagorda Bay and Estuary system shall be fully satisfied prior to diversion of the 7,500 acre-feet of water and are described as follows:

When 78.18% or more of the reservoir's capacity contains stored inflows, all inflows into the reservoir up to the historical monthly median flow during the months of January (84.5 cfs), February (142.4 cfs), March (86.8 cfs), July (126.5 cfs), November (68.3 cfs), and December (79.3 cfs), and all inflows up to the historical monthly average flow of the months of April (806.8 cfs), May (1,169.3 cfs), June (1,191.4 cfs), August (265.7 cfs), September (1,027.3 cfs), and October (708.3 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

B. The diversion of the additional 7,500 acre-feet of water and the previously authorized 4,500 acre-feet of water per annum on an interruptible basis shall be limited to those times that the lake level is at or above 43 feet msl.

C. The owner shall install and maintain a measuring device approved by the Commission that will be used to measure and account for the amount of water diverted from Lake Texana, and Owner shall allow representatives of the Texas Commission on Environmental Quality (South Texas Watermaster) reasonable access to the property in inspect the measuring device. If owner diverts water prior to installation of the referenced marker, this amendment shall expire and become null and void.

D. Prior to the diversion of water authorized herein, owner shall contact the South Texas Watermaster.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as specifically amended herein. The owner is still obligated to the condition that should the owner initiate plans of construction for Stage 2 reservoir or the diversion of water under Stage 2 appropriation, the Commission may consider a modified freshwater release schedule which may include an intermediate trigger for a more gradual reduction of freshwater releases from the Lake Texana project (Stage 1 and 2) for bay and estuary purposes.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment. All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY

Margaret Hoffman

For the Commission

Date issued: FEB 21 2003

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AMENDMENT TO CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 16-2095E TYPE §§ 11.122, 11.042

Owner:	Lavaca-Navidad River Authority	Address:	P.O. Box 429 Edna, Texas 77957
Filed:	July 7, 2015	Granted:	August 31, 2015
Purposes:	Agricultural, Industrial, Municipal, Domestic, Mining, and Recreational	County:	Aransas, Atascosa, Bee, Duval, Jim Wells, Jackson, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun, and Refugio
Watercourse:	Navidad River, tributary of Lavaca River, and Lavaca River	Watershed:	Guadalupe River Basin, Lavaca River Basin, Nueces River Basin, San Antonio River Basin, Colorado-Lavaca Coastal Basin, Lavaca-Guadalupe Coastal Basin, Nueces-Rio Grande Coastal Basin, and San Antonio-Nueces Coastal Basin

WHEREAS, Certificate of Adjudication No. 16-2095, as amended, authorize the Lavaca-Navidad River Authority, Owner, to impound 170,300 acre-feet of water in the Stage 1 reservoir (Lake Texana) on the Navidad River, tributary of the Lavaca River, Lavaca River Basin, in Jackson County, to divert and use not to exceed 79,000 acre-feet of water per year at a maximum combined diversion rate of 330 cfs (148,000 gpm) as follows:

A. 42,518 acre-feet of water per year for municipal purpose and 32,482 acre feet of water per year for industrial purpose with a priority date of May 15, 1972;

B. 4,000 acre-feet of water per year for municipal purpose with a priority date of May 24, 1982; and

WHEREAS, Owner is also authorized to transport not to exceed 46,590 acre-feet of water per year (46,340 acre-feet for municipal purposes and 250 acre-feet for industrial purposes) out of the 79,000 acre-feet of water for use in thirteen (13) counties in the Lavaca-Guadalupe Coastal Basin, San Antonio-Nueces Coastal Basin, Nueces-Rio Grande Coastal Basin, Nueces River Basin, Guadalupe River Basin, and the San Antonio River Basin; and

WHEREAS, Owner is authorized the right to reclaim for use not to exceed 10,400 acre-feet of water out of that 46,590 acre-feet of water per year for use within the Lavaca River Basin, Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin; and

WHEREAS, upon completion of the Stage 2 dam, the Owner is also authorized to impound 93,340 acre-feet of water in the Stage 2 reservoir on the Lavaca River, Lavaca River Basin, Jackson County and to divert and use not to exceed 48,122 acre-feet of water as follows and subject to special conditions:

A. 7,150 acre-feet of water per year for municipal purpose and 22,850 acre-feet of water per year for industrial purpose with a priority date of May 15, 1972;

B. at least 18,122 acre-feet of water per year shall be for the maintenance of the Lavaca Matagorda Bay and Estuary System with a priority date of October 6, 1993; and

WHEREAS, Owner is also authorized to use all impounded waters for recreational purposes and construction and maintenance of the dams; and

WHEREAS, Owner is also authorized to divert and use an additional 7,500 acre-feet of interruptible water per year for municipal and industrial purposes in these twelve (12) counties: Aransas, Atascosa, Bee, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, and Willacy, located in whole or in part in the Nueces River Basin, San Antonio River Basin, Nueces-Rio Grande Coastal Basin, and the San Antonio-Nueces Coastal Basin; and

WHEREAS, Owner seeks to add authorization to divert anywhere along the perimeter of Lake Texana (Stage 1 reservoir) located on the Navidad River, Lavaca River Basin; and

WHEREAS, Owner seeks to add municipal, industrial, agricultural, domestic, mining, and recreational purposes to the authorized 79,000 acre-foot portion of water; and

WHEREAS, Owner seeks modification to the Special Condition in Certificate No. 16-2095C to read "Owners shall have the right to cease transporting 10,400 acre-feet of the 46,590 acre-feet of water per annum referred to in paragraph 1.b. of Certificate of Adjudication No. 16-2095C and to use that water within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin"; and

WHEREAS, this application is subject to the Texas Coastal Management Program (CMP) and must be consistent with the CMP goals and policies; and

WHEREAS, the Texas Commission on Environmental Quality finds that jurisdiction over the application is established; and

WHEREAS, this amendment, if granted, is subject to requirements and orders of the South Texas Watermaster; and

WHEREAS, the Executive Director recommends that special conditions should be included in the amendment; and

WHEREAS, no requests for a contested case hearing were received for this application; and

WHEREAS, the Texas Commission on Environmental Quality finds that the issuance of this amendment is consistent with the goals and policies of the Texas CMP; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Commission on Environmental Quality in issuing this amendment;

NOW, THEREFORE, this amendment to Certificate of Adjudication No. 16-2095, designated Certificate of Adjudication No. 16-2095E, is issued to Lavaca-Navidad River Authority subject to the following terms and conditions:

1. USE

In addition to the previous authorizations, Owner is also authorized to divert and use the authorized 79,000 acre-foot portion of water per year for municipal, industrial, agricultural, domestic, mining, and recreational purposes in its fifteen counties (Aransas, Atascosa, Bee, Duval, Jim Wells, Jackson, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio, Victoria, Calhoun, and Refugio Counties).

2. DIVERSION

In addition to the previous authorizations, Owner is also authorized to divert from the perimeter of Lake Texana (Stage 1 reservoir) in Jackson County.

3. PRIORITY DATE

A. The time priority of 30,000 acre-feet from Stage 2 reservoir and 75,000 acre-feet from Stage 1 reservoir is May 15, 1972.

B. The time priority of 18,122 acre-feet from Stage 2 reservoir is October 6, 1993.

C. The time priority of 4,000 acre-feet from Stage 1 reservoir is May 24, 1982.

D. The time priority of 7,500 acre-feet from Stage 1 reservoir is July 1, 2002.

4. SPECIAL CONDITIONS

A. In lieu of the Special Condition described in Certificate of Adjudication No. 16-2095C, the Owner shall have the right to cease transporting up to 10,400 acre-feet of the 46,590 acre-feet of water per year referred to in Paragraph 1. USE b. of Certificate of Adjudication No. 16-2095C and to use that water within the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin.

B. In order to minimize entrainment and impingement of aquatic organisms, the Owner shall utilize screens on any new diversion structures.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate of Adjudication No. 16-2095, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Lavaca River Basin.

Owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Commission on Environmental Quality and to the right of continuing supervision of State water resources exercised by the Commission.

For the Commission

ISSUED: August 31, 2015

FILED and RECORDED

Instrument Number: 2015-02520 B: OR V: 493 P: 497

Filing and Recording Date: 09/15/2015 11:12:53 AM Recording Fee: 42.00

I hereby certify that this instrument was FILED on the date and time stamped heron and RECORDED in the OFFICIAL PUBLIC RECORDS of Jackson County, Texas.

COUNTY OF JACKSON STATE OF TEXAS

Barbara Williams, County Clerk
Jackson County, Texas

ANY PROVISION CONTAINED IN ANY DOCUMENT WHICH RESTRICTS THE SALE, RENTAL, OR USE OF THE REAL PROPERTY DESCRIBED THEREIN BECAUSE OF RACE OR COLOR IS INVALID UNDER FEDERAL LAW AND IS UNENFORCEABLE.

APPENDIX B

LNRA Monthly Water Reports (examples)

Form# 089
Rev '04

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
MONTHLY WATER SUPPLY SUMMARY

FEBRUARY 2019

(Reservoir data is for the last day of the month at 0800hrs)

TOP of CONSERVATION POOL	44.00	(FEET ~ MSL)
WATER SURFACE ELEVATION	44.12	(FEET ~ MSL)
RESERVOIR CONTENT	162,305	(ACRE-FEET)
RESERVOIR SURFACE AREA	9,782	(ACRES)
PRECIPITATION	3.750	(INCHES)
TOTAL PAN EVAPORATION	3.028	(INCHES)
OPERATIONAL TESTING	0.00	(ACRE-FEET)
SEEPAGE B & E	172.20	(ACRE-FEET)
ROW RELEASES	0.00	(ACRE-FEET)
SPILLWAY RELEASES	37,574.57	(ACRE-FEET)
M & I DIVERSIONS	4,094.82	(ACRE-FEET)
TOTAL OUTFLOW	41,841.59	(ACRE-FEET)

COMMENTS:

MONTHLY BAY & ESTUARY RELEASES	6,482.80	(ACRE-FEET)
YTD BAY & ESTUARY RELEASES	12,658.60	(ACRE-FEET)
YTD TOTAL OUTFLOW	88,630.75	(ACRE-FEET)

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
DAILY OUTFLOW DETAIL

FEBRUARY 2019

DATE	WATER SURFACE ELEVATION (FEET ~ MSL)	RESERVOIR CONTENT (AC-FT)	RELEASES					DIVERSIONS	
			SPILLWAY (AC-FT)	ROW (AC-FT)	SPILLWAY B & E (AC-FT)	ROW B & E (AC-FT)	SEEPAGE B & E (AC-FT)	M & I EAST (AC-FT)	M & I WEST (AC-FT)
1	44.11	162,203	1,028.74	0.00	0.00	0.00	6.15	62.22	37.74
2	44.11	162,203	1,129.69	0.00	0.00	0.00	6.15	53.48	37.60
3	44.08	161,898	2,063.00	0.00	0.00	0.00	6.15	57.77	37.33
4	44.15	162,611	18.15	0.00	1,919.15	0.00	6.15	55.81	75.20
5	44.11	162,203	861.76	0.00	0.00	0.00	6.15	65.58	106.74
6	44.15	162,611	820.82	0.00	0.00	0.00	6.15	59.26	130.53
7	44.07	161,796	861.76	0.00	0.00	0.00	6.15	63.99	131.29
8	44.14	162,509	0.00	0.00	0.00	0.00	6.15	60.43	131.67
9	44.11	162,203	0.00	0.00	0.00	0.00	6.15	57.43	132.10
10	44.09	161,999	0.00	0.00	0.00	0.00	6.15	62.43	132.31
11	44.08	161,898	0.00	0.00	0.00	0.00	6.15	60.58	132.18
12	44.14	162,509	0.00	0.00	0.00	0.00	6.15	58.08	132.12
13	44.11	162,203	0.00	0.00	0.00	0.00	6.15	58.04	132.11
14	44.09	161,999	0.00	0.00	0.00	0.00	6.15	64.25	132.23
15	44.09	161,999	0.00	0.00	0.00	0.00	6.15	65.21	88.26
16	44.14	162,509	0.00	0.00	0.00	0.00	6.15	62.08	64.56
17	44.12	162,305	0.00	0.00	0.00	0.00	6.15	64.26	64.32
18	44.16	162,713	0.00	0.00	0.00	0.00	6.15	61.68	64.15
19	44.13	162,407	0.00	0.00	726.84	0.00	6.15	67.14	63.84
20	44.01	161,187	0.00	0.00	850.83	0.00	6.15	54.08	63.34
21	43.96	160,713	0.00	0.00	0.00	0.00	6.15	56.26	63.32
22	43.96	160,713	0.00	0.00	0.00	0.00	6.15	56.08	63.22
23	43.94	160,528	0.00	0.00	0.00	0.00	6.15	63.50	63.02
24	43.96	160,713	0.00	0.00	0.00	0.00	6.15	64.46	63.03
25	43.95	160,621	0.00	0.00	781.39	0.00	6.15	64.68	63.62
26	43.86	159,785	0.00	0.00	465.22	0.00	6.15	60.23	62.96
27	44.12	162,305	8,752.55	0.00	1,567.17	0.00	6.15	61.43	63.05
28	44.12	162,305	15,727.50	0.00	0.00	0.00	6.15	59.35	63.19
SUBTOTALS			31,263.97	0.00	6,310.60	0.00	172.20	1,699.79	2,395.03

MONTHLY		*ANNUAL*
0.00	OPERATIONAL TESTING	0.00
172.20	SEEPAGE B & E	362.85
0.00	ROW B & E RELEASE	0.00
6,310.60	SPILLWAY B & E RELEASE	12,295.75
0.00	ROW FLOOD RELEASE	0.00
31,263.97	SPILLWAY FLOOD RELEASE	67,728.41
37,746.77	TOTAL RELEASE	80,387.01
4,094.82	M & I DIVERSION	8,243.74
41,841.59	TOTAL OUTFLOW	88,630.75

Form# 124
Rev '04

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
HISTORICAL SPILLWAY & ROW RELEASES

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1982	~	~	~	~	267,600.50	945.20	3,989.80	178.78	1,832.31	13,434.55	114,253.76	17,292.00	419,526.90
1983	33,280.19	143,037.92	121,552.05	1,656.41	46,527.94	8,430.07	152,900.68	15,482.09	86,402.71	178,306.04	66,650.49	4,836.28	859,062.87
1984	47,642.28	14,699.28	3,548.34	171.24	38,536.98	4,883.02	7,995.81	2,083.76	10,271.51	161,573.58	11,831.87	4,514.60	307,752.27
1985	67,276.29	51,853.98	148,386.86	172,763.09	5,759.61	9,849.83	21,003.84	195.17	5,979.83	29,810.42	170,115.99	42,915.06	725,909.97
1986	1,726.00	4,319.00	374.40	247.80	6,316.46	144,962.32	110.00	180.00	14,587.55	34,682.37	9,675.68	146,793.15	363,974.73
1987	35,761.15	83,636.93	31,399.98	115.06	42,194.70	323,861.22	30,783.73	981.47	111.14	122.33	57,154.23	55,693.37	661,815.31
1988	1,224.72	102.55	2,160.76	9,640.83	9,106.77	9,782.97	3,895.26	6,061.80	5,987.91	734.19	111.33	109.57	48,918.66
1989	79,958.55	11,303.11	132.72	103.29	94,365.59	8,845.71	4,858.12	103.29	106.91	103.27	104.83	101.71	200,087.10
1990	101.71	1,957.97	21,695.20	27,202.12	14,493.18	103.28	7,774.73	1,002.65	10,401.01	103.29	1,385.63	103.29	86,324.06
1991	114,263.24	43,069.12	6,782.82	219,981.80	359.69	9,199.12	22,506.92	2,990.86	26,296.03	932.25	973.96	213,196.82	660,552.63
1992	218,393.94	538,594.87	81,716.10	250,068.18	285,312.94	133,270.09	11,784.64	3,532.13	7,647.47	3,976.64	51,874.21	34,909.29	1,621,080.50
1993	61,044.28	90,741.43	84,432.13	92,291.56	286,489.84	400,762.75	8,549.77	726.05	2,903.11	15,476.37	5,427.50	2,149.40	1,050,994.19
1994	2,113.28	2,728.80	11,331.66	10,497.72	114,352.62	72,512.54	6,769.66	9,011.63	18,316.85	605,237.42	5,521.48	65,866.78	924,260.44
1995	84,809.61	5,152.05	82,363.09	50,322.48	24,060.69	41,849.17	24,175.23	11,154.52	8,086.18	10,406.96	3,042.78	54,525.78	399,948.54
1996	2,274.75	584.38	732.91	1,723.86	1,875.32	15,767.98	5,260.07	31,505.97	110,836.15	6,021.53	5,000.15	22,648.39	204,231.46
1997	128,935.74	54,089.79	356,741.32	373,085.86	200,127.80	203,083.84	5,461.32	6,975.50	21,359.28	316,779.94	31,953.84	50,157.72	1,748,751.95
1998	36,582.31	117,269.36	43,887.96	6,639.60	33,123.89	2,090.10	4,621.25	30,263.35	286,566.45	513,640.74	404,607.14	50,906.29	1,530,198.44
1999	16,085.26	4,019.35	29,743.40	3,635.30	23,471.17	104,181.33	18,531.94	4,258.17	1,039.79	2,377.62	439.09	558.27	208,340.69
2000	546.22	510.98	546.22	12,344.12	53,378.50	31,928.66	3,596.36	2,904.16	1,553.11	4,577.42	101,114.00	17,489.54	230,489.29
2001	66,291.12	2,613.68	87,892.09	3,644.57	32,124.96	3,272.15	5,111.66	30,028.81	284,698.83	37,968.21	31,882.28	104,699.71	690,228.07
2002	3,584.85	2,085.62	1,139.12	35,672.49	3,007.01	1,636.46	104,076.73	5,601.71	94,109.56	192,695.52	279,421.87	139,890.93	862,921.87
2003	64,852.00	40,578.47	12,385.65	7,633.01	2,110.78	2,816.42	43,177.72	1,100.13	28,862.14	47,385.62	38,292.84	2,623.47	291,818.25
2004	26,257.31	78,913.38	45,311.96	95,512.21	282,843.11	355,774.18	79,296.32	5,587.51	11,413.77	50,514.88	697,503.09	11,954.61	1,740,882.33
2005	15,506.17	141,853.74	117,298.72	7,599.82	55,022.14	17,184.33	34,390.24	5,535.89	4,483.60	11,466.07	2,648.32	3,851.40	416,840.44
2006	1,927.86	1,809.30	693.41	1,132.68	20,947.59	5,797.94	27,002.36	1,648.40	12,506.95	73,496.35	2,051.44	2,328.17	151,342.45
2007	152,841.68	7,796.93	120,101.08	60,947.00	177,220.85	15,398.53	490,567.72	80,724.48	47,821.97	40,091.57	13,672.93	2,676.52	1,209,861.26
2008	23,002.52	43,705.67	33,559.90	5,255.43	2,967.21	1,271.22	2,563.15	1,644.91	15,006.78	2,869.35	855.67	399.23	133,101.04
2009	293.92	274.87	301.22	60,891.28	688.48	315.70	295.14	321.83	289.52	89,302.16	31,882.93	115,745.90	300,602.95
2010	129,362.82	75,510.15	4,379.16	5,446.14	52,045.81	10,537.47	131,455.65	2,987.47	80,263.55	4,207.05	1,528.62	837.31	498,561.20
2011	3,025.34	2,811.65	976.61	289.48	297.82	201.63	295.55	322.09	212.70	321.94	289.58	191.29	9,235.68
2012	268.34	1,366.19	15,065.10	3,798.40	11,148.76	2,070.94	68,275.24	3,965.49	4,695.82	14,712.17	1,760.78	1,206.36	128,333.59
2013	1,590.87	404.08	200.06	7,922.45	10,162.79	1,690.54	2,269.49	990.03	2,680.79	6,588.37	3,708.77	1,063.98	39,272.22
2014	1,398.51	431.06	2,458.67	325.38	114,972.12	49,532.62	5,662.13	3,726.53	5,616.12	3,599.32	1,590.64	295.57	189,608.67
2015	2,993.10	1,618.51	194,656.16	154,701.25	136,513.85	471,590.28	14,073.47	4,975.90	10,538.29	45,422.18	26,875.84	40,555.26	1,104,514.09
2016	19,971.98	4,504.03	83,683.50	135,317.91	100,406.69	88,011.31	5,983.30	69,852.67	25,681.66	2,609.93	2,524.50	3,612.51	542,159.99
2017	73,600.17	88,600.83	75,398.52	71,827.53	6,538.53	7,253.20	6,697.39	421,068.45	71,320.21	4,793.34	1,935.04	2,258.65	831,291.86
2018	2,754.71	4,687.72	2,885.59	4,470.15	1,887.04	9,916.02	6,100.12	2,920.24	12,906.57				

COMMENTS:

Shown in AC-FT.

Releases are from the Spillway & River Outlet Works and include: Operational testing, Seepage, Bay & Estuary, and Flood.

First recorded freshwater release ~ May 1982.

Bay & Estuary releases began in 1994.

Form# 126
Rev '04

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
HISTORICAL DETAIL OF M & I DIVERSIONS

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
2010													
EAST	1,692.49	1,531.15	1,708.55	1,774.24	1,917.68	1,938.92	2,029.44	2,130.28	1,958.30	2,089.97	1,757.80	1,779.20	22,308.02
WEST	4,004.07	3,776.54	4,293.79	4,087.87	4,153.17	4,169.80	4,450.15	4,437.23	4,238.80	4,338.81	4,173.32	4,193.66	50,317.21
TOTAL	5,696.56	5,307.69	6,002.34	5,862.11	6,070.85	6,108.72	6,479.59	6,567.51	6,197.10	6,428.78	5,931.12	5,972.86	72,625.23
2011													
EAST	1,703.90	1,553.53	1,871.59	1,996.95	1,969.87	2,095.95	2,288.15	2,387.78	1,824.01	1,997.77	2,024.95	2,009.92	23,724.37
WEST	3,983.96	3,696.93	4,099.78	3,968.86	4,171.98	4,083.35	4,268.25	3,858.21	2,170.53	2,243.11	2,144.77	2,218.26	40,907.99
TOTAL	5,687.86	5,250.46	5,971.37	5,965.81	6,141.85	6,179.30	6,556.40	6,245.99	3,994.54	4,240.88	4,169.72	4,228.18	64,632.36
2012													
EAST	2,073.41	1,809.74	2,003.89	2,028.15	2,178.25	2,233.95	2,205.14	2,412.91	2,173.63	2,101.34	2,127.38	2,120.10	25,467.89
WEST	2,950.07	3,781.66	4,286.34	4,081.04	4,217.51	4,070.73	4,400.18	3,764.11	4,112.08	4,178.15	3,997.14	3,976.38	47,815.38
TOTAL	5,023.48	5,591.40	6,290.23	6,109.19	6,395.76	6,304.68	6,605.32	6,177.02	6,285.71	6,279.49	6,124.52	6,096.48	73,283.27
2013													
EAST	1,989.57	1,757.81	2,001.20	1,932.84	2,087.41	2,124.24	2,415.40	2,402.03	2,170.11	2,159.07	1,918.75	1,942.02	24,900.45
WEST	3,844.10	3,685.36	4,074.21	3,917.57	4,044.26	3,950.29	4,161.85	4,182.35	4,030.30	4,109.99	3,566.42	3,459.01	47,025.71
TOTAL	5,833.67	5,443.17	6,075.41	5,850.41	6,131.67	6,074.53	6,577.25	6,584.38	6,200.41	6,269.06	5,485.17	5,401.03	71,926.16
2014													
EAST	1,971.93	1,770.45	1,995.54	2,035.51	2,176.28	2,301.63	2,362.78	2,416.68	2,152.47	2,033.79	1,527.63	1,692.59	24,437.28
WEST	3,767.17	3,557.46	4,054.54	3,919.35	4,025.30	3,868.02	4,295.14	4,244.05	3,868.63	4,148.66	3,472.60	3,118.48	46,339.40
TOTAL	5,739.10	5,327.91	6,050.08	5,954.86	6,201.58	6,169.65	6,657.92	6,660.73	6,021.10	6,182.45	5,000.23	4,811.07	70,776.68
2015													
EAST	1,833.72	1,773.72	1,962.26	1,991.48	2,177.53	2,190.28	2,430.14	2,369.59	2,089.72	1,992.85	1,972.61	1,918.00	24,701.90
WEST	3,620.98	3,641.28	3,983.79	3,862.79	4,030.91	3,724.97	3,057.41	2,489.43	2,160.66	1,995.06	4,039.70	2,136.95	38,743.93
TOTAL	5,454.70	5,415.00	5,946.05	5,854.27	6,208.44	5,915.25	5,487.55	4,859.02	4,250.38	3,987.91	6,012.31	4,054.95	63,445.83
2016													
EAST	1,854.81	1,774.35	1,987.09	1,977.27	2,160.62	2,236.48	2,321.09	2,254.59	2,146.61	1,948.64	1,979.78	1,871.57	24,512.90
WEST	1,285.40	3,736.18	3,931.63	3,748.88	3,745.06	3,742.54	3,955.66	3,052.27	2,989.09	4,010.12	3,905.20	3,775.98	41,878.01
TOTAL	3,140.21	5,510.53	5,918.72	5,726.15	5,905.68	5,979.02	6,276.75	5,306.86	5,135.70	5,958.76	5,884.98	5,647.55	66,390.91
2017													
EAST	1,727.70	1,374.28	1,964.93	1,931.56	2,079.71	1,928.80	2,083.92	1,735.33	1,857.71	2,067.12	1,978.08	1,878.80	22,607.94
WEST	3,926.39	3,538.47	3,874.37	3,887.94	4,147.11	4,118.07	4,023.01	3,810.45	3,647.51	3,851.36	3,819.37	3,698.33	46,342.38
TOTAL	5,654.09	4,912.75	5,839.30	5,819.50	6,226.82	6,046.87	6,106.93	5,545.78	5,505.22	5,918.48	5,797.45	5,577.13	68,950.32
2018													
EAST	1,765.23	1,711.92	2,140.17	1,955.96	2,221.83	2,048.94	2,186.45	2,279.71	2,100.92	2,101.88	1,885.13	1,873.87	24,272.01
WEST	3,799.87	661.49	2,939.45	3,250.18	3,338.53	3,168.48	2,668.65	3,376.03	3,272.09	3,899.37	3,829.05	3,936.77	38,139.96
TOTAL	5,565.10	2,373.41	5,079.62	5,206.14	5,560.36	5,217.42	4,855.10	5,655.74	5,373.01	6,001.25	5,714.18	5,810.64	62,411.97
2019													
EAST	1,822.36	1,699.79											
WEST	2,326.56	2,395.03											
TOTAL	4,148.92	4,094.82											

COMMENTS:
Shown in AC-FT.
West M&I diversions began in October 1998.

Form# 129
Rev '04

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
HISTORICAL RAINFALL AT TEXANA WEATHER STATION

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	ANNUAL TOTAL
1989	4.880	0.300	0.990	0.730	1.180	4.790	3.230	1.880	2.140	2.320	1.580	1.020	25.040
1990	2.360	3.630	4.250	4.970	2.740	1.050	5.620	0.820	2.650	1.210	2.720	2.070	34.090
1991	6.540	4.320	2.160	7.930	3.530	2.160	4.530	1.400	5.150	2.150	1.920	8.400	50.190
1992	4.700	7.800	2.130	5.600	4.830	5.870	2.370	3.160	2.480	2.170	5.660	3.250	50.020
1993	4.580	4.330	3.240	3.260	11.490	8.400	0.040	1.210	1.180	4.130	2.260	4.570	48.690
1994	1.330	1.060	4.050	2.550	4.400	5.680	0.730	6.080	4.130	11.550	0.580	2.460	44.600
1995	2.440	0.790	4.990	3.950	6.190	3.070	1.100	8.510	4.040	4.750	2.110	7.480	49.420
1996	0.360	0.340	1.010	1.190	0.120	7.140	0.730	0.020	4.460	1.400	2.230	2.510	21.510
1997	4.130	2.540	11.620	5.480	16.130	2.630	2.500	0.600	6.020	8.960	2.620	2.300	65.530
1998	2.290	5.290	2.300	0.810	0.030	0.490	0.530	4.920	15.360	6.800	10.830	1.700	51.350
1999	1.260	1.050	3.740	0.820	6.910	3.820	4.530	0.490	1.410	0.880	0.930	2.440	28.280
2000	2.280	1.350	3.180	2.210	7.890	2.660	0.540	1.080	1.670	2.490	8.890	2.390	36.630
2001	3.260	0.840	2.470	0.140	1.410	2.610	1.200	9.290	8.850	5.870	7.590	5.630	49.160
2002	1.070	0.571	0.450	3.290	1.690	3.180	9.220	2.550	12.490	8.790	5.350	4.412	53.063
2003	4.250	2.290	1.480	0.220	0.270	6.520	5.040	0.530	8.910	5.239	2.430	1.290	38.469
2004	3.370	2.630	1.310	5.800	12.090	12.360	4.970	3.290	1.240	4.310	6.400	1.560	59.330
2005	1.840	4.000	4.110	0.990	5.380	0.810	6.131	1.310	1.690	3.680	5.280	1.550	36.771
2006	0.971	1.460	0.540	2.140	6.660	3.680	5.540	1.250	4.910	3.020	0.420	2.090	32.681
2007	6.250	0.310	7.200	2.810	6.680	3.950	15.720	5.780	1.670	2.080	2.880	0.980	56.310
2008	3.960	1.020	2.230	1.800	0.620	0.720	3.520	4.270	1.930	1.200	2.410	0.740	24.420
2009	0.150	0.170	2.010	2.070	2.120	0.070	0.680	2.330	4.850	6.270	3.580	4.500	28.800
2010	3.450	3.010	2.080	0.460	5.500	2.630	15.040	1.360	12.500	0.010	2.180	2.410	50.630
2011	3.320	0.570	0.730	0.010	1.110	2.090	0.510	0.370	1.120	1.900	0.630	1.590	13.950
2012	3.420	4.290	4.560	2.490	3.400	2.130	13.810	1.800	4.010	0.850	0.490	2.560	43.810
2013	4.290	2.010	0.470	1.920	0.790	1.550	3.840	4.090	7.080	7.530	2.560	0.510	36.640
2014	1.480	1.770	2.510	0.670	5.760	3.080	0.960	1.070	4.680	2.380	4.570	3.010	31.940
2015	2.310	1.250	7.290	4.970	7.800	11.170	0.600	3.230	4.160	4.640	1.870	1.420	50.710
2016	2.210	2.260	3.660	6.050	5.330	4.560	1.500	7.910	5.050	0.070	2.110	3.360	44.070
2017	1.300	4.260	3.190	5.630	2.990	3.480	1.590	13.450	3.690	0.980	1.520	3.370	45.450
2018	1.050	0.990	2.920	1.180	0.630	7.150	0.290	2.560	8.370	6.590	3.140	4.760	39.630
2019	2.350	3.750											6.100
MONTHLY AVERAGE	2.716	2.249	2.712	2.667	4.536	4.507	3.627	3.092	5.207	3.805	3.418	2.839	40.601

COMMENTS:
Shown in Inches.
Rainfall records began ~ January 1973

Form# 128
Rev '04

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
HISTORICAL MONTHLY PAN EVAPORATION

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	MONTHLY AVERAGE P/YEAR	ANNUAL TOTAL
1989	2.540	2.850	5.670	5.260	9.590	9.150	8.670	9.630	8.270	7.510	3.650	2.510	6.275	75.300
1990	3.090	5.120	5.540	7.140	7.170	9.180	10.030	7.860	6.450	7.800	4.080	3.490	6.413	76.950
1991	6.080	5.690	5.490	11.360	5.538	7.831	9.461	8.552	7.319	6.352	3.268	5.729	6.889	82.670
1992	4.619	4.801	5.648	7.127	8.760	7.984	9.541	8.572	8.597	7.103	4.598	6.163	6.959	83.513
1993	3.816	5.218	5.655	7.292	8.748	7.799	8.588	9.725	8.130	8.129	4.507	3.550	6.763	81.157
1994	3.555	2.903	5.732	5.714	6.769	8.380	10.578	8.126	7.240	13.028	3.970	2.535	6.544	78.530
1995	3.201	3.181	6.470	6.659	9.325	8.702	8.911	9.300	6.518	7.019	3.733	5.835	6.571	78.854
1996	3.679	6.511	5.673	6.881	8.367	12.430	9.713	6.638	6.307	5.097	5.968	3.124	6.699	80.388
1997	3.471	3.076	3.516	7.799	6.022	9.385	9.523	9.785	9.665	4.186	6.879	3.029	6.361	76.336
1998	3.250	2.539	4.383	6.673	7.058	12.436	10.537	7.615	7.358	4.142	6.386	2.246	6.219	74.623
1999	3.088	3.394	4.680	5.899	6.395	9.541	6.634	8.718	7.363	6.510	7.428	4.141	6.149	73.791
2000	4.256	7.084	6.088	8.913	7.504	8.960	10.852	9.770	8.861	5.072	3.403	2.721	6.957	83.484
2001	3.169	3.251	4.528	6.716	8.267	8.652	10.370	8.676	6.486	5.207	3.645	2.618	5.965	71.585
2002	2.734	4.400	8.136	6.733	9.087	8.317	8.043	8.481	6.097	4.404	3.925	2.984	6.112	73.341
2003	2.740	2.556	4.324	5.990	8.837	8.950	6.816	8.693	5.437	5.241	4.072	3.652	5.609	67.308
2004	2.985	3.038	4.685	5.366	7.443	5.252	7.639	7.646	6.370	5.005	2.721	2.858	5.084	61.008
2005	2.974	2.764	5.380	6.827	6.582	8.559	9.153	8.919	7.971	6.012	4.741	3.301	6.099	73.183
2006	3.960	3.861	5.318	6.230	7.494	7.290	6.005	7.564	6.224	4.538	4.446	3.116	5.504	66.046
2007	1.642	3.031	5.037	5.066	5.775	6.167	4.829	6.642	5.484	6.006	4.355	3.105	4.762	57.139
2008	3.321	3.941	5.708	6.929	8.464	10.310	8.926	7.088	7.417	7.865	4.767	3.572	6.526	78.308
2009	4.402	5.025	6.340	7.968	7.932	10.720	11.944	10.357	4.850	3.795	3.191	2.002	6.544	78.526
2010	2.763	2.626	5.681	6.384	7.073	8.281	6.627	7.882	4.960	6.631	4.382	3.651	5.578	66.941
2011	2.757	3.456	5.837	7.616	8.825	10.190	11.228	11.668	10.531	7.963	5.047	3.865	7.415	88.983
2012	3.839	2.286	4.838	7.518	8.273	8.331	5.658	8.741	6.480	5.884	4.566	3.924	5.862	70.338
2013	2.653	3.455	6.486	5.142	7.859	9.088	7.990	7.753	6.561	5.476	3.248	2.637	5.696	68.348
2014	3.315	2.627	4.287	6.655	6.903	7.415	8.838	9.519	6.535	6.456	3.056	2.973	5.715	68.579
2015	2.565	3.041	3.916	5.606	4.167	7.164	9.627	9.507	5.266	6.768	3.879	2.685	5.349	64.191
2016	3.069	4.837	5.398	5.574	6.228	7.824	9.518	7.151	7.356	6.508	4.281	3.220	5.914	70.964
2017	4.063	4.062	6.166	6.935	8.105	8.290	10.485	7.574	6.196	6.770	4.341	3.446	6.369	76.433
2018	3.082	2.534	5.221	6.322	8.354	8.806	9.166	10.464	4.961	4.482	3.338	3.584	5.860	70.314
2019	3.290	3.028											3.159	6.318
MONTHLY AVERAGE P/MO	3.432	3.743	5.399	6.840	7.392	8.748	8.899	8.668	6.936	6.285	4.309	3.532	6.121	

COMMENTS:

Shown in Inches.

Impoundment of water began ~ May 1980

Pan evaporation records began ~ May 1982

Form# 0103
Rev '13

LAVACA-NAVIDAD RIVER AUTHORITY
LAKE TEXANA ~ PALMETTO BEND PROJECT
COMPUTATIONS FOR
AGREEMENT CONCERNING BAY AND ESTUARY RELEASES

INFLOW PERIOD

28-Jan-19	TO	3-Feb-19
AT 0000 HRS		AT 2400 HRS

DAY	DATE	110 MUSTANG (CFS)	1799 EAST MUSTANG (CFS)	*UNGAUGED* EAST MUSTANG 28% OF 1799 (CFS)	221 SANDY (CFS)	*UNGAUGED* SANDY 69.9% OF 221 (CFS)	1699 NAVIDAD at STRANE PARK (CFS)	*UNGAUGED* NAVIDAD 3.8% OF 1699 (CFS)	ACTUAL INFLOW RATE (CFS)	AGREEMENT RATE MAXIMUM (CFS)	ACTUAL INFLOW VOLUME (AC-FT)	AGREEMENT VOLUME MAXIMUM (AC-FT)	TOTAL RELEASE VOLUME (AC-FT)
MONDAY	01/28/19	24.4	6.1	1.7	93.9	65.6	153.0	5.8	350.5	84.5	695.4	167.6	167.60
TUESDAY	01/29/19	46.4	4.9	1.4	121.7	85.1	141.1	5.4	406.0	84.5	805.5	167.6	167.60
WEDNESDAY	01/30/19	35.1	3.8	1.1	111.0	77.6	138.9	5.3	372.8	84.5	739.6	167.6	167.60
THURSDAY	01/31/19	25.5	3.2	0.9	80.7	56.4	127.5	4.8	299.0	84.5	593.2	167.6	167.60
FRIDAY	02/01/19	57.7	4.0	1.1	95.8	67.0	152.5	5.8	383.9	142.4	761.7	282.5	282.50
SATURDAY	02/02/19	59.1	5.9	1.7	106.2	74.2	158.9	6.0	412.0	142.4	817.4	282.5	282.50
SUNDAY	02/03/19	86.3	107.8	30.2	109.0	76.2	211.0	8.0	628.5	142.4	1,246.9	282.5	282.50
										TOTALS	5,659.7	1,517.9	1,517.90

ALTERNATIVE RELEASE SCHEDULES:

ELEVATION OF RESERVOIR				44.15	FEET	ELEVATION OF RESERVOIR				44.15	FEET
1	SPILLWAY GATE(S)					1	ROW GATE				
AT	1	STAGE		0	CFS	AT	1	STAGE		0	CFS
RELEASE RATE				0.00	AF/HR	RELEASE RATE				0.00	AF/HR
RELEASE VOLUME				0.00	AC-FT	RELEASE VOLUME				0.00	AC-FT
SEEPAGE B & E				0.00	AC-FT	SEEPAGE B & E				0.00	AC-FT
NET VOLUME FOR RELEASE				0.00	AC-FT	NET VOLUME FOR RELEASE				0.00	AC-FT
TIME NECESSARY FOR RELEASE				0.00	HOURS	TIME NECESSARY FOR RELEASE				0.00	HOURS
0	DAY(S)	0	HOUR(S)	0	MINUTE(S)	0	DAY(S)	0	HOUR(S)	0	MINUTE(S)

ACTUAL RELEASES FOR: 01/28/19 thru 02/03/19

DATE	RESERVOIR ELEVATION (FEET ~ MSL)	RESERVOIR CONTENT (AC-FT)	RELEASES SPILLWAY (AC-FT)	RELEASES ROW (AC-FT)	SEEPAGE B & E (AC-FT)	TOTAL RELEASE (AC-FT)
01/28/19	44.06	161,695	223.71	0.00	6.15	229.86
01/29/19	44.18	162,917	410.41	0.00	6.15	416.56
01/30/19	44.12	162,305	706.82	0.00	6.15	712.97
01/31/19	44.12	162,305	1,030.40	0.00	6.15	1,036.55
02/01/19	44.11	162,203	1,028.74	0.00	6.15	1,034.89
02/02/19	44.11	162,203	1,129.69	0.00	6.15	1,135.84
02/03/19	44.08	161,898	2,063.00	0.00	6.15	2,069.15
SUBTOTALS			6,592.77	0.00	43.05	
TOTAL RELEASES						6,635.82

RELEASE ASSIGNMENT:	01/28/19 thru 02/03/19
SPILLWAY RELEASE	6,592.77
ROW RELEASE	0.00
SEEPAGE B & E	43.05
TOTAL RELEASE	6,635.82
B & E REQUIREMENT	1,517.90
CORRECTION	0.00
FLOOD RELEASE	5,117.92
TOTAL RELEASE	6,635.82

COMPLETED BY: Chadwick Kinfaster

4-Feb-19
COMMENTS:
B&E for the week 2-4-19 taken out of flood release. 1517.9

APPROVED: 1223   740   1202   1100

DATE: 2/4/19   2/4/19   2/4/19   2/4/19

APPENDIX C

Agreement Concerning Bay and Estuary Releases

STATE OF TEXAS §
§
§
COUNTY OF TRAVIS §

AGREEMENT CONCERNING BAY AND ESTUARY RELEASES

WHEREAS, Lake Texana (formerly known as Palmetto Bend Reservoir) is located on the Navidad River and impounds water that might otherwise flow into Lavaca Tres Palacios Bay and Estuary System;

WHEREAS, Certificate of Adjudication 16-2095 provides that the Lake Texana appropriation is subject to the release of water for the maintenance of Lavaca-Matagorda Bay and Estuary System, as may be determined by the Commission;

WHEREAS, the Texas Parks and Wildlife Department (TPWD), the Texas Water Development Board (TWDB) and the Lavaca-Navidad River Authority (LNRA) participated as adversary parties in a Texas Water Commission proceeding to determine what releases, if any, should be made from Lake Texana for the benefit of the bays and estuaries, which proceeding has not resulted in a final decision resolving the issue;

WHEREAS, TPWD and TWDB staff over the last two years have cooperated in developing a schedule to pass natural reservoir inflows through Lake Texana in a manner calculated to retain the maximum water supply capability for the reservoir, while providing appropriate protection for Lavaca Tres Palacios Bay and Estuary System;

WHEREAS, increasing water supply demands are being placed upon Lake Texana at this time and additional major water supply commitments are being contemplated,but any decision as to ultimate construction of Stage II is uncertain and would only be made following extensive environmental analysis and consideration of potential impacts of Stage II construction on the bays and estuaries;

WHEREAS, Lavaca Navidad River Authority is in the process of exercising its option to acquire TWDB's interest in the Lake Texana project;

WHEREAS, additional unappropriated water is now available, over and above the amounts already appropriated for Stage I and Stage II, which if not appropriated to the projects in order to preserve its availability to satisfy freshwater inflow requirements might be appropriated for other purposes;

WHEREAS, given the pass through provision described herein, and the additional appropriation contemplated, Lake Texana retains an original conditions firm yield of 74,400 acre feet/year, as compared to the 75,000 acre feet/year yield initially authorized by the Texas Water Rights Commission, which is available for diversion;

WHEREAS, TPWD, TWDB, and LNRA agree that it is desirable to quantify the release or pass through requirement for the Lake Texana project in order to provide the certainty required for future operations and for preservation of the bay and estuary system;

NOW, THEREFORE, TPWD, TWDB, and LNRA (the "parties") hereby agree to the following:

1. The parties agree that Certificate of Adjudication 16-2095 should be amended to quantify existing requirements by providing the following "pass through requirements" for stage one of Lake Texana:

   a. when 78.18% or more of the reservoir's capacity contains stored inflows, all inflows into the reservoir up to the historical monthly median flow during the months of January, February, March, July, November, and December, and all inflows up to the historical monthly average flow of the months of April, May, June, August, September, and October shall be passed through the reservoir and shall not be subject to diversion for other uses. For purposes of this paragraph the historical median monthly flows and historical monthly average flows shall be those shown on Attachment A.

   b. when less than 78.18% of the reservoir's capacity contains stored inflows, all inflows up to the annual median daily flow for the drought period January 1954 through December 1956 (5 cfs) shall be passed through the reservoir and shall not be subject to diversion for other uses.

   As used in this provision, the term "inflows" refers to naturally occurring in-basin inflows. It does not include water supplies imported from out of the basin, unless those supplies are imported by a junior permittee upstream of Lake Texana for the purpose of replacing naturally occurring in-basin inflows in order to avoid impairment of water rights granted pursuant to Certificate of Adjudication 16-2095, as amended, including required freshwater inflows.

2. Following amendment of the certificate of adjudication, as set forth above, the parties will cooperate in developing operating procedures for the reservoir to be utilized to implement the pass through requirements.

3. Release or pass through requirements for Stage II of the reservoir project will be determined in the future by the Texas Water Commission prior to beginning of construction of Stage II. The parties agree to establish a joint committee, composed of representatives of TPWD, TWDB, and LNRA, to utilize then available data and bay and estuary models to determine an appropriate level of releases or pass throughs to assure that salinity and nutrient availability conditions of the Lavaca-Matagorda Bay and Estuary System are not significantly adversely affected by construction and operation of Stage II. The committee will present its unanimous report to the Texas Water Commission for

establishment of Stage II release or pass through requirements prior to construction of Stage II.

4. The parties agree that Lake Texana's Certificate of Adjudication should be amended as follows:

   a. All additional "additional firm yield" of Stage II should be appropriated for the project, increasing the total appropriation to 47,000 af/yr.

   b. Amend Stage II authorization to require provision for and determination of freshwater inflows adequate to assure that salinity and nutrient availability conditions are not significantly adversely affected in the bay and estuary system, to include explicit recognition of provision of bay and estuary inflows as an authorized use under the permit, and to require the freshwater inflow determinations prior to commencement of construction of Stage II.

5. The parties agree to cooperate in amending the Lake Texana permit to appropriate available unappropriated water consistent with the other provisions herein.

6. The parties agree that gaging stations to measure inflows into Lake Texana shall be in-place and operational within one year after the issuance of Lake Texana bonds. Gaging stations to measure outflows from Lake Texana will not be required to be in-place until the latter of one year after LNRA has entered contracts committing at least 40,000 acre-feet per year from Lake Texana or one year following issuance of Lake Texana Bonds, subject to obtaining necessary federal approvals. During the period prior to installation of the outflow gaging stations, LNRA shall maintain records of dam outlet settings and shall prepare monthly estimates of inflows passed through the dam.

7. This agreement is intended to resolve all outstanding contested cases, whether administrative or judicial, between the parties. Toward that end, the parties agree as follows:

   a. The parties will recommend to the Texas Water Commission that, contemporaneously with adoption of the pass through requirements identified under paragraph one and the amendments identified in paragraph 4.b., the Texas Water Commission should dismiss the pending hearing to determine bay and estuary releases, if any, from Lake Texana.

   b. The parties will cooperate in requesting the remand of pending lawsuits in Travis County District Court to the Texas Water Commission and recommend to the Commission that the additional appropriation previously requested by LNRA and TWDB (now the subject of Cause No. 361,294) be granted.

c. TPWD will support LNRA's efforts in monitoring and attempting to control the authorization of new appropriations above the project or the renewal of existing term permits to the extent those efforts are consistent with the provisions of this agreement.

d. Each party agrees to use its best efforts to persuade all other parties to the foregoing proceedings to endorse these principles of agreement.

e. The parties agree that the provisions of Texas Water Code § 16.1341 should not apply to the pass through of inflows required by paragraph one.

May 26, 1992
DATE

Andrew Sansom

Andy Sansom, Executive Director
Texas Parks and Wildlife Commission

ATTEST:

Myron J. Hess

Myron Hess, Legal Services
Division

May 22, 1992
DATE

Craig Pedersen

Craig Pedersen, Executive Administrator
Texas Water Development Board

ATTEST:

Suzanne Schwartz

Suzanne Schwartz, General Counsel

05/20/92
DATE

Emmett Gloyna

Emmett Gloyna, General Manager
Lavaca Navidad River Authority

ATTEST:

Denise Ryan

Denise Ryan, Assistant General
Manager for Administration

ATTACHMENT A

MONTH	CFS	MONTH	CFS
January	84.5	July	126.5
February	142.4	August	265.7
March	86.8	September	1,027.3
April	806.8	October	708.3
May	1,169.3	November	68.3
June	1,191.4	December	79.3

APPENDIX D

Agreement Concerning Upstream Permit Holders
(Compromise Settlement Agreement)

<u>COMPROMISE SETTLEMENT AGREEMENT</u>

THIS AGREEMENT is by and between the Lavaca-Navidad River Authority ("LNRA"), the Texas Water Development Board ("TWDB"), Travis Norris Raun and Richard Raun ("Rauns"), Edmund J. Weinheimer, Jr. ("Weinheimer"), T-Bar-D, L.L.C. ("T-Bar-D"), William J. Naiser ("Naiser"), A. J. Richter ("Richter"), Jack Birkner ("Birkner"), Mr. & Mrs. Anton Brandl, Jr. ("Brandls"), Eva Ruth Hancock, et al. ("Hancock"), Kenneth Goff ("Goff"), John Richards ("Richards"), Edmund A. Weinheimer, III ("Weinheimer, III"), El Rancho de los Patos, Inc. ("El Rancho"), Don Srubar ("Srubar"), Alan Meek ("Meek"), Engstrom Brothers ("Engstroms"), P. M. Tucker ("Tucker"), and F. E. Appling Interests ("Appling"), collectively referred to as the "Parties." In consideration of the agreements set forth below, the Parties do hereby compromise and settle all disputes between them as to the matters set forth herein.

WHEREAS, Lake Texana, also called the Palmetto Bend Project, was constructed by the United States Bureau of Reclamation in the late 1970's at a total cost of 90 million dollars;

WHEREAS, the entire firm yield of the water of Lake Texana has been appropriated through a water rights adjudication and permitting process as evidenced by Certificate of Adjudication No. 16-2095 and its amendments.

WHEREAS, the LNRA and TWDB are local sponsors and permittees for the Palmetto Bend Project and are obligated to repay the approximately 70 million dollar (plus interest) owed to the United States Bureau of Reclamation;

WHEREAS, the means of repayment of the aforementioned debt is through revenues from the sale of water from Lake Texana;

WHEREAS, the LNRA has entered into a water delivery contract with the City of Corpus Christi, Texas ("Corpus Christi") which requires the diversion of about 42,000 acre-feet/year of water to Corpus Christi;

WHEREAS, in order to fulfill such contractual obligations to Corpus Christi, the LNRA and TWDB have filed at the Texas Natural Resource Conservation Commission ("TNRCC") an application to amend Certificate of Adjudication No. 16-2095 to authorize the transbasin diversion and change in purpose of use of water from Lake Texana to Corpus Christi;

WHEREAS, the LNRA and TWDB application is Docket No. 96-0417, Application by Lavaca-Navidad River Authority and Texas Water Development Board for Amendment to Certificate of Adjudication No. 16-2095, Before the Texas Natural Resource Conservation Commission ("LNRA/TWDB Application").

WHEREAS, the Rauns hold term permit no. 4252 authorizing them to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, the Rauns have filed a protest in opposition to the LNRA/TWDB Application and have also filed, in Docket No. 96-0520-WR before the TNRCC, Application No. 4559A for renewal of their term permit;

WHEREAS, Weinheimer holds term permit No. 4241 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Weinheimer has filed a protest in opposition to the LNRA/TWDB Application and has also filed, in Docket No. 96-0519-WR before the TNRCC, Application No. 4560B for renewal of his term permit;

WHEREAS, T-Bar-D holds term permit no. 4102 authorizing it to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, T-Bar-D has filed, in Docket No. 96-0522-WR before the TNRCC, Application No. 4327A for renewal of his term permit;

WHEREAS, Naiser holds term permit no. 2090 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Naiser has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Richter holds term permit no. 2086 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Richter has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Birkner holds term permit no. 3665A authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Birkner has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, the Brandls hold term permit no. 4298 authorizing them to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, the Brandls have filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Hancock holds term permit no. 5370 authorizing permittees to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Hancock has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Goff holds term permit no. 4300A authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Goff has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Richards holds term permit no. 5168 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Richards has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Weinheimer, III, holds term permit no. 3910 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Weinheimer, III, has filed a protest in opposition to the LNRA/TWDB application;

WHEREAS, El Rancho holds term permit no. 3905A authorizing it to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, El Rancho has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Srubar holds term permit no. 4085A authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Srubar has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Meek holds term permit no. 3876A authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Meek has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Engstroms hold term permit no. 2080 authorizing them to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Engstroms have filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Tucker holds term permit no. 2093 authorizing him to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Tucker has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, Appling holds term permit no. 4270 authorizing it to divert and use water upstream from Lake Texana for irrigation purposes;

WHEREAS, Appling has filed a protest in opposition to the LNRA/TWDB Application;

WHEREAS, the LNRA and TWDB have each filed protests to the granting of Applications No. 4327A and 4342A and requested hearings on these applications;

WHEREAS, LNRA and TWDB have been granted party status in contested case hearings on all these applications;

WHEREAS, the LNRA has filed protests and to the granting of Applications No. 4560B and 4559A and requested hearings on these applications;

WHEREAS, the Parties desire to avoid the time and expense involved in potential contested case proceedings involving the LNRA/TWDB Application as well as involving the above-described term permit renewal applications;

WHEREAS, the Parties desire to compromise and settle all claims and causes of action of any kind which any of the Parties now have or may have in the future related to the LNRA/TWDB Application, the above-described term permit renewal applications, and future applications for renewal of term permits upstream from Lake Texana; and,

WHEREAS, the Parties intend that the full terms and conditions of the compromise and settlement be set forth in this Compromise Settlement Agreement.

NOW THEREFORE, in consideration of the premises and the promises and covenants herein contained including the recitals set forth hereinabove, and for good and valuable consideration, the receipt of which is hereby acknowledged, the Parties agree as follows:

1. Raun and Weinheimer agree for themselves; their co-permittees, if any; their families; agents and representatives to immediately withdraw their protests to the LNRA/TWDB Application.

2. Naiser, Richter, Birkner, Brandls, Hancock, Goff, Richards, El Rancho, Srubar, Meek, Engstroms, Tucker, and Appling agree for themselves; their co-permittees, if any; their families; agents and representatives to immediately withdraw their protests to the LNRA/TWDB Application.

3. The LNRA and TWDB agree to withdraw their protests to the term permit renewal applications of Raun, Weinheimer and T-Bar-D subject to the following terms and conditions:

    a. The expired term permits of Raun (at 5500 af/yr), Weinheimer, and T-Bar D will be renewed by TNRCC for another ten-year term with the condition that, except as authorized in paragraphs 5 and 6 below, they expire one year following certification of substantial completion of the Lake Texana to Corpus Christi pipeline or other conveyance facility designed to transport the remainder of the Lake Texana yield, or approximately 42,000 acre-feet/year; and,

    b. All existing unexpired term permits will be allowed to continue through completion of their current term, even if that date is over one year following certification of completion of the Lake Texana to Corpus Christi pipeline or other conveyance facility described in 3a, above.

4. The LNRA and TWDB agree not to protest renewal of the term permits of Naiser Richter, Birkner, Brandls, Hancock, Goff, Richards, El Rancho, Srubar, Meek, Engstroms, Tucker, and Appling diversions are conditioned so that one year following certification of completion of the Lake Texana to Corpus Christi pipeline or other conveyance facility designed to transport the remainder of the Lake Texana yield as authorized by paragraphs 5 and 6 below.

5. Subject to the agreement of the Texas Parks and Wildlife Department, the LNRA and TWDB agree to the issuance or amendment of existing or expired term permits upstream from Lake Texana to allow diversion of water during winter months at times when Lake Texana is at or above 43.0 msl, or spilling, for the

purpose of creating or enhancing waterfowl habitat. This provision shall apply for the duration of the term of the permit.

6. Subject to the agreement of the Texas Parks and Wildlife Department, the LNRA and TWDB will agree to renewal or amendment of existing term permits to allow diversion and use of water upstream from Lake Texana for irrigation purposes during the 10 year term of the permits, provided that such diversions are limited to times when Lake Texana is at or above 43.0 msl. Prior to initiating diversions, permittees must confirm the level of Lake Texana with either the LNRA or the water master. Diversions must cease within 24 hours following the time that Lake Texana's level drops below 43.0 msl. This provision shall apply for the duration of the term of the permit.

7. The Parties agree to support creation of a water master for the Lavaca Basin and will seek to have the creation accomplished by the TNRCC as expeditiously as possible.

8. Following establishment of a water master, LNRA and TWDB agree not to object to conversion of term permits to permanent water rights, provided the authorization of such rights is limited as described in paragraphs 5 and 6, above.

9. The Parties agree that each has read and understands the effect of the foregoing Compromise Settlement Agreement and execute same of his or its own free will and accord for the purposes and considerations set forth herein.

10. It is understood and agreed that this Compromise Settlement Agreement shall be binding upon and inure to the benefit of each of the parties, their co-permittees, if any; their families; agents and representatives.

11. It is understood and agreed that this Compromise Settlement Agreement contains the entire agreement between the Parties and supersedes any and all prior agreements, arrangements or understandings between the Parties relating to the subject matter. No oral understandings, statements, promises or inducements contrary to the terms of this Compromise Settlement Agreement exist. This Compromise Settlement Agreement cannot be changed or terminated orally.

12. It is understood and agreed that this Compromise Settlement Agreement shall be governed by, construed and enforced in accordance with, and subject to, the laws of the State of Texas.

13. It is understood and agreed that this Compromise Settlement Agreement may be executed in a number of identical counterparts, each of which shall be deemed an original for all purposes.

IN WITNESS WHEREOF, the Parties have executed this agreement.

LAVACA-NAVIDAD RIVER AUTHORITY

By: Emmett Gloyna
Name: Emmett Gloyna
Its: General Manager

TEXAS WATER DEVELOPMENT BOARD

By: Craig D. Pedersen
Name: Craig D. Pedersen
Its: Executive Administrator

Travis Norris Raun
Travis Norris Raun

Edmund J. Weinheimer, Jr.
Edmund J. Weinheimer, Jr.

T-BAR-D, L.L.P.

By:
Name: John T. Draper
Its: Managing Partner

William J. Naiser

A. J. Richter
A. J. Richter

Jack W. Birkner
Jack Birkner

M. Anton Brandl Jr
Mrs Anton Brandl Jr.
Mr. & Mrs. Anton Brandl, Jr.

Eva Ruth Hancock
Eva Ruth Hancock, et al.

Kenneth Goff
Kenneth Goff

John Richards
John Richards

EL RANCHO DE LOS PATOS, INC.

By: Keith Treybig
Name: KEITH TREYBIG, POWER OF ATTORNEY
Its: El Rancho de los Patos, Inc.

Don Srubar
Don Srubar

Alan Meek
Alan Meek

ENGSTROM BROTHERS

By:____________________
Name:
Its:____________________

P M Tucker
P. M. Tucker

F. E. APPLING INTERESTS

By: Lloyd E. Appling Jr.
Name:

Its:______________________________

Edmund A. Weinheimer III
Edmund A. Weinheimer, III

ACKNOWLEDGMENTS

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

BEFORE ME, the undersigned authority, on this day personally appeared Emmett Gloyna, General Manager of Lavaca-Navidad River Authority, known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL of office, this 4th day of October, 19 96.

DENISE RYAN
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 10-6-99

Denise Ryan
Notary Public in and for
The State of Texas

Print Name Denise Ryan
My Commission Expires 10-06-99

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

BEFORE ME, the undersigned authority, on this day personally appeared Craig D. Pedersen Executive Administrator of Texas Water Development Board, known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL of office, this 13th day of November, 19 96.

Jean A. Hobbs
Notary Public in and for
The State of Texas

Print Name Jean A. Hobbs
My Commission Expires 6-7-2000

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 15th day of October, 1996, by Travis Norris Raun.

Debbie Radley

Notary Public in and for
The State of Texas

Print Name Debbie Radley

My Commission Expires ______

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 15th day of October, 1996, by Edmund ~~A~~. Weinheimer, Jr.

Debbie Radley

Notary Public in and for
The State of Texas

Print Name Debbie Radley

My Commission Expires ______

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

BEFORE ME, the undersigned authority, on this day personally appeared John J. Draper of T-Bar-D, L.L.P., known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL of office, this 23rd day of October ___, 19 96.

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 9-17-98

Debbie Radley
Notary Public in and for
The State of Texas

Print Name ______________________
My Commission Expires ____________

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

This instrument was acknowledged before me on the ____ day of ______________, 19___, by William J. Naiser.

____
Notary Public in and for
The State of Texas

Print Name ______________________
My Commission Expires ____________

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 15th day of October, 1996, by A.J. Richter.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 15th day of October, 1996, by Jack Birkner.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 21st day of October, 1996, by Mr. & Mrs. Anton Brandl, Jr.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 17th day of October, 1996 by Eva Ruth Hancock, et. al.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 15th day of October, 1996, by Kenneth Goff.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 15th day of October, 1996, by John Richards.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

Treybig **BEFORE ME**, the undersigned authority, on this day personally appeared Keith Treybig, w/ Power of Attorney of El Rancho de Los Patos, Inc., known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL of office, this 15th day of October, 19 96 .

Debbie Radley
Notary Public in and for
The State of Texas

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

Print Name Debbie Radley
My Commission Expires ____________

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 15th day of October, 19 96, by Don Srubar.

Debbie Radley
Notary Public in and for
The State of Texas

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

Print Name Debbie Radley
My Commission Expires ____________

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 15th day of October, 1996, by Alan Meek.

Debbie Radley

Notary Public in and for
The State of Texas

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-96

Print Name Debbie Radley
My Commission Expires ____________

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

BEFORE ME, the undersigned authority, on this day personally appeared ____________, ______________ of Engstrom Brothers, known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL of office, this ___ day of ____________ ___, 19_______.

____
Notary Public in and for
The State of Texas

Print Name ______________________
My Commission Expires ____________

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

This instrument was acknowledged before me on the 15th day of October, 1996, by P.M. Tucker.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

THE STATE OF TEXAS §
Wharton §
COUNTY OF ~~TRAVIS~~ §

BEFORE ME, the undersigned authority, on this day personally appeared F.E. Appling __________, ______________ **of F.E. Appling Interests, known to me to be the person and officer whose name is subscribed to the foregoing document, and acknowledged to me that he executed the same for the purposes and considerations therein expressed, as the act and deed of said bank, and in the capacity therein stated.**

GIVEN UNDER MY HAND AND SEAL of office, this 15th **day of** October, **19**96.

Debbie Radley
Notary Public in and for
The State of Texas
Print Name Debbie Radley
My Commission Expires ______________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

LNRA3AGR.CBF

THE STATE OF TEXAS §
§
COUNTY OF ~~TRAVIS~~ Wharton §

This instrument was acknowledged before me on the 16th day of October, 1996, by Edmund A. Weinheimer, III.

Debbie Radley

Notary Public in and for
The State of Texas

Print Name Debbie Radley

My Commission Expires ____________

DEBBIE LEE RADLEY
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 8-17-98

NOTARY PUBLIC
STATE OF TEXAS

LAVACA-NAVIDAD RIVER AUTHORITY

DROUGHT CONTINGENCY PLAN

APRIL 2019

Table of Contents

INTRODUCTION

Droughts and other uncontrollable circumstances can disrupt the normal availability of water supplies from either ground or surface sources. Natural limitations of the supply of either ground or surface water, or limitations on facilities to pump, treat, store or distribute water can present a public water supply utility with an emergency demand management situation.

During drought periods, consumer demand is typically 15 to 25 percent higher than under normal conditions. Most often, this additional demand is a direct result of the irrigation of lawns, but may be created by leaks caused by a shift in the drying soils surrounding distribution systems.

The 75th Texas Legislature enacted Senate Bill1, which directed the State to take a regional approach to water planning. One of the provisions of the legislation required the Texas Commission on Environmental quality (TCEQ) to adopt rules requiring wholesale and retail public water suppliers to develop water conservation and drought contingency plans (DCP). The amended Title 30, Texas Administrative Code, Chapter 288 became effective on December 6, 2012. The next revision of the drought contingency plans for retail public water suppliers serving 3,300 or more connections, wholesale public water suppliers, and irrigation districts must be submitted no later than May1, 2014, and every five years thereafter to coincide with the regional water planning group process. Any new or revised plans must be submitted to the TCEQ within 90 days of adoption by the governing body of the entity.

The DCP establishes temporary methods designed to be used during an emergency situation or other short water supply events exist. The purpose of the DCP is to specify how LNRA will manage stored water supplies during a repetition of the critical drought of record for Texas from 1950 to 1957. Most recently the extreme drought conditions experienced from September 14, 2011 to February 5, 2012 when the Lake Texana elevation fell to 30.38 msl on January 9, 2012, left the reservoir with 38.83% capacity. Consistent with Texas Commission on Environmental Quality (TCEQ) regulations, the LNRA has recommended that, as appropriate, its wholesale water customers consider adoption of drought contingency measures to be implemented in response to LNRA trigger conditions. As a provision of their respective water supply contracts, all LNRA customers will have drought contingency plans on file with the TCEQ.

The Lavaca-Navidad River Authority (LNRA), as a water right holder and wholesale water supplier, is required to submit a Water Conservation and Drought Contingency Plan to the TCEQ and the Texas Water Development Board (TWDB). The Texas Legislature created the Jackson County Flood Control District on May 27, 1949 to manage the flood waters of the Lavaca and Navidad Rivers. The name was changed to the Lavaca-Navidad River Authority in August, 1959. The “Palmetto Bend Project” was approved by Congress in 1968 to provide a dependable municipal and industrial water supply for the area. It was a cooperative water resource project between the LNRA, TWDB and the United States Bureau of Reclamation (USBOR). LNRA was the local sponsor responsible for operations and maintenance and became sole owner of the project in 2002.

SECTION I DECLARATION OF POLICY, PURPOSE, AND INTENT

LNRA contracts raw water to its customers. In cases of extreme drought, periods of abnormally high usage, system contamination, or extended reduction, or inability to supply water due to equipment failure, LNRA may require water customers to institute temporary restrictions to limit non-essential water usage. The purpose of the DCP is to encourage a reduction of water use in order to maintain supply, storage, or pressure or to comply with the requirements of a court, government agency or other authority. LNRA may require plan updates from time to time in accordance with changes in state law or LNRA rules.

SECTION II WHOLESALE WATER CUSTOMER EDUCATION

LNRA will periodically provide wholesale water customers with information about this drought contingency plan, including the importance of the plan, information about the conditions under which each stage of the plan is to be initiated, processes to reduce water usage, and impending or current drought conditions.

Drought plan information will be provided by means of: *meetings with staff, website, and/or information sheets available on site.*

SECTION III INITIATION AND TERMINATION OF RESPONSE STAGES

LNRA's General Manager will be responsible for the initiation and termination of drought response stages based on the triggering criteria set forth in this plan.

Triggering Criteria for Initiation and Termination of Drought Response Stages

(1) STAGE 1 – Mild Water Shortage Condition One

A. **Requirements for Initiation:** Stage 1 will be initiated when one or a combination of such triggering criteria occurs:
- Reservoir Conservation Pool elevation equal to or less than 43.00 feet msl; and
- Upon notification from LNRA that it is implementing Trigger I of the LNRA DCP.

B. **Requirements for termination:** LNRA announces that mandatory water restrictions for firm water customers are no longer required in accordance with the LNRA DCP.

(2) STAGE 2 – Moderate Water shortage Condition Two

A. **Requirements for Initiation:** Stage 2 will be initiated when one or a combination of such triggering criteria occurs:

- Reservoir Conservation Pool elevation equal to or less than 39.98 feet msl; and
- Upon notification from LNRA that it is implementing Trigger II of the LNRA DCP.

B. **Requirements for termination:** LNRA announces that mandatory water restrictions for firm water customers are no longer required in accordance with the LNRA DCP.

(3) STAGE 3 – Severe Water Shortage Condition Three

A. **Requirements for Initiation:** Stage 3 will be initiated when one or a combination of such triggering criteria occurs:
- Reservoir Conservation Pool elevation equal to or less than 35.00 feet msl, in accordance with the LNRA DCP;
- The LNRA Board declares a drought worse than the Drought of Record or other water supply emergency and orders the mandatory curtailment of firm water supplies; and
- Upon notification from LNRA that it is implementing Stage 3 of the LNRA DCP.

B. **Requirements for Termination**: LNRA announces that mandatory water restrictions for firm water customers are no longer required in accordance with the LNRA DCP.

(4) STAGE 4 – Critical Water Shortage Condition Four

A. **Requirements for Initiation:** Stage 4 will be initiated when one or a combination of such triggering criteria occurs:
- Natural or man-made contamination of the water supply source;
- Natural or otherwise catastrophic event causing failure or damage to the operating structures rendering these inoperable, or causing emergency evacuation of the reservoir; and
- Any other emergency water supply or demand conditions that the LNRA General Manager or the LNRA Board determines that either constitutes a water supply emergency or is associated with the LNRA Board declaration of a drought worse than the drought of record.

B. **Requirements for Termination:** LNRA announces that mandatory water restrictions for firm water customers are no longer required in accordance with the LNRA DCP.

SECTION IV DROUGHT RESPONSE MEASURES

The following contingency measures should be taken as trigger conditions are met. As a wholesale water supplier, the LNRA continuously monitors Lake Texana water levels and communicates with its wholesale water customers as to the condition of surface water supplies in the Lavaca River Basin.

(1) STAGE 1 – Mild Water Shortage Condition One

A trigger condition has been established by an agreement between the LNRA and specified water rights permit holders upstream of Lake Texana that use surface water for irrigation purposes. According to that certain Compromise Settlement Agreement, diversions for irrigation purposes upstream of Lake Texana are limited to times that Lake Texana is at or above elevation 43.00 msl. Prior to initiating diversions, permittees must confirm the level of Lake Texana with either the LNRA or the TCEQ South Texas Watermaster. Diversions must cease within 24 hours following the time when the reservoir level drops below elevation 43.00 msl.

A. **Target:** The water use reduction under Stage 1 should equate to a 50% reduction of the use of surface water that would have occurred in the absence of this drought contingency measure.

B. **Water Use Reduction Response Measures:**

- Notify the TCEQ Watermaster of reservoir conditions.
- Watermaster will notify water rights permit holders upstream of Lake Texana of reservoir conditions.
- Inform public, giving notice of reservoir conditions to the customers served by LNRA.

(2) STAGE 2 – Moderate Water Shortage Condition Two

A trigger condition has been established by an agreement between LNRA, Texas Parks and Wildlife Department and Texas Water Development Board. Accordingly, upon Lake Texana reaching a conservation pool elevation of 78.18% of the reservoir capacity or roughly elevation 39.98 feet msl, as calculated per periodic reservoir volumetric surveys, LNRA will reduce the volume of freshwater releases to the local bays and estuaries to the historical subsistence flow of five (5) cubic feet per second.

A. **Target:** The water use reduction under Stage 2 should equate to a 5% reduction of the surface water use that would have occurred in the absence of drought contingency measures.

B. **Water Use Reduction Response Measures**

- Notify the TCEQ Watermaster of reservoir conditions.
- Notify TPWD of reservoir conditions and change in B&E release schedule.
- Inform public, giving notice of reservoir condition to the customers served by LNRA and include in the information recommendations for water conservation.

(3) STAGE 3 – Severe Water Shortage Condition Three – Severe Local Drought

A trigger condition has been established by virtue of LNRA's reservoir refilling guidelines as defined by LNRA's Standard Operation Procedures that have been developed for Lake Texana.

Lower reservoir pool elevations will impact LNRA's ability to divert water from Lake Texana. Generally, upon reaching 50% capacity, the remaining water shall be divided among the water customers in accordance with Texas Water Code §11.039. LNRA will plan for up to a 50% reduction of the surface water use that would have occurred in the absence of drought contingency measures.

A. **Target:** Upon reaching Stage 3, LNRA will implement the following relevant actions as the reservoir condition declines. Suggested pro-rata water reductions are shown in Table 3.0.

Reservoir Storage Capacity	Pro-Rata Water Use Reduction
50%	10%
40%	20%
30%	35%
20%	50%
10%	--%

Table 3.0
Pro-rata Water Use Reductions during Periods of Shortage and/or Drought

B. **Water Use Reduction Response Measures:**

- Notify the TCEQ Watermaster of reservoir conditions.
- Notify the TCEQ Dam Safety Team of reservoir conditions.
- Notify LNRA water customers giving notice of reservoir conditions and current delivery volume.
- Implement a pro rata reduction of water deliveries to industrial and municipal customers as shown in table 3.0. Delivered volume to be measured against average daily use of individual customers. The average daily use will be calculated using the prior twelve (12) months data.
- Through the news media, the public should be advised by the customers of the trigger condition. Include in the information to the public an advisement of the mandatory reduction and that water users conserve water.

Modifications to the percentage of pro rata water reductions will occur as the reservoir elevation rises or falls. Resumption of normal operation and termination of water supply reductions will occur when reservoir levels are equal to or greater than elevation 35.00 feet msl.

(4) STAGE 4 – Emergency Water Conditions

A. **Target:** Water supply reduction target as determined by the LNRA Board and Management.

B. **Water Use Reduction Response Measures:**

- Notify the TCEQ Watermaster of reservoir conditions.
- Notify the TCEQ Dam Safety Team of reservoir conditions.
- Notify LNRA water customers giving notice of reservoir condition and current delivery volume.
- Implement a pro rata reduction of water deliveries to industrial and municipal customers as shown in table 3.0. Delivered volume to be measured against average daily use of individual customers. The average daily use will be calculated using the prior twelve (12) months data.

- Through the news media, the public should be advised by the customers of the trigger condition. Include in the information to the public an advisement of the mandatory reduction and that water users conserve water.

SECTION V INFORMATION

Once trigger conditions have been reached for the LNRA system, LNRA will notify the TCEQ Watermaster and its customers, whereby customers should notify the public within their jurisdictions of conditions and conservation measures to be taken. The process for notifying the public should include:

a. Posting the Notice of Drought conditions at City Hall, County Courthouse, Post Office, Public Library, Senior Citizens Center and Major Supermarkets;
b. Copy of notice to newspapers and hold press conferences;
c. Copy of notice to local radio and television stations; and
d. Post notice on their respective websites.

SECTION VI TERMINATION NOTIFICATION

Termination of the drought contingency measures should take place when the trigger conditions that initiated the drought contingency measure have subsided, and an emergency situation no longer exists.

LNRA will notify the TCEQ Watermaster and its customers. Customers should notify the public within their jurisdiction of termination of the drought contingency measures in the same manner they were informed of initiation of the drought contingency measures through the city officials in charge.

SECTION VII LNRA ENVIRONMENTAL ASSURANCE PROGRAM

LNRA participates in the TCEQ sponsored Texas Clean Rivers Program, conducting water quality assessments of the Lavaca River Basin. The purpose of the water quality assessment is to identify issues affecting water quality in the Lavaca River Basin, and to develop solution techniques for improving water quality. The assessment program is divided into two phases. LNRA's Clean Rivers Program involves collecting, reviewing, and analyzing past and present water quality data, addressing public opinion, and identifying areas of potential pollution. The program has required the implementation of a comprehensive data management system, the establishment of a water quality monitoring network, and the identification of specific water quality concerns throughout the Lavaca River Basin. LNRA is providing water quality and water conservation information to citizens throughout the Lavaca River Basin as a means of public education. The LNRA Clean Rivers Program will assist in the protection of the water resources in the Lavaca River Basin.

SECTION VII PUBLIC INVOLVEMENT AND CUSTOMER COORDINATION

LNRA's wholesale water supply contracts are based on allocations from firm yield and are governed by and are enforceable in all respects in accordance with the laws of the State of Texas.

LNRA's water customers are required to prepare and submit Water Conservation and/or Drought Contingency Plans to the TCEQ. LNRA works closely and coordinates with its customers and recommends that each develop plans consistent with LNRA's DCP and conditions as established herein.

H.B. 252, 83rd Legislature, requires LNRA to inform the Commission when LNRA's available water supply is reduced such that it is less than or equal to 180 days. Consistent with this mandatory requirement, LNRA will fulfill its reporting requirement under the Stage 3 and/or 4 response measures.

As a means of actively informing the public and to provide opportunity for input in the preparation of the DCP, and to inform LNRA's customers of the plan, information concerning drought management will be provided to the customers and the public by means of annual customer meetings, public board meetings, mail, telephone and the news media as appropriate.

SECTION IX PRO RATA WATER ALLOCATION

In the event that a) the triggering criteria specified herein have been met and b) the General Manager, or his designee, deems it necessary, LNRA, in coordination with the South Texas Watermaster and LNRA water customers will allocate water supplies on a pro-rata basis in accordance with Texas Water Code, §11.039.

SECTION X ENFORCEMENT

This DCP and all plans developed hereunder are incorporated by reference into all LNRA water supply contracts. Violation of this DCP is a violation of the contract and will be treated as such.

SECTION XI VARIANCES

The General Manager, or his designee, may grant a temporary variance to the pro-rata water allocation policies provided by this DCP if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

a. Compliance with this DCP cannot be technically accomplished during the duration of the water supply shortage or other conditions for which the DCP is in effect.

b. Alternative methods can be implemented which will achieve the same level of reduction in water use.

SECTION XII PLAN UPDATE

LNRA shall review and update, as appropriate, this DCP at least every five (5) years, based on new or updated information, such as revisions in the regional water plan.

APPENDIX A

Texas Administrative Code, Section 288.22

APPENDIX A
Texas Commission on Environmental Quality Rules on Drought Contingency Plans for Wholesale Water Suppliers

<u>TITLE 30</u>	ENVIRONMENTAL QUALITY
<u>PART 1</u>	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
<u>CHAPTER 288</u>	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
<u>SUBCHAPTER B</u>	DROUGHT CONTINGENCY PLANS
RULE § 288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to ensure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) A pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, § 11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, § 11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this § 288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 938

APPENDIX 3H
Accounting Plan

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

DRAFT LAKE TEXANA ENHANCED YIELD PROJECT ACCOUNTING PLAN

Prepared for:

Lavaca-Navidad River Authority

March 20, 2020

Prepared by:

FREESE AND NICHOLS, INC.
10497 Town and Country Way, Suite 600
Houston, Texas 77024
713-600-6800

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DRAFT LAKE TEXANA ENHANCED YIELD PROJECT ACCOUNTING PLAN

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DRAFT
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF **JASON AFINOWICZ**, P.E., TEXAS NO. **100102** ON **March 20, 2020**. IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.
FREESE AND NICHOLS, INC.
TEXAS REGISTERED ENGINEERING FIRM F- 2144

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LVA18507

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1.0 LTYEP WATER RIGHT

The Lavaca-Navidad River Authority (LNRA) is seeking a Texas water right for the Lake Texana Enhanced Yield Project (LTYEP). This accounting plan addresses compliance with the terms and conditions of the proposed LTYEP water right.

The LTYEP project seeks to create additional supply for LNRA by supplementing existing supplies from Lake Texana with diversions from the Lavaca River and construction of a new off-channel reservoir (OCR). The project will be built in two phases. The first phase (Phase I) is storage of Lavaca River water in Lake Texana. The second phase (Phase II) is adding an off-channel reservoir to the project. Specific authorizations relevant to this accounting plan include:

- A new appropriation to:
  - Divert up to 96,022 acre-feet per year from a reach of the Lavaca River between Diversion Point A (28.887744 N 96.618490 W) and Diversion Point B (28.876220 N 96.611804 W) in Jackson County at a maximum diversion rate of 309.4 cfs (200 MGD).
  - Construct and maintain a dam that will impound up to 240 acre-feet in an on-channel diversion reservoir within that reach.
  - Temporarily store the water in the existing Lake Texana for subsequent re-diversion and use at a maximum combined diversion rate of 660 cfs.
  - Store water in a new 50,000 acre-foot off-channel reservoir in Jackson County in the Lavaca-Colorado Coastal Basin for subsequent re-diversion and use.
  - Use the re-diverted water for municipal, industrial, and mining purposes in Calhoun, Jackson, Matagorda, Wharton and Victoria Counties in the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin.
- Use of the bed-and-banks of Lake Texana to convey the water diverted from the Lavaca River and discharged at a point on the perimeter of Lake Texana to the two existing diversion structures on Lake Texana or any other future diversion point on the perimeter of Lake Texana.
- When Lake Texana is full and spilling, spills from Lake Texana exceed the Bay and Estuary Release Schedule in CoA 16-2095B 4.A.1 and CoA 16-2095D Special Condition 5.A., and water could have been diverted from the Lavaca River because environmental flows have been satisfied, an equivalent amount of the water that would have been diverted from the Lavaca River can be diverted from Lake Texana, as long as those diversions do not cause spills to drop below the required Bay and Estuary Release schedule.

2.0 ELEMENTS OF THE ACCOUNTING PLAN

2.1 OVERVIEW

The accounting plan consists of this documentation and an Excel workbook that performs the accounting calculations. The Excel workbook contains the following tables:

- Table of Contents – list of the worksheets in the workbook.
- Table 1 Summary – summary of the status of various authorizations and warning messages.
- Table 2 Basic Data – primary entry place for data used in the accounting plan.
- Table 3 Lake Texana – pool accounting for imported Lavaca River water.
- Table 4 Edna Environmental Flows – calculation of base/subsistence flows and pulse flows from gage data measured at the USGS gage 08164000 Lavaca River near Edna gage (Edna gage).
- Table 5 Base Flow Compliance – demonstrates compliance with base and subsistence flows at the Edna gage.
- Table 6 Environmental Flows after Diversion – calculates pulse flows based on the Edna gage flows less the Lavaca River diversions.
- Table 7 Graph Data – data series and graphs that show environmental flows.
- Table 8 Comparison of Pulses Before and After Diversions – compares pulse flow compliance before diversions (Table 5) and after diversions (Table 6).
- Table 9 Overdraft in Lieu of Pumping – calculates water that is available for overdraft from Lake Texana.
- Table 10 References – miscellaneous reference data used in the accounting plan.
- Table 11 Edna Instream Flow Criteria – reference data used in the environmental flow calculations at the Edna gage.
- Table 12 Lake Texana Area-Capacity-Elevation – volumetric data for Lake Texana.

Each table is described in detail in the next section.

Most workbooks consist of a monthly section and a daily section, with most of the calculations occurring in the daily portion of the table. The monthly portion is provided as a summary. The monthly portion of the table can be viewed by clicking on the “Show” button on the upper left hand corner of the workbook. It can be hidden by clicking on the “Hide” button.

The last worksheet, named ImportExport, contains data that can be copied from the previous year’s plan for use in this year’s plan, as well as data for the upcoming year’s plan.

2.2 WORKBOOK TABLES

The monthly and daily tables in the accounting plan have five-row header labels for each column, with one set for monthly data and one set for daily data. An example from the first seven columns of Table 2 is shown below. The first row groups the columns by function. In the example below, the data are grouped by the three columns that contain date information (day, month and Excel date) and the five columns that have data for the diversions from the Lavaca river (gage data, total diversions, shut off pumping during a pulse, and the portion of the diversions that go to Lake Texana and to the Off-Channel Reservoir).

Date			Lavaca Diversions				
2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
Ref	Ref	Ref	Input	Input	Input	Input	Input
Date	Date	Date	MG	MG	Y/N	MG	MG
Day	Month	Date	Lavaca River nr Edna	Diversion from Lavaca River	Shutoff During Pulse	Lavaca Water to Lake Texana	Lavaca Water to OCR

The second row is a column number with the digits to the left of the decimal point indicating the table number and the digits to the right of the decimal point indicating the unique column number. For example, Column 2.4 refers to the gage flows in the Lavaca River nr Edna column in the above example. This convention is used throughout this document to refer to specific columns in the accounting plan tables.

The third row contains text labels that describe the origin of the data in the column. The following table has descriptions of these labels.

Label	Description
Ref	Column is used as reference data. Includes day, month and Excel date values in all tables, as well as other reference data such as environmental flow criteria, etc.
Input	Data input by user. May contain formulas entered by the user that reference other data. Also indicated by yellow shading.
Calc	Data in column is calculated using Excel formulas.
Linked	Data in column is directly obtained from another column in the accounting plan.
Lookup	Data are obtained from a lookup table elsewhere in the accounting plan.

The fourth row contains the units used in the column. The following table contains the units used in the accounting plan.

Unit	Description
ac-ft	Acre-feet over the time period in the date row. In the monthly portion of the table, acre-feet per month. In the daily portion of the table, acre-feet per day.
B or P	B for base flow day or P for pulse flow day
Boolean	Condition is TRUE or FALSE. Used when the condition is used as a reference for other calculations.
cfs	Cubic feet per second
Date	Number of days, month number, or Excel date
days	Value in days
dsf	Volume representing an average flow in cfs over a 24-hour period. 1 dsf = 86,400 cubic feet.
feet	Feet, usually feet above mean sea level
in/day	Inches per day
in/month	Inches per month
none	No units
ref	Non-specific reference value
text	Text entry
var	Various units within column
Y/N	"Y" for yes (condition is TRUE), or "N" for no (condition is FALSE). Applied in cases where these values are referenced for user input.

The individual workbook tables are described in the remainder of this section.

2.2.1 Table of Contents

The Table of Contents is a list of all of the tables with clickable links to the tables. Each table also has a clickable link in the upper left-hand corner that will take you to the Table of Contents.

2.2.2 Table 1 Summary

Table 1 is the location where the year of the accounting plan is entered. It also has a set of tables that shows the current status of the LNRA water rights. This table can be used to assist assigning diversions to various authorizations.

The lower table is a list of checks that display warning messages under certain conditions. If these checks indicate a potential problem with the entries, "check inputs" will appear in the Check column. This does not necessarily indicate a problem with the data or the calculations. It only indicates that there may be a problem. A notes column is provided in cases where the checks signal that inputs need to be checked and the user has verified that the calculations reflect operations.

2.2.3 Table 2 Basic Data

Table 2 is the primary location for input data used in the Accounting Plan. The user inputs daily values in the daily portion of the table, and these are summed to monthly values in the monthly portion of the table (revealed by clicking on the Show button). It is also the location where the user assigns diversions to the LTYEP authorizations. Y/N flags are provided to assist with the assignment, with Y indicating that there are available authorizations at that particular priority date, and an N indicating that those authorizations are not available, either because they have been fully utilized or other conditions prevent use of those rights. Data used to calculate the Y/N flags may be found in Columns 2.24 and 2.25.

Daily average flows are calculated by LNRA from USGS 15-minute data reported directly to LNRA. These averages may be slightly different than those reported by USGS. Evaporation and precipitation data are as reported by LNRA from their own weather station. If data are obtained from another source, then the source will be recorded in Column 2.26 (daily only).

Column	Label	Description
Date		
2.1	Days	Monthly – number of days in the month Daily – day of the month.
2.2	Month	Month number.
2.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Lavaca River Data		
2.4	Lavaca River nr Edna	Monthly – monthly flow volume in acre-feet. Daily – daily average flow in cfs, as input by user.
2.5	Diversion from Lavaca River	Monthly – monthly volume diverted from the Lavaca River during the current month in acre-feet. Daily – daily flow volume diverted from Lavaca River in MG, as input by user.

Column	Label	Description
2.6	Shutoff During Pulse	A flag that signifies whether pumping was suspended during a pulse flow event. Often some water will be pumped on a day when either a pulse initiates or qualifies. A pulse can and usually will trigger in the middle of a day, so some pumping could occur earlier in the day. Similarly, a pulse can meet the volume criteria in the middle of a day, so pumping can be resumed. This flag allows for these situations to be recorded in the accounting plan. Monthly – number of days shut off because of pulse bypass. Daily – Y or N if pumping was cut off some time during the day in order to bypass a pulse. Input by user.
2.7	Lavaca Water to Lake Texana	Total Lavaca River pumping volume sent to Lake Texana. Includes water that may be passed using the bed and banks of Lake Texana to the OCR. Monthly – monthly volume of Lavaca River water sent to Lake Texana. Daily – daily flow volume in MG sent to Lake Texana. Input by user.
2.8	LTYEP Water from Texana to OCR	Flow volume pumped from Lake Texana to the OCR. Includes water diverted using the overdraft in lieu of pumping authorizations that has been sent to the OCR. Monthly – monthly volume of water pumped from Lake Texana to the OCR. Daily – daily flow volume in MG pumped from Lake Texana to the OCR. Input by user.
2.9	Lavaca Water Pumped Directly to OCR	Flow volume pumped directly from the Lavaca River pump station to the OCR. Monthly – monthly volume pumped directly to the OCR. Daily – daily flow volume pumped directly to the OCR. Input by user.
2.10	Total LTYEP Water to OCR	Sum of Columns 2.8 and 2.9. Includes water passed through Lake Texana and water sent directly to OCR. Also may include overdraft in lieu of pumping water from Lake Texana sent to the OCR. Monthly – total volume of Lavaca River water sent to OCR. Daily – total daily flow volume in MG sent to OCR.
Lake Texana Data		
2.11	Elevation	Monthly – end-of-month elevation of Lake Texana. Daily – daily elevation of Lake Texana as reported by LNRA. Input by user.
2.12	Reservoir Spills	Outflows through Palmetto Bend Dam during flood operations (reservoir at or near 44 feet). Includes releases associated with bay and estuary freshwater inflows. Does not include diversions from the reservoir. Monthly – monthly volume in acre-feet. Daily – daily outflows in acre-feet during flood operations. Input by user.
2.13	Pan Evaporation	Monthly – monthly rate of pan evaporation in inches. Daily – daily rate of pan evaporation in inches as reported by LNRA. Standard pan factors are applied in Table 3. Input by user.
2.14	Precipitation	Monthly – monthly rainfall in inches per month. Daily – daily rainfall in inches per day as reported by LNRA. Input by user.

Column	Label	Description
Lake Texana Diversions		
2.15	LTYEP Texana Diversion	Monthly – volume of water diverted from Lake Texana under the proposed LTYEP water right in acre-feet. Daily – total daily average diversion from Lake Texana under this authorization in cfs. Input by user. Column 2.16 and the LNRA Water Rights Summary in Table 1 are available to assist the user in assigning diversions to these authorizations. The cells will be shaded pink if the diversion exceeds the LTYEP authorization. Diversions in this column plus column 2.20 (Diversions from OCR) are limited to 96,022 acre-feet per year.
2.16	Available from Lavaca	Monthly – number of days that LTYEP Lake Texana water is available in each month. Daily – a “Y” indicates that water is available to be diverted under this authorization. A “N” indicates that water is not available to be diverted under this authorization. Diversions are in Column 2.15. Water is available if the remaining authorizations in Column 2.24 less the diversions in Column 2.20 are greater than zero and there is: • Water in the storage account in Lake Texana (Column 2.25), and/or • Lavaca water has been sent to Lake Texana (Column 2.7 less Column 2.8). This check does not consider environmental flows, which are addressed separately.
2.17	Available for Overdraft	Calculated volume of water available for overdraft. Imported from Column 9.10. Monthly – volume in acre-feet. Daily – volume in MG.
2.18	Overdraft Diversion	Volume of diversion from Lake Texana assigned to overdraft in lieu of pumping. Monthly – monthly sum in acre-feet. Daily – volume of diversion in MG. Input by user.
2.19	Total Texana LTYEP Diversion	Total LTYEP diversions from Lake Texana. Sum of Columns 2.15 and 2.19. Monthly – monthly sum of diversions in acre-feet. Daily – daily sum of diversions in MG.
OCR		
2.20	Diversion	Diversions for water supply from the Off-Channel Reservoir (OCR). Monthly – volume diverted from the OCR in acre-feet. Daily – average daily flow diverted from the OCR in cfs. Input by user. The cells will be shaded pink if the diversion exceeds the LTYEP authorization. Diversions in this column plus column 2.19 (Total LTYEP Texana Diversion) are limited to 92,022 acre-feet per year.

Column	Label	Description
2.21	Available	Monthly – number of days that LTYEP OCR water is available in each month. Daily – a "Y" indicates that water is available to be diverted under this authorization. A "N" indicates that all of these authorizations have been used. Diversions are in Column 2.20. Water is available if the remaining authorizations in Column 2.24 are greater than zero. Will always be "N" if no elevation is entered in Column 2.23. This check does not consider environmental flows, which are addressed separately.
2.22	Total LTYEP Diversion	Sum of columns 2.19 and 2.20. Monthly – volume diverted for water supply under the LTYEP authorizations in acre-feet. Daily – average daily flows diverted for water supply under the LTYEP authorization in cfs.
2.23	OCR Elevation	Monthly – end-of-month elevation in the OCR. Daily – daily elevation in the OCR. Input by user. A value is needed for water to be available from the OCR (Column 2.21). These values are for information and are not used in any other calculations.

Columns 2.24 and 2.25 are used to determine the availability flags in Columns 2.16, and 2.21. Column 2.26 is for notes regarding the daily data. Notes should be entered whenever an alternative source is used for the data. Other information regarding the day's data may be entered here as well. Columns 2.24 to 2.26 are only in the daily portion of the table.

Column	Label	Description
Available Flow		
2.24	Remaining LTYEP	Volume at beginning of day remaining for LTYEP water supply diversions. Values are in MG.
2.25	Texana Storage Account Previous Day	Volume of Lavaca River water currently in the storage account in Lake Texana on the previous day in MG. Imported from Column 3.18.
2.26	Notes	Place for the user to enter notes about the daily data, including information regarding data that comes from alternate sources.

2.2.4 Table 3 Lake Texana

Table 3 performs storage accounting for water imported from the Lavaca River into the reservoir. The section labeled Lake Texana Operation calculates the storage, surface area, and net evaporative loss for the reservoir. The Imports and Diversions section is linked to the diversion data entered in Table 2. The Lake Texana Storage Accounting section includes the storage accounting of Lavaca River water imported into Lake Texana that is not immediately re-diverted and used.

The storage account for the imported Lavaca River water is a "bubble" account that comes and goes as imported water is stored in the reservoir. Imported Lavaca River water will be stored in Lake Texana when diversions of imported water entered in Column 3.14 are less than the actual imported water in Column 3.13. (Overdraft in lieu of pumping diversions are not considered in this calculation). Once water is stored, it can be rediverted at a later date, subject to losses due to evaporation or spills from the reservoir. Bay and estuary freshwater inflow releases are limited to Navidad River inflows, so these releases are not taken out of the Lavaca River water storage account. Evaporative losses are applied based on the fraction that the storage account represents of the total reservoir storage. Total net evaporative losses are in Column 3.11. Column 3.19 contains the fraction of the total storage represented by the storage account. Similarly, spills are also proportioned based on the storage fraction. Spills are found in Column 3.12 and are applied only when the reservoir level (Column 3.4) is more than 44 feet.

In this table, the monthly values are simply the daily values summed up by month except where noted.

Column	Label	Description
Date		
3.1	Days	Monthly – number of days in the month. Daily – day of the month.
3.2	Month	Month number.
3.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Lake Texana Operation		
3.4	Elevation	Imported from column 2.11. Values are in feet above msl. Monthly – end-of-month elevation of Lake Texana. Daily – daily elevation of Lake Texana.
3.5	Storage	Total storage in Lake Texana, calculated using the elevations in Column 3.4 and the area-capacity-elevation data in Table 12. Values are in acre-feet. Monthly – end-of-month storage. Daily – daily storage.
3.6	Surface Area	Surface area of Lake Texana, calculated using the elevations in Column 3.4 and the area-capacity-elevation data in Table 12. Values are in acres. Monthly – end-of-month surface area. Daily – daily surface area.
3.7	Pan Evaporation	Pan evaporation rate as reported by LNRA, converted to feet. Imported from Column 2.13.
3.8	Pan Factor	Pan factors imported from Column 10.10 using month number as index.
3.9	Evaporation Rate	Pan evaporation in Column 3.7 multiplied by the Pan Factor in Column 3.8.
3.10	Precipitation Rate	Precipitation as reported by LNRA, converted to feet. Imported from Column 2.14. Values in feet.

Column	Label	Description
3.11	Net Evaporative Loss	Calculated by multiplying the daily evaporation less precipitation by the calculated surface area for the previous day. Values in acre-feet.
3.12	Lake Excess Texana Spills	Spills and releases from the reservoir that are not associated with the release of freshwater inflows. Imported from Column 2.12 less the released freshwater inflows from Column 9.6.
Imports and Diversions		
3.13	Imported Water	Water pumped from the Lavaca River into Lake Texana. Calculated by subtracting the LTYEP water sent from Texana to the OCR in Column 2.8 from the total pumping to Lake Texana in Column 2.7, with daily values converted to acre-feet per day. Limited to positive values since some water could be pumped from Texana to the OCR as overdraft in lieu of pumping.
3.14	LTYEP Diversion	Volume of water pumped from Lake Texana using the proposed LTYEP authorizations. Imported from Column 2.15, with daily values converted to acre-feet per day.
Lake Texana Storage Accounting		
3.15	Excess Imported Water	Volume of water imported from the Lavaca River not immediately diverted for other purposes. This volume of water will go into a storage account. Daily values are calculated by subtracting Column 3.14 from Column 3.13. Zero if negative. Monthly values are summed from daily volumes.
3.16	Stored Water Losses	Losses incurred to the storage account due to evaporation or reservoir spills in acre-feet. Calculated on a daily basis by multiplying the fraction of the total storage in Lake Texana in the storage account on the previous day (Column 3.19) by the evaporative loss (Column 3.11) plus, if the reservoir is spilling, the spills from the reservoir not used to meet bay and estuary freshwater inflows (Column 3.12). The losses are limited to the volume in the storage account on the previous day (Column 3.18). Monthly values are the sum of the daily calculations.
3.17	Diversion from Imported Water Storage	Volume of water diverted from the storage account. Calculated on a daily basis by subtracting the imported water from the Lavaca River in Column 3.13 from the LTYEP diversion in Column 3.14, limited to positive numbers. Monthly values are the sum of the daily calculations.
3.18	Imported Water Storage	Volume of water in the imported water storage account. Calculated as the previous day's storage volume (Column 3.18) plus the excess imported water (Column 3.15) less the losses from the account (Column 3.16) and the amount diverted from the account (Column 3.17). The monthly values are the volume at the end of the month. Volume can go negative if too much LTYEP water is diverted from the reservoir.
3.19	Fraction Imported Water Storage	Fraction of the total storage in Lake Texana that is in the imported water storage account. Calculated by dividing the current day's storage in the account (Column 3.18) by the total storage in Lake Texana (Column 3.5).

Columns 3.20 and 3.21 are used to check the balance of LTYEP water sent into and out of the system on a monthly basis. These are used in the checks in Table 1. Column 3.20 subtracts the LTYEP diversions from Lake Texana in Column 3.14 (excluding overdraft diversions) and losses from the storage account in Column 3.16 from the imported water from the Lavaca River in Column 3.13. Column 3.21 subtracts the diversion from the storage account in Column 3.17 from the sum of the excess water going into the storage account in Column 3.15 and the losses from the storage account in Column 3.16. The sum at the end of the year should be close to the volume of water in the storage account at the end of the year in Column 3.18.

Column 3.22 is an index for the end-of-month values in the daily table.

2.2.5 Table 4 Edna Environmental Flow

Table 5 calculates base/subsistence and pulse flows for the Lavaca River near Edna gage, USGS 08164000, which will serve as the measurement point for the LTYEP authorizations. The gage is located upstream of the diversion location. In this accounting plan, environmental flows are first calculated based on the measured flows at the Edna gage, as shown in Table 4. These flows are then compared to calculations made on the Edna gage flows, less the downstream diversions in Table 6. Table 8 then compares the two. If these two tables show the same qualifying pulses, and shutoff has occurred during the required number of pulses, then the diversions are considered to be in compliance with the standards.

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The standards are from 30 TAC §298.330(e)(15) except for the Summer Average and Wet Base flow, which appear to be switched in the TAC. The following table lists the standards.

Environmental Flow Standards – Lavaca River near Edna

Season	Hydrologic Condition	Subsistence Flow (cfs)	Base Flow (cfs)	Small Seasonal Pulse (2 per Season)	Large Seasonal Pulse (1 per Season)	Annual Pulse
Winter	Severe	8.5	30	Trigger: 2,000 cfs Volume: 8,000 ac-ft Duration: 6 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days
	Dry	N/A	30			
	Average	N/A	55			
	Wet	N/A	94			
Spring	Severe	10.0	30	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	
	Dry	N/A	30			
	Average	N/A	55			
	Wet	N/A	94			
Summer	Severe	1.3	20	Trigger: 88 cfs Volume: 370 ac-ft Duration: 4 days	Trigger: 420 cfs Volume: 1,800 ac-ft Duration: 6 days	
	Dry	N/A	20			
	Average	N/A	33*			
	Wet	N/A	48*			
Fall	Severe	1.2	20	Trigger: 1,600 cfs Volume: 6,100 ac-ft Duration: 6 days	Trigger: 4,500 cfs Volume: 18,00 ac-ft Duration: 6 days	
	Dry	N/A	20			
	Average	N/A	33			
	Wet	N/A	58			

* The Summer Average and Wet Criteria appear to be switched in the TAC. We have assumed that the smaller value applies during Average conditions and the larger value applies during Wet conditions.

The accounting plan uses the following codes for each season. These codes serve as indices for lookup tables in Table 11.

Month	Season	Code
1	Winter	1
2	Winter	1
3	Spring	2
4	Spring	2
5	Spring	2
6	Spring	2
7	Summer	3
8	Summer	3
9	Fall	4
10	Fall	4
11	Fall	4
12	Winter	1

The accounting plan uses the following codes for hydrologic condition. These codes serve as indices for lookup tables in Table 11.

Hydrologic Condition	Texana Elevation (ft)	Code
Severe	#N/A	1
Dry	39.95	2
Average	43	3
Wet	44	4

For the purposes of this accounting plan, a qualifying pulse is a pulse that begins when flows in response to a rainfall event exceed the pulse flow trigger level. The pulse qualifies once either the duration criteria or the volume criteria has been achieved, whichever comes first.

One of the features of the pulse calculation is the ability of the user to override the simple on and off triggers in Columns 4.20 to 4.22, 4.34 to 4.36 and 4.46 to 4.48. In most cases, the pulse identification logic will correctly identify a pulse. However, under some situations a pulse flow can be incorrectly identified. Rather than including complex logic in the accounting plan, the user is given the opportunity to reassign days as either a pulse flow day ("P" in Columns 4.23, 4.37, or 4.49) or a base flow day ("B" in the same three columns). Examples of situations where a pulse override would be required include:

- Times of extended high flows that do not fall below the trigger level for long periods of time. This will cause the accounting plan to trigger a new pulse once the first event qualifies. The user should enter a "B" in the appropriate column until either the flows drop below the trigger level, or a new rainfall event initiates a new pulse.

- When crossing into a new season at a flow rate that is higher than the pulse flow trigger level for that season. This frequently happens when transitioning from the spring season to the summer season, which has a relatively low trigger level. Flows often have not fallen to summer levels at the beginning of the summer season. There is some logic in the accounting plan that can prevent this from occurring, but it will not work correctly if flows are slightly increasing. The user should examine any pulses that occur on seasonal boundaries, particularly in the transition from spring to summer.
- When a small pulse initiates on one day and large pulse initiates on the next day. This can occur in the winter, summer or fall when the small pulse criteria are less than the large pulse criteria. In this case, the entire pulse could be classified as a large pulse, and the day that the small pulse initiates should be identified as a pulse day by entering a "P" in Column 4.37. A similar situation can occur with a large pulse and an annual pulse in the summer season. This type of override could occur only when needed.

Other situations may occur as well that require overrides. In all cases where an override occurs, notes regarding the reason for the override should be entered in Column 4.62.

The following section describes the base and subsistence flow calculations. The descriptions below apply to the daily data except where noted.

Column	Label	Description
Date		
4.1	Days	Monthly – number of days in the month. Daily – day of the month.
4.2	Month	Month number.
4.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Base Flow Calculation		
4.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4. Daily values are in cfs and monthly values are in acre-feet.
4.5	Lake Texana Elevation	Daily or end-of-month elevation of Lake Texana in feet msl. Imported from Column 2.11.
4.6	Season	Season as defined in 30 TAC §298.305. Evaluated from lookup table in Column 11.2 using the month in Column 4.2 as the index.
4.7	Season Code	A code for each season, with 1 = Winter, 2 = Spring, 3 = Summer, and 4 = Fall. Evaluated from lookup table in Column 11.3 using the month in Column 4.2 as the index.
4.8	New Season?	TRUE if the first day of a season, otherwise FALSE. Calculated by comparing the season code of the current day or month to the season code of the previous day or month. If they are not equal, then the value is TRUE.

Column	Label	Description
4.9	Hydrologic Condition	Severe, Dry, Average or Wet based on Column 11.21 using the hydrologic condition code in Column 4.10 as an index.
4.10	Hydrologic Condition Code	A code for each hydrologic condition, with 1 = Severe (Texana elevation less than 39.95 feet), 2 = Dry (Texana elevation between 39.95 and 43 feet), 3 = Average, (Texana elevation between 43 feet and 44 feet), and 4 = Wet (Texana elevation greater than or equal to 44 feet). Evaluated on the first day of each season (Column 4.8) based on the previous day's elevation of Lake Texana. The value remains constant until the next season. Codes are from Column 11.23.
4.11	Initial Base Flow Criteria	Base flow criteria from the lookup table in Columns 11.6 through 11.9, using the season code in Column 4.7 and the hydrologic condition code in Column 4.10 as indices. Monthly values are the volume in acre-feet potentially reserved by these criteria over the month.
4.12	Subsistence Criteria	Subsistence flow criteria from Column 11.5 using the Season Code in Column 4.7 as an index. Only applies in Severe conditions when flows are less than the Severe Base criteria in Column 11.6. Monthly values are the volume in acre-feet potentially reserved by subsistence flows over the month.
4.13	Final Bypass	Except for in Severe conditions (Column 4.10 = 1), equal to the Initial Base Flow Criteria in Column 4.11. In Severe conditions the Subsistence flow is used if the measured flow in Column 4.4 is less than the Severe Base flow in Column 4.11. Otherwise it is equal to Column 4.11. The value in this column has not been limited to the actual flow at the gage. Monthly values are the volume of water in acre-feet potentially reserved by these criteria.

The next section of the table calculates small and large pulses. The logic for determining the two types of pulses is practically identical.

Column	Label	Description
Small Pulse		
4.14	Edna Gage Flow	Repeat of Column 4.4. Imported from Column 2.4.
4.15	Pulse Index	The pulse index is used to allow a pulse that started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 4.25 on the previous day. If this is greater than zero, then the value of Column 4.15 from the previous day is used. If Column 4.25 is equal to zero, then the value is set to the season code in Column 4.7. The monthly part of the table is set equal to the season code in Column 4.7.

Column	Label	Description
4.16	Trigger	The flow in cfs that triggers a small pulse. Lookup from Column 11.10 using the pulse index in Column 4.15 as the index.
4.17	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.11 using the pulse index in Column 4.15 as the index.
4.18	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.12 using the pulse index in Column 4.15 as the index.
4.19	Number per Season	Number of small pulses expected in the current season. Lookup from Column 11.13 using the pulse index in Column 4.15 as the index.
4.20	Flow > Trigger	TRUE if the gage flow in Column 4.14 is greater than the trigger in Column 4.16. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
4.21	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 4.8 = TRUE and there is no carry over pulse indicated by Column 4.15 not being equal to the season code in Column 4.7), a new pulse occurs if the flow is greater than the trigger (Column 4.20 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 4.8 is FALSE), then the flow must be greater than the trigger (Column 4.20 is TRUE) and the previous day must not be part of a pulse (Column 4.24 is zero). Will be FALSE if Column 4.23 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.22	Last Day of Pulse	TRUE if the duration in Column 4.25 is greater than or equal to the criteria in Column 4.18 or the cumulative volume in Column 4.26 is greater than or equal to the criteria in Column 4.17. Monthly values are a count of the number of pulses terminated in the current month.
4.23	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 4.24 = 0) even if the logic in Columns 4.20 through 4.22 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 4.24 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.
4.24	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 4.23, this column is set equal to 1 if it is the first day of a pulse (Column 4.21 is TRUE), or if the previous day was part of the pulse (Column 4.24 on the previous day is equal to 1) and the duration in Column 4.25 on the previous day is less than the criteria in Column 4.18 and the cumulative volume on the previous day in Column 4.26 is less than the volume criteria in Column 4.17. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.

Column	Label	Description
4.25	Duration	The number of days in the current pulse since it was initiated. Equal to the value in Column 4.24 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.22 being TRUE. No value is calculated in the monthly portion of the table.
4.26	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.24 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.14 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 4.17. No value is calculated in the monthly portion of the table.
4.27	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 4.21 is TRUE). Counting starts over at the beginning of each season (Column 4.8 is TRUE).
Large Pulse		
4.28	Edna Gage Flow	A repeat of Columns 4.4 and 4.14. Imported from Column 2.4.
4.29	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 4.39 on the previous day. If this is greater than zero, then the value of Column 4.29 from the previous day is used. If Column 4.39 is equal to zero, then the value is set to the season code in Column 4.7. The monthly part of the table is set equal to the season code in Column 4.7.
4.30	Trigger	The flow in cfs that triggers a large pulse. Lookup from Column 11.14 using the pulse index in Column 4.29 as the index.
4.31	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.15 using the pulse index in Column 4.29 as the index.
4.32	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.16 using the pulse index in Column 4.29 as the index.
4.33	Number per Season	Number of large pulses expected in the current season. Lookup from Column 11.17 using the pulse index in Column 4.15 as the index.
4.34	Flow > Trigger	TRUE if the gage flow in Column 4.28 is greater than the trigger in Column 4.30. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.

Column	Label	Description
4.35	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 4.8 = TRUE and there is no carry over pulse indicated by Column 4.29 not being equal to the season code in Column 4.7), a new pulse occurs if the flow is greater than the Trigger (Column 4.34 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 4.8 is FALSE), then the flow must be greater than the Trigger (Column 4.34 is TRUE) and the previous day must not be part of a pulse (Column 4.38 is zero). Will be FALSE if Column 4.37 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.36	Last Day of Pulse	TRUE if the duration in Column 4.39 is greater than or equal to the criteria in Column 4.32 or the cumulative volume in Column 4.40 is greater than or equal to the criteria in Column 4.31. Monthly values are a count of the number of pulses terminated in the current month.
4.37	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 4.38 = 0) even if the logic in Columns 4.34 through 4.36 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 4.38 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.
4.38	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 4.37, this column is set equal to 1 if it is the first day of a pulse (Column 4.35 is TRUE), or if the previous day was part of the pulse (Column 4.38 on the previous day is equal to 1) and the duration in Column 4.39 on the previous day is less than the criteria in Column 4.32 and the cumulative volume on the previous day in Column 4.40 is less than the volume criteria in Column 4.31. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.
4.39	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 4.38 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.36 being TRUE. No value is calculated in the monthly portion of the table.
4.39	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.38 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.28 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 4.31. No value is calculated in the monthly portion of the table.

Column	Label	Description
4.41	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 4.35 is TRUE). Counting starts over at the beginning of each season (Column 4.8 is TRUE).

The next section calculates annual pulses. The annual pulse calculations are similar to small and large except there is only one set of criteria. Since the annual pulses do not vary by seasons, the pulse index and number per season are not needed.

Column	Label	Description
Annual Pulse		
4.42	Edna Gage Flow	A repeat of Columns 4.4, 4.14 and 4.28. Imported from Column 2.4.
4.43	Trigger	The flow in cfs that triggers an annual pulse. Value from Column 11.18. Since there is a single value (i.e. it does not vary by season), there is no need for an index.
4.44	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Value from Column 11.19.
4.45	Duration Criteria	Duration in days associated with a qualifying pulse. Value from Column 11.20.
4.46	Flow > Trigger	TRUE if the gage flow in Column 4.42 is greater than the trigger in Column 4.43. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
4.47	First Day of Pulse	TRUE if the current day initiates a new pulse. The flow must be greater than the trigger (Column 4.46 is TRUE) and the previous day must not be part of a pulse (Column 4.50 is zero). Will be FALSE if Column 4.49 is set to “B”, making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.48	Last Day of Pulse	TRUE if the duration in Column 4.51 is greater than or equal to the criteria in Column 4.45 or the cumulative volume in Column 4.52 is greater than or equal to the criteria in Column 4.44. Monthly values are a count of the number of pulses terminated in the current month.
4.49	Pulse Override	Entered by LNRA staff. A “B” entered in the will make the current day a base flow day (Column 4.50 = 0) even if the logic in Columns 4.46 through 4.48 indicate that the day is a pulse day. Similarly, a “P” entered will make the day a pulse day (Column 4.50 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.

Column	Label	Description
4.50	Is Pulse	Equal to 1 if a pulse is on-going, zero otherwise. Unless overridden by Column 4.49, this column is set equal to 1 if it is the first day of a pulse (Column 4.47 is TRUE), or if the previous day was part of the pulse (Column 4.50 on the previous day is equal to 1) and the duration in Column 4.51 on the previous day is less than the criteria in Column 4.45 and the cumulative volume on the previous day in Column 4.52 is less than the volume criteria in Column 4.44. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if an annual pulse has already occurred.
4.51	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 4.50 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.48 being TRUE. No value is calculated in the monthly portion of the table.
4.50	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.50 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.41 converted to acre-feet. The volume is limited to the qualifying Pulse Volume in Column 4.44. No value is calculated in the monthly portion of the table.
4.51	Pulse Counter	Counts the number of pulses that have occurred so far in the year. The value is incremented by 1 every time a new pulse occurs (Column 4.47 is TRUE).

The summary section accumulates pulse information for the pulses that are used to meet the number per season criteria.

Column	Label	Description
Summary		
4.54	Edna Gage Flow	A repeat of Columns 4.4, 4.14, 4.28 and 4.42. Imported from Column 2.4.
4.55	Base Flow Pass	The minimum of the gage flow in Column 4.54 and the final base bypass in Column 4.13. Monthly values are the sum of the flows converted to acre-feet.
4.56	Small Pulse Bypass?	Logical flag that indicates the need for passage of a small pulse. TRUE if Column 4.24 is equal to 1 and the seasonal pulse counter in Column 4.27 is less than or equal to the number per season in Column 4.19. Monthly values are the number of days in the month with a small pulse bypass.
4.57	Large Pulse Bypass?	Logical flag that indicates the need for passage of a large pulse. TRUE if Column 4.38 is equal to 1 and the seasonal pulse counter in Column 4.41 is less than or equal to the number per season in Column 4.33. Monthly values are the number of days in the month with a large pulse bypass.

4.58	Annual Pulse Bypass?	Logical flag that indicates the need for passage of the annual pulse. TRUE if Column 4.50 is equal to 1 and the pulse counter in Column 4.53 is less than or equal to 1. Monthly values are the number of days in the month with an annual pulse bypass.
4.59	Pulse Day	Code for the type of pulse that occurs when a bypass is flagged. Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Monthly values not calculated.
4.60	Pulse Number	Increments by 1 every time a new pulse of any type (small, large or annual) is flagged for passage. Calculated by adding the value on the previous day plus 1 if the pulse day flag in Column 4.59 is zero on the previous day and greater than zero on the current day.
4.61	Pulse Type	Set to the largest type encountered in the current pulse. If Column 4.59 is zero, this is also set to zero. If Column 4.59 is non-zero, the maximum value encountered for the current pulse number in Column 4.60. This allows for pulses that may initially qualify as a small pulse but ultimately qualify as a large pulse to be identified as a large pulse. A similar situation can happen for annual pulses.
4.62	Notes	Information regarding overrides (Columns 4.23, 4.37, and 4.49) or other descriptive information about the data. Entered by the user.

Columns 4.63 through 4.68 have daily data that are used when comparing the pulses based on the measured flows at the Edna gage to the estimated pulses after diversion in Table 6. These calculations only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
4.63	Offset	For qualifying pulses, number of columns to offset the current column for subsequent calculations in Columns 4.64 to 4.66. #NA if not a qualifying pulse, or a qualifying pulse that occurs after the number of pulses needed to meet the criteria has been met.
4.64	Pulse Trigger	For qualifying pulses, the pulse trigger flow for the pulse, obtained from Columns 4.16, 4.30 or 4.43, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.65	Volume Criteria	For qualifying pulses, the volume criteria for the pulse, obtained from Columns 4.17, 4.31 or 4.44, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Column	Label	Description
4.66	Duration Criteria	For qualifying pulses, the duration criteria for the pulse, obtained from Columns 4.18, 4.32 or 4.45, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.67	Volume	The maximum volume of the pulse, calculated from Columns 4.26, 4.40 or 4.52, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.68	Duration	The maximum duration in days of the pulse, calculated from Columns 4.25, 4.39 or 4.51, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

2.2.6 Table 5 Base Flow Compliance

This table compares the daily diverted flow from the Lavaca River to the available flow based on the daily average flow measured at the Edna gage. Since the pumping operations occur in real time, based on 15-minute reported data, and are not required to change pumping rates more often than every 24 hours, there may be times when there are small discrepancies between the calculated available flow and the actual diversion. The accounting plan tracks deficits and provides opportunities to make up these deficits as soon as possible.

This calculation is conservative in that it does not consider flows entering the Lavaca River between the gage and the diversion point.

Column	Label	Description
Date		
5.1	Days	Monthly – number of days in the month. Daily – day of the month.
5.2	Month	Month number.
5.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Base Flow Check		
5.4	Season	Season of the year imported from Column 4.6. Provided for reference.
5.5	Edna Gage Flow	Flow at the Edna Gage imported from Column 2.4.
5.6	Base Flow Pass	Base or subsistence flow passage for the current day or month. Imported from Column 4.13.

Column	Label	Description
5.7	Available Flow	Daily flow at the Edna Gage in Column 5.5 less the bypass in Column 5.6 in cfs, limited to positive values. The monthly portion of the table is the monthly flow volume in acre-feet.
5.8	Diverted Flow	Daily and monthly diversions from the Lavaca River imported from Column 2.5.
5.9	Check	TRUE if the daily diverted flow in Column 5.8 is less than or equal to the available flow in Column 5.7. The monthly value is the number of days that the value is TRUE.
5.10	Excess/Deficit	The difference between the available flow in Column 5.7 and the diverted flow in Column 5.8. Summed and converted to acre-feet in the monthly portion of the table.
5.11	Cumulative Deficit	Daily cumulative sum of Column 5.10 limited to negative values. Will be zero once sufficient flows have been bypassed to make up for any previous deficit due to diversions. Monthly values are the cumulative deficit at the end of each month.

Column 5.12 is a utility calculation that counts the number of days that the calculation shows a deficit.

2.2.7 Table 6 Post Diversion Pulses

Table 6 is similar to the pulse flow section of Table 4 but instead of using the reported gage flows the calculations are based on gage flows less the Lavaca River diversions. The pulse flows calculated in this table are then compared to the pulse flows calculated in Table 4. Refer to Section 2.2.5 for more additional information regarding pulse flows in the accounting plan, including situations where the pulse flow calculations need to be overridden by the user.

LNRA is considered to be in compliance if the pulse flow remains a qualifying pulse flow both before and after diversion and pumping was shut off before the pulse fully qualified. This approach was used since there may be some discrepancies between actual operation, which is based on 15-minute real time reported data, and calculations using daily average flows. LNRA is also not required to changed pumping rates more often than once every 24 hours.

This calculation is conservative in that it does not consider flows entering the Lavaca River between the gage and the diversion point.

The descriptions below apply to the daily data except where noted. The following section calculates the gage flows less the Lavaca River diversions.

Column	Label	Description
Date		
6.1	Days	Monthly – number of days in the month Daily - day of the month.
6.2	Month	Month number.
6.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Post Diversion Flows		
6.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4. Daily values are in cfs and monthly values are in acre-feet.
6.5	Lavaca Diversion	Diversion from the Lavaca River from Column 2.5. Daily values in cfs and monthly values in acre-feet.
6.6	Post Diversion Flows	Flow in the Lavaca River (Column 6.4) less diversions (Column 6.5). Does not consider any intervening flows between the gage and the diversion.
6.7	Season	Season as defined in 30 TAC §298.305. Evaluated from lookup table in Column 11.2 using the month in Column 6.2 as the index.
6.8	Season Code	A code for each season, with 1 = Winter, 2 = Spring, 3 = Summer, and 4 = Fall. Evaluated from lookup table in Column 11.3 using the month in Column 6.2 as the index.
6.9	New Season?	TRUE if the first day of a season, otherwise FALSE. Calculated by comparing the season code of the current day or month to the season code of the previous day or month. If they are not equal, then the value is TRUE.

The next section of the table calculates small and large pulses. The logic for determining the two types of pulses is practically identical.

Column	Label	Description
Small Pulse		
6.10	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6.
6.11	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 6.21 on the previous day. If this is greater than zero, then the value of Column 6.11 from the previous day is used. If Column 6.21 is equal to zero, then the value is set to the season code in Column 6.8. The monthly part of the table is set equal to the season code in Column 6.8.
6.12	Trigger	The flow in cfs that triggers a small pulse. Lookup from Column 11.10 using the Pulse Index in Column 6.11 as the index.

Column	Label	Description
6.13	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.11 using the Pulse Index in Column 6.11 as the index.
6.14	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.12 using the Pulse Index in Column 6.11 as the index.
6.15	Number per Season	Number of small pulses expected in the current season. Lookup from Column 11.13 using the Pulse Index in Column 6.11 as the index.
6.16	Flow > Trigger	TRUE if the post diversion flow in Column 6.10 is greater than the trigger in Column 6.12. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the Trigger flow.
6.17	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 6.9 = TRUE and there is no carry over pulse indicated by Column 6.11 not being equal to the season code in Column 6.8), a new pulse occurs if the flow is greater than the trigger (Column 6.16 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 6.8 is FALSE), then the flow must be greater than the trigger (Column 6.16 is TRUE) and the previous day must not be part of a pulse (Column 6.20 is zero). Will be FALSE if Column 6.19 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.18	Last Day of Pulse	TRUE if the duration in Column 6.21 is greater than or equal to the criteria in Column 6.14 or the cumulative volume in Column 6.22 is greater than or equal to the criteria in Column 6.13. Monthly values are a count of the number of pulses terminated in the current month.
6.19	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 6.20 = 0) even if the logic in Columns 6.16 through 6.18 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 6.20 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.
6.20	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 6.19, this column is set equal to 1 if it is the first day of a pulse (Column 6.17 is TRUE), or if the previous day was part of the pulse (Column 6.20 on the previous day is equal to 1) and the duration in Column 6.21 on the previous day is less than the criteria in Column 6.14 and the cumulative volume on the previous day in Column 6.22 is less than the volume criteria in Column 6.13. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.

Column	Label	Description
6.21	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.20 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.18 being TRUE. No value is calculated in the monthly portion of the table.
6.22	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.20 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 6.10 converted to acre-feet. The volume is limited to the qualifying Pulse Volume in Column 6.13. No value is calculated in the monthly portion of the table.
6.23	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 6.17 is TRUE). Counting starts over at the beginning of each season (Column 6.9 is TRUE).
Large Pulse		
6.24	Post Diversion Flow	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. and 6.10.
6.25	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 6.35 on the previous day. If this is greater than zero, then the value of Column 6.25 from the previous day is used. If Column 6.35 is equal to zero, then the value is set to the season code in Column 6.8. The monthly part of the table is set equal to the season code in Column 6.7.
6.26	Trigger	The flow in cfs that triggers a large pulse. Lookup from Column 11.14 using the pulse index in Column 6.25 as the index.
6.27	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.15 using the pulse index in Column 6.25 as the index.
6.28	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.16 using the pulse index in Column 6.25 as the index.
6.29	Number per Season	Number of large pulses expected in the current season. Lookup from Column 11.17 using the pulse index in Column 6.25 as the index.
6.30	Flow > Trigger	TRUE if the post diversion flow in Column 6.24 is greater than the trigger in Column 6.26. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.

Column	Label	Description
6.31	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 6.9 = TRUE and there is no carry over pulse indicated by Column 6.25 not being equal to the season code in Column 6.8), a new pulse occurs if the flow is greater than the trigger (Column 6.30 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 6.9 is FALSE), then the flow must be greater than the trigger (Column 6.30 is TRUE) and the previous day must not be part of a pulse (Column 6.34 is zero). Will be FALSE if Column 6.33 is set to “B”, making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.32	Last Day of Pulse	TRUE if the duration in Column 6.35 is greater than or equal to the criteria in Column 6.28 or the cumulative Volume in Column 6.36 is greater than or equal to the criteria in Column 6.27. Monthly values are a count of the number of pulses terminated in the current month.
6.33	Pulse Override	Entered by LNRA staff. A “B” entered in the will make the current day a base flow day (Column 6.34 = 0) even if the logic in Columns 6.30 through 6.32 indicate that the day is a pulse day. Similarly, a “P” entered will make the day a pulse day (Column 6.34 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.
6.34	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 6.33, this column is set equal to 1 if it is the first day of a pulse (Column 6.31 is TRUE), or if the previous day was part of the pulse (Column 6.34 on the previous day is equal to 1) and the duration in Column 6.35 on the previous day is less than the criteria in Column 6.28 and the cumulative volume on the previous day in Column 6.36 is less than the volume criteria in Column 6.27. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.
6.35	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.34 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.32 being TRUE. No value is calculated in the monthly portion of the table.
6.36	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.34 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the post diversion flow in Column 5.24 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 6.27. No value is calculated in the monthly portion of the table.

Column	Label	Description
6.37	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 6.31 is TRUE). Counting starts over at the beginning of each season (Column 6.9 is TRUE).

The next section calculates annual pulses. The annual pulse calculations are similar to small and large except there is only one set of criteria. Since the annual pulses do not vary by seasons, the pulse index and number per season are not needed.

Column	Label	Description
Annual Pulse		
6.38	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. 6.10 and 6.24.
6.39	Trigger	The flow in cfs that triggers an annual pulse. Value from Column 11.18. Since there is a single value there is no index.
6.40	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Value from Column 11.19.
6.41	Duration Criteria	Duration in days associated with a qualifying pulse. Value from Column 11.20.
6.42	Flow > Trigger	TRUE if the gage flow in Column 6.38 is greater than the trigger in Column 6.39. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
6.43	First Day of Pulse	TRUE if the current day initiates a new pulse. The flow must be greater than the trigger (Column 6.42 is TRUE) and the previous day must not be part of a pulse (Column 6.46 is zero). Will be FALSE if Column 6.45 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.44	Last Day of Pulse	TRUE if the duration in Column 6.47 is greater than or equal to the criteria in Column 6.41 or the cumulative volume in Column 6.48 is greater than or equal to the criteria in Column 6.40. Monthly values are a count of the number of pulses terminated in the current month.
6.45	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 6.46 = 0) even if the logic in Columns 6.42 through 6.44 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 6.46 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.

Column	Label	Description
6.46	Is Pulse	Equal to 1 if a pulse is on-going, zero otherwise. Unless overridden by Column 6.45, this column is set equal to 1 if it is the first day of a pulse (Column 6.43 is TRUE), or if the previous day was part of the pulse (Column 6.46 on the previous day is equal to 1) and the duration in Column 6.47 on the previous day is less than the criteria in Column 6.41 and the cumulative volume on the previous day in Column 6.48 is less than the volume criteria in Column 6.40. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if an annual pulse has already occurred.
6.47	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.46 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.44 being TRUE. No value is calculated in the monthly portion of the table.
6.48	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.46 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the post diversion flow in Column 6.38 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 6.40. No value is calculated in the monthly portion of the table.
6.49	Pulse Counter	Counts the number of pulses that have occurred so far in the Year. The value is incremented by 1 every time a new pulse occurs (Column 6.43 is TRUE).

The summary section accumulates pulse information for the pulses that are used to meet the number per season criteria.

Column	Label	Description
Summary		
6.50	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. 6.10, 6.24 and 6.38.
6.51	Small Pulse Bypass?	Logical flag that indicates the need for passage of a small pulse. TRUE if Column 6.20 is equal to 1 and the seasonal pulse counter in Column 6.23 is less than or equal to the number per season in Column 6.15. Monthly values are the number of days in the month with a small pulse bypass.
6.52	Large Pulse Bypass?	Logical flag that indicates the need for passage of a large pulse. TRUE if Column 6.34 is equal to 1 and the seasonal pulse counter in Column 6.37 is less than or equal to the number per season in Column 6.29. Monthly values are the number of days in the month with a large pulse bypass.
6.53	Annual Pulse Bypass?	Logical flag that indicates the need for passage of the annual pulse. TRUE if Column 6.46 is equal to 1 and the pulse counter in Column 6.49 is less than or equal to 1. Monthly values are the number of days in the month with an annual pulse bypass.

6.54	Pulse Day	Code for the type of pulse that occurs when a bypass is flagged. Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Monthly values not calculated.
6.55	Pulse Number	Increments by 1 every time a new pulse of any type (small, large or annual) is flagged for passage. Calculated by adding the value on the previous day plus 1 if the pulse day flag in Column 6.53 is zero on the previous day and greater than zero on the current day.
6.56	Pulse Type	Set to the largest type encountered in the current pulse. If Column 6.54 is zero, this is also set to zero. If Column 6.54 is non-zero, the maximum value encountered for the current Pulse Number in Column 6.55. This allows for pulses that may initially qualify as a small pulse but ultimately qualify as a large pulse to be identified as a large pulse. A similar situation can happen for annual pulses.
6.57	Notes	Enter information regarding overrides (Columns 6.19, 6.33, and 6.45) or other information about the data.

Columns 6.58 through 6.63 have daily data that are used when comparing the pulses based on the post-diversion flows to the gaged flow pulses after diversion in table 5. These calculations only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
6.57	Offset	For qualifying pulses, number of columns to offset current column for subsequent calculations in Columns 6.59 to 6.61. #NA if not a qualifying pulse, or a qualifying pulse that occurs after the number of needed pulses has been met.
6.58	Pulse Trigger	For qualifying pulses, the pulse trigger flow for the pulse, obtained from Columns 6.12, 6.26 or 6.39, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.59	Volume Criteria	For qualifying pulses, the volume criteria for the pulse, obtained from Columns 6.13, 6.27 or 6.40, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.60	Duration Criteria	For qualifying pulses, the duration criteria for the pulse, obtained from Columns 6.14, 6.28 or 6.41, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Column	Label	Description
6.62	Volume	The maximum volume of the pulse, calculated from Columns 6.22, 6.36 or 6.48, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.63	Duration	The maximum duration in days of the pulse, calculated from Columns 6.21, 6.35 or 6.47, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Columns 6.64 through 6.68 are used to accumulate information regarding shut off of pumping during a pulse flow. Since operations are based on real-time flows, the shut off of diversions may not exactly correspond to calculations made with daily average flows. For example, diversions could be shut off in the middle of one day and recommence before the end of the next day after the required pulse volume has passed. On a daily average basis, there would be pumping shown on both days even though LNRA would be in compliance with the standards.

Columns 6.64 to 6.66 are used to assign the shutoff data to the pulse, which is then referenced in Table 9. Columns 6.67 and 6.68 are provided for reference.

These columns only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
6.64	Pulse Number	This is the pulse number from Column 6.55 but is only non-zero during the qualifying period of the pulse.
6.65	No Pumping for Day	Set equal to 1 if the user enters a “Y” in Column 2.6, indicating that pumping was shut down for pulse passage during all or part of the current day.
6.66	No Pumping During Pulse	Equal to TRUE if pumping was shut off during the pulse qualifying period.
6.67	Lavaca Pumping	Daily diversions from the Lavaca River in acre-feet per day. Imported from Column 2.5. Provided for reference.
6.68	Volume Pumped During Pulse	Total volume pumped during the qualifying days associated with the pulse, as calculated based on the daily average data. Provided for reference.

2.2.8 Table 7 Graph Data

Table 7 provides graphical displays of daily time series to aid review of compliance with the Lavaca River environmental flow standards. The data are displayed in both linear and log plots. All values imported from elsewhere. Columns 7.4, 7.5 and 7.7 through 7.12 are plotted on the graphs.

Column	Label	Description
Date		
7.1	Days	Day of the month.
7.2	Month	Month number.
7.3	Date	Excel date for each day.
Graph Data		
7.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4.
7.5	Base Flow	Final base or subsistence flow target, not limited by inflow. Imported from Column 4.13.
7.6	Pulse Type	Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Imported from Column 4.61
7.7	Small Pulse Flow	Edna gage flow during a small pulse. If Column 7.6 is equal to 1, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph.
7.8	Large Pulse Flow	Edna gage flow during a large pulse. If Column 7.6 is equal to 2, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph.
7.9	Annual Pulse Flow	Edna gage flow during the annual pulse. If Column 7.6 is equal to 3, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph
7.10	Small Pulse Trigger	Small pulse trigger flow level. Imported from Column 4.16.
7.11	Large Pulse Trigger	Large pulse trigger flow level. Imported from Column 4.30.
7.12	Annual Pulse Trigger	Annual pulse trigger flow level. Imported from Column 4.43.

2.2.9 Table 8 Comparison of Pulses Before and After Diversions

Table 8 compares the pulses calculated in Table 4 (before diversions) and Table 6 (after diversion). The table only compares the number of pulses required by the criteria, a maximum of 13 pulses (4 seasons times 2 small pulses plus 1 large pulse, plus one annual pulse). Other pulses can and do occur, but these are not considered as contributing to compliance with the standards. Most of the time there will be fewer than 13 pulses, since an annual pulse counts as a large pulse, and so forth. Also, the required number of pulses may not have occurred during a particular season.

LNRA is considered to be in compliance if there is the same number of qualifying pulses before and after diversions, and diversions were shut off during the qualification period for each pulse.

Column	Label	Description
8.1	Pulse Index	Value of 1 to 13.
Pre-Diversion Pulses		
8.2	Row Index	Row index for each qualifying pulse calculated in Table 4. The row index is the row within the daily portion of the table. Calculated by matching the pulse number in Column 8.1 with the first occurrence of the number in Column 4.60. Set to #N/A if there is no corresponding index for the pulse number.
8.3	Season Code	The seasonal code from Column 4.7. The codes for each season are from Column 11.3. Set to “na” if there is no corresponding index for the pulse number.
8.4	Pulse Code	The pulse type code from Column 4.61. Codes are 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Set to “na” if there is no corresponding index for the pulse number.
8.5	Season	The name of the season, obtained from Column 11.2 using the season code in Column 8.3 as an index.
8.6	Pulse Type	The type of pulse (small, large or annual), obtained from Column 11.25 using the pulse code in Column 8.4 as an index.
8.7	Pulse Trigger	The pulse trigger flow criteria from Column 4.64.
8.8	Volume Criteria	The pulse volume criteria from Column 4.65.
8.9	Duration Criteria	The pulse duration criteria from Column 4.66.
8.10	Volume	The volume for the pulse when the pulse qualified from Column 4.67.
8.11	Duration	The duration of the pulse when the pulse qualified from Column 4.68.
Post-Diversion Pulses		
8.12	Row Index	Row index for each qualifying pulse calculated in Table 6. The row index is the row within the daily portion of the table. Calculated by matching the pulse number in Column 8.1 with the first occurrence of the number in Column 6.55. Set to #N/A if there is no corresponding index for the pulse number.
8.13	Season Code	The seasonal code from Column 6.8. The codes for each season are from Column 11.3. Set to “na” if there is no corresponding index for the pulse number.
8.14	Pulse Code	The pulse type code from Column 6.56. Codes are 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Set to “na” if there is no corresponding index for the pulse number.
8.15	Pulse Trigger	The pulse trigger flow criteria from Column 6.59.
8.16	Volume Criteria	The pulse volume criteria from Column 6.60.
8.17	Duration Criteria	The pulse duration criteria from Column 6.61.
8.18	Volume	The volume for the pulse when the pulse qualified from Column 6.62.

Column	Label	Description
8.19	Duration	The duration of the pulse when the pulse qualified from Column 6.63.
Comparison		
8.20	Matches Season	"Y" if the season codes match in Columns 8.3 and 8.13. "N" if they do not match.
8.21	Matches Pulse Type	"Y" if the pulse codes match in Columns 8.4 and 8.14. "N" if they do not match.
8.22	Matches Volume	"Y" if the volumes match in Columns 8.10 and 8.18. "N" if they do not match.
8.23	Matches Duration	"Y" if the durations match in Columns 8.11 and 8.19. "N" if they do not match.
8.24	Shutoff During Pulse	"Y" if LNRA shut off pumping during the qualifying period of the pulse.

2.2.10 Table 9 Overdraft in Lieu of Pumping

Table 9 performs calculations that tell when conditions are suitable for overdrafting Lake Texana in lieu of pumping from the Lavaca River. Overdrafting can occur when:

1. Water is available for pumping from the Lavaca River because environmental flows are met,
2. Lake Texana is full and spilling, and
3. Pumping from Lake Texana does not reduce outflows from Lake Texana to less than the bay and estuary freshwater inflow release schedule from the Lake Texana water right (Certificate of Adjudication 16-2095B 4.A.1.).

Overdraft is limited to actual diversions from Lake Texana. Overdraft water can potentially be stored in the off-channel reservoir, if present.

Available flow calculated in Table 9 is linked to Table 2 for use in determining when some diversions can be assigned to overdraft.

Column	Label	Description
Date		
9.1	Days	Monthly – number of days in the month Daily - day of the month.
9.2	Month	Month number.
9.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Overdraft Calculation		
9.4	Lake Texana Elevation	Daily elevations imported from Column 2.11. Monthly portion of the table is not used.

Column	Label	Description
9.5	Reservoir Spills	Daily and monthly Lake Texana spills and releases during flood operations. Imported from Column 2.12. Includes outflows that may be associated with bay and estuary freshwater inflow releases.
9.6	Freshwater Inflow Bypass During Spill	Daily values are the calculated bypass in cfs associated with releases for bay and estuary purposes from Lake Texana. Calculation only occurs when Lake Texana elevation is greater than or equal to 44 feet. Monthly releases values are from Columns 10.11 and 10.12 using the month in Column 9.2 as an index. Monthly values are the flow volume in acre-feet for each month.
9.7	Spills > Bypass?	Set to 1 if the spill in Column 9.5 is greater than the bypass in Column 9.6. m Otherwise set to zero. In the monthly part of the table, the value is the number of days in the month where spills are more than the bypass.
9.8	Lavaca Flow Available During Spill	If a pulse flow has occurred based on the daily average flow at the Edna gage but has not yet qualified and the required number of pulses has not occurred during the current season, then this value is zero. This is indicated by a non-zero value in Column 4.67. Otherwise set to the base flow available after bypass from Column 5.7. Both values are multiplied by Column 9.7, which will be equal to 1 if conditions are met for overdraft diversions, and zero if those conditions have not been met.
9.9	Lavaca Diversion During Spill	Diversion from the Lavaca River during a spill event, imported from Column 2.5, converted to cfs. Multiplied by Column 9.7, which will be a 1 if conditions are met for the overdraft, zero if conditions are not met for overdraft.
9.10	Available for Overdraft	Set to the minimum of: • The available flow in Column 9.8 less the diversions from the Lavaca River in Column 9.9, and • The maximum diversion rate from Column 10.8 (200 MGD) less any diversions made on the same day assigned to non-overdraft rights from Column 2.15. This column is imported into Table 2 to assist the user in assigning diversions to the overdraft authorizations.

2.2.11 Table 10 Reference

Table 10 contains miscellaneous values used elsewhere in the accounting plan, including whether the current year is a leap year, conversion factors, the Lake Texana Freshwater Inflow criteria, various water right authorizations, and pan factors. Although these values are entered by the user, they are not expected to change between accounting plans.

Column	Label	Description
Year Reference Data		
10.1	Parameter	Labels for Column 10.2

Column	Label	Description
10.2	Value	Current year and Boolean flag for a leap year (TRUE if the current year is a leap year).
Conversion Factors		
10.3	To get	Unit for result
10.4	From	Unit for original value
10.5	Multiply by	Conversion factor
Project Authorizations		
10.6	Priority Date	Priority date of the various authorizations
10.7	Diversion Amount	Diversion amount in acre-feet per year associated with the authorization
10.8	Use Type	Type of use associated with the authorizations.
Pan Factors		
10.9	Month	Numerical month of the year
10.10	Factor	Factor to be used to convert LNRA pan evaporation to gross evaporation.
Lake Texana Freshwater Bypass		
10.11	Month	Numerical month of the year
10.12	Above 78.18%	Bay and estuary freshwater inflow requirement from the Lake Texana water right. Applies when the storage (less imported water) is more than 78.18% of the conservation storage.
10.13	Less than 78.18%	Bay and estuary freshwater inflow requirement from the Lake Texana water right. Applies when the storage (less imported water) is less than 78.18% of the conservation storage.

2.2.12 Table 11 Edna Environmental Flow Criteria

Table 11 contains data for the environmental flow standards for the Lavaca River near Edna gage. These data are references primarily in Tables 5 and 6.

Column	Label	Description
Season Codes		
11.1	Month	Numerical month of the year
11.2	Season	Name of each season (Winter, Spring, Summer and Fall)
11.3	Code	Code associated with each season (1 through 4). This code is used as an index for the base and subsistence flows in Columns 11.4 through 11.9.
Subsistence and Base Flows		
11.4	Season	Season name (Winter, Spring, Summer or Fall)
11.5	Subsistence	Subsistence flow criteria for each season. Applies only in Severe conditions when flows are less than the base flows in Column 11.6. Hydrologic condition is set by the Lake Texana elevations in Column 11.22.
11.6	Severe Base	Severe base flow criteria. Applies when flows are greater than the base flow.
11.7	Dry Base	Dry condition base flow criteria.

Column	Label	Description
11.8	Average Base	Average condition base flow criteria.
11.9	Wet Base	Wet conditions base flow criteria.
Small Pulse		
11.10	Small Pulse Trigger	Trigger flow in cfs that initiates a small pulse.
11.11	Small Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.12	Small Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.
11.13	Number per Season	Number of small pulses per season. A large pulse or an annual pulse also counts to the achievement of this criteria. Diversions do not need to cease for subsequent small pulses later in the same season.
Large Pulse		
11.14	Large Pulse Trigger	Trigger flow in cfs that initiates a large pulse.
11.15	Large Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.16	Large Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.
11.17	Number per Season	Number of large pulses per season. An annual pulse also counts toward the achievement of this criteria. Diversions do not need to cease for subsequent large pulses later in the same season.
Annual Pulse		
11.18	Annual Pulse Trigger	Trigger flow in cfs that initiates an annual pulse.
11.19	Annual Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.20	Annual Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.

Column	Label	Description
Hydrologic Condition		
11.21	Hydrologic Condition	Severe, Dry, Average or Wet
11.22	Texana Elevation	Texana pool elevation that signals a change in the condition. Hydrologic condition is set at the beginning of each season based on the elevation on the last day of the previous season. If Texana is at or above 44 feet, it signals a Wet condition. If Texana is between 43 feet and 44 feet, it signals an Average condition. If Texana is between 39.95 feet and 43 feet, it signals a Dry condition. Below 39.95 feet, it signals Severe conditions.
11.23	Code	Numeric code for each season. Used as an index for lookup calculations.
Pulse Codes		
11.24	Code	Numeric code for each pulse type, 1 for small, 2 for large and 3 for annual
11.25	Pulse Type	Label for pulse code.

2.2.13 Table 12 Lake Texana Area-Capacity-Elevation

Volumetric and other information for Lake Texana. The name of the survey is entered in merged cells B3 through D3, labeled as "Survey Name" below. The table may change as new surveys become available. It may be necessary to extend the survey above conservation storage at 44 feet if Lake Texana was above 44 feet during the year.

Column	Label	Description
Survey Name		
12.1	Elevation	Pool elevation from the survey
12.2	Area	Area in acres at the elevation in Column 12.1.
12.3	Capacity	Storage volume at the elevation in Column 12.1.
Storage and Elevation Data		
12.4	Conservation Elevation	The normal pool elevation of Lake Texana (44 feet).
12.5	Conservation Storage	The storage when Lake Texana is at the conservation elevation in Column 12.4.
12.6	B&E Percent	The percent of conservation storage where the bay and estuary freshwater inflow releases change (78.18 percent).
12.7	B&E Storage	The storage at 78.18 percent conservation. Calculated by multiplying Column 12.5 by Column 12.6.
12.8	B&E Elevation	The pool elevation corresponding to the storage in Column 12.7.

2.2.14 Import/Export

Values that need to be copied from one year's plan to the next. The values in row 9 (shaded green) can be copied and pasted directly into row 19 of the next year's plan (row 19). The column labels below correspond to the equivalent labels in the accounting plan tables. Refer to the individual tables for a description of each column.

The export is set up so that it automatically gets the correct data for the last day of the year, even during leap years.

Column	Label
2.4	Lavaca River nr Edna
2.5	Diversion from Lavaca River
2.6	Shutoff During Pulse [a]
2.11	Texana Elevation
3.18	Imported Water Storage
4.10	Hydrologic Condition Code
4.13	Final Base Bypass
4.21	First Day of Small Pulse
4.24	Is Small Pulse
4.25	Small Pulse Duration
4.26	Small Pulse Cumulative Volume
4.27	Small Pulse Seasonal Counter
4.35	First Day of Large Pulse
4.38	Is Large Pulse
4.39	Large Pulse Duration
4.40	Large Pulse Cumulative Volume
4.41	Large Pulse Seasonal Counter
4.47	First Day of Annual Pulse
4.50	Is Annual Pulse
4.51	Annual Pulse Duration
4.52	Annual Pulse Cumulative Volume
5.11	Cumulative Deficit
6.17	First Day of Small Pulse
6.20	Is Small Pulse
6.21	Small Pulse Duration
6.22	Small Pulse Cumulative Volume
6.23	Small Pulse Seasonal Counter
6.31	First Day of Large Pulse
6.34	Is Large Pulse
6.35	Large Pulse Duration
6.36	Large Pulse Cumulative Volume
6.37	Large Pulse Seasonal Counter
6.43	First Day of Annual Pulse
6.46	Is Annual Pulse

Column	Label
6.47	Annual Pulse Duration
6.48	Annual Pulse Cumulative Volume

a Will default to “N” if blank on last day of year.

Innovative approaches
Practical results
Outstanding service

DRAFT LAKE TEXANA ENHANCED YIELD PROJECT ACCOUNTING PLAN

Prepared for:

Lavaca-Navidad River Authority

March 20, 2020

Prepared by:

FREESE AND NICHOLS, INC.
10497 Town and Country Way, Suite 600
Houston, Texas 77024
713-600-6800

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DRAFT
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF **JASON AFINOWICZ**, P.E., TEXAS NO. **100102** ON **March 20, 2020**. IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.
FREESE AND NICHOLS, INC.
TEXAS REGISTERED ENGINEERING FIRM F- 2144

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LVA18507

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1.0 LTYEP WATER RIGHT

The Lavaca-Navidad River Authority (LNRA) is seeking a Texas water right for the Lake Texana Enhanced Yield Project (LTYEP). This accounting plan addresses compliance with the terms and conditions of the proposed LTYEP water right.

The LTYEP project seeks to create additional supply for LNRA by supplementing existing supplies from Lake Texana with diversions from the Lavaca River and construction of a new off-channel reservoir (OCR). The project will be built in two phases. The first phase (Phase I) is storage of Lavaca River water in Lake Texana. The second phase (Phase II) is adding an off-channel reservoir to the project. Specific authorizations relevant to this accounting plan include:

- A new appropriation to:
    - Divert up to 96,022 acre-feet per year from a reach of the Lavaca River between Diversion Point A (28.887744 N 96.618490 W) and Diversion Point B (28.876220 N 96.611804 W) in Jackson County at a maximum diversion rate of 309.4 cfs (200 MGD).
    - Construct and maintain a dam that will impound up to 240 acre-feet in an on-channel diversion reservoir within that reach.
    - Temporarily store the water in the existing Lake Texana for subsequent re-diversion and use at a maximum combined diversion rate of 660 cfs.
    - Store water in a new 50,000 acre-foot off-channel reservoir in Jackson County in the Lavaca-Colorado Coastal Basin for subsequent re-diversion and use.
    - Use the re-diverted water for municipal, industrial, and mining purposes in Calhoun, Jackson, Matagorda, Wharton and Victoria Counties in the Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca-Guadalupe Coastal Basin.
- Use of the bed-and-banks of Lake Texana to convey the water diverted from the Lavaca River and discharged at a point on the perimeter of Lake Texana to the two existing diversion structures on Lake Texana or any other future diversion point on the perimeter of Lake Texana.
- When Lake Texana is full and spilling, spills from Lake Texana exceed the Bay and Estuary Release Schedule in CoA 16-2095B 4.A.1 and CoA 16-2095D Special Condition 5.A., and water could have been diverted from the Lavaca River because environmental flows have been satisfied, an equivalent amount of the water that would have been diverted from the Lavaca River can be diverted from Lake Texana, as long as those diversions do not cause spills to drop below the required Bay and Estuary Release schedule.

2.0 ELEMENTS OF THE ACCOUNTING PLAN

2.1 OVERVIEW

The accounting plan consists of this documentation and an Excel workbook that performs the accounting calculations. The Excel workbook contains the following tables:

- Table of Contents – list of the worksheets in the workbook.
- Table 1 Summary – summary of the status of various authorizations and warning messages.
- Table 2 Basic Data – primary entry place for data used in the accounting plan.
- Table 3 Lake Texana – pool accounting for imported Lavaca River water.
- Table 4 Edna Environmental Flows – calculation of base/subsistence flows and pulse flows from gage data measured at the USGS gage 08164000 Lavaca River near Edna gage (Edna gage).
- Table 5 Base Flow Compliance – demonstrates compliance with base and subsistence flows at the Edna gage.
- Table 6 Environmental Flows after Diversion – calculates pulse flows based on the Edna gage flows less the Lavaca River diversions.
- Table 7 Graph Data – data series and graphs that show environmental flows.
- Table 8 Comparison of Pulses Before and After Diversions – compares pulse flow compliance before diversions (Table 5) and after diversions (Table 6).
- Table 9 Overdraft in Lieu of Pumping – calculates water that is available for overdraft from Lake Texana.
- Table 10 References – miscellaneous reference data used in the accounting plan.
- Table 11 Edna Instream Flow Criteria – reference data used in the environmental flow calculations at the Edna gage.
- Table 12 Lake Texana Area-Capacity-Elevation – volumetric data for Lake Texana.

Each table is described in detail in the next section.

Most workbooks consist of a monthly section and a daily section, with most of the calculations occurring in the daily portion of the table. The monthly portion is provided as a summary. The monthly portion of the table can be viewed by clicking on the “Show” button on the upper left hand corner of the workbook. It can be hidden by clicking on the “Hide” button.

The last worksheet, named ImportExport, contains data that can be copied from the previous year’s plan for use in this year’s plan, as well as data for the upcoming year’s plan.

2.2 WORKBOOK TABLES

The monthly and daily tables in the accounting plan have five-row header labels for each column, with one set for monthly data and one set for daily data. An example from the first seven columns of Table 2 is shown below. The first row groups the columns by function. In the example below, the data are grouped by the three columns that contain date information (day, month and Excel date) and the five columns that have data for the diversions from the Lavaca river (gage data, total diversions, shut off pumping during a pulse, and the portion of the diversions that go to Lake Texana and to the Off-Channel Reservoir).

Date			Lavaca Diversions				
2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
Ref	Ref	Ref	Input	Input	Input	Input	Input
Date	Date	Date	MG	MG	Y/N	MG	MG
Day	Month	Date	Lavaca River nr Edna	Diversion from Lavaca River	Shutoff During Pulse	Lavaca Water to Lake Texana	Lavaca Water to OCR

The second row is a column number with the digits to the left of the decimal point indicating the table number and the digits to the right of the decimal point indicating the unique column number. For example, Column 2.4 refers to the gage flows in the Lavaca River nr Edna column in the above example. This convention is used throughout this document to refer to specific columns in the accounting plan tables.

The third row contains text labels that describe the origin of the data in the column. The following table has descriptions of these labels.

Label	Description
Ref	Column is used as reference data. Includes day, month and Excel date values in all tables, as well as other reference data such as environmental flow criteria, etc.
Input	Data input by user. May contain formulas entered by the user that reference other data. Also indicated by yellow shading.
Calc	Data in column is calculated using Excel formulas.
Linked	Data in column is directly obtained from another column in the accounting plan.
Lookup	Data are obtained from a lookup table elsewhere in the accounting plan.

The fourth row contains the units used in the column. The following table contains the units used in the accounting plan.

Unit	Description
ac-ft	Acre-feet over the time period in the date row. In the monthly portion of the table, acre-feet per month. In the daily portion of the table, acre-feet per day.
B or P	B for base flow day or P for pulse flow day
Boolean	Condition is TRUE or FALSE. Used when the condition is used as a reference for other calculations.
cfs	Cubic feet per second
Date	Number of days, month number, or Excel date
days	Value in days
dsf	Volume representing an average flow in cfs over a 24-hour period. 1 dsf = 86,400 cubic feet.
feet	Feet, usually feet above mean sea level
in/day	Inches per day
in/month	Inches per month
none	No units
ref	Non-specific reference value
text	Text entry
var	Various units within column
Y/N	"Y" for yes (condition is TRUE), or "N" for no (condition is FALSE). Applied in cases where these values are referenced for user input.

The individual workbook tables are described in the remainder of this section.

2.2.1 Table of Contents

The Table of Contents is a list of all of the tables with clickable links to the tables. Each table also has a clickable link in the upper left-hand corner that will take you to the Table of Contents.

2.2.2 Table 1 Summary

Table 1 is the location where the year of the accounting plan is entered. It also has a set of tables that shows the current status of the LNRA water rights. This table can be used to assist assigning diversions to various authorizations.

The lower table is a list of checks that display warning messages under certain conditions. If these checks indicate a potential problem with the entries, “check inputs” will appear in the Check column. This does not necessarily indicate a problem with the data or the calculations. It only indicates that there may be a problem. A notes column is provided in cases where the checks signal that inputs need to be checked and the user has verified that the calculations reflect operations.

2.2.3 Table 2 Basic Data

Table 2 is the primary location for input data used in the Accounting Plan. The user inputs daily values in the daily portion of the table, and these are summed to monthly values in the monthly portion of the table (revealed by clicking on the Show button). It is also the location where the user assigns diversions to the LTYEP authorizations. Y/N flags are provided to assist with the assignment, with Y indicating that there are available authorizations at that particular priority date, and an N indicating that those authorizations are not available, either because they have been fully utilized or other conditions prevent use of those rights. Data used to calculate the Y/N flags may be found in Columns 2.24 and 2.25.

Daily average flows are calculated by LNRA from USGS 15-minute data reported directly to LNRA. These averages may be slightly different than those reported by USGS. Evaporation and precipitation data are as reported by LNRA from their own weather station. If data are obtained from another source, then the source will be recorded in Column 2.26 (daily only).

Column	Label	Description
Date		
2.1	Days	Monthly – number of days in the month Daily – day of the month.
2.2	Month	Month number.
2.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Lavaca River Data		
2.4	Lavaca River nr Edna	Monthly – monthly flow volume in acre-feet. Daily – daily average flow in cfs, as input by user.
2.5	Diversion from Lavaca River	Monthly – monthly volume diverted from the Lavaca River during the current month in acre-feet. Daily – daily flow volume diverted from Lavaca River in MG, as input by user.

Column	Label	Description
2.6	Shutoff During Pulse	A flag that signifies whether pumping was suspended during a pulse flow event. Often some water will be pumped on a day when either a pulse initiates or qualifies. A pulse can and usually will trigger in the middle of a day, so some pumping could occur earlier in the day. Similarly, a pulse can meet the volume criteria in the middle of a day, so pumping can be resumed. This flag allows for these situations to be recorded in the accounting plan. Monthly – number of days shut off because of pulse bypass. Daily – Y or N if pumping was cut off some time during the day in order to bypass a pulse. Input by user.
2.7	Lavaca Water to Lake Texana	Total Lavaca River pumping volume sent to Lake Texana. Includes water that may be passed using the bed and banks of Lake Texana to the OCR. Monthly – monthly volume of Lavaca River water sent to Lake Texana. Daily – daily flow volume in MG sent to Lake Texana. Input by user.
2.8	LTYEP Water from Texana to OCR	Flow volume pumped from Lake Texana to the OCR. Includes water diverted using the overdraft in lieu of pumping authorizations that has been sent to the OCR. Monthly – monthly volume of water pumped from Lake Texana to the OCR. Daily – daily flow volume in MG pumped from Lake Texana to the OCR. Input by user.
2.9	Lavaca Water Pumped Directly to OCR	Flow volume pumped directly from the Lavaca River pump station to the OCR. Monthly – monthly volume pumped directly to the OCR. Daily – daily flow volume pumped directly to the OCR. Input by user.
2.10	Total LTYEP Water to OCR	Sum of Columns 2.8 and 2.9. Includes water passed through Lake Texana and water sent directly to OCR. Also may include overdraft in lieu of pumping water from Lake Texana sent to the OCR. Monthly – total volume of Lavaca River water sent to OCR. Daily – total daily flow volume in MG sent to OCR.
Lake Texana Data		
2.11	Elevation	Monthly – end-of-month elevation of Lake Texana. Daily – daily elevation of Lake Texana as reported by LNRA. Input by user.
2.12	Reservoir Spills	Outflows through Palmetto Bend Dam during flood operations (reservoir at or near 44 feet). Includes releases associated with bay and estuary freshwater inflows. Does not include diversions from the reservoir. Monthly – monthly volume in acre-feet. Daily – daily outflows in acre-feet during flood operations. Input by user.
2.13	Pan Evaporation	Monthly – monthly rate of pan evaporation in inches. Daily – daily rate of pan evaporation in inches as reported by LNRA. Standard pan factors are applied in Table 3. Input by user.
2.14	Precipitation	Monthly – monthly rainfall in inches per month. Daily – daily rainfall in inches per day as reported by LNRA. Input by user.

Column	Label	Description
Lake Texana Diversions		
2.15	LTYEP Texana Diversion	Monthly – volume of water diverted from Lake Texana under the proposed LTYEP water right in acre-feet. Daily – total daily average diversion from Lake Texana under this authorization in cfs. Input by user. Column 2.16 and the LNRA Water Rights Summary in Table 1 are available to assist the user in assigning diversions to these authorizations. The cells will be shaded pink if the diversion exceeds the LTYEP authorization. Diversions in this column plus column 2.20 (Diversions from OCR) are limited to 96,022 acre-feet per year.
2.16	Available from Lavaca	Monthly – number of days that LTYEP Lake Texana water is available in each month. Daily – a “Y” indicates that water is available to be diverted under this authorization. A “N” indicates that water is not available to be diverted under this authorization. Diversions are in Column 2.15. Water is available if the remaining authorizations in Column 2.24 less the diversions in Column 2.20 are greater than zero and there is: • Water in the storage account in Lake Texana (Column 2.25), and/or • Lavaca water has been sent to Lake Texana (Column 2.7 less Column 2.8). This check does not consider environmental flows, which are addressed separately.
2.17	Available for Overdraft	Calculated volume of water available for overdraft. Imported from Column 9.10. Monthly – volume in acre-feet. Daily – volume in MG.
2.18	Overdraft Diversion	Volume of diversion from Lake Texana assigned to overdraft in lieu of pumping. Monthly – monthly sum in acre-feet. Daily – volume of diversion in MG. Input by user.
2.19	Total Texana LTYEP Diversion	Total LTYEP diversions from Lake Texana. Sum of Columns 2.15 and 2.19. Monthly – monthly sum of diversions in acre-feet. Daily – daily sum of diversions in MG.
OCR		
2.20	Diversion	Diversions for water supply from the Off-Channel Reservoir (OCR). Monthly – volume diverted from the OCR in acre-feet. Daily – average daily flow diverted from the OCR in cfs. Input by user. The cells will be shaded pink if the diversion exceeds the LTYEP authorization. Diversions in this column plus column 2.19 (Total LTYEP Texana Diversion) are limited to 92,022 acre-feet per year.

Column	Label	Description
2.21	Available	Monthly – number of days that LTYEP OCR water is available in each month. Daily – a "Y" indicates that water is available to be diverted under this authorization. A "N" indicates that all of these authorizations have been used. Diversions are in Column 2.20. Water is available if the remaining authorizations in Column 2.24 are greater than zero. Will always be "N" if no elevation is entered in Column 2.23. This check does not consider environmental flows, which are addressed separately.
2.22	Total LTYEP Diversion	Sum of columns 2.19 and 2.20. Monthly – volume diverted for water supply under the LTYEP authorizations in acre-feet. Daily – average daily flows diverted for water supply under the LTYEP authorization in cfs.
2.23	OCR Elevation	Monthly – end-of-month elevation in the OCR. Daily – daily elevation in the OCR. Input by user. A value is needed for water to be available from the OCR (Column 2.21). These values are for information and are not used in any other calculations.

Columns 2.24 and 2.25 are used to determine the availability flags in Columns 2.16, and 2.21. Column 2.26 is for notes regarding the daily data. Notes should be entered whenever an alternative source is used for the data. Other information regarding the day's data may be entered here as well. Columns 2.24 to 2.26 are only in the daily portion of the table.

Column	Label	Description
Available Flow		
2.24	Remaining LTYEP	Volume at beginning of day remaining for LTYEP water supply diversions. Values are in MG.
2.25	Texana Storage Account Previous Day	Volume of Lavaca River water currently in the storage account in Lake Texana on the previous day in MG. Imported from Column 3.18.
2.26	Notes	Place for the user to enter notes about the daily data, including information regarding data that comes from alternate sources.

2.2.4 Table 3 Lake Texana

Table 3 performs storage accounting for water imported from the Lavaca River into the reservoir. The section labeled Lake Texana Operation calculates the storage, surface area, and net evaporative loss for the reservoir. The Imports and Diversions section is linked to the diversion data entered in Table 2. The Lake Texana Storage Accounting section includes the storage accounting of Lavaca River water imported into Lake Texana that is not immediately re-diverted and used.

The storage account for the imported Lavaca River water is a "bubble" account that comes and goes as imported water is stored in the reservoir. Imported Lavaca River water will be stored in Lake Texana when diversions of imported water entered in Column 3.14 are less than the actual imported water in Column 3.13. (Overdraft in lieu of pumping diversions are not considered in this calculation). Once water is stored, it can be rediverted at a later date, subject to losses due to evaporation or spills from the reservoir. Bay and estuary freshwater inflow releases are limited to Navidad River inflows, so these releases are not taken out of the Lavaca River water storage account. Evaporative losses are applied based on the fraction that the storage account represents of the total reservoir storage. Total net evaporative losses are in Column 3.11. Column 3.19 contains the fraction of the total storage represented by the storage account. Similarly, spills are also proportioned based on the storage fraction. Spills are found in Column 3.12 and are applied only when the reservoir level (Column 3.4) is more than 44 feet.

In this table, the monthly values are simply the daily values summed up by month except where noted.

Column	Label	Description
Date		
3.1	Days	Monthly – number of days in the month. Daily – day of the month.
3.2	Month	Month number.
3.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Lake Texana Operation		
3.4	Elevation	Imported from column 2.11. Values are in feet above msl. Monthly – end-of-month elevation of Lake Texana. Daily – daily elevation of Lake Texana.
3.5	Storage	Total storage in Lake Texana, calculated using the elevations in Column 3.4 and the area-capacity-elevation data in Table 12. Values are in acre-feet. Monthly – end-of-month storage. Daily – daily storage.
3.6	Surface Area	Surface area of Lake Texana, calculated using the elevations in Column 3.4 and the area-capacity-elevation data in Table 12. Values are in acres. Monthly – end-of-month surface area. Daily – daily surface area.
3.7	Pan Evaporation	Pan evaporation rate as reported by LNRA, converted to feet. Imported from Column 2.13.
3.8	Pan Factor	Pan factors imported from Column 10.10 using month number as index.
3.9	Evaporation Rate	Pan evaporation in Column 3.7 multiplied by the Pan Factor in Column 3.8.
3.10	Precipitation Rate	Precipitation as reported by LNRA, converted to feet. Imported from Column 2.14. Values in feet.

Column	Label	Description
3.11	Net Evaporative Loss	Calculated by multiplying the daily evaporation less precipitation by the calculated surface area for the previous day. Values in acre-feet.
3.12	Lake Excess Texana Spills	Spills and releases from the reservoir that are not associated with the release of freshwater inflows. Imported from Column 2.12 less the released freshwater inflows from Column 9.6.
Imports and Diversions		
3.13	Imported Water	Water pumped from the Lavaca River into Lake Texana. Calculated by subtracting the LTYEP water sent from Texana to the OCR in Column 2.8 from the total pumping to Lake Texana in Column 2.7, with daily values converted to acre-feet per day. Limited to positive values since some water could be pumped from Texana to the OCR as overdraft in lieu of pumping.
3.14	LTYEP Diversion	Volume of water pumped from Lake Texana using the proposed LTYEP authorizations. Imported from Column 2.15, with daily values converted to acre-feet per day.
Lake Texana Storage Accounting		
3.15	Excess Imported Water	Volume of water imported from the Lavaca River not immediately diverted for other purposes. This volume of water will go into a storage account. Daily values are calculated by subtracting Column 3.14 from Column 3.13. Zero if negative. Monthly values are summed from daily volumes.
3.16	Stored Water Losses	Losses incurred to the storage account due to evaporation or reservoir spills in acre-feet. Calculated on a daily basis by multiplying the fraction of the total storage in Lake Texana in the storage account on the previous day (Column 3.19) by the evaporative loss (Column 3.11) plus, if the reservoir is spilling, the spills from the reservoir not used to meet bay and estuary freshwater inflows (Column 3.12). The losses are limited to the volume in the storage account on the previous day (Column 3.18). Monthly values are the sum of the daily calculations.
3.17	Diversion from Imported Water Storage	Volume of water diverted from the storage account. Calculated on a daily basis by subtracting the imported water from the Lavaca River in Column 3.13 from the LTYEP diversion in Column 3.14, limited to positive numbers. Monthly values are the sum of the daily calculations.
3.18	Imported Water Storage	Volume of water in the imported water storage account. Calculated as the previous day's storage volume (Column 3.18) plus the excess imported water (Column 3.15) less the losses from the account (Column 3.16) and the amount diverted from the account (Column 3.17). The monthly values are the volume at the end of the month. Volume can go negative if too much LTYEP water is diverted from the reservoir.
3.19	Fraction Imported Water Storage	Fraction of the total storage in Lake Texana that is in the imported water storage account. Calculated by dividing the current day's storage in the account (Column 3.18) by the total storage in Lake Texana (Column 3.5).

Columns 3.20 and 3.21 are used to check the balance of LTYEP water sent into and out of the system on a monthly basis. These are used in the checks in Table 1. Column 3.20 subtracts the LTYEP diversions from Lake Texana in Column 3.14 (excluding overdraft diversions) and losses from the storage account in Column 3.16 from the imported water from the Lavaca River in Column 3.13. Column 3.21 subtracts the diversion from the storage account in Column 3.17 from the sum of the excess water going into the storage account in Column 3.15 and the losses from the storage account in Column 3.16. The sum at the end of the year should be close to the volume of water in the storage account at the end of the year in Column 3.18.

Column 3.22 is an index for the end-of-month values in the daily table.

2.2.5 Table 4 Edna Environmental Flow

Table 5 calculates base/subsistence and pulse flows for the Lavaca River near Edna gage, USGS 08164000, which will serve as the measurement point for the LTYEP authorizations. The gage is located upstream of the diversion location. In this accounting plan, environmental flows are first calculated based on the measured flows at the Edna gage, as shown in Table 4. These flows are then compared to calculations made on the Edna gage flows, less the downstream diversions in Table 6. Table 8 then compares the two. If these two tables show the same qualifying pulses, and shutoff has occurred during the required number of pulses, then the diversions are considered to be in compliance with the standards.

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The standards are from 30 TAC §298.330(e)(15) except for the Summer Average and Wet Base flow, which appear to be switched in the TAC. The following table lists the standards.

Environmental Flow Standards – Lavaca River near Edna

Season	Hydrologic Condition	Subsistence Flow (cfs)	Base Flow (cfs)	Small Seasonal Pulse (2 per Season)	Large Seasonal Pulse (1 per Season)	Annual Pulse
Winter	Severe	8.5	30	Trigger: 2,000 cfs Volume: 8,000 ac-ft Duration: 6 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days
	Dry	N/A	30			
	Average	N/A	55			
	Wet	N/A	94			
Spring	Severe	10.0	30	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	Trigger: 4,500 cfs Volume: 18,400 ac-ft Duration: 7 days	
	Dry	N/A	30			
	Average	N/A	55			
	Wet	N/A	94			
Summer	Severe	1.3	20	Trigger: 88 cfs Volume: 370 ac-ft Duration: 4 days	Trigger: 420 cfs Volume: 1,800 ac-ft Duration: 6 days	
	Dry	N/A	20			
	Average	N/A	33*			
	Wet	N/A	48*			
Fall	Severe	1.2	20	Trigger: 1,600 cfs Volume: 6,100 ac-ft Duration: 6 days	Trigger: 4,500 cfs Volume: 18,00 ac-ft Duration: 6 days	
	Dry	N/A	20			
	Average	N/A	33			
	Wet	N/A	58			

* The Summer Average and Wet Criteria appear to be switched in the TAC. We have assumed that the smaller value applies during Average conditions and the larger value applies during Wet conditions.

The accounting plan uses the following codes for each season. These codes serve as indices for lookup tables in Table 11.

Month	Season	Code
1	Winter	1
2	Winter	1
3	Spring	2
4	Spring	2
5	Spring	2
6	Spring	2
7	Summer	3
8	Summer	3
9	Fall	4
10	Fall	4
11	Fall	4
12	Winter	1

The accounting plan uses the following codes for hydrologic condition. These codes serve as indices for lookup tables in Table 11.

Hydrologic Condition	Texana Elevation (ft)	Code
Severe	#N/A	1
Dry	39.95	2
Average	43	3
Wet	44	4

For the purposes of this accounting plan, a qualifying pulse is a pulse that begins when flows in response to a rainfall event exceed the pulse flow trigger level. The pulse qualifies once either the duration criteria or the volume criteria has been achieved, whichever comes first.

One of the features of the pulse calculation is the ability of the user to override the simple on and off triggers in Columns 4.20 to 4.22, 4.34 to 4.36 and 4.46 to 4.48. In most cases, the pulse identification logic will correctly identify a pulse. However, under some situations a pulse flow can be incorrectly identified. Rather than including complex logic in the accounting plan, the user is given the opportunity to reassign days as either a pulse flow day ("P" in Columns 4.23, 4.37, or 4.49) or a base flow day ("B" in the same three columns). Examples of situations where a pulse override would be required include:

- Times of extended high flows that do not fall below the trigger level for long periods of time. This will cause the accounting plan to trigger a new pulse once the first event qualifies. The user should enter a "B" in the appropriate column until either the flows drop below the trigger level, or a new rainfall event initiates a new pulse.

- When crossing into a new season at a flow rate that is higher than the pulse flow trigger level for that season. This frequently happens when transitioning from the spring season to the summer season, which has a relatively low trigger level. Flows often have not fallen to summer levels at the beginning of the summer season. There is some logic in the accounting plan that can prevent this from occurring, but it will not work correctly if flows are slightly increasing. The user should examine any pulses that occur on seasonal boundaries, particularly in the transition from spring to summer.
- When a small pulse initiates on one day and large pulse initiates on the next day. This can occur in the winter, summer or fall when the small pulse criteria are less than the large pulse criteria. In this case, the entire pulse could be classified as a large pulse, and the day that the small pulse initiates should be identified as a pulse day by entering a "P" in Column 4.37. A similar situation can occur with a large pulse and an annual pulse in the summer season. This type of override could occur only when needed.

Other situations may occur as well that require overrides. In all cases where an override occurs, notes regarding the reason for the override should be entered in Column 4.62.

The following section describes the base and subsistence flow calculations. The descriptions below apply to the daily data except where noted.

Column	Label	Description
Date		
4.1	Days	Monthly – number of days in the month. Daily – day of the month.
4.2	Month	Month number.
4.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Base Flow Calculation		
4.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4. Daily values are in cfs and monthly values are in acre-feet.
4.5	Lake Texana Elevation	Daily or end-of-month elevation of Lake Texana in feet msl. Imported from Column 2.11.
4.6	Season	Season as defined in 30 TAC §298.305. Evaluated from lookup table in Column 11.2 using the month in Column 4.2 as the index.
4.7	Season Code	A code for each season, with 1 = Winter, 2 = Spring, 3 = Summer, and 4 = Fall. Evaluated from lookup table in Column 11.3 using the month in Column 4.2 as the index.
4.8	New Season?	TRUE if the first day of a season, otherwise FALSE. Calculated by comparing the season code of the current day or month to the season code of the previous day or month. If they are not equal, then the value is TRUE.

Column	Label	Description
4.9	Hydrologic Condition	Severe, Dry, Average or Wet based on Column 11.21 using the hydrologic condition code in Column 4.10 as an index.
4.10	Hydrologic Condition Code	A code for each hydrologic condition, with 1 = Severe (Texana elevation less than 39.95 feet), 2 = Dry (Texana elevation between 39.95 and 43 feet), 3 = Average, (Texana elevation between 43 feet and 44 feet), and 4 = Wet (Texana elevation greater than or equal to 44 feet). Evaluated on the first day of each season (Column 4.8) based on the previous day's elevation of Lake Texana. The value remains constant until the next season. Codes are from Column 11.23.
4.11	Initial Base Flow Criteria	Base flow criteria from the lookup table in Columns 11.6 through 11.9, using the season code in Column 4.7 and the hydrologic condition code in Column 4.10 as indices. Monthly values are the volume in acre-feet potentially reserved by these criteria over the month.
4.12	Subsistence Criteria	Subsistence flow criteria from Column 11.5 using the Season Code in Column 4.7 as an index. Only applies in Severe conditions when flows are less than the Severe Base criteria in Column 11.6. Monthly values are the volume in acre-feet potentially reserved by subsistence flows over the month.
4.13	Final Bypass	Except for in Severe conditions (Column 4.10 = 1), equal to the Initial Base Flow Criteria in Column 4.11. In Severe conditions the Subsistence flow is used if the measured flow in Column 4.4 is less than the Severe Base flow in Column 4.11. Otherwise it is equal to Column 4.11. The value in this column has not been limited to the actual flow at the gage. Monthly values are the volume of water in acre-feet potentially reserved by these criteria.

The next section of the table calculates small and large pulses. The logic for determining the two types of pulses is practically identical.

Column	Label	Description
Small Pulse		
4.14	Edna Gage Flow	Repeat of Column 4.4. Imported from Column 2.4.
4.15	Pulse Index	The pulse index is used to allow a pulse that started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 4.25 on the previous day. If this is greater than zero, then the value of Column 4.15 from the previous day is used. If Column 4.25 is equal to zero, then the value is set to the season code in Column 4.7. The monthly part of the table is set equal to the season code in Column 4.7.

Column	Label	Description
4.16	Trigger	The flow in cfs that triggers a small pulse. Lookup from Column 11.10 using the pulse index in Column 4.15 as the index.
4.17	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.11 using the pulse index in Column 4.15 as the index.
4.18	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.12 using the pulse index in Column 4.15 as the index.
4.19	Number per Season	Number of small pulses expected in the current season. Lookup from Column 11.13 using the pulse index in Column 4.15 as the index.
4.20	Flow > Trigger	TRUE if the gage flow in Column 4.14 is greater than the trigger in Column 4.16. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
4.21	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 4.8 = TRUE and there is no carry over pulse indicated by Column 4.15 not being equal to the season code in Column 4.7), a new pulse occurs if the flow is greater than the trigger (Column 4.20 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 4.8 is FALSE), then the flow must be greater than the trigger (Column 4.20 is TRUE) and the previous day must not be part of a pulse (Column 4.24 is zero). Will be FALSE if Column 4.23 is set to “B”, making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.22	Last Day of Pulse	TRUE if the duration in Column 4.25 is greater than or equal to the criteria in Column 4.18 or the cumulative volume in Column 4.26 is greater than or equal to the criteria in Column 4.17. Monthly values are a count of the number of pulses terminated in the current month.
4.23	Pulse Override	Entered by LNRA staff. A “B” entered in the will make the current day a base flow day (Column 4.24 = 0) even if the logic in Columns 4.20 through 4.22 indicate that the day is a pulse day. Similarly, a “P” entered will make the day a pulse day (Column 4.24 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.
4.24	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 4.23, this column is set equal to 1 if it is the first day of a pulse (Column 4.21 is TRUE), or if the previous day was part of the pulse (Column 4.24 on the previous day is equal to 1) and the duration in Column 4.25 on the previous day is less than the criteria in Column 4.18 and the cumulative volume on the previous day in Column 4.26 is less than the volume criteria in Column 4.17. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.

Column	Label	Description
4.25	Duration	The number of days in the current pulse since it was initiated. Equal to the value in Column 4.24 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.22 being TRUE. No value is calculated in the monthly portion of the table.
4.26	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.24 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.14 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 4.17. No value is calculated in the monthly portion of the table.
4.27	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 4.21 is TRUE). Counting starts over at the beginning of each season (Column 4.8 is TRUE).
Large Pulse		
4.28	Edna Gage Flow	A repeat of Columns 4.4 and 4.14. Imported from Column 2.4.
4.29	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 4.39 on the previous day. If this is greater than zero, then the value of Column 4.29 from the previous day is used. If Column 4.39 is equal to zero, then the value is set to the season code in Column 4.7. The monthly part of the table is set equal to the season code in Column 4.7.
4.30	Trigger	The flow in cfs that triggers a large pulse. Lookup from Column 11.14 using the pulse index in Column 4.29 as the index.
4.31	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.15 using the pulse index in Column 4.29 as the index.
4.32	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.16 using the pulse index in Column 4.29 as the index.
4.33	Number per Season	Number of large pulses expected in the current season. Lookup from Column 11.17 using the pulse index in Column 4.15 as the index.
4.34	Flow > Trigger	TRUE if the gage flow in Column 4.28 is greater than the trigger in Column 4.30. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.

Column	Label	Description
4.35	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 4.8 = TRUE and there is no carry over pulse indicated by Column 4.29 not being equal to the season code in Column 4.7), a new pulse occurs if the flow is greater than the Trigger (Column 4.34 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 4.8 is FALSE), then the flow must be greater than the Trigger (Column 4.34 is TRUE) and the previous day must not be part of a pulse (Column 4.38 is zero). Will be FALSE if Column 4.37 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.36	Last Day of Pulse	TRUE if the duration in Column 4.39 is greater than or equal to the criteria in Column 4.32 or the cumulative volume in Column 4.40 is greater than or equal to the criteria in Column 4.31. Monthly values are a count of the number of pulses terminated in the current month.
4.37	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 4.38 = 0) even if the logic in Columns 4.34 through 4.36 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 4.38 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.
4.38	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 4.37, this column is set equal to 1 if it is the first day of a pulse (Column 4.35 is TRUE), or if the previous day was part of the pulse (Column 4.38 on the previous day is equal to 1) and the duration in Column 4.39 on the previous day is less than the criteria in Column 4.32 and the cumulative volume on the previous day in Column 4.40 is less than the volume criteria in Column 4.31. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.
4.39	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 4.38 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.36 being TRUE. No value is calculated in the monthly portion of the table.
4.39	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.38 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.28 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 4.31. No value is calculated in the monthly portion of the table.

Column	Label	Description
4.41	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 4.35 is TRUE). Counting starts over at the beginning of each season (Column 4.8 is TRUE).

The next section calculates annual pulses. The annual pulse calculations are similar to small and large except there is only one set of criteria. Since the annual pulses do not vary by seasons, the pulse index and number per season are not needed.

Column	Label	Description
Annual Pulse		
4.42	Edna Gage Flow	A repeat of Columns 4.4, 4.14 and 4.28. Imported from Column 2.4.
4.43	Trigger	The flow in cfs that triggers an annual pulse. Value from Column 11.18. Since there is a single value (i.e. it does not vary by season), there is no need for an index.
4.44	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Value from Column 11.19.
4.45	Duration Criteria	Duration in days associated with a qualifying pulse. Value from Column 11.20.
4.46	Flow > Trigger	TRUE if the gage flow in Column 4.42 is greater than the trigger in Column 4.43. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
4.47	First Day of Pulse	TRUE if the current day initiates a new pulse. The flow must be greater than the trigger (Column 4.46 is TRUE) and the previous day must not be part of a pulse (Column 4.50 is zero). Will be FALSE if Column 4.49 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
4.48	Last Day of Pulse	TRUE if the duration in Column 4.51 is greater than or equal to the criteria in Column 4.45 or the cumulative volume in Column 4.52 is greater than or equal to the criteria in Column 4.44. Monthly values are a count of the number of pulses terminated in the current month.
4.49	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 4.50 = 0) even if the logic in Columns 4.46 through 4.48 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 4.50 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of this section for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 4.62.

Column	Label	Description
4.50	Is Pulse	Equal to 1 if a pulse is on-going, zero otherwise. Unless overridden by Column 4.49, this column is set equal to 1 if it is the first day of a pulse (Column 4.47 is TRUE), or if the previous day was part of the pulse (Column 4.50 on the previous day is equal to 1) and the duration in Column 4.51 on the previous day is less than the criteria in Column 4.45 and the cumulative volume on the previous day in Column 4.52 is less than the volume criteria in Column 4.44. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if an annual pulse has already occurred.
4.51	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 4.50 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 4.48 being TRUE. No value is calculated in the monthly portion of the table.
4.50	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 4.50 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 4.41 converted to acre-feet. The volume is limited to the qualifying Pulse Volume in Column 4.44. No value is calculated in the monthly portion of the table.
4.51	Pulse Counter	Counts the number of pulses that have occurred so far in the year. The value is incremented by 1 every time a new pulse occurs (Column 4.47 is TRUE).

The summary section accumulates pulse information for the pulses that are used to meet the number per season criteria.

Column	Label	Description
Summary		
4.54	Edna Gage Flow	A repeat of Columns 4.4, 4.14, 4.28 and 4.42. Imported from Column 2.4.
4.55	Base Flow Pass	The minimum of the gage flow in Column 4.54 and the final base bypass in Column 4.13. Monthly values are the sum of the flows converted to acre-feet.
4.56	Small Pulse Bypass?	Logical flag that indicates the need for passage of a small pulse. TRUE if Column 4.24 is equal to 1 and the seasonal pulse counter in Column 4.27 is less than or equal to the number per season in Column 4.19. Monthly values are the number of days in the month with a small pulse bypass.
4.57	Large Pulse Bypass?	Logical flag that indicates the need for passage of a large pulse. TRUE if Column 4.38 is equal to 1 and the seasonal pulse counter in Column 4.41 is less than or equal to the number per season in Column 4.33. Monthly values are the number of days in the month with a large pulse bypass.

4.58	Annual Pulse Bypass?	Logical flag that indicates the need for passage of the annual pulse. TRUE if Column 4.50 is equal to 1 and the pulse counter in Column 4.53 is less than or equal to 1. Monthly values are the number of days in the month with an annual pulse bypass.
4.59	Pulse Day	Code for the type of pulse that occurs when a bypass is flagged. Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Monthly values not calculated.
4.60	Pulse Number	Increments by 1 every time a new pulse of any type (small, large or annual) is flagged for passage. Calculated by adding the value on the previous day plus 1 if the pulse day flag in Column 4.59 is zero on the previous day and greater than zero on the current day.
4.61	Pulse Type	Set to the largest type encountered in the current pulse. If Column 4.59 is zero, this is also set to zero. If Column 4.59 is non-zero, the maximum value encountered for the current pulse number in Column 4.60. This allows for pulses that may initially qualify as a small pulse but ultimately qualify as a large pulse to be identified as a large pulse. A similar situation can happen for annual pulses.
4.62	Notes	Information regarding overrides (Columns 4.23, 4.37, and 4.49) or other descriptive information about the data. Entered by the user.

Columns 4.63 through 4.68 have daily data that are used when comparing the pulses based on the measured flows at the Edna gage to the estimated pulses after diversion in Table 6. These calculations only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
4.63	Offset	For qualifying pulses, number of columns to offset the current column for subsequent calculations in Columns 4.64 to 4.66. #NA if not a qualifying pulse, or a qualifying pulse that occurs after the number of pulses needed to meet the criteria has been met.
4.64	Pulse Trigger	For qualifying pulses, the pulse trigger flow for the pulse, obtained from Columns 4.16, 4.30 or 4.43, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.65	Volume Criteria	For qualifying pulses, the volume criteria for the pulse, obtained from Columns 4.17, 4.31 or 4.44, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Column	Label	Description
4.66	Duration Criteria	For qualifying pulses, the duration criteria for the pulse, obtained from Columns 4.18, 4.32 or 4.45, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.67	Volume	The maximum volume of the pulse, calculated from Columns 4.26, 4.40 or 4.52, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
4.68	Duration	The maximum duration in days of the pulse, calculated from Columns 4.25, 4.39 or 4.51, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

2.2.6 Table 5 Base Flow Compliance

This table compares the daily diverted flow from the Lavaca River to the available flow based on the daily average flow measured at the Edna gage. Since the pumping operations occur in real time, based on 15-minute reported data, and are not required to change pumping rates more often than every 24 hours, there may be times when there are small discrepancies between the calculated available flow and the actual diversion. The accounting plan tracks deficits and provides opportunities to make up these deficits as soon as possible.

This calculation is conservative in that it does not consider flows entering the Lavaca River between the gage and the diversion point.

Column	Label	Description
Date		
5.1	Days	Monthly – number of days in the month. Daily – day of the month.
5.2	Month	Month number.
5.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Base Flow Check		
5.4	Season	Season of the year imported from Column 4.6. Provided for reference.
5.5	Edna Gage Flow	Flow at the Edna Gage imported from Column 2.4.
5.6	Base Flow Pass	Base or subsistence flow passage for the current day or month. Imported from Column 4.13.

Column	Label	Description
5.7	Available Flow	Daily flow at the Edna Gage in Column 5.5 less the bypass in Column 5.6 in cfs, limited to positive values. The monthly portion of the table is the monthly flow volume in acre-feet.
5.8	Diverted Flow	Daily and monthly diversions from the Lavaca River imported from Column 2.5.
5.9	Check	TRUE if the daily diverted flow in Column 5.8 is less than or equal to the available flow in Column 5.7. The monthly value is the number of days that the value is TRUE.
5.10	Excess/Deficit	The difference between the available flow in Column 5.7 and the diverted flow in Column 5.8. Summed and converted to acre-feet in the monthly portion of the table.
5.11	Cumulative Deficit	Daily cumulative sum of Column 5.10 limited to negative values. Will be zero once sufficient flows have been bypassed to make up for any previous deficit due to diversions. Monthly values are the cumulative deficit at the end of each month.

Column 5.12 is a utility calculation that counts the number of days that the calculation shows a deficit.

2.2.7 Table 6 Post Diversion Pulses

Table 6 is similar to the pulse flow section of Table 4 but instead of using the reported gage flows the calculations are based on gage flows less the Lavaca River diversions. The pulse flows calculated in this table are then compared to the pulse flows calculated in Table 4. Refer to Section 2.2.5 for more additional information regarding pulse flows in the accounting plan, including situations where the pulse flow calculations need to be overridden by the user.

LNRA is considered to be in compliance if the pulse flow remains a qualifying pulse flow both before and after diversion and pumping was shut off before the pulse fully qualified. This approach was used since there may be some discrepancies between actual operation, which is based on 15-minute real time reported data, and calculations using daily average flows. LNRA is also not required to changed pumping rates more often than once every 24 hours.

This calculation is conservative in that it does not consider flows entering the Lavaca River between the gage and the diversion point.

The descriptions below apply to the daily data except where noted. The following section calculates the gage flows less the Lavaca River diversions.

Column	Label	Description
Date		
6.1	Days	Monthly – number of days in the month Daily - day of the month.
6.2	Month	Month number.
6.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Post Diversion Flows		
6.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4. Daily values are in cfs and monthly values are in acre-feet.
6.5	Lavaca Diversion	Diversion from the Lavaca River from Column 2.5. Daily values in cfs and monthly values in acre-feet.
6.6	Post Diversion Flows	Flow in the Lavaca River (Column 6.4) less diversions (Column 6.5). Does not consider any intervening flows between the gage and the diversion.
6.7	Season	Season as defined in 30 TAC §298.305. Evaluated from lookup table in Column 11.2 using the month in Column 6.2 as the index.
6.8	Season Code	A code for each season, with 1 = Winter, 2 = Spring, 3 = Summer, and 4 = Fall. Evaluated from lookup table in Column 11.3 using the month in Column 6.2 as the index.
6.9	New Season?	TRUE if the first day of a season, otherwise FALSE. Calculated by comparing the season code of the current day or month to the season code of the previous day or month. If they are not equal, then the value is TRUE.

The next section of the table calculates small and large pulses. The logic for determining the two types of pulses is practically identical.

Column	Label	Description
Small Pulse		
6.10	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6.
6.11	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 6.21 on the previous day. If this is greater than zero, then the value of Column 6.11 from the previous day is used. If Column 6.21 is equal to zero, then the value is set to the season code in Column 6.8. The monthly part of the table is set equal to the season code in Column 6.8.
6.12	Trigger	The flow in cfs that triggers a small pulse. Lookup from Column 11.10 using the Pulse Index in Column 6.11 as the index.

Column	Label	Description
6.13	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.11 using the Pulse Index in Column 6.11 as the index.
6.14	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.12 using the Pulse Index in Column 6.11 as the index.
6.15	Number per Season	Number of small pulses expected in the current season. Lookup from Column 11.13 using the Pulse Index in Column 6.11 as the index.
6.16	Flow > Trigger	TRUE if the post diversion flow in Column 6.10 is greater than the trigger in Column 6.12. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the Trigger flow.
6.17	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 6.9 = TRUE and there is no carry over pulse indicated by Column 6.11 not being equal to the season code in Column 6.8), a new pulse occurs if the flow is greater than the trigger (Column 6.16 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 6.8 is FALSE), then the flow must be greater than the trigger (Column 6.16 is TRUE) and the previous day must not be part of a pulse (Column 6.20 is zero). Will be FALSE if Column 6.19 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.18	Last Day of Pulse	TRUE if the duration in Column 6.21 is greater than or equal to the criteria in Column 6.14 or the cumulative volume in Column 6.22 is greater than or equal to the criteria in Column 6.13. Monthly values are a count of the number of pulses terminated in the current month.
6.19	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 6.20 = 0) even if the logic in Columns 6.16 through 6.18 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 6.20 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.
6.20	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 6.19, this column is set equal to 1 if it is the first day of a pulse (Column 6.17 is TRUE), or if the previous day was part of the pulse (Column 6.20 on the previous day is equal to 1) and the duration in Column 6.21 on the previous day is less than the criteria in Column 6.14 and the cumulative volume on the previous day in Column 6.22 is less than the volume criteria in Column 6.13. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.

Column	Label	Description
6.21	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.20 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.18 being TRUE. No value is calculated in the monthly portion of the table.
6.22	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.20 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the gage flow in Column 6.10 converted to acre-feet. The volume is limited to the qualifying Pulse Volume in Column 6.13. No value is calculated in the monthly portion of the table.
6.23	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 6.17 is TRUE). Counting starts over at the beginning of each season (Column 6.9 is TRUE).
Large Pulse		
6.24	Post Diversion Flow	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. and 6.10.
6.25	Pulse Index	The pulse index is used to allow a pulse that has started in one season to continue into the next season using the criteria from the previous season. Once a cross seasonal pulse has terminated, either due to meeting the duration criteria or volume criteria, the criteria switches to the new season. Calculated by looking at the duration in Column 6.35 on the previous day. If this is greater than zero, then the value of Column 6.25 from the previous day is used. If Column 6.35 is equal to zero, then the value is set to the season code in Column 6.8. The monthly part of the table is set equal to the season code in Column 6.7.
6.26	Trigger	The flow in cfs that triggers a large pulse. Lookup from Column 11.14 using the pulse index in Column 6.25 as the index.
6.27	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Lookup from Column 11.15 using the pulse index in Column 6.25 as the index.
6.28	Duration Criteria	Duration in days associated with a qualifying pulse. Lookup from Column 11.16 using the pulse index in Column 6.25 as the index.
6.29	Number per Season	Number of large pulses expected in the current season. Lookup from Column 11.17 using the pulse index in Column 6.25 as the index.
6.30	Flow > Trigger	TRUE if the post diversion flow in Column 6.24 is greater than the trigger in Column 6.26. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.

Column	Label	Description
6.31	First Day of Pulse	TRUE if the current day initiates a new pulse. On the first day of a season (Column 6.9 = TRUE and there is no carry over pulse indicated by Column 6.25 not being equal to the season code in Column 6.8), a new pulse occurs if the flow is greater than the trigger (Column 6.30 is TRUE) and flow is increasing. This prevents a pulse from being initiated based on lower trigger criteria in the new season. If it is not the first day of the season (Column 6.9 is FALSE), then the flow must be greater than the trigger (Column 6.30 is TRUE) and the previous day must not be part of a pulse (Column 6.34 is zero). Will be FALSE if Column 6.33 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.32	Last Day of Pulse	TRUE if the duration in Column 6.35 is greater than or equal to the criteria in Column 6.28 or the cumulative Volume in Column 6.36 is greater than or equal to the criteria in Column 6.27. Monthly values are a count of the number of pulses terminated in the current month.
6.33	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 6.34 = 0) even if the logic in Columns 6.30 through 6.32 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 6.34 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.
6.34	Is Pulse	Equal to 1 if a pulse that has not yet qualified is occurring on the current day, zero otherwise. Unless overridden by Column 6.33, this column is set equal to 1 if it is the first day of a pulse (Column 6.31 is TRUE), or if the previous day was part of the pulse (Column 6.34 on the previous day is equal to 1) and the duration in Column 6.35 on the previous day is less than the criteria in Column 6.28 and the cumulative volume on the previous day in Column 6.36 is less than the volume criteria in Column 6.27. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if the required number of pulses in the season has already occurred.
6.35	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.34 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.32 being TRUE. No value is calculated in the monthly portion of the table.
6.36	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.34 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the post diversion flow in Column 5.24 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 6.27. No value is calculated in the monthly portion of the table.

Column	Label	Description
6.37	Seasonal Pulse Counter	Counts the number of pulses that have occurred so far in the season. The value is incremented by 1 every time a new pulse occurs (Column 6.31 is TRUE). Counting starts over at the beginning of each season (Column 6.9 is TRUE).

The next section calculates annual pulses. The annual pulse calculations are similar to small and large except there is only one set of criteria. Since the annual pulses do not vary by seasons, the pulse index and number per season are not needed.

Column	Label	Description
Annual Pulse		
6.38	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. 6.10 and 6.24.
6.39	Trigger	The flow in cfs that triggers an annual pulse. Value from Column 11.18. Since there is a single value there is no index.
6.40	Pulse Volume	Volume in acre-feet associated with a qualifying pulse. Value from Column 11.19.
6.41	Duration Criteria	Duration in days associated with a qualifying pulse. Value from Column 11.20.
6.42	Flow > Trigger	TRUE if the gage flow in Column 6.38 is greater than the trigger in Column 6.39. Otherwise FALSE. The monthly data is a count of the number of days in the current month that exceed the trigger flow.
6.43	First Day of Pulse	TRUE if the current day initiates a new pulse. The flow must be greater than the trigger (Column 6.42 is TRUE) and the previous day must not be part of a pulse (Column 6.46 is zero). Will be FALSE if Column 6.45 is set to "B", making the current day a base flow day. Monthly values are a count of the number of pulses is initiated in the current month.
6.44	Last Day of Pulse	TRUE if the duration in Column 6.47 is greater than or equal to the criteria in Column 6.41 or the cumulative volume in Column 6.48 is greater than or equal to the criteria in Column 6.40. Monthly values are a count of the number of pulses terminated in the current month.
6.45	Pulse Override	Entered by LNRA staff. A "B" entered in the will make the current day a base flow day (Column 6.46 = 0) even if the logic in Columns 6.42 through 6.44 indicate that the day is a pulse day. Similarly, a "P" entered will make the day a pulse day (Column 6.46 = 1) even if other logic does not indicate that it is a pulse. See writeup at the beginning of Section 2.2.5 for a description of circumstances where this might be applied. Any other values in this column will be ignored. Notes regarding the reason for the override should be entered in Column 6.57.

Column	Label	Description
6.46	Is Pulse	Equal to 1 if a pulse is on-going, zero otherwise. Unless overridden by Column 6.45, this column is set equal to 1 if it is the first day of a pulse (Column 6.43 is TRUE), or if the previous day was part of the pulse (Column 6.46 on the previous day is equal to 1) and the duration in Column 6.47 on the previous day is less than the criteria in Column 6.41 and the cumulative volume on the previous day in Column 6.48 is less than the volume criteria in Column 6.40. The monthly values are the number of days in the month that are considered part of a pulse. This calculation results in the number 1 for every pulse, even if an annual pulse has already occurred.
6.47	Duration	The number of days in the current pulse since the pulse was initiated. Equal to the value in Column 6.46 (which is 1 if there is a pulse) plus the value in the current column on the previous day unless the pulse qualified on the previous day, which would be indicated by Column 6.44 being TRUE. No value is calculated in the monthly portion of the table.
6.48	Cumulative Volume	Cumulative volume in acre- feet for the current pulse. If it is not a pulse (or the pulse has qualified), this value is zero. Calculated by multiplying the value in Column 6.46 (which will be 1 for a pulse, zero otherwise) by the cumulative volume on the previous day plus the post diversion flow in Column 6.38 converted to acre-feet. The volume is limited to the qualifying pulse volume in Column 6.40. No value is calculated in the monthly portion of the table.
6.49	Pulse Counter	Counts the number of pulses that have occurred so far in the Year. The value is incremented by 1 every time a new pulse occurs (Column 6.43 is TRUE).

The summary section accumulates pulse information for the pulses that are used to meet the number per season criteria.

Column	Label	Description
Summary		
6.50	Post Diversion Flows	Flows at the Edna Gage less the Lavaca diversions. Repeat of Column 6.6. 6.10, 6.24 and 6.38.
6.51	Small Pulse Bypass?	Logical flag that indicates the need for passage of a small pulse. TRUE if Column 6.20 is equal to 1 and the seasonal pulse counter in Column 6.23 is less than or equal to the number per season in Column 6.15. Monthly values are the number of days in the month with a small pulse bypass.
6.52	Large Pulse Bypass?	Logical flag that indicates the need for passage of a large pulse. TRUE if Column 6.34 is equal to 1 and the seasonal pulse counter in Column 6.37 is less than or equal to the number per season in Column 6.29. Monthly values are the number of days in the month with a large pulse bypass.
6.53	Annual Pulse Bypass?	Logical flag that indicates the need for passage of the annual pulse. TRUE if Column 6.46 is equal to 1 and the pulse counter in Column 6.49 is less than or equal to 1. Monthly values are the number of days in the month with an annual pulse bypass.

6.54	Pulse Day	Code for the type of pulse that occurs when a bypass is flagged. Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Monthly values not calculated.
6.55	Pulse Number	Increments by 1 every time a new pulse of any type (small, large or annual) is flagged for passage. Calculated by adding the value on the previous day plus 1 if the pulse day flag in Column 6.53 is zero on the previous day and greater than zero on the current day.
6.56	Pulse Type	Set to the largest type encountered in the current pulse. If Column 6.54 is zero, this is also set to zero. If Column 6.54 is non-zero, the maximum value encountered for the current Pulse Number in Column 6.55. This allows for pulses that may initially qualify as a small pulse but ultimately qualify as a large pulse to be identified as a large pulse. A similar situation can happen for annual pulses.
6.57	Notes	Enter information regarding overrides (Columns 6.19, 6.33, and 6.45) or other information about the data.

Columns 6.58 through 6.63 have daily data that are used when comparing the pulses based on the post-diversion flows to the gaged flow pulses after diversion in table 5. These calculations only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
6.57	Offset	For qualifying pulses, number of columns to offset current column for subsequent calculations in Columns 6.59 to 6.61. #NA if not a qualifying pulse, or a qualifying pulse that occurs after the number of needed pulses has been met.
6.58	Pulse Trigger	For qualifying pulses, the pulse trigger flow for the pulse, obtained from Columns 6.12, 6.26 or 6.39, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.59	Volume Criteria	For qualifying pulses, the volume criteria for the pulse, obtained from Columns 6.13, 6.27 or 6.40, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.60	Duration Criteria	For qualifying pulses, the duration criteria for the pulse, obtained from Columns 6.14, 6.28 or 6.41, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Column	Label	Description
6.62	Volume	The maximum volume of the pulse, calculated from Columns 6.22, 6.36 or 6.48, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.
6.63	Duration	The maximum duration in days of the pulse, calculated from Columns 6.21, 6.35 or 6.47, depending on whether the pulse is classified as a small pulse, large pulse or an annual pulse. Set to zero if not a qualifying pulse, or for qualifying pulses that occur after the number of needed pulses has been met.

Columns 6.64 through 6.68 are used to accumulate information regarding shut off of pumping during a pulse flow. Since operations are based on real-time flows, the shut off of diversions may not exactly correspond to calculations made with daily average flows. For example, diversions could be shut off in the middle of one day and recommence before the end of the next day after the required pulse volume has passed. On a daily average basis, there would be pumping shown on both days even though LNRA would be in compliance with the standards.

Columns 6.64 to 6.66 are used to assign the shutoff data to the pulse, which is then referenced in Table 9. Columns 6.67 and 6.68 are provided for reference.

These columns only appear in the daily portion of the table.

Column	Label	Description
Qualifying Pulse Data		
6.64	Pulse Number	This is the pulse number from Column 6.55 but is only non-zero during the qualifying period of the pulse.
6.65	No Pumping for Day	Set equal to 1 if the user enters a “Y” in Column 2.6, indicating that pumping was shut down for pulse passage during all or part of the current day.
6.66	No Pumping During Pulse	Equal to TRUE if pumping was shut off during the pulse qualifying period.
6.67	Lavaca Pumping	Daily diversions from the Lavaca River in acre-feet per day. Imported from Column 2.5. Provided for reference.
6.68	Volume Pumped During Pulse	Total volume pumped during the qualifying days associated with the pulse, as calculated based on the daily average data. Provided for reference.

2.2.8 Table 7 Graph Data

Table 7 provides graphical displays of daily time series to aid review of compliance with the Lavaca River environmental flow standards. The data are displayed in both linear and log plots. All values imported from elsewhere. Columns 7.4, 7.5 and 7.7 through 7.12 are plotted on the graphs.

Column	Label	Description
Date		
7.1	Days	Day of the month.
7.2	Month	Month number.
7.3	Date	Excel date for each day.
Graph Data		
7.4	Edna Gage Flow	Daily average flow or monthly flow volume measured at the Edna gage. Imported from Column 2.4.
7.5	Base Flow	Final base or subsistence flow target, not limited by inflow. Imported from Column 4.13.
7.6	Pulse Type	Equal to 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Imported from Column 4.61
7.7	Small Pulse Flow	Edna gage flow during a small pulse. If Column 7.6 is equal to 1, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph.
7.8	Large Pulse Flow	Edna gage flow during a large pulse. If Column 7.6 is equal to 2, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph.
7.9	Annual Pulse Flow	Edna gage flow during the annual pulse. If Column 7.6 is equal to 3, set to the flow in Column 7.4. Otherwise equal to #N/A, which will not show up on the graph
7.10	Small Pulse Trigger	Small pulse trigger flow level. Imported from Column 4.16.
7.11	Large Pulse Trigger	Large pulse trigger flow level. Imported from Column 4.30.
7.12	Annual Pulse Trigger	Annual pulse trigger flow level. Imported from Column 4.43.

2.2.9 Table 8 Comparison of Pulses Before and After Diversions

Table 8 compares the pulses calculated in Table 4 (before diversions) and Table 6 (after diversion). The table only compares the number of pulses required by the criteria, a maximum of 13 pulses (4 seasons times 2 small pulses plus 1 large pulse, plus one annual pulse). Other pulses can and do occur, but these are not considered as contributing to compliance with the standards. Most of the time there will be fewer than 13 pulses, since an annual pulse counts as a large pulse, and so forth. Also, the required number of pulses may not have occurred during a particular season.

LNRA is considered to be in compliance if there is the same number of qualifying pulses before and after diversions, and diversions were shut off during the qualification period for each pulse.

Column	Label	Description
8.1	Pulse Index	Value of 1 to 13.
Pre-Diversion Pulses		
8.2	Row Index	Row index for each qualifying pulse calculated in Table 4. The row index is the row within the daily portion of the table. Calculated by matching the pulse number in Column 8.1 with the first occurrence of the number in Column 4.60. Set to #N/A if there is no corresponding index for the pulse number.
8.3	Season Code	The seasonal code from Column 4.7. The codes for each season are from Column 11.3. Set to "na" if there is no corresponding index for the pulse number.
8.4	Pulse Code	The pulse type code from Column 4.61. Codes are 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Set to "na" if there is no corresponding index for the pulse number.
8.5	Season	The name of the season, obtained from Column 11.2 using the season code in Column 8.3 as an index.
8.6	Pulse Type	The type of pulse (small, large or annual), obtained from Column 11.25 using the pulse code in Column 8.4 as an index.
8.7	Pulse Trigger	The pulse trigger flow criteria from Column 4.64.
8.8	Volume Criteria	The pulse volume criteria from Column 4.65.
8.9	Duration Criteria	The pulse duration criteria from Column 4.66.
8.10	Volume	The volume for the pulse when the pulse qualified from Column 4.67.
8.11	Duration	The duration of the pulse when the pulse qualified from Column 4.68.
Post-Diversion Pulses		
8.12	Row Index	Row index for each qualifying pulse calculated in Table 6. The row index is the row within the daily portion of the table. Calculated by matching the pulse number in Column 8.1 with the first occurrence of the number in Column 6.55. Set to #N/A if there is no corresponding index for the pulse number.
8.13	Season Code	The seasonal code from Column 6.8. The codes for each season are from Column 11.3. Set to "na" if there is no corresponding index for the pulse number.
8.14	Pulse Code	The pulse type code from Column 6.56. Codes are 1 for a small pulse, 2 for a large pulse and 3 for an annual pulse. Set to "na" if there is no corresponding index for the pulse number.
8.15	Pulse Trigger	The pulse trigger flow criteria from Column 6.59.
8.16	Volume Criteria	The pulse volume criteria from Column 6.60.
8.17	Duration Criteria	The pulse duration criteria from Column 6.61.
8.18	Volume	The volume for the pulse when the pulse qualified from Column 6.62.

Column	Label	Description
8.19	Duration	The duration of the pulse when the pulse qualified from Column 6.63.
Comparison		
8.20	Matches Season	"Y" if the season codes match in Columns 8.3 and 8.13. "N" if they do not match.
8.21	Matches Pulse Type	"Y" if the pulse codes match in Columns 8.4 and 8.14. "N" if they do not match.
8.22	Matches Volume	"Y" if the volumes match in Columns 8.10 and 8.18. "N" if they do not match.
8.23	Matches Duration	"Y" if the durations match in Columns 8.11 and 8.19. "N" if they do not match.
8.24	Shutoff During Pulse	"Y" if LNRA shut off pumping during the qualifying period of the pulse.

2.2.10 Table 9 Overdraft in Lieu of Pumping

Table 9 performs calculations that tell when conditions are suitable for overdrafting Lake Texana in lieu of pumping from the Lavaca River. Overdrafting can occur when:

1. Water is available for pumping from the Lavaca River because environmental flows are met,
2. Lake Texana is full and spilling, and
3. Pumping from Lake Texana does not reduce outflows from Lake Texana to less than the bay and estuary freshwater inflow release schedule from the Lake Texana water right (Certificate of Adjudication 16-2095B 4.A.1.).

Overdraft is limited to actual diversions from Lake Texana. Overdraft water can potentially be stored in the off-channel reservoir, if present.

Available flow calculated in Table 9 is linked to Table 2 for use in determining when some diversions can be assigned to overdraft.

Column	Label	Description
Date		
9.1	Days	Monthly – number of days in the month Daily - day of the month.
9.2	Month	Month number.
9.3	Date	Monthly – Excel date at the end of the month. Daily – Excel date for each day.
Overdraft Calculation		
9.4	Lake Texana Elevation	Daily elevations imported from Column 2.11. Monthly portion of the table is not used.

Column	Label	Description
9.5	Reservoir Spills	Daily and monthly Lake Texana spills and releases during flood operations. Imported from Column 2.12. Includes outflows that may be associated with bay and estuary freshwater inflow releases.
9.6	Freshwater Inflow Bypass During Spill	Daily values are the calculated bypass in cfs associated with releases for bay and estuary purposes from Lake Texana. Calculation only occurs when Lake Texana elevation is greater than or equal to 44 feet. Monthly releases values are from Columns 10.11 and 10.12 using the month in Column 9.2 as an index. Monthly values are the flow volume in acre-feet for each month.
9.7	Spills > Bypass?	Set to 1 if the spill in Column 9.5 is greater than the bypass in Column 9.6. m Otherwise set to zero. In the monthly part of the table, the value is the number of days in the month where spills are more than the bypass.
9.8	Lavaca Flow Available During Spill	If a pulse flow has occurred based on the daily average flow at the Edna gage but has not yet qualified and the required number of pulses has not occurred during the current season, then this value is zero. This is indicated by a non-zero value in Column 4.67. Otherwise set to the base flow available after bypass from Column 5.7. Both values are multiplied by Column 9.7, which will be equal to 1 if conditions are met for overdraft diversions, and zero if those conditions have not been met.
9.9	Lavaca Diversion During Spill	Diversion from the Lavaca River during a spill event, imported from Column 2.5, converted to cfs. Multiplied by Column 9.7, which will be a 1 if conditions are met for the overdraft, zero if conditions are not met for overdraft.
9.10	Available for Overdraft	Set to the minimum of: • The available flow in Column 9.8 less the diversions from the Lavaca River in Column 9.9, and • The maximum diversion rate from Column 10.8 (200 MGD) less any diversions made on the same day assigned to non-overdraft rights from Column 2.15. This column is imported into Table 2 to assist the user in assigning diversions to the overdraft authorizations.

2.2.11 Table 10 Reference

Table 10 contains miscellaneous values used elsewhere in the accounting plan, including whether the current year is a leap year, conversion factors, the Lake Texana Freshwater Inflow criteria, various water right authorizations, and pan factors. Although these values are entered by the user, they are not expected to change between accounting plans.

Column	Label	Description
Year Reference Data		
10.1	Parameter	Labels for Column 10.2

Column	Label	Description
10.2	Value	Current year and Boolean flag for a leap year (TRUE if the current year is a leap year).
Conversion Factors		
10.3	To get	Unit for result
10.4	From	Unit for original value
10.5	Multiply by	Conversion factor
Project Authorizations		
10.6	Priority Date	Priority date of the various authorizations
10.7	Diversion Amount	Diversion amount in acre-feet per year associated with the authorization
10.8	Use Type	Type of use associated with the authorizations.
Pan Factors		
10.9	Month	Numerical month of the year
10.10	Factor	Factor to be used to convert LNRA pan evaporation to gross evaporation.
Lake Texana Freshwater Bypass		
10.11	Month	Numerical month of the year
10.12	Above 78.18%	Bay and estuary freshwater inflow requirement from the Lake Texana water right. Applies when the storage (less imported water) is more than 78.18% of the conservation storage.
10.13	Less than 78.18%	Bay and estuary freshwater inflow requirement from the Lake Texana water right. Applies when the storage (less imported water) is less than 78.18% of the conservation storage.

2.2.12 Table 11 Edna Environmental Flow Criteria

Table 11 contains data for the environmental flow standards for the Lavaca River near Edna gage. These data are references primarily in Tables 5 and 6.

Column	Label	Description
Season Codes		
11.1	Month	Numerical month of the year
11.2	Season	Name of each season (Winter, Spring, Summer and Fall)
11.3	Code	Code associated with each season (1 through 4). This code is used as an index for the base and subsistence flows in Columns 11.4 through 11.9.
Subsistence and Base Flows		
11.4	Season	Season name (Winter, Spring, Summer or Fall)
11.5	Subsistence	Subsistence flow criteria for each season. Applies only in Severe conditions when flows are less than the base flows in Column 11.6. Hydrologic condition is set by the Lake Texana elevations in Column 11.22.
11.6	Severe Base	Severe base flow criteria. Applies when flows are greater than the base flow.
11.7	Dry Base	Dry condition base flow criteria.

Column	Label	Description
11.8	Average Base	Average condition base flow criteria.
11.9	Wet Base	Wet conditions base flow criteria.
Small Pulse		
11.10	Small Pulse Trigger	Trigger flow in cfs that initiates a small pulse.
11.11	Small Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.12	Small Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.
11.13	Number per Season	Number of small pulses per season. A large pulse or an annual pulse also counts to the achievement of this criteria. Diversions do not need to cease for subsequent small pulses later in the same season.
Large Pulse		
11.14	Large Pulse Trigger	Trigger flow in cfs that initiates a large pulse.
11.15	Large Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.16	Large Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.
11.17	Number per Season	Number of large pulses per season. An annual pulse also counts toward the achievement of this criteria. Diversions do not need to cease for subsequent large pulses later in the same season.
Annual Pulse		
11.18	Annual Pulse Trigger	Trigger flow in cfs that initiates an annual pulse.
11.19	Annual Pulse Volume	Volume in acre-feet that signals that a pulse has qualified. Diversions can begin again once the pulse volume criteria have been achieved, respecting base flow requirements. The duration criteria do not need to be met if the volume criteria have been met.
11.20	Annual Pulse Duration	Duration in days that signals that a pulse has qualified. Either achieving the volume criteria or the duration criteria signals that a pulse has qualified. If the volume criteria have not been met, diversions can begin again once the number of days specified in the duration criteria has passed, respecting base flow requirements.

Column	Label	Description
Hydrologic Condition		
11.21	Hydrologic Condition	Severe, Dry, Average or Wet
11.22	Texana Elevation	Texana pool elevation that signals a change in the condition. Hydrologic condition is set at the beginning of each season based on the elevation on the last day of the previous season. If Texana is at or above 44 feet, it signals a Wet condition. If Texana is between 43 feet and 44 feet, it signals an Average condition. If Texana is between 39.95 feet and 43 feet, it signals a Dry condition. Below 39.95 feet, it signals Severe conditions.
11.23	Code	Numeric code for each season. Used as an index for lookup calculations.
Pulse Codes		
11.24	Code	Numeric code for each pulse type, 1 for small, 2 for large and 3 for annual
11.25	Pulse Type	Label for pulse code.

2.2.13 Table 12 Lake Texana Area-Capacity-Elevation

Volumetric and other information for Lake Texana. The name of the survey is entered in merged cells B3 through D3, labeled as “Survey Name” below. The table may change as new surveys become available. It may be necessary to extend the survey above conservation storage at 44 feet if Lake Texana was above 44 feet during the year.

Column	Label	Description
Survey Name		
12.1	Elevation	Pool elevation from the survey
12.2	Area	Area in acres at the elevation in Column 12.1.
12.3	Capacity	Storage volume at the elevation in Column 12.1.
Storage and Elevation Data		
12.4	Conservation Elevation	The normal pool elevation of Lake Texana (44 feet).
12.5	Conservation Storage	The storage when Lake Texana is at the conservation elevation in Column 12.4.
12.6	B&E Percent	The percent of conservation storage where the bay and estuary freshwater inflow releases change (78.18 percent).
12.7	B&E Storage	The storage at 78.18 percent conservation. Calculated by multiplying Column 12.5 by Column 12.6.
12.8	B&E Elevation	The pool elevation corresponding to the storage in Column 12.7.

2.2.14 Import/Export

Values that need to be copied from one year’s plan to the next. The values in row 9 (shaded green) can be copied and pasted directly into row 19 of the next year’s plan (row 19). The column labels below correspond to the equivalent labels in the accounting plan tables. Refer to the individual tables for a description of each column.

The export is set up so that it automatically gets the correct data for the last day of the year, even during leap years.

Column	Label
2.4	Lavaca River nr Edna
2.5	Diversion from Lavaca River
2.6	Shutoff During Pulse [a]
2.11	Texana Elevation
3.18	Imported Water Storage
4.10	Hydrologic Condition Code
4.13	Final Base Bypass
4.21	First Day of Small Pulse
4.24	Is Small Pulse
4.25	Small Pulse Duration
4.26	Small Pulse Cumulative Volume
4.27	Small Pulse Seasonal Counter
4.35	First Day of Large Pulse
4.38	Is Large Pulse
4.39	Large Pulse Duration
4.40	Large Pulse Cumulative Volume
4.41	Large Pulse Seasonal Counter
4.47	First Day of Annual Pulse
4.50	Is Annual Pulse
4.51	Annual Pulse Duration
4.52	Annual Pulse Cumulative Volume
5.11	Cumulative Deficit
6.17	First Day of Small Pulse
6.20	Is Small Pulse
6.21	Small Pulse Duration
6.22	Small Pulse Cumulative Volume
6.23	Small Pulse Seasonal Counter
6.31	First Day of Large Pulse
6.34	Is Large Pulse
6.35	Large Pulse Duration
6.36	Large Pulse Cumulative Volume
6.37	Large Pulse Seasonal Counter
6.43	First Day of Annual Pulse
6.46	Is Annual Pulse

Column	Label
6.47	Annual Pulse Duration
6.48	Annual Pulse Cumulative Volume

a Will default to “N” if blank on last day of year.

TOC **Table 5 Base Flow Compliance**

Date			Base Flow Check				
5.1 Ref Date	5.2 Ref Date	5.3 Ref Date	5.4 Linked text	5.5 Linked ac-ft	5.6 Linked ac-ft	5.7 Calc ac-ft	5.8 Linked ac-ft
Days	Month	Date	Season	Edna Gage Flow	Base Flow Pass	Available Flow	Diverted Flow
31	1	1/31/2015	Winter	1,538	864	843	643
28	2	2/28/2015	Winter	252	472	0	0
31	3	3/31/2015	Spring	117,165	1,527	115,690	497
30	4	4/30/2015	Spring	73,591	1,785	71,805	0
31	5	5/31/2015	Spring	75,737	1,845	73,893	3,651
30	6	6/30/2015	Spring	205,294	1,785	203,509	11,551
31	7	7/31/2015	Summer	9,289	1,230	8,059	5,333
31	8	8/31/2015	Summer	2,022	1,230	792	45
30	9	9/30/2015	Fall	1,672	854	818	327
31	10	10/31/2015	Fall	11,288	372	10,916	1,392
30	11	11/30/2015	Fall	8,734	1,190	7,544	593
31	12	12/31/2015	Winter	12,149	3,382	9,237	0
		Annual		518,729	16,536	503,105	24,032

Date			Base Flow Check				
5.1 Ref Date	5.2 Ref Date	5.3 Ref Date	5.4 Linked text	5.5 Linked cfs	5.6 Linked cfs	5.7 Calc cfs	5.8 Linked cfs
Day	Month	Date	Season	Edna Gage Flow	Base Flow Pass	Available Flow	Diverted Flow
		12/31/2014		4	8.5		
1	1	1/1/2015	Winter	3.8	8.5	0	0
2	1	1/2/2015	Winter	3.55	8.5	0	0
3	1	1/3/2015	Winter	2.89	8.5	0	0
4	1	1/4/2015	Winter	2.14	8.5	0	0
5	1	1/5/2015	Winter	1.45	8.5	0	0
6	1	1/6/2015	Winter	0.99	8.5	0	0
7	1	1/7/2015	Winter	0.84	8.5	0	0
8	1	1/8/2015	Winter	0.96	8.5	0	0
9	1	1/9/2015	Winter	1.19	8.5	0	0
10	1	1/10/2015	Winter	1.49	8.5	0	0
11	1	1/11/2015	Winter	152	30	122	80.7
12	1	1/12/2015	Winter	126	30	96	117.74
13	1	1/13/2015	Winter	51.8	30	21.8	0

14	1	1/14/2015	Winter	26.9	8.5	18.4	0
15	1	1/15/2015	Winter	17.4	8.5	8.9	0
16	1	1/16/2015	Winter	12.2	8.5	3.7	0
17	1	1/17/2015	Winter	8.73	8.5	0.23	0
18	1	1/18/2015	Winter	6.13	8.5	0	0
19	1	1/19/2015	Winter	4.63	8.5	0	0
20	1	1/20/2015	Winter	3.67	8.5	0	0
21	1	1/21/2015	Winter	3.21	8.5	0	0
22	1	1/22/2015	Winter	49.3	30	19.3	7.35
23	1	1/23/2015	Winter	99.7	30	69.7	81
24	1	1/24/2015	Winter	56.9	30	26.9	37.47
25	1	1/25/2015	Winter	44.9	30	14.9	0
26	1	1/26/2015	Winter	30.5	30	0.5	0
27	1	1/27/2015	Winter	22.2	8.5	13.7	0
28	1	1/28/2015	Winter	15.1	8.5	6.6	0
29	1	1/29/2015	Winter	10.7	8.5	2.2	0
30	1	1/30/2015	Winter	7.71	8.5	0	0
31	1	1/31/2015	Winter	6.24	8.5	0	0
1	2	2/1/2015	Winter	5.56	8.5	0	0
2	2	2/2/2015	Winter	4.57	8.5	0	0
3	2	2/3/2015	Winter	4.91	8.5	0	0
4	2	2/4/2015	Winter	6.33	8.5	0	0
5	2	2/5/2015	Winter	6.63	8.5	0	0
6	2	2/6/2015	Winter	6.01	8.5	0	0
7	2	2/7/2015	Winter	4.74	8.5	0	0
8	2	2/8/2015	Winter	3.91	8.5	0	0
9	2	2/9/2015	Winter	4.23	8.5	0	0
10	2	2/10/2015	Winter	3.94	8.5	0	0
11	2	2/11/2015	Winter	3.69	8.5	0	0
12	2	2/12/2015	Winter	3.22	8.5	0	0
13	2	2/13/2015	Winter	3.04	8.5	0	0
14	2	2/14/2015	Winter	3	8.5	0	0
15	2	2/15/2015	Winter	3.27	8.5	0	0
16	2	2/16/2015	Winter	3.63	8.5	0	0
17	2	2/17/2015	Winter	3.64	8.5	0	0
18	2	2/18/2015	Winter	3.52	8.5	0	0
19	2	2/19/2015	Winter	3.31	8.5	0	0
20	2	2/20/2015	Winter	3.49	8.5	0	0
21	2	2/21/2015	Winter	3.9	8.5	0	0
22	2	2/22/2015	Winter	4.39	8.5	0	0
23	2	2/23/2015	Winter	5.16	8.5	0	0
24	2	2/24/2015	Winter	5.53	8.5	0	0
25	2	2/25/2015	Winter	5.81	8.5	0	0
26	2	2/26/2015	Winter	5.54	8.5	0	0
27	2	2/27/2015	Winter	5.7	8.5	0	0
28	2	2/28/2015	Winter	6.26	8.5	0	0
1	3	3/1/2015	Spring	6.8	10	0	0

2	3	3/2/2015	Spring	6.5	10	0	0
3	3	3/3/2015	Spring	6.63	10	0	0
4	3	3/4/2015	Spring	6.3	10	0	0
5	3	3/5/2015	Spring	6.89	10	0	0
6	3	3/6/2015	Spring	6.94	10	0	0
7	3	3/7/2015	Spring	6.37	10	0	0
8	3	3/8/2015	Spring	7.11	10	0	0
9	3	3/9/2015	Spring	919	30	889	95.85
10	3	3/10/2015	Spring	5550	30	5520	154.72
11	3	3/11/2015	Spring	8550	30	8520	0
12	3	3/12/2015	Spring	5300	30	5270	0
13	3	3/13/2015	Spring	600	30	570	0
14	3	3/14/2015	Spring	322	30	292	0
15	3	3/15/2015	Spring	210	30	180	0
16	3	3/16/2015	Spring	157	30	127	0
17	3	3/17/2015	Spring	125	30	95	0
18	3	3/18/2015	Spring	1320	30	1290	0
19	3	3/19/2015	Spring	5280	30	5250	0
20	3	3/20/2015	Spring	5220	30	5190	0
21	3	3/21/2015	Spring	2990	30	2960	0
22	3	3/22/2015	Spring	7330	30	7300	0
23	3	3/23/2015	Spring	9380	30	9350	0
24	3	3/24/2015	Spring	3850	30	3820	0
25	3	3/25/2015	Spring	617	30	587	0
26	3	3/26/2015	Spring	378	30	348	0
27	3	3/27/2015	Spring	270	30	240	0
28	3	3/28/2015	Spring	209	30	179	0
29	3	3/29/2015	Spring	171	30	141	0
30	3	3/30/2015	Spring	144	30	114	0
31	3	3/31/2015	Spring	125	30	95	0
1	4	4/1/2015	Spring	112	30	82	0
2	4	4/2/2015	Spring	99.3	30	69.3	0
3	4	4/3/2015	Spring	89.9	30	59.9	0
4	4	4/4/2015	Spring	86.7	30	56.7	0
5	4	4/5/2015	Spring	83.5	30	53.5	0
6	4	4/6/2015	Spring	73.4	30	43.4	0
7	4	4/7/2015	Spring	68.2	30	38.2	0
8	4	4/8/2015	Spring	63.4	30	33.4	0
9	4	4/9/2015	Spring	59.1	30	29.1	0
10	4	4/10/2015	Spring	60.3	30	30.3	0
11	4	4/11/2015	Spring	77.5	30	47.5	0
12	4	4/12/2015	Spring	87.8	30	57.8	0
13	4	4/13/2015	Spring	76.8	30	46.8	0
14	4	4/14/2015	Spring	1250	30	1220	0
15	4	4/15/2015	Spring	648	30	618	0
16	4	4/16/2015	Spring	238	30	208	0
17	4	4/17/2015	Spring	1270	30	1240	0

18	4	4/18/2015	Spring	6700	30	6670	0
19	4	4/19/2015	Spring	11400	30	11370	0
20	4	4/20/2015	Spring	8820	30	8790	0
21	4	4/21/2015	Spring	1640	30	1610	0
22	4	4/22/2015	Spring	635	30	605	0
23	4	4/23/2015	Spring	774	30	744	0
24	4	4/24/2015	Spring	713	30	683	0
25	4	4/25/2015	Spring	430	30	400	0
26	4	4/26/2015	Spring	423	30	393	0
27	4	4/27/2015	Spring	416	30	386	0
28	4	4/28/2015	Spring	313	30	283	0
29	4	4/29/2015	Spring	221	30	191	0
30	4	4/30/2015	Spring	173	30	143	0
1	5	5/1/2015	Spring	146	30	116	0
2	5	5/2/2015	Spring	128	30	98	0
3	5	5/3/2015	Spring	115	30	85	83.64
4	5	5/4/2015	Spring	103	30	73	71.81
5	5	5/5/2015	Spring	93.9	30	63.9	62.15
6	5	5/6/2015	Spring	88.4	30	58.4	56.71
7	5	5/7/2015	Spring	83.3	30	53.3	51.8
8	5	5/8/2015	Spring	79.5	30	49.5	47.72
9	5	5/9/2015	Spring	75.9	30	45.9	44.85
10	5	5/10/2015	Spring	70.9	30	40.9	39.81
11	5	5/11/2015	Spring	67	30	37	37.85
12	5	5/12/2015	Spring	83.4	30	53.4	41.95
13	5	5/13/2015	Spring	107	30	77	63.84
14	5	5/14/2015	Spring	176	30	146	148.63
15	5	5/15/2015	Spring	446	30	416	161.86
16	5	5/16/2015	Spring	1320	30	1290	309.45
17	5	5/17/2015	Spring	1150	30	1120	309.45
18	5	5/18/2015	Spring	1420	30	1390	309.45
19	5	5/19/2015	Spring	1960	30	1930	0
20	5	5/20/2015	Spring	1970	30	1940	0
21	5	5/21/2015	Spring	403	30	373	0
22	5	5/22/2015	Spring	227	30	197	0
23	5	5/23/2015	Spring	174	30	144	0
24	5	5/24/2015	Spring	1170	30	1140	0
25	5	5/25/2015	Spring	4600	30	4570	0
26	5	5/26/2015	Spring	3030	30	3000	0
27	5	5/27/2015	Spring	5890	30	5860	0
28	5	5/28/2015	Spring	7170	30	7140	0
29	5	5/29/2015	Spring	1650	30	1620	0
30	5	5/30/2015	Spring	697	30	667	0
31	5	5/31/2015	Spring	3490	30	3460	0
1	6	6/1/2015	Spring	6270	30	6240	0
2	6	6/2/2015	Spring	914	30	884	0
3	6	6/3/2015	Spring	404	30	374	0

4	6	6/4/2015	Spring	295	30	265	0
5	6	6/5/2015	Spring	234	30	204	0
6	6	6/6/2015	Spring	195	30	165	164.97
7	6	6/7/2015	Spring	169	30	139	137.77
8	6	6/8/2015	Spring	151	30	121	118.67
9	6	6/9/2015	Spring	135	30	105	103.17
10	6	6/10/2015	Spring	121	30	91	89.09
11	6	6/11/2015	Spring	110	30	80	78.82
12	6	6/12/2015	Spring	99.8	30	69.8	68.46
13	6	6/13/2015	Spring	93.6	30	63.6	64.94
14	6	6/14/2015	Spring	1250	30	1220	237.69
15	6	6/15/2015	Spring	4570	30	4540	309.45
16	6	6/16/2015	Spring	1900	30	1870	309.45
17	6	6/17/2015	Spring	7020	30	6990	309.45
18	6	6/18/2015	Spring	27500	30	27470	309.45
19	6	6/19/2015	Spring	28100	30	28070	309.45
20	6	6/20/2015	Spring	13100	30	13070	309.45
21	6	6/21/2015	Spring	5520	30	5490	309.45
22	6	6/22/2015	Spring	1690	30	1660	309.45
23	6	6/23/2015	Spring	852	30	822	309.45
24	6	6/24/2015	Spring	580	30	550	309.45
25	6	6/25/2015	Spring	512	30	482	309.45
26	6	6/26/2015	Spring	537	30	507	309.45
27	6	6/27/2015	Spring	367	30	337	309.45
28	6	6/28/2015	Spring	291	30	261	272.51
29	6	6/29/2015	Spring	248	30	218	228.62
30	6	6/30/2015	Spring	274	30	244	236.29
1	7	7/1/2015	Summer	253	20	233	217.73
2	7	7/2/2015	Summer	911	20	891	60.81
3	7	7/3/2015	Summer	489	20	469	232.08
4	7	7/4/2015	Summer	319	20	299	299.05
5	7	7/5/2015	Summer	243	20	223	228.37
6	7	7/6/2015	Summer	197	20	177	172.33
7	7	7/7/2015	Summer	172	20	152	143.51
8	7	7/8/2015	Summer	156	20	136	126.72
9	7	7/9/2015	Summer	142	20	122	111.66
10	7	7/10/2015	Summer	133	20	113	102.07
11	7	7/11/2015	Summer	125	20	105	93.76
12	7	7/12/2015	Summer	117	20	97	85.76
13	7	7/13/2015	Summer	111	20	91	79.14
14	7	7/14/2015	Summer	105	20	85	73.35
15	7	7/15/2015	Summer	99.8	20	79.8	68.22
16	7	7/16/2015	Summer	94.2	20	74.2	62.38
17	7	7/17/2015	Summer	90.1	20	70.1	58.27
18	7	7/18/2015	Summer	85.2	20	65.2	53.72
19	7	7/19/2015	Summer	80.7	20	60.7	48.64
20	7	7/20/2015	Summer	77	20	57	44.9

21	7	7/21/2015	Summer	74.6	20	54.6	42.07
22	7	7/22/2015	Summer	72.2	20	52.2	39.96
23	7	7/23/2015	Summer	68.7	20	48.7	36.78
24	7	7/24/2015	Summer	65.2	20	45.2	32.89
25	7	7/25/2015	Summer	62.9	20	42.9	30.39
26	7	7/26/2015	Summer	60.7	20	40.7	28.21
27	7	7/27/2015	Summer	58.8	20	38.8	26.12
28	7	7/28/2015	Summer	57.5	20	37.5	24.99
29	7	7/29/2015	Summer	57.1	20	37.1	24.15
30	7	7/30/2015	Summer	53.8	20	33.8	21.89
31	7	7/31/2015	Summer	51.6	20	31.6	18.81
1	8	8/1/2015	Summer	51.2	20	31.2	18.78
2	8	8/2/2015	Summer	47.5	20	27.5	3.88
3	8	8/3/2015	Summer	45.6	20	25.6	0
4	8	8/4/2015	Summer	44.1	20	24.1	0
5	8	8/5/2015	Summer	42.5	20	22.5	0
6	8	8/6/2015	Summer	40.7	20	20.7	0
7	8	8/7/2015	Summer	39.4	20	19.4	0
8	8	8/8/2015	Summer	37.5	20	17.5	0
9	8	8/9/2015	Summer	35.6	20	15.6	0
10	8	8/10/2015	Summer	34.1	20	14.1	0
11	8	8/11/2015	Summer	32.3	20	12.3	0
12	8	8/12/2015	Summer	30.3	20	10.3	0
13	8	8/13/2015	Summer	30.9	20	10.9	0
14	8	8/14/2015	Summer	29.5	20	9.5	0
15	8	8/15/2015	Summer	28	20	8	0
16	8	8/16/2015	Summer	30.2	20	10.2	0
17	8	8/17/2015	Summer	30.3	20	10.3	0
18	8	8/18/2015	Summer	27.4	20	7.4	0
19	8	8/19/2015	Summer	26.5	20	6.5	0
20	8	8/20/2015	Summer	29.3	20	9.3	0
21	8	8/21/2015	Summer	35.5	20	15.5	0
22	8	8/22/2015	Summer	36	20	16	0
23	8	8/23/2015	Summer	35	20	15	0
24	8	8/24/2015	Summer	32.1	20	12.1	0
25	8	8/25/2015	Summer	30	20	10	0
26	8	8/26/2015	Summer	26.3	20	6.3	0
27	8	8/27/2015	Summer	23.6	20	3.6	0
28	8	8/28/2015	Summer	22.5	20	2.5	0
29	8	8/29/2015	Summer	21.9	20	1.9	0
30	8	8/30/2015	Summer	21.6	20	1.6	0
31	8	8/31/2015	Summer	22.1	20	2.1	0
1	9	9/1/2015	Fall	27.5	20	7.5	0
2	9	9/2/2015	Fall	25.3	20	5.3	0
3	9	9/3/2015	Fall	23.7	20	3.7	0
4	9	9/4/2015	Fall	25.4	20	5.4	0
5	9	9/5/2015	Fall	26.2	20	6.2	0

6	9	9/6/2015	Fall	26.5	20	6.5	0
7	9	9/7/2015	Fall	23.5	20	3.5	0
8	9	9/8/2015	Fall	23.3	20	3.3	0
9	9	9/9/2015	Fall	27.7	20	7.7	0
10	9	9/10/2015	Fall	47.8	20	27.8	13.49
11	9	9/11/2015	Fall	83	20	63	56.78
12	9	9/12/2015	Fall	50.9	20	30.9	39.87
13	9	9/13/2015	Fall	46.6	20	26.6	19.76
14	9	9/14/2015	Fall	53.8	20	33.8	34.77
15	9	9/15/2015	Fall	31.9	20	11.9	0
16	9	9/16/2015	Fall	26.1	20	6.1	0
17	9	9/17/2015	Fall	23.3	20	3.3	0
18	9	9/18/2015	Fall	22.3	20	2.3	0
19	9	9/19/2015	Fall	21.5	20	1.5	0
20	9	9/20/2015	Fall	20.7	20	0.7	0
21	9	9/21/2015	Fall	20.2	20	0.2	0
22	9	9/22/2015	Fall	19.6	1.2	18.4	0
23	9	9/23/2015	Fall	19.1	1.2	17.9	0
24	9	9/24/2015	Fall	18.3	1.2	17.1	0
25	9	9/25/2015	Fall	18.4	1.2	17.2	0
26	9	9/26/2015	Fall	18	1.2	16.8	0
27	9	9/27/2015	Fall	18	1.2	16.8	0
28	9	9/28/2015	Fall	18	1.2	16.8	0
29	9	9/29/2015	Fall	17.7	1.2	16.5	0
30	9	9/30/2015	Fall	18.8	1.2	17.6	0
1	10	10/1/2015	Fall	17.3	1.2	16.1	0
2	10	10/2/2015	Fall	16.1	1.2	14.9	0
3	10	10/3/2015	Fall	15.3	1.2	14.1	0
4	10	10/4/2015	Fall	14.9	1.2	13.7	0
5	10	10/5/2015	Fall	14.8	1.2	13.6	0
6	10	10/6/2015	Fall	14.6	1.2	13.4	0
7	10	10/7/2015	Fall	14.5	1.2	13.3	0
8	10	10/8/2015	Fall	14.6	1.2	13.4	0
9	10	10/9/2015	Fall	14.8	1.2	13.6	0
10	10	10/10/2015	Fall	14.6	1.2	13.4	0
11	10	10/11/2015	Fall	14.3	1.2	13.1	0
12	10	10/12/2015	Fall	14.6	1.2	13.4	0
13	10	10/13/2015	Fall	15.1	1.2	13.9	0
14	10	10/14/2015	Fall	14.5	1.2	13.3	0
15	10	10/15/2015	Fall	14.3	1.2	13.1	0
16	10	10/16/2015	Fall	13.9	1.2	12.7	0
17	10	10/17/2015	Fall	13.5	1.2	12.3	0
18	10	10/18/2015	Fall	12.9	1.2	11.7	0
19	10	10/19/2015	Fall	12.8	1.2	11.6	0
20	10	10/20/2015	Fall	13.2	1.2	12	0
21	10	10/21/2015	Fall	14.3	1.2	13.1	0
22	10	10/22/2015	Fall	15.3	1.2	14.1	0

23	10	10/23/2015	Fall	18.8	1.2	17.6	0
24	10	10/24/2015	Fall	31.5	20	11.5	0
25	10	10/25/2015	Fall	748	20	728	198.11
26	10	10/26/2015	Fall	2510	20	2490	77.36
27	10	10/27/2015	Fall	1500	20	1480	154.72
28	10	10/28/2015	Fall	261	20	241	271.65
29	10	10/29/2015	Fall	137	20	117	0
30	10	10/30/2015	Fall	92.2	20	72.2	0
31	10	10/31/2015	Fall	72.2	20	52.2	0
1	11	11/1/2015	Fall	85.9	20	65.9	0
2	11	11/2/2015	Fall	737	20	717	0
3	11	11/3/2015	Fall	179	20	159	0
4	11	11/4/2015	Fall	99.8	20	79.8	0
5	11	11/5/2015	Fall	72.4	20	52.4	0
6	11	11/6/2015	Fall	59.3	20	39.3	0
7	11	11/7/2015	Fall	52.5	20	32.5	0
8	11	11/8/2015	Fall	46.4	20	26.4	26.18
9	11	11/9/2015	Fall	53.1	20	33.1	23.7
10	11	11/10/2015	Fall	99.5	20	79.5	76.32
11	11	11/11/2015	Fall	60.9	20	40.9	44.75
12	11	11/12/2015	Fall	48.7	20	28.7	29.26
13	11	11/13/2015	Fall	42.3	20	22.3	18.57
14	11	11/14/2015	Fall	37.3	20	17.3	17.14
15	11	11/15/2015	Fall	34.5	20	14.5	8.06
16	11	11/16/2015	Fall	33.1	20	13.1	0
17	11	11/17/2015	Fall	47.3	20	27.3	7.81
18	11	11/18/2015	Fall	97.9	20	77.9	47.05
19	11	11/19/2015	Fall	1540	20	1520	0
20	11	11/20/2015	Fall	320	20	300	0
21	11	11/21/2015	Fall	141	20	121	0
22	11	11/22/2015	Fall	93	20	73	0
23	11	11/23/2015	Fall	71.3	20	51.3	0
24	11	11/24/2015	Fall	60.4	20	40.4	0
25	11	11/25/2015	Fall	54.4	20	34.4	0
26	11	11/26/2015	Fall	50.5	20	30.5	0
27	11	11/27/2015	Fall	47.7	20	27.7	0
28	11	11/28/2015	Fall	47.6	20	27.6	0
29	11	11/29/2015	Fall	46.7	20	26.7	0
30	11	11/30/2015	Fall	43.7	20	23.7	0
1	12	12/1/2015	Winter	42.1	55	0	0
2	12	12/2/2015	Winter	40.5	55	0	0
3	12	12/3/2015	Winter	37.7	55	0	0
4	12	12/4/2015	Winter	36.4	55	0	0
5	12	12/5/2015	Winter	35.5	55	0	0
6	12	12/6/2015	Winter	34.6	55	0	0
7	12	12/7/2015	Winter	33.8	55	0	0
8	12	12/8/2015	Winter	33	55	0	0

9	12	12/9/2015	Winter	32.5	55	0	0
10	12	12/10/2015	Winter	32	55	0	0
11	12	12/11/2015	Winter	32	55	0	0
12	12	12/12/2015	Winter	32.9	55	0	0
13	12	12/13/2015	Winter	72.4	55	17.4	0
14	12	12/14/2015	Winter	1640	55	1585	0
15	12	12/15/2015	Winter	2160	55	2105	0
16	12	12/16/2015	Winter	439	55	384	0
17	12	12/17/2015	Winter	233	55	178	0
18	12	12/18/2015	Winter	158	55	103	0
19	12	12/19/2015	Winter	120	55	65	0
20	12	12/20/2015	Winter	99.1	55	44.1	0
21	12	12/21/2015	Winter	87.2	55	32.2	0
22	12	12/22/2015	Winter	78.2	55	23.2	0
23	12	12/23/2015	Winter	71.4	55	16.4	0
24	12	12/24/2015	Winter	65.1	55	10.1	0
25	12	12/25/2015	Winter	61.8	55	6.8	0
26	12	12/26/2015	Winter	58.8	55	3.8	0
27	12	12/27/2015	Winter	60.5	55	5.5	0
28	12	12/28/2015	Winter	69.6	55	14.6	0
29	12	12/29/2015	Winter	72	55	17	0
30	12	12/30/2015	Winter	74.5	55	19.5	0
31	12	12/31/2015	Winter	81.3	55	26.3	0

Conversion Factors				1.983471	1.547229

5.9 Calc days	5.10 Calc ac-ft	5.11 Calc ac-ft
Check	Excess/ Deficit	EOM Cumulative Deficit
28	199	0
28	0	0
31	115,193	0
30	71,805	0
29	70,241	0
27	191,957	-14
29	2,726	0
31	747	0
28	491	0
30	9,524	0
28	6,951	0
31	9,237	0
350	479,072	

5.9 Calc Boolean	5.10 Calc cfs	5.11 Calc cfs		Util 5.12 Calc days
Check	Excess/ Deficit	Cumulative Deficit		Days of Deficit
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	1.9834711	1.98347107

MEMORANDUM

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TO: File

CC:

FROM: Jon S. Albright

SUBJECT: Water Availability Modeling for LTYEP

DATE: 3/19/2020

PROJECT: LVA18507

Introduction

This memorandum describes the water availability analysis for the proposed Lake Texana Yield Enhancement Project (LTYEP). The modeling includes three scenarios:

- A Baseline scenario which includes existing permanent water rights, including the authorized but not built Stage 2 reservoir at the location specified in Certificate of Adjudication 16-2095 (CoA 16-2095), as amended,
- Phase I which adds diversions from the Lavaca River stored in Lake Texana and removes the Stage 2 modeling, and
- Phase II which includes storage of diversions from the Lavaca River in a 50,000 acre-foot Off-Channel Reservoir (OCR) and Lake Texana.

The Phase I and Phase II models were used to determine the additional yield made available by the LTYEP. The Baseline scenario was used as a comparison point for the Phase I and Phase II scenarios for achievement of adopted Bay and Estuary freshwater inflow standards.

The modeling uses a version of the Lavaca Water Availability Model (Lavaca WAM) full authorization scenario with proposed changes to the Lake Texana and Stage 2 modeling described in the March 29, 2016 Memorandum to Kathy Alexander, TCEQ *Proposed Revisions to Lavaca and Lavaca-Guadalupe WAMs*. The latest modeling takes an alternative approach to modeling the adopted environmental flow standards that directly uses the modeled storage in Lake Texana and uses new instream flow modeling capabilities recently incorporated into WRAP. The specific modifications are included in **Attachment A** of this memorandum.

The model does not include the overdraft in lieu of pumping because the overdraft is a one to one exchange between Lavaca and Navidad water.

Water Availability Analysis

The Phase I model models the LTYEP using these steps:

1. Determine the available flow at the Lavaca near Edna gage, which is the proposed measurement point for environmental flows for the LTYEP project.

2. Divert 200 MGD from the proposed diversion reach, limited to the available flow at the Edna gage. This gives a conservative estimate of available flows at the project site because it ignores intervening flow between the measurement point and the diversion site.

3. Divert the additional yield from Lake Texana using the diverted water plus previously stored water. The additional yield comes from both the Lavaca River diversions and unused storage in Lake Texana. (The Baseline model has unused storage at the end of the critical drought, which partially contributes to the additional yield available from the project.)

4. Fill empty storage in Lake Texana with the diverted flows not used for the additional yield.

5. Return unused Lavaca River diversions to the river at the diversion point.

Phase II is similar, but it adds the OCR. The Phase II model uses the following steps:

1. Determine the available flow at the Lavaca near Edna gage, which is the proposed measurement point for environmental flows for the LTYEP project.

2. Divert 200 MGD from the proposed diversion reach, limited to the available flow at the Edna gage. This gives a conservative estimate of available flows at the project site since it ignores intervening flows between the measurement point and the diversion point.

3. Divert the additional yield from the OCR using the diverted water and water previously stored in the OCR. Fill empty storage in the OCR with unused Lavaca River diversions.

4. Fill Lake Texana storage with any Lavaca River diversions not used at the OCR.

5. Back up shortages from the OCR diversions from Lake Texana.

6. Return unused Lavaca River diversions to the river at the diversion point.

Table 1 shows the firm yield and the maximum diversion from the Lavaca River for each scenario.

Table 1: Yield Analysis

Scenario	Firm Yield (ac-ft/yr)	Maximum Diversion from Lavaca River (ac-ft/yr)
Phase I Store in Texana	23,500	78,318
Phase II OCR and Store in Texana	30,600	96,022

Table 2 compares the annual depletions from the Lavaca River for the Baseline (current water rights), to Phase I and Phase II of the LTYEP. The Baseline depletions are the Stage 2 reservoir depletions for water use and filling storage. They do not include the 18,122 acre-feet per year bay and estuary diversion, which is returned to the river. The Phase I and Phase II depletions are only for the LTYEP. In most years the depletions from the Lavaca River made by the LTYEP are less than the depletions for Stage 2.

Table 2: Comparison of Annual Depletions from the Lavaca River
(Values in acre-feet per year)

Year	Stage 2 Depletions	Phase I Depletions	Phase II Depletions
1940	46,664	24,315	34,413
1941	41,112	21,865	28,930
1942	39,679	33,895	41,548
1943	49,815	25,842	29,779
1944	44,808	25,383	37,367
1945	32,554	12,694	20,719
1946	53,830	40,427	53,743
1947	29,021	29,036	30,393
1948	46,453	29,881	30,135
1949	66,970	28,828	47,855
1950	24,218	6,228	8,732
1951	36,641	19,306	19,306
1952	86,627	45,872	55,351
1953	45,208	25,065	38,725
1954	11,694	4,896	5,378
1955	79,414	46,968	46,968
1956	4,102	972	972
1957	98,479	47,709	96,022
1958	39,107	27,221	35,093
1959	42,166	38,033	51,301
1960	38,791	23,469	31,046
1961	44,903	24,304	33,080
1962	45,101	42,880	42,880
1963	24,429	13,418	14,465
1964	54,073	30,881	30,881
1965	60,850	31,450	91,869
1966	31,727	15,857	18,612
1967	56,221	30,025	45,385
1968	39,248	29,572	38,990
1969	43,910	24,019	28,920
1970	42,164	29,040	46,713
1971	49,440	31,345	41,646
1972	41,572	21,210	24,398
1973	42,474	36,789	49,676
1974	42,806	48,443	47,617
1975	41,092	32,106	35,961
1976	34,324	78,318	81,143
1977	43,673	36,197	37,135
1978	45,327	23,925	50,411
1979	42,584	35,011	43,024

Table 2 (continued)

Year	Stage 2 Depletions	Phase I Depletions	Phase II Depletions
1980	29,362	16,587	22,348
1981	57,834	34,250	52,724
1982	48,237	27,046	39,071
1983	43,768	38,708	46,470
1984	49,767	11,558	9,324
1985	42,036	42,955	65,592
1986	40,218	23,106	33,749
1987	40,662	23,373	28,591
1988	26,029	7,364	7,364
1989	34,080	10,160	8,407
1990	26,362	12,847	12,842
1991	87,761	46,041	74,563
1992	44,516	23,321	41,762
1993	41,290	16,557	26,664
1994	58,349	28,730	47,022
1995	36,251	38,624	40,813
1996	51,334	28,882	27,494
Average	44,581	28,119	37,393
Min	4,102	972	972
Max	98,479	78,318	96,022

Table 3 shows the adopted Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay system. The flow quantities in this table are the sum of the flows from the Lavaca River, which is modeled by the Lavaca WAM, and Garcitas Creek, which is modeled in the Lavaca-Guadalupe WAM. The Spring Inflow Quantity is the maximum flow from the Lavaca River and Garcitas Creek that occurs during any period of three consecutive months beginning in February, March, April, or May. In other words, the modeled flows are summed over the months of February through April, March through May, April through June, and May through July. The maximum volume of flow from these four windows is the Spring Inflow Quantity for that year. Similarly, the Fall Inflow Quantity is the maximum three-month sum over any period of three consecutive months beginning in August, September, or October. The Intervening Inflow Quantity is the sum of flows for the remaining six months that were not included in the Fall Inflow or Spring Inflow Quantities for that year.

Table 3: Bay and Estuary Freshwater Inflow Criteria

Inflow Regime	Goal Attainment Frequency	Spring Inflow Quantity (ac-ft)	Fall Inflow Quantity (ac-ft)	Intervening Inflow Quantity (ac-ft)
Subsistence	96%	13,500	9,600	6,900
Base Dry	82%	55,080	39,168	28,152
Base Average	46%	127,980	91,080	65,412
Base Wet	28%	223,650	158,976	114,264

Table 4 is a comparison of the modeled Bay and Estuary Freshwater Inflow achievement for the three scenarios. The Baseline (with Stage 2) is the frequency with current water rights, including the proposed Stage 2. The Phase I and Phase II inflows assume replacement of the Stage 2 project with the LTYEP. Note that the achievement is as good or better with the proposed project compared to current water rights.

Table 4: Comparison of Modeled Bay and Estuary Freshwater Inflow Achievement

Inflow Regime	Goal (Full Year)	Baseline (with Stage 2)			
		Full Year	Spring	Fall	Intervening
Subsistence	96%	80.7%	93.0%	84.2%	94.7%
Base Dry	82%	61.4%	80.7%	70.2%	84.2%
Base Average	46%	29.8%	71.9%	49.1%	64.9%
Base Wet	28%	21.1%	61.4%	40.4%	50.9%
Inflow Regime	Goal (Full Year)	Store in Texana (Phase I)			
		Full Year	Spring	Fall	Intervening
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	35.1%	71.9%	52.6%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%
Inflow Regime	Goal (Full Year)	Store in OCR and Texana (Phase II)			
		Full Year	Spring	Fall	Intervening
Subsistence	96%	86.0%	93.0%	89.5%	96.5%
Base Dry	82%	64.9%	82.5%	73.7%	89.5%
Base Average	46%	33.3%	71.9%	50.9%	66.7%
Base Wet	28%	22.8%	61.4%	42.1%	54.4%

Table 5 shows the annual freshwater inflows from the three modeling scenarios. Flows that are greater than the Base Wet criteria are shaded in blue, flows that are greater than the Base Average criteria but less than the Base Wet are shaded green. Flows that are less than the Base Dry criteria but more than the Subsistence criteria are shaded orange. Flows that are less than the Subsistence criteria are shaded pink. This table shows that on average the flows into the bay are greater with the new project compared to existing permits.

Table 5: Comparison of Bay and Estuary Freshwater Inflow Regime Levels
(values in acre-feet per year)

Year	Baseline			Phase I			Phase II		
	Spring	Fall	Intervening	Spring	Fall	Intervening	Spring	Fall	Intervening
1940	679,165	1,187,126	36,546	688,536	1,194,781	41,280	681,982	1,191,641	41,216
1941	1,134,166	133,235	639,515	1,136,516	139,482	650,079	1,135,730	136,982	646,299
1942	244,995	73,910	215,209	246,461	68,884	226,517	244,610	68,884	218,537
1943	68,406	55,426	54,126	72,148	74,012	64,495	68,212	73,775	65,335
1944	525,657	63,659	297,898	528,840	68,393	308,829	528,582	66,136	299,266
1945	242,705	47,434	110,204	244,863	51,291	121,969	236,543	51,912	121,969
1946	321,072	619,573	302,401	321,598	622,889	317,317	313,715	621,418	307,689
1947	172,545	8,355	190,571	159,239	12,972	202,765	157,059	20,166	202,357
1948	206,966	6,435	29,558	204,729	7,268	45,653	202,904	7,268	50,463
1949	230,683	246,080	33,509	246,964	252,973	59,438	227,026	250,818	50,507
1950	104,811	5,897	70,958	115,029	6,685	75,865	115,029	6,685	74,162
1951	13,870	9,434	6,182	17,578	18,695	8,592	17,578	18,695	8,592
1952	235,943	71,188	12,894	259,691	88,328	18,043	252,399	80,428	17,793
1953	142,786	96,620	29,933	147,512	103,851	40,970	134,277	103,851	36,005
1954	6,323	5,409	4,152	10,031	5,504	6,334	10,031	5,504	5,866
1955	53,979	9,808	22,513	67,921	14,329	45,515	57,703	14,329	45,515
1956	2,673	6,264	2,636	3,640	6,959	3,250	3,640	6,959	3,250
1957	435,979	626,792	33,651	453,928	634,132	59,534	430,488	613,851	59,534
1958	233,862	78,332	255,950	236,805	79,521	265,917	236,780	79,357	256,492
1959	585,071	181,549	177,017	587,715	180,365	192,972	580,399	173,885	192,134
1960	415,920	893,389	305,054	422,978	891,213	315,426	413,792	890,274	317,974
1961	422,853	690,773	570,598	427,189	695,114	583,030	423,693	692,147	580,887
1962	161,904	10,753	38,739	141,090	20,954	57,743	141,090	20,954	57,743
1963	39,643	7,508	12,140	39,280	10,117	28,881	38,229	10,117	28,881
1964	17,550	24,943	14,410	21,202	34,517	21,113	22,023	34,517	21,113
1965	454,525	211,548	203,447	446,919	227,245	229,334	437,081	220,789	199,844
1966	352,105	37,408	141,963	356,496	40,935	148,142	355,446	41,380	146,436
1967	5,564	478,896	11,901	9,484	494,813	16,995	9,484	479,344	16,995
1968	869,486	60,866	426,475	881,114	65,359	426,169	878,246	63,823	419,978
1969	695,881	42,317	293,281	700,465	47,637	302,359	698,856	47,114	299,679
1970	376,498	193,271	152,467	381,045	210,078	151,219	376,598	206,751	143,963
1971	7,670	404,819	130,376	13,055	416,408	136,368	13,055	401,736	135,254
1972	677,819	42,097	202,683	683,004	44,819	214,799	682,274	44,819	212,491
1973	1,608,175	510,263	295,321	1,611,562	511,534	304,559	1,610,327	510,653	293,696
1974	304,688	582,367	350,319	287,719	594,813	372,266	291,896	582,084	371,830
1975	534,420	87,828	150,797	531,402	93,780	164,000	529,513	93,071	161,352
1976	338,147	638,449	53,192	303,205	649,469	80,161	303,205	647,130	75,161
1977	388,959	11,103	199,134	392,945	22,137	195,527	391,376	22,137	195,173
1978	90,801	646,747	90,208	89,543	658,807	107,963	79,020	653,136	105,468
1979	878,066	322,569	629,187	870,936	335,004	639,107	868,672	332,636	637,146

Table 5 (continued)

Year	Baseline			Phase I			Phase II		
	Spring	Fall	Intervening		Spring	Fall	Intervening		Spring
1980	213,392	12,569	258,522	212,321	17,397	266,260	209,411	19,927	266,339
1981	654,060	883,780	75,605	665,460	889,781	85,903	645,580	887,425	85,291
1982	644,891	227,889	114,187	650,685	234,230	122,435	649,523	226,619	120,386
1983	436,894	435,736	253,370	443,133	446,123	261,630	442,386	442,800	256,205
1984	42,232	153,069	100,954	48,949	176,861	105,645	51,347	176,730	106,890
1985	650,631	262,022	202,386	645,590	274,325	200,822	631,046	267,946	196,448
1986	198,076	269,861	40,988	199,127	274,128	51,183	193,479	269,506	51,183
1987	875,019	149,805	281,370	876,052	155,819	291,334	873,788	154,441	289,762
1988	41,328	1,742	23,118	46,429	2,910	31,517	46,429	2,910	32,917
1989	103,531	2,672	67,634	109,076	2,784	84,442	110,370	2,784	84,552
1990	86,652	15,752	38,795	94,273	16,828	40,611	94,273	16,628	41,277
1991	495,983	372,382	219,848	505,391	381,565	245,994	497,345	364,198	241,632
1992	1,603,580	86,277	1,152,860	1,609,126	91,336	1,163,270	1,608,514	89,905	1,146,872
1993	1,435,280	45,676	377,067	1,441,311	51,588	389,485	1,439,749	51,588	381,001
1994	341,589	1,364,457	72,697	348,566	1,376,797	82,270	336,010	1,371,160	82,172
1995	339,868	37,210	199,809	346,049	42,416	202,443	342,301	42,416	202,107
1996	33,692	106,789	33,557	37,085	116,912	40,399	37,116	118,283	40,399
Average	394,369	243,125	180,875	397,176	249,963	191,511	393,109	247,235	188,587
Min	2,673	1,742	2,636	3,640	2,784	3,250	3,640	2,784	3,250
Max	1,608,175	1,364,457	1,152,860	1,611,562	1,376,797	1,163,270	1,610,327	1,371,160	1,146,872

Greater than Base Wet
Between Base Wet and Base Average
Between Base Average and Base Dry
Between Base Dry and Subsistence
Less than Subsistence

The modeled flows in **Table 5** include flows from Garcitas Creek from the Lavaca-Guadalupe WAM. These flows are the same for all scenarios and are included in **Attachment B**.

No Injury Analysis

Table 6 compares the Volume Reliability for non-LNRA water rights for the three scenarios. There are 32 water rights that are more reliable with Phase I, and 31 water rights that are more reliable with Phase II. The increase in reliability is primarily due to the cancelation of the Stage 2 authorizations, which makes upstream junior water rights more reliable. The proposed LTYEP authorizations will be junior to those existing authorizations. Other water rights that are slightly more reliable are the water rights that are upstream of Lake Texana that are cut off when Lake Texana is below 43 feet msl (drought Index 3 in the Lavaca WAM). No water rights are less reliable with the proposed project.

Table 6: Comparison of Volume Reliabilities for Non-LNRA Water Rights

Water Right ID	Baseline	Phase I	Phase II	Change Baseline to Phase I	Change Baseline to Phase II
2078_1	95.73%	95.73%	95.73%	0.00%	0.00%
61602088	89.96%	89.96%	89.96%	0.00%	0.00%
61602082	63.80%	63.80%	63.80%	0.00%	0.00%
2078_2	94.22%	94.22%	94.22%	0.00%	0.00%
61602080	59.04%	59.04%	59.04%	0.00%	0.00%
61602099	97.61%	97.61%	97.61%	0.00%	0.00%
2098_1	96.94%	96.94%	96.94%	0.00%	0.00%
61602100	95.59%	95.59%	95.59%	0.00%	0.00%
61602097	94.53%	94.53%	94.53%	0.00%	0.00%
61602101	94.43%	94.43%	94.43%	0.00%	0.00%
61602092	64.18%	64.18%	64.18%	0.00%	0.00%
61602087	98.83%	98.83%	98.83%	0.00%	0.00%
2083_1	66.51%	66.51%	66.51%	0.00%	0.00%
2077_1	91.83%	91.83%	91.83%	0.00%	0.00%
61602084	72.06%	72.06%	72.06%	0.00%	0.00%
2094_1	82.98%	82.98%	82.98%	0.00%	0.00%
2094_2	82.98%	82.98%	82.98%	0.00%	0.00%
61602091	88.89%	88.89%	88.89%	0.00%	0.00%
61602075	98.20%	98.20%	98.20%	0.00%	0.00%
61602081	56.23%	56.23%	56.23%	0.00%	0.00%
2086_1	54.42%	54.42%	54.42%	0.00%	0.00%
61602090	86.04%	86.04%	86.04%	0.00%	0.00%
2077_2	86.78%	86.78%	86.78%	0.00%	0.00%
2096_1	95.05%	95.05%	95.05%	0.00%	0.00%
2085_1	84.51%	84.51%	84.51%	0.00%	0.00%
61602093	83.49%	83.49%	83.49%	0.00%	0.00%
61602089	78.65%	78.65%	78.65%	0.00%	0.00%
2083_2	59.65%	59.65%	59.65%	0.00%	0.00%
C2095_1	100.00%	100.00%	100.00%	0.00%	0.00%
11603665	26.24%	30.01%	26.88%	3.77%	0.64%
11603725	26.24%	29.37%	26.88%	3.13%	0.64%
11603727	25.64%	27.60%	26.27%	1.96%	0.63%
3876_1	25.37%	26.92%	26.02%	1.55%	0.65%
3876_2	0.58%	1.43%	0.58%	0.85%	0.00%
3836_1	24.50%	25.40%	25.14%	0.90%	0.64%
3910_1	32.42%	34.20%	33.17%	1.78%	0.75%
3905_1	32.12%	33.90%	32.87%	1.78%	0.75%
11603906	40.29%	44.09%	41.17%	3.80%	0.88%
11603904	24.22%	26.04%	24.86%	1.82%	0.64%
11603908	25.05%	27.49%	25.69%	2.44%	0.64%

Table 6 (continued)

Water Right ID	Baseline	Phase I	Phase II	Change Baseline to Phase I	Change Baseline to Phase II
11603909	37.90%	38.76%	38.67%	0.86%	0.77%
3907_1	23.64%	24.45%	24.28%	0.81%	0.64%
3907_2	23.56%	24.20%	24.18%	0.64%	0.62%
11603903	24.53%	28.24%	25.17%	3.71%	0.64%
3911_1	4.31%	4.38%	4.37%	0.07%	0.06%
3912_1	57.13%	62.83%	57.77%	5.70%	0.64%
2098_2	46.85%	86.70%	86.70%	39.85%	39.85%
3978_1	63.70%	91.45%	91.45%	27.75%	27.75%
11604102	14.39%	17.51%	15.95%	3.12%	1.56%
4085_1	13.21%	16.07%	14.51%	2.86%	1.30%
11604252	13.64%	15.65%	14.09%	2.01%	0.45%
11604241	21.95%	24.67%	22.79%	2.72%	0.84%
5168_1	13.33%	15.34%	13.78%	2.01%	0.45%
5168_2	38.59%	40.20%	39.47%	1.61%	0.88%
5263_1	12.09%	14.95%	13.39%	2.86%	1.30%
5370_1	32.66%	38.86%	33.65%	6.20%	0.99%
5584_1	44.11%	96.95%	96.95%	52.84%	52.84%
5584_2	43.40%	99.39%	99.39%	55.99%	55.99%
5584_5	99.42%	99.42%	99.42%	0.00%	0.00%
5595_1	13.13%	16.07%	14.51%	2.94%	1.38%
5706_1	13.23%	16.36%	14.80%	3.13%	1.57%
5579_1	11.59%	14.57%	12.90%	2.98%	1.31%

Attachment A: Modifications to WRAP Code

Modifications to the Lavaca WAM WRAP code include:

- Revised modeling of the adopted environmental flow standards for the Lavaca Basin using new capabilities of WRAP,
- Modeling of the proposed LTYEP project, and
- Changes to the Lavaca WAM as previously provided to TCEQ in March 2016, excluding changes suggested for environmental flows.

The changes to the WRAP code for Lake Texana and Stage 2 proposed in 2016 are summarized in this appendix for reference.

Environmental Flow Standards

The modeling of the environmental flow standards has been replaced with code that uses the new HC and ES Records in WRAP. Although these records seem to be oriented toward the daily WRAP model, they do function in the monthly model and result in considerably less code than current methods. They also allow for more direct application of reservoir storage as a method for setting hydrologic condition, although the model logic does not seem to anticipate the use of both storage and flow as a basis for setting the condition. The method for determining monthly pulse flow targets is the same as that employed in previous monthly models – the monthly flow volume is based on the pulse volume and duration plus the applicable base flow for the remaining days of the month. However, unlike previous versions the model does not calculate the monthly pulse targets within the model – it is done externally. A future improvement would be to incorporate this calculation within the WRAP code.

The code in this memo is only for the Lavaca River near Edna gage. However, this technique was applied at all of the adopted flow measurement points.

Base Flow Targets

Define artificial control points *FKLE01* and *FKLE02* used in the hydrologic condition calculations.

```
CPFKLE01      OUT                        2     NONE    NONE                  1    0          9999999
CPFKLE02      OUT                        2     NONE    NONE                  1    0          9999999
```

Use a Type 8 water right and a TO record to get the end-of-month storage in Lake Texana in the previous timestep. This will be used to determine dry, average and wet conditions.

```
**   Use a type 8 water right to get the previous month's storage in Lake Texana
WR GS300                20110301   8                                     TexStor   LavEd
TO    -4                                    TEXANA
```

Using a combination of IF, HC, and ES Records at artificial control point *FKLE01*, set a flag that signifies that you are in Dry (code 200), Average (code 300) or Wet (code 400) conditions. These codes, which are based on Lake Texana storage, apply at all measurement points. The codes for Severe (code 0) and Subsistence (code 100), which are dependent on flow, are set later in the process at each individual gage. The HC Record uses the storage values from *TexStor* to select one of the four base flow conditions on the following ES Records. Conditions are evaluated in March, July, September and December. The values entered on the ES Records convert to approximately the condition codes (i.e. 0, 200, 300 or 400) when converted from cfs to acre-feet per month.

```
**  Record code for dry, average, wet conditions based on Texana storage
**   This will be the same for all SB3 IF calculations
IFFKLE01      -9        20110301   2                   IF_other   LavEd
HC GS300   1  WR      M   J S  D       0  132439  160929  170299      -9              //          TexStor
ES BASE1      0       0       0       0       0       0       0       0       0       0       0       0
ES BASE2   3.253   3.601   3.253   3.361   3.253   3.361   3.253   3.253   3.361   3.253   3.361   3.253
ES BASE3   4.879   5.402   4.879   5.042   4.879   5.042   4.879   4.879   5.042   4.879   5.042   4.879
ES BASE4   6.505   7.202   6.505   6.722   6.505   6.722   6.505   6.505   6.722   6.505   6.722   6.505
```

The next step is to determine the Dry or Severe flow target, if applicable. For this example, we are showing the target for the Lavaca River near Edna gage (USGS 08164000). Dry or Severe conditions can vary at different measurement points and can vary month-by-month within a season.

Using IF and ES Records at artificial control point *FKLE02* sets the Dry flow target of 30 or 20 cfs. The program will calculate targets in acre-feet per month, taking into account the number of days in the month, including leap years.

```
**  Monthly dry/severe flow target for Edna
IFFKLE02      -9        20110301   2                  LE_IF_dry   LavEd
ES BASE       30      30      30      30      30      30      20      20      20      20      20      30
```

Divide the actual regulated flow at *GS300* (the Lavaca near Edna gage) by the monthly Dry flow targets set in *LE_IF_dry*.

```
**  Divide regulated flow by monthly dry/severe target
WR GS300          XMONTH20110301   8                              LE_SEVTRIGGER   LavEd
TO     2            ADD                GS300                                 CONT
TO    13            DIV                                  LE_IF_dry
```

Using a Type 8 water right, set a monthly target equal to 100 (the Severe code) if *LE_SEVTRIGGER* is greater than 1 (i.e. flows are greater than the Dry flow target of 20 or 30 cfs), or 0 (the Subsistence code) if *LE_SEVTRIGGER* is less than 1 (i.e. flows are less than 20 or 30 cfs).

```
**  If SEVTRIGGER is greater than 1, use severe code (100), otherwise it is subsistence code (0)
WR GS300     100  XMONTH20110301   8                                     LE_sub   LavEd
TO    13            LIM       1  999999                  LE_SEVTRIGGER
```

Set the final hydrologic condition code as the maximum of the value calculated in *LE_sub* and *IF_other*.

```
**  Set hydrologic condition code for Lavaca near Edna
WR GS300                20110301   8                                 LE_hc_code   LavEd
TO    13            SET                                     LE_sub     CONT
TO    13            MAX                                   IF_other
```

Now that the hydrologic condition codes have been set (i.e. 0 for Subsistence, 100 for Severe, 200 for Dry, 300 for Average and 400 for Wet), the base flows can be set at the measurement point. Since the values for dry average and wet codes are not exactly equal to the codes, the values that set the base flow condition are set so that subsistence is triggered if the code is greater than or equal to 0 but less than 20, severe is triggered if the code is greater than or equal to 20 but less than 120, and so on. Note that the values for the base flows are entered in cfs. The program will calculate monthly targets in acre-feet per month, taking into account the number of days in each month, including leap years.

```
** Set base flow triggers using condition codes
IFLEBASE      -9        20110301   2                  LEBASEFIN   LavEd
HC GS300   1  WR                       0      20     120     220     320      -9                //     LE_hc_code
** Lavaca River nr Edna sub and base flows
ES BASE1     8.5     8.5    10.0    10.0    10.0    10.0     1.3     1.3     1.2     1.2     1.2     8.5
ES BASE2    30.0    30.0    30.0    30.0    30.0    30.0    20.0    20.0    20.0    20.0    20.0    30.0
```

```
ES BASE3    30.0    30.0    30.0    30.0    30.0    30.0    20.0    20.0    20.0    20.0    20.0    30.0
ES BASE4    55.0    55.0    55.0    55.0    55.0    55.0    33.0    33.0    33.0    33.0    33.0    55.0
ES BASE5    94.0    94.0    94.0    94.0    94.0    94.0    48.0    48.0    58.0    58.0    58.0    94.0
```

Pulse Flow Targets

The new pulse flow records do not automatically account for the base flows that occur during the rest of the month, so the pulse flow volumes cannot be directly input into the program. Like the previous methods for inputting pulses, the pulse volume plus the base flow volume for the rest of the month must be calculated and input into the WRAP code. For the new WRAP instream flow records, the monthly volumes must be converted into daily average volumes. The pulse flow calculations for the Lavaca near Edna gage are shown in **Table A-1**.

Note that for these calculations we are assuming a non-leap year (28 days in February). Since the new WRAP code respects leap years, the monthly values will be off slightly in February of leap years. This was determined not to be critical to the flow calculations, since pulses are not engaged every February.

Also note that for the Annual and Large pulses, during Severe conditions the Subsistence flow could never apply. If one of those pulses occur, the average flow in the month would necessarily be higher than the Dry target flow. This is also true for the Small pulses except for the Summer season. A small pulse could occur in July or August and the average flow over the month would be less than the Dry base flow - the average flow of 7.15 cfs with a pulse is less than the Dry base flow of 20 cfs. This requires special handling in the code, setting the Summer Season separately.

Table A-1: Monthly Pulse Flow Target Calculations

Annual Pulse (1 per year)

						Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Feb	Winter	28	18,400	9,277	7	8.5	178.5	9,455	337.68	30	630	9,907	353.81	55	1,155	10,432	372.56	94	1,974	11,251	401.81
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	18,400	9,277	7	1.3	31.2	9,308	300.25	20	480	9,757	314.73	33	792	10,069	324.8	48	1,152	10,429	336.41
Aug	Summer	31	18,400	9,277	7	1.3	31.2	9,308	300.25	20	480	9,757	314.73	33	792	10,069	324.8	48	1,152	10,429	336.41
Sep	Fall	30	18,400	9,277	7	1.2	27.6	9,304	310.14	20	460	9,737	324.56	33	759	10,036	334.52	58	1,334	10,611	353.69
Oct	Fall	31	18,400	9,277	7	1.2	28.8	9,305	300.18	20	480	9,757	314.73	33	792	10,069	324.8	58	1,392	10,669	344.15
Nov	Fall	30	18,400	9,277	7	1.2	27.6	9,304	310.14	20	460	9,737	324.56	33	759	10,036	334.52	58	1,334	10,611	353.69
Dec	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02

Large Pulse (1 per season)

						Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Feb	Winter	28	18,400	9,277	7	8.5	178.5	9,455	337.68	30	630	9,907	353.81	55	1,155	10,432	372.56	94	1,974	11,251	401.81
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	1,800	908	6	1.3	32.5	940	30.32	20	500	1,408	45.4	33	825	1,733	55.89	48	1,200	2,108	67.98
Aug	Summer	31	1,800	908	6	1.3	32.5	940	30.32	20	500	1,408	45.4	33	825	1,733	55.89	48	1,200	2,108	67.98
Sep	Fall	30	18,000	9,075	6	1.2	28.8	9,104	303.46	20	480	9,555	318.5	33	792	9,867	328.9	58	1,392	10,467	348.9
Oct	Fall	31	18,000	9,075	6	1.2	30	9,105	293.71	20	500	9,575	308.87	33	825	9,900	319.35	58	1,450	10,525	339.52
Nov	Fall	30	18,000	9,075	6	1.2	28.8	9,104	303.46	20	480	9,555	318.5	33	792	9,867	328.9	58	1,392	10,467	348.9
Dec	Winter	31	18,400	9,277	7	8.5	204	9,481	305.83	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02

Table (continued)

Small Pulse (2 per season)

Month	Season	Days Per Month	Pulse Volume (ac-ft)	Pulse Volume (dsf)	Pulse Duration (days)	Subsistence Conditions				Severe or Dry Conditions				Average Conditions				Wet Conditions			
						Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)	Base Flow (cfs)	Base Flow Volume (dsf)	Total Volume (dsf)	Daily Average Volume (cfs)
Jan	Winter	31	8,000	4,033	6	8.5	212.5	4,246	136.96	30	750	4,783	154.3	55	1,375	5,408	174.46	94	2,350	6,383	205.91
Feb	Winter	28	8,000	4,033	6	8.5	187	4,220	150.73	30	660	4,693	167.62	55	1,210	5,243	187.26	94	2,068	6,101	217.9
Mar	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Apr	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
May	Spring	31	18,400	9,277	7	10	240	9,517	306.99	30	720	9,997	322.47	55	1,320	10,597	341.83	94	2,256	11,533	372.02
Jun	Spring	30	18,400	9,277	7	10	230	9,507	316.89	30	690	9,967	332.22	55	1,265	10,542	351.39	94	2,162	11,439	381.29
Jul	Summer	31	370	187	4	1.3	35.1	222	**7.15**	20	540	727	23.44	33	891	1,078	34.76	48	1,296	1,483	47.82
Aug	Summer	31	370	187	4	1.3	35.1	222	**7.15**	20	540	727	23.44	33	891	1,078	34.76	48	1,296	1,483	47.82
Sep	Fall	30	6,100	3,075	6	1.2	28.8	3,104	103.47	20	480	3,555	118.51	33	792	3,867	128.91	58	1,392	4,467	148.91
Oct	Fall	31	6,100	3,075	6	1.2	30	3,105	100.17	20	500	3,575	115.34	33	825	3,900	125.82	58	1,450	4,525	145.98
Nov	Fall	30	6,100	3,075	6	1.2	28.8	3,104	103.47	20	480	3,555	118.51	33	792	3,867	128.91	58	1,392	4,467	148.91
Dec	Winter	31	8,000	4,033	6	8.5	212.5	4,246	136.96	30	750	4,783	154.3	55	1,375	5,408	174.46	94	2,350	6,383	205.91

In the WRAP code, we first set the Annual pulse using a combination of IF, HC and ES Records. Since we are never in Severe conditions, the monthly flow targets can be set directly by the storage in Lake Texana recorded in *TexStor*. The hydrologic condition codes used for the base flows are not used because only one pulse occurs during a year.

```
**  Annual pulse
IFLEAPUL      -9        20110301   2                    LEannPul   LavEd
HCLEAPUL   1  WR      M   J S  D       0  132439  160929  170299      -9         //               TexStor
** Lavaca River nr Edna annual pulse
ES HA 11  322.47  353.81  322.47  332.22  322.47  332.22  314.73  314.73  324.56  314.73  324.56  322.47
ES HA 12  322.47  353.81  322.47  332.22  322.47  332.22  314.73  314.73  324.56  314.73  324.56  322.47
ES HA 13  341.83  372.56  341.83  351.39  341.83  351.39  324.80  324.80  334.52  324.80  334.52  341.83
ES HA 14  372.02  401.81  372.02  381.29  372.02  381.29  336.41  336.41  353.69  344.15  353.69  372.02
```

The Large pulse is similar to the annual pulse – it can never occur during subsistence conditions and can be set by storage in Lake Texana. The hydrologic condition codes used for the base flows are not used because only one pulse occurs during a season.

```
IFLELPUL      -9        20110301   2                    LElrgPul   LavEd
HCLELPUL   1  WR      M   J S  D       0  132439  160929  170299      -9        //               TexStor
** Lavaca River nr Edna large pulse
ES HS 11  322.47  353.81  322.47  332.22  322.47  332.22   45.40   45.40  318.50  308.87  318.50  322.47
ES HS 12  322.47  353.81  322.47  332.22  322.47  332.22   45.40   45.40  318.50  308.87  318.50  322.47
ES HS 13  341.83  372.56  341.83  351.39  341.83  351.39   55.89   55.89  328.90  319.35  328.90  341.83
ES HS 14  372.02  401.81  372.02  381.29  372.02  381.29   67.98   67.98  348.90  339.52  348.90  372.02
```

The Small pulses can also be set directly by storage in Lake Texana except for in the Summer when it could occur during subsistence conditions. The first set of code sets the Small pulses for every season except the Summer.

```
IFLESPUL      -9        20110301   2                    LEsmlPul   LavEd
HCLESPUL   1  WR      M   J S  D       0  132439  160929  170299      -9         //                    TexStor
** Lavaca River nr Edna small pulse rest of year
ES HS 21  154.30  167.62  322.47  332.22  322.47  332.22       0       0  118.51  115.34  118.51  154.30
ES HS 22  154.30  167.62  322.47  332.22  322.47  332.22       0       0  118.51  115.34  118.51  154.30
ES HS 23  174.46  187.26  341.83  351.39  341.83  351.39       0       0  128.91  125.82  128.91  174.46
ES HS 24  205.91  217.90  372.02  381.29  372.02  381.29       0       0  148.91  145.98  148.91  205.91
```

The summer pulse is set using the hydrologic condition codes calculated by *LE_hc_code*. This code only works because there are only two months in the Summer season – July and August – and the method assumes that only one pulse can occur in any given month. The hydrologic condition codes do not work with the seasonal calculations in the ES Records.

```
IFLESPUL     -99        20110301   2                  LEsmlPul2   LavEd
HC GS300   1  WR                       0      20     120     220     320      -9             //    LE_hc_code
** Lavaca River nr Edna small pulse summer only
ES HS 21       0       0       0       0       0       0    7.15    7.15       0       0       0       0
ES HS 22       0       0       0       0       0       0   23.44   23.44       0       0       0       0
ES HS 23       0       0       0       0       0       0   23.44   23.44       0       0       0       0
ES HS 24       0       0       0       0       0       0   34.76   34.76       0       0       0       0
ES HS 25       0       0       0       0       0       0   47.82   47.82       0       0       0       0
```

Modeling Lake Texana

The code modeling the existing authorizations in Lake Texana is modified to include a PX 3 Record so that the additional yield due to the LTYEP does not change the appropriation at the current priority dates.

```
**  FNI change for LTYEP - add PX3
WRDV221A   74500      TA19720515   1   1                                 C2095_1  texana
WSTEXANA  160930
PX     3
**
**   500 ac-ft at from original authorization, set to 2002 priority to reflect subordination
**
WRDV221A    1680    INTW20020701   1   1     1.0    NOUT       2      72_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                  500
PX     3
**
**  4,000 ac-ft from 1982 authorization, set to 2002 priority to reflect subordination
**
WRDV221A   13440    INTW20020701   1   1     1.0    NOUT       2      82_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                 4000
PX     3
**
**  7,500 ac-ft from Amendment D.
**
WRDV221A   26880    INTW20020701   1   1     1.0    NOUT       2      02_INTERUP  texana  TEXANA
WSTEXANA  170300                         160930
SO                                                                 7500
PX     3
**
** FINAL FILLUP FOR LAKE TEXANA
WRDV221A       0        20020701   1                                  REFILL  texana  TEXANA
WSTEXANA  170300
PX     3
```

Modeling the LTYEP

The diversion from the Lavaca River is assumed to be at the same location as the Stage 2 reservoir, which is near the upper end of the diversion reach. However, control point *STG_II*, the Stage 2 control point, included 25.77 square miles of the drainage area of Dry Creek, which is a tributary of the Lavaca River between the Lavaca River and Lake Texana. Dry Creek would have been impounded by the Stage 2 dam. However, since the confluence with the Lavaca River is downstream of the diversion reach it is not included in the modeling for the LTYEP. The control points *STG_II* and *S2RF* are defined as follows:

```
**CP DV211   CB220                       7           GS300      -2
CP DV211  STG_II                       7           GS300      -2
CPSTG_II    S2RF                       7           GS300      -2
CP  S2RF   CB220                       7           GS300      -2
```

Control point *TWW217* is on Dry Creek and is no longer part of the drainage area upstream of control point *STG_II*.

```
CPTWW217   CB220                       7           GS300      -1
**CPTWW217  STG_II                       7           GS300      -1
```

The following changes were made to the .dis file:

```
FDSTG_II   EP000       1   GS300  WGS800   GS500
FD  S2RF   EP000       1   GS300  WGS800   GS500


**WPSTG_II  865.00                     1.0
WPSTG_II  839.23                     1.0
```

```
WP  S2RF  839.23                     1.0
**WP  S2RF  865.00                     1.0
**
```

Comment out all code associated with Stage 2.

```
**WRSTG_II    7150       119720515   1   1    0.00                       61602095_3 stage_2
**WSSTAGE2   93340
**WRSTG_II   22850       219720515   1   1    0.00                       61602095_4 stage_2
**WSSTAGE2   93340
**WRSTG_II   18122  BAYES119931006   1   1     1.0                           2095_5 stage_2
**PX     3
```

All diversions for the LTYEP occur only in the second simulation. This prevents Lake Texana from filling storage emptied by the new diversions from being refilled at a senior priority date.

Define artificial control point *HOLD* and control point *OCRLOC*. *HOLD* will serve as a place to temporarily hold flows diverted from the Lavaca River, and *OCRLOC* is the location for the off-channel reservoir. Both control points have zero flow. Evaporation is repeated from control point *GS300*. This is the same evaporation used for Lake Texana.

```
CP  HOLD     OUT                       2    ZERO    ZERO
CPOCRLOC     OUT                       2    ZERO   GS300
```

Since the measurement point for environmental flows is upstream, the first step records the available flow at the Lavaca near Edna gage (*GS300*) using a Type 8 WR Record. This will serve as a limit on diversions downstream. It ignores any incremental flow between *GS300* and the diversion point. However, this flow is small and should not make a significant contribution to water supply for the LTYEP.

```
**  See what the available flow is at GS300, Lavaca at Edna
WR GS300               20200000   8                                     ASF_LE  texana   LTYEP
TO     3
```

Fill the channel dam, limited to available flow at *GS300*. The channel dam is assumed to be at the same location as Stage 2. At this time storage and volume curves for the storage is not available, so the generic relationship for smaller storage in the Lavaca WAM is used.

```
WRSTG_II               20200000   1   1                             FillChanDam  texana   LTYEP
WS CHDAM     240    1.00   0.727    0.00
LO    13            SET                                          ASF_LE
PX     2
```

Divert the available flow less channel dam depletions, limited to 200 MGD. Store in artificial control point *HOLD*. Note that stored water in the channel dam is assumed to not be available for diversion. The storage in the channel dam is intended to provide enough head for pumping and is not a source of stored water.

```
WRSTG_II  224200   MONTH20200000   1   1     1.0    HOLD              Divert_LE  texana   LTYEP
LO    13            SET                                          ASF_LE
LO     6            SUB                                     FillChanDam
PX     2
```

Storage in Lake Texana Only (Phase I)

For Phase I, Lake Texana is the only place to use the diverted water. For this step, fill Lake Texana with water from artificial control point *HOLD* and take additional yield from the reservoir.

```
WRDV221A   23500      TA20200000   1                                  LTYEP_tex  texana   LTYEP
WSTEXANA  170300
```

```
SO                          HOLD
PX     2
```

Return unused water to the river.

```
WR  HOLD                20200000   1   1     1.0  STG_II             return_hold  texana   LTYEP
TO     2
PX     2
```

Storage of Water in Off-Channel Reservoir and Lake Texana (Phase II)

In Phase II, diverted water is first used to fill the off-channel reservoir and meet demands there.

```
WROCRLOC   30600      TA20200000   1                                   LTYEP_OCR  texana   LTYEP
WSLAVOCR   50000
SO                          HOLD
PX     2
```

Fill Lake Texana with left over water and back up any shortages at the off-channel reservoir.

```
WRDV221A       0      TA20200000   1                                   LTYEP_tex  texana   LTYEP
WSTEXANA  170300
BU                     LTYEP_OCR
SO                          HOLD
PX     2
```

Finally, return any unused water back to the river.

```
WR  HOLD                20200000   1   1     1.0  STG_II             return_hold  texana   LTYEP
TO     2
PX     2
```

Previously Proposed Modifications

The modifications proposed in 2016 include:

- Changing the storage and area tables (SV and SA Records) to use the original storage characteristics, consistent with the assumptions used in other Full Authorization WAM models. The storage and area tables were obtained from computer runs by the Texas Department of Water Resources (TDWR) associated with the original permit. These runs were found in FNI files from that time. The original Lavaca WAM used the year 2000 survey by the Texas Water Development Board.
- Addition of a primary control point at the mouth of the Lavaca River. This change corrects for flow inconsistencies associated with negative incremental flows downstream of the gaged primary control points.
- Placing Stage 2 at the location authorized in CoA 16-2095. The previous version of the WAM had Stage 2 at a more likely site upstream of the authorized location. However, the water right was never amended to include that location. To be consistent with the water right Stage 2 should be at its originally proposed location.

Lake Texana SV and SA Records

The TDWR SV and SA records are:

```
SVTEXANA       0     480    2950    9190   21420   40060   64210   94790  132820  170300  180840
SATEXANA       0     190     790    1700    3190    4270    5390    6840    8370   10370   10880
```

This change required modifications to the WS Record associated with water right ID *2095_1*. This water right models the non-interruptible portion of Lake Texana, with a maximum storage at elevation 43 feet.

```
WRDV221A   74500      TA19720515   1   1                                 C2095_1 TEXANA1
WSTEXANA  160930
```

DI Records for drought index 3 also needed adjustment to correspond with the changed SV Records.

```
** DROUGHT INDEX RECORDS water rights that have the 43 ft msl restriction.
DI     3   0   1  TEXANA
IS     6       0   10000  100000  160930  160931  170300
IP             0       0       0       0     100     100
```

New Control Point at Mouth of Lavaca River

The original Lavaca WAM uses flows at control point *GS500* (USGS Gage 08164500, Navidad River near Ganado) to estimate flows at control point *EP000*, the mouth of the Lavaca River. As a result, in approximately 26 percent of the months the naturalized flow at the mouth was less than the combined naturalized flow from the upstream primary control points *GS500, GS300* (USGS Gage 08164000, Lavaca River near Edna) and *WGS800* (USGS Gage 08164503, West Mustang Creek near Ganado). Because the naturalized flow calculation for *EP000* is solely based on *GS500*, whenever flow at *GS500* is zero, flow at *EP000* is also modeled as zero even though there are flows shown from the Lavaca River and West Mustang Creek. It does not seem reasonable to assume that these flows are lost prior to entering the bay. These observations indicate that the naturalized flow methodology applied for *EP000* in the existing model is not a reliable approach.

The proposed approach calculated new naturalized flows at *EP000* using the total flow at *GS500, GS300,* and *WGS800* multiplied by the ratio of the drainage areas found in the DIS file (2,322.46 divided by 822.05 + 1058.52+ 167.53 equals 1.134). This is consistent with the method used by WRAP to calculate naturalized flows at secondary control points between primary control points. This is also consistent with a number of other WAMs which have synthetic flows at the outlet point of the model.

The following proposed code changes implement the new naturalized flows at the mouth.

1. A modified CP record changes EP000 from a secondary to a primary control point.

```
CP EP000     OUT                        1           GS300       0
```

2. The following IN records were added to the INF file.

```
IN EP000    1940  2090.7 26948.5  5332.9  3707.4  7929.7 23720.6639742.9  7358.4  4238.2 41153.7728331.6347518.9
IN EP000    1941119749.2 72502.6221902.4269463.5438255.8291206.0139189.6 51369.0 18366.7 67584.4 65360.1 25033.9
IN EP000    1942 10873.5 14823.0 15068.6174049.1 15590.5 13164.0221570.7 14218.5 43974.3 15073.0 25871.1 15765.1
IN EP000    1943 30324.2 10251.7 59369.1  9478.6 30296.5 16451.4 24444.6  9659.1  7135.7  5978.3 50465.5 76706.4
IN EP000    1944192479.2 43633.8307243.9 19213.7178756.1 20630.3 11070.0  7742.1 36672.3  7857.2 33994.9 81711.6
IN EP000    1945 82422.6 27362.0 20095.6210268.9 11194.8 15455.9  9637.9 43345.7 12651.5 16381.5  5450.9 17978.3
IN EP000    1946 48893.2115426.4 69399.5 28169.3 71036.8234881.2 34622.0 88200.0226323.3184951.0145143.6 32193.2
IN EP000    1947154774.4 16801.3 38700.4 26285.7110784.0  8516.0  9493.2  8734.9  7708.8  3264.7  8773.4 19871.8
IN EP000    1948 24928.4 55144.5 45498.8  9122.1151905.6  6450.6 12879.7   803.1  9609.7  2468.3  4834.1  2689.3
IN EP000    1949  5213.7 53345.4 28429.2218539.8 29374.6  6545.3 17822.1 15598.8 11826.1191600.5 11652.3105499.5
IN EP000    1950 45526.4 34829.1  7269.0 27761.3 11201.0 75919.3  6830.1   342.3  8421.1  2466.8  2947.3  2123.8
IN EP000    1951  1693.2  2992.1  6635.2  4229.2  3836.5 86156.3  2251.9     0.0 36705.4  9784.6  4859.0  2814.3
IN EP000    1952  1272.4 10829.9  5277.3 88717.3219581.3 33196.6  4978.0  1466.3  7287.6  1879.6 52075.0 87359.8
IN EP000    1953 12117.8 13125.6  5145.4  6476.6161518.8  2339.5  6572.5 53183.7 75035.9  5872.3  5267.8  7810.6
IN EP000    1954  1952.6  2317.7  1726.7  7664.9 12569.4   261.3  1796.8   206.7  1351.5  2709.7  2318.0   696.7
```

```
IN EP000    1955  1514.7103160.7  1690.8  5037.7 99206.5 19019.4  2756.9 15006.1 20370.2 14653.6  2335.8   887.7
IN EP000    1956   872.8  8022.8   640.3  2882.3  2916.2     0.0  3186.9     0.0    73.4   765.9  2341.3  6614.9
IN EP000    1957     0.9 14443.7122317.2250494.9140918.8126944.7  3055.9   171.3 45338.0358842.1207530.9 19566.8
IN EP000    1958135682.4188849.9 23429.6 12069.5 68970.9  2500.0 20515.6  1000.7 70343.1 38097.8 21122.1 42542.4
IN EP000    1959 22238.7238171.0 17788.6305689.5 61885.7 76755.8 11524.5 22639.8 18217.5 92510.7 66779.8 65386.0
IN EP000    1960 59319.2 65915.7 16462.4 27904.0 38350.7349034.7 60992.7138141.0 22064.1482953.4181637.3132192.7
IN EP000    1961198123.5292766.8 27028.5 18377.4 15580.0285187.3126135.2 11538.7464724.2 21677.3160588.1 17203.4
IN EP000    1962 15002.3 16393.5 11177.0 90558.7 21379.0 43665.1 18479.3  1535.0 27730.0  8287.5  5637.8 19793.0
IN EP000    1963 26036.7 43530.2  6719.4  4849.4  8537.3  6686.5 27990.2   402.1  1914.7  2698.9 11397.9 20413.1
IN EP000    1964  5777.1 26369.1 18700.1  8928.6  5252.2 53428.0  6460.8  2753.1 48196.4 13189.9  6901.4  2766.0
IN EP000    1965 90378.1123659.3 10040.4 11646.4315458.4 98309.8 11985.0  2479.3 11670.5 26637.4171274.1 61713.6
IN EP000    1966 37240.7 72822.2 38400.9111372.3193786.9 43374.0 23390.3 17586.8 13956.1  8786.1  4237.3  3521.2
IN EP000    1967  4355.9  3486.5  3476.6 14801.6 11547.7  1248.3  4021.8 19288.6394597.4143305.0 13450.2  6288.0
IN EP000    1968305217.7 29962.2 29329.6 36123.0255916.9518567.1 59057.9  8982.4 29754.6 22864.0 18104.6 54656.8
IN EP000    1969 31532.4222380.2146490.6224752.8269762.7 17396.5  6318.4  2849.1 17209.1 26800.1 16911.4 58847.9
IN EP000    1970 58130.4 10424.1109639.7 18254.2246297.4 70845.1 19730.1  4315.2107681.7126512.2 10030.1  5474.8
IN EP000    1971  4215.4  6386.1  4739.3  7928.5  8050.4  6141.6  4443.0 93715.6243004.1103831.3 11636.5116313.2
IN EP000    1972 65627.5107044.4 36413.9 11194.7546948.0 79854.1 32928.9 19686.1 15013.3 10059.1 10215.5  5319.6
IN EP000    1973 19070.7 40148.1209229.9478659.4 92606.4965679.3 72542.7 41403.8130105.4300523.6 51277.0 23646.9
IN EP000    1974245445.4 36674.6 22707.2 34417.9110405.7126901.7 14974.3 23001.3407122.6 34066.7169927.2 65183.6
IN EP000    1975 36303.3 28911.2 13747.2 90101.3326517.0124750.9 80591.8 26107.5 26662.0 17822.1  9016.7 61034.4
IN EP000    1976  7298.4  6679.1  7103.1 81499.4128432.6 76227.6 66206.3  3237.2  9048.0113943.6 61646.5409538.6
IN EP000    1977 58199.4179226.4 22486.5197443.5 33108.4 74756.9 17937.5  2904.3  6001.7  6004.2 38806.0  5296.4
IN EP000    1978 73279.9 46725.7 12182.9 37054.7  2787.8 39600.0 15851.0  1189.7504590.6 22795.3 33865.3 16854.2
IN EP000    1979328344.8154065.5 78472.6222374.2379935.2155362.5 36208.6  8068.9270814.4  6017.8  8093.1 11959.2
IN EP000    1980214429.4 37071.7 11002.6 10382.5154725.0  7463.9 13796.8  2121.1  9100.2 33266.1  5917.1  8184.3
IN EP000    1981  9053.4  6998.0 11409.7 35901.3 68242.0416622.0 76587.9 58141.3476075.5 81384.2347454.1 26581.1
IN EP000    1982  9603.4 82802.1 25832.0 27558.2520352.9 19251.3 20748.4  1958.7  7943.3 12730.0192815.5 16414.4
IN EP000    1983 73316.0205624.4185353.8 34821.1 62308.9 16195.3111186.2 13388.4130033.5179570.7116676.8  7270.5
IN EP000    1984 73694.9 28969.0 22098.1 16338.4 13780.0 14631.0 20879.0  4491.0  1289.5209596.7 20092.9 15504.7
IN EP000    1985 97135.0 62613.3199652.5311015.9 43615.0 22521.4 38716.4 11019.5 16835.8 34831.3234181.9 53999.4
IN EP000    1986  5231.9  7476.6  2692.6 11351.7 13537.6222155.7 18822.5  6647.8 20944.3 46198.1 35759.8205256.1
IN EP000    1987 62688.7147733.4 46920.7 16782.0 70739.9641075.9 54200.7  9430.1  5010.2  1650.7 92411.3 88231.4
IN EP000    1988 10869.3  2616.8 23180.7 24584.8 18234.0 13524.9 23770.9  7784.3    95.3 14043.5  1834.1 12217.9
IN EP000    1989111586.8 17773.5 12246.6  5264.7130619.7 14957.8  7438.9  2644.6     0.0  4063.1  5210.9   361.1
IN EP000    1990  3278.0 31669.1 65935.9 51452.6 33591.2    26.9 25582.4  3156.9 13740.7 11035.7  1594.6    22.5
IN EP000    1991171119.6 61208.7 16555.0302089.4 34939.3 37368.7 48253.2  8537.6 33876.8  2490.7  6802.8376359.2
IN EP000    1992334581.3883200.3133695.2419298.4456711.8246171.7 31863.9  9491.1  9644.1  8018.2 68756.1 61189.6
IN EP000    1993 80669.9124668.1125973.9110964.4451581.3674427.7 44156.1 21405.6  2708.0 29939.2  6379.5 43800.5
IN EP000    1994  9577.9  2141.5 38242.6 40219.6237854.3 73967.3 12097.1 27520.4 20486.4 1147303 14445.0116565.0
IN EP000    1995129152.6  9865.1202807.3 46508.2124490.0 27104.2 48545.2 18165.1 10761.5   686.2 17050.8 66300.2
IN EP000    1996  8009.8  3691.9 10633.4  9639.6 13425.4 68185.9 17246.4 15949.2 99096.7  1835.9 15087.5 19054.0
```

3. The following records were changed in the DIS file.

On Lavaca:

```
FD 20955   EP000        1   GS300  WGS800   GS500
FD CB220   EP000        1   GS300  WGS800   GS500
FD DV211   EP000        1   GS300  WGS800   GS500
FD DV212   EP000        1   GS300  WGS800   GS500
FD DV213   EP000        1   GS300  WGS800   GS500
FD DV214   EP000        1   GS300  WGS800   GS500
FD DV215   EP000        1   GS300  WGS800   GS500
FD DV216   EP000        1   GS300  WGS800   GS500
FD WQ002   EP000        1   GS300  WGS800   GS500
```

On Navidad:

```
FD CB230   EP000        2  WGS800   GS500   GS300
FDDV221A   EP000        2  WGS800   GS500   GS300
FDDV221B   EP000        2  WGS800   GS500   GS300
FDRSRTRN   EP000        2  WGS800   GS500   GS300
FD WQ004   EP000        2  WGS800   GS500   GS300
```

Below confluence of Lavaca and Navidad:

```
FD CB210   EP000       3   GS300  WGS800   GS500
FD DV201   EP000       3   GS300  WGS800   GS500
FD GS100   EP000       3   GS300  WGS800   GS500
FD GS200   EP000       3   GS300  WGS800   GS500
FD WQ001   EP000       3   GS300  WGS800   GS500
FD WQ003   EP000       3   GS300  WGS800   GS500
```

Revisions to Modeling of Lake Texana Interruptible Diversions

The 12,000 acre-feet per year of interruptible supply from Lake Texana consists of three separate authorizations:

- 500 acre-feet per year from the original 75,000 acre-feet per year authorized from Lake Texana in the unamended certificate with a priority date of May 15, 1972. Amendment D changed this supply to interruptible because the implementation of bay and estuary pass-through requirements in Amendment B reduced the firm yield of the reservoir from 79,000 acre-feet per year to 74,500 acre-feet per year. So 500 acre-feet per year of the original authorization was changed to interruptible. It appears that the priority date of this authorization was not changed.
- 4,000 acre-feet per year authorized in Amendment B with a priority date of May 24, 1982. This is the remaining 4,000 acre-feet per year of the 4,500 acre-foot total reduction in firm yield mentioned in the previous bullet. Amendment D makes this interruptible without changing the priority date.
- 7,500 acre-feet per year authorized in Amendment D with a priority date of July 1, 2002.

According to Special Condition 5.B. of Amendment D, the 12,000 acre-feet of the interruptible water can only be diverted when the lake level is above 43 feet. The upper tier of the bay and estuary pass-through requirements must be met at all times for interruptible water to be diverted, as specified in Bay and Estuary Release Schedule 4.A.1 of Amendment B and repeated in Special Condition 5.A. of Amendment D.

In the current TCEQ WAM, the interruptible authorization is modeled as a single 12,000 acre-feet per year diverted at a July 2, 2002 priority date. The reason for the change in the priority date of the authorization is not documented, but it may be due to the implementation of the LNRA Water Management Plan and the 1996 *Compromise Settlement Agreement* between LNRA and upstream water right holders, which is included in the Water Management Plan. The compromise agreement allows upstream diverters to take water when Lake Texana is above 43 feet. Changing the priority date allows the upstream diverters to take water when Texana is above 43 feet but below 170,300 acre-feet. The proposed modifications to the interruptible code split out the three authorizations so that their origin can be clearly linked to the water rights. The junior priority date of all authorizations has been maintained, but it has been changed to the July 1, 2002 date found in Amendment D.

Two other revisions have been proposed for the interruptible modeling. The first uses the annual diversion limit in Field 10 of the SO Record to limit annual diversions rather than diverting more water than needed to a dummy control point and returning unused water to the reservoir. The annual diversion limit option was not available when the Lavaca WAM was developed. The proposed technique is simpler and more robust than the previous version. The second change uses a pattern that allows more water to be diverted in the last three months of the year if interruptible targets have not been met earlier in the year. The annual limits on the SO record prevent over-use of water.

Like the previous modeling, the 43-foot limit is established by making storage below 43 feet inactive (Field 7 of the WS Record) and bay and estuary limits are implemented using a drought index tied to 78.18 percent of the storage in Lake Texana.

The following changes were made to the model code:

1. A new UC record was added to set monthly interruptible diversion targets. A monthly limit of 2,880 ac-ft has been retained from the old model for the first nine months of the year. This has been increased for the last three months so that the full amount of interruptible water may be diverted if it was not available earlier in the year.

```
UC  INTW     288     288     288     288     288     288
UC           288     288     288     480     480     480
```

2. The 500 ac-ft/yr of interruptible water originating from firm authorization in the original permit is modeled using the following code. Please note that a separate water right record that fills Lake Texana at the 2002 priority date has been commented out because the proposed revisions no longer rely on diverting more water from the reservoir than is needed to meet interruptible targets. The annual diversion target is set to divert 120 ac-ft/month during the first nine months of the year and 200 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 500 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero target to zero.

```
**   500 ac-ft at from original authorization, set to 2002 priority to reflect subordination
**
WRDV221A    1680    INTW20020701   1   1     1.0    NOUT       2      72_INTERUP         TEXANA
WSTEXANA  170300                          160930
SO                                                                   500
PX     3
```

3. The 4,000 ac-ft/yr of interruptible water authorized by Amendment B is modeled using the following code. The annual diversion target is set to divert 960 ac-ft/month during the first nine months of the year and 1,600 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 4,000 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero.

```
**  4,000 ac-ft from 1982 authorization, set to 2002 priority to reflect subordination
**
WRDV221A   13440    INTW20020701   1   1     1.0    NOUT       2      82_INTERUP         TEXANA
WSTEXANA  170300                          160930
SO                                                                  4000
PX     3
```

4. The following code models the 7,500 ac-ft/yr of interruptible water authorized in Amendment D. The annual diversion target is set to divert 1,920 ac-ft/month during the first nine months of the year and 3,200 ac-ft/month in the last three months of the year. Field 10 of the SO record limits annual diversions to 7,500 ac-ft/yr. The 160,930 ac-ft limit in the WS record prevents the reservoir from

dropping below 43 ft msl because of this diversion. If Lake Texana is below 78.18 percent, the reference to Drought Index 2 on the WR record sets the diversion target to zero.

```
**  7,500 ac-ft from Amendment D.
**
WRDV221A   26880    INTW20020701   1   1     1.0    NOUT       2      02_INTERUP          TEXANA
WSTEXANA  170300                          160930
SO                                                                  7500
PX     3
```

Revisions to Stage 2 Location and SVSA Records

In the existing Lavaca WAM, Stage 2 of the Palmetto Bend project does not appear to be modeled at the location or capacity authorized in COA 16-2095, as amended. The location description in the permit states that "Station 129+60 on the centerline, being a point common to the Stage 1 and Stage 2 Dams, bears N 71°27'W, 3333 feet from the northwest corner of the Stephen F. Austin Survey, Abstract No. 5, Jackson Co. Texas." This point is at the tip of the blue arrow in **Figure A-1**, approximately where the proposed Stage 2 dam intersects the existing Stage 1 dam. **Figure A-1** also shows the proposed location of the Stage 2 dam from the 1963 report *Plan of Development for Palmetto Bend Project Texas*. The existing WAM has Stage 2 modeled at control point WQ002, also shown on **Figure A-1**, which is upstream of the location described in the permit. COA 16-2095A authorizes the storage of 93,340 ac-ft in Stage 2. In the existing WAM, the storage for the project is 62,454 ac-ft. The storage in the existing WAM appears to be the location and storage for an alternative version of Stage 2 described in the 1991 report *Cost Update for Palmetto Bend Stage 2 and Yield Enhancement Alternative for Lake Texana and Palmetto Bend Stage 2*. FNI was unable to find any indication that the permit was amended to reflect either the upstream location or the reduced storage.

In order to model Stage 2 as described and authorized in COA 16-2095, FNI proposes:

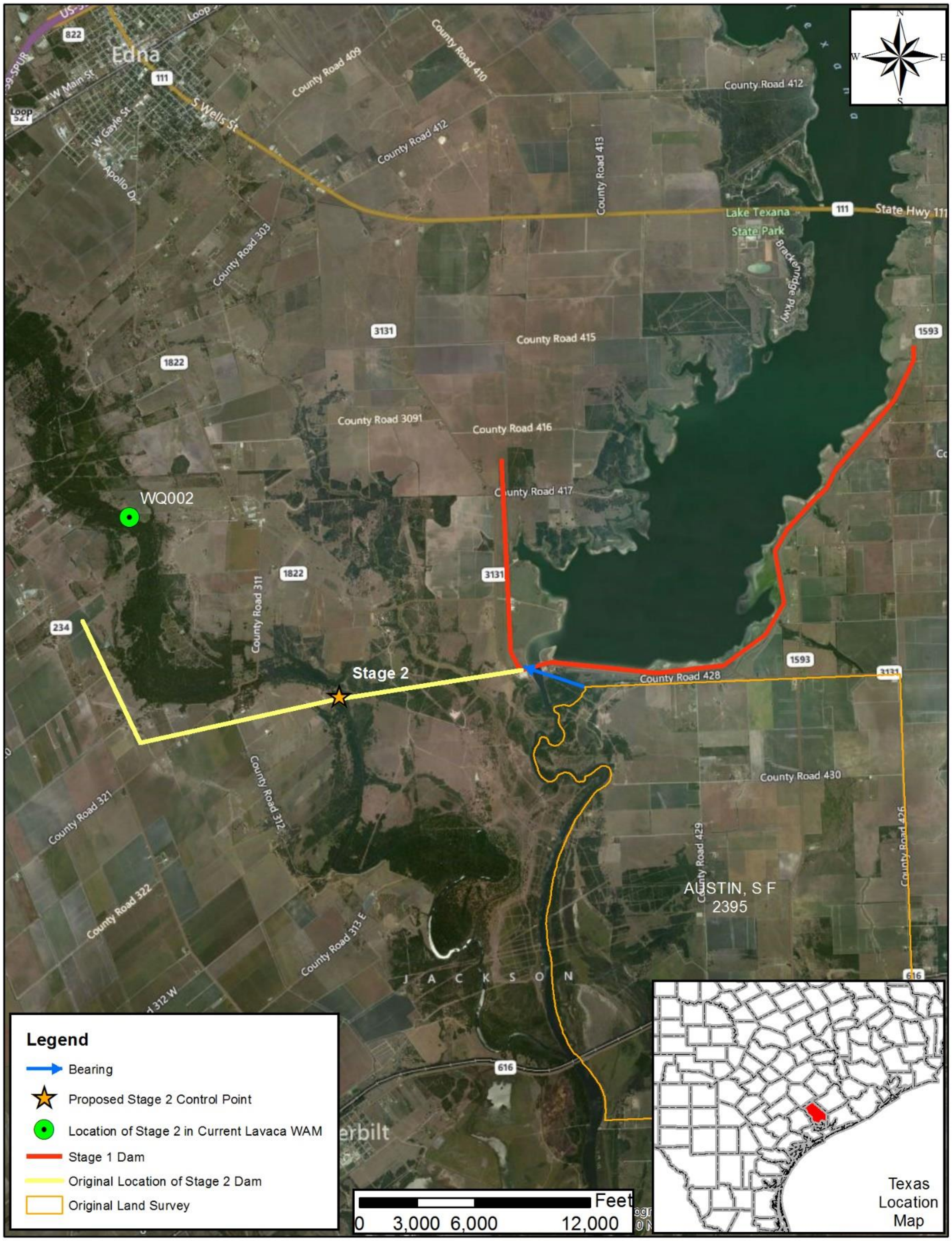
- Adding a new control point STG_II where the dam described in the 1963 Report intersects the Lavaca River
- Moving the location of the dam to the new control point
- Using the storage-area relationship found in the 1963 Report.

The Stage 2 dam, as proposed in the 1963 Report, would also impound water flowing down Dry Creek, a tributary located between the Lavaca and Navidad Rivers. The dam is upstream of the confluence of Dry Creek and the Navidad River, cutting off a portion of the Dry Creek drainage area. The drainage area for the new control point STG_II includes the portion of the Dry Creek drainage area above the dam.

FNI estimated the drainage area of control point STG_II to be 865 square miles based on the incremental drainage area between control point DV211 and the dam (including the Dry Creek drainage area above the dam). This is less than the 929 square miles in the 1963 Report. The 1963 Report also has a drainage area of 887 square miles for the Lavaca River near Edna, TX (USGS Gage 08164000). This was the gage drainage area reported by the USGS at the time. The USGS subsequently revised the gage drainage area to 817 square miles. The Lavaca WAM has a drainage area of 822.0499 square miles for the Edna gage (control point GS300). Applying the delta between the Lavaca WAM drainage area for GS300 (822 square miles) and the Edna gage drainage area in the 1963 Report (887 square miles) to the Stage 2 drainage area in the 1963

Report (929 square miles) results in a drainage area of 864 square miles; this is very close to the recommended drainage area of 865 square miles.

Figure A-1: Model Stage 2 Reservoir Location



In order to implement the proposed changes, the following revisions were made to the model:

1. A new control point (STG_II) was added to the DAT file.

```
**  FNI change - add new control point for Stage 2 authorized location
**CP DV211   CB220                       7           GS300      -2
CP DV211  STG_II                       7           GS300      -2
CPSTG_II   CB220                       7           GS300      -2
**  FNI change - this control point is above Stage 2 authorized location
**CPTWW217   CB220                       7           GS300      -1
CPTWW217  STG_II                       7           GS300      -1
**  end FNI change
```

2. Associated revisions were also made to the DIS file. Note that this code assumes a primary control point at EP000.

```
** new control point STG_II for authorized location
FDSTG_II   EP000       1   GS300  WGS800   GS500

**  FNI change - new control point at authorized location for Stage 2
WPSTG_II  865.00                     1.0
```

3. Modeling of diversion and storage was revised. The only changes to the existing code for these records are the control point and the storage amount.

```
**  FNI change - move to authorized location at new control point STG_II and store full amount
authorized in water right
**
WRSTG_II    7150       119720515   1   1    0.00                      61602095_3 TEXANA2
WSSTAGE2   93340
**
WRSTG_II   22850       219720515   1   1    0.00                      61602095_4 TEXANA2
WSSTAGE2   93340
**
WRSTG_II   18122  BAYES119931006   1   1     1.0   20955                  2095_5
**
```

New SV and SA records for the downstream location from the 1963 Report were added.

```
**  FNI change
**  Stage 2 SVSA from 1963 Definite Plan Report Palmetto Bend Project Texas
**  elev       0       5      10      15      20      25      30      35      40      44      47
50
SVSTAGE2       0     133     563    1388    4168   11301   24320   43358   68338   93344  116279
147046
SASTAGE2       0      53     119     211     901    1952    3256    4359    5633    6870    8420
11234
**
```

Table B-1: Modeled Bay Inflows from Garcitas Creek
(values in acre-feet per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1940	824	5,630	851	560	1,445	3,598	85,166	1,455	740	7,378	88,158	42,020	237,826
1941	17,460	11,366	35,582	32,346	91,565	61,381	31,112	5,011	2,245	6,545	6,293	3,841	304,748
1942	2,384	2,745	2,010	23,411	2,949	2,292	37,553	1,475	7,170	4,795	2,235	3,198	92,216
1943	3,077	2,321	5,510	1,446	3,723	4,677	199	1,372	886	3,526	3,414	9,434	39,586
1944	19,558	5,558	34,575	3,204	26,815	4,663	0	1,227	5,285	3,710	2,606	5,424	112,625
1945	10,695	3,530	3,359	15,644	1,937	4,572	0	1,065	387	3,872	505	2,292	47,858
1946	2,675	12,363	6,423	2,639	5,402	25,104	4,670	18,516	41,671	35,228	16,992	5,776	177,460
1947	18,246	3,727	5,442	4,204	19,080	2,741	0	635	391	3,298	879	2,583	61,225
1948	2,031	5,144	4,082	1,014	38,989	2,805	0	240	436	3,143	309	1,870	60,064
1949	1,357	4,993	1,853	26,592	5,021	2,498	185	2,143	835	11,712	943	12,205	70,338
1950	3,574	3,357	1,106	2,723	2,641	4,615	0	101	120	2,998	100	1,741	23,076
1951	726	1,324	468	349	495	10,062	0	0	3,559	3,541	313	1,815	22,651
1952	617	1,788	587	5,925	42,463	6,558	0	440	372	2,974	7,339	10,846	79,908
1953	1,711	2,248	813	1,194	22,255	1,487	0	5,856	2,797	3,468	414	1,875	44,117
1954	761	1,219	270	2,060	2,321	876	0	61	129	2,912	0	1,478	12,088
1955	578	15,717	363	743	22,659	3,883	0	3,782	1,043	2,990	10	1,588	53,357
1956	460	1,343	122	62	384	718	0	0	0	2,896	0	2,262	8,247
1957	303	2,802	11,805	36,346	14,928	9,696	0	50	4,260	46,452	29,699	4,381	160,723
1958	19,135	27,984	4,357	1,823	12,507	1,587	0	299	9,868	8,113	1,660	4,297	91,630
1959	1,998	27,581	2,726	33,867	11,030	4,769	0	1,732	1,842	8,928	5,955	5,597	106,025
1960	5,558	6,166	2,127	2,806	2,826	32,797	11,375	16,500	1,939	85,968	21,834	15,894	205,791
1961	27,111	27,109	4,272	2,811	3,081	41,255	21,112	2,023	53,173	6,472	28,128	4,516	221,063
1962	3,002	3,107	1,873	15,784	3,186	7,625	843	460	3,865	4,218	861	2,930	47,755
1963	2,639	8,166	1,260	696	1,075	1,531	3,572	119	106	2,995	450	2,411	25,022
1964	1,325	2,637	2,307	1,791	1,083	9,263	0	594	4,874	3,814	221	1,829	29,738
1965	17,069	23,863	2,142	1,714	53,166	20,770	0	744	460	4,872	20,973	8,236	154,009
1966	3,772	7,517	3,935	14,804	23,951	4,815	1,451	1,067	841	3,310	430	2,000	67,894
1967	995	1,402	663	1,803	1,319	1,027	0	406	48,334	22,113	2,106	2,591	82,759
1968	28,417	4,540	4,318	5,452	44,596	58,340	9,820	1,503	2,747	3,905	1,185	6,378	171,202
1969	3,482	26,693	19,042	35,785	46,711	3,976	0	855	1,264	5,692	1,599	8,684	153,782
1970	7,905	2,572	9,639	1,951	40,993	13,491	203	0	10,580	3,798	183	165	91,480
1971	163	82	175	191	47	5,188	1,076	1,715	53,829	36,219	2,524	11,550	112,759
1972	15,451	5,121	419	202	68,574	1,050	5,167	8,743	627	523	893	319	107,087
1973	2,453	12,583	5,433	48,167	1,951	79,098	1,081	1,043	12,309	39,243	1,597	904	205,862
1974	6,858	1,196	846	394	33,948	21,554	967	1,146	20,027	919	14,364	8,026	110,245
1975	3,234	719	531	329	33,131	10,211	3,277	777	1,851	636	500	49,659	104,855
1976	1,680	539	700	28,211	39,129	2,838	6,682	480	9,638	31,593	17,130	62,326	200,946
1977	9,874	23,464	1,854	4,837	1,067	36,030	961	554	1,155	2,705	3,556	853	86,911
1978	5,201	11,282	658	3,227	735	12,935	177	86	180,536	1,590	1,926	865	219,217
1979	47,195	22,355	2,146	14,666	118,651	24,595	8,647	1,060	77,100	2,507	1,022	908	320,852

Table B-1 (continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	29,899	4,295	1,073	747	72,229	1,022	74	24	1,433	1,813	278	199	113,088
1981	505	301	320	329	13,400	169,853	7,012	633	537	4,707	16,035	659	214,290
1982	515	18,070	2,496	2,371	112,935	1,573	244	0	199	4,446	66,627	5,627	215,103
1983	2,444	25,067	15,522	1,084	782	207	50,676	4,060	5,641	37,991	12,027	1,082	156,582
1984	12,745	4,205	970	527	975	182	25	138	249	8,210	2,570	2,194	32,988
1985	12,461	5,742	47,916	65,130	2,995	2,459	6,950	474	353	1,473	1,316	1,498	148,768
1986	1,004	448	342	328	2,307	18,510	226	0	232	4,224	1,771	37,254	66,646
1987	11,388	21,957	4,133	502	2,529	166,884	4,365	606	1,070	576	17,435	5,472	236,919
1988	1,417	626	568	743	607	29	67	0	0	57	53	121	4,289
1989	4,711	1,890	150	120	8	0	50	0	0	5	2	6	6,943
1990	8	29	1,723	3,650	327	0	28,635	699	1,054	64	45	17	36,252
1991	16,208	14,135	3,530	150,328	1,904	573	9,622	703	3,910	935	1,285	45,556	248,690
1992	52,136	123,417	4,021	84,023	68,135	20,084	962	497	594	234	2,535	1,494	358,132
1993	8,446	14,693	37,944	7,536	94,839	155,426	2,478	315	254	340	495	419	323,183
1994	719	595	12,703	812	35,531	1,628	212	596	6,861	164,343	1,588	7,740	233,326
1995	13,093	623	13,463	1,526	1,390	2,683	174	256	620	108	1,663	3,447	39,047
1996	535	177	118	64	5	7,959	304	3,317	19,960	368	172	272	33,251