Franklin County Water District
Development of Alternatives to Restore Downstream Slope, Franklin County Dam

PRELIMINARY ENGINEERING REPORT

FINAL | February 2020

In Association With:

TBPE No. F-882

Franklin County Water District
Development of Alternatives to Restore Downstream Slope, Franklin County Dam

Preliminary Engineering Report

FINAL | February 2020

STATE OF TEXAS
PHILIP W. BULLOCK JR.
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PROFESSIONAL ENGINEER

2/21/2020

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Section 1

SUMMARY AND RECOMMENDATIONS

The Franklin County Dam on Lake Cypress Springs has experienced substantial surface and internal erosion on the current 3H:1V downstream slope. Observable erosion features include jugging vertical cavities and horizontal tunnels (both open and collapsed), some which are interconnected. These erosion features are typical of dispersive soils that were most likely used in the construction of the previous dam remediation project completed in 2010. The Texas Commission on Environmental Quality (TCEQ) report from August 2018 requires the Franklin County Water District (FCWD) to address restoration of the downstream slope of the Franklin County Dam.

Carollo engaged Schnabel Engineering, LLC (Schnabel) as a sub consultant for their dam inspection, design, and construction expertise. Schnabel completed a review of available documents and subsequently met with TCEQ Dam Safety personnel to confirm project requirements. Based on all information reviewed and discussions with TCEQ, Schnabel developed conceptual design alternatives to address issues with the downstream slope. During this evaluation, Schnabel identified potential evidence of issues with the dam structure that could be contributing to the observed erosion. However, additional data needs to be collected to assess these potential issues. A strategic exploration and instrumentation program is recommended prior to proceeding with major restoration of dam to allow for development of a cost-effective solution to provide long-term dam integrity. Without the subsurface exploration and instrumentation program, dam restoration measures would need to be designed to account for a substantial number of unknowns. This conservative approach could result in more costly design and construction efforts than may be necessary to restore the dam. Schnabel has prepared a Preliminary Engineering Report (PER) documenting all of these efforts as attached in *Appendix A: Schnabel Preliminary Engineering Report*.

1.1 Recommended Subsurface Exploration and Instrumentation Program

Below is a summary of the recommended subsurface exploration and instrumentation program. These efforts will generate data and information that will allow the dam restoration alternatives presented below in Section 1.2 to be refined to develop an effective and efficient long-term solution.

- Obtain and review detailed piezometer data and drain flow readings reported as flow rate to improve understanding of the existing dam structure.
- Perform geophysical surveys to determine whether latent erosion features are contributing to the current slope erosion process.
- Install additional piezometers to document the phreatic surface within the embankment and other instrumentation (survey monitoring points and inclinometers) to document structure movement.
- Collect geotechnical data and samples during piezometer installation to further characterize the existing embankment and foundation soils.

- Collect samples from the downstream slope materials for analysis to evaluate the potential for future dispersive soil activity.
- Perform preliminary engineering analyses on all data collected to document stability of the dam and identify potential risk associated with the existing dam structure.

Interim surficial repairs will be performed on the downstream dam slope to facilitate maintenance activities during the data collection and monitoring period.

1.2 Potential Dam Restoration Alternatives

Although the collection of additional data as described in Section 1.1 is recommended prior to proceeding with long-term dam restoration, Schnabel developed general recommendations to address current issues with the previously rehabilitated dam slope, as well as the potential issues identified in this evaluation. These alternatives are preliminary and should not be considered viable for implementation until more detailed studies are completed and design drawings and specifications are prepared.

Four alternatives were initially identified for restoration of the Franklin County Dam. Two alternatives were eliminated as they resulted in the unacceptable loss of the existing access road/berm along the top of the riprap wave protection for Lake Bob Sandlin. Schnabel developed conceptual designs for the two remaining options:

- Option 1 – Removal of only dispersive material from the downstream slope, leaving some of the material from the 2010 downstream slope modifications in place, and lime amendment of removed material for replaced on the downstream slope.
- Option 2 – Removal of and replacement of <u>all</u> fill material placed during the 2010 downstream slope modifications with placement of new, non-dispersive borrow material on the downstream slope.

Opinions of probable construction costs (OPCCs) were developed for the two options. These are considered "Order-of-Magnitude" estimates, which have an accuracy of +50 percent to -30 percent. Although Option 1 is less expensive at $2.78 million ($2.78M), there is risk associated with leaving potentially dispersive soils in place without an adequate filter and drainage system upstream to collect and convey seepage water to the downstream toe. Additionally, lime treatment would not be required for Option 2 assuming suitable borrow material can be identified. The OPCC for Option 2 is $3.24M. For either option, an internal drainage system is recommended to improve long-term performance of the dam and address concerns related to the potential for latent defects in the original dam embankment. The OPCC for the drainage system is estimated to be between $0.5M and $1.0M.

If FCWD elects to forego the strategic exploration and instrumentation program and proceed directly to dam restoration, Schnabel recommends Option 2. The cost savings associated with Option 1 do not offset the risk of future issues due to remaining dispersive soils. The total project cost for Option 2 is $5.05M, which includes $3.24M for construction of the dam restoration measures, $1.0M for the drainage system, and $0.81M for professional engineering services and permitting. As a cost savings measure, topsoil and revegetation of the disposal area can be eliminated (Option 2 in the Schnabel PER), reducing the OPCC to $3.08M and professional engineering services and permitting to $0.77M. With $1.0M for the drainage system, total project costs are $4.85M. Schnabel estimates a construction duration of 280 days for this option.

1.3 Recommended Strategic Environmental Plan

Arroyo Environmental Consultants, LLC (Arroyo), also part of the Carollo team, completed an environmental review for the proposed dam restoration measures. Wetland delineation for the areas impacted was completed and Arroyo has developed a recommended environmental strategy for permitting this project. This environmental evaluation and the wetland delineation are included in *Appendix B: Arroyo Environmental Reports*.

Based on Arroyo's environmental evaluation, a Section 404 Permit will be required regardless of the dam restoration alternative selected. Additional efforts including potential additional wetland determination and delineation, a critical habitat survey for threatened and endangered species, and some coordination with the Texas Historical Commission (THC) to address any archeological concerns will be necessary as part of this permitting process. These additional efforts will be defined once the dam restoration design is developed.

Section 2

PROJECT OVERVIEW

2.1 Background

Lake Cypress Springs is a manmade lake located in Franklin County in northeast Texas. It consists of an approximately 75-square mile watershed and a dam. The dam, owned by FCWD, is located on Big Cypress Creek, a tributary of the Cypress Bayou.

The dam is a 5,230-feet long earth-fill embankment with a top crest at an elevation of 395.0 feet above mean sea level (msl), National Geodetic Vertical Datum 29 (NGVD29). To control the release of flows, the dam was constructed with a morning glory-style service spillway located at the south end of the main dam embankment with a spillway elevation of 378.0 feet above msl. The service spillway has a fish screen from 378.0 msl to 384.0 msl, one foot below the emergency spillway elevation of 385.0 msl. The speed at which water flows over the spillway is determined by the water pressure in Lake Cypress Springs and in Lake Bob Sandlin downstream.

To the north of the dam is the emergency spillway, which is a generally flat graded area with a design elevation crest at 385.0 feet msl and a crest length of approximately 1,000 feet. The emergency spillway has never been engaged in the history of the reservoir. The only controlled releases of water are performed with a low-flow 18-inch valve structure that releases water into the bottom of the morning-glory type service spillway, which the FCWD uses to meet obligations with the downstream water-right owners.

Figure 1 below shows a vicinity location of Lake Cypress Springs. Figure 2 shows a schematic diagram of Lake Cypress Springs's spillway, including the lake and conservation pool's elevations, the morning glory spillway, FCWD water customer intake elevations, and Lake Bob Sandlin.

2.2 Purpose of this Report

The Franklin County Dam on Lake Cypress Springs has experienced substantial surface and internal erosion on the current 3H:1V downstream slope. Observable erosion features include jugging vertical cavities and horizontal tunnels (both open and collapsed), some which are interconnected. These erosion features are typical of dispersive soils that were most likely used in the construction of the previous dam remediation project completed in 2010.

The FCWD is now embarking on the restoration of the Franklin County Dam on Lake Cypress Springs. This Preliminary Design Report discusses the project history, documents coordination with TCEQ, provides responses to TCEQ comments, and presents a summary of the archival review. Most importantly, this report describes alternatives developed to address the issues that currently exist with the downstream slope of the embankment, and summarizes the environmental review for the proposed dam restoration measures.

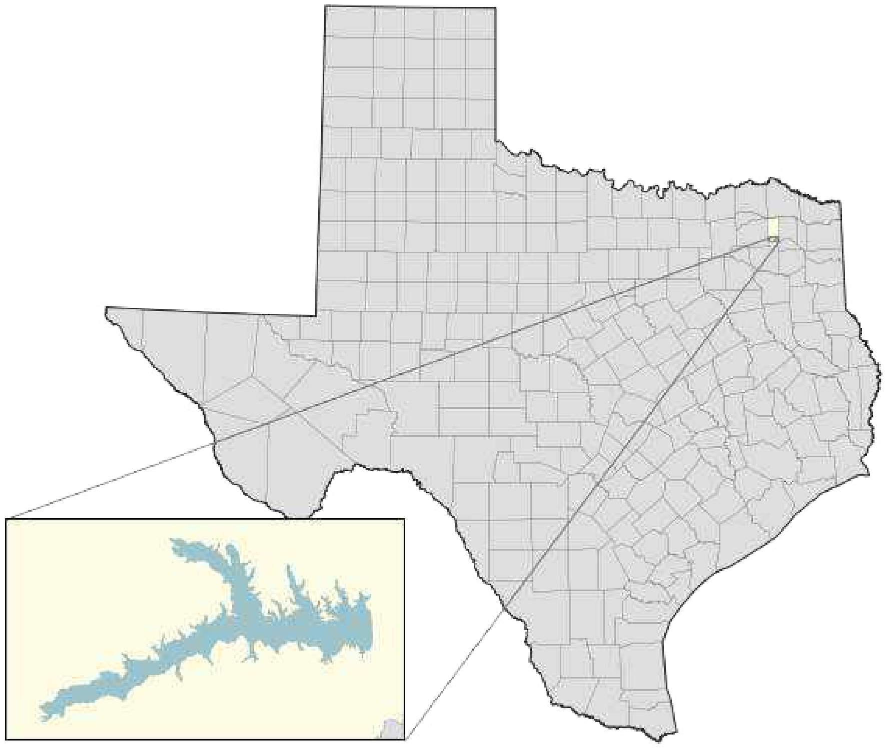

Figure 1 Vicinity Map

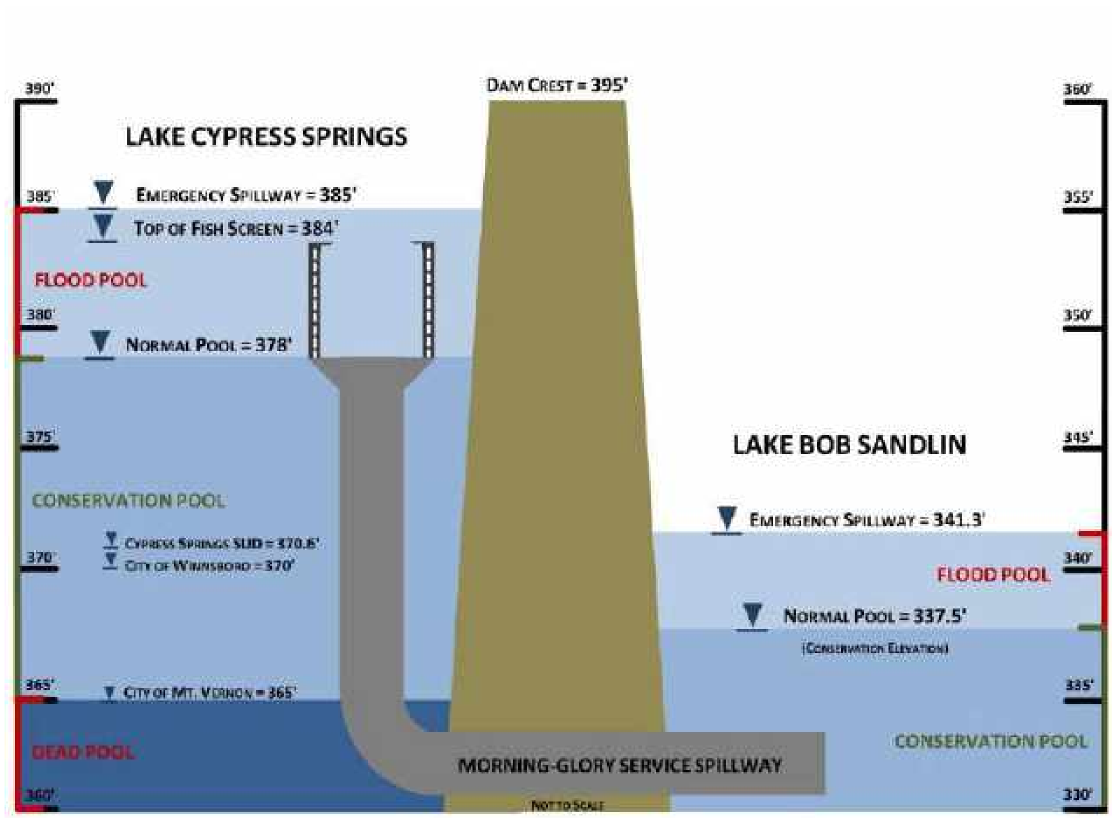

Figure 2 Lake Cypress Springs Dam and Spillway Schematic

Section 3

TCEQ COORDINATION

3.1 TCEQ Meeting - March 11th, 2019

On March 11, 2019, FCWD, Carollo, and Schnabel met with the TCEQ at their Austin offices to discuss the Franklin County Dam Inventory No. TX03288 Dam Safety Inspection and Report dated August 8, 2018. This report is included in *Appendix C: TCEQ Dam Safety Inspection Report - Franklin County Dam*.

The intent of this meeting was to discuss each of the TCEQ's comments (Numbers 1-14) and develop a path forward to restore the Franklin County Dam. Presentation materials developed and presented during this meeting are included in *Appendix D: TCEQ Meeting Presentation*.

Subsequently, Carollo provided the TCEQ with an initial comment response addressing the TCEQ's concerns. This set of comment responses included planned actions to be undertaken by FCWD and was accepted by the TCEQ to represent an appropriate response as included in *Appendix E: Carollo Comment Response 1 TCEQ*.

3.2 Subsequent Comment-Response

As part of this report, Carollo has prepared a subsequent comment-response to provide a second planning-level response to the TCEQ comments. This document can be found in *Appendix F: Carollo Comment Response 2 TCEQ*. Response comments are provided to represent the continued commitment of FCWD to developing a permanent repair plan for the Franklin County Dam's downstream slope. Documentation of the additional analysis to provide responses to Comments numbers 1-4, and 7 is included in the Schnabel PER (*Appendix B*).

Section 4

DAM RESTORATION ALTERNATIVES

4.1 Archival/Document Review and Analysis

Schnabel completed a review of past inspection reports, construction documents, laboratory testing results, surveys, piezometer level and drain discharge data provided by FCWD. The Franklin County Dam has a history of uncontrolled seepage and slope instability, resulting in boils and slides that prompted the construction of a 3H:1V downstream slope to remediate the dam in 2010. Modifications to the drainage system that included the use of a non-woven needle punched geotextile were also constructed at this time to convey collected seepage from the dam drains. TCEQ noted erosion-related issues and evidence of seepage in October 2011. These issues with the new downstream slope have continued to worsen over time.

Previously conducted laboratory testing of soils from the borrow areas used for the 2010 downstream slope modification indicates it is very likely dispersive soils were used. Based on analysis of available documents and data, Schnabel identified potential evidence of issues with the dam structure that could be contributing to the observed erosion. Additional data needs to be collected to assess these potential issues and any impacts on dam integrity.

4.2 Recommended Strategic Exploration and Instrumentation Program

A strategic exploration and instrumentation program is recommended prior to proceeding with major restoration of dam. The additional data needed will be collected and analyzed, allowing for development of a cost-effective solution to provide long-term dam integrity. Without the subsurface exploration and instrumentation program, dam restoration measures would need to be designed to account for a substantial number of unknowns. This conservative approach could result in more costly design and construction efforts than may be necessary to restore the dam.

The strategic exploration and instrumentation program recommendations include:

- Obtain and review detailed piezometer data and drain flow readings reported as flow rate to improve understanding of the existing dam structure.
- Perform geophysical surveys to determine whether latent erosion features are contributing to the current slope erosion process.
- Install additional piezometers to document the phreatic surface within the embankment and other instrumentation (survey monitoring points and inclinometers) to document structure movement.
- Collect geotechnical data and samples during piezometer installation to further characterize the existing embankment and foundation soils.
- Collect samples from the downstream slope materials for analysis to evaluate the potential for future dispersive soil activity.
- Perform preliminary engineering analyses on all data collected to document stability of the dam and identify potential risk associated with the existing dam structure.

Interim surficial repairs will be performed on the downstream dam slope to facilitate maintenance activities during the data collection and monitoring period.

4.3 Dam Restoration Alternatives Developed

Although the collection of additional data as described in Section 4.2 is recommended prior to proceeding with long-term dam restoration, Schnabel developed general recommendations to address current issues with the previously rehabilitated dam slope, as well as the potential issues identified in this evaluation. These alternatives are preliminary and should not be considered viable for implementation until more detailed studies are completed and design drawings and specifications are prepared. Four restoration alternatives were developed for the downstream slope of the dam. Two of these alternatives were eliminated from further consideration after an initial review:

- Flatten Downstream Slope to 3.25H:1V with Reduced Excavation.
- Widen Crest of Dam and Cap Downstream Slope with No Excavation.

Both of these alternatives would result in the loss of the existing access road/berm along the top of the riprap wave protection for Lake Bob Sandlin, which was deemed unacceptable.

The two alternatives carried forward for further evaluation are:

- Option 1 – Removal of Dispersive Material from the Surface of the Downstream Slope.
- Option 2 – Removal of All Recent Fill from the Downstream Slope above Berm.

Option 1 involves removal of downstream slope material from the crest of the dam to the downstream access road/berm to a depth of 5 feet across the downstream slope in order to remove the dispersive material. Removed material would be hauled to a staging area near the dam and amended with lime. After placing and compacting the lime-treated material on the downslope, topsoil from the auxiliary spillway would be spread to encourage re-vegetation. Disturbed ground for both the staging area and the auxiliary spillway would also receive topsoil.

Option 2 involves removal and replacement of all fill material above the downstream slope access road/berm. Removed material would be hauled back to the original borrow area near the south end of the embankment structure. New, non-dispersive borrow material from a suitable source would be used to re-flatten the downstream slope of the dam to a 3H:1V slope. Ideally, borrow soils that could be utilized "as-is", and which would not require the lime-treatment process described in Option 1, would be identified. However, if necessary this option could potentially be modified to include lime treatment of removed dispersive soils as necessary to supplement the new, non-dispersive borrow material. Costs presented in Section 3.3 are based upon the use of new non-dispersive new soils with no lime augmentation.

For both of the alternatives, an internal drainage system with a chimney drain, adequate filter, and sufficient outlets is recommended. This system will improve long-term performance of the dam and will address concerns related to the potential for latent defects in the original dam embankment.

4.4 Alternatives Evaluation

Table 1 presents a comparison of Options 1 and 2 for restoration of the downstream slope of the Franklin County Dam.

Table 1 Evaluation of Franklin County Dam Restoration Options 1 and 2

Option 1	Option 2
Pros	
Re-use current material on downstream slope (does not required borrow material)	All dispersive soils removed
Proven method for soil remediation	Lime amendment not required (or minimized)
Lower construction cost	Reduced topsoil depth (6 inches) required
Cons	
Requires lime amendment (potential environmental and social issues)	Requires borrow material
Requires increased topsoil depth (12 inches)	Requires revegetation of borrow area
Risk associated with leaving dispersive soils in place	Higher construction cost

Schnabel developed opinions of probable cost and estimated construction schedules for both alternatives. The construction cost estimates for the alternatives considered are "Order-of-Magnitude" estimates which have a +50 to -30 percent accuracy. Note that the costs do not include the internal drainage system. Additional information will be analyzed during design to define the requirements for this system and develop associated costs. In addition, the presented costs do not include the removal and replacement of the soils below or beneath the downstream berm, as these soils will need to be tested and evaluated during the final design phase.

Option 1 includes the placement of a 12-inch thick layer of topsoil over the lime-treated fill on the downstream slope of the dam, as well as over the lime-treatment staging area. To reduce construction cost, the topsoil depth could be reduced to 6 inches (Option 1A). This issue with reducing topsoil depth is the potential for increased long-term maintenance associated with establishing and preserving adequate vegetative cover.

Option 2 includes placing 6 inches of topsoil over the disposal area, in addition to the downstream slope of the dam and the borrow area. Given the proposed disposal area is currently un-vegetated, topsoil placement and revegetation could be eliminated (Option 2A) as a cost savings measure.

Schnabel's opinions of probable cost and estimated construction schedules are presented in Table 2. For engineering costs associated with additional investigation, design and construction phase services are estimated at 25 percent of the construction cost. It is very difficult to accurately estimate engineering services until a detailed scope of work is established.

Table 2 Evaluation of Franklin County Dam Restoration Options 1 and 2

Alternative	Opinion of Probable Construction Cost	Engineering Cost	Estimated Construction Duration (Days)
Option 1	$2.78 M	$0.70M	270
Option 1A	$2.65 M	$0.66M	250
Option 2	$3.24 M	$0.81M	280
Option 2A	$3.08 M	$0.77M	260

4.5 Recommended Alternative

If FCWD elects to forego the strategic exploration and instrumentation program and proceed directly to dam restoration, Schnabel recommends FCWD proceed with Option 2. Although Option 1 is less expensive, there is risk associated with leaving potentially dispersive soils in place without an adequate filter and drainage system upstream to collect and convey seepage water to the downstream toe. To reduce construction costs, FCWD can eliminate topsoil and revegetation of the disposal area, given this area is currently not vegetated.

OPCCs were developed for the two options. These are considered "Order-of-Magnitude" estimates, which have an accuracy of +50 percent to -30 percent. Although Option 1 is less expensive at $2.78 million ($2.78M), there is risk associated with leaving potentially dispersive soils in place without an adequate filter and drainage system upstream to collect and convey seepage water to the downstream toe. Additionally, lime treatment would not be required for Option 2 assuming suitable borrow material can be identified. The OPCC for Option 2 is $3.24M. For either option, an internal drainage system is recommended to improve long-term performance of the dam and address concerns related to the potential for latent defects in the original dam embankment. The OPCC for the drainage system is estimated to be between $0.5M and $1.0M.

If FCWD elected to forego the strategic exploration and instrumentation program and proceed directly to dam restoration, Schnabel recommends Option 2. The cost savings associated with Option 1 do not offset the risk of future issues due to remaining dispersive soils. The total project cost for Option 2 is $5.05M, which includes $3.24M for construction of the dam restoration measures, $1.0M for the drainage system, and $0.81M for professional engineering services and permitting. As a cost savings measure, topsoil and revegetation of the disposal area can be eliminated (Option 2 in the Schnabel PER), reducing the OPCC to $3.08M and professional engineering services and permitting to $0.77M. With $1.0M for the drainage system, total project costs are $4.85M. Schnabel estimates a construction duration of 280 days for this option.

Section 5

ENVIRONMENTAL EVALUATION

5.1 Review of Potential Environmental Liabilities

Arroyo completed a desktop review of potential environmental liabilities in the proposed project area. This review is summarized below:

- Threatened and Endangered Species – Critical habitat for several state threatened species are likely within the project area and additional impact analysis will be required, including in-depth literature research and development of a site-specific species plan for construction activities.
- Jurisdictional Waters and Adjacent Wetlands – Lake Cypress Springs is considered a jurisdictional water and there are wetland areas within the project area per the National Wetland Inventory (NWI). Emergent wetland vegetation was observed during a 2016 topographic survey conducted by Arroyo and Carollo along the shoreline of the emergency spillway.
- Historical/Archeological Sites – No historically significant sites were identified and additional coordination with the Texas Historical Commission (THC) has been initiated to address any potential archeological concerns for areas not included in the 2008 Texas Antiquities Permit No.4768 Intensive Survey and the Archeological Survey of the Borrow Pits near the Franklin County Dam (AR Consultants, Inc., 2008).

5.2 Permitting Requirements

Arroyo completed a review of potential environmental permitting requirements and performed preliminary coordination with pertinent environmental agency staff. Permits that may be required for this project include:

- Section 401 of the Clean Water Act (CWA).
- Section 404 of the CWA.

Section 401 of the CWA is administered by TCEQ and regulates the water quality resulting from the discharge of fill material to jurisdictional waters and upland disposal sites. TCEQ's 401 Water Quality Certification must be issued to a Section 404 permit to ensure project activities will not impact water quality to jurisdictional waters.

The United States Army Corps of Engineers (USACE) administers Section 404 of the CWA, which regulates the discharge of fill materials into jurisdictional waters of the Unites States and the State of Texas. Environmental reviews and comments from the Environmental Protection Agency (EPA), United States Fish and Wildlife Services (USFWS), TCEQ, Texas Parks and Wildlife Department (TPWD), Texas General Land Office (GLO) and other regional groups are included under Section 404. Types of Section 404 permits include:

- Nationwide Permit for common activities which are minimal in scale and environmental impacts and require up to 90 days to receive;

- Individual Permit – Tier I for projects that do not meet the requirements for a Nationwide Permit and impact less than 3 acres or 1,500 linear stream feet and require 120 days or more to receive; and
- Individual Permit – Tier II for projects that do not meet the requirements for a Nationwide Permit and impact greater than 3 acres or 1,500 linear stream feet and can require several years to receive for a large, complex project.

5.3 Recommended Strategic Environmental Plan

Arroyo developed a strategic environmental plan for the two dam restoration alternatives. Note that the environmental efforts for Options 1A and 2A are identical to those for Options 1 and 2, respectively. Regardless of the alternative ultimately selected, a Section 404 permit will be required if shoreline emergent wetland vegetation and/or open water (Lake Cypress Springs below normal pool) is disturbed along the spillway and the dam. In addition, wetland determination and delineation, a critical habitat survey for threatened and endangered species, and some coordination with the THC to address any archeological concerns will be necessary for both options. Hydrologic conditions will not change as a result of this project as there are no significant modifications to the emergency spillway structure or changes to the current crest elevation of the spillway.

Both options evaluated by Schnabel include modifying the existing emergency spillway, constructing an off-road haul road, and increasing the width of the existing maintenance road along the dam. Option 1 requires a lime-staging area be established. The area originally planned for this area contains upland forest and forested wetland habitat, which would require additional assessment of threatened and endangered species and mitigation for jurisdictional impacts. An alternate area was assessed to reduce the impacts and costs for this option. Option 2 does not require a lime staging area, but does require an upland staging area be established. Environmental impacts are limited to shoreline vegetation along the spillway and dam for Option 2, which significantly reduces costs associated with mitigation and threatened and endangered species surveys. Arroyo identified and delineated 5.1 acres of freshwater emergent wetlands and 0.5 acres of freshwater forested wetlands within the proposed project areas. Most were associated with the shoreline for Lake Cypress Springs and Lake Bob Sandlin.

The required environmental permitting and supporting efforts for both options are presented in Table 3 along with estimated costs. Note that mitigation costs are not included below and will be developed during the design of the selected dam restoration alternative.

Table 3 Recommended Strategic Environmental Plan for Options 1 and 2

Required Environmental Activity	Description	Option 1 Cost	Option 2 Cost
Wetland Determination and Delineation	Conduct following USACE methodologies to evaluate onsite vegetation, soils, and hydrology Produce wetland delineation report to include with Section 404 Permit Application	Complete	Complete
Threatened and Endangered Species Critical Habitat Impact Analysis	Complete critical habitat survey for species identified as threatened and endangered, focusing on terrestrial species only (no impact on open water areas) Supplemental report included with Section 404 Permit Application	$12,500	$7,500
Cultural/Archeological Surveys	Per pre-application conference call with USACE, intensive surveys not requires Coordination with THC to address any potential concerns	$2,000	$2,000
Section 401/404 Permit	Agency and project team coordination, documentation of project activities and environmental findings, development of illustrations, maps and design drawings needed for permit application	$20,000	$20,000
Total		**$34,500**	**$29,500**

Appendix A

SCHNABEL PRELIMINARY ENGINEERING REPORT

PRELIMINARY ENGINEERING REPORT

DEVELOPMENT OF ALTERNATIVES TO RESTORE DOWNSTREAM SLOPE

Franklin County Dam
National Inventory of Dams #TX03288
Franklin County, Texas

Schnabel Reference 19C17022.00
February 12, 2020

Schnabel ENGINEERING

Schnabel
ENGINEERING

February 12, 2020

Phillip W. Bullock, PE
Lead Engineer
Carollo Engineers, Inc.
10375 Richmond Ave., Suite 1625
Houston, Texas 77042

Subject: **Preliminary Engineering Report, Development of Alternatives to Restore Downstream Slope, Franklin County Dam (NID #TX03288), Franklin County, Texas, Schnabel Project No. 19C17022.00 (Carollo Project No. 10070B.oS)**

Dear Mr. Bullock:

SCHNABEL ENGINEERING, LLC (Schnabel) has completed the authorized engineering services related to the development of alternatives to restore/address the erosion and soil dispersion issues associated with the downstream slope of the Franklin County Dam. This report discusses our understanding of the project, presents a summary of the archival review performed by Schnabel, and a description of the alternatives developed to address the issues that currently exist with the downstream slope of the embankment.

The alternatives presented herein, when fully vetted, properly designed, and implemented in accordance with completed construction plans/technical specifications, will improve the condition of the embankment and address ongoing maintenance issues associated with the existing embankment soils. The alternatives are preliminary and should not be considered viable for implementation until more detailed studies are completed and design drawings and specifications are prepared and reviewed by the Texas Dam Safety Program.

We appreciate the opportunity to work with you on this project. Please contact either of the undersigned if you have any questions or comments regarding any aspect of this report, or if we may be of further service.

Sincerely,

SCHNABEL ENGINEERING, LLC

Joseph S. Monroe, PE
Principal

James R. Crowder, PE
Principal
(Registered PE in Texas)

JSM:JRC:CJS:JTC

PRELIMINARY ENGINEERING REPORT
DEVELOPMENT OF ALTERNATIVES TO RESTORE DOWNSTREAM SLOPE
FRANKLIN COUNTY DAM
FRANKLIN COUNTY, TEXAS

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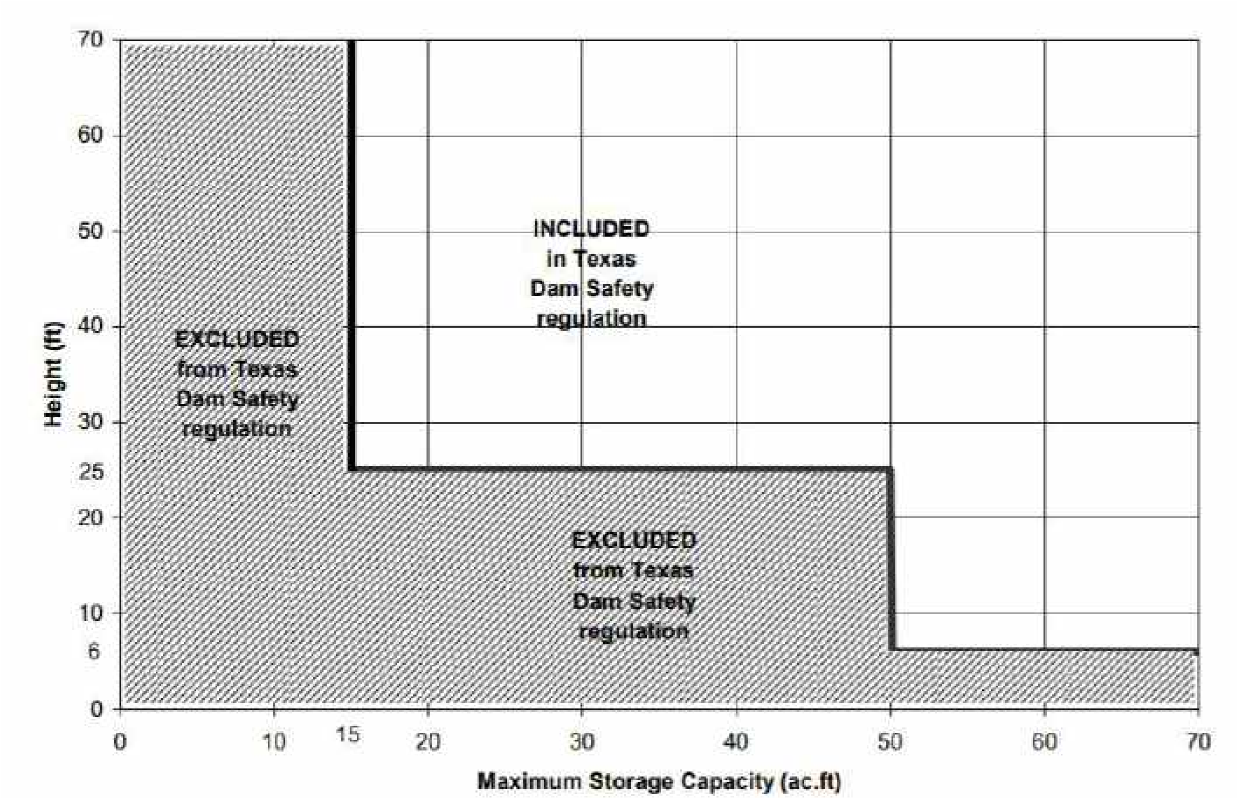
APPENDICES

1.0 TEXAS DAM SAFETY OVERVIEW

The Texas Commission on Environmental Quality (TCEQ) regulates both public and private dams within the state via the Dam Safety Program. Texas Administrative Code Title 30, Part 1, Chapter 299, titled 'Dams and Reservoirs', provides the framework and requirements for structures regulated by the Dam Safety Program. TCEQ regulates dams that have a height equal to, or greater than, 25 feet and a maximum storage capacity of not less than 15-feet acre feet. In addition, TCEQ provides for the regulation of smaller dams (6 feet in height or greater) impounding large storage volumes (50 acre-feet and greater). Figure 1 below summarizes the structures that are regulated by TCEQ based upon height and/or volume.

Figure 1: Texas Dam Safety Regulation



Once a dam has been identified as being tall enough and/or having a maximum storage volume large enough to be regulated by TCEQ, the referenced regulations separate the dams into size categories as shown in Table 1.

Table 1: Texas Dam Size Classification

SIZE CLASSIFICATION		
Category	Impoundment Maximum Storage (Acre-Foot)	Height (Ft.)
Small	Equal to or Greater than 15 and Less than 1,000 Equal to or Greater than 50 and Less than 1,000	Equal to or Greater than 25 and Less than 40 Greater than 6 & Less than 40
Intermediate	Equal to or Greater than 1,000 and Less than 50,000	Equal to or Greater than 40 and Less than 100
Large	Equal to or Greater than 50,000	Equal to or Greater than 100

Additionally, TCEQ classifies dams based upon their hazard potential should the structure fail catastrophically. Summarized below are the three hazard classifications for dams regulated by TCEQ.

- Low hazard potential
  - no loss of human life expected (no permanent habitable structures in the breach inundation area downstream of the dam)
  - minimal economic loss (located primarily in rural areas where failure may damage occasional farm buildings, limited agricultural improvements, and minor highways)
- Significant hazard potential
  - loss of human life possible (one to six lives or one or two habitable structures in the breach inundation area downstream of the dam)
  - appreciable economic loss, located primarily in rural areas where failure may cause damage to isolated homes, damage to secondary highways, damage to minor railroads; or interruption of service or use of public utilities
- High hazard potential
  - loss of life expected (seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam)
  - excessive economic loss, located primarily in or near urban areas where failure would be expected to cause extensive damage to public facilities, agricultural, industrial, or commercial facilities, public utilities, including the design purpose of the utility, main highways or railroads used as a major transportation system.

The minimum design flood hydrograph for dams regulated by TCEQ is established based upon the size and hazard classification of the dam and calculated using the criteria in the most current version of the agency's *Hydrologic and Hydraulic Guidelines for Dams in Texas (Guidelines)*.

Based upon the recorded height of the Franklin County Dam (73 feet) and the maximum potential storage volume of the impounded reservoir (160,000 acre-feet), the subject structure is classified as being 'Large'. The TCEQ, Dam Safety Program currently classifies the dam as a high hazard structure. Therefore, this dam is subject to the requirements in Texas Administrative Code, Chapter 299 and the *Guidelines*.

2.0 PROJECT OVERVIEW

The subject dam is located in Franklin County about ten (10) miles southeast of Mount Vernon, Texas. Texas Farm to Market Road 3007 (a.k.a. FM 3007) traverses the crest of the dam. The dam is owned, operated, and maintained by the Franklin County Water District (FCWD). According to available records, the dam was constructed in 1971 with major modifications being performed on the structure in 2010.

According the National Inventory of Dams (NID) database, which is maintained by the US Army Corps of Engineers, Franklin County Dam is an earthen embankment structure having a maximum height on the order of 73 feet and impounding a reservoir with a maximum storage volume in excess of 160,000 acre-feet.

According to the construction plans for the dam prepared by Wisenbaker, Fix, and Associates (WFA) with a latest revision date of May 1967, the reservoir impounded by the dam, Lake Cypress Springs, has a surface area of about 3,425 acres at the normal operating pool elevation of 378 feet. The upstream slope of the subject dam, which is partially armored by rock rip rap, was designed in 1965 with a general grade of 2.7 horizontal to 1 vertical (2.7H:1V) while the downstream slope was designed with a grade of 2H:1V. Seepage through the dam was designed to be controlled by a “wetted and rolled embankment” containing the “most impervious materials” that initiated at the upstream face of the dam and extended to a 1H:1V downstream slope that began near the center of the crest.

Seepage from the upper levels of the foundation was intended to be controlled by a core trench (keyway) that extended from 5 feet (when the foundation is above normal pool) to more than 40 feet below existing site grades. This core trench was constructed of the same materials as the upstream portion of the embankment. The downstream portion of the embankment is believed to have been designed with sandy earth fill constructed on a drainage blanket that extended from the normal pool elevation of the left abutment to the normal pool elevation of the right abutment. The outlet for the drainage blanket was designed as an 8-inch diameter perforated, corrugated steel pipe surrounded by unfiltered ‘pea gravel’.

The principal and auxiliary spillways for the structure were designed as a vertical ‘morning glory’ drop inlet with a 10-foot by 10-foot low-level box conduit located near the right abutment and an earthen channel located upstream of the left abutment of the dam with a bottom width of 1000 feet. A “Service Outlet” was designed as an 18-inch diameter pre-stressed cylinder pipe, encased in concrete that enters the 10-foot by 10-foot box conduit 65 feet downstream of the centerline of the ‘morning glory’ drop inlet. According the WFA drawings, neither the core trench nor the sand blanket encompassed the principal spillway conduit. The construction of a core and filter drain around conduits through earthen dams provides measures to control seepage along what is typically a preferential seepage path through the embankment.

In 2010, the downstream slope of the embankment was flattened to 3H:1V to address a history of slope issues. In addition, modifications to the drainage system, which included the use of non-woven needle punched geotextile, were constructed as part of the remedial measures to convey collected seepage water from the drains.

Lake Bob Sandlin, which is impounded by Fort Sherman Dam and has a normal operating pool elevation of 337.5 feet, is located immediately downstream of, and inundates, the downstream toe of Franklin County Dam. Given that the floodplain immediately downstream of Franklin County Dam is at, or slightly lower, than elevation 330 feet according to WFA drawings, approximately 7 to 10 feet of the subject dam is inundated by Lake Bob Sandlin.

Major activities associated with the Franklin County Dam are summarized below.

- July 1970 – Deliberate impoundment of Lake Cypress Springs began.
- February 1971 – Franklin County Dam construction project completed.
- July 1972 – Texas Water Development Board (TWDB) observed severe erosion on the downstream slope extending into the crest of the dam. A seepage area nearly 15 feet in diameter was detected immediately south of the service spillway outlet at the toe of the dam.
- 1976 – The dam was inspected four times. A 6-foot by 9-foot sink hole had developed in the previously noted seepage area. Many erosion areas and gullies created by surface erosion were observed along the downstream slope of the dam.
- April 1977 – A TWDB inspection revealed a crucial problem with the operation of the service spillway. Due to a vacuum break occurring in the spillway pipe, a “booming geyser effect” was witnessed at the spillway outlet, spraying water 15 to 20 feet into the air. A slide (55 feet long and 3 to 4 feet deep) occurred near the crest on the south end of the downstream slope. The previously noted seepage area had several small boils and very fine soil was being moved in the seepage waters.
- November 1977 – TWDB recommended an inspection of the service spillway conduit.
- December 1978 – An internal inspection of the spillway conduit revealed that the spillway pipe was in overall good condition, with only minimal leakage and minor spalling noted. Two conduit section joints were observed to have 1-inch drops across the joints. Cavitation in the spillway was provided as a possible explanation for this separation. This explanation was further supported with the observation that the discharge end of the spillway was 3 inches higher than the entrance (also caused by cavitation/vacuum breaking). An extensive, yet unsuccessful, attempt to locate the outlet of the toe drain was made during this inspection.
- July 1978 – A Phase I inspection of the dam determined that the dam was capable of storing and/or discharging runoff from 100% of the Probable Maximum Flood (PMF) with roughly 1.2 feet of freeboard.
- 1978 – Construction of Fort Sherman Dam and impoundment of Lake Bob Sandlin began. During filling, stakeholders determined that Lake Bob Sandlin would inundate the downstream toe and service spillway outlet of Franklin County Dam. This development called into question the effectiveness of the previously un-located toe drain outlet due to the effects of the backwater from a fully impounded Lake Bob Sandlin. The Texas Water Rights Commission (TWRC), a predecessor agency of the TCEQ, recommended that a study be conducted to evaluate the impact that Lake Bob Sandlin would have on the stability of the Franklin County Dam. Full impoundment of Lake Bob Sandlin was delayed until uncertainties could be investigated.
- April 1980 – An inspection documented more small slides on the steep, 2H:1V downstream slope. A boil with suspended fines was identified about 60 feet downstream of the spillway outlet and a hole was found above the “buried spillway pipe” (surmised to be the principal spillway box

conduit). The hole discharged into an underground channel that exited at the spillway outlet-bank line.

- June 1980 – Seven piezometers were installed at the dam in an attempt to better understand the nature of the seepage and boil problems.
- June 1981 – A slope stability evaluation and summary report were completed. Based on the piezometer readings, the drainage blanket of the dam was determined to be working. After review, TDWR stated that the dam was stable and the backwaters of Lake Bob Sandlin would not have an effect on the stability of Franklin County Dam. Report reviews by TDWR and National Soil Service, Inc. determined that the steep downstream slope would still require periodic maintenance to deal with both the slides and expected wave action erosion from Lake Bob Sandlin.
- December 1981 – In consideration of the results of the studies performed earlier in 1981, FCWD began implementation of a design to construct a 3H:1V maintenance berm with a toe drain, a filter, and protective riprap to deal with wave erosion from Lake Bob Sandlin. Ultimately, a plan to flatten the entire downstream slope was not undertaken.
- November 1982 - Remedial work was completed at the seepage area around the spillway outlet, which included installation of a filter over the boil zone, with riprap and bedding, to protect the area encircling the concrete headwall at the spillway outlet.
- November 1985 – TWDB inspection noted deeply incised erosion gullies, erosion tunnels, small sink holes, a superficial slide, and extensive animal burrowing on the downstream slope. Boil activity near the spillway outlet appeared to have subsided considerably. Piezometer measurements, for those that could be located, indicated no changes since the previous 1982 inspection.
- 1990 through 1994 – TWDB inspections revealed that there were sunken/benched areas in the riprap on the upstream slope. The downstream slope was observed to have burrows, erosion gullies, and numerous reoccurring small slides. A significant slide was observed to be 250 feet long with depths ranging from 1 to 8 feet. Piezometer readings taken closely agreed with previous readings. The 1994 inspection report recommended a cost analysis to compare repetitive slope repairs to a permanent slope modification.
- August 1997 – A fish screen was added to the morning glory service spillway drop inlet.
- April 1998 – Six new piezometers were installed.
- May 2002 – The Texas Natural Resource Conservation Commission (TNRCC), another predecessor agency of TCEQ, performed an inspection of the dam. No piezometer readings were taken during this inspection, but FCWD personnel informed the TNRCC that a consulting engineering firm would take measurements and TNRCC would be copied on the results. TCEQ files do not contain records of these measurements. The inspection noted animal burrows and slides on the downstream slope. A wet area was also documented on the south side of the submerged outlet works about 75 feet from the downstream toe.
- September 2005 – TCEQ conducted a dam safety inspection. The downstream slope was determined to be in poor condition, and most of the slope was observed to be between 1H:1V and 1.5H:1V with substantial erosion in several areas. Near the mid-section of the northern half of the dam, a slide (approximately 10 feet wide by 6 feet deep) was observed along the midpoint of the slope. Minor seepage was noted in both the left and right downstream contact points near the toe of the dam. A standing marsh was observed at the north end of the downstream slope. A

seep was also observed at the south end of the downstream area just to the right of the spillway outlet.

- July 2008 – TCEQ approved Freese and Nichols (F&N) construction plans to rehabilitate the downstream slope of the dam.
- April 2010 – Franklin County Dam Rehabilitation Project was completed.
- October 2011 – TCEQ performed a dam safety inspection. The dam was found to be in an overall good condition. Several items of concern were noted including erosion holes and tunnels on the north end of the downstream slope, excessive vegetation on portions of both upstream and downstream slopes, and seepage immediately south of the service spillway's outlet headwall. This inspection was summarized by TCEQ in a letter to FCWD, dated April 12, 2012.
- May 2012 – FCWD responded to TCEQ's inspection letter, noting that the erosion areas may be a small section of dispersive clay and that the holes would be filled with compacted clay by the end of May 2012. In addition, FCWD stated that other areas that may form would be filled at the time they were observed.
- 2013 – More holes and tunnels were observed on the downstream slope. As a result, F&N and several other engineers retained by either F&N or by FCWD issued reports with different opinions regarding causes and repair options. The presence of dispersive soils was the focus of the reports.
- 2014 – A new fence was installed around the service spillway morning glory.
- December 2015 – A large rain event elevated the lake to approximately 6 feet above the crest of the morning glory (normal pool elevation).
- March 2017 – Carollo Engineers, Inc. prepared a Preliminary Engineering Report to determine feasible solutions to curtail negative impacts from flood events similar to the 2015 flood. A number of alternatives were presented.
- February 2018 – Carollo completed a second study focused on the emergency spillway. Four alternatives were evaluated. Carollo recommended that the emergency spillway not be used for agricultural purposes.
- May 2018 –TCEQ staff performed a dam safety inspection and noted that the downstream slope was in poor condition. The primary issues of concern included: numerous holes and tunnels on the downstream slope; toe drain outlets needing to be opened periodically; erosion on the upstream slope, along the downstream berm, and at the downstream groins; vegetation in the upstream slope riprap; cracking and deterioration of the older riprap on the upstream slope; animal burrows and ant mounds on the crest; and seepage at both ends of the downstream slope.

2.1 Archival/Document Review

A number of past inspection reports, construction documents, laboratory testing results, and surveys have been provided to Schnabel by FCWD. A summary of the reviewed documentation/information is provided below:

- Subsurface Investigation, Proposed Dam on Big Cypress Creek (Trinity Testing Laboratories of Austin, c. 1967)
- Stability Evaluation, Franklin County Dam (Mason-Johnston & Associates, 1980)

- Slope Stability Investigation, Franklin County Dam (Woodward-Clyde Consultants, 1981)
- Boundary Survey, Franklin County Dam (Stanger Surveying Mt. Pleasant, LLC, 2008)
- Drone Video and Photographs (July 2017)
- Project Manual, Modification to Franklin County Dam (URS, April 1982)
- Antiquities Permit Application Form, Archeology (AR Consultants, January 2008)
- Archaeological Survey of Borrow Pits, Franklin County Dam (AR Consultants, February 2008)
- Archeology Permit #4768, Texas Antiquities Committee (AR Consultants, January 2008)
- Intake Structure Inspection, Lake Cypress Springs (U.S. Underwater Services, LP, July 2009)
- Borrow Soils Investigation, Lake Cypress Springs (ETTL Engineers & Consultants, June 2018)
- Aerial Photographs (February 2018)
- Construction Plans, Big Cypress Creek Reservoir (WFA, May 1967)
- Specifications & Contract Documents (WFA, 1967)
- Slope Rehabilitation Drawings (Freese & Nichols, June 2008)
- Specifications & Contract Documents (Freese & Nichols, June 2008)
- Phase 1 Inspection Report (US Army Corps of Engineers, 1978)
- Inspection Report, Franklin County Dam (Hayter Engineering, 1997)
- Specifications & Contract Documents, Slope Maintenance for Cypress Springs Dam (NRS Consulting Engineers, August 2003)
- Dam Inspection Reports (TCEQ)
    - October 2005
    - December 2009
    - July 2010
    - April 2012
    - August 2018

As noted in the historical summary presented in the background section above, the embankment has a history of uncontrolled seepage and slope instability. In numerous documents, discussions of boils and slides are noted. These issues were apparently resolved by the construction of a 3H:1V downstream slope. However, shortly after construction of the 2010 remedial measures, issues with the ‘new’ slope manifested. Based upon a review of the historical documentation, provided below is a summary of possible causes of the historic slope issues and recommendations to address deficiencies noted.

2.2 Downstream Slope Erosion

The TCEQ 2018 Dam Inspection Report documented substantial surface and internal erosion of the current 3H:1V downstream slope. Observable erosion features include “jugging” vertical cavities and horizontal tunnels (both open and collapsed), some which are inter-connected. Seepage in the features was not observed at the time of the inspection; however, deposition of sediment at the downstream toe access road is evidence that intermittent movement of water occurs. These erosion features are typical of dispersive soils.

The probability that dispersive soils were utilized in the 2008-2010 downstream slope modification is very likely, based on subsequent laboratory testing of northern and southern borrow area soils by others (i.e. ETTL).

Soil classification tests on samples from the borrow areas and dam borings (both original and subsequent) indicate the regional soils generally may be characterized as silty clayey sand, clayey sand, sandy silt, sandy lean clay, lean clay with sand, and fat clay. Liquid Limit values range from roughly 20 to 70 (median of 40), with Plasticity Index values ranging from roughly 5 to 48 (median of 23). The percentage passing the No. 200 sieve ranges from roughly 15 to 100 percent (median of 69).

The original dam was constructed such that the “most impervious materials” were placed in the upstream portion of the embankment and central core, and sandy materials were utilized for downstream portions of the embankment. The 2008-2010 downstream slope modification involved flattening the original 2H:1V slope to a 3H:1V slope using “random earthfill”. Documents for the original construction and modification do not indicate the presence of a chimney drain between the “most impervious materials” and sandy fill material in the original dam construction, nor between the original downstream slope and the new 3H:1V downstream embankment. A chimney drain downstream of the core of an earthen dam is the primary defensive measure for protecting the embankment against internal erosion. Therefore, the lack of a chimney drain presents a major concern for a structure that is believed to have latent defects, as described herein.

Dispersive soil erosion features (of the type present) develop in cracks that form in the soil mass. Cracking mechanisms include drying (shrinkage), differential settlement (strain incompatibility), and shear displacement (tension). These mechanisms are dependent on a range of material characteristics, foundation conditions, and embankment geometry. The hazard related to dispersive soil is potential development of internal erosion features that can contribute to compromising the core of the dam (hydraulic barrier).

Crack development by moisture loss related volume change (i.e. shrinkage) is directly related to the soil’s fines content (percent passing No. 200 sieve) and plasticity. The potential for volume change increases with increasing fine-grained soils content and plasticity. The regional soils possess characteristics conducive to shrinkage behavior. Additionally, textural characteristics of the regional soils can produce moderate to rapid conductance of soil moisture to the surface, along with significant capillarity to draw moisture from depth (on the order of several feet). Transpiration is an additive mechanism of soil moisture loss. These factors, in conjunction with the seasonal hot and dry Texas environment, increase the probability of deep shrinkage surface cracking.

Crack development by differential settlement is often a concern at dam abutments, where both the foundation profile and dam geometric cross-section change markedly. Erosion features have been persistent at the left (north) abutment. Also, seepage has been persistent right (south) of the service spillway outlet, which corresponds with a rising foundation abutment. However, this seepage may be related to one or more of the following:

- Insufficient foundation seepage cutoff
- Possible absence of an impermeable foundation layer in the right abutment area
- Failure for the core trench to completely encompass the low-level conduit

- Absence of an adequate filter around the conduit.

In the analysis performed by Trinity for the original dam design, “the maximum height of embankment was considered to be 65 feet”. This height does not appear to consider the core cutoff trench depth in the analysis. Based on the dam centerline cross-section profile, the average embankment height (including cutoff trench) is roughly 100 feet in the Cypress Creek valley. This represents more than a 50 percent increase in compressible embankment thickness over the analysis assumption. Additionally, inclusion of the compressible cutoff trench volume in the settlement analysis potentially increases the consolidation drainage path length, which lengthens the time for primary consolidation of the embankment (proportional to the square of the drainage path length). The original analysis estimated 1.3 feet of embankment consolidation settlement (excluding foundation movement), and estimated more than 10 years and more than 100 years to reach 50 and 90 percent consolidation, respectively. Including the cutoff trench would increase both the magnitude and time for consolidation settlement. In summary, it is possible that the embankment contains differential settlement induced cracks, especially near the abutments. In addition, the potential for future movement exists.

We note that the 1997 Dam Inspection Report by Hayter Engineering describes a centerline profile survey of the dam and does not indicate any unusual settlement compared to the original TxDOT plans for construction of FM 3007.

Crack development could also occur at or along the interface of the stream diversion opening, described in the specification titled “Handling of Water During Construction”, and the adjacent embankment sections. In the referenced specification section, prepared by WFA, the stream diversion opening had a bottom width of at least 50 feet and side slopes of 3H to 1V. The opening was reportedly not closed until the adjacent embankment sections were at or above elevation 380 feet or 15 feet below the crest elevation of 395 feet. Construction of the embankment in this manner could result in differential settlements between the adjacent embankment sections and closure sections and could result in detrimental cracking.

Crack development can also occur upon initial impoundment of the reservoir. Water loading on the upstream slope and/or saturation of the foundation and upstream embankment can cause deformation in the structure that can be incompatible with stiffer, unsaturated sections of the structure resulting in cracking. As the seepage front advances downstream, seepage forces exerted within the embankment and/or saturation of the foundation can cause additional deformation of the structure that can be incompatible with the previously wetted sections of the structure, resulting in cracking. The regional soils possess textural characteristics that tend to produce more brittle, higher modulus behavior (low to medium plasticity and moderate to high sand content). This type of material behavior is less tolerant of differential movements than the ductile behavior of clay compacted wet of optimum moisture content. As a result, it is possible that the dam embankment contains cracks in the upper elevations from initial reservoir impoundment.

Crack development in the original downstream embankment by shear displacement (tension) is possible. Instability of the original downstream slope has been documented with regularity in dam inspection reports prior to the 2008. It’s unclear whether those features were adequately mitigated in the 2008-2010 downstream slope modification. Therefore, latent issues that may now be buried within the downstream portion of the embankment may be possible.

In summary, mechanisms exist that may result in the continued development of both surface and internal cracking.

The original 2H:1V downstream slope exhibited erosion and instability issues requiring a series of mitigation and rehabilitation actions. The instability issues were addressed by a downstream slope modification in 2008-2010 (flattening to 3H:1V), but persistent erosion issues (surface and potentially internal) continue. While it is probable that the original and modified downstream slope embankments were constructed of similar soil types that exhibit dispersive behavior, the pattern of erosion hotspots (high concentration of erosion features) are cause for concern.

Photos A.1 through A.4 in Appendix A contain aerial images (obtained from Google Earth Pro) of the downstream slope over time, ranging from 1996 through 2019. Note the relatively consistent location of erosion hotspots along the dam structure; by comparison of pre-modification (1996 and 2005) to post-modification (2015 and 2019) images. Soil borrow source and/or borrow soil horizon are not likely to explain this consistency (both horizontal and vertical position), since the original and modified slopes represent unconnected construction activities. Therefore, the relatively consistent erosion hotspot locations suggest issues beyond just dispersive soils are causing the downstream slope erosion issues.

Note in the 2005 photo (Photo A.2) that vegetation appears to be thriving at the erosion hotspot locations. Conditions appear more arid away from the erosion features. Given that the entire slope is likely exposed to the same environment (precipitation, temperature, wind, humidity), seepage through the dam/foundation is the likely source of water, which promotes the vegetal growth. Two possible sources of water seepage are: 1) release of water retained in erosion jugs and tunnels; and 2) intermittent reservoir seepage through existing cracks or internal erosion features related to changes (specifically increases) in reservoir level.

The intermittent reservoir seepage, if present, may not be hydraulically connected with the steady-seepage regime (phreatic line); therefore, the intermittent seepage would not be present in the piezometric data. The intermittent seepage would be path specific, where the rising reservoir encounters cracks and other features above the phreatic surface within the dam cross-section, as a separate flow regime.

The possibility that latent features in the original embankment may be contributing to the current erosion processes, increases the risk associated with any partial removal and replacement of the downstream slope alternative. Erosion in dispersive soils requires a source of freshwater. Placing lime-augmented soil as a barrier (cap) between precipitation and the unremoved dispersive soils may mitigate external water sources. However, the surface barrier will not mitigate internal, intermittent reservoir seepage that could continue to produce internal erosion in the unremoved dispersive soils. Additionally, lime-augmented soils exhibit higher modulus (stiffer, more brittle) behavior, as compared to the base soil, making it less tolerant of differential movements (collapsing erosion pipes, embankment consolidation settlements, etc.). Should cracking occur in the stabilized soil barrier, internal erosion could resume.

The connection between possible latent features in the original embankment and current downstream erosion issues cannot be ruled out. Assuming that the latent features and associated seepage are contributing to the currently observed embankment issues, the risk of using a stabilized soil barrier is concealment of evidence that internal erosion is occurring. A thick surface barrier may span erosion tunnels, allowing active erosion features to remain undetected for longer periods of time. With time, inter-connection of undetected downstream erosion features with latent features in the original dam could produce a “pipe” that breaches the dam core under a sustained, elevated reservoir level, potentially leading to progressive loss of the reservoir. This possibility is further supported by the fact that no filter/drain exists between the original downstream slope and the 2008-2010 modification embankment.

2.3 Potential Latent Seepage Features in Original Embankment

The section above references a series of aerial images (Photos A.1 through A.4) of the downstream slope over time, ranging from 1996 to 2019. The primary purpose of those images was to show the persistence of seepage locations along the downstream slope, pre- and post-modification (in 2008-2010). The 2005 image (Photo A.2) is especially relevant to the latent seepage feature discussion as the photograph indicates the presence of thriving vegetation at the erosion hotspot locations, with arid conditions away from the erosion features.

Historical rainfall and lake level data were obtained and reviewed to evaluate the condition of the vegetation for the period of time coincident with the aerial photographs contained in the appendix. The historical rainfall and reservoir level data is presented in graphical form following its corresponding aerial image, covering a date range of about one year prior to and after the aerial image date.

In 2005, the historical data indicates less than 0.1 inch of rainfall occurred in the month of October, a rainfall deficit of 6.5 inches over a two-month period (September-October), and a rainfall deficit of 16.7 inches for the year-to-date (January-October). The lake level roughly coincided with the service spillway crest elevation of 378 feet from January through May 2005, and then progressively dropped to an elevation of about 375.5 feet by October 2005. Considering that the entire downstream slope is exposed to similar environmental conditions (precipitation, temperature, wind, and humidity), the differential vegetation growth observed in the aerial photographs is possibly explained by an irregularly distributed water source (i.e., seepage pathways). This suggests that the original (pre-modification) dam embankment contains transverse, latent seepage features.

Review of the historical lake level data, in conjunction with the presence of latent seepage features, provides evidence to explain the persistence and acceleration of the post-modified, downstream slope embankment erosion. Surficial and internal erosion processes may be contributing to the erosion of the current downstream slope. Both processes are enabled by the likely presence of dispersive soil in the downstream slope. Surface erosion is the consequence of surface cracks that concentrate and conduct rainfall to dispersive soils within the current downstream embankment. Internal erosion is supported by:

- The existence of latent seepage features in the original dam embankment;
- The conspicuous upper vertical control of erosion initiation along much of the dam structure, and to a lesser degree;
- The presence of downstream-oriented, inter-connected horizontal tunnels (collapsed and open).

Internal erosion may result from latent embankment cracks providing a pathway for reservoir water to seep into dispersive soils within the current downstream embankment. This mechanism may be a continuous process at reservoir levels near the service spillway crest at an elevation of 378 feet.

However, when a rainfall (or operational) event causes the reservoir to rise above this level, the ‘new’ or modified seepage regime encounters supplemental latent cracks, which increases seepage flow and accelerates internal seepage. The degree of post-modification downstream slope erosion may be explained by the historical data rainfall and lake level data.

For the 2015 post-modification aerial image (Photo A.3), the historical rainfall data indicates an excess amount of rainfall of 27 inches over the average annual normal rainfall amount of roughly 47 inches. Lake levels in 2015-2016 were at or above the service spillway crest approximately two-thirds of 2015 and one-half of 2016. More importantly, the lake level spiked six times in 2016, ranging from 2 to 6 feet above the service spillway crest.

For the 2019 post-modification aerial image (Photo A.4), the historical rainfall data indicates an excess amount of rainfall of 12 inches over the average annual normal rainfall amount of roughly 47 inches. Lake levels in 2018 were within about 2 feet of the service spillway crest, and in 2019 (to present) continuously above the service spillway crest. The lake level has spiked twice since January 2019 to roughly 3 feet above the service spillway crest.

While the 2015 and 2019 lake level summaries represent data in only four out of the nine years since the downstream slope modification (2008-2010), the data demonstrates that lake levels have periodically risen above the service spillway crest, which supports to the internal erosion mechanism hypothesis.

A precondition of both active erosion processes (surface and internal) is the existence of cracks in the dam embankment. As discussed in Section 2.2, causes of soil cracking in earth embankments include soil drying (shrinkage), shear displacement (tension), and differential settlement (strain incompatibility). The first two cracking mechanisms were substantiated in Section 2.2. Qualitative substantiation for differential settlement as a cracking mechanism in the Lake Cypress dam is discussed herein.

The dam was originally constructed as a homogeneous structure, consisting of the “most impervious materials” in the upstream embankment and central core, with sandy materials comprising downstream portions of the embankment. The maximum embankment section of the dam, which is on the order of 70 feet above the original ground surface, occurs in the Big Cypress Creek valley (Sta. 10+00 to Sta. 31+00). The dam was also constructed with a centerline core cutoff trench, having a 10-foot wide base and 1H:1V upstream and downstream excavation slopes. Construction plans indicate the cutoff trench was designed to extend more than 30 feet below the original ground surface in some locations of the Big Cypress valley (Sta. 10+00 to Sta. 31+00).

Trinity's 1967 geotechnical design report presents an estimated total settlement magnitude of 2.2 feet, for the dam's maximum embankment height. This magnitude is composed of time-rate (i.e. consolidation) movements of 1.3 feet in the embankment and 0.3 feet in the foundation, plus 0.75 feet of immediate foundation movement (note that the quantities sum to 2.35 feet). Trinity's report narrative indicates this settlement analysis assumes:

- A maximum embankment height of 65 feet., consisting of impervious (i.e. potentially time-rate compressible) soils; and
- A 20-foot layer of time-rate compressible soils in the upper (near surface) foundation stratigraphy.

Trinity estimated the embankment time-rate settlement could take 11.8 and 114 years to reach 50 and 90 percent consolidation, respectively. The foundation time-rate settlement could take 1.6 and 19.7 years to reach 50 and 90 percent consolidation, respectively, according to Trinity's analysis.

Trinity's settlement analyses do not appear to address the following:

- Contribution of the core cutoff trench at the dam centerline
  - The cutoff trench depth represents more than a 50 percent increase in compressible embankment thickness, with contributory time-rate movement.
  - The potential exists that the dam embankment could experience total settlement exceeding Trinity's estimate, at points near the dam centerline (coincident with the cutoff trench, and maximum embankment height); and correspondingly, larger differential movements between the centerline and points upstream and downstream of the cutoff trench.
- Influence of the cutoff trench volume on the time-rate prediction of embankment movement
  - Inclusion of the cutoff trench volume in the settlement analysis geometry increases the consolidation drainage path length for time-rate compressible soils beneath the dam centerline, which markedly lengthens the time for primary consolidation (proportional to the square of the drainage path length)
  - This could contribute to the rate of differential movements between the centerline and points upstream and downstream of the cutoff trench.

However, the most compelling factor substantiating differential movement as a likely cracking mechanism is the variability of subsurface conditions in the Big Cypress Creek valley. Portions of the New Hope, Texas USGS 7.5-minute (1:24000) topographic map versions from 1965 (pre- construction) and 2016 (current) are presented as Figures 3 and 4, respectively. Figure 1 is "Sheet 3R – Plan of Dam" from the original construction documents. Figures 1 and 3 clearly document that Big Cypress Creek has undergone significant, progressive lateral channel migration in the vicinity of the dam footprint. In fact, several meander cutoffs exist immediately downstream of the dam location at the time of construction

(Figure 3). This type of geomorphological environment produces abrupt changes in soil types and their vertical and horizontal distribution.

Trinity advanced five borings in the Big Cypress Creek valley (Sta. 10+00 to Sta. 31+00), at a roughly 500-foot spacing along the dam's proposed centerline. These boring logs are not included in Trinity's 1967 report, which was a supplement to their original report in 1966 (which is not currently available). However, the dam centerline borings are plotted as graphic stems on "Sheet 6 – Dam Centerline Cross-Section Profile" of the original construction documents, included as Figure 2.

Trinity's embankment settlement analyses assigned a 20-foot thick compressible layer in the upper (near surface) foundation soil stratigraphy. The valley borings in Figure 2 are annotated with red boxes delineating the likely time-rate compressible foundation soils (i.e. clay soils). The thickness of time-rate compressible soils in the borings ranges from about 2 feet (Boring No. 1) to 20 feet (Boring No. 7). While Trinity's assumption of a uniform 20-foot time-rate compressible soil layer in the foundation may be conservative for the purpose of estimating total settlement of the dam centerline crest, it does not assess differential movements as a consequence of soil deposit variations throughout the foundation of the embankment footprint. Note the variation in time-rate compressible soil thickness between boring No. 1 and the surrounding borings.

Figure 1 shows the significant channel meandering of Big Cypress Creek within the footprint of the embankment, delineating a probable zone of variable soil conditions influencing embankment differential movements. This zone is superimposed on the March 2019 aerial image (Figure 5) and indicates correlation with the persistent seepage hotspot on the downstream slope in the Big Cypress Creek valley.

Differential embankment movements are a common concern in embankment dams (upstream and downstream of their central cutoff core) where the foundation response (magnitude and rate) is expected to be different due to variations in loading. The added component at this site is the likelihood of variations in the naturally-deposited foundation soils, compounding differential movements both relative to the cutoff soils and point-to-point within the upstream and downstream embankments beyond the cutoff trench.

Latent seepage features in the original dam embankment appear to exist, as evidenced by the presence of thriving vegetation at erosion features during extended periods of low rainfall in fall 2005 and the conspicuous upper vertical control of erosion initiation along much of the dam structure. Rising lake levels increase reservoir seepage flow through the dam embankment, as the rising reservoir encounters additional existing cracks in the embankment, above the normal phreatic seepage regime. The presence of differential settlement-induced cracks in the original dam embankment is possible, not only at the abutments, but also within the embankment at the general vicinity of the original Big Cypress Creek channel.

2.4 Review of Piezometric Data

Schnabel was provided with historic piezometric data for six piezometers installed in the subject dam. Three of the piezometers, labeled as Piezometer 1, 3, and 5, are situated along the downstream edge of the crest and the remaining three, labeled as Piezometer 2, 4, and 6, are situated along the upstream edge of the berm/access road located along the downstream toe of the dam. A plan depicting the location of the piezometers is included in Appendix C, along with graphs depicting the measurements of each of the piezometers since 2012. In addition to plotting the water levels in the piezometers, water levels for Lake Cypress Springs and Lake Bob Sandlin are included on the graphs for the crest piezometers and access road piezometers, respectively.

Details of the piezometer installation were not available as of the date of this report. However, Schnabel presumes that the piezometers were installed such the water level or phreatic surface of the embankment is being measured. In addition, Schnabel presumes that the crest piezometers are measuring the phreatic surface within the lower portion of the "wetted and rolled embankment" materials identified as being the "most impervious materials" and the access road piezometers are measuring the phreatic surface within the downstream random fill materials.

Based upon a review of the provided piezometric data, Schnabel offers the following observations.

- Water levels in piezometers 1, 3, and 5 have been increasing since 2012. Additional observations for these piezometers are presented below.
    - Piezometer 1 has shown the greatest variability and the greatest total change in level since 2012.
    - Piezometer 3 has generally shown the greatest variability in level between readings, except during a period of time between March of 2016 and September of 2018.
    - The level in Piezometer 5 remained relatively constant between April of 2018 and April 2019
- Water levels in piezometers 2, 4, and 6 have been increasing since 2012. Additional observations for these piezometers are presented below.
    - Piezometer 2 has shown the greatest variability in level and currently has a recorded elevation higher than the reservoir elevation of Lake Bob Sandlin.
    - Except for episodic spikes in 2015 and 2018, the level in Piezometer 4 has been relatively constant since 2014.
    - Piezometer 6 has shown the greatest total change in level and has recorded water levels higher than the normal pool of Lake Bob Sandlin since 2014.
    - Piezometer 4 appears to react inversely to Piezometers 2 and 6. Note September measures for 2015, 2017, 2018, and 2019, where Piezometers 2 and 6 decreased and Piezometer 4 increased.

The continued increases in piezometric levels may be a cause for concern and should be monitored for continued changes. Recorded water levels should be compared with values utilized in the record stability analyses. In the event the recorded levels are greater than the values utilized in the record stability analyses or, if record stability analyses are not available, consideration should be given to performing stability analyses utilizing the recorded water levels.

The variability in water levels between piezometers and the deviation of trends between piezometers and within individual piezometers may be indicative of intermittent seepage issues within latent defects discussed herein.

2.5 Review of Drain Discharge Data

Schnabel was provided with discharge data for 14 drain outlets (see Appendix C). The data began in July 2018 and continues through January 2020. Data was limited to “Yes” and “No”, which refers to whether water was observed to be discharging from the referenced drain outlet. The data for drain outlets D-1, D-2, D-3, D-7, D-8, D-11, and D-14 indicated that no discharges were observed for the period of measurement, while the data for drain outlet D-13 indicated that discharge was observed at each measurement. The remaining drain outlets (6 total) were recorded as having discharge some months and no discharge other months. The change in characterization from “No” to “Yes” for each drain is episodic, which may be indicative of intermittent seepage issues within latent defects discussed herein. In addition, the water levels in Piezometers 2, 4, and 6 are lower than the outlets from the drainage system (elevation 340 feet), which may explain the absence of discharge from some of the drain outlets. The water levels in the piezometers that are reported to be lower than the drain outlets supports the possibility for varied seepage regimes given some of the drains have shown continuous discharge.

2.6 Review of 1967 Wisenbaker, Fix, and Associates Construction Plans

A copy of the WFA construction plans titled “Plans for the Big Cypress Creek Reservoir Dam and Spillway for the Franklin County Water District”, dated May 1967, was provided to Schnabel for review. Based upon a review of the 29 sheets of plans, Schnabel offers the following comments pertaining to the seepage and stability characteristics of the project. No comments are provided relative to the spillway design.

- The foundation upon which the dam was constructed is comprised of lenticular deposits of sand and clay with zones of shale and lignite (soft coal showing traces of plant structure, intermediate between bituminous coal and peat).
- The last third of the downstream slope is underlain by a drainage blanket comprised of “sandy soil”. According the construction plans, the drainage blanket extends to and daylights at the downstream toe of the slope.
- A toe drain trench is located under/beneath the drainage blanket near the downstream end. The toe drain trench is comprised of unfiltered ‘pea gravel’ and “8-inch diameter, corrugated steel pipe, asphalt coated, asbestos bonded” with perforations. The outlet from the toe drain trench, consisting of an 8-inch pipe, is depicted to be located at or near station 27+50. According to the WFA documents, the outlet is at or near elevation 324 feet.
- Subsequent to the construction of the Lake Cypress Springs Dam, Lake Bob Sandlin was impounded at an elevation of 337.5 feet, which inundates the downstream toe of the dam and the outlet from the drainage blanket and toe drain.
- The upstream slope, central portion, and keyway of the embankment was depicted on the plans as a “wetted and rolled embankment”, and constructed of the “most impervious materials”. The downstream slope of the “wetted and rolled embankment” section begins near the centerline of

the dam and slopes to the foundation at a grade of 1H to 1V. The keyway beneath the centerline of the embankment has a bottom width of 10 feet and side slope extending back to the foundation at grades of 1H to 1V. The invert elevation of the keyway varies across the floodplain.

- The downstream portion of the embankment is comprised of sandy material placed from the surface of the "wetted and rolled embankment" to the designed grade of 2H to 1V.

Based upon the above comments, Schnabel has concerns related to the following:

- Extensive differential settlement associated with the variable nature of the foundation materials
- Cracking of the embankment materials due to differential settlement
- Uncontrolled seepage and the movement of embankment materials (soils) due to the lack of a chimney or vertical drainage system that extends to the normal pool elevation
- Uncontrolled seepage and the movement of embankment materials (soils) due to the lack of filter around the toe drain "pea gravel" collector
- Inability to observe the discharge from the blanket drain and toe drain due to the presence of Lake Bob Sandlin
- Degradation of foundation materials and the potential for movement of foundation soils along preferential seepage paths

The above concerns, specifically those related to seepage and the movement of materials, are highlighted due to the noted presence of areas of concentrated seepage and boils in 1977, 1980, and 1985. Lake Bob Sandlin, which was impounded in the late 1970's and early 1980's, may be obscuring the presence of other boils and features indicative of uncontrolled seepage and movement of materials.

2.7 Review of 2008 Freese and Nichols Construction Plans

A copy of the F&N construction plans titled "Modifications to Downstream Slope, Franklin County Dam and Lake Cypress Springs", dated June 2008, were provided to Schnabel for review. Based upon a review of the 24 sheets of plans, Schnabel offers the following comments pertaining to the seepage and stability characteristics of the project.

- The new or supplemental internal drainage system includes the use of filter fabric.
- The new or supplemental internal drainage system does not include a chimney or vertical drain to separate the existing embankment materials from the proposed new embankment materials.
- The plans require the installation of 13 piezometers. Based upon provided piezometric data, only 6 piezometers are being monitored and recorded on the project.

Based upon the above comments, Schnabel has concerns related to the following:

- The new or supplemental internal drainage system may not be sufficient to capture seepage through the existing embankment.
- The presence of the geotextile fabric, which is prone to clogging in the presence of fine grained or clayey soils, will likely clog overtime and reduce the effectiveness of the drainage system.

- Given the length of the dam, six actively monitored piezometers is not considered adequate to monitor the structure for changes in phreatic levels. Given the distance between piezometers, the probability of developing seepage issues going unnoticed is increased.

3.0 DEVELOPMENT OF ALTERNATIVES

Based on information gathered during the archival review, Schnabel developed alternatives to address the issues of concern with the downstream slope. These alternatives have been developed in the absence of additional data provided by a proposed strategic exploration and instrumentation program described in 3.4.1.

3.1 Alternatives Considered But Not Carried Forward for Further Evaluation

Schnabel originally developed four alternatives to address ongoing issues with the downstream slope of the dam. Based on conversations with representatives of Carollo and FCWD, two of the four options were determined not to be viable prior to further evaluation. These alternatives are described in the following subsections.

3.1.1 Flatten Downstream Slope to 3.25H:1V with Reduced Excavation

This alternative would reduce the amount of material from the existing embankment that would need to be excavated and would require placement of lime-treated earthfill such that the downstream slope is further flattened between the crest of the dam and Lake Bob Sandlin. The benefit of this alternative would be a flatter slope, which would improve the overall stability of the embankment and maintenance of the slope. The lime-treated earthfill would provide a cap over the existing, dispersive embankment soil, reducing the potential for surficial erosion and shallow slides along the slope. One issue with this alternative would be the need to identify a borrow source for additional embankment material suitable for amendment with lime. A more significant drawback would be the loss of the existing access road/berm along the top of the riprap wave protection for Lake Bob Sandlin, as the proposed flattened downstream slope would tie-out near the top of the riprap. The loss of the existing access road/berm was determined to be too significant to consider this alternative for further evaluation.

3.1.2 Widen Crest of Dam and Cap Downstream Slope with No Excavation

This alternative would require little to no excavation of soils from the downstream slope of the existing embankment, and would result in the placement of lime-treated earthfill over the downstream slope. The crest of the existing dam would be extended on its downstream edge, and lime-treated earthfill would be placed on a 3H:1V slope from the crest to the existing access road/berm on the downstream slope. Benefits of this alternative would be that a minimal amount of existing material would need to be removed from the downstream slope, and the lime-treated earthfill would provide a cap over the existing, dispersive embankment soil, reducing the potential for surficial erosion and shallow slides. Drawbacks to this alternative would be the need to identify a borrow source for additional embankment material suitable for amendment with lime and the need to remove and re-compact the existing loose material on the embankment prior to the addition of lime-treated soil. A more significant drawback would be the loss of the existing access road/berm along the top of the riprap wave protection for Lake Bob Sandlin, as the proposed flattened downstream slope would tie-out near the top of the riprap. The loss of the existing access road/berm was determined to be too significant to consider this alternative for further evaluation.

3.2 Alternatives Considered with Further Evaluation

Based on conversations with representatives of Carollo and FCWD, two alternatives to address ongoing issues with the downstream slope of the dam were determined to be viable for further evaluation. Note that the alternatives presented below are based upon the presumption that the soil beneath/lower than the elevation of the berm/access road can remain. In the event construction of an adequate drainage system cannot be accomplished while leaving these materials in-place, or if future/detailed engineering studies suggest that these materials are dispersive as well, modifications to the presented concepts may be required. Conceptual profiles and site plans for these two alternatives are included in Appendix B. These alternatives are described in the following subsections.

3.2.1 Option 1 - Removal of Dispersive Material from the Surface of the Downstream Slope

This alternative involves the removal of downstream slope material from the crest of the dam to the downstream access road/berm to a depth of 5 feet across the entirety of the downstream slope. The intent is to remove the dispersive material. This material would be excavated from the downstream slope and hauled to a staging area near the downstream right abutment of the dam (see Appendix B). Material removed from the downstream slope would be amended with a prescribed amount of lime determined from a battery of laboratory testing, then re-placed and compacted in lifts along the downstream slope of the dam. After the placement and compaction of the lime-treated material is completed, topsoil from available borrow sources would be spread over the downstream slope to encourage re-vegetation of the disturbed ground surface with an appropriate, maintainable turf grass. The newly seeded downstream slope would require irrigation until a suitable stand of grass is established.

The proposed staging area where lime-amending operations would take place would be located on property currently owned by the FCWD near the downstream right abutment of the dam (see Appendix B). Initially, the property to the north was being considered for lime staging. However, the environmental assessment conducted by Arroyo Environmental Consultants, LLC (Arroyo) noted wetland habitats on this property. The area now being proposed for lime staging will be further evaluated by Arroyo. This area is currently wooded and would require some clearing, grubbing, and grading to produce a suitable staging area, but at approximately 16 acres in size, would provide ample space for lime-amending operations. Disturbed ground for both the staging area and the borrow sources would be re-vegetated.

The benefits of this alternative include the ability to re-use current material on the downstream slope of the dam and remediation of the soils using a proven method, which should reduce the potential for future operation and maintenance issues associated with the in-place dispersive soils. Drawbacks to this alternative include the effort and inconveniences associated with the lime-amending process. Depending on site conditions, lime treatment can be a very dusty process, which could create civil issues with neighboring property owners. Additionally, lime-treated fill can impede the ability to establish permanent turf. A 12-inch thick layer of topsoil is recommended for both the downstream slope of the dam and the staging area to encourage/facilitate the re-establishment of vegetation in these areas. As such, the amount of area necessary to generate this volume of topsoil is relatively significant, which increases the costs to haul and place the topsoil. The thickness of this topsoil layer could be reduced to 6 inches to reduce costs. However, this could increase long-term maintenance associated with establishing and preserving adequate vegetative cover. Costs for both a 12-inch thick topsoil layer (Option 1) and a 6-inch thick topsoil layer (Option 1A) are presented in Section 3.3.

3.2.2 Option 2 - Removal of All Recent Fill from the Downstream Slope above Berm

This alternative involves removal and replacement of all fill material above the downstream slope access road/berm placed during the rehabilitation project to flatten the downstream slope of the dam. Fill material placed over the previous 2H:1V downstream slope from the downstream edge of the crest of the dam to an elevation commiserate with the downstream slope access road/berm would be excavated and hauled back to the borrow area from which it was originally obtained. This borrow area is located near the south end of the embankment structure, on the east side of FM 3007 on property owned by the FCWD (see Appendix B). The borrow site for the fill material used during the 2008 to 2010 rehabilitation project has an area of approximately 14 acres and was left in a state that is generally un-vegetated based on a review of available recent aerial photography. This area would be used as the disposal area for the dispersive soils excavated from the downstream slope of the embankment. When excavation and disposal operations are completed, the disposal site would be covered with topsoil and re-vegetated.

New, non-dispersive borrow material from a suitable source would be mined, hauled, placed, and compacted to re-flatten the downstream slope of the dam to a 3H:1V slope. Candidate areas to obtain suitable soils include the existing vegetated auxiliary spillway channel to the north and west of the dam (see Appendix B), as well as properties owned by others located immediately to the north and east of the dam. Prior to utilizing these areas as borrow sources, a thorough subsurface exploration and laboratory testing program would be required to sufficiently classify, map, and quantify the borrow material. The goal of this geotechnical exploration would be to identify ample fill material absent of the dispersive qualities that the material placed during the 2008 to 2010 rehabilitation project exhibited. Ideally, borrow soils that could be utilized “as-is”, and which would not require the lime-treatment process described in Option 1, would be identified during this exploration.

In the event ample non-dispersive soils cannot be reasonably identified, this option could be modified such that the removed soils are lime treated in a manner similar to that described in Option 1. Please note that the costs presented in Section 3.3 are based upon the use of new non-dispersive soils and without lime augmentation.

The benefits of this method include a favorable process for the removal and disposal of the existing dispersive downstream slope fill material in the original borrow site, as well as the potential to avoid the need for amending the new downstream slope soils with lime. The disposal site for the existing dispersive soils on the downstream slope would require minimal site preparation prior to use, and the area is a relatively short haul distance from the dam. Additionally, the topsoil depth needed to facilitate re-vegetation of the downstream slope of the dam would be less than for the lime-treatment alternative. A

6-inch thick layer of topsoil is recommended for the downstream slope of the dam, the borrow area, and the disposal area to encourage/facilitate the re-establishment of vegetation in these areas. The disadvantages associated with this alternative include a potentially long haul distance for new fill material depending on the location of a suitable borrow source, as well as the need to re-vegetate several large areas including the new borrow location, the downstream slope of the dam, and the disposal site (old borrow area). The topsoil layer could be eliminated at the disposal area as a cost savings measure. The cost for this option (Option 2A) is presented in Section 3.3 along with the cost for Option 2 (6 inches of topsoil on the downstream slope of the dam, the borrow area, and the disposal area).

3.2.3 Drainage System Modifications

For all alternatives, an adequate internal drainage system, which would include a chimney drain, adequate filter, and sufficient outlets, is recommended. Due to concerns related to the potential for latent defects in the original construction to allow water to be conveyed to the downstream slope, an adequate internal system is critical to the long-term performance of the dam.

3.3 Opinions of Construction Cost & Duration

Opinions of construction cost have been developed for the alternatives presented. Note that costs associated with the alternatives only consider the time, effort, and materials necessary for a contractor to construct the various alternatives as of the published date of this report. The opinions of costs do not include design costs, permitting costs, costs associated with acquisition of land or other property, or engineering services during construction. However, for preliminary planning purposes, we recommend that not less than 25 percent of the estimated construction cost be allocated for engineering design and construction services. We caution that the actual fee for engineering services cannot be accurately estimated until a detailed scope of work is established and items of work, such boring depths, laboratory testing protocols, etc., are quantified. The cost estimates for the alternatives considered are “Order-of-Magnitude” estimates which have a +50 to -30 percent accuracy associated with them. The American Association of Cost Engineers recommends dividing engineering construction cost estimates into three basic categories:

<u>Order-of-Magnitude Estimate</u>

This estimate is made without detailed engineering data. Some examples would be an estimate from cost-capacity curves, an estimate using scale-up or scale-down factors, or an approximate ratio estimate. It is normally expected that this type of estimate would be accurate within +50 to -30 percent.

<u>Budget Estimate</u>

“Budget” in this case applies to the Owner’s budget and not to the budget as a project control document. A budget estimate is prepared using flow-sheets, layouts, and equipment details. An estimate of this type is accurate within +30 to -15 percent.

<u>Definitive Estimate</u>

As the name implies, this is an estimate prepared from defined engineering data. As a minimum, the data must include fairly complete plans and elevations, piping, and instrumentation diagrams, one-line electrical diagrams, equipment data sheets and quotations, structural sketches, soil data, and sketches of major foundations, building sketches, and a complete set of specifications. The “maximum” definitive estimate would be made from “Approved for Construction” drawings and specifications. A definitive estimate is accurate within +15 percent to -5 percent.

Opinions of construction cost and the estimated duration to complete construction for the alternatives are presented in Table 3.1.

Table 3.1: Opinions of Construction Cost & Estimated Duration of Work

Alternative	Opinion of Cost	Estimated Duration
Option 1	$2.78 million	270 days
Option 1A	$2.65 million	250 days
Option 2	$3.24 million	280 days
Option 2A	$3.08 million	260 days

Option 1 includes the placement of a 12-inch thick layer of topsoil over the lime-treated fill on the downstream slope of the dam, as well as over the lime-treatment staging area. As a potential cost-saving measure, Option 1A is similar to Option 1 with the exception that a 6-inch thick layer of topsoil would be utilized over the downstream slope and staging area. This would reduce the construction cost and duration of the project, but could result in increased long-term maintenance associated with establishing and preserving adequate vegetative cover on the areas associated with lime-treatment activities.

Option 2 includes placing topsoil over the disposal area, in addition to the downstream slope of the dam and the borrow area, at the completion of construction to facilitate revegetation. Costs associated with seeding the disposal area are also included. The proposed disposal area is the same location as the borrow source for the materials used to flatten the downstream slope of the dam between 2008 and 2010, and is currently un-vegetated. Option 2A eliminates placement of topsoil and revegetation of the disposal site as a cost savings measure.

Opinions of cost and estimated construction schedules for both alternatives are provided in Appendix B. Note that the opinions of cost or the estimated schedules do not include any measures to address the existing internal drainage system beneath the downstream slope of the dam. Costs for this system can be developed during the design once requirements for the system have been defined. For planning purposes, modifications and improvements to the internal drainage system could add on the order of $0.5 million to $1 million to the opinions of construction cost presented herein. In addition, the presented costs do not include the removal and replacement of the soils below or beneath the downstream berm. These soils will need to be tested and evaluated during the final design phase.

3.4 Recommendations

3.4.1 Near-Term Recommendations to Address Deficiencies

While concerns related to the presence of dispersive soils placed in conjunction with the recent remedial efforts for the dam prompted this evaluation, Schnabel recommends that a strategic exploration and instrumentation program be implemented to gather additional data. This will provide guidance on other potential issues with the structure that may present concerns relative to the integrity of the dam structure and will result in a long-term solution that is mutually beneficial to all stakeholders of the dam and the reservoir it impounds.

In light of both the current issues with the rehabilitated downstream slope and the concerns discovered during the review of historic documents for the dam, Schnabel offers the following near-term activities to begin addressing deficiencies with the dam:

- Detailed piezometer data be obtained and reviewed to improve understanding of the existing dam structure;
- Detailed drain flow readings be obtained, and reported as a flow rate (ounces or gallons per minute);
- Geophysical surveys be performed to detect the potential presence of latent internal features at higher elevations in the original dam embankment, to confirm or refute the link between latent erosion features and the current slope erosion process;
- Install sufficient piezometers to document the phreatic surface within the embankment and other instrumentation, such as survey monitoring points and inclinometers, to document the performance (i.e. movements) of the structure. While installing the piezometers, additional geotechnical data and samples will be obtained to further characterize the existing embankment and foundation soils;
- Obtain samples and perform laboratory testing on the existing downstream slope materials to evaluate the potential for future dispersive soil activity;
- Perform preliminary engineering analyses (i.e. subsurface exploration, laboratory testing, and engineering calculations) to document the stability of the rehabilitated dam and highlight the potential risks associated with the possible latent defects/settlement driven seepage; and
- Perform interim, surficial repairs to the downstream slope of the dam to facilitate maintenance activities on the dam while additional data is being collected to develop a preferred, long-term rehabilitation strategy for the dam.

If the recommended strategic subsurface exploration and instrumentation program is not implemented, restoration measures will have to be advanced/designed with a number of substantial unknowns which may result in more costly design and construction efforts.

3.4.2 Long-Term Recommendations to Address Deficiencies

Although Schnabel recommends the collection of additional data to develop a long-term rehabilitation strategy for the dam, we offer the following general recommendations that, while more extensive than the near-term recommendations, would address both the current issues with the rehabilitated slope, as well as the potential issues described in the archival documentation. However, as noted previously, these recommendations account for potential unknown conditions which may be confirmed or eliminated by the performance of the recommended subsurface exploration and instrumentation program. We are of the opinion that prior to implementing these measures, a better understanding of the original structure be established, so that potential issues with the existing structure can be addressed concurrently with the repair work for the downstream slope.

- Remove and replace the materials associated with the 2008-2010 downstream slope modifications;
- Augment the removed materials with lime (see below for general information on lime augmentation), and place the augmented soil as engineered fill to the 2008-2010 modification line and grade or reconstruct the embankment to the 2008-2010 template utilizing non-dispersive soils from an acceptable borrow source; and
- In conjunction with the augmented soil placement, install a chimney filter/drain between the original downstream slope and the new augmented soil embankment.

As described in Sections 3.2 and 3.3, Option 1, which involves removal of a 'surficial amount' of 2008-2010 fill materials, has a lower initial cost than Option 2, which involves removal of all 2008-2010 fill materials. There is substantial risk associated with leaving potentially dispersive soils in place without an adequate filter and drainage system upstream to collect and convey seepage water to the downstream toe. The amount of savings associated with leaving the dispersive soils in place that may be impacted by seepage from the dam appears to be relatively small when compared to the heightened risk. Therefore, Schnabel recommends that FCWD proceed with Option 2.

Lime Augmentation

The required lime dosage rate for satisfactory performance of lime-augmented soil on this project will be alternative-dependent, as capping application characteristics will differ from complete removal and replacement characteristics.

The required lime dosage must also consider the potential variation in base soil properties. A range of potential soil types should be tested in the laboratory to quantify the sensitivity of soil characteristics on augmented behavior, and hence the minimum required dosage rate.

Construction lime is available in a range of modes (quick vs. hydrated), products [quick (CaO), hydrated ($Ca(OH)_2$), lime kiln dust (LKD)], and formats (pelletized, pulverized, and slurry). Each of these products can have a significant influence on the augmented soil behavior, impacting the required dosage rate as well as the construction schedule. The laboratory testing protocol needs to be specific to these factors. Of note, agricultural (or Dolomitic) lime ($Mg(OH)_2$) contains less calcium, resulting in a slower reaction with soil. However, the Natural Resources Conservation Service (NRCS) prefers a mix of 1/3 hydrated (calcium) and 2/3 agricultural (magnesium) lime to better promote vegetation growth.

Thorough blending during construction is a key factor in achieving the desired lime-augmented soil performance. The required addition of moisture during blending should be anticipated in conjunction with dry lime augmentation of the regional soils, independent of soil source (excavated out of bank or from the dam structure). Ample free moisture is essential to allow complete lime hydration, producing full enhancement of the augmented soil. Use of lime in pelletized rather than pulverized form should be carefully considered. Delays in diffusion of pelletized lime (as compared to finely-divided pulverized lime) can result in incomplete hydration (a stoichiometric limit) due to insufficient free moisture post blending and aging, and result in less than desired lime-augmented soil performance.

The laboratory testing program should be established such that the candidate borrow soils (whether out of bank or from the dam structure) are adequately tested for the presence of sulfate, which can negatively impact the effectiveness of lime treatment.

Development of an acceptable lime-augmentation design will require a large laboratory bench-scale testing program, designed to address a matrix of factors (lime type, dosage rate, aging, moisture-density, volume change, dispersivity, etc.) on a range of soil types. The project schedule should allow for several months to complete a laboratory bench-scale testing program.

4.0 RESPONSE TO SELECTED TCEQ COMMENTS

Representatives of Schnabel performed a site reconnaissance of the dam on December 4, 2018. A photographic log of this site visit is included in Appendix C. Schnabel also reviewed a recent report from the TCEQ Dam Safety Program, dated August 8, 2018. The TCEQ report listed fourteen requirements/recommendations for the dam. Schnabel was requested to provide engineering services to address, or begin the process of addressing, Comment Nos. 1, 2, 3, 4, and 7 in the report. These comments are summarized in the following sections.

4.1 Permanent Repair Plan for Downstream Slope (Comment 1)

> *It is recommended that the District take immediate steps to retain an engineer, possibly someone not involved in the litigation, to develop a permanent repair plan for the entire downstream slope. The plan needs to take into consideration: the length of time that the slope has been exposed with no repairs or surface treatment undertaken; the increasing size and depth of the holes and tunnels; the formation of new holes; the observation of cracks on the slope, which could lead to new holes; the presence of dispersive soils, as evidenced by tests taken by various engineers and the appearance of the slope; and the loss of soil integrity evident on the sides of the holes. LiDAR data has been developed by the District, which should be incorporated into the development of the plan. The plans and specifications and geotechnical report should be submitted to this agency for review at various percentages of completion and eventually for approval.*

FCWD engaged Carollo on February 19, 2019 to furnish engineering services in connection with the dam restoration for Lake Cypress Springs. Schnabel was subsequently retained by Carollo on March 28, 2019 to provide engineering services to assist in the permitting through the TCEQ Dam Safety Program, as well as to develop restoration alternatives for the earthen dam impounding Lake Cypress Springs.

Section 3 of this report describes two viable conceptual alternatives to address the issues with the downstream slope of the Franklin County Dam. Either of these alternatives, after detailed design is accomplished, would improve the surficial deficiencies with the downstream slope, and would also reduce required maintenance of the currently affected areas.

With respect to the LiDAR data, Schnabel's CAD personnel have determined that FCWD should anticipate the need to perform traditional topographical survey of the dam and appurtenant areas depending upon the preferred alternative to improve the downstream slope of the dam. While the LiDAR data was suitable for analysis of the downstream slope and the development of visual aids during litigation, the digital size and complexity of the files do not lend themselves well to the development of construction drawings.

4.2 Instrumentation Review (Comment 2)

> *The toe drain outlets need to be monitored and the flap valves opened and cleaned on a quarterly schedule. A log of observations (including drain flow rates and lake levels) and photographs should be kept. The results should be evaluated by the District's engineer with the piezometer readings. The District may desire to consider a lighter flap valve, which may prevent water ponding in the pipe.*

Schnabel has reviewed piezometer data provided by Carollo in the form of a spreadsheet. This data includes the period of time between March 2012 and June 2019. Based on the tabular data provided for the piezometer measurements, Schnabel has developed two graphs. The first graph plots the water surface elevation in Lake Cypress Springs with the piezometer measurements for the three wells located along the downstream edge of the crest of the dam (P-1, P-3, and P-5). The second graph plots the water surface elevation in Lake Bob Sandlin with the piezometer measurements for the three wells located along the upstream side of the access road/berm on the downstream slope of the Franklin County Dam (P-2, P-4, and P-6). A layout of the current piezometer locations and the data provided for review are included in Appendix C of this report.

A review of the available piezometer and lake level data suggests that the water levels in all six piezometers are generally trending up. Please see the discussion in Section 2.0 for additional information.

Regarding the toe drain outlets, the data provided is limited to a period of time between July 2018 and June 2019. Records for fourteen (14) drain outlets were provided. The drain records only indicate whether or not a drain was flowing at the time of the observations, and no flow rate information is included. Of the 14 drain outlets, seven (7) were never observed to be flowing at the time of their observation, and one drain outlet (D-13) has been observed to be flowing in every instance that it was observed. The remaining six (6) drain outlets have been observed to discharge sporadically. Please see discussion in Section 2.0 for additional information.

In summary, we recommend that FCWD remove the flap valves from the drain outlets and record measurements of the discharge from the drain outlets on a monthly basis.

4.3 Upstream Slope Erosion (Comment 3)

It is recommended that the erosion on the upstream slope be repaired before the damage becomes worse. The erosion is affecting the guardrail posts in several places. A grass cover needs to be established once the repairs are completed.

The placement of compacted earthfill with suitable topsoil and the establishment of acceptable vegetation of this area with permanent turf is recommended. Schnabel recommends considering the placement of sod in these areas as an alternative to using seed. Portions of the existing guardrail may need to be removed and re-installed to facilitate the proper execution of this activity. Some grading may be necessary to produce a uniform grade that is more conducive for turf grass establishment and growth. The FCWD should anticipate the need to irrigate the re-vegetated areas until the vegetation is established.

Conversely, consideration could be given to properly armoring the upstream slope with riprap or articulated blocks which would significantly reduce the need for future maintenance. While the initial costs associated with riprap or articulated blocks would far exceed the initial costs associated with regrassing, the long-term maintenance costs would be significantly reduced.

4.4 Downstream Berm and Contacts Erosion (Comment 4)

The erosion along the downstream berm and at the downstream groins also needs to be repaired.

Erosion along the downstream berm and at the groins should be addressed during the improvements to the downstream slope of the dam described in Section 3 of this report. The erosion gullies adjacent to the access road should be excavated to form a trapezoidal channel which would be lined with an appropriate geotextile fabric, bedding stone, and riprap sized according to the anticipated surface water flows and velocities based on the channel geometry.

4.5 Upstream Slope Riprap (Comment 7)

The older riprap on the right end of the upstream slope was cracked and deteriorated. The rock needs to be evaluated by the District's engineer to determine if rock needs to be added or replaced. In addition, the pockets lacking riprap need to have new rock placed.

The rock riprap in this area, as well as other areas along the upstream slope which are noted to be deteriorated, should be refreshed in accordance with accepted engineering standards. Schnabel recommends that refurbishment of the riprap be performed in conjunction with the restoration activities associated with the downstream slope.

APPENDIX A

PROJECT BACKGROUND INFORMATION

Figure 1 – Original Construction Plan Sheet 3R – Plan of Dam

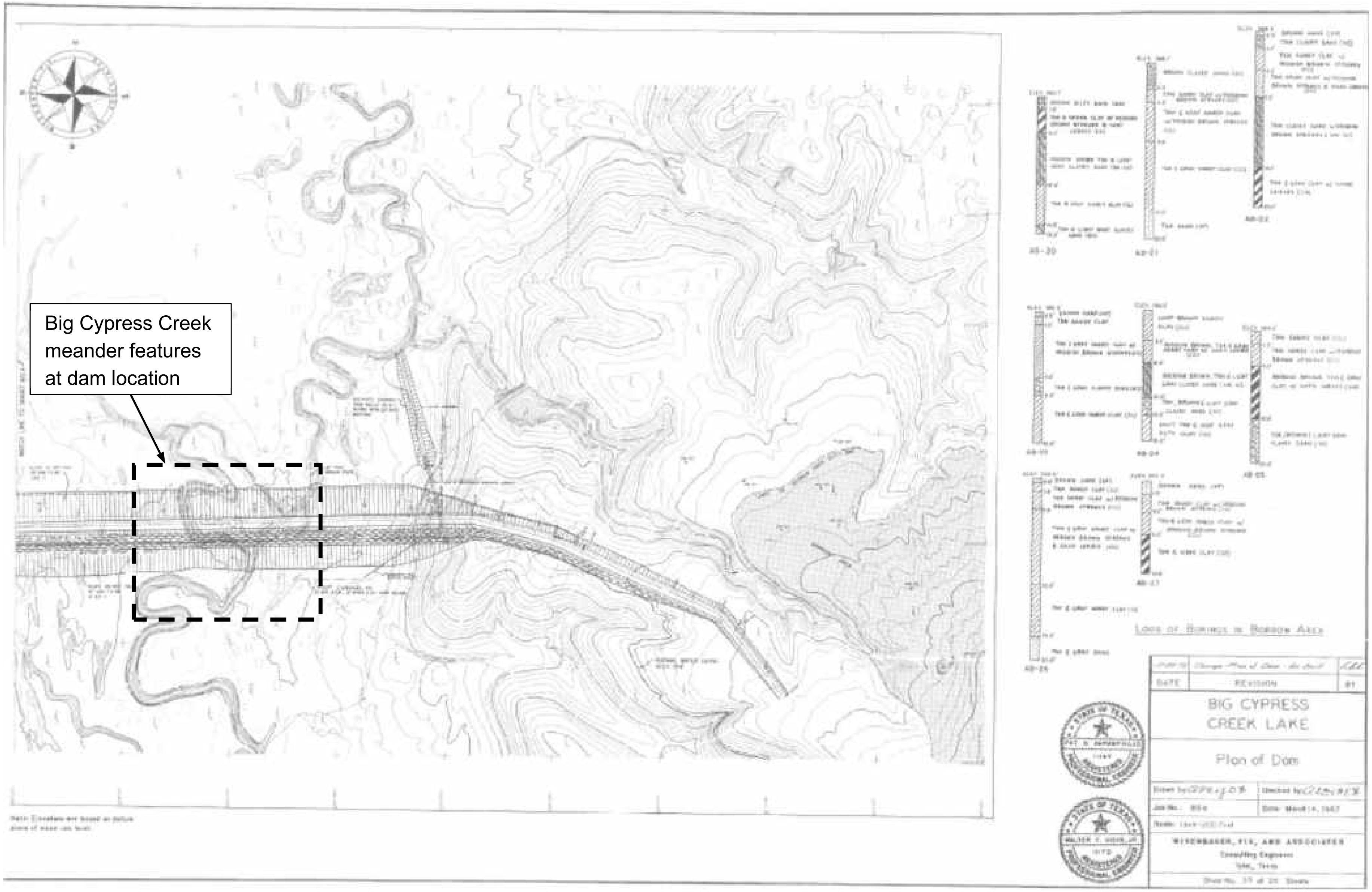


Figure 2 – Original Construction Plan Sheet 6 – Dam Centerline Cross-Section Profile

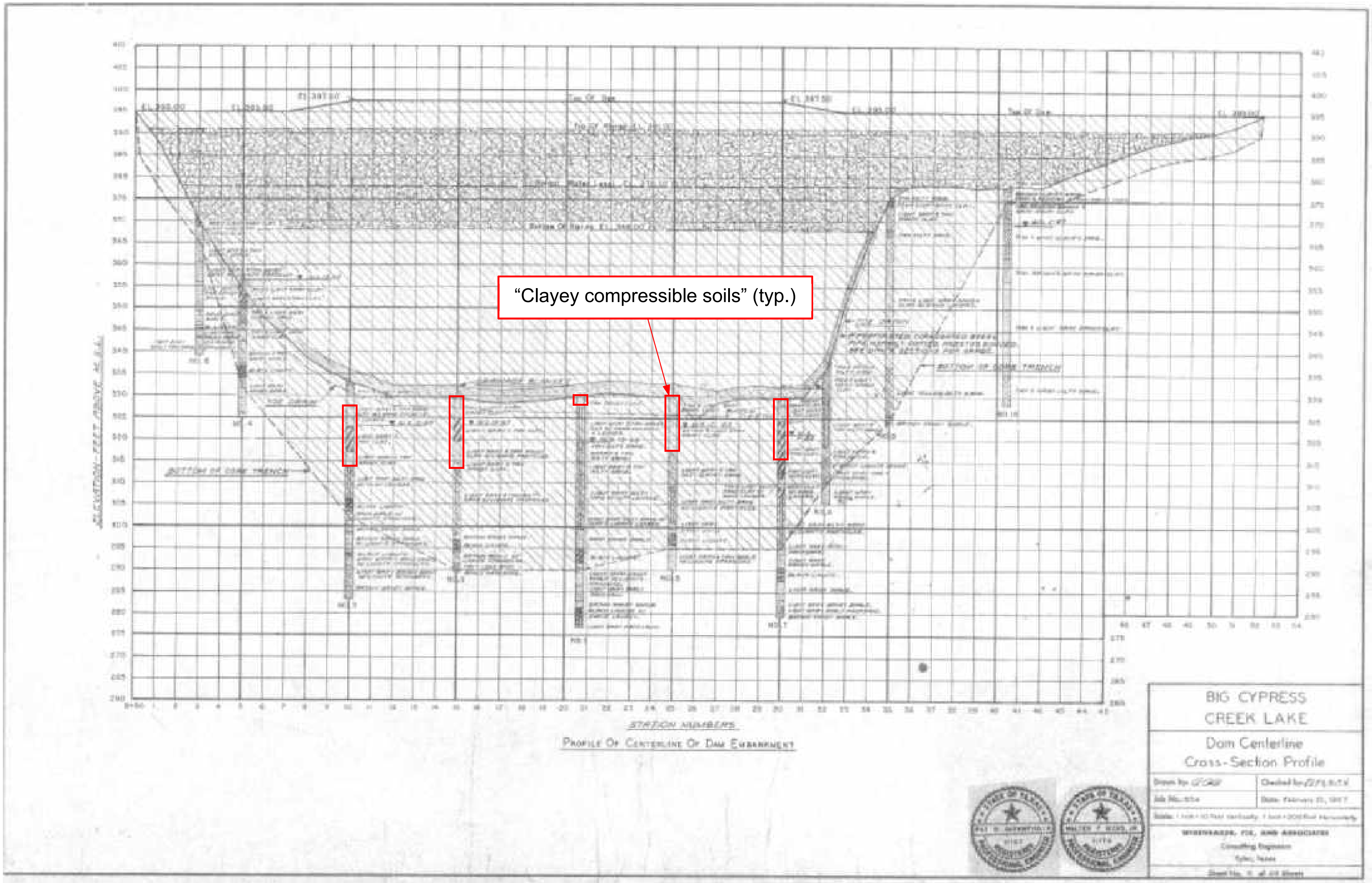


Figure 4 - USGS 7.5 Minute (1:24000) Topographic Map - New Hope, Tx (2016)

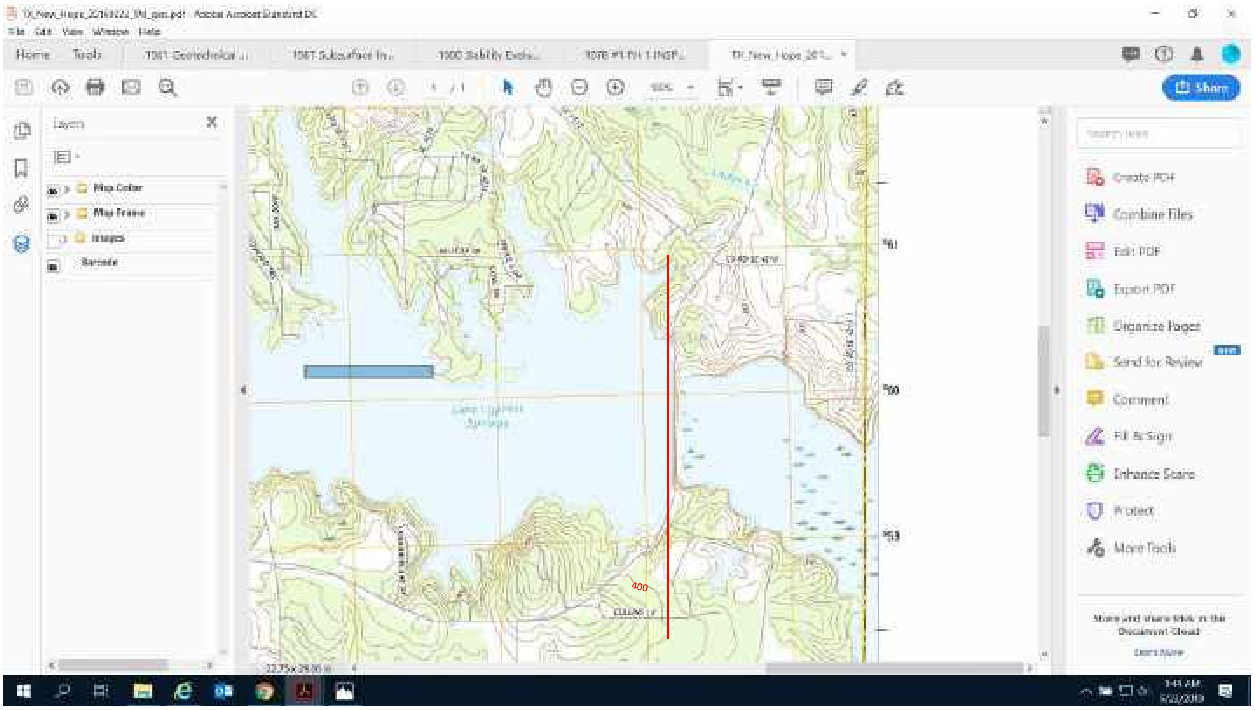


Figure 3 - USGS 7.5-Minute (1:24000) Topographic Map - New Hope, Tx (1965)

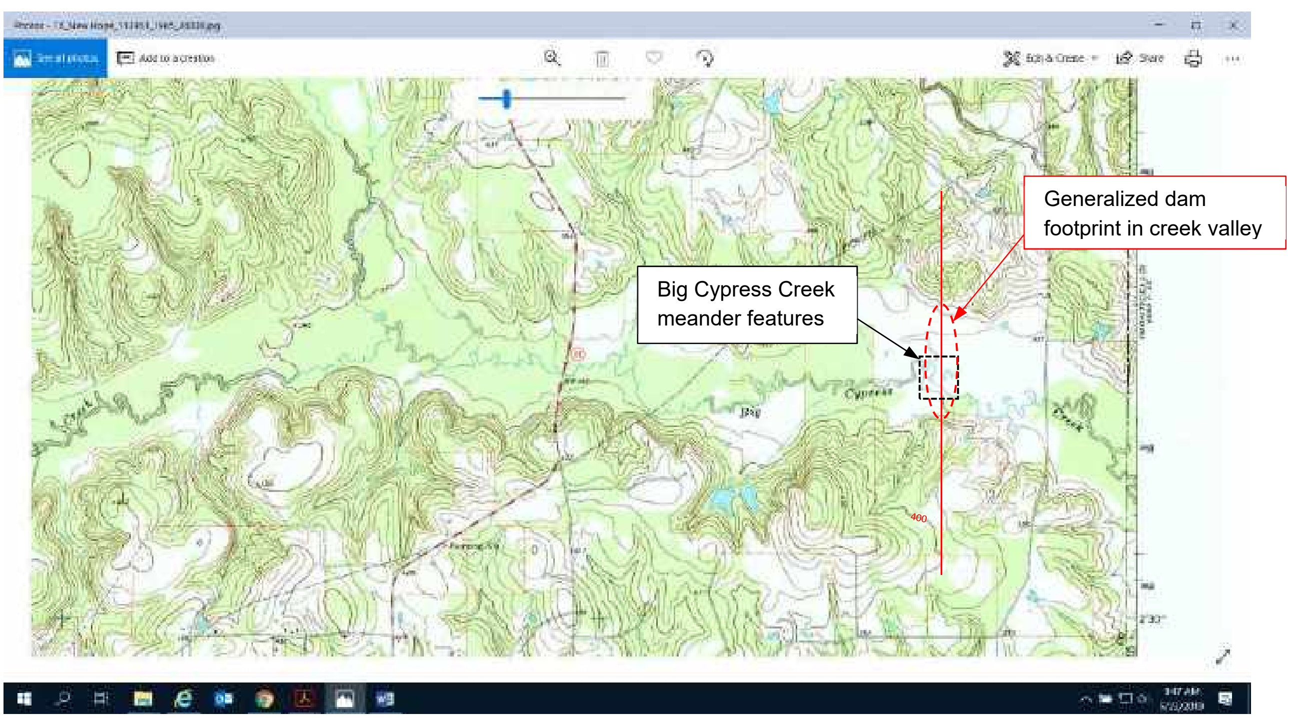


Figure 5 – Relative position of Big Cypress Creek meander features existing Franklin County Dam downstream erosion hotspots (March 2019)

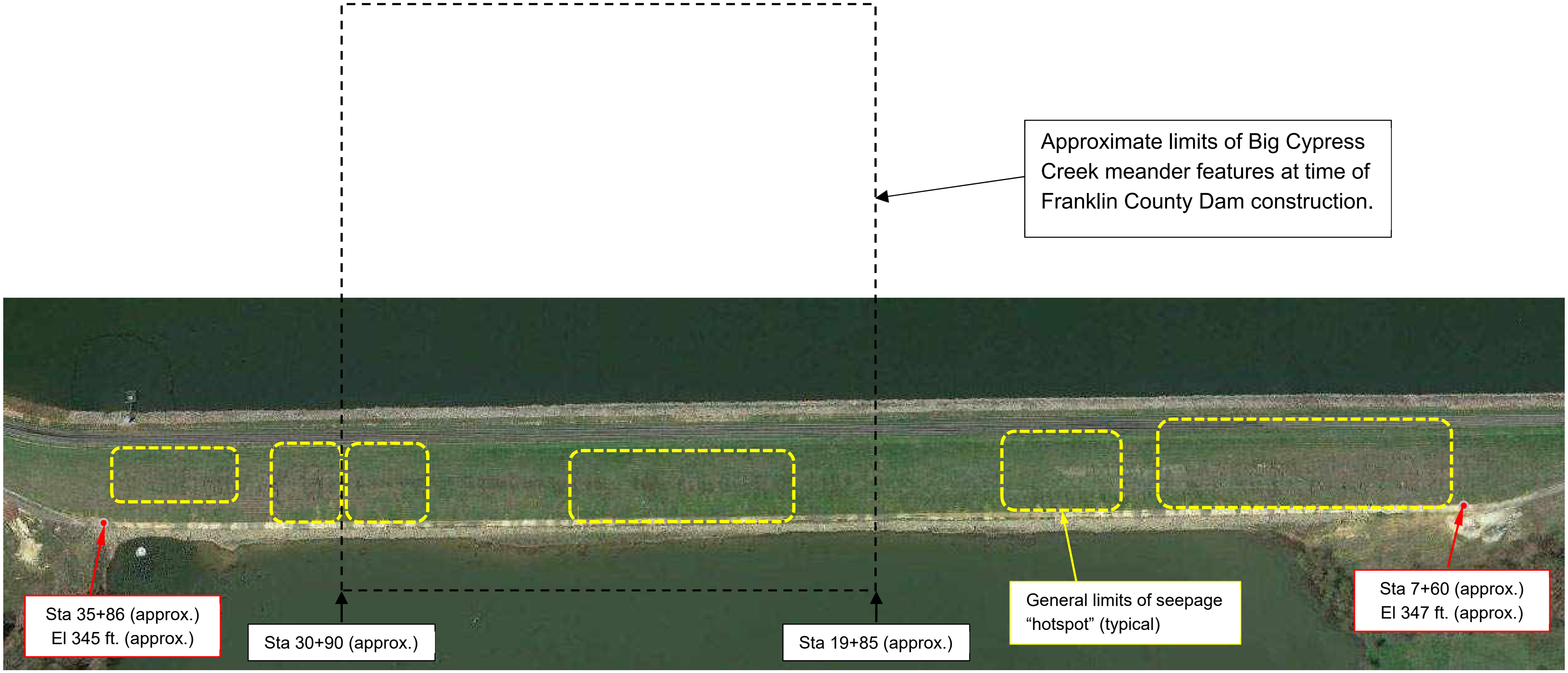
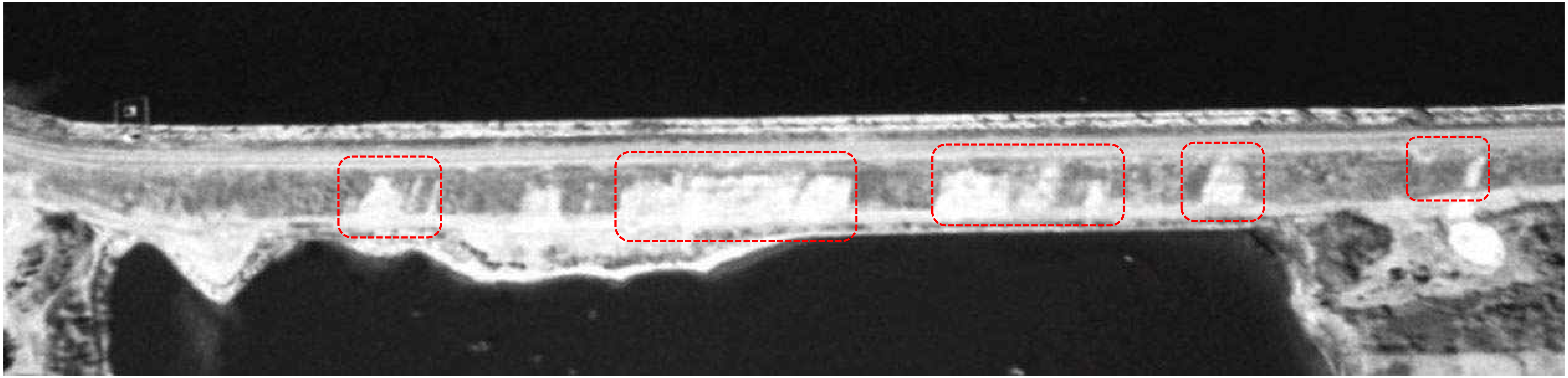
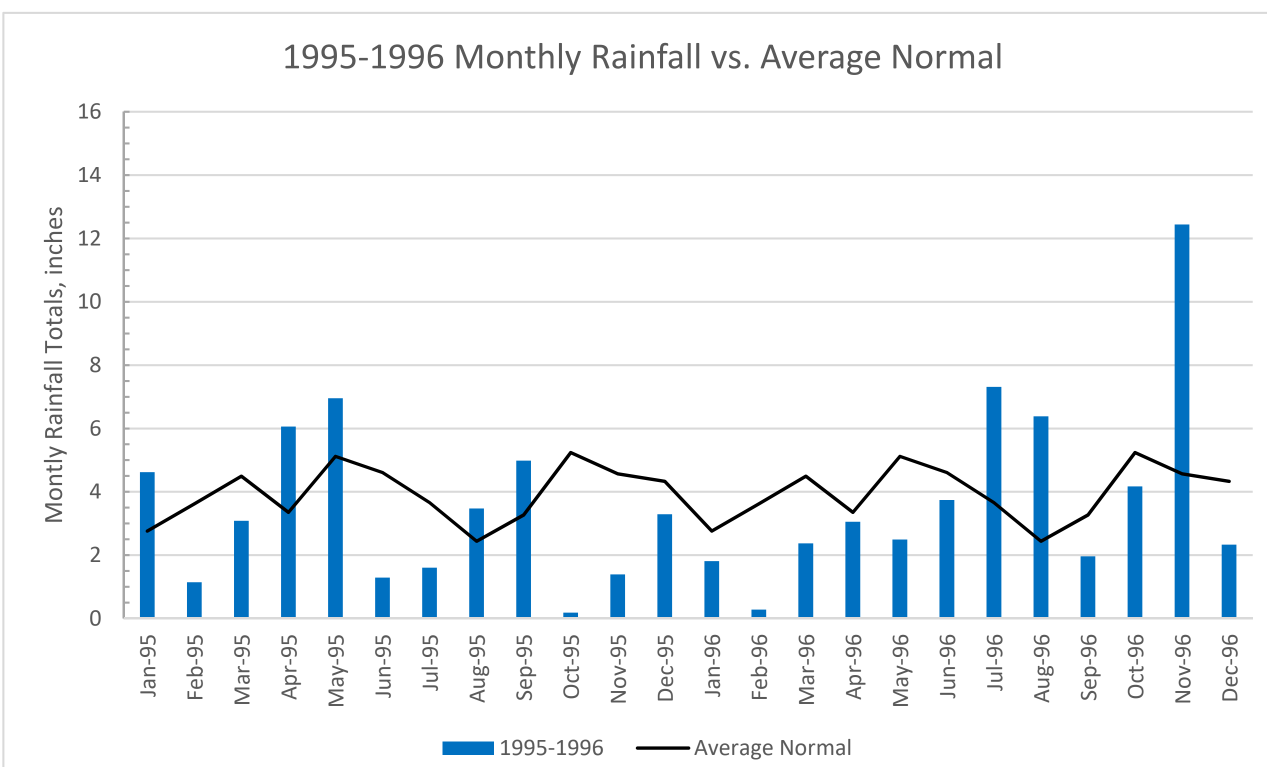
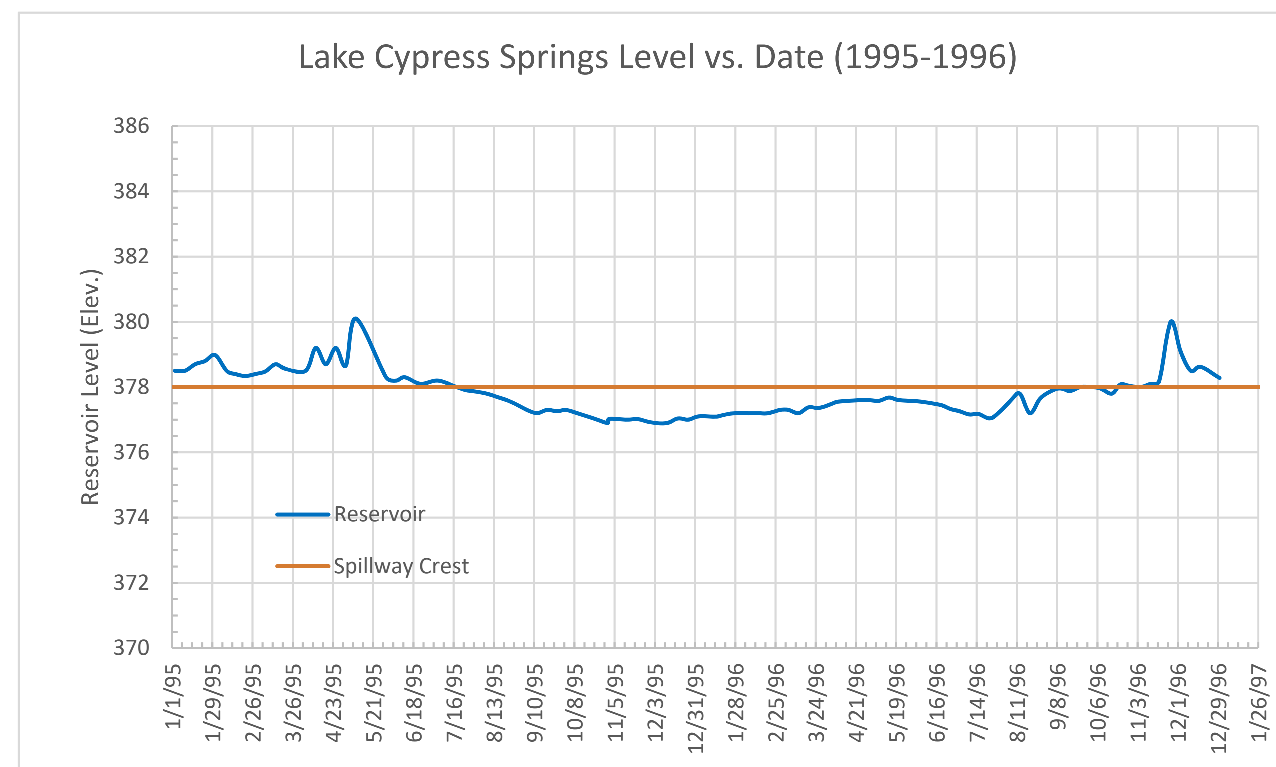


Photo A.1: Original 2H:1V Slope – January 1996



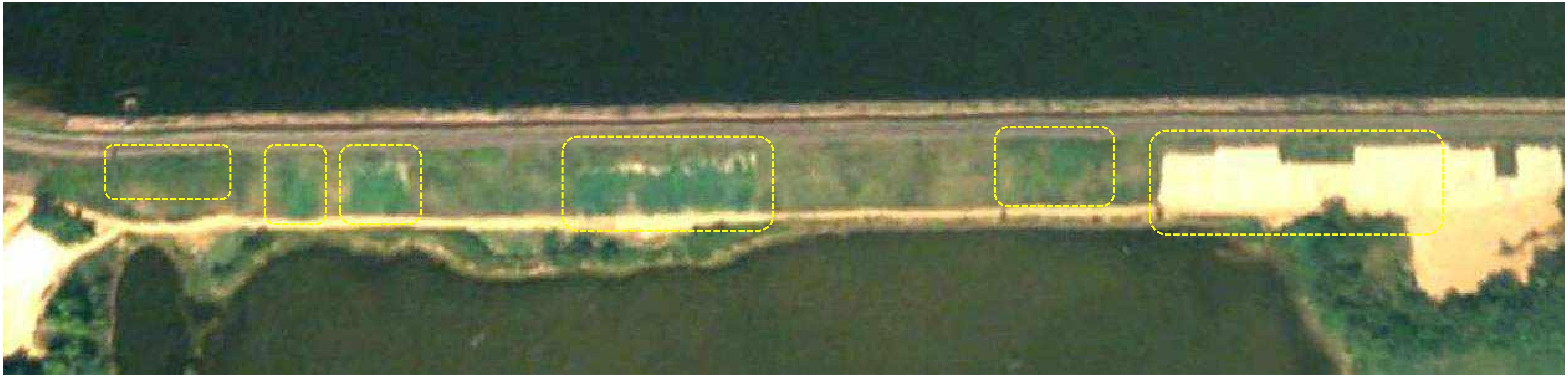


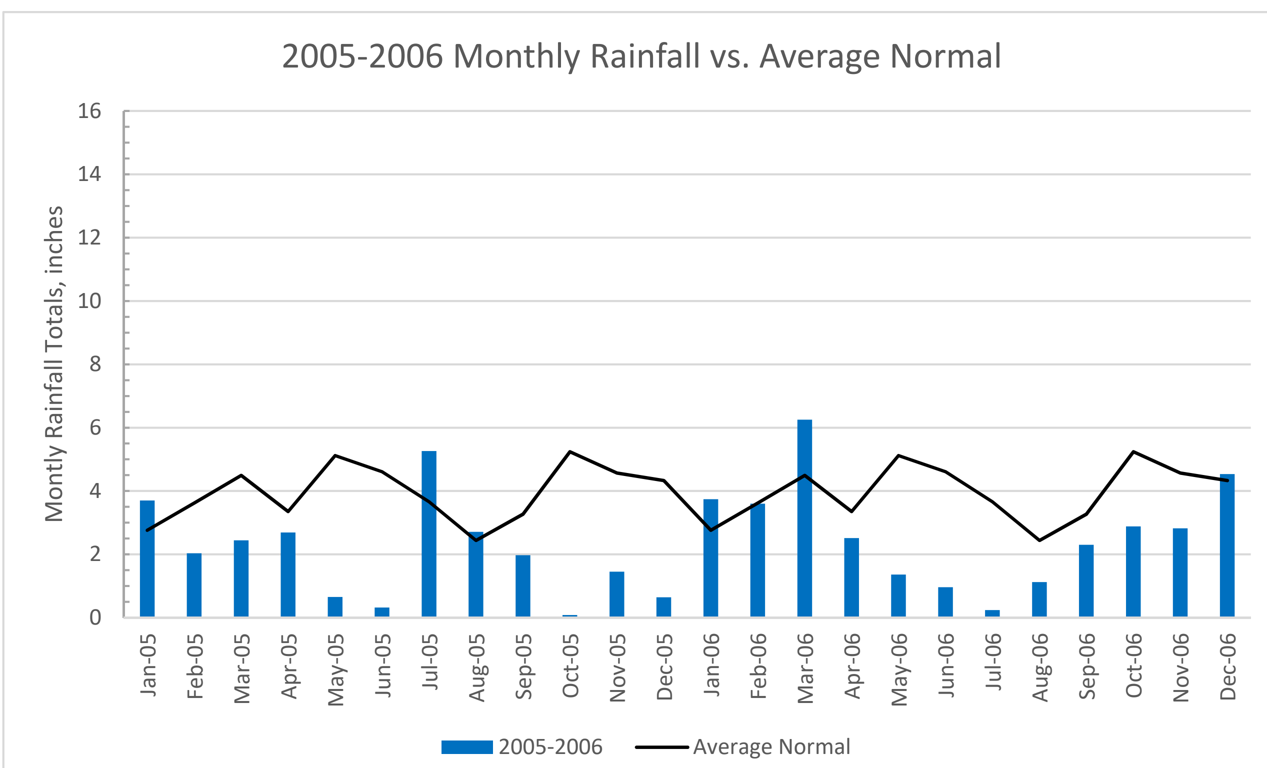
https://www.climate.gov/maps-data/dataset/past-weather-zip-code-data-table

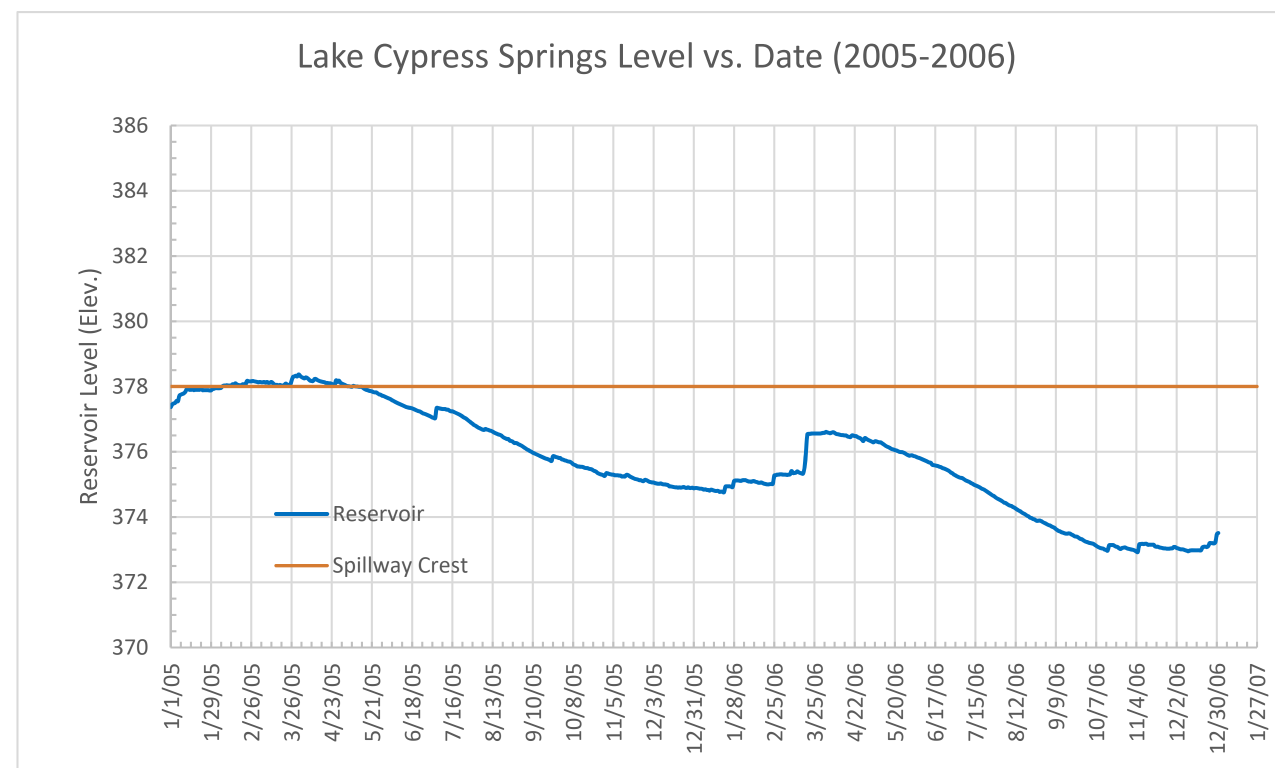


https://www.fcwd.com/content/lake/lake.php

Photo A.2: Original 2H:1V Slope – October 2005



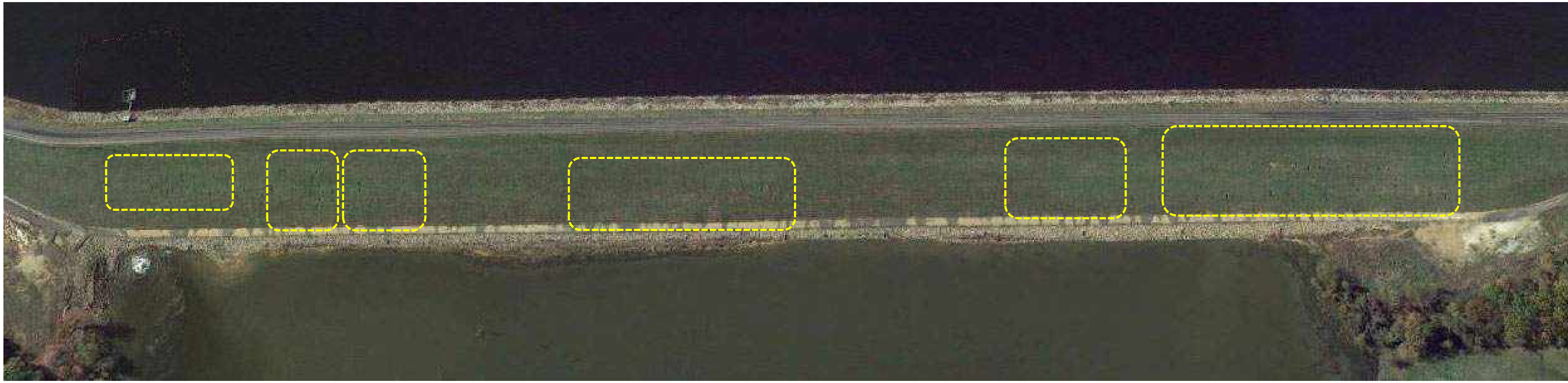


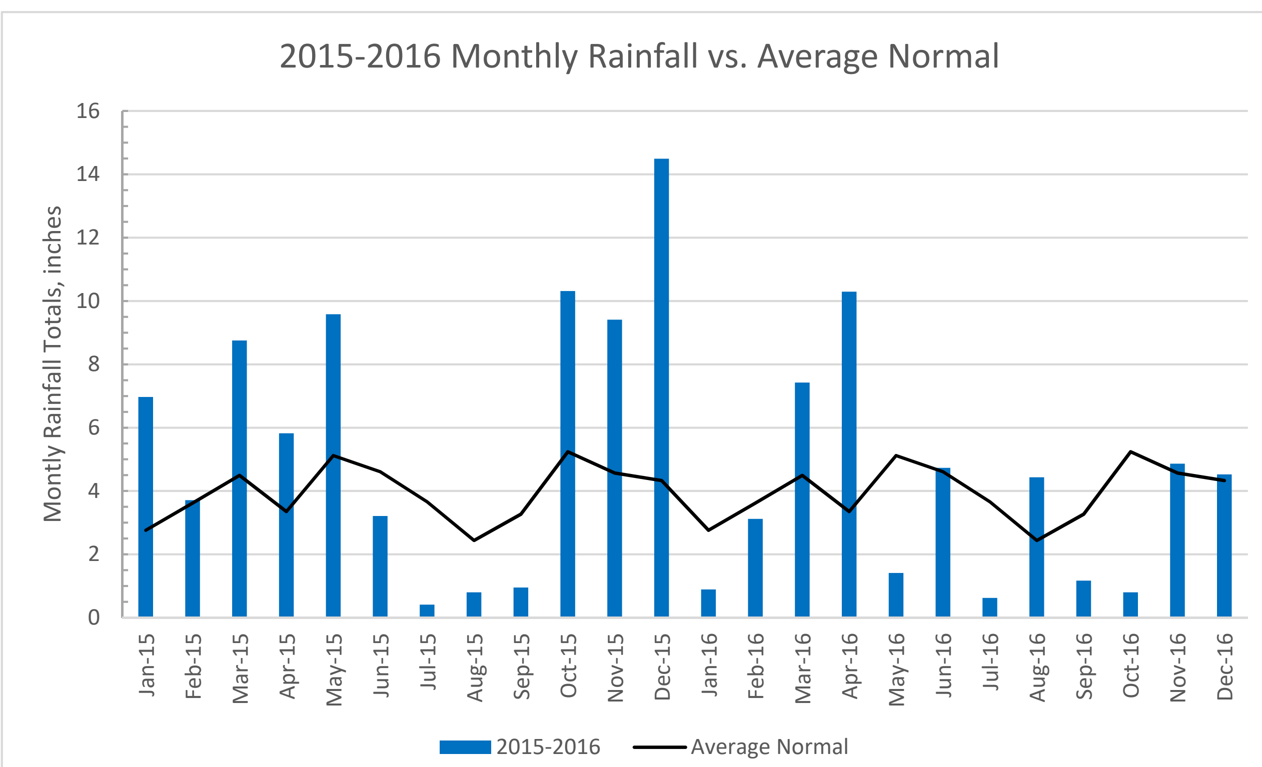


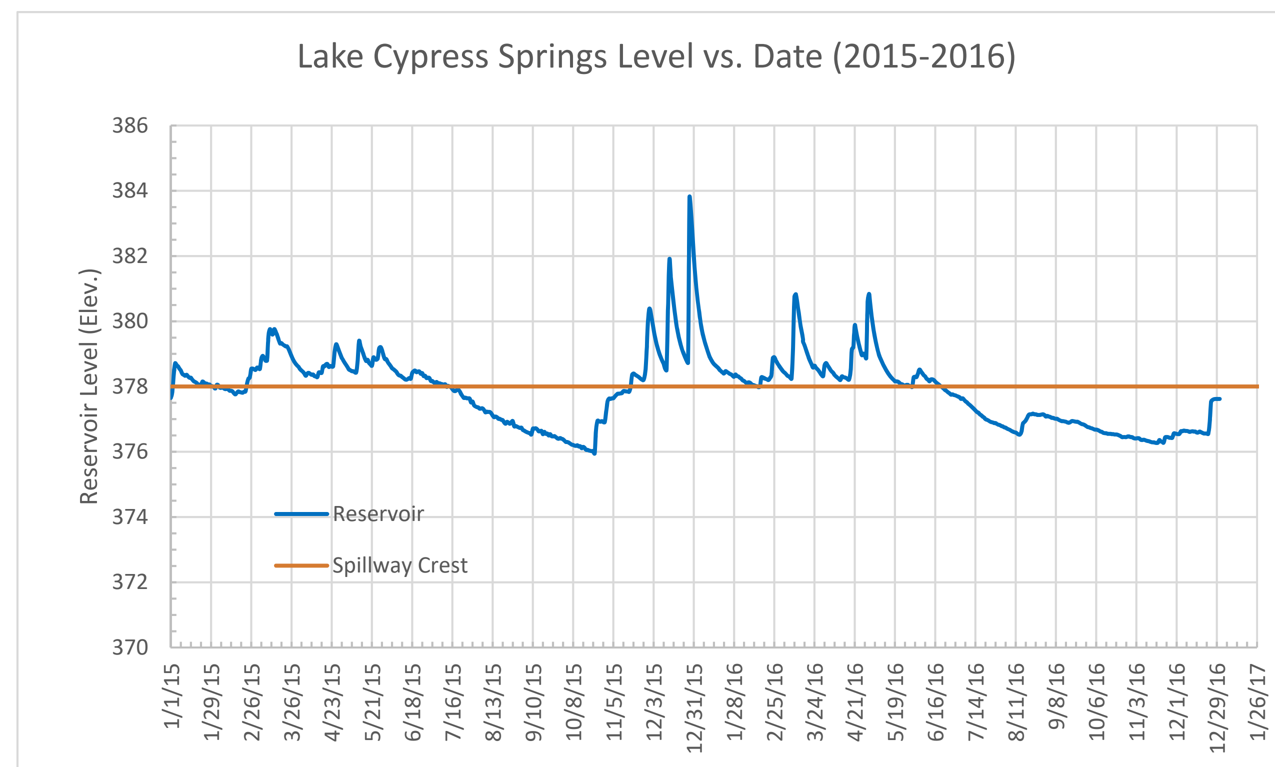
https://www.climate.gov/maps-data/dataset/past-weather-zip-code-data-table

https://www.fcwd.com/content/lake/lake.php

Photo A.3: Modified 3H:1V Slope – December 2015



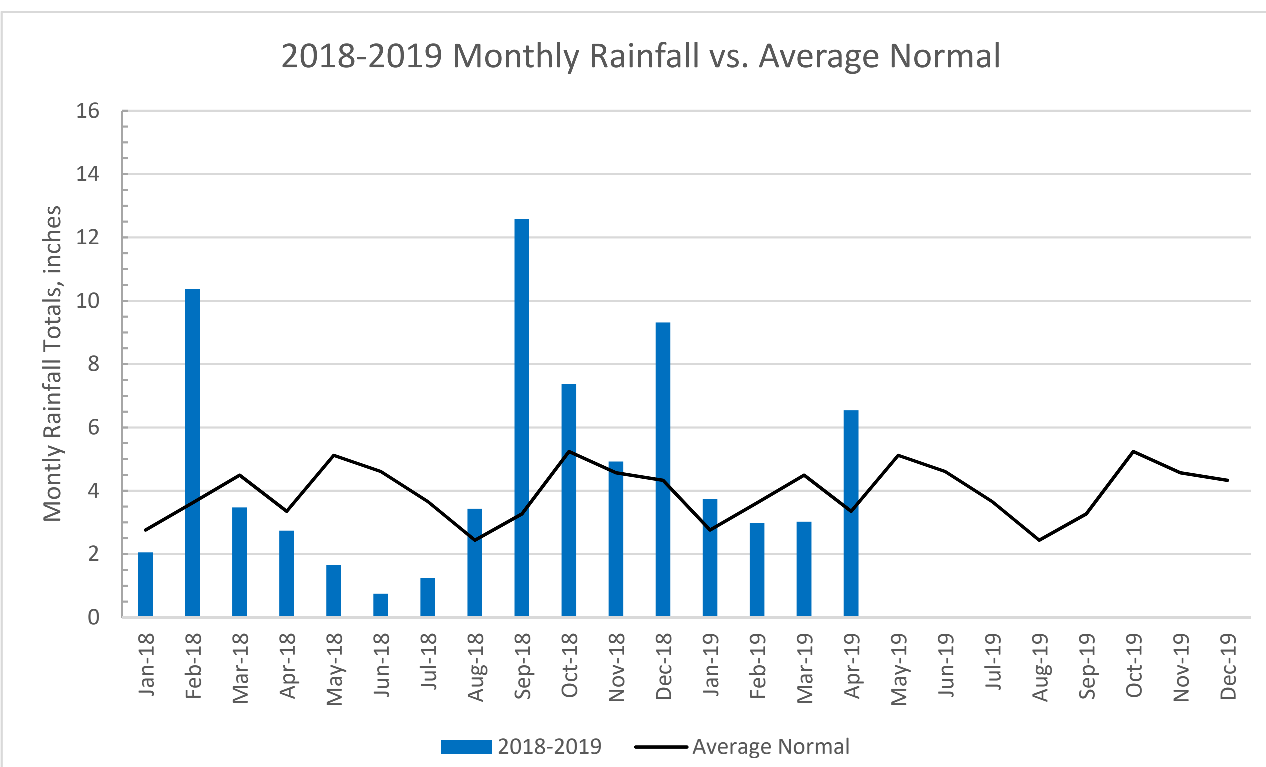


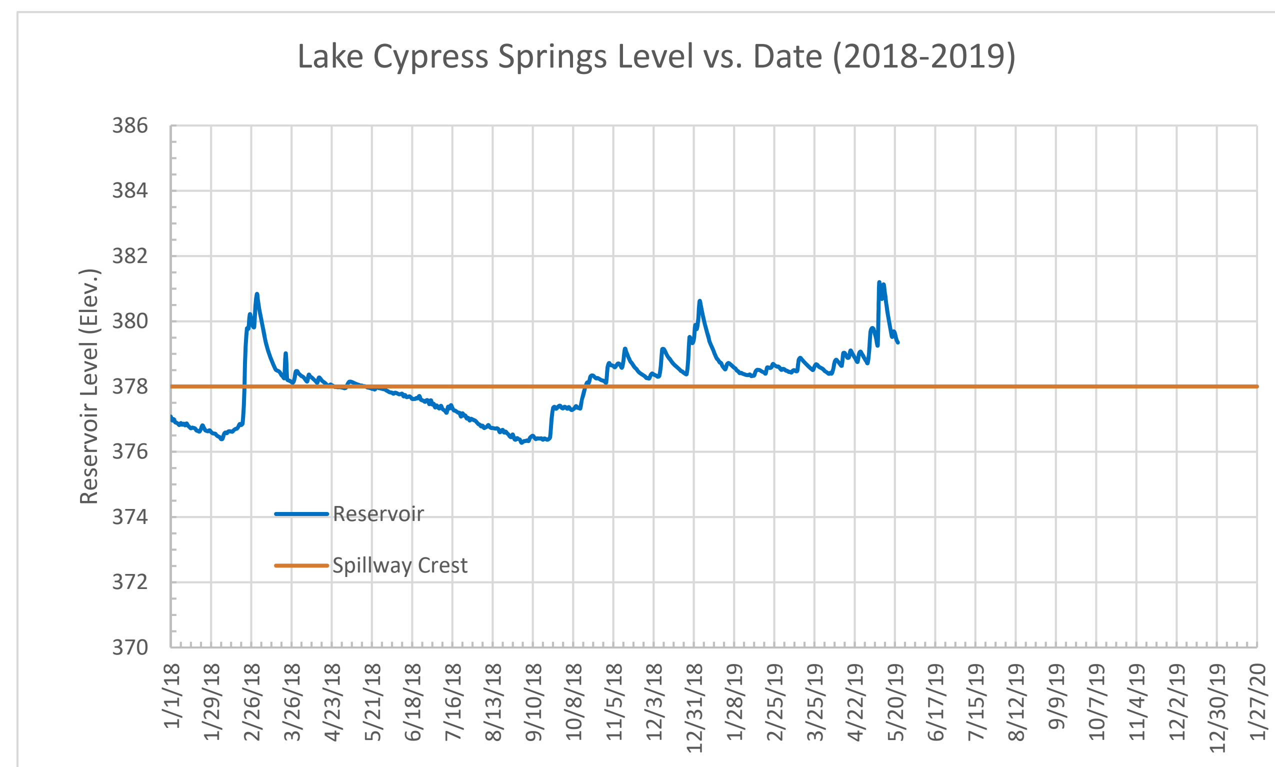


https://www.climate.gov/maps-data/dataset/past-weather-zip-code-data-table

https://www.fcwd.com/content/lake/lake.php

Photo A.4: Modified 3H:1V Slope – March 2019



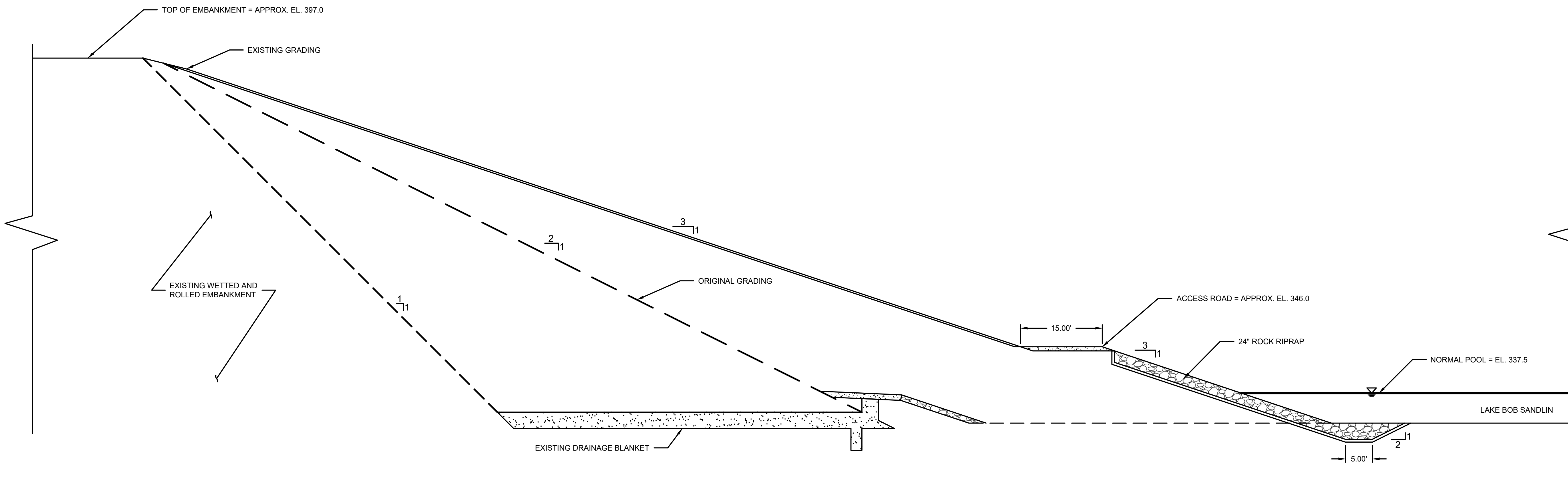


https://www.climate.gov/maps-data/dataset/past-weather-zip-code-data-table

https://www.fcwd.com/content/lake/lake.php

APPENDIX B

ALTERNATIVES TO RESTORE DOWNSTREAM SLOPE



TYPICAL EMBANKMENT SECTION

EXISTING

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REV	DESCRIPTION	DATE

DESIGNED BY: XXX
DRAWN BY: BPH
CHECKED BY: XXX

JAMES R. CROWDER, P.E.

DATE:

STATE PROFESSIONAL ENGINEER NO. XXXXX

Schnabel ENGINEERING

6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

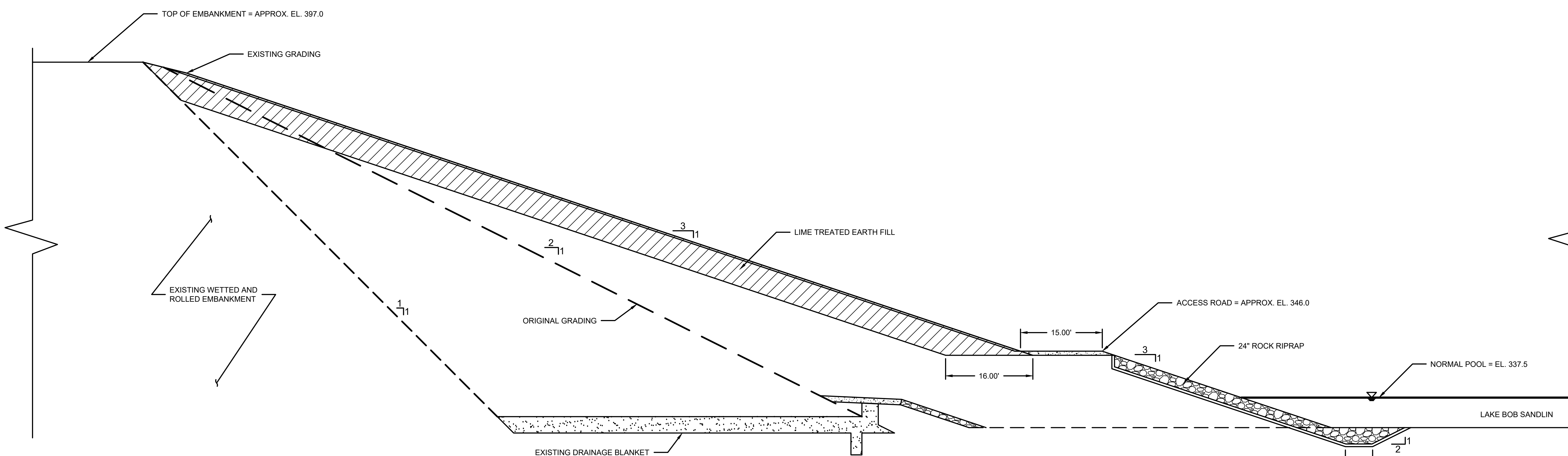
LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

EXISTING EMBANKMENT CONDITIONS

PROJECT: 19C17022.00

DATE: MAY 2019

SHEET
1 OF 3



EMBANKMENT SECTION

OPTION #1

SCALE: 1"=10'

0 10' 20'

DATE | DESCRIPTION | REV.

DESIGNED BY: XXX | DRAWN BY: BPH | CHECKED BY: XXX

JAMES R. CROWDER, P.E.

DATE:

STATE PROFESSIONAL ENGINEER NO. XXXXX

Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

EMBANKMENT REPAIR
OPTION #1

PROJECT: 19C17022.00
DATE: MAY 2019
SHEET
2 OF 3

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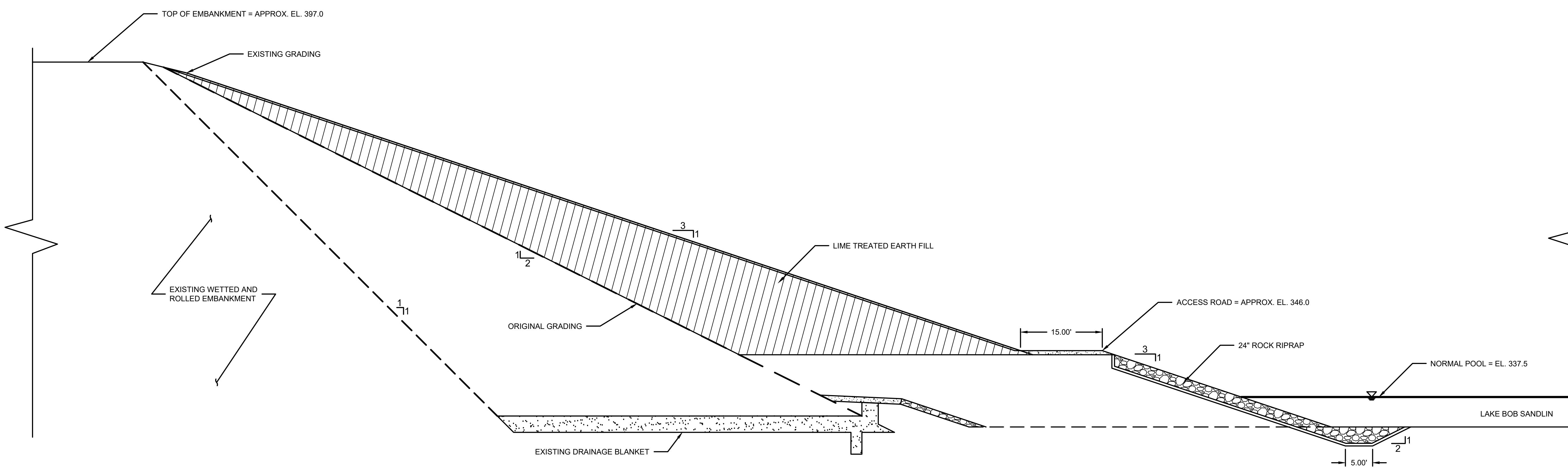

EMBANKMENT SECTION

OPTION #4

SCALE: 1"=10'

0 10' 20'

REV | DATE | DESCRIPTION

DESIGNED BY: XXX

DRAWN BY: BPH

CHECKED BY: XXX

JAMES R. CROWDER, P.E.

DATE:

STATE PROFESSIONAL ENGINEER NO. XXXXX

Schnabel
ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

EMBANKMENT REPAIR
OPTION #2

PROJECT: 19C17022.00

DATE: MAY 2019

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Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

OPTION 1 SITE PLAN

PROJECT: 19C17022.00
DATE: OCTOBER 2019
SHEET

SCALE: 1"=400'
0 400' 800'

REV | DESCRIPTION | DATE

DESIGNED BY:
DRAWN BY:
CHECKED BY:
DATE:

Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

OPTION 2 SITE PLAN

PROJECT: 19C17022.00
DATE: OCTOBER 2019
SHEET

G:\2019\ALPHARETTA\19C17022_00_LAKE_CYPRESS_SPRINGS_PRELIM_ENG\03-SEPRODUCTS\08-CADD\DRAWINGS\06-WORKING\SITEPLAN-LAYOUT.DWG

10/1/2019

ENGINEER'S OPINION OF COST
FRANKLIN COUNTY DAM
DOWNSTREAM SLOPE REPAIR
OPTION 1
(LIME TREATMENT ALTERNATIVE)

Base Item No.	Work or Material	Quantity	Unit	Unit Price	Amount
1	Pollution Control	1	LS	$ 119,000.00	$ 119,000.00
2	Sediment Fence	9000	LF	$ 3.50	$ 31,500.00
3	Vegetation Establishment (Dam)	14	AC	$ 5,000.00	$ 70,000.00
4	Vegetation Establishment (Staging Area)	16	AC	$ 4,000.00	$ 64,000.00
5	Vegetation Establishment (Borrow Area)	34	AC	$ 3,000.00	$ 102,000.00
6	Irrigation System	1	LS	$ 50,000.00	$ 50,000.00
7	Irrigation Water	10230	1000 GAL	$ 10.00	$ 102,300.00
8	Mobilization & Demobilization	1	LS	$ 260,000.00	$ 260,000.00
9	Clearing & Grubbing (Staging Area)	16	AC	$ 2,500.00	$ 40,000.00
10	Excavation, Common	76179	CY	$ 6.00	$ 457,074.00
11	Topsoil (Dam 12-Inch Thickness)*	66749	SY	$ 3.00	$ 200,247.00
12	Topsoil (Staging Area 12-Inch Thickness)*	77440	SY	$ 2.00	$ 154,880.00
13	Topsoil (Borrow Area 6-Inch Thickness)	168264	SY	$ 1.00	$ 168,264.00
14	Lime Treated Earthfill	57835	CY	$ 10.00	$ 578,350.00
15	Furnishing and Handling Lime (2%)	1640	TON	$ 200.00	$ 328,000.00
16	Construction Surveys	1	LS	$ 50,000.00	$ 50,000.00
				TOTAL	**$ 2,775,615.00**

Note: AC = Acres, CY = Cubic Yard, LF = Linear Feet, LS = Lump Sum, SY = Square Yard, TON = Ton, GAL = Gallon

*Option 1 includes the placement of a 12-inch thick layer of topsoil over the lime-treated fill on the downstream slope of the dam, as well as over the lime-treatment staging area

FRANKLIN COUNTY DAM (LAKE CYPRESS SPRINGS)
ESTIMATE OF CONSTRUCTION SCHEDULE
Franklin County, Texas
October 2019

Base Item No.	Work or Material	Quantity	Unit	Rate (per day)	Time (days)
1	Pollution Control	1	LS	14	14
2	Sediment Fence	9,000	LF	300	30
3	Vegetation Establishment (Dam)	14	AC	2	7
6	Irrigation System	1	LS	7	7
7	Irrigation Water	10,230	1000 GAL		35
8	Mobilization & Demobilization	1	LS	60	60
10	Excavation, Common	76,179	CY	3000	25
11	Topsoil (Dam 12-Inch Thickness)*	66,749	SY	2500	27
12	Topsoil (Staging Area 12-Inch Thickness)*	77,440	SY	5000	15
13	Topsoil (Borrow Area 6-Inch Thickness)	168,264	SY	10000	17
14	Lime Treated Earthfill	57,835	CY	2000	29
15	Furnishing and Handling Lime (2%)	1,640	TON		0
16	Construction Surveys	1	LS		0
			TOTAL	Days	266
				Weeks	38
				Months	8.8

10/1/2019

ENGINEER'S OPINION OF COST
FRANKLIN COUNTY DAM
DOWNSTREAM SLOPE REPAIR
OPTION 1A
(LIME TREATMENT ALTERNATIVE)

Base Item No.	Work or Material	Quantity	Unit	Unit Price	Amount
1	Pollution Control	1	LS	$ 113,000.00	$ 113,000.00
2	Sediment Fence	9000	LF	$ 3.50	$ 31,500.00
3	Vegetation Establishment (Dam)	14	AC	$ 5,000.00	$ 70,000.00
4	Vegetation Establishment (Staging Area)	16	AC	$ 4,000.00	$ 64,000.00
5	Vegetation Establishment (Borrow Area)	34	AC	$ 3,000.00	$ 102,000.00
6	Irrigation System	1	LS	$ 50,000.00	$ 50,000.00
7	Irrigation Water	10230	1000 GAL	$ 10.00	$ 102,300.00
8	Mobilization & Demobilization	1	LS	$ 250,000.00	$ 250,000.00
9	Clearing & Grubbing (Staging Area)	16	AC	$ 2,500.00	$ 40,000.00
10	Excavation, Common	76179	CY	$ 6.00	$ 457,074.00
11	Topsoil (Dam 6-Inch Thickness)*	66749	SY	$ 2.00	$ 133,498.00
12	Topsoil (Staging Area 6-Inch Thickness)*	77440	SY	$ 1.50	$ 116,160.00
13	Topsoil (Borrow Area 6-Inch Thickness)	168264	SY	$ 1.00	$ 168,264.00
14	Lime Treated Earthfill	57835	CY	$ 10.00	$ 578,350.00
15	Furnishing and Handling Lime (2%)	1640	TON	$ 200.00	$ 328,000.00
16	Construction Surveys	1	LS	$ 50,000.00	$ 50,000.00
				TOTAL	**$ 2,654,146.00**

Note: AC = Acres, CY = Cubic Yard, LF = Linear Feet, LS = Lump Sum, SY = Square Yard, TON = Ton, GAL = Gallon

*Option 1A includes the placement of a 6-inch thick layer of topsoil over the lime-treated fill on the downstream slope of the dam, as well as over the lime-treatment staging area

FRANKLIN COUNTY DAM (LAKE CYPRESS SPRINGS)
ESTIMATE OF CONSTRUCTION SCHEDULE
LIME TREATMENT ALTERNATIVE
Franklin County, Texas
October 2019

Base Item No.	Work or Material	Quantity	Unit	Rate (per day)	Time (days)
1	Pollution Control	1	LS	14	14
2	Sediment Fence	9,000	LF	300	30
3	Vegetation Establishment (Dam)	14	AC	2	7
6	Irrigation System	1	LS	7	7
7	Irrigation Water	10,230	1000 GAL		35
8	Mobilization & Demobilization	1	LS	60	60
10	Excavation, Common	76,179	CY	3000	25
11	Topsoil (Dam 6-Inch Thickness)*	66,749	SY	5000	13
12	Topsoil (Staging Area 6-Inch Thickness)*	77,440	SY	10000	8
13	Topsoil (Borrow Area 6-Inch Thickness)	168,264	SY	10000	17
14	Lime Treated Earthfill	57,835	CY	2000	29
15	Furnishing and Handling Lime (2%)	1,640	TON		0
16	Construction Surveys	1	LS		0
			TOTAL	Days	245
				Weeks	35
				Months	8.1

10/1/2019

ENGINEER'S OPINION OF COST
FRANKLIN COUNTY DAM
DOWNSTREAM SLOPE REPAIR
OPTION 2
(EARTHFILL REPLACEMENT ALTERNATIVE)

Base Item No.	Work or Material	Quantity	Unit	Unit Price	Amount
1	Pollution Control	1	LS	$ 120,000.00	$ 120,000.00
2	Sediment Fence	9500	LF	$ 3.50	$ 33,250.00
3	Vegetation Establishment (Dam)	14	AC	$ 5,000.00	$ 70,000.00
4	Vegetation Establishment (Disposal Area)*	14	AC	$ 4,000.00	$ 56,000.00
5	Vegetation Establishment (Borrow Area)	34	AC	$ 3,000.00	$ 102,000.00
6	Irrigation System	1	LS	$ 50,000.00	$ 50,000.00
7	Irrigation Water	8948	1000 GAL	$ 10.00	$ 89,480.00
8	Mobilization & Demobilization	1	LS	$ 260,000.00	$ 260,000.00
9	Excavation, Common	132460	CY	$ 6.50	$ 860,990.00
10	Topsoil (Dam 6-Inch Thickness)	66749	SY	$ 2.00	$ 133,498.00
11	Topsoil (Disposal Area 6-Inch)*	68743	SY	$ 1.50	$ 103,114.50
12	Topsoil (Borrow Area 6-Inch Thickness)	168264	SY	$ 1.00	$ 168,264.00
13	Earthfill	114116	CY	$ 10.00	$ 1,141,160.00
14	Construction Surveys	1	LS	$ 50,000.00	$ 50,000.00
				TOTAL	**$ 3,237,756.50**

Note: AC = Acres, CY = Cubic Yard, LF = Linear Feet, LS = Lump Sum, SY = Square Yard, TON = Ton, GAL = Gallon

*Option 2 includes placing topsoil over the disposal area at the completion of construction to facilitate revegetation of that area, as well as establishing permanent vegetation

FRANKLIN COUNTY DAM (LAKE CYPRESS SPRINGS)
ESTIMATE OF CONSTRUCTION SCHEDULE (OPTION 2)
Franklin County, Texas
October 2019

Base Item No.	Work or Material	Quantity	Unit	Rate (per day)	Time (days)
1	Pollution Control	1	LS	14	14
2	Sediment Fence	9,500	LF	300	32
3	Vegetation Establishment (Dam)	14	AC	2	7
6	Irrigation System	1	LS	2	2
7	Irrigation Water	8,948	1000 GAL		35
8	Mobilization & Demobilization	1	LS	14	14
9	Excavation, Common	132,460	CY	1500	88
10	Topsoil (Dam 6-Inch Thickness)	66,749	SY	5000	13
11	Topsoil (Disposal Area 6-Inch)*	68,743	SY	5000	14
12	Topsoil (Borrow Area 6-Inch Thickness)	168,264	SY	5000	34
13	Earthfill	114,116	SY	5000	23
14	Construction Surveys	1	SY		
			TOTAL	Days	276
				Weeks	39
				Months	9.1

10/1/2019

ENGINEER'S OPINION OF COST
FRANKLIN COUNTY DAM
DOWNSTREAM SLOPE REPAIR
OPTION 2A
(EARTHFILL REPLACEMENT ALTERNATIVE)

Base Item No.	Work or Material	Quantity	Unit	Unit Price	Amount
1	Pollution Control	1	LS	$ 120,000.00	$ 120,000.00
2	Sediment Fence	9500	LF	$ 3.50	$ 33,250.00
3	Vegetation Establishment (Dam)	14	AC	$ 5,000.00	$ 70,000.00
4	Vegetation Establishment (Disposal Area)*	0	AC	$ 4,000.00	$ -
5	Vegetation Establishment (Borrow Area)	34	AC	$ 3,000.00	$ 102,000.00
6	Irrigation System	1	LS	$ 50,000.00	$ 50,000.00
7	Irrigation Water	8948	1000 GAL	$ 10.00	$ 89,480.00
8	Mobilization & Demobilization	1	LS	$ 260,000.00	$ 260,000.00
9	Excavation, Common	132460	CY	$ 6.50	$ 860,990.00
10	Topsoil (Dam 6-Inch Thickness)	66749	SY	$ 2.00	$ 133,498.00
11	Topsoil (Disposal Area 6-Inch)*	0	SY	$ -	$ -
12	Topsoil (Borrow Area 6-Inch Thickness)	168264	SY	$ 1.00	$ 168,264.00
13	Earthfill	114116	CY	$ 10.00	$ 1,141,160.00
14	Construction Surveys	1	LS	$ 50,000.00	$ 50,000.00
				TOTAL	**$ 3,078,642.00**

Note: AC = Acres, CY = Cubic Yard, LF = Linear Feet, LS = Lump Sum, SY = Square Yard, TON = Ton, GAL = Gallon

*Option 2A does not include placing topsoil over the disposal area at the completion of construction to facilitate revegetation of that area, nor does this option include vegetation establishment over this area

FRANKLIN COUNTY DAM (LAKE CYPRESS SPRINGS)
ESTIMATE OF CONSTRUCTION SCHEDULE (OPTION 2A)
EARTHFILL REPLACEMENT ALTERNATIVE
Franklin County, Texas
October 2019

Base Item No.	Work or Material	Quantity	Unit	Rate (per day)	Time (days)
1	Pollution Control	1	LS	14	14
2	Sediment Fence	9,500	LF	300	32
3	Vegetation Establishment (Dam)	14	AC	2	7
6	Irrigation System	1	LS	2	2
7	Irrigation Water	8,948	1000 GAL		35
8	Mobilization & Demobilization	1	LS	14	14
9	Excavation, Common	132,460	CY	1500	88
10	Topsoil (Dam 6-Inch Thickness)	66,749	SY	5000	13
11	Topsoil (Disposal Area 6-Inch)*	0	SY		
12	Topsoil (Borrow Area 6-Inch Thickness)	168,264	SY	5000	34
13	Earthfill	114,116	SY	5000	23
14	Construction Surveys	1	SY		

TOTAL	Days	262
	Weeks	37
	Months	8.6

APPENDIX C

OTHER CONSIDERATIONS

PHOTO NUMBER: 1

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 2

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

Schnabel ENGINEERING	FRANKLIN COUNTY DAM SITE VISIT PHOTOGRAPHS Franklin County, Texas PROJECT NO. 19C17022.00	

PHOTO NUMBER: 3

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 4

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

Schnabel ENGINEERING

FRANKLIN COUNTY DAM
SITE VISIT PHOTOGRAPHS
Franklin County, Texas
PROJECT NO. 19C17022.00

PHOTO NUMBER: 5

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 6

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 7

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 8

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 9

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 10

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 11

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 12

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

Schnabel ENGINEERING	FRANKLIN COUNTY DAM SITE VISIT PHOTOGRAPHS Franklin County, Texas PROJECT NO. 19C17022.00

PHOTO NUMBER: 13

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 14

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 15

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 16

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 17

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 18

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 19

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 20

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 21

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

PHOTO NUMBER: 22

DATE TAKEN: 12/4/2018

LOCATION:

COMMENTS:

NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS

REV	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY:
CHECKED BY:
DATE:

Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

DAM SECTION 'A'
PIEZOMETER LOCATIONS

PROJECT: 19C17022.00
DATE: OCTOBER 2019
SHEET

G:\2019\ALPHARETTA\19C17022_00_LAKE_CYPRESS_SPRINGS_PRELIM_ENG\03-SEPRODUCTS\08-CAD\DRAWINGS\06-WORKING\SITEPLAN-LAYOUT.DWG

NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS

REV	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY:
CHECKED BY:
DATE:

Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
schnabel-eng.com

LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

DAM SECTION 'B' PIEZOMETER LOCATIONS

PROJECT: 19C17022.00
DATE: OCTOBER 2019
SHEET

NOTE: PIEZOMETER LOCATIONS HAVE BEEN APPROXIMATED BASED ON FCWD RECORDS

REV	DESCRIPTION	DATE

DESIGNED BY:

DRAWN BY:

CHECKED BY:

DATE:

Schnabel ENGINEERING
6445 Shiloh Road, Suite A / Alpharetta, GA 30005 /
Phone: 770-781-8008 / Fax: 770-781-8003 /
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LAKE CYPRESS SPRINGS
FRANKLIN COUNTY WATER DISTRICT
FRANKLIN COUNTY, TEXAS

DAM SECTION 'C' PIEZOMETER LOCATIONS

PROJECT: 19C17022.00

DATE: OCTOBER 2019

SHEET

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Franklin County Dam Drain Data Sheet

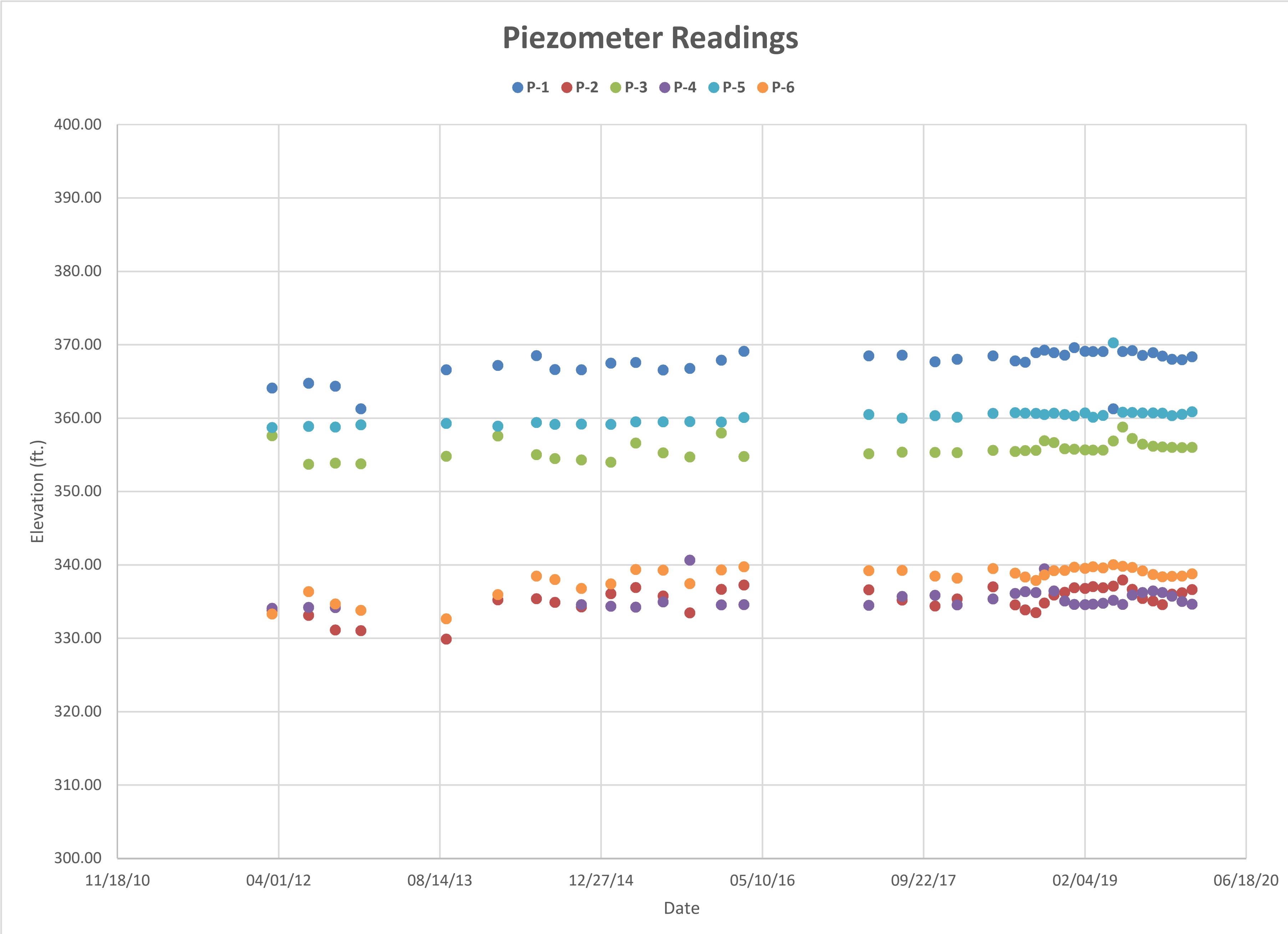
10/3/2019

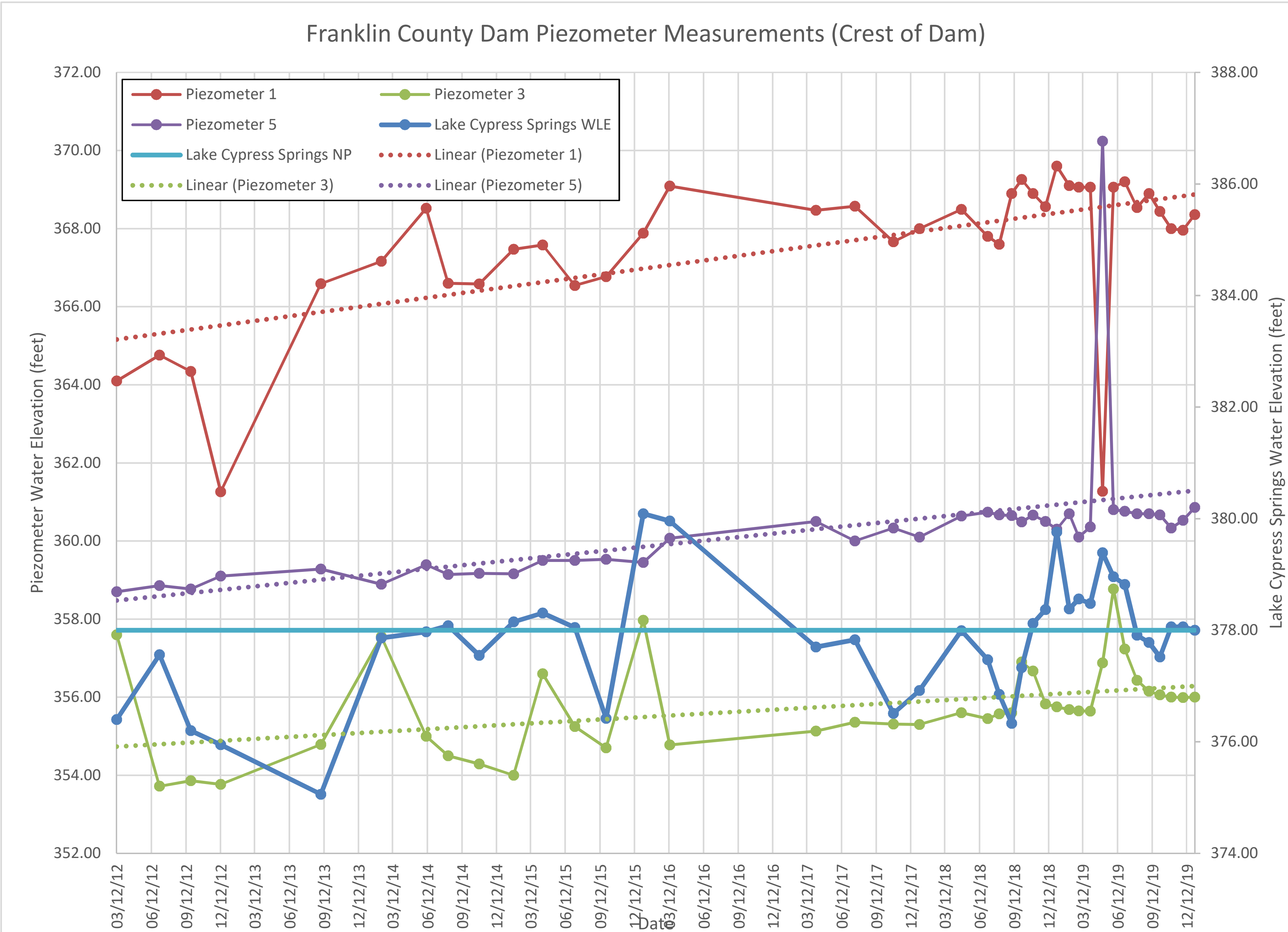
Check Date	Drain Number													
	NORTH D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	SOUTH D-14
07/03/18	No	No	No	Yes	No	No	No	No	No	No	No	No	Yes	No
08/04/18	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
09/05/18	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
10/01/18	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
10/31/18	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
12/03/18	No	No	No	No	No	Yes	No	No	No	No	No	No	Yes	No
01/02/19	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
02/04/19	No	No	No	Yes	No	No	No	No	Yes	No	No	Yes	Yes	No
03/01/19	No	No	No	No	Yes	No	No	No	No	Yes	No	Yes	Yes	No
04/01/19	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
05/03/19	No	No	No	No	Yes	No	No	No	No	Yes	No	Yes	Yes	No
06/01/19	No	No	No	Yes	Yes	No	No	No	No	Yes	No	Yes	Yes	No
07/01/19	No	No	No	No	No	Yes	No	No	No	No	No	No	Yes	No
08/02/19	No	No	No	No	Yes	No	No	No	No	Yes	No	Yes	Yes	No
09/03/19	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
10/02/19	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
11/01/19	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
12/02/19	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
01/02/20	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No

Franklin County Dam Piezometer Data Sheet

1/24/2020

Sample Date	Lake Elevation	Lake Normal Pool	Tailwater Elevation	Tailwater Normal Pool	Piezometer Number											
					P-1		P-2		P-3		P-4		P-5		P-6	
	Lake Cypress Springs	Lake Cypress Springs	Lake Bob Sandlin	Lake Bob Sandlin	398		347		398		347		397.5		347	
					Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation
03/12/12	376.40	378.00	331.71	337.50	33.9	364.10	13.20	333.80	40.40	357.60	12.90	334.10	38.80	358.70	13.70	333.30
07/03/12	377.56	378.00		337.50	33.24	364.76	13.87	333.13	44.28	353.72	12.80	334.20	38.64	358.86	10.66	336.34
09/24/12	376.20	378.00		337.50	33.66	364.34	15.88	331.12	44.14	353.86	12.82	334.18	38.73	358.77	12.33	334.67
12/12/12	375.95	378.00		337.50	36.74	361.26	15.95	331.05	44.23	353.77			38.40	359.10	13.18	333.82
09/03/13	375.06	378.00		337.50	31.41	366.59	17.10	329.90	43.21	354.79			38.22	359.28	14.34	332.66
02/10/14	377.86	378.00		337.50	30.84	367.16	11.77	335.23	40.45	357.55			38.61	358.89	11.04	335.96
06/09/14	377.97	378.00		337.50	29.48	368.52	11.61	335.39	43.00	355.00			38.11	359.39	8.54	338.46
08/06/14	378.08	378.00		337.50	31.40	366.60	12.10	334.90	43.50	354.50			38.36	359.14	9.00	338.00
10/27/14	377.55	378.00		337.50	31.42	366.58	12.74	334.26	43.71	354.29	12.43	334.57	38.33	359.17	10.21	336.79
01/26/15	378.15	378.00		337.50	30.53	367.47	10.92	336.08	44.00	354.00	12.64	334.36	38.34	359.16	9.60	337.40
04/13/15	378.31	378.00		337.50	30.42	367.58	10.10	336.90	41.40	356.60	12.75	334.25	38.00	359.50	7.62	339.38
07/07/15	378.05	378.00		337.50	31.46	366.54	11.24	335.76	42.75	355.25	12.04	334.96	38.00	359.50	7.71	339.29
09/28/15	376.42	378.00		337.50	31.23	366.77	13.54	333.46	43.30	354.70	6.34	340.66	37.97	359.53	9.55	337.45
01/04/16	380.09	378.00		337.50	30.12	367.88	10.34	336.66	40.03	357.97	12.45	334.55	38.05	359.45	7.70	339.30
03/14/16	379.96	378.00		337.50	28.91	369.09	9.75	337.25	43.22	354.78	12.41	334.59	37.43	360.07	7.26	339.74
04/05/17	377.70	378.00		337.50	29.53	368.47	10.40	336.60	42.87	355.13	12.50	334.50	37.00	360.50	7.77	339.23
07/17/17	377.83	378.00		337.50	29.43	368.57	11.81	335.19	42.64	355.36	11.30	335.70	37.50	360.00	7.76	339.24
10/27/17	376.51	378.00		337.50	30.34	367.66	12.60	334.40	42.69	355.31	11.15	335.85	37.17	360.33	8.52	338.48
01/04/18	376.92	378.00		337.50	30.00	368.00	11.64	335.36	42.70	355.30	12.45	334.55	37.40	360.10	8.80	338.20
04/25/18	377.99	378.00		337.50	29.51	368.49	10.00	337.00	42.40	355.60	11.63	335.37	36.86	360.64	7.50	339.50
07/03/18	377.47	378.00	337.04	337.50	30.20	367.80	12.44	334.56	42.55	355.45	10.90	336.10	36.76	360.74	8.13	338.87
08/03/18	376.85	378.00	336.60	337.50	30.40	367.60	13.13	333.87	42.43	355.57	10.65	336.35	36.83	360.67	8.65	338.35
09/05/18	376.33	378.00	336.12	337.50	29.10	368.90	13.50	333.50	42.40	355.60	10.76	336.24	36.85	360.65	9.11	337.89
10/01/18	377.33	378.00	337.03	337.50	28.74	369.26	12.21	334.79	41.10	356.90	7.52	339.48	37.01	360.49	8.36	338.64
10/31/18	378.12	378.00	337.63	337.50	29.10	368.90	11.10	335.90	41.33	356.67	10.54	336.46	36.84	360.66	7.78	339.22
12/03/18	378.37	378.00	337.74	337.50	29.44	368.56	10.73	336.27	42.17	355.83	11.92	335.08	37.00	360.50	7.76	339.24
01/02/19	379.76	378.00	338.01	337.50	28.40	369.60	10.12	336.88	42.25	355.75	12.38	334.62	37.20	360.30	7.32	339.68
02/04/19	378.38	378.00	337.68	337.50	28.90	369.10	10.20	336.80	42.32	355.68	12.41	334.59	36.80	360.70	7.47	339.53
03/01/19	378.56	378.00	337.97	337.50	28.94	369.06	9.97	337.03	42.35	355.65	12.36	334.64	37.40	360.10	7.24	339.76
04/01/19	378.48	378.00	337.90	337.50	28.94	369.06	10.13	336.87	42.36	355.64	12.22	334.78	37.14	360.36	7.42	339.58
05/03/19	379.39	378.00	338.37	337.50	36.73	361.27	9.91	337.09	41.12	356.88	11.84	335.16	27.26	370.24	6.96	340.04
06/01/19	378.96	378.00	337.94	337.50	28.94	369.06	9.05	337.95	39.23	358.77	12.40	334.60	36.70	360.80	7.20	339.80
07/01/19	378.82	378.00	337.78	337.50	28.80	369.20	10.34	336.66	40.77	357.23	11.10	335.90	36.74	360.76	7.36	339.64
08/02/19	377.91	378.00	337.33	337.50	29.46	368.54	11.57	335.43	41.57	356.43	10.78	336.22	36.80	360.70	7.82	339.18
09/03/19	377.78	378.00	336.84	337.50	29.10	368.90	11.92	335.08	41.85	356.15	10.54	336.46	36.80	360.70	8.30	338.70
10/02/19	377.52	378.00	336.53	337.50	29.56	368.44	12.42	334.58	41.94	356.06	10.77	336.23	36.83	360.67	8.62	338.38
11/01/19	378.06	378.00	336.71	337.50	30.00	368.00	11.00	336.00	42.00	356.00	11.27	335.73	37.17	360.33	8.56	338.44
12/02/19	378.06	378.00	336.70	337.50	30.04	367.96	10.80	336.20	42.01	355.99	11.99	335.01	36.97	360.53	8.52	338.48
01/02/20	378.00	378.00	336.74	337.50	29.64	368.36	10.38	336.62	42.00	356.00	12.35	334.65	36.64	360.86	8.23	338.77


Piezometer Readings
P-1
P-2
P-3
P-4
P-5
P-6
400.00
390.00
380.00
370.00
360.00
350.00
340.00
330.00
320.00
310.00
300.00
Elevation (ft.)
11/18/10
04/01/12
08/14/13
12/27/14
05/10/16
09/22/17
02/04/19
06/18/20
Date


Franklin County Dam Piezometer Measurements (Crest of Dam)
Piezometer 1
Piezometer 3
Piezometer 5
Lake Cypress Springs WLE
Lake Cypress Springs NP
Linear (Piezometer 1)
Linear (Piezometer 3)
Linear (Piezometer 5)
Piezometer Water Elevation (feet)
Lake Cypress Springs Water Elevation (feet)
Date
372.00
370.00
368.00
366.00
364.00
362.00
360.00
358.00
356.00
354.00
352.00
388.00
386.00
384.00
382.00
380.00
378.00
376.00
374.00
03/12/12
06/12/12
09/12/12
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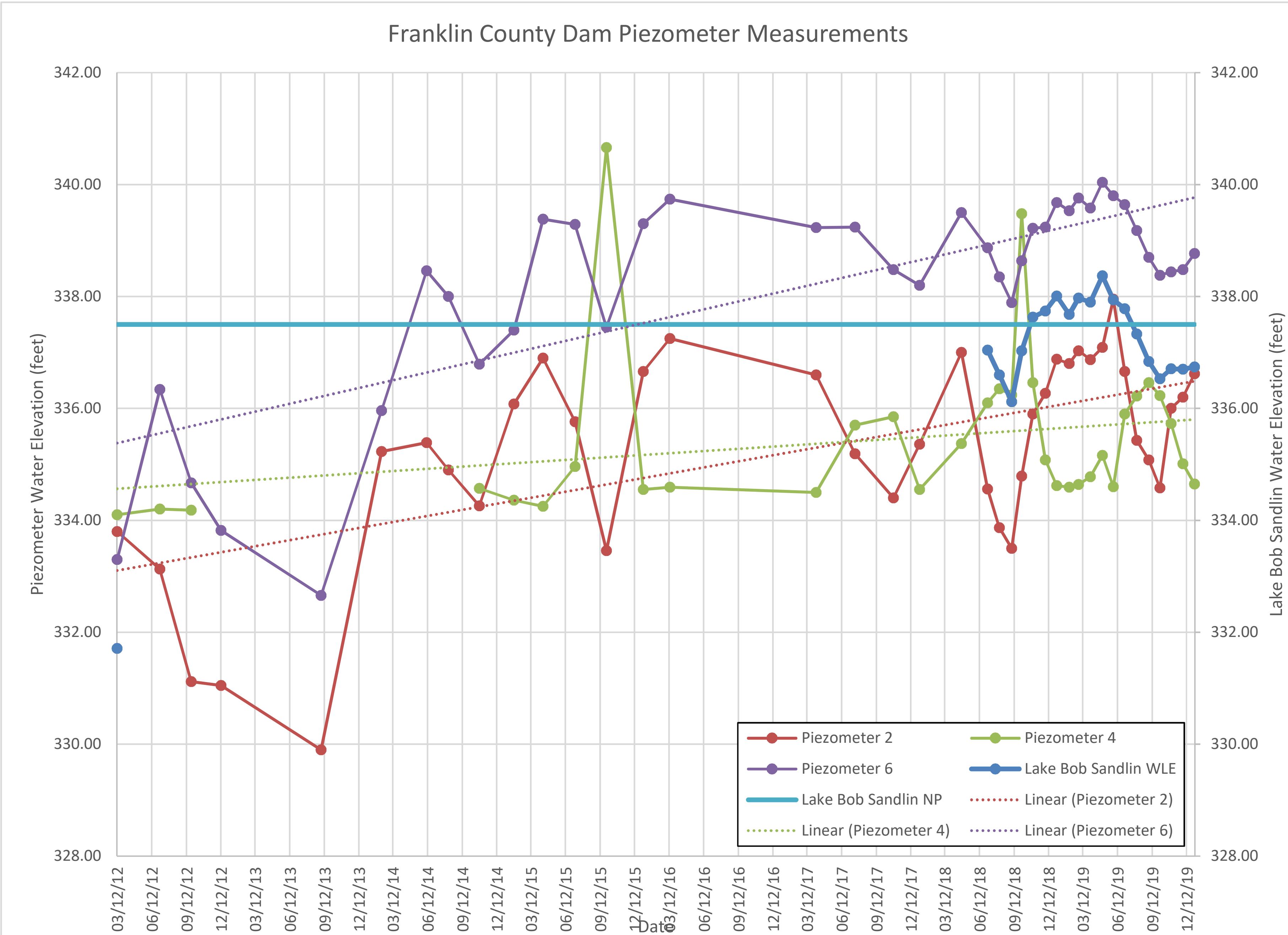
09/12/19
12/12/19


Franklin County Dam Piezometer Measurements
Piezometer Water Elevation (feet)
Lake Bob Sandlin Water Elevation (feet)
342.00
340.00
338.00
336.00
334.00
332.00
330.00
328.00
Date
03/12/12
06/12/12
09/12/12
12/12/12
03/12/13
06/12/13
09/12/13
12/12/13
03/12/14
06/12/14
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03/12/17
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09/12/17
12/12/17
03/12/18
06/12/18
09/12/18
12/12/18
03/12/19
06/12/19
09/12/19
12/12/19
Piezometer 2
Piezometer 4
Piezometer 6
Lake Bob Sandlin WLE
Lake Bob Sandlin NP
Linear (Piezometer 2)
Linear (Piezometer 4)
Linear (Piezometer 6)

Appendix B

ARROYO ENVIRONMENTAL EVALUATION REPORT

ENVIRONMENTAL EVALUATION OF LAKE CYPRESS SPRINGS DAM RESTORATION

10/1/2019

Environmental Evaluation of Two Proposed Infrastructure Modifications to Lake Cypress Springs Dam

Prepared by: Arroyo Environmental Consultants, LLC

Prepared for: Franklin County Water District and Carollo Engineers, Inc.

Environmental Evaluation of Lake Cypress Springs Dam Restoration

ENVIRONMENTAL EVALUATION OF TWO PROPOSED INFRASTRUCTURE MODIFICATIONS TO LAKE CYPRESS SPRINGS DAM

INTRODUCTION

Arroyo Environmental Consultants, LLC (Arroyo) was hired to perform an environmental review of two proposed conceptual design options for remediation measures at the Lake Cypress Springs Dam. This work is in support of on-going engineering services Carollo Engineers, Inc. (Carollo) is providing for the Franklin County Water District. As a subconsultant to Carollo, Arroyo performed a desktop review of potential environmental liabilities present near the proposed project area including: threatened and endangered species review, jurisdictional waters and wetland review, historical/archeological area review, review of potential environmental permitting requirements, and preliminary coordination with pertinent environmental agency staff (Figure 1).

Background

Lake Cypress Springs is located in Franklin County, Texas approximately 60 miles east of the Dallas metropolitan area. Lake Cypress Springs impounds Big Cypress Creek and has an area of approximately 3,460 surface acres. Currently there is one morning glory structure that allows water to discharge from Lake Cypress Springs to Lake Bob Sandlin, and an emergency spillway located on the north shoreline of Lake Cypress Springs near the dam. The emergency spillway flows into Andy's Creek, a USGS topographic map designated intermittent stream (Figure 2).

Ecoregion

This area is located on the border of two Environmental Protection Agency (EPA) Level III ecoregions: the East Central Texas Plains and the South Central Plains (Figure 3). The South Central Plains, commonly referred to as the "Piney Woods", is considered the western edge of the coniferous forest. This ecoregion was originally dominated by a pine-hardwood forest mix. Currently, two thirds of the ecoregion is dominated by loblolly and shortleaf pine stands. The East Central Texas Plains are also known as the "Post Oak Savannah". Historically the vegetation has been post oak savannah vegetation, thus differing from the Piney Woods to the east and the prairies to the north, south and west. This ecoregion also has a unique dense underlying clay pan that differs from surrounding ecoregions.

Soils

Soils within the proposed project area can be generally described as being of a sandy loam mixture with some soils having more silt or clay portions (Figure 4). Slopes within the project area range from less than five percent (Bernaldo [BbB] – fine sandy loam, Bowie [BoC] – fine sandy loam, Freestone [FrB] – fine sandy loam, Kirvin [KfC] – very fine sandy loam, Kirven [KgC] – gravelly fine sandy loam, Woodtell [WoC] – fine sandy loam) to five to twenty percent (Cuthbert [CsE] – fine sandy loam, and Woodtell [WoE] – fine sandy loam). Udorthents (Ud) is described as loamy and clayey and is associated with the emergency spillway area. Nahatche [Na] is described as frequently flooded and is along Andy's Creek (Figure 4; USDA 2018).

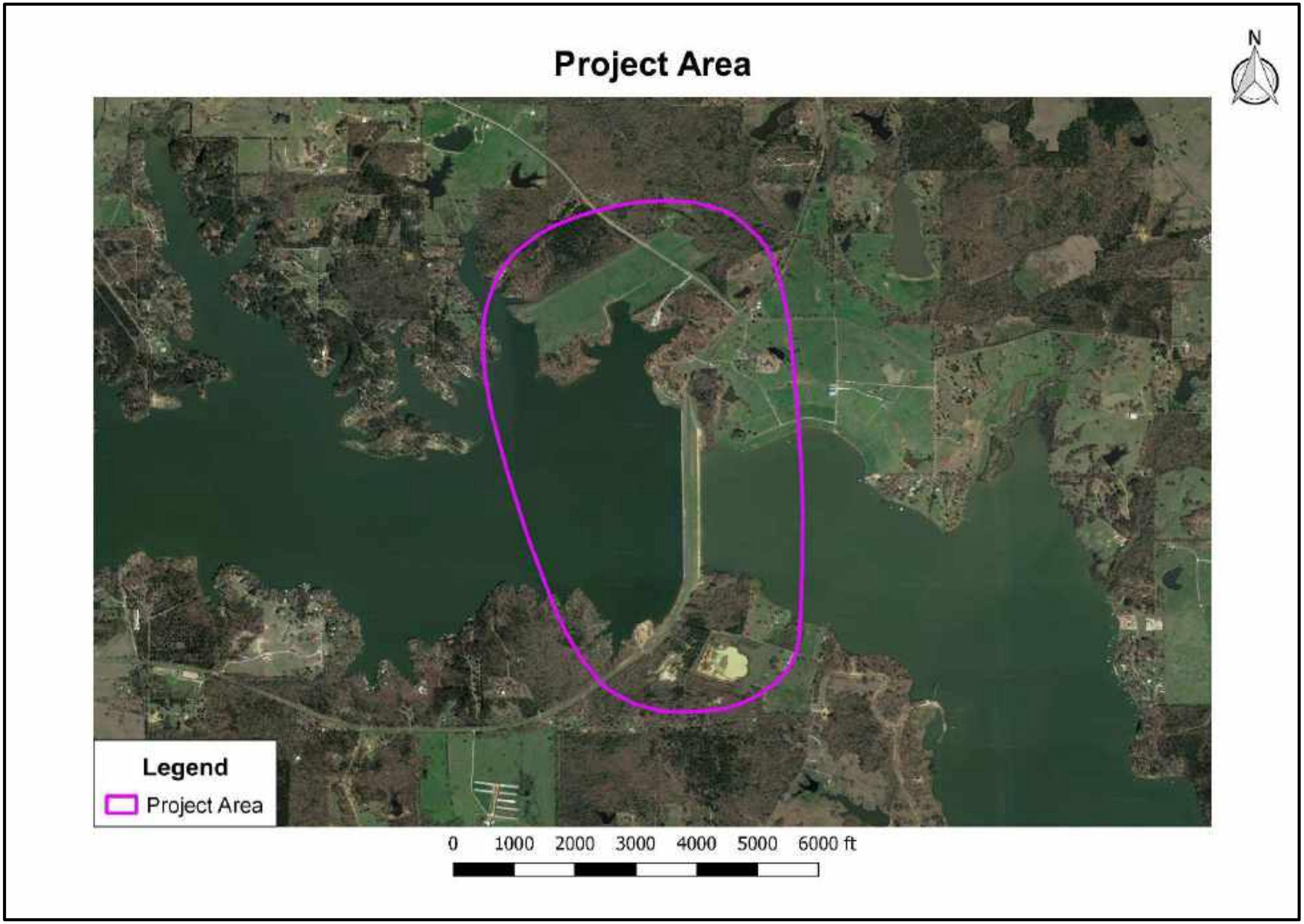

FIGURE 1. PROPOSED PROJECT AREA

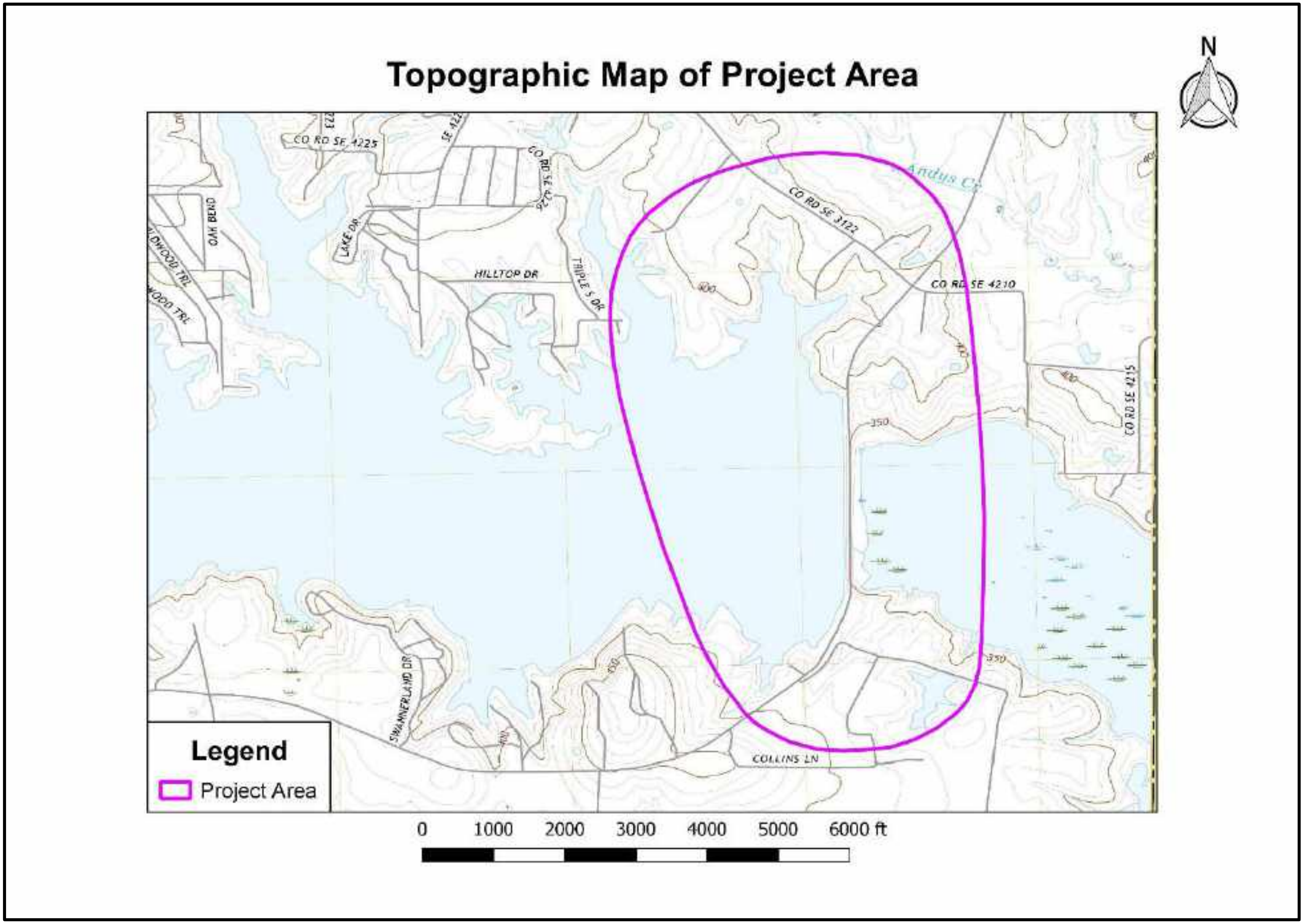

FIGURE 2. TOPOGRAPHIC MAP OF THE PROPOSED PROJECT AREA

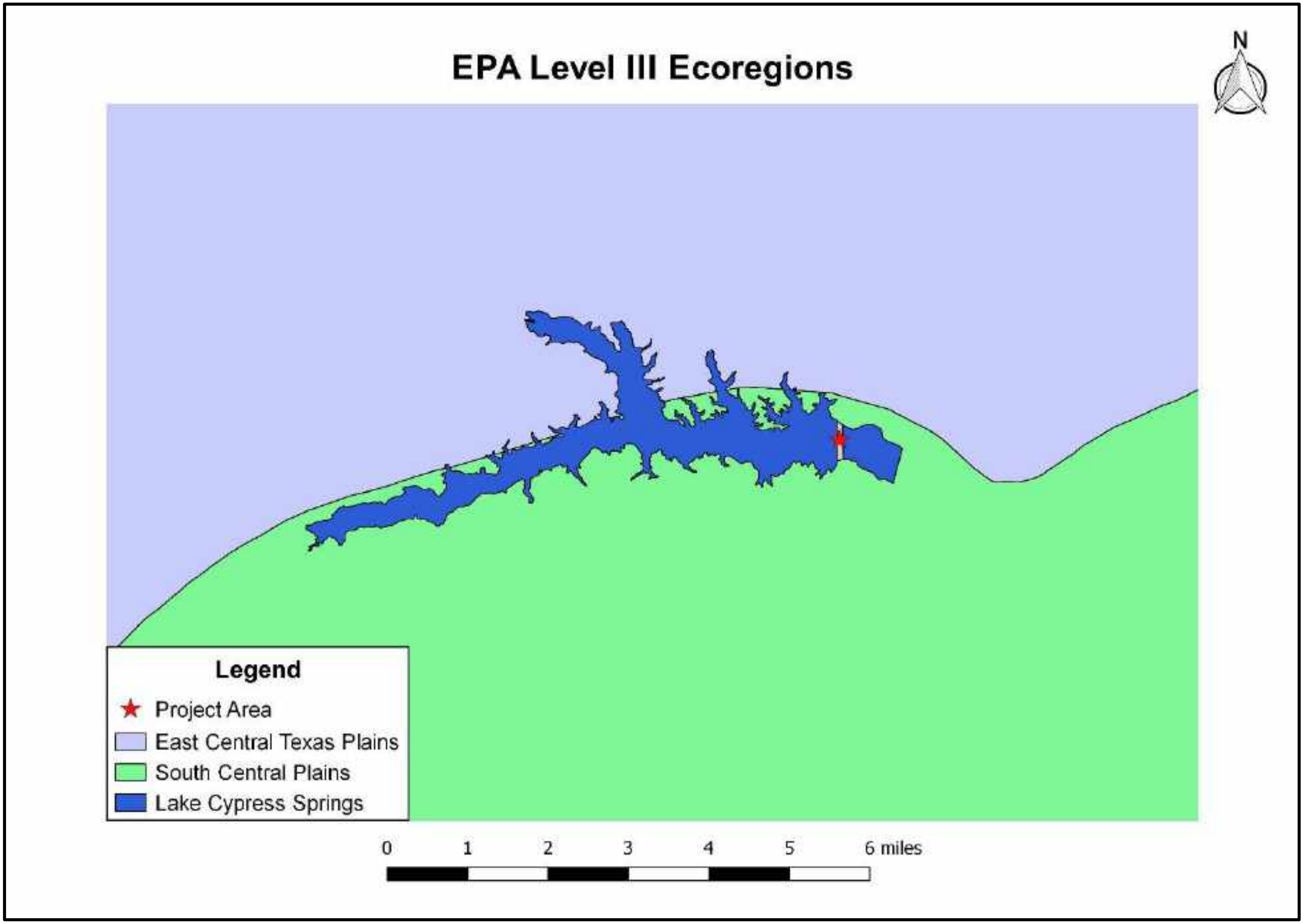

FIGURE 3. PROJECT AREA AND LEVEL III ECOREGIONS

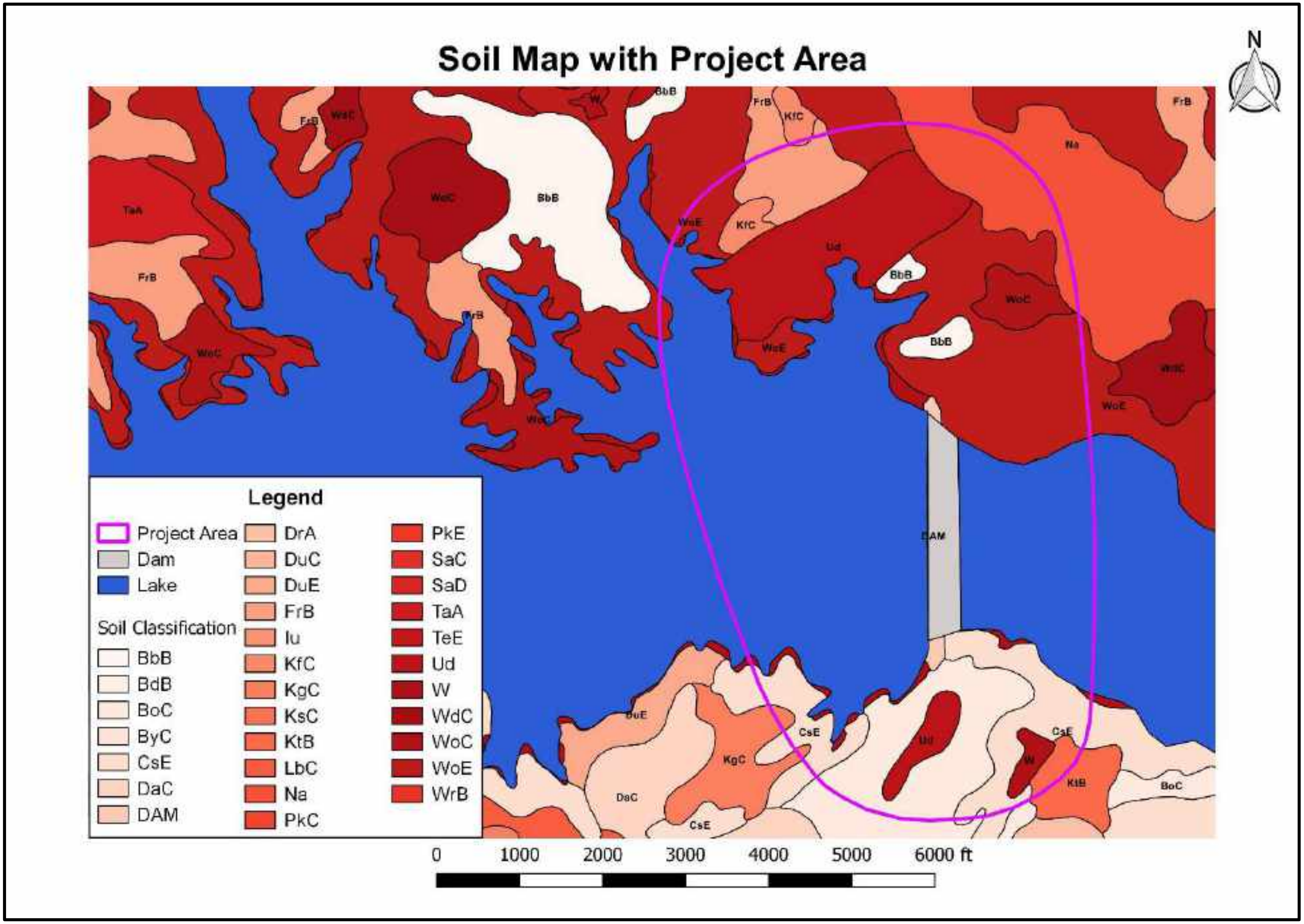

FIGURE 4. SOIL MAP FOR PROPOSED PROJECT AREA

Threatened and Endangered Species

A review of federal and state threatened and endangered species was conducted for the proposed project area (Appendix A). A desktop analysis of the data gathered for this review shows critical habitat for several state threatened species likely to occur within the project area mainly associated with forested areas. It is assumed if critical habitat for a species is present then the species is likely to occur. Species likely to occur within the project area are: Bachman's sparrow (*Peucaea aestivalis*), Bald eagle (*Haliaeetus leucocephalus*), Interior least tern (*Stermila antillarum athalassos*), Swallow-tailed kite (*Elanoides forficatus*) and Alligator snapping turtle (*Macrochelys temminckii;* see Table 1).

If forested areas are disturbed as part of the construction process, additional impact analysis will be required for the species identified above. This would likely include more in-depth literature research on critical habitat and species requirements and a site-specific species plan for construction activities.

TABLE 1. THREATENED AND ENDANGERED SPECIES (T = THREATENED; E = ENDANGERED; LT = LISTED THREATENED; LE = LISTED ENDANGERED)

Franklin County Threatened, Endangered and Species of Concern				
Species		Status		Comments
Common Name	Scientific Name	Federal	State	
Bachman's sparrow	*Peucaea aestivalis*		T	Anticipated. Preferred habitat within project area. Project activities may adversely affect.
Open pine woods with scattered bushes and grassy understory in Piney woods region, brushy or overgrown grassy hillsides, overgrown fields with thickets and brambles, grassy orchards; remnant grasslands in Post Oak Savannah region; nests on ground against grass tuft or under low shrub.				
Bald Eagle	*Haliaeetus leucocephalus*		T	Anticipated. Preferred habitat within project area; however, project activities are not likely to adversely affect.
Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.				
Interior least tern	*Stermila antillarum athalassos*	LE	E	Anticipated. Preferred habitat within project area; however, project activities are not likely to adversely affect.
Sand beaches, flats, bays, inlets, lagoons, islands. Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also known to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc.); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony.				
Piping plover	*Charadrius melodus*	LT	T	Not anticipated. Preferred habitat not found within project area.
Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands. Also spoil islands in the Intracoastal Waterway. Based on the November 30, 1992 Section 6 Job No. 9.1, Piping Plover and Snowy Plover Winter Habitat Status Survey, algal flats appear to be the highest quality habitat. Some of the most important aspects of algal flats are their relative inaccessibility and their continuous availability throughout all tidal conditions. Sand flats often appear to be preferred over algal flats when both are available, but large portions of sand flats along the Texas coast are available only during low-very low tides and are often completely unavailable during extreme high tides or strong north winds. Beaches appear to serve as a secondary habitat to the flats associated with the primary bays, lagoons, and inter-island passes. Beaches are rarely used on the southern Texas coast, where bayside habitat is always available, and are abandoned as bayside habitats become available on the central and northern coast. However, beaches are probably a vital habitat along the central and northern coast (i.e. north of Padre Island) during periods of extreme high tides that cover the flats. Optimal site characteristics appear to be large in area, sparsely vegetated, continuously available or in close proximity to secondary habitat, and with limited human disturbance.				
Swallow-tailed kite	*Elanoides forficatus*		T	Anticipated. Preferred habitat within project area; however, project activities are not likely to adversely affect.
Lowland forested regions, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes, and ponds; nests high in tall tree in clearing or on forest woodland edge, usually in pine, cypress, or various deciduous trees.				

<table>
<tr><th colspan="5">Franklin County Threatened, Endangered and Species of Concern</th></tr>
<tr><th colspan="2">Species</th><th colspan="2">Status</th><th rowspan="2">Comments</th></tr>
<tr><th>Common Name</th><th>Scientific Name</th><th>Federal</th><th>State</th></tr>
<tr><td>White-faced ibis</td><td>Plegadis chihi</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.</td></tr>
<tr><td>Wood stork</td><td>Mycteria americana</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">Prefers to nest in large tracts of baldcypress (Taxodium distichum) or red mangrove (Rhizophora mangle); forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960.</td></tr>
<tr><td>Paddlefish</td><td>Polydon spathula</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat within project area, however, there are no known reintroductions in Lake Cypress Springs.</td></tr>
<tr><td colspan="4">Species occurred in every major river drainage from the Trinity Basin eastward, but its numbers and range had been substantially reduced by the 1950's; recently reintroduced into Big Cypress drainage upstream of Caddo Lake. Prefers large, free-flowing rivers but will frequent impoundments with access to spawning sites.</td></tr>
<tr><td>Black bear</td><td>Ursus americanus</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">In Chisos, prefers higher elevations where pinyon-oaks predominate; also occasionally sighted in desert scrub of Trans-Pecos (Black Gap Wildlife Management Area) and Edwards Plateau in juniper-oak habitat. For ssp. luteolus, bottomland hardwoods, floodplain forests, upland hardwoods with mixed pine; marsh. Bottomland hardwoods and large tracts of inaccessible forested areas.</td></tr>
<tr><td>Louisiana pigtoe</td><td>Pleurobema riddellii</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">Streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins.</td></tr>
<tr><td>Southern hickorynut</td><td>Obovaria arkansasensis</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">Medium sized gravel substrates with low to moderate current; Neches, Sabine, and Cypress river basins</td></tr>
<tr><td>Alligator snapping turtle</td><td>Macrochelys temminckii</td><td></td><td>T</td><td rowspan="2">Anticipated. Preferred habitat within project area; however, project activities are not likely to adversely affect.</td></tr>
<tr><td colspan="4">Perennial water bodies; deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October.</td></tr>
</table>

<table>
<tr><th colspan="5">Franklin County Threatened, Endangered and Species of Concern</th></tr>
<tr><th colspan="2">Species</th><th colspan="2">Status</th><th rowspan="2">Comments</th></tr>
<tr><th>Common Name</th><th>Scientific Name</th><th>Federal</th><th>State</th></tr>
<tr><td>Texas horned lizard</td><td>Phrynosoma cormutum</td><td></td><td>T</td><td rowspan="2">Not anticipated. Preferred habitat not found within project area.</td></tr>
<tr><td colspan="4">Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area. Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.</td></tr>
</table>

Jurisdictional Waters and Adjacent Wetlands

Any jurisdictional waters or adjacent wetlands identified within the project area are regulated under Sections 401 and 404 of the Clean Water Act (CWA). Lake Cypress Springs is considered a jurisdictional water ("Water of the United States" and "Water of the State"). Figure 5 shows wetlands areas identified by the National Wetland Inventory (NWI; USFWS 2019) within the proposed project area[1]. Two wetland types are shown on the NWI map, Freshwater Emergent and Freshwater Forested/Shrub. Adjacent wetland areas that have a hydrologic connection to jurisdictional waters are considered jurisdictional as well. While Figure 5 does not depict any wetland areas near the current emergency spillway, emergent wetland vegetation was observed during a 2016 topographic survey (Arroyo and Carollo 2016) along the shoreline of the emergency spillway.

Historical/Archeological

No historically significant sites were identified within the Texas Historical Commission (THC) database. Additional coordination with the THC has been initiated. THC archaeological concerns (if any) will likely be focused on current project areas not included in the 2008 Texas Antiquities Permit # 4768 Intensive Survey and the Archeological Survey of the Borrow Pits near the Franklin County Dam (AR Consultants, Inc. 2008).

PERMITTING

Section 401 of the Clean Water Act

Section 401 of the CWA regulates the water quality resulting from the discharge of fill material to jurisdictional waters and upland disposal sites. This program is administered by the Texas Commission on Environmental Quality (TCEQ) and is part of the United States Army Corps of Engineers (USACE) Section 404 Permit process. TCEQ's 401 Water Quality Certification must be issued to a Section 404 permit and ensures project activities will not impact water quality to jurisdictional waters.

Section 404 of the Clean Water Act

Section 404 of the Clean Water Act regulates the discharge of fill material into jurisdictional waters of the United States and the State of Texas. This program is administered by the USACE and includes environmental reviews and comments from the EPA, United States Fish and Wildlife Service (USFWS), TCEQ, Texas Parks and Wildlife Department (TPWD), Texas General Land Office (GLO) and other regional groups. Both conceptual design options for remediation of the dam involve activities that would result in direct or incidental fill material being placed in jurisdictional waters and as such would require a Section 404 permit from the USACE.

There are several types of Section 404 permits including: a Nationwide Permit (for common activities which are minimal in scale and environmental impacts), an Individual Permit – Tier I (for projects that do not fit Nationwide Permit constraints, with project impacts less than three acres or 1,500 linear stream feet) and an Individual Permit – Tier II (for individual project impacts greater than three acres or 1,500 linear stream feet). The timeline to attain a Section 404 permit is highly variable and dependent on many aspects such as project size, the presence of threatened and endangered species habitat, etc. Time to receive a Nationwide Permit can be up to 90 days from the time of permit application submittal. Time to receive an Individual Permit can range from 120 days (for a simple Tier I project) to several years for large complex projects.

[1] The NWI map is considered a planning tool and preliminary in the information it provides. The United States Fish and Wildlife Services along with the United States Army Corps of Engineers requires investigation of onsite resources prior to any project activities.

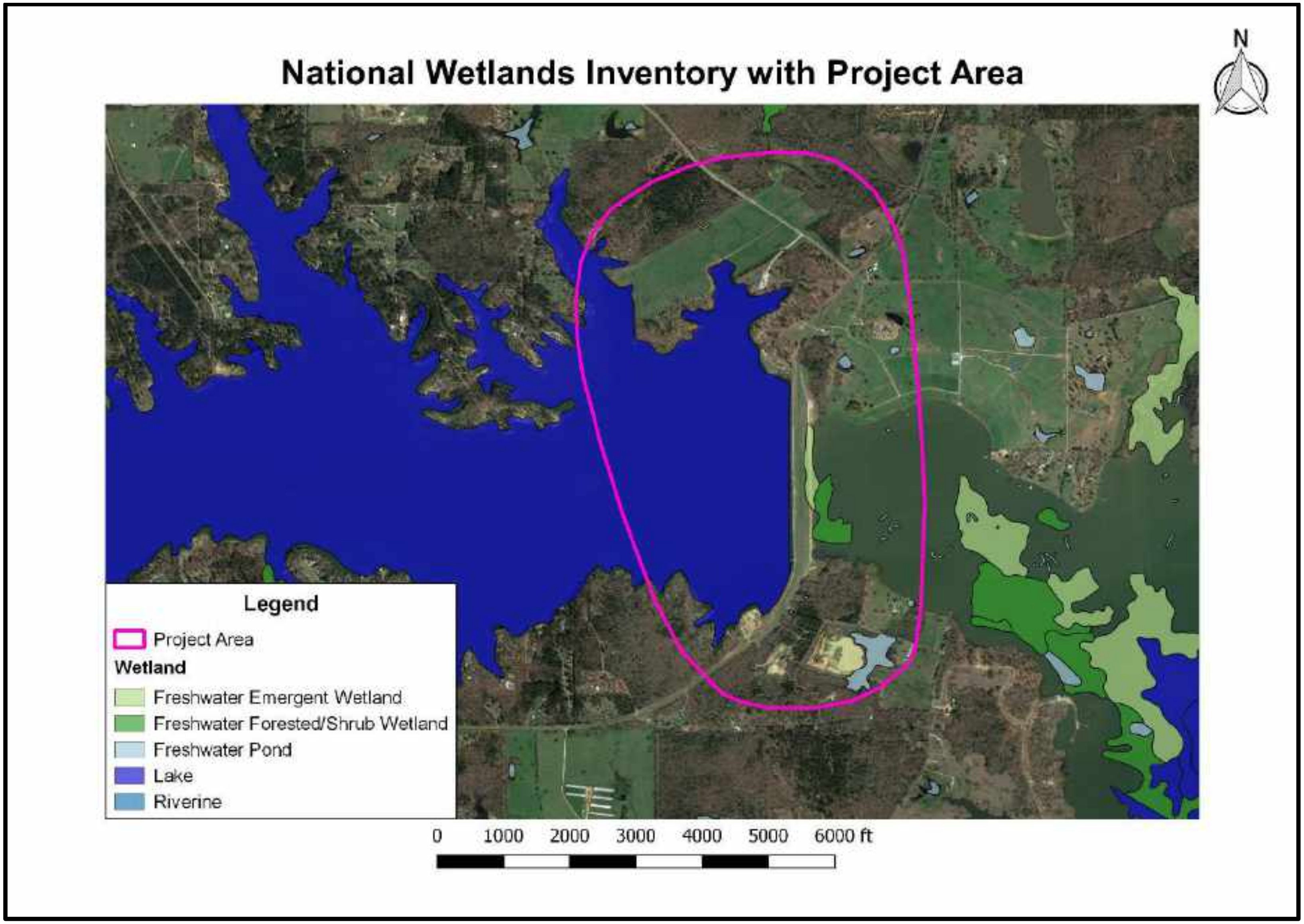

FIGURE 5. NATIONAL WETLAND INVENTORY MAP OF PROPOSED PROJECT AREA

STRATEGIC PLAN MOVING FORWARD

A strategic plan that outlines necessary environmental permitting and supporting information for each of the two conceptual design options for remediation of the dam is described below. Approximate costs for these efforts have been included wherever possible. A Section 404 permit will be required for either project option if shoreline emergent wetland vegetation and/or open water (Lake Cypress below normal pool) is disturbed along the spillway and the Lake Cypress Dam.

No significant modifications to the emergency spillway structure or changes to the current crest elevation of the spillway are anticipated. Therefore, downstream hydrologic conditions will not change as a result of this project.

Proposed Project Option 1

Proposed Project Option 1 includes modifying the existing emergency spillway, constructing an off-road haul road, increasing the width of an existing maintenance road along the dam and establishing a lime staging area. Environmental impacts and costs for Option 1were significantly greater than for Option 2 due to the originally proposed Lime Staging Area in Option 1. This area contains upland forest and forested wetland habitat. The use of this area would require additional Threatened and Endangered Species work as well as mitigation for jurisdictional impacts. Recent onsite environmental work included an investigation into a new proposed Lime Staging Area (Figure 6) that could reduce impacts and costs for this Option. The consideration of the new Lime Staging Area is included below.

Wetland Determination and Delineation – (in progress)

Based on the Section 404 permitting requirements a wetland determination and wetland delineation would need to be conducted. This work would follow USACE methodologies (USACE 1987 and 2010) and would include the evaluation of onsite vegetation, soils and hydrology. A wetland delineation report would be produced and included with the Section 404 permit application.

Threatened and Endangered Species Critical Habitat Impact Analysis – ($12,500)

Based on the Section 404 permitting requirements and environmental agency review (specifically, TPWD and USFWS), a critical habitat survey would need to be conducted for species identified in “Threatened and Endangered Species” (see Appendix A) as being likely to occur.

This analysis would focus on terrestrial species only, because the proposed project will not impact open water areas along the spillway shoreline, dam and the lime staging area. A supplemental report documenting individual findings would be included with the Section 404 permit application.

***This work does not include individual presence/absence surveys for threatened and endangered species because it is not known if critical habitat exists onsite. These studies will be added as necessary.**

Cultural/Archeological – ($2,000)

Intensive cultural surveys will not be required by the USACE (per a pre-application conference call) and will not likely be required by the THC due to the previous findings from the 2008 survey. However, some coordination effort will be required to obtain concurrence from the THC for areas not included in the 2008 survey.

FIGURE 6. LIME TREATMENT STAGING AREA OPTIONS: ORIGINAL IN YELLOW; NEW IN GREEN

Proposed Project Option 2

The proposed Project Option 2 includes modifying the existing emergency spillway, constructing an off-road haul road, increasing the width of an existing maintenance road along the dam and establishing an upland staging area. Environmental impacts for this option are limited to shoreline vegetation along the spillway and dam. This would significantly reduce mitigation and threatened and endangered species costs.

Wetland Determination and Delineation – (in progress)

Based on the Section 404 permitting requirements a wetland determination and wetland delineation would need to be conducted. This work would follow USACE methodologies (USACE 1987 and 2010) and would include the evaluation of onsite vegetation, soils and hydrology. A wetland delineation report would be produced and included with the Section 404 permit application.

Threatened and Endangered Species Critical Habitat Surveys ($7,500)

Based on the Section 404 permitting requirements and environmental agency review (specifically, TPWD and USFWS) a critical habitat survey would need to be conducted for species identified in "Threatened and Endangered Species" (see Appendix A) as being likely to occur.

This analysis would focus on terrestrial species only, because the proposed project will not impact open water areas along the spillway shoreline, dam and the lime staging area. A supplemental report documenting individual findings would be included with the Section 404 permit application.

***This work does not include individual presence/absence surveys for threatened and endangered species because it is not known if critical habitat exists onsite. These studies will be added as necessary.**

Cultural/Archeological – ($2,000)

Intensive cultural surveys will not be required by the USACE (per a pre-application conference call) and will not likely be required by the THC due to the previous findings from the 2008 survey. However, some coordination effort will be required to obtain concurrence from the THC for areas not included in the 2008 survey.

Permitting Costs

Section 401/404 Permit – ($20,000)

Environmental permitting would be focused on applying for a Section 404 permit. As stated above, permit type, time and resources needed to obtain a Section 404 permit are highly variable and dependent on onsite environmental conditions and project size. Based on the information gathered for this environmental review both Options 1 and 2 would require a Section 404 Permit. Work would include agency and project team coordination, summary of project activities and environmental findings, creation of all necessary application illustrations, project design sheets and map, etc.

Additional costs to be quantified during design include those associated with mitigation. Onsite or offsite mitigation can be offered to compensate for project impacts, however purchasing mitigation bank credits would be the preferred method. Some mitigation banks do not offer mitigation credits less than one acre in size. Onsite mitigation requires land and a commitment from the applicant to monitor the site for five to ten years.

REFERENCES

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Appendix A.

TABLE 2. TPWD COMPLETE THREATENED AND ENDANDERED SPECIES FOR FRANKLIN COUNTY (UPDATED 07/17/2019)

	FRANKLIN COUNTY	
	AMPHIBIANS	
southern crawfish frog	*Lithobates areolatus areolatus*	
The Southern Crawfish Frog can be found in abandoned crawfish holes and small mammal burrows. This species inhabits moist meadows, pasturelands, pine scrub, and river flood plains. This species spends nearly all of its time in burrows and only leaves the burrow area to breed. Although this species can be difficult to detect due to its reclusive nature, the call of breeding males can be heard over great distances. Eggs are laid and larvae develop in temporary water such as flooded fields, ditches, farm ponds and small lakes. Habitat: Shallow water, Herbaceous Wetland, Riparian, Temporary Pool, Cropland/hedgerow, Grassland/herbaceous, Suburban/orchard, Woodland – Conifer.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4T4	State Rank: S3
southern dusky salamander	*Desmognathus conanti*	
Details unknown.		
Federal Status:	State Status:	SGCN: N
Endemic:	Global Rank: G5	State Rank: S1
Strecker's chorus frog	*Pseudacris streckeri*	
Wooded floodplains and flats, prairies, cultivated fields and marshes. Likes sandy substrates.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3
Woodhouse's toad	*Anaxyrus woodhousii*	
Extremely catholic up to 5000 feet, does very well (except for traffic) in association with man.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: SU

	BIRDS	
Bachman's sparrow	*Peucaea aestivalis*	
Open pine woods with scattered bushes and grassy understory in Pineywoods region, brushy or overgrown grassy hillsides, overgrown fields with thickets and brambles, grassy orchards; remnant grasslands in Post Oak Savannah region; nests on ground against grass tuft or under low shrub.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3B
bald eagle	*Haliaeetus leucocephalus*	
Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3B,S3N
black rail	*Laterallus jamaicensis*	
Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia.		
Federal Status: PT	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S2
Franklin's gull	*Leucophaeus pipixcan*	
Habitat description is not available at this time.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4G5	State Rank: S2N
interior least tern	*Sternula antillarum athalassos*	
Sand beaches, flats, bays, inlets, lagoons, islands. Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony.		
Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G4T2Q	State Rank: S1B

piping plover	*Charadrius melodus*	
Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands. Also spoil islands in the Intracoastal Waterway. Based on the November 30, 1992 Section 6 Job No. 9.1, Piping Plover and Snowy Plover Winter Habitat Status Survey, algal flats appear to be the highest quality habitat. Some of the most important aspects of algal flats are their relative inaccessibility and their continuous availability throughout all tidal conditions. Sand flats often appear to be preferred over algal flats when both are available, but large portions of sand flats along the Texas coast are available only during low-very low tides and are often completely unavailable during extreme high tides or strong north winds. Beaches appear to serve as a secondary habitat to the flats associated with the primary bays, lagoons, and inter-island passes. Beaches are rarely used on the southern Texas coast, where bayside habitat is always available, and are abandoned as bayside habitats become available on the central and northern coast. However, beaches are probably a vital habitat along the central and northern coast (i.e. north of Padre Island) during periods of extreme high tides that cover the flats. Optimal site characteristics appear to be large in area, sparsely vegetated, continuously available or in close proximity to secondary habitat, and with limited human disturbance.		
Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2N
swallow-tailed kite	*Elanoides forficatus*	
Lowland forested regions, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes, and ponds; nests high in tall tree in clearing or on forest woodland edge, usually in pine, cypress, or various deciduous trees.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S2B
white-faced ibis	*Plegadis chihi*	
Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4B
wood stork	*Mycteria americana*	
Prefers to nest in large tracts of baldcypress (Taxodium distichum) or red mangrove (Rhizophora mangle); forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: SHB,S2N

	CRUSTACEANS	
a crayfish	*Orconectes maletae*	
Streams of varying sizes and bottoms, almost always with leaf litter.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2	State Rank: S2
	FISH	
paddlefish	*Polyodon spathula*	
Species occurred in every major river drainage from the Trinity Basin eastward, but its numbers and range had been substantially reduced by the 1950's; recently reintroduced into Big Cypress drainage upstream of Caddo Lake. Prefers large, free-flowing rivers but will frequent impoundments with access to spawning sites.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S3
silverband shiner	*Notropis shumardi*	
In Texas, found from Red River to Lavaca River; Main channel with moderate to swift current velocities and moderate to deep depths; associated with turbid water over silt, sand, and gravel.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4
taillight shiner	*Notropis maculatus*	
Restricted to the Sulphur and Cypress drainages in northeast Texas; Quiet, usually vegetated oxbow lakes, ponds, or backwaters.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S1
	INSECTS	
American bumblebee	*Bombus pensylvanicus*	
Habitat description is not available at this time.		
Federal Status:	State Status:	SGCN: Y
Endemic:	Global Rank: G3G4	State Rank: SNR

	MAMMALS	
big brown bat	*Eptesicus fuscus*	
Any wooded areas or woodlands except south Texas. Riparian areas in west Texas.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5
black bear	*Ursus americanus*	
In Chisos, prefers higher elevations where pinyon-oaks predominate; also occasionally sighted in desert scrub of Trans-Pecos (Black Gap Wildlife Management Area) and Edwards Plateau in juniper-oak habitat. For ssp. luteolus, bottomland hardwoods, floodplain forests, upland hardwoods with mixed pine; marsh. Bottomland hardwoods and large tracts of inaccessible forested areas.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3
eastern red bat	*Lasiurus borealis*	
Found in a variety of habitats in Texas. Usually associated with wooded areas. Found in towns especially during migration.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S4
eastern spotted skunk	*Spilogale putorius*	
Catholic; open fields prairies, croplands, fence rows, farmyards, forest edges & woodlands. Prefer wooded, brushy areas & tallgrass prairies. S.p. ssp. interrupta found in wooded areas and tallgrass prairies, preferring rocky canyons and outcrops when such sites are available.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S1S3
hoary bat	*Lasiurus cinereus*	
Known from montane and riparian woodland in Trans-Pecos, forests and woods in east and central Texas.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S4

long-tailed weasel	*Mustela frenata*	
Includes brushlands, fence rows, upland woods and bottomland hardwoods, forest edges & rocky desert scrub. Usually live close to water.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5
Mexican free-tailed bat	*Tadarida brasiliensis*	
Roosts in buildings in east Texas. Largest maternity roosts are in limestone caves on the Edwards Plateau. Found in all habitats, forest to desert.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5
mink	*Neovison vison*	
Intimately associated with water; coastal swamps & marshes, wooded riparian zones, edges of lakes. Prefer floodplains.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4
mountain lion	*Puma concolor*	
Rugged mountains & riparian zones.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S2S3
plains spotted skunk	*Spilogale putorius interrupta*	
Catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie.		
Federal Status:	State Status:	SGCN: N
Endemic: N	Global Rank: G4T4	State Rank: S1S3
southeastern myotis bat	*Myotis austroriparius*	
Caves are rare in Texas portion of range; buildings, hollow trees are probably important. Historically, lowland pine and hardwood forests with large hollow trees; associated with ecological communities near water. Roosts in cavity trees of bottomland hardwoods, concrete culverts, and abandoned man-made structures.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S3

southern short-tailed shrew	*Blarina carolinensis*	
Habitat description is not available at this time.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4
swamp rabbit	*Sylvilagus aquaticus*	
Habitat description is not available at this time.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5
tricolored bat	*Perimyotis subflavus*	
Forest, woodland and riparian areas are important. Caves are very important to this species.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2G3	State Rank: S3S4
woodland vole	*Microtus pinetorum*	
Include grassy marshes, swamp edges, old-field/pine woodland ecotones, tallgrass fields; generally sandy soils.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3
	MOLLUSKS	
Louisiana pigtoe	*Pleurobema riddellii*	
Streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G1G2	State Rank: S1
southern hickorynut	*Obovaria arkansasensis*	
Medium sized gravel substrates with low to moderate current; Neches, Sabine, and Cypress river basins.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: GNR	State Rank: S1

	REPTILES	
alligator snapping turtle	*Macrochelys temminckii*	
Perennial water bodies; deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S2
American alligator	*Alligator mississippiensis*	
Coastal marshes; inland natural rivers, swamps and marshes; manmade impoundments.		
Federal Status:	State Status:	SGCN: N
Endemic: N	Global Rank: G5	State Rank: S4
eastern box turtle	*Terrapene carolina*	
Eastern box turtles inhabit forests, fields, forest-brush, and forest-field ecotones. In some areas they move seasonally from fields in spring to forest in summer. They commonly enter pools of shallow water in summer. For shelter, they burrow into loose soil, debris, mud, old stump holes, or under leaf litter. They can successfully hibernate in sites that may experience subfreezing temperatures. In Maryland bottomland forest, some hibernated in pits or depressions in forest floor (usually about 30 cm deep) usually within summer range; individuals tended to hibernate in same area in different years (Stickel 1989). Also attracted to farms, old fields and cut-over woodlands, as well as creek bottoms and dense woodlands. Egg laying sites often are sandy or loamy soils in open areas; females may move from bottomlands to warmer and drier sites to nest. In Maryland, females used the same nesting area in different years (Stickel 1989).		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3
slender glass lizard	*Ophisaurus attenuatus*	
Prefers relatively dry microhabitats, usually associated with grassy areas. Habitats include open grassland, prairie, woodland edge, open woodland, oak savannas, longleaf pine flatwoods, scrubby areas, fallow fields, and areas near streams and ponds, often in habitats with sandy soil. This species often appears on roads in spring. During inactivity, it occurs in underground burrows. In Kansas, slender glass lizards were scarce in heavily grazed pastures, increased as grass increased with removal of grazing, and declined as brush and trees replaced grass (Fitch 1989). Eggs are laid underground, under cover, or under grass clumps (Ashton and Ashton 1985); in cavities beneath flat rocks or in abandoned tunnels of small mammals (Scalopus, Microtus) (Fitch 1989).		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

Texas horned lizard	*Phrynosoma cornutum*	
Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area. Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.		
Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4G5	State Rank: S3
western box turtle	*Terrapene ornata*	
Ornate or western box trutles inhabit prairie grassland, pasture, fields, sandhills, and open woodland. They are essentially terrestrial but sometimes enter slow, shallow streams and creek pools. For shelter, they burrow into soil (e.g., under plants such as yucca) (Converse et al. 2002) or enter burrows made by other species; winter burrow depth was 0.5-1.8 meters in Wisconsin (Doroff and Keith 1990), 7-120 cm (average depth 54 cm) in Nebraska (Converse et al. 2002). Eggs are laid in nests dug in soft well-drained soil in open area (Legler 1960, Converse et al. 2002). Very partial to sandy soil.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3
	PLANTS	
Arkansas meadow-rue	*Thalictrum arkansanum*	
Mostly deciduous forests on alluvial terraces and upper drainages of hardwood slope forests at contacts with calcareous prairies; flowering March-April, withering by midsummer.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2Q	State Rank: S2
goldenwave tickseed	*Coreopsis intermedia*	
In deep sandy soils of sandhills in openings in or along margins of post oak woodlands and pine-oak forests of east Texas; Perennial; Flowering/Fruiting May-Aug.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3

Mohlenbrock's sedge	*Cyperus grayioides*	
Deep sand and sandy loam in dry, almost barren openings in upland longleaf pine savannas, mixed pine-oak forests, and post oak woodlands; Occurs primarily in deep, periodically disturbed sandy soils in open areas maintained by factors such as wind, erosion, or fire. This species does not occur in shaded areas or in areas of high competition with other herbaceous species. Habitats include remnant sand prairies, sandy fields, sand blow outs, sandhill woodlands, pine barrens, and open barrens in which the slope is sufficient to produce sand erosion. May also occur in areas where the soils have been disturbed by logging or road construction; Perennial.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S3S4
rough-stem aster	*Symphyotrichum puniceum var. scabricaule*	
Relatively open sites in saturated soils associated with seepage areas, bogs, marshes, ponds, drainages, and degraded wetland remnants on the Queen City, Carrizo, and Sparta sand formations; flowering late September-early November.		
Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5T2	State Rank: S1S2
Texas cornsalad	*Valerianella florifera*	
Grasslands and early-successional openings in the post oak belt of east-central and northeast Texas; Sandy soils; Annual; Flowering March-April.		
Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

LAKE CYPRESS SPRINGS WETLAND DELINEATION REPORT

11/19/19

Lake Cypress Springs

Prepared by: Arroyo Environmental Consultants, LLC

Prepared for: Franklin County Water District

Lake Cypress Springs Wetland Delineation Report

INTRODUCTION

As part of a United States Army Corps of Engineers (USACE) Section 404 Permit application for the project entitled Lake Cypress Springs Dam Restoration, a wetland determination was conducted to meet permit requirements. Lake Cypress Springs is located just outside of Mount Vernon, Franklin County, Texas (Figure 1). The wetland determination field investigation was conducted September 24 through September 28, 2019. The National Wetland Inventory (NWI) identified wetland areas surrounding the proposed project boundary (Figure 2).

The proposed project area would include approximately 100 total project acres adjacent to Lake Cypress Springs. The investigation focused on the individual project areas and included the collection of data from 12 Wetland Determination plots and two Data Form 1 plots (Figure 3).

METHODOLOGY

All wetland work followed protocol set forth in the Corps of Engineers Wetlands Delineation Manual (USACE, 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (USACE, 2010). Under the guidelines a potential wetland must exhibit three characteristics in order to be classified as a wetland: hydrology, hydric soils, and hydrophytic vegetation. If the investigation shows that any one of the three characteristics is not present, the area does not satisfy the criteria to be considered a wetland adjacent to a jurisdictional water of the United States.

Survey and Mapping

Professional grade Trimble GeoXH GPS handheld units with Trimble Terrasync V5.81 software were used to collect sample points and delineate wetland and upland boundaries within the project area. GPS data collected in the field was analyzed and processed with Trimble Pathfinder Office V5.85 and QGIS 2.18.28 software.

Determination of Wetland Hydrology

Following the procedures and examples provided in the USACE Wetland Delineation Manual (1987), field observations, USGS topographic maps, and aerial photographs were used as evidence of past or present hydrologic events (e.g. location and height of flooding).

Wetland hydrology indicators, defined in the U.S. Army Corps of Engineers Wetland Delineation Manual (1987), are divided into two categories: primary and secondary.

- Primary indicators of wetland hydrology may include but are not limited to the presence of surface water, saturation, water marks and drift deposits, among others (see Appendix A – Wetland Determination Data Forms for the complete list). Any one primary indicator from any group is sufficient to qualify for wetland hydrology.
- In the event that a primary indicator is absent, at least two secondary indicators must be present in order to conclude that wetland hydrology is present (see Appendix A – Wetland Determination Data Forms for the complete list). Secondary indicators include surface soil cracks, drainage patterns, crayfish burrows, and geomorphic position, among others.

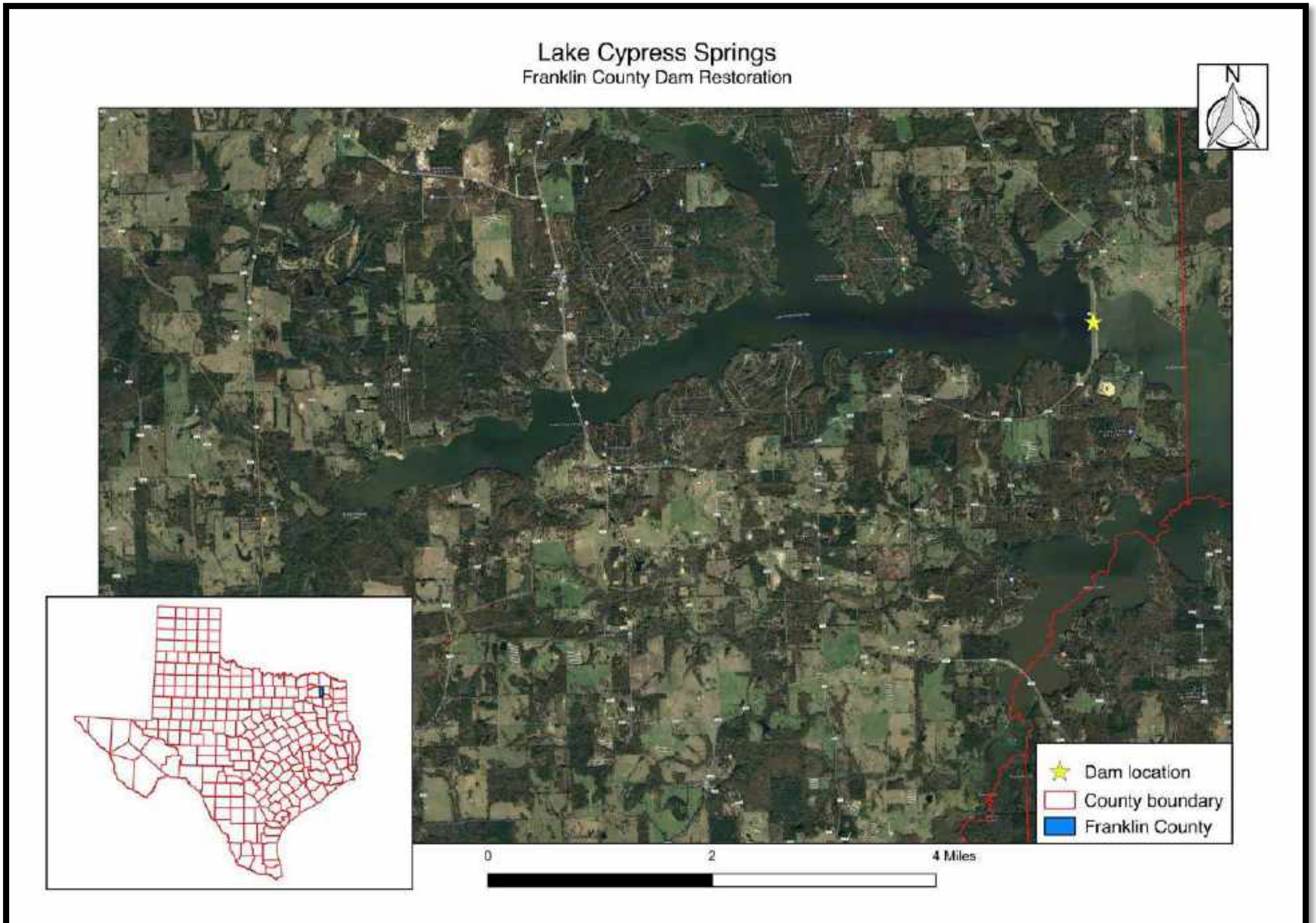

FIGURE 1. LOCATION MAP OF LAKE CYPRESS SPRINGS DAM

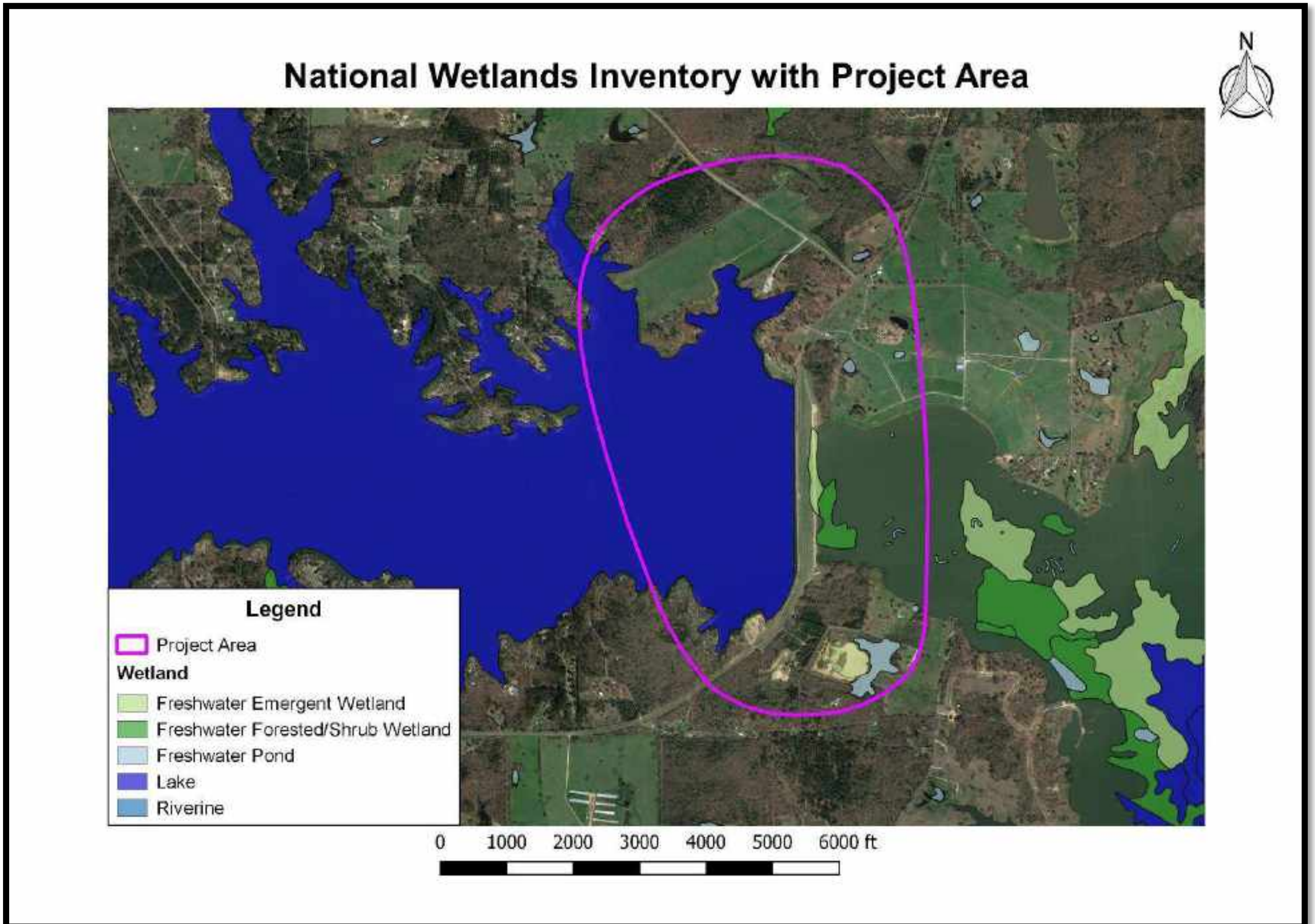

FIGURE 2. NATIONAL WETLANDS INVENTORY MAP FOR THE LAKE CYPRESS SPRINGS PROJECT AREA (USFWS 2019)

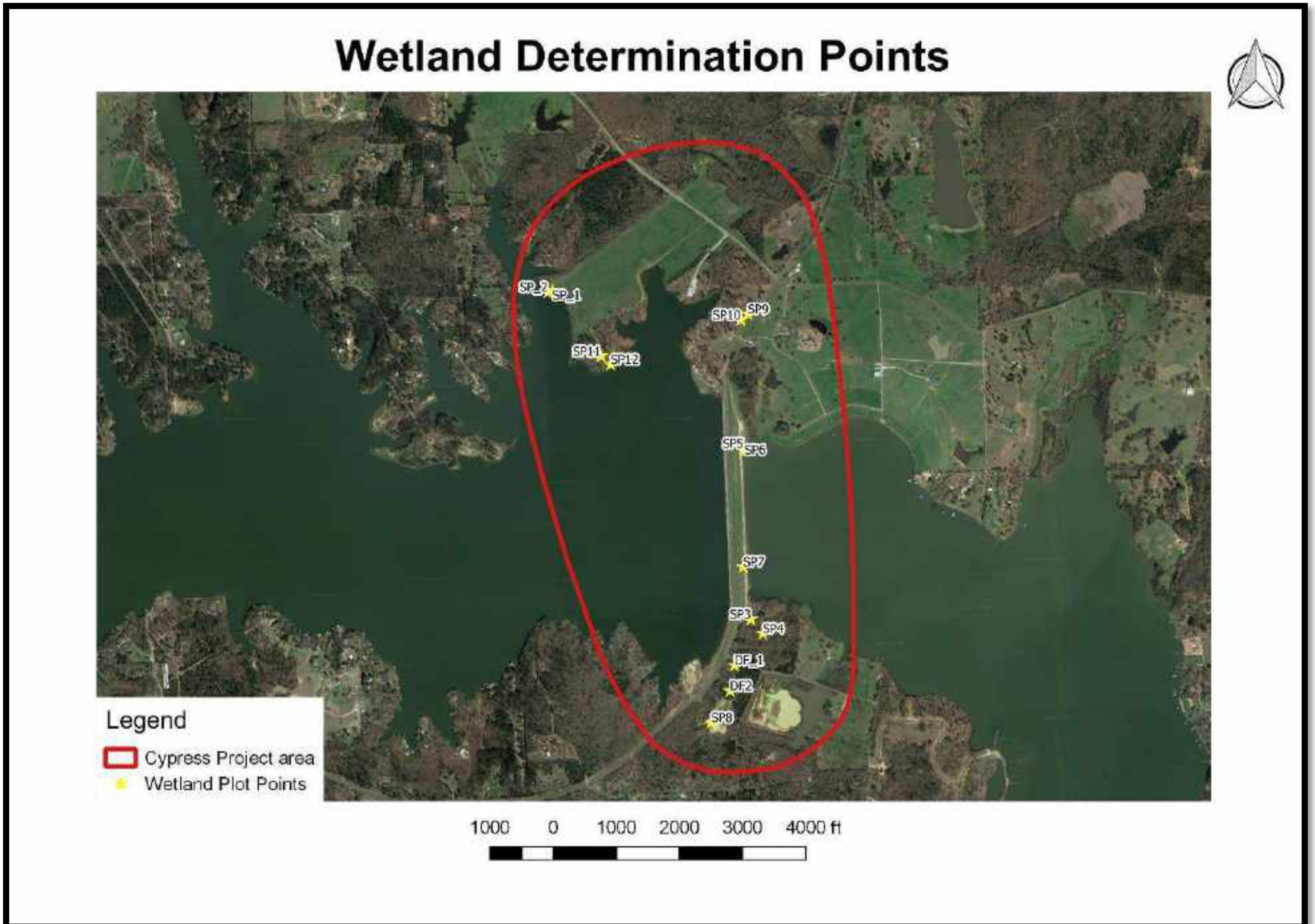

FIGURE 3. MAP OF THE WETLAND DETERMINATION PLOTS

Determination of Hydrophytic Vegetation

Thirty-foot, 15-foot or 5-foot diameter sample plots were used to assess the presence or absence of hydrophytic vegetation in forested, shrub or herbaceous areas, respectively. One additional rectangular-shaped sample plot was used along the shoreline of Lake Cypress Springs in order to capture a representative wetland area. In each plot, communities of trees, saplings, herbs, and woody vine species were identified. The basal area for each species in those communities was qualitatively assigned in the field and then used to determine the relative percentage of aerial cover. All data was recorded on the USACE delineation forms provided in the USACE Regional Supplement (2010). Vegetation was assigned a wetland indicator status for each species that made up the plant community. Wetland indicator status was obtained from the 2016 National Wetland Plant List (Lichvar et al., 2016). The hydrophytic vegetation community was determined by using the Dominance Test as a wetland vegetation indicator as outlined in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual* (USACE, 2010).

If more than 50% of the dominant plant species across all strata in the community are obligate wetland plants (OBL), facultative wetland plants (FACW), or facultative plants (FAC), then the area is considered to be dominated by hydrophytic vegetation.

Determination of Hydric Soils

Soil core samples were collected using a manual AMS soil auger, then examined for texture and specific hydric soil indicators presented in the Regional Supplement (USACE, 2010). Soil color, mottling or greying, and presence of saturation were all determined and recorded in the field. Color, value, and chroma were assessed by referencing the Munsell Soil Color Chart (X-Rite, 2009). The data results were recorded on the Great Plains Region Data Form (see Appendix A – Wetland Determination Data Forms).

Soil samples and vegetation were examined in wetlands and in adjacent upland areas. Quality assurance processes involved reviewing and comparing soil samples to the Natural Resources Conservation Service (NRCS) soil survey (NRCS, 2017).

Determination of Wetland Boundaries

Wetland boundaries were delineated following USACE protocol (USACE, 1987; USACE, 2010). Topographic features observed at the soil sample locations were used to determine an average of topographic characteristics of the area in which wetland soils were identified. This information was compared to the presence of hydric vegetation and hydrology indicators, along with vegetation data and soil sample data, so that a boundary line could be constructed around areas that satisfied all the wetland indicator criteria.

Wetland boundaries were determined using a combined approach of visual changes in topography and verification of the presence of hydric soils.

During the investigation, georeferenced photographs were also collected with an Olympus TG-4 digital camera. These photographs document the different habitats identified during the investigation, as well as other important project area characteristics.

RESULTS

As mentioned previously, the NWI map (Figure 2) identified the presence of wetland areas adjacent to the proposed project boundary. Twelve Wetland Determination plots and two Data Form 1 sample plots were investigated adjacent to the proposed project area. A total of 72 different species were identified during the wetland determination investigation (Table 1).

TABLE 1. COMPREHENSIVE VEGETATION LIST WITH USACE WETLAND INDICATOR STATUS (USACE 2016)

Lake Cypress Springs - Wetland Delineation Vegetation and Indicator Status		
Common Name	**Scientific Name**	**Wetland Indicator Status**
Alabama supplejack	*Berchemia scandens*	FAC
American beauty berry	*Callicarpa americana*	FACU
American cupscale	*Sacciolepsis striata*	OBL
American elm	*Ulmus americana*	FAC
Bermuda grass	*Cynodon dactylon*	FACU
black willow	*Salix nigra*	FACW
blackjack oak	*Quercus marilandica*	UPL
Brazilian vervain	*Verbena brasiliensis*	UPL
Canadian clearweed	*Pilea pumila*	FAC
cherry-bark oak	*Quercus pagoda*	FAC
climbing hempvine	*Mikania scandens*	FACW
coco yam	*Colocasia esculenta*	OBL
common buttonbush	*Cephalanthus occidentalis*	OBL
common dewberry	*Rubus trivialis*	FACU
common paw paw	*Asimina triloba*	FACU
curly dock	*Rumex crispus*	FAC
delta arrow head	*Sagittaria platyphylla*	OBL
Eastern poison ivy	*Toxicodendron radicans*	FACU
fall panic grass	*Panicum dichotomiflorum*	FAC
floating marsh-pennywort	*Hydrocotyle ranunculoides*	OBL
freshwater cord grass	*Spartina pectinata*	FACW
golden crown grass	*Paspalum dilatatum*	FAC
great ragweed	*Ambrosia trifida*	FAC
green ash	*Fraxinus pennsylvanica*	FAC
groundseltree	*Baccharis halimifolia*	FAC
hairy crabgrass	*Digitaria sanguinalis*	FACU
hedge false bindweed	*Calystegia sepium*	FAC
Heller's rosette grass	*Dichanthelium oligosanthes*	FACU
hogwort	*Croton capitatus*	UPL
horsebriar	*Smilax rotundifolia*	FAC
Johnson grass	*Sorghum halepense*	FACU
little-hogweed	*Portulaca oleracea*	FAC
loblolly pine	*Pinus taeda*	FAC
longleaf wood-oats	*Chasmanthium sessiflorum*	FAC
maiden-cane	*Panicum hemitomon*	OBL
muscadine	*Vitis rotundifolia*	FAC
narrow-leaf cattail	*Typha angustifolia*	OBL
narrow-leaf marsh elder	*Iva angustifolia*	UPL

Lake Cypress Springs - Wetland Delineation Vegetation and Indicator Status		
Common Name	**Scientific Name**	**Wetland Indicator Status**
opposite-leaf spotflower	*Acmella repens*	FACW
peppervine	*Ampelopsis arborea*	FAC
perennial ragweed	*Abrosia psilostachya*	FACU
plains lovegrass	*Eragrostis intermedia*	UPL
poorjoe	*Hexasepalum teres*	FACU
purple river-hemp	*Sesbania punicea*	FACW
red maple	*Acer rubrum*	FAC
river birch	*Betula nigra*	FACW
rough cockleburr	*Xanthium strumarium*	FAC
round-leaf goldenrod	*Solidago patula*	OBL
seaside American aster	*Symphyotrichum subulatum*	OBL
sensitive fern	*Onoclea sensibilis*	FACW
shag-bark hickory	*Carya ovata*	FACU
Shumard's oak	*Quercus shummardii*	FAC
slender wood-oats	*Digitaria sanguinalis*	FAC
snapdragon vine	*Maurandella antirrhiniflora*	UPL
Southern red oak	*Quercus falcata*	FACU
sugar-berry	*Celtis laevigata*	FAC
swamp smartweed	*Persicaria hydropiperoides*	OBL
swamp-loosestrife	*Decodon verticillatus*	OBL
sweet-gum	*Liquidambar styraciflua*	FAC
tall goldenrod	*Solidago altissima*	FACU
Texas dropseed	*Sporobolus texanus*	FAC
Texas windmill grass	*Chloris texensis*	UPL
turkey tangle	*Phyla nodiflora*	FAC
Vasey's grass	*Paspalum urvillei*	FACW
Virginia buttonweed	*Diodia virginiana*	OBL
Virginia creeper	*Parthenocissus quinquefolia*	FACU
wand panic grass	*Panicum virgatum*	FAC
water oak	*Quercus nigra*	FAC
waxy rush-pea	*Hoffmannseggia glauca*	FAC
Western rough goldenrod	*Solidago radula*	UPL
willow oak	*Quercus phellos*	FACW
yellowdicks	*Helenium amarum*	FACU

Wetland Determination Plots

General descriptions and information for all wetland determination plots is provided in this section. Each plot detail sets out which wetland criteria were met and whether or not the plot scores out as a wetland. Table 2 summarizes this information for each plot.

TABLE 2. LAKE CYPRESS SPRINGS WETLAND DETERMINATION PLOT CRITERIA INFORMATION

Wetland Determination Plots				
Plot	**Hydrology**	**Vegetation**	**Soils**	**Wetland**
1	Y	N	N	N
2	Y	Y	Y	Y
3	Y	Y	N	N
4	Y	Y	Y	Y
5	Y	Y	N	N
6	Y	Y	Y	Y
7	Y	N	N	N
8	N	Y	N	N
9	Y	Y	Y	Y
10	N	Y	N	N
11	N	Y	N	N
12	Y	Y	Y	Y
DF1	Y	Y	Y	Y
DF2	Y	Y	Y	Y

Y = Presence

N = Absence

Wetland Plot 1

Wetland Plot 1 is located on the slope of the emergency spillway associated with the Lake Cypress Springs dam (Figure 4). The plot is located at 33.06839 (latitude), -95.14880 (longitude). This area did not have an NWI classification and appeared to be well drained. Criteria for Hydrology were satisfied, while criteria for Vegetation and Soils were not satisfied. Plot 1 does not meet the requirements for a Wetland classification (USACE 1987; USACE 2010).

FIGURE 4. VIEW OF WETLAND PLOT 1

HYDROLOGY

One hydrology indicator was observed during the field investigation: presence of reduced iron. Hydrology criteria were satisfied for Plot 1.

VEGETATION

The dominant plant species present at Plot 1 included wand panic grass (*Panicum virgatum*) and Heller's rosette grass (*Dichanthelium oligosanthes*). Plot 1 vegetation did not meet the criteria for the rapid test for hydrophytic vegetation, the Dominance Test was not satisfied at 33% (below the 50% threshold) and the Prevalence Index was not met with a value of 3.9. Therefore, Plot 1 vegetation does not satisfy the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 3).

TABLE 3. PLOT 1 VEGETATION PRESENT

Wetland Determination Plot 1 Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Herb			
	common dewberry	*Rubus trivialis*	FACU
	great ragweed	*Ambrosia trifida*	FAC
	Heller's rosette grass	*Dichanthelium oligosanthes*	FACU
	hogwort	*Croton capitatus*	UPL
	horsebriar	*Smilax rotundifolia*	FAC
	plains lovegrass	*Eragrostis intermedia*	UPL
	poorjoe	*Hexasepalum teres*	FACU
	slender wood-oats	*Digitaria sanguinalis*	FAC
	wand panic grass	*Panicum virgatum*	FAC
	yellowdicks	*Helenium amarum*	FACU

SOILS

A soil core sample taken at Plot 1 consisted of two soil types (Figure 5). The sample indicates a 10YR 4/4 color matrix with 2% redox features (7.5YR 5/8) in sandy loam soil from 0 to 6 inches, and 2.5YR 4/8 in clay soil (organic material present) from 6 to 8 inches. With the absence of any indicators, the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 5. SOIL CORE SAMPLE AT PLOT 1

Wetland Plot 2

Wetland Plot 2 is located along the shoreline on the Lake Cypress Springs spillway (Figure 6). The plot is located at 33.06833 (latitude), -95.14910 (longitude). This area did not have an NWI classification or topographic relief. Criteria for all three wetland indicators were satisfied according to the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010), and Plot 2 is considered a wetland.

FIGURE 6. VIEW OF WETLAND PLOT 2

HYDROLOGY

Surface water was present at the time of the field investigation (1.25 inches in depth). Primary hydrology indicators observed include surface water, high water table, saturation, water marks, sediment deposits, inundation visible on aerial imagery, water-stained leaves, presence of reduced iron and a thin muck surface. Secondary hydrology indicators observed include saturation visible on aerial imagery, geomorphic position, and a positive FAC-neutral test. In summary, the hydrology criteria were satisfied for Plot 2.

VEGETATION

Dominant plant species present at Plot 2 include maiden-cane (*Panicum hemitomon*), narrow-leaf cattail (*Typha angustifolia*) and Virginia buttonweed (*Diodia virginiana;* Table 4). The vegetation passed the Dominance and Prevalence Index tests at 100% (above 50% threshold) and 2.08 (below 3.0 threshold), respectively. Therefore, vegetation criteria were satisfied for Plot 2.

TABLE 4. PLOT 2 VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Sapling			
	climbing hempvine	*Mikania scandens*	FACW
	common buttonbush	*Cephalanthus occidentalis*	OBL
Herb			
	floating marsh-pennywort	*Hydrocotyle ranunculoides*	OBL
	little-hogweed	*Portulaca oleracea*	FAC
	maiden-cane	*Panicum hemitomon*	OBL
	narrow-leaf cattail	*Typha angustifolia*	OBL
	swamp-loosestrife	*Decodon verticillatus*	OBL
	Virginia buttonweed	*Diodia virginiana*	OBL

SOILS

A soil core sample taken at Plot 2 consisted of two soil types (Figure 7). The sample indicates a 2.5Y 4/1 matrix color with 7% redox features with a color of 5YR 5/8 from 0 to 3 inches in loamy sand soil and a matrix color of 5Y 6/1 with 30% redox features (5YR 5/8) from 3 to 9 inches in clay. The primary soil indicator observed was a depleted matrix, which satisfies the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 7. SOIL CORE SAMPLE AT PLOT 2

Wetland Plot 3

Wetland Plot 3 is located on a terrace near the Lake Cypress Springs dam (Figure 8). The plot is located at 33.05383 (latitude), -95.13910 (longitude). This area did not have an NWI classification, appeared well drained with no topographic relief. Criteria for Vegetation and Hydrology were satisfied, while criteria for Soils were not satisfied. Plot 3 does not meet the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 8. VIEW OF WETLAND PLOT 3

HYDROLOGY

One primary hydrology indicator and two secondary indicators were observed during the field investigation: presence of reduced iron (primary), geomorphic position and FAC-Neutral Test. Hydrology criteria were satisfied for Plot 3.

VEGETATION

The dominant plant species present at Plot 3 include slender wood-oats (C*hasmanthium laxum*) and freshwater cord grass (*Spartina pectinata*). The Rapid Test and Dominance Test were satisfied at 100% (above the 50% threshold), and therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 5).

TABLE 5. PLOT 3 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Herb			
	freshwater cord grass	*Spartina pectinata*	FACW
	Heller's rosette grass	*Dichanthelium oligosanthes*	FACU
	hogwort	*Croton capitatus*	UPL
	long-leaf wood-oats	*Chasmanthium sessiliflorum*	FAC
	narrow-leaf marsh elder	*Iva angustifolia*	UPL
	perennial ragweed	*Abrosia psilostachya*	FACU
	slender wood-oats	*Chasmanthium laxum*	FAC
	snapdragon vine	*Maurandella antirrhiniflora*	UPL
	waxy rush-pea	*Hoffmannseggia glauca*	FAC

SOILS

A soil core sample taken at Plot 3 consisted of clay soil (Figure 9). The sample indicates a 10YR 4/4 color matrix with 20% redox features (10YR 4/8) from 0 to 14 inches, and 5YR 4/6 with 30% redox features (2.5YR 3/6) from 14 to 19 inches. With the absence of any indicators, the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 9. SOIL CORE SAMPLE AT PLOT 3

Wetland Plot 4

Wetland Plot 4 is located on a terrace in a forested area near the Lake Cypress Springs dam (Figure 10). The plot is located at 33.05319 (latitude), -95.13850 (longitude). This area did not have an NWI classification and no topographic relief. Criteria for all three wetland indicators were satisfied. Plot 4 meets the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 10. VIEW OF WETLAND PLOT 4

HYDROLOGY

Primary hydrology indicators observed during the field investigation include sediment deposits, drift deposits, algal mats or crust, water-stained leaves and the presence of reduced iron. Secondary hydrology indicators include drainage patterns, geomorphic position and a positive FAC-Neutral test. Hydrology criteria were satisfied for Plot 4.

VEGETATION

The dominant plant species present at Plot 4 include sweet-gum (*Liquidambar styraciflua*), river birch (*Betula nigra*) and longleaf wood-oats (*Chasmanthium sessiflorum*). The Rapid Test and Dominance Test were satisfied (80%; above the 50% threshold) as well as the Prevalence Index (2.8; below the ≤3 threshold) and the plot therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (

Table 6).

TABLE 6. PLOT 4 VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Tree			
	American elm	*Ulmus americana*	FAC
	river birch	*Betula nigra*	FACW
	sweet-gum	*Liquidambar styraciflua*	FAC
	willow oak	*Quercus phellos*	FACW
Sapling/Shrub			
	shag-bark hickory	*Carya ovata*	FACU
	water oak	*Quercus nigra*	FAC
Herb			
	Alabama supplejack	*Berchemia scandens*	FAC
	American beautyberry	*Scallicarpa americana*	FACU
	Eastern poison ivy	*Toxicodendron radicans*	FACU
	horsebrier	*Smilax rotundifoloia*	FAC
	longleaf wood-oats	*Chasmanthium sessiflorum*	FAC
	sensitive fern	*Onoclea sensibilis*	FACW
	Texas dropseed	*Sporobolus texanus*	FAC
	Virginia creeper	*Parthenocissus quinquefolia*	FACU
	Western rough goldenrod	*Solidago radula*	UPL
Woody vine			
	muscadine	*Vitis rotundifolia*	FAC

SOILS

A soil core sample taken at Plot 4 consisted of sandy clay soil (Figure 11). The sample indicates a 10YR 4/2 color matrix (high organic matter present) from 0 to 4 inches and 7.5YR 5/8 (organic matter present) with 2% redox features (5YR 5/8) from 4 to 10 inches. The soil met the description of the loamy mucky mineral indicator confirming the soils meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 11. SOIL CORE SAMPLE AT PLOT 4

Wetland Plot 5

Wetland Plot 5 is located in a drainageway near Lake Cypress Springs dam (Figure 12). Plot 5 is located at 33.06126 (latitude), -95.13920 (longitude). This area did not have an NWI classification and no topographic relief. Criteria for Hydrology and Vegetation were satisfied while those for Soil were not. Plot 5 does not meet the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 12. VIEW OF WETLAND PLOT 5

HYDROLOGY

Although surface water was not present at the time of the field investigation, primary hydrology indicators observed include sediment deposits, drift deposits and water-stained leaves. Geomorphic position and a positive FAC-Neutral Test were the two secondary hydrology indicators observed. In summary, the hydrology criteria were satisfied for Plot 5.

VEGETATION

The dominant plant species present at Plot 5 include common buttonbush (*Cephalanthus occidentalis*), black willow (*Salix nigra*), swamp smartweed (*Persicaria hydropiperoides*) and tall goldenrod (*Solidago altissima*). The Rapid Test, Dominance Test (75%; above the 50% threshold), and Prevalence Index (1.9; below the threshold ≤3.0) were met. Vegetation at Plot 5 therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (

Table 7).

TABLE 7. PLOT 5 VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Sapling/Shrub			
	black willow	*Salix nigra*	FACW
	common buttonbush	*Cephalanthus occidentalis*	OBL
Herb			
	American cupscale	*Sacciolepsis striata*	OBL
	coco yam	*Colocasia esculenta*	OBL
	fall panic grass	*Panicum dichotomiflorum*	FAC
	Johnson grass	*Sorghum halepense*	FACU
	maiden-cane	*Panicum hemitomon*	OBL
	purple river-hemp	*Sesbania punicea*	FACW
	rough cockleburr	*Xanthium strumarium*	FAC
	seaside American aster	*Symphyotrichum subulatum*	OBL
	snapdragon vine	*Maurandella antirrhiniflora*	UPL
	swamp smartweed	*Persicaria hydropiperoides*	OBL
	tall goldenrod	*Solidago altissima*	FACU
	turkey-tangle	*Phyla nodiflora*	FAC

SOILS

A soil core sample taken at Plot 5 consisted of two soil types (Figure 13). The sample indicates a clay soil with a 2.5Y 6/3 color matrix and 13% redox features (2.5YR 4/8) from 0 to 8 inches and a sandy clay soil with a 2.5Y 6/3 color matrix and 10% redox features (2.5YR 4/8). No soil indicators were observed. Plot 5 does not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 13. SOIL CORE SAMPLE AT PLOT 5

Wetland Plot 6

Wetland Plot 6 is located in a drainage way on the Lake Cypress Springs Dam (Figure 14). Plot 6 is located at 33.06121 (latitude), -95.13920 (longitude). This area did not have an NWI classification and appeared concave. Criteria for Vegetation, Soils and Hydrology were satisfied. Plot 6 met the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 14. VIEW OF WETLAND PLOT 6

HYDROLOGY

Primary hydrology indicators observed during the field investigation were high water table, saturation, water-stained leaves and dry-season water table. Saturation visible on aerial imagery, geomorphic position and a positive FAC-Neutral test were the secondary indicators observed during the field investigation. Hydrology criteria were satisfied for Plot 6.

VEGETATION

The only dominant plant species present at Plot 6 was maiden-cane (*Panicum hemitomon*). The Rapid Test and the Dominance Test was satisfied at 100% (above the 50% threshold), and the plot therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 8).

TABLE 8. PLOT 6 VEGEATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Herb			
	coco yam	*Colocasia esculenta*	OBL
	delta arrow head	*Sagittaria platyphylla*	OBL
	maiden-cane	*Panicum hemitomon*	OBL
	swamp smartweed	*Persicaria hydropiperoides*	OBL

SOILS

A soil core sample taken at Plot 6 consisted of two soil types (Figure 15). The sample indicates a loam soil with a 2.5Y 6/1 color matrix and 10% redox features (7.5YR 5/8) from 0 to 4 inches (high organic matter present) and a loamy sand soil with a GLEY-1 5/10Y color matrix with 10% redox features (5YR 4/6) from 4 to 9 inches. Primary soil indicators observed during the investigation were sandy gleyed matrix, loamy mucky mineral and loamy gleyed matrix. Plot 6 satisfies the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 15. SOIL CORE SAMPLE AT PLOT 6

Wetland Plot 7

Wetland Plot 7 is located on a hill slope on the Lake Cypress Springs dam (Figure 16). Plot 7 is located at 33.05612 (latitude), -95.13940 (longitude). This area did not have an NWI classification and appeared well drained with an approximately 20 percent slope. Criteria for Hydrology were satisfied, while criteria for Vegetation and Soils were not satisfied. Plot 7 does not meet the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 16. VIEW OF WETLAND PLOT 7

HYDROLOGY

The only primary hydrology indicator observed during the field investigation was the presence of reduced iron. Hydrology criteria were satisfied for Plot 7.

VEGETATION

The dominant plant species present at Plot 7 include hogwort (*Croton capitatus*) and golden crown grass (*Paspalum dilatatum*). None of the Hydrophytic Vegetation Indicators were satisfied. A table of all species found at the sample site is provided below (Table 9).

TABLE 9. PLOT 7 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Herb			
	Brazilian vervain	*Verbena brasiliensis*	UPL
	golden crown grass	*Paspalum dilatatum*	FAC
	hairy crabgrass	*Digitaria sanguinalis*	FACU
	hogwort	*Croton capitatus*	UPL
	Texas windmill grass	*Chloris texensis*	UPL

SOILS

A soil core sample taken at Plot 7 consisted of a sandy loam soil (Figure 17). The sample indicates a 10YR 4/4 color matrix with 7% redox features (2.5YR 4/8) from 0 to 10 inches (organic matter at top). The absence of any indicators concludes that the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 17. SOIL CORE SAMPLE AT PLOT 7

Wetland Plot 8

Wetland Plot 8 is located on a terrace south of the Lake Cypress Springs dam (Figure 18). Plot 8 is located at 33.04940 (latitude), -95.14130 (longitude). This area did not have an NWI classification and appeared well drained with no topographic relief. Criteria for Vegetation were satisfied, while criteria for Soils and Hydrology were not satisfied. Plot 8 does not meet the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 18. VIEW OF WETLAND PLOT 8

HYDROLOGY

No primary hydrology indicators were observed during the investigation and a positive FAC-Neutral test was the only secondary hydrology indicator observed. In summary, the hydrology criteria were not satisfied for Plot 8.

VEGETATION

The dominant plant species present at Plot 8 include wand panic grass (*Panicum virgatum*) and slender wood-oats (*Chasmanthium laxum*). The vegetation passed the Dominance Test at 100% (above 50% threshold). Therefore, Plot 8 satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 10).

TABLE 10. PLOT 8 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Herb			
	Bermuda grass	*Cynodon dactylon*	FACU
	hogwort	*Croton capitatus*	UPL
	slender wood-oats	*Chasmanthium laxum*	FAC
	wand panic grass	*Panicum virgatum*	FAC

SOILS

A soil core sample taken at Plot 8 consisted of two soil types (Figure 19). The sample indicates a mixed 10YR 5/4 (49%) and 7.5YR 3/2 (49%) color matrix with 2% redox features (2.5YR 4/8) from 0 to 4 inches (loam with organic matter) and a mixed 5Y 7/1 (40%) and 7.5YR 5/8 (60%) color matrix from 4 to 9 inches (sandy loam). The absence of any indicators concludes that the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 19. CORE SAMPLE AT PLOT 8

Wetland Plot 9

Wetland Plot 9 is located in a drainage ditch north of the Lake Cypress Springs dam (Figure 20). Plot 9 is located at 33.06710 (latitude), -95.13880 (longitude). This area did not have an NWI classification and was concave. Criteria for all three wetland indicators were satisfied. Plot 9 met the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 20. VIEW OF WETLAND PLOT 9

HYDROLOGY

Primary hydrology indicators observed include drift deposits, algal mats or crust, water-stained leaves and the presence of reduced iron. Secondary hydrology indicators observed include drainage patterns and geomorphic position. In summary. Hydrology criteria were satisfied for Plot 9.

VEGETATION

The dominant plant species present at Plot 9 include Vasey's grass (*Paspalum urvillei*) and hairy crabgrass (*Digitaria sanguinalis*). The Prevalence Index was satisfied with 2.8 (below the ≤3 threshold), and therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 11).

TABLE 11. PLOT 9 VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Herb			
	curly dock	*Rumex crispus*	FAC
	golden crown grass	*Paspalum dilatatum*	FAC
	hairy crabgrass	*Digitaria sanguinalis*	FACU
	hedge false bindweed	*Calystegia sepium*	FAC
	swamp smartweed	*Persicaria hydropiperoides*	OBL
	Vasey's grass	*Paspalum urvillei*	FACW
	Virginia buttonweed	*Diodia virginiana*	OBL

SOILS

A soil core sample taken at Plot 9 consisted of sandy loam (Figure 21). The sample indicates a 10YR 3/3 color matrix with 10% redox features (7.5YR 4/6) from 0 to 6 inches and a 2.5Y 6/3 color matrix with 15% redox features (5YR 4/6) from 6 to 10 inches. The presence of the redox depression indicator concludes that the soils meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 21. SOIL CORE SAMPLE AT PLOT 9

Wetland Plot 10

Wetland Plot 10 is located on a hillslope north of Lake Cypress Springs dam (Figure 22). Plot 10 is located at 33.06686 (latitude), -95.13910 (longitude). This area did not have an NWI classification and appeared well drained with an approximately seven percent slope. Criteria for Vegetation were satisfied, while criteria for Hydrology and Soils were not satisfied. Plot 10 does not meet the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 22. VIEW OF WETLAND PLOT 10

HYDROLOGY

No hydrology indicators were observed for Plot 10. In summary, Hydrology criteria were not satisfied for Plot 10.

VEGETATION

The dominant plant species present at Plot 10 include blackjack oak (*Quercus marilandica*), American elm (*Ulmus americana*) and sugar-berry (*Celtis laevigata*). The Dominance Test was satisfied at 75% (above the 50% threshold) and therefore satisfies the hydrophytic vegetation criteria. A table of all species found at the sample site is provided below (Table 12).

TABLE 12. PLOT 10 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Tree			
	blackjack oak	*Quercus marilandica*	UPL
	green ash	*Fraxinus pennsylvanica*	FAC
Sapling/Shrub			
	American elm	*Ulmus americana*	FAC
	sugar-berry	*Celtis laevigata*	FAC
Herb			
	Eastern poison ivy	*Toxicodenron radicans*	FACU
	hairy crabgrass	*Digitaria sanguinalis*	FACU
	horsebriar	*Smilax rotundifolia*	FAC
	poorjoe	*Diodia teres*	FACU
	slender wood-oats	*Chasmanthium laxum*	FAC

SOILS

A soil core sample taken at Plot 10 consisted of a loamy sand soil (Figure 23). The sample indicates a 10YR 3/3 color matrix from 0 to 2 inches and a mottled 7.5YR 4/4 (80%) and 2.5YR 4/8 (20%) color matrix from 2 to 11 inches. The absence of any indicators concludes that the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 23. SOIL CORE SAMPLE AT PLOT 10

Wetland Plot 11

Wetland Plot 11 is located on a terrace near the Lake Cypress Springs spillway (Figure 24). The plot is located at 33.06547 (latitude), -95.14640 (longitude). This area did not have an NWI classification and an approximately 2 percent slope. Criteria for Hydrophytic vegetation was met; however, criteria for Soils and Hydrology were not met. Plot 11 did not satisfy criteria for wetland indicators according to the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 24. VIEW OF WETLAND PLOT 11

HYDROLOGY

Only one secondary hydrology indicator was observed (FAC-Neutral test) during the field investigation. However, two secondary indicators are required for the hydrology to meet requirements. Therefore, Hydrology criteria were not satisfied for Plot 11.

VEGETATION

The dominant plant species present at Plot 11 include Shumard's oak (*Quercus shummardii*), cherry-bark oak (*Quercus pagoda*), American beauty berry (*Callicarpa americana*) and Texas dropseed (*Sporobolus texanus*). The vegetation passed the Dominance Test (67%, above 50% threshold). Therefore, Vegetation criteria were satisfied for Plot 11. A table of all species found at the sample site is provided below (

Table 13).

TABLE 13. PLOT 11 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Tree			
	cherry-bark oak	*Quercus pagoda*	FAC
	Shumard's oak	*Quercus shummardii*	FAC
	Southern red oak	*Quercus falcata*	FACU
	willow oak	*Quercus phellos*	FACW
Sapling/Shrub			
	common paw paw	*Asimina triloba*	FACU
Herb			
	American beauty berry	*Callicarpa americana*	FACU
	Heller's rosette grass	*Dichanthelium oligosanthes*	FACU
	horsebriar	*Smilax rotundifolia*	FAC
	long-leaf wood-oats	*Chasmanthium sessiliflorum*	FAC
	Texas dropseed	*Sporobolus texanus*	FAC
	Virginia creeper	*Parthenocissus quinquefolia*	FACU
Woody Vine			
	muscadine	*Vitis rotundifolia*	FAC

SOILS

A soil core sample taken at Plot 11 consisted of a loamy sand (Figure 25). The sample indicates a 10YR 5/3 color matrix from 0 to 10 inches. The absence of any indicators concludes that the soils do not meet or satisfy the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 25. SOIL CORE SAMPLE AT PLOT 11

Wetland Plot 12

Wetland Plot 12 is located along the Lake Cypress Springs shoreline near the spillway (Figure 26). Plot 12 is located at 33.06510 (latitude), -95.14590 (longitude). This area did not have an NWI classification and appeared to inundate with water due to topographic relief. Criteria for all three wetland indicators were satisfied. Plot 12 meets the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 26. VIEW OF WETLAND PLOT 12

HYDROLOGY

Although surface water was not present at the time of the field investigation, three primary hydrology indicators were observed: inundation visible on aerial imagery, water-stained leaves and the presence of reduced iron. Additionally, saturation visible on aerial imagery, geomorphic position and a positive FAC-Neutral test were the secondary hydrology indicators observed. In summary, the hydrology criteria were satisfied for Plot 12.

VEGETATION

The dominant plant species present at Plot 12 include common buttonbush (*Cephalanthus occidentalis*), maiden-cane (*Panicum hemitomon*) and swamp smartweed (*Persicaria hydropiperoides*). The vegetation passed the Rapid Test, Dominance Test (at 100%; above 50% threshold) and the Prevalence Index (at 2.76; below 3.0 threshold). Therefore, vegetation criteria were satisfied for Plot 12. A table of all species found at the sample site is provided below (

Table 14).

TABLE 14. PLOT 12 VEGETATION PRESENT

Wetland Determination Vegetation Species

Stratum	Common Name	Scientific Name	Wetland Indicator Status
Sapling/Shrub			
	common buttonbush	*Cephalanthus occidentalis*	OBL
	groundseltree	*Baccharis halimifolia*	FAC
Herb			
	Canadian clearweed	*Pilea pumila*	FAC
	climbing hempvine	*Mikania scandens*	FACW
	coco yam	*Colocasia esculenta*	OBL
	hedge false bindweed	*Calystegia sepium*	FAC
	horsebriar	*Smilax rotundifolia*	FAC
	maiden-cane	*Panicum hemitomon*	OBL
	narrow-leaf cattail	*Typha angustifolia*	OBL
	opposite-leaf spotflower	*Acmella repens*	FACW
	round-leaf goldenrod	*Solidago patula*	OBL
	swamp smartweed	*Persicaria hydropiperoides*	OBL
	turkey tangle	*Phyla nodiflora*	FAC
	Virginia buttonweed	*Diodia virginiana*	OBL

SOILS

A soil core sample taken at Plot 12 consisted of a loamy sand soil type transitioning to a sandy loam (Figure 27). The sample indicates a 7.5YR 3/3 color matrix from 0 to 4 inches (loamy sand with peat mix) and 2.5YR 4/1 color matrix with 7% redox (2.5YR 3/6) from 4 to 9 inches (sandy loam). The hydric soil indicator observed during the investigation was a depleted matrix. Plot 12 satisfies the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 27. SOIL CORE SAMPLE AT PLOT 12

Data Form 1 (DF1)

The Data Form 1 (DF1) plot is located south of the Lake Cypress Springs dam (Figure 28) at 33.05185 (latitude), -95.14003 (longitude). This area had an NWI classification as a pond, appeared to inundate with water and had concave topographic relief. Criteria for all three wetland indicators were satisfied. DF1 met the requirements for a wetland classification (USACE 1987; USACE 2010).

FIGURE 28. VIEW OF WETLAND DF1 PLOT

HYDROLOGY

Drainage patterns in wetlands was the only Data Form 1 primary hydrology indicator observed during the investigation. Water stained leaves and a positive FAC-Neutral test were the two secondary indicators. In summary, the hydrology criteria were satisfied for DF1.

VEGETATION

The dominant plant species present at Plot 13 include sweet-gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), horsebrier (*Smilax rotundifolia*) and peppervine (*Ampelopsis arborea*). The Dominance Test was satisfied at 100% (above the 50% threshold), and therefore satisfies the hydrophytic vegetation criteria. A table of dominant species found at the sample site is provided below (Table 15).

TABLE 15. DF1 VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	**Common Name**	**Scientific Name**	**Wetland Indicator Status**
Tree			
	sweet-gum	*Liquidambar styraciflua*	FAC
	red maple	*Acer rubrum*	FAC
Herb			
	horsebrier	*Smilax rotundifoloia*	FAC
	peppervine	*Ampelopsis arborea*	FAC

SOILS

A soil core sample taken at DF1 consisted of a loamy clay soil type (Figure 29). The sample indicates a 7.5 YR 5/3 color matrix with 15% redox (5YR 4/6) from 0 to 18 inches. Hydric soil indicators observed in DF1 were reducing conditions and concretions. Soils found in DF1 met or satisfied the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 29. SOIL CORE SAMPLE AT DF1 PLOT

Data Form 2 (DF2)

Wetland Plot 14 is located south of the Lake Cypress Springs dam (Figure 30) at 33.05074 (latitude), -95.14030 (longitude). This area did not have an NWI classification, appeared to inundate with water and had concave topographic relief. Criteria for all three wetland indicators were satisfied according to the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010) and DF2 is considered a wetland.

FIGURE 30. VIEW OF WETLAND DF2 PLOT

HYDROLOGY

Primary DF1 hydrology indicators observed include drift lines, sediment deposits and drainage patterns in wetlands. Water-stained leaves and a positive FAC-Neutral test were the secondary hydrology indicators observed. In summary, the hydrology criteria were satisfied for DF1.

VEGETATION

The dominant plant species present at the DF2 plot include red maple (*Acer rubrum*), loblolly pine (*Pinus taeda*) and sweet-gum (*Liquidambar styraciflua*). The Dominance Test was satisfied at 100% (above the 50% threshold) and therefore satisfies the hydrophytic vegetation criteria. A table of dominant species found at the sample site is provided below (Table 16).

TABLE 16. DF2 PLOT VEGETATION PRESENT

Wetland Determination Vegetation Species			
Stratum	Common Name	Scientific Name	Wetland Indicator Status
Tree			
	loblolly pine	*Pinus taeda*	FAC
	red maple	*Acer rubrum*	FAC
	sweet-gum	*Liquidambar styraciflua*	FAC

SOILS

A soil core sample taken at the DF2 plot consisted of a clay soil type transitioning to a sandy loam (Figure 31). The sample indicates a 10 YR 5/3 color matrix with 40% redox (5YR 4/6) from 0 to 6.5 inches (clay) and a mottled soil layer from 6.5 to 12 inches with 10YR 5/3 (65%) color matrix and 5YR 5/8 (35%) color matrix. Hydric soil indicators observed during the investigation included reducing conditions and concretions. DF2 satisfies the soil criteria as outlined in the *Corps of Engineers Wetlands Delineation Manual* (1987) and Regional Supplement (USACE 2010).

FIGURE 31. SOIL CORE SAMPLE AT DF2 PLOT

SUMMARY

National Wetland Inventory maps do not provide sufficient wetland information in and around the Lake Cypress Springs area and in fact do not reflect current Lake Bob Sandlin conditions. During the 2019 wetland determination investigation, several wetland areas were identified within the proposed project areas.

A total of 5.1 acres of freshwater emergent wetlands and 0.5 acres of freshwater forested wetlands were identified in and near the proposed project boundaries (see Figure 32 thru Figure 35). Most of the wetland areas were associated with shoreline areas around Lake Cypress Springs and Lake Bob Sandlin. Forested wetland areas identified south of the Lake Cypress Springs Dam were located in an area adjacent to a spoil area. These forested wetland areas appear to be created by alterations to local topography and hydrology patterns as a result of the construction of utility roads.

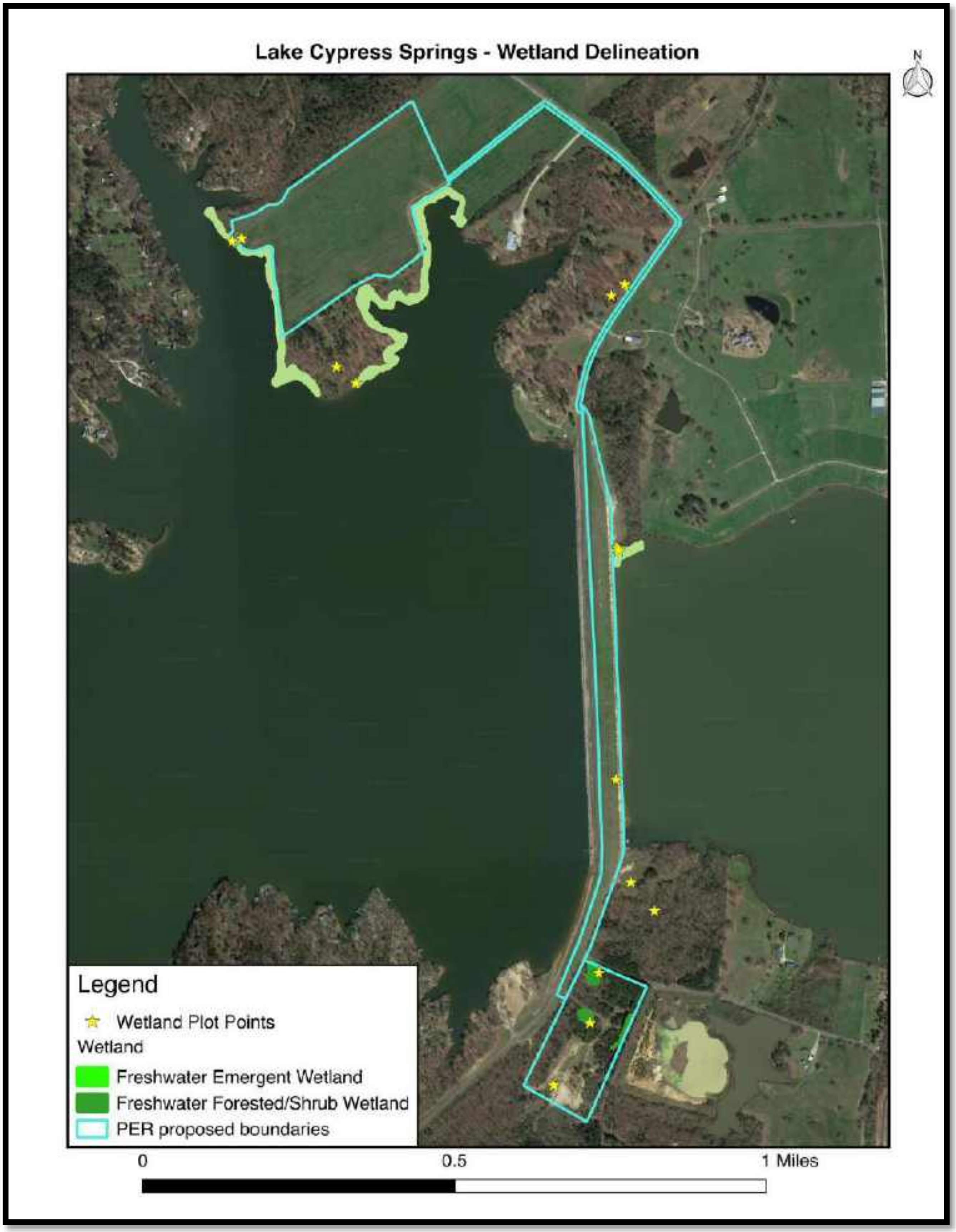

FIGURE 32. OVERALL WETLAND DELINEATION MAP SHOWING PER PROPOSED PROJECT BOUNDARIES

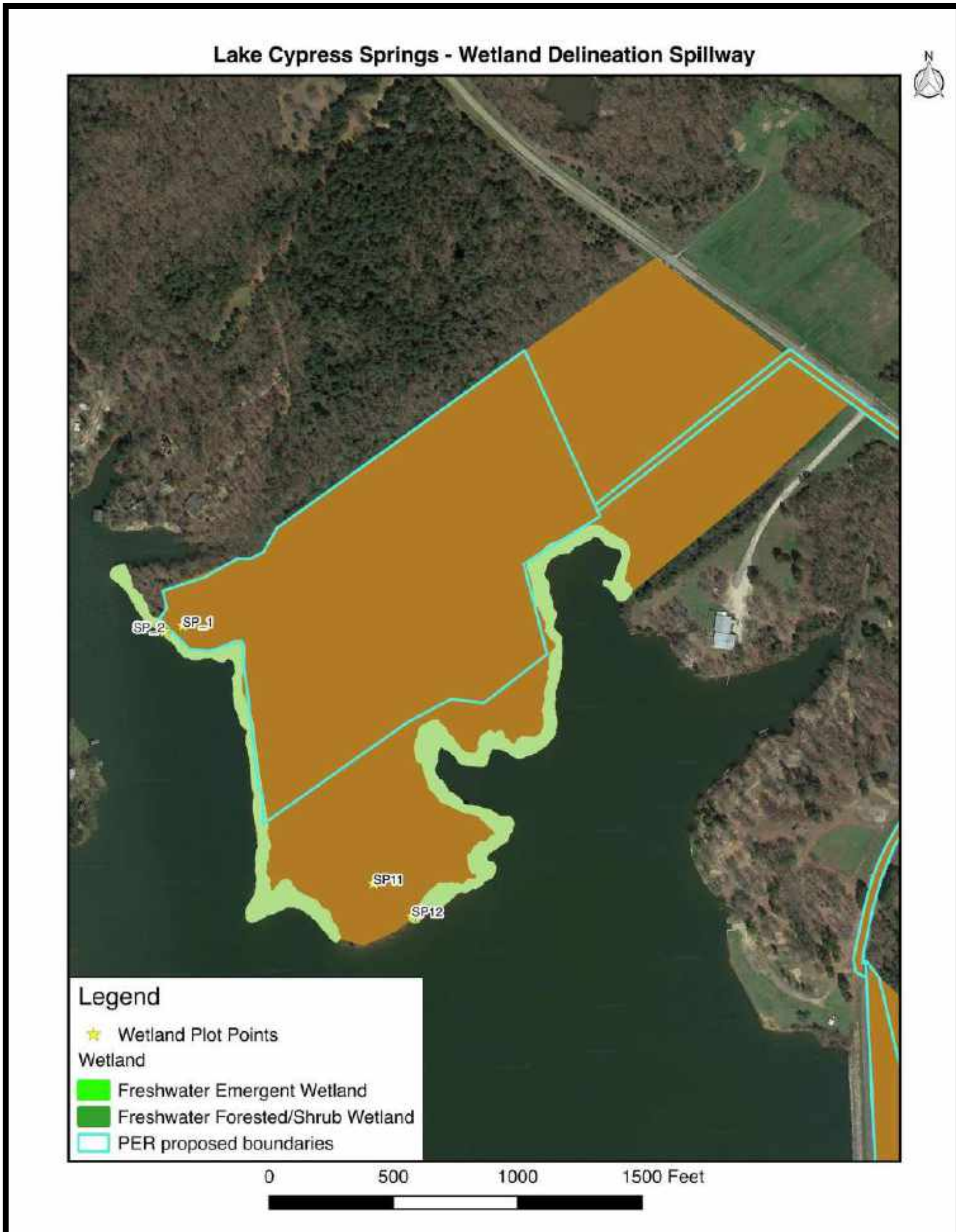

FIGURE 33. WETLAND DELINEATION & PER PROPOSED BOUNDARIES ON SPILLWAY

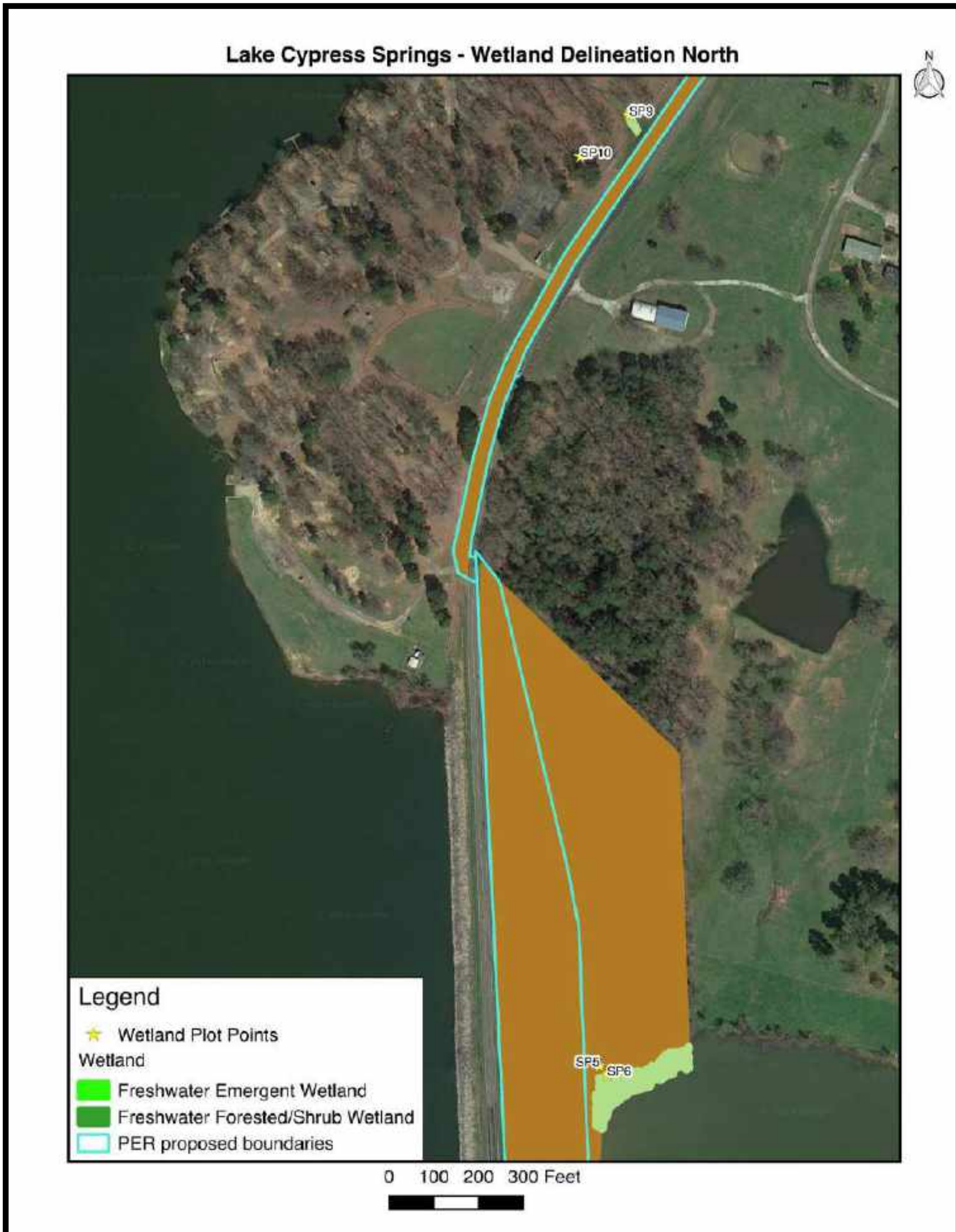

FIGURE 34. WETLAND DELINEATION & PER PROPOSED BOUNDARIES ALONG ROAD AND NORTH DAM

FIGURE 35. WETLAND DELINEATION & PER BOUNDARIES ON SOUTH DAM AND STAGING AREA

REFERENCES

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APPENDIX A

Wetland Determination Data Forms

Appendix C

TCEQ DAM SAFETY INSPECTION REPORT - FRANKLIN COUNTY DAM

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 8, 2018

Mr. David Weidman, General Manager
Franklin County Water District
P.O. Box 559
Mount Vernon, Texas 75457

Re: Franklin County Dam
Inventory No. TX03288

Dear Mr. Weidman:

As you are aware, the above referenced dam was inspected by Texas Commission on Environmental Quality (TCEQ) Dam Safety staff on May 22 and 23, 2018. We have completed our inspection report and have enclosed a copy for your reference. The dam was found to be in fair condition due to the poor condition of the downstream slope.

See the enclosed inspection report for recommendations.

Please review the enclosed report and respond to our office by September 30, 2018, with a written plan of action that addresses each recommendation in the report. We understand that it may take some time to accomplish the recommended actions; however, we ask that you inform us of your plans and a time schedule for completing these actions.

We appreciated your and J. R. Alphin's assistance during the inspection. Please contact me with any questions at warren.samuelson@tceq.texas.gov or (512) 239-5195.

Sincerely,

Warren D Samuelson

Warren D. Samuelson, P.E.
Manager, Dam Safety Section
Critical Infrastructure Division, MC-177

Enclosure

DAM SAFETY SECTION
CRITICAL INFRASTRUCTURE DIVISION

Dam Safety Inspection Report

TCEQ

GENERAL INFORMATION

INVENTORY NO.: TX03288

DAM: Franklin County Dam

OWNER: Franklin County Water District (District)

STREAM: Big Cypress Creek

BASIN: Cypress COUNTY: Franklin

GENERAL LOCATION: 8 miles SE of Mount Vernon

DAM HEIGHT: 73 feet SIZE CLASSIFICATION: Large

NORMAL CAPACITY: 67,690 ac-ft (based on 1998 Volumetric Survey)

MAXIMUM CAPACITY: 164,000 ac-ft

PREVIOUS INSPECTION DATE: October 25, 2011

CURRENT INSPECTION DATE: May 22 and 23, 2018

INSPECTION BY TCEQ PERSONNEL:

Warren D. Samuelson, P. E., Manager, Dam Safety Section
Johnny Cosgrove, P. E., Team Leader, Dam Safety Section

PERSONNEL CONTACTED:

David Weidman, General Manager, Franklin County Water District
J. R. Alphin, Jr., Operations Manager, Franklin County Water District

SUMMARY

Franklin County Dam, a large size earthen dam, was inspected by TCEQ staff on May 22 and 23, 2018, as part of the TCEQ regular inspection schedule. The District requested the inspection. On April 4, 2018, a date for the inspection was scheduled. The dam was found in overall fair condition due to the poor condition of the downstream slope. The primary issues of concern included: numerous holes and tunnels on the downstream slope; toe drain outlets needing to be opened periodically; erosion on the upstream slope, along the downstream berm, and at the downstream groins; vegetation in the upstream slope riprap; cracking and deterioration of the older riprap on the upstream slope; animal burrows and ant mounds on the crest; and seepage at both ends of the downstream slope. In addition, there is a need for an emergency action plan table top exercise, a hydraulic adequacy study, and an evaluation of the piezometric data. A verbal exit interview, explaining some of the results of the inspection, was conducted on May 23 with both Mr. Weidman and Mr. Alphin.

BACKGROUND

The Franklin County Dam Rehabilitation Project was completed on April 14, 2010. Freese and Nichols, Inc. was the engineer on the project.

TCEQ Dam Safety's last inspection of Franklin County Dam was undertaken on October 25, 2011, 1.5 years after completion of the project. Items of concern at that time included: erosion holes and tunnels on the left end of the downstream slope; excessive vegetation on portions of the upstream and downstream slopes; and seepage immediately south of the service spillway outlet headwall.

A letter was sent to the District with a copy of the report on April 12, 2012.

In response, the District sent a letter dated May 7, 2012, indicating that: 1.) The erosion areas may be a small section of dispersive clay and that the holes would be filled with compacted clay by the end of May of 2012, and other areas that may form would be filled at the time they were observed; 2.) A mower would be purchased, and the downstream slope would be regularly mowed; 3.) The vegetation on the upstream slope had been sprayed and would continue to be sprayed as necessary; 4.) The seepage area would be monitored once a month; and 5.) The piezometers would be read monthly and toe drain discharges would be noted, and the data would be evaluated by their engineer.

In 2013, reportedly, more holes and tunnels were observed on the downstream slope. As a result, the District's engineer, Freese and Nichols, Inc., and several other engineers retained by the District or by Freese and Nichols, Inc., issued reports, with different opinions regarding causes and repair options. The presence of dispersive soils was the focus of the reports. This safety inspection report will not address the different proposed options for repair.

Eventually, litigation was filed in the District Court of Franklin County: Cause No. 11900, Franklin County Water District vs Freese and Nichols, Inc. vs Earth Builders, LP, Earth Builders, Inc., and Earth Builders Management, LLC.

Numerous depositions have been taken, including one from the writer of this report. The case is still pending.

In 2014, a new fence was installed around the service spillway morning glory.

On December 27, 2015, a large rainfall event occurred over the watershed of Lake Cypress Springs (reservoir impounded by Franklin County Dam). The lake rose to elevation 383.92, or 5.92 feet above the crest of the morning glory (normal pool elevation). There were 38 houses and other property reportedly affected. Carollo

Engineers, Inc., was tasked with preparing a Preliminary Engineering Report to determine feasible solutions to curtail negative impacts from flood events similar to the 2015 flood. The report was completed on March 6, 2017. A number of alternatives were presented.

Six structural alternatives were presented, which included: 1.) Building a canal in the emergency spillway at approximately the elevation of the service spillway; 2.) Installing a series of box culverts through the dam to the left of the service spillway; 3.) Constructing a tainter gate system through the dam; 4.) Building a pump station at the left end of the dam; and 5.) Building a second morning glory spillway. In addition, an operational alternative was presented: lowering the lake level either permanently or by pre-release in advance of a storm event.

Carollo Engineers, Inc. also presented the results of a field survey of the emergency spillway. It was found that the emergency spillway had areas that were higher than designed.

Mr. Weidman wrote a letter to the District Board dated April 18, 2017. He recommended that none of the structural alternatives be pursued due to the costs and low Benefit Cost Ratios. He also recommended that an additional study be undertaken to address the elevation issue in the emergency spillway.

Carollo Engineers, Inc. completed the second study on February 2, 2018. Four alternatives were evaluated: 1.) Leave the spillway as is; 2.) Return the spillway to the design levels (remove 0.5 to 2 feet of fill); 3.) Optimize restoration of the spillway, including alteration of County Road 3122; and 4.) Optimize restoration in other areas of the spillway. Carollo Engineers, Inc. recommended in the study that the emergency spillway not be used for agricultural purposes, as was being done at that time.

Mr. Weidman wrote another letter to the District Board dated March 20, 2018. He recommended that no action be taken on the emergency spillway due to the low annual percent chance probability of engagement coupled with a low Benefit Cost Ratio. He also recommended that the District should discontinue the agricultural practices in the emergency spillway.

In a letter dated May 12, 2018, Mr. Weidman recommended that the District should take no action to permanently or seasonally lower Lake Cypress Springs. The District Board voted unanimously on June 12, 2018, to not temporarily or permanently lower the Lake Cypress Springs water service elevation for flood protection purposes.

On March 14, 2018, Mr. Weidman contacted this office and requested an inspection by the TCEQ Dam Safety Program. After several attempts to set a date, the subject inspection was scheduled.

PRE-INSPECTION MEETING

Mr. Weidman and Mr. Alphin were met at the dam. They were present during part of the inspection on May 22 and arrived as the inspection was being completed on May 23.

The discussions centered on operational aspects on the dam. There were no discussions about the litigation. See the individual sections of the report for any comments.

INSPECTION FINDINGS

Figure 1 is a location map. Figure 2 is an aerial photo of the dam with contours. Figures 3 - 6 are plan views of the dam, indicating photo locations. Note that right and left indications are from the perspective of an observer looking downstream. The USGS gage indicated that the water level was at 377.91 feet-msl, or 0.09 feet below the service spillway. However, water was slightly spilling over the spillway crest.

CREST

- The 44-foot wide crest of the dam was in good condition. FM 3007 extends along the crest and is well traveled. There were no visible signs of cracks, low spots, or misalignment. See Photos 3 – 5. According to the 2014 Freese and Nichols, Inc. report, the crest varies from 395 to 397 feet msl. According to Mr. Weidman, there has not been a recent survey of the crest of the dam.
- A grass cover exists between the road and the guardrails on both sides of the road. This area is well maintained. A mower was on-site mowing the crest along the upstream guardrail as the inspectors left the dam. The grass beneath the guardrails, and at least a foot on either side of the guardrails, is kept short. See Photos 6-9.
- There were numerous ant mounds along the area of the guardrails. See Photo No. 10.
- There were a number of animal holes near the guardrail posts and utility poles. See Photos 11 and 12.
- Piezometers P-1, P-3, and P-5 were located on the crest. See Photos 13-15. No other piezometers were located on the crest.
- The guardrails on both sides were straight with no signs of movement. See Photos 6-8.
- Several of the utility poles on the downstream side of the crest were leaning downstream near the center of the dam. See Photo No. 9. This situation occurred during periods of historic sliding on the downstream slope, prior to completion of the 2010 rehabilitation. It does not appear that the condition was worse.

UPSTREAM SLOPE

- The 2.88 horizontal to 1 vertical [2.88H:1V] upstream slope was in good condition. There is a berm at elevation 368 feet msl. Rock riprap extends up the slope to elevation 391.0 feet msl. Currently, the slope from the top of the riprap to the upstream edge of the crest has very little to no vegetative cover. See Photos 16-18.

- The riprap to the right of the service spillway is older riprap. See Photo No. 19. The riprap from the service spillway to the left end of the dam is primarily newer rock; however, there is some older rock mixed with the new rock. See Photo No. 20.
- Some of the older rock was continuing to deteriorate and crack. See Photo No. 21.
- There was an indention in the rock riprap along the water line. See Photos 22 and 23.
- There was an area in the older rock that lacked larger rock. See Photo No. 24.
- There was minor growth of vegetation in various areas of the rock riprap. See Photos 19, 20, and 22.
- The area above the rock riprap on the slope was eroding due to lack of vegetative cover. The vegetative cover noted in this area in the past was no longer present. Erosion gullies were noted primarily toward the ends of the dam. These gullies were as much as 2 feet deep and 2 to 3 feet wide. See Photos 25, 26, and 28.
- Erosion was occurring next to guardrail posts in several places. See Photos 27 and 28.

<u>DOWNSTREAM SLOPE</u>

- The 3 H:1V downstream slope was found to be in poor condition.
- Numerous holes were observed on the slope from approximately Station 6+00 to Station 36+00, primarily in the center portion of the slope; however, there were holes in the other sections of the slope, as well. It was dangerous to walk the slope due to the abundance of holes. See Photos 35-59.
- There was a grass and weed cover on the slope, except where the holes were located. The portions of the slope that did not have holes had been mowed; however, the other sections had been maintained to some extent by hand. Mr. Alphin indicated that the slope had collapsed in areas of tunnels when the mowers drove over the tunnels. No one was injured, but the mowers had to be pulled out of the holes.
- According to the various reports that have been prepared, tests that have been performed, and the appearance of the slope, dispersive soils appear to be the cause for the holes. There are the standard jugs (holes) and tunnels that are associated with dispersive soils. The tunnels have been collapsing between holes, forming erosion gullies. It is recognized that there are different opinions on the cause for the holes. Regardless, the holes exist.
- The extent of the dispersive soil on the slope is not known. From walking the slope, most of the center section of the slope is affected. It is not known if there are dispersive soils in the other portions of the slope.
- The holes at the left end of the dam are the deepest, with holes that are 6 to 7 feet deep and 5 to 7 feet wide. The holes at the right end are 3 to 4 feet deep and 3 to 5 feet wide. The size and depth of the holes are much larger than the holes that were first noted during the 2011 TCEQ Dam Safety inspection. A review of the as-built plans indicated that the depth of holes between Stations 10+00 and 12+00 are at 60 to 70% of the vertical depth of fill added in those areas.

- In several areas, there appeared to be new holes forming.
- Cracks were located on the slope. See Photo No. 60. These cracks could lead to additional holes during periods of rainfall.
- The soil in the holes is compromised. See Photo No. 55 for an example.
- Material has washed off the slope and is covering the access road along the berm downstream. The material was an inch deep in one place.
- Erosion has also occurred on the downstream edge of the road.
- Erosion was also occurring at both groins. See Photos 61 and 62.

SEEPAGE

- There was no seepage or standing water in any of the holes on the downstream slope.
- Seepage was again noted to the right of the service spillway outlet. Seepage, boils, and a sinkhole have historically been noted in this area. See Photo No. 71.
- A flowing seepage area was located along the left groin of the downstream slope. The flow was minor. See Photo No.72. This has also existed in the past.

INSTRUMENTATION

- Six piezometers were installed during the 2010 dam rehabilitation project, three on the crest and three on the downstream slope just upstream of the berm along the downstream toe. These are located at Stations 10+00, 18+50, and 30+00.
- According to Mr. Weidman, the five piezometers that were existing at the time of the rehabilitation project were replaced.
- The six piezometers are read quarterly by District staff.
- All six piezometers were located during the inspection. See Photos 13-15 and 73-75.
- A graph of the piezometer readings from April 1, 2012, to the present was provided following the inspection.
- The piezometers on the crest, P-1, P-3, and P-5, have shown consistent readings, with P-1 showing the highest reading. P-1 is located at Station 10+00. P-1 has trended upward since the initial reading in 2012 on the graph that was provided, but has leveled off since 2016.
- The piezometers along the toe are P-2, P-4, and P-6, with P-2 located at Station 10+00. P-2 has stayed consistent. P-6, located at Station 30+00, has also trended upward since the initial reading in 2012 on the graph that was provided, but has been leveled off since 2016.
- P-4 has shown periods of high readings from approximately January 2013 to August of 2014. The level was shown to be at the top of the piezometer during that time. There was also a spike in 2015 of 5 to 6 feet. The readings have leveled off since early 2016. It cannot be determined if these were bad readings or some type of reporting error or high piezometric readings.
- Mr. Weidman indicated that the operations and maintenance staff saw no unusual wet areas or seepage in the vicinity of P-4 during that time. Also, there have been no comments or observations from the District's engineer, Freese and

Nichols, Inc., at that time. It is noted that P-4 is 50 feet south of the toe drain outlet at Station 18+00 that had standing water in the pipe and the most flow from the pipe during this inspection.

TOE DRAIN OUTLETS

- There are 14 toe drain outlets (installed during the 2010 rehabilitation project) that discharge into concrete discharge boxes in the riprap below the downstream slope berm. The outlets are located every 200 feet at even number stations. The outlets are 12-inch pipes that extend from finger drains, which tie into an old existing drainage blanket. A 12-inch flap valve exists at the end of each pipe to prevent water from Lake Bob Sandlin from entering the drainage system.
- All of the outlets were checked. See Photos 63-70.
- Some of the flap valves were glued shut due to bacteria build-up from iron-ochre laden sludge in the seepage water.
- The following outlets flowed after the flaps were raised: Station 16+00; Station 18+00; Station 26+00; Station 28+00; Station 30+00; Station 32+00; and Station 34+00.
- Since the flap valves had not been opened recently, the pipes at Stations 18+00 and 34+00 were standing half full of water.
- The outlet at Station 18+00 flowed for over a minute. It was checked as the inspection finished the first day, and it was still flowing. See Photo No. 70. It was checked the next morning, and it was still flowing.
- It is interesting to note that there was flow from several outlets and not from others. Two outlet pipes were half full, which could imply that water would back up in the system and discharge 200 feet away. That was not occurring in some of the areas.

SERVICE SPILLWAY

- The service spillway is located approximately 1,600 feet from the right end of the dam near Station 34+00.
- The service spillway is a concrete morning glory drop inlet with a 23.5-foot by 23.5-foot opening and a 10-foot by 10-foot conduit. A chain link fence surrounds the inlet, and a line of buoys extends out into the lake to prevent boats from getting too close to the inlet. See Photos 76-78. The fence was added in 2014.
- A metal walkway provides access to a metal trash guard and walkway around the inlet. The access gate was locked, and the inspection party did not request access.
- The outlet end of the service spillway was under water from Lake Bob Sandlin. See Photo No. 79.
- The visible portions of the service spillway were found to be in good condition.
- There has been a surging effect in the service spillway since initial construction during substantial spillway flows. The surge is loud and a geyser forms at the outlet that extends a considerable distance above Lake Bob Sandlin.
- The conduit was checked for any problems most recently on March 20, 2006, by divers. The water was murky, and everything was done by feel. There were no

significant signs of deterioration noted; however, it was recommended that the pipe be dewatered for future inspections. In 2010, the conduit was dewatered, and a walk through of the conduit was conducted. No report was written, but Mr. Weidman did not remember any problems.

EMERGENCY SPILLWAY

- The emergency spillway is located approximately ½ mile west of the left end of the dam.
- The emergency spillway is a 1,000-foot wide earthcut channel. County Road 3122 crosses the discharge channel.
- The emergency spillway has a good grass cover and was well maintained. The ditches along the roadway were clear and well maintained. See Photos 81 and 82.
- The emergency spillway was found to be in good condition.
- The emergency spillway was no longer being used for agricultural purposes.

LOW FLOW OUTLET

- The low flow outlet consists of an 18-inch diameter pre-stressed concrete cylinder pipe encased in concrete and connected to the sidewall of the service spillway conduit.
- The low flow outlet/service spillway discharge conduit junction is located directly below the upstream slope of the dam about 65 feet from the centerline of the drop inlet morning glory.
- Two 18-inch flanged gate valves, connected in series, control the low flow discharges. See Photo No. 79.
- The low flow outlet valve stems were repaired, and the valves were serviced in September 2010.
- The low flow outlet appeared to be in good condition.

DOWNSTREAM CHANNEL

The downstream channel is Lake Bob Sandlin. There are no issues associated with this area. See Photo No. 80.

CONFIDENTIAL: DOWNSTREAM HAZARDS

This dam is classified as a high hazard dam. A 2006 breach analysis by the District's engineer indicated that a failure of the Franklin County Dam would potentially impact FM-3007, FM-21, numerous habitable structures constructed along the Lake Bob Sandlin shoreline, eliminate Lake Cypress Springs as a water supply reservoir, and cause significant economic loss to the Franklin County Water District and downstream residents.

The Texas Department of Transportation (TXDOT) classifies FM 3007 and FM-21 as "rural major collectors". Per 30 Texas Administrative Code (TAC), Chapter 299, Section

(§) 299.2(58), a roadway classified by TXDOT as a rural major collector is considered by the TCEQ to be a secondary highway.

It should be noted that the hazard classification is not a description of the condition of the structure, but rather, a description of the potential for loss of downstream life or property in the event of a failure of the dam. The high hazard classification indicates that there is a potential for loss of life.

HYDROLOGIC / HYDRAULIC ANALYSES

This dam is required to safely pass 75% of the PMF.

A hydrologic and hydraulic study was conducted in 1978 as part of the Phase I, National Dam Safety Program. At that time, the dam was found to pass 100% of the PMF with 1.2 feet of freeboard and was considered to be hydraulically adequate.

However, as indicated in the Background Section, the emergency spillway has been found to be 0.5 to 2 feet higher than designed. The report prepared by Carollo Engineers, Inc. did not address hydraulic adequacy. In addition, the 2014 Freese and Nichols, Inc. report indicated that the crest of the dam has an elevation that varies from 395 to 397 feet msl (at 396.4 feet msl per TCEQ records). Therefore, there are uncertainties about the hydraulic adequacy of the dam.

OPERATION AND MAINTENANCE (O&M) PLAN

The owner indicated that a written O&M plan is available.

EMERGENCY ACTION PLAN (EAP)

An EAP, dated February 12, 2010, was submitted and is on record. Annual updates have been submitted each year, with the last received on January 31, 2018.

Mr. Weidman indicated that a table top exercise had not been undertaken due to the pending litigation.

REQUIREMENTS/RECOMMENDATIONS

The following requirements and/or recommendations are provided based on the results of this inspection and the TCEQ's responsibilities under the Texas Water Code and not upon an opinion from an engineering report:

1. It is recommended that the District take immediate steps to retain an engineer, possibly someone not involved in the litigation, to develop a permanent repair plan for the entire downstream slope. The plan needs to take into consideration: the length of time that the slope has been exposed with no repairs or surface treatment undertaken; the increasing size and depth of the

holes and tunnels; the formation of new holes; the observation of cracks on the slope, which could lead to new holes; the presence of dispersive soils, as evidenced by tests taken by various engineers and the appearance of the slope; and the loss of soil integrity evident on the sides of the holes. LiDAR data has been developed by the District, which should be incorporated into the development of the plan. The plans and specifications and geotechnical report should then be submitted to this agency for review at various percentages of completion and eventually for approval.

2. The toe drain outlets need to be monitored and the flap valves opened and cleaned on a quarterly schedule. A log of observations (including drain flow rates and lake levels) and photographs should be kept. The results should be evaluated by the District's engineer with the piezometer readings. The District may desire to consider a lighter flap valve, which may prevent water ponding in the pipe.
3. It is recommended that the erosion on the upstream slope be repaired before the damage becomes worse. The erosion is affecting the guardrail posts in several places. A grass cover needs to be established once the repairs are completed.
4. The erosion along the downstream berm and at the downstream groins also needs to be repaired.
5. The leaning utility poles on the crest of the dam should be monitored to determine if there is any additional movement of the dam. There does not appear to be any movement at this time. However, if movement does occur, the District's engineer should be contacted to determine the source of the movement and to recommend a method for correction.
6. The vegetation in the upstream slope riprap should be sprayed or removed on a regular schedule.
7. The older riprap on the right end of the upstream slope was cracked and deteriorated. The rock needs to be evaluated by the District's engineer to determine if rock needs to be added or replaced. In addition, the pockets lacking riprap need to have new rock placed.
8. The indention along the upstream slope water line and the slope above this area should be monitored. If movement occurs, the District's engineer should be contacted to determine the source of the movement and to recommend a method for correction.
9. The animal burrows and ant mounds on the crest needs to be addressed as part of the regular maintenance program.
10. The seepage areas at both ends of the downstream slope should be regularly monitored. Any changes in flow or evidence of soil movement should be documented and the District's engineer should be contacted.
11. As required in the rules, an EAP table top exercise needs to be undertaken as soon as possible. The Dam Safety Program should be informed of the exercise.
12. A hydraulic adequacy study needs to be performed due to the emergency spillway being higher than designed and the crest of the dam possibly being lower than designed. In 2018, Carollo Engineers, Inc. did not address the percent passage of the PMF.

13. The piezometric data should be evaluated by the District's engineer as there appear to be some inconsistencies. It is recommended that the quarterly readings be continued until the District's engineer provides a basis for changing the reading frequency. The TCEQ Dam Safety Program has no documentation that the piezometers that were existing at the time of the 2010 rehabilitation project were abandoned and possibly replaced. The District's engineer should also determine if the piezometers were abandoned or replaced and if additional piezometers are required.
14. It was recommended by the District's engineer in the past that the service spillway pipe be inspected every 5 years, preferably with the water drained from the pipe. It is recommended that the District's current engineer develop a schedule for inspections in the future to determine if the surging that occurs in the pipe is causing any damage to the concrete and the joints in the pipe. A report should be developed as a result of each inspection. Some of the inspections should be undertaken with the water drained from the pipe.

CONCLUSIONS

1. There were no indications that the dam is a threat to fail or that there are conditions that create an emergency situation.
2. Based on walking the slope and viewing the holes and tunnels, the damage appears confined to the portion of the slope that was rehabilitated in 2010.
3. There was no evidence of piping through the dam. The seepage noted at both ends of the downstream slope has existed since before the 2010 rehabilitation project. There was no water noted in the holes and tunnels.
4. Continued delay of needed repairs will only result in additional damage.
5. The owner of this dam may be liable for downstream damages in the event of a spill or breach. It is the owner's responsibility to maintain the dam in a safe condition in order to prevent loss of life and limit the potential for property loss.
6. In addition, regular maintenance may reduce future rehabilitation and repair costs.
7. Due to the condition of the downstream slope, this structure will be scheduled for reinspection in 2 years, or in conjunction with any modifications.

Warren D. Samuelson
Warren D. Samuelson, P. E.
Manager, Dam Safety Section
Critical Infrastructure Division

Johnny Cosgrove, P. E.
Team Leader, Dam Safety Section
Critical Infrastructure Division

Google Maps

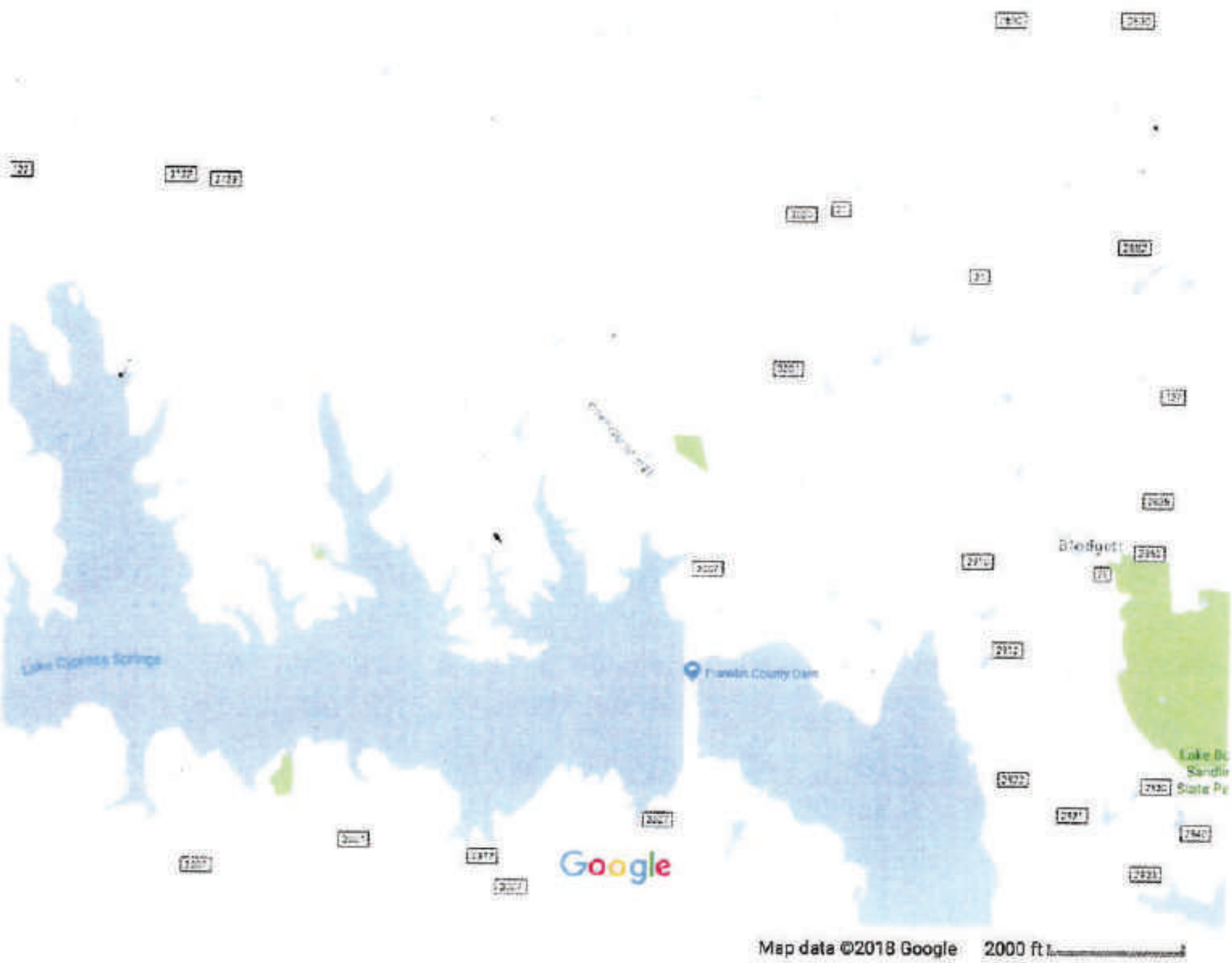


FIGURE 1
Location MAP


Emergency Spillway
400
350
350
400
450
0 225 450 900 1,350 1,800
Feet
N
Figure 2

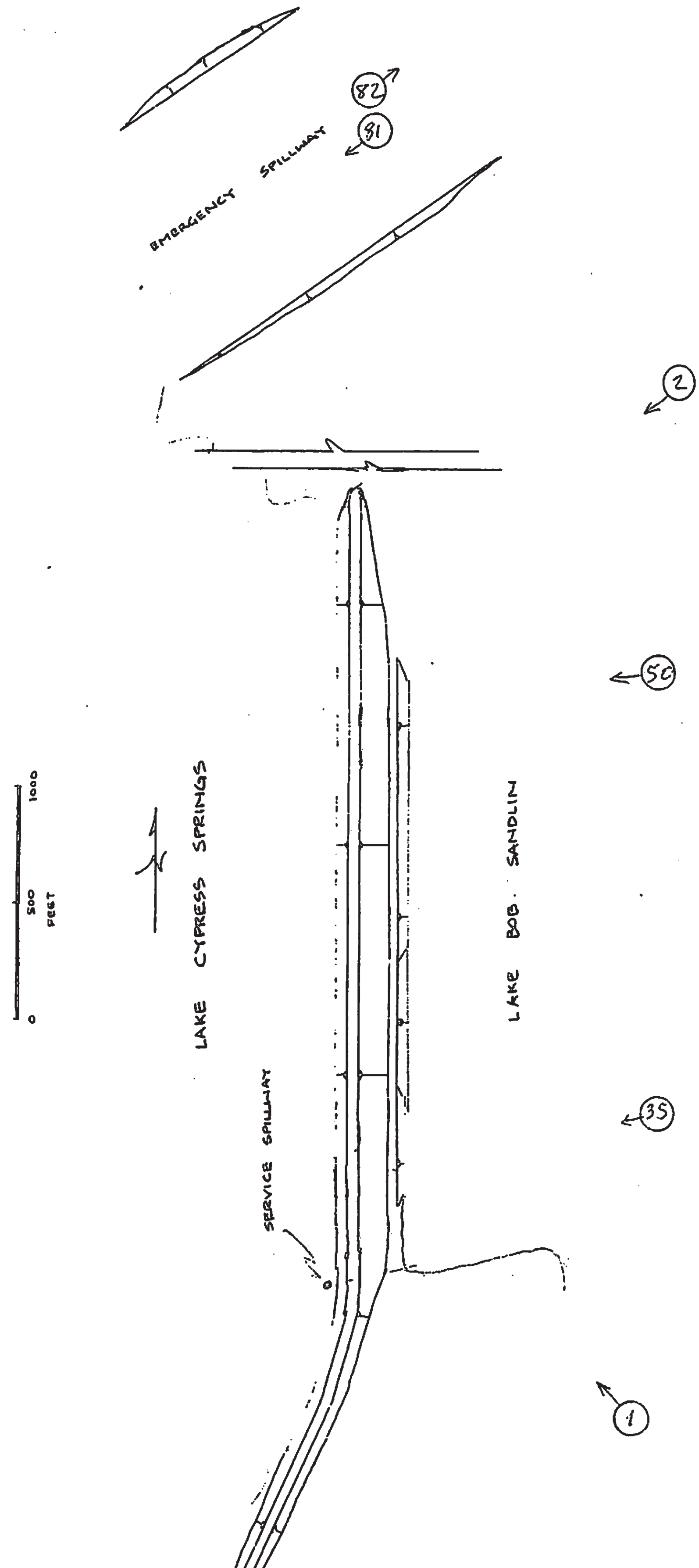

EMERGENCY SPILLWAY
82
81
2
5C
3S
1
LAKE CYPRESS SPRINGS
LAKE BOB SANDLIN
SERVICE SPILLWAY
0
500
1000
FEET

FIGURE 3

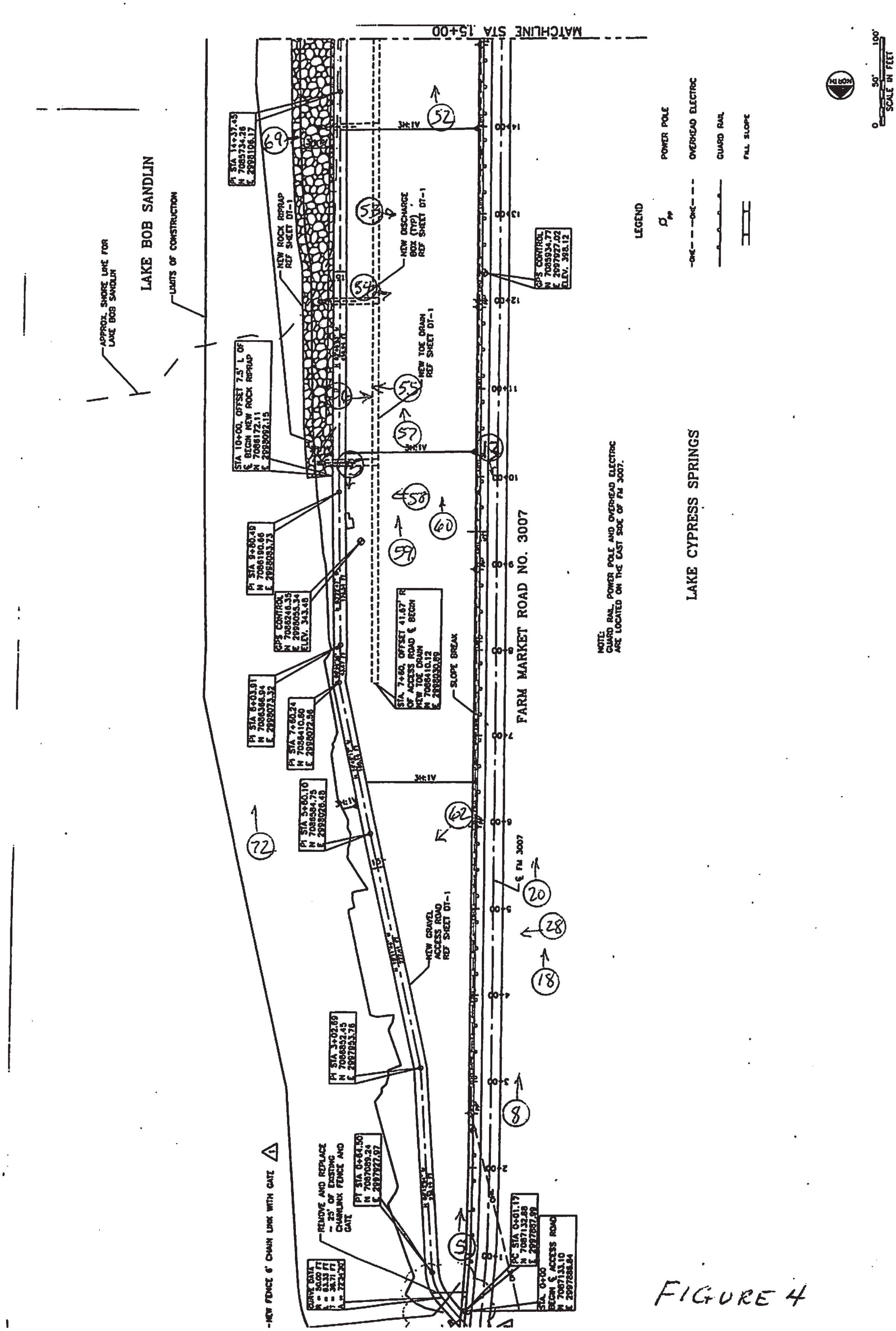
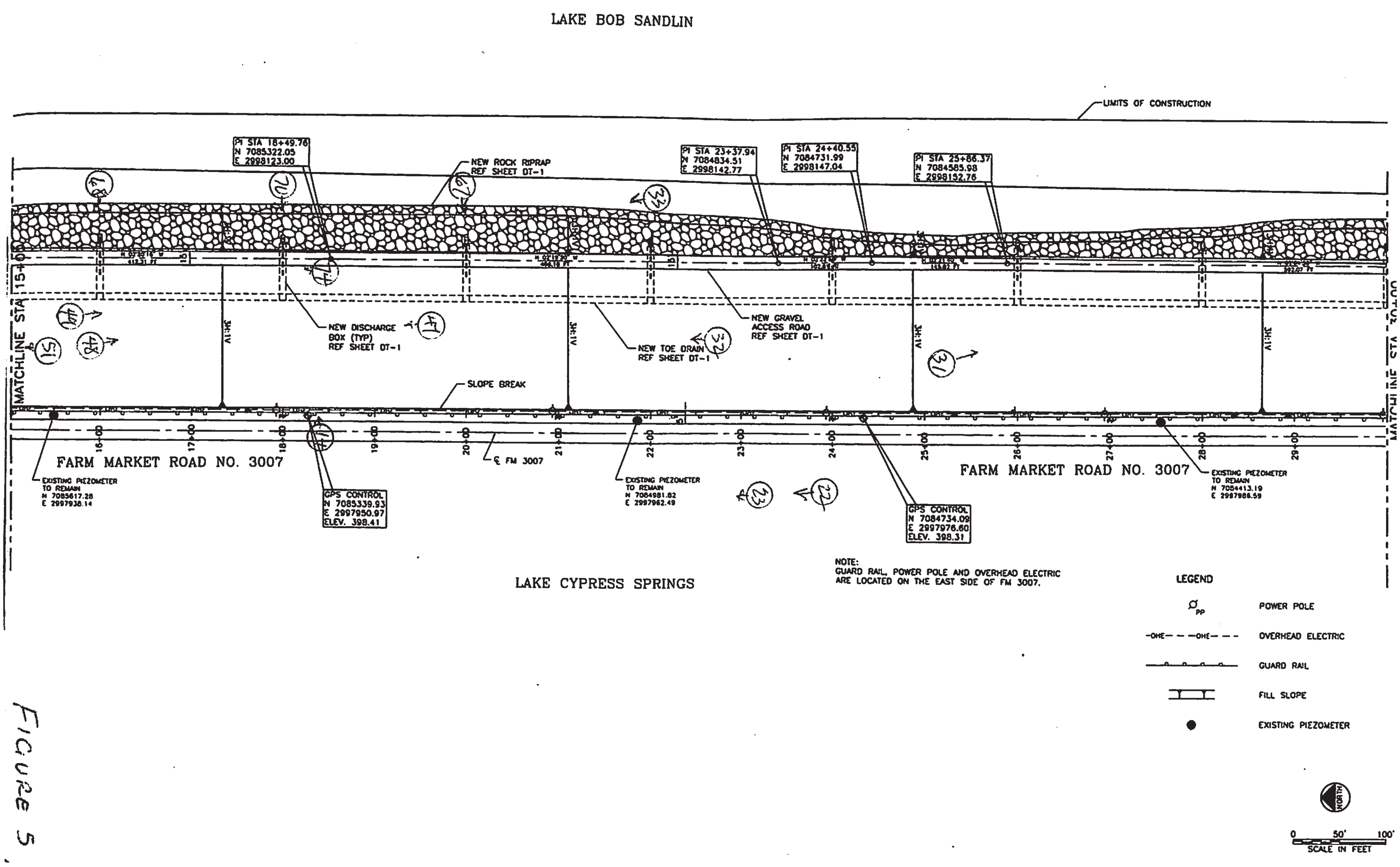

MATCHLINE STA 15+00
LAKE BOB SANDLIN
APPROX. SHORE LINE FOR LAKE BOB SANDLIN
LIMITS OF CONSTRUCTION
NEW ROCK RIPRAP REF SHEET DT-1
NEW DISCHARGE BOX (TYP) REF SHEET DT-1
NEW TOE DRAIN REF SHEET DT-1
SLOPE BREAK
NEW GRAVEL ACCESS ROAD REF SHEET DT-1
FARM MARKET ROAD NO. 3007
LAKE CYPRESS SPRINGS
NOTE: GUARD RAIL, POWER POLE AND OVERHEAD ELECTRIC ARE LOCATED ON THE EAST SIDE OF FM 3007.
LEGEND
POWER POLE
OVERHEAD ELECTRIC
GUARD RAIL
FILL SLOPE
SCALE IN FEET
NEW FENCE 6' CHAIN LINK WITH GATE
REMOVE AND REPLACE ~ 25' OF EXISTING CHAINLINK FENCE AND GATE
STA. 0+00 BEGIN ℄ ACCESS ROAD

FIGURE 4



LAKE BOB SANDLIN
LIMITS OF CONSTRUCTION
PI STA 18+49.76
N 7085322.05
E 2998123.00
NEW ROCK RIPRAP
REF SHEET DT-1
PI STA 23+37.94
N 7084834.51
E 2998142.77
PI STA 24+40.55
N 7084731.99
E 2998147.04
PI STA 25+86.37
N 7084585.98
E 2998152.76
MATCHLINE STA 15+00
NEW DISCHARGE
BOX (TYP)
REF SHEET DT-1
NEW TOE DRAIN
REF SHEET DT-1
NEW GRAVEL
ACCESS ROAD
REF SHEET DT-1
3H:1V
SLOPE BREAK
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
℄ FM 3007
FARM MARKET ROAD NO. 3007
EXISTING PIEZOMETER
TO REMAIN
N 7085617.28
E 2997938.14
GPS CONTROL
N 7085339.93
E 2997950.97
ELEV. 398.41
EXISTING PIEZOMETER
TO REMAIN
N 7084981.82
E 2997962.49
GPS CONTROL
N 7084734.09
E 2997976.60
ELEV. 398.31
EXISTING PIEZOMETER
TO REMAIN
N 7084413.19
E 2997986.59
48
70
67
33
74
49
48
51
47
32
31
17
23
22
LAKE CYPRESS SPRINGS
NOTE:
GUARD RAIL, POWER POLE AND OVERHEAD ELECTRIC
ARE LOCATED ON THE EAST SIDE OF FM 3007.
LEGEND
POWER POLE
OVERHEAD ELECTRIC
GUARD RAIL
FILL SLOPE
EXISTING PIEZOMETER
NORTH
0
50'
100'
SCALE IN FEET

FIGURE 5

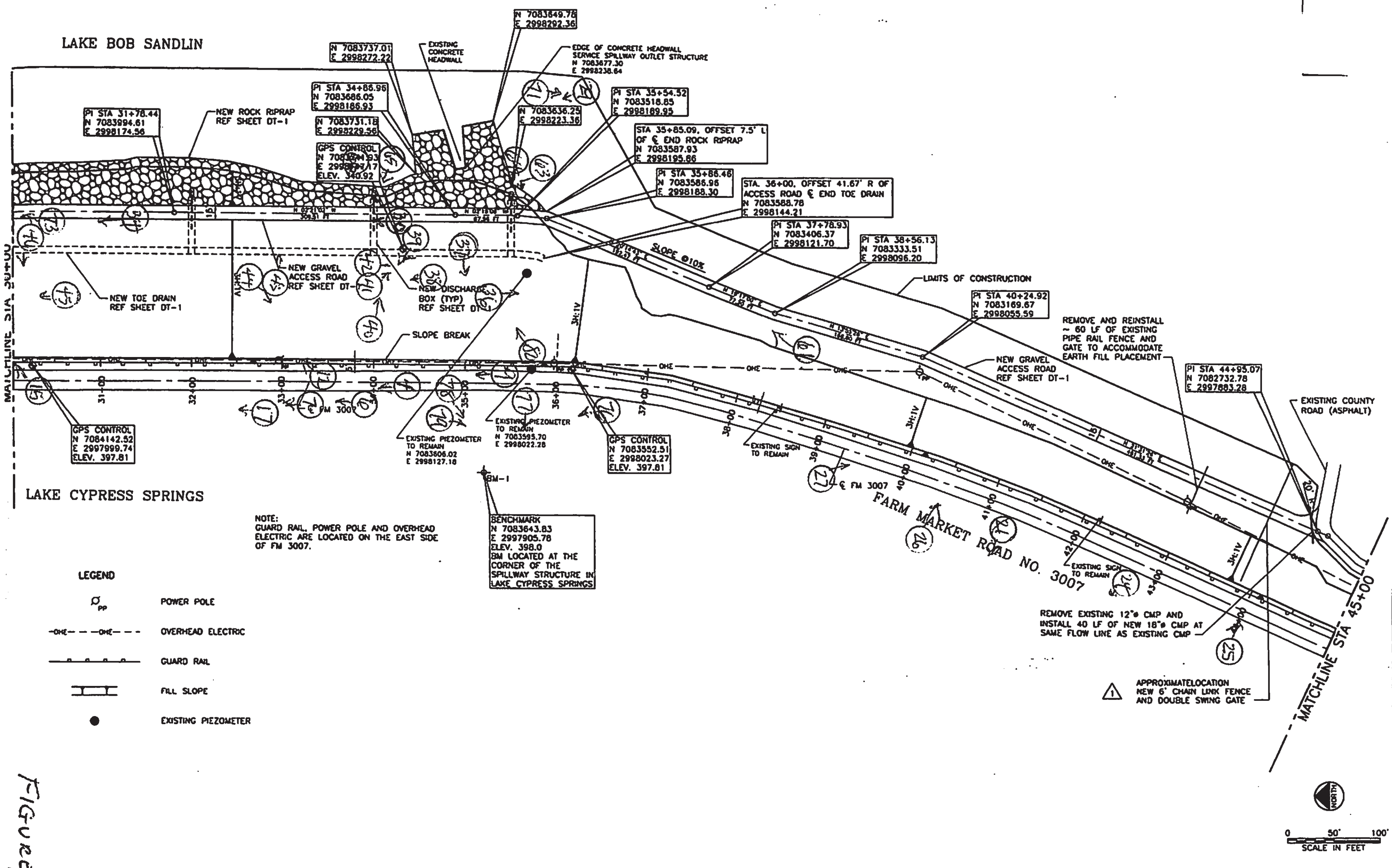

LAKE BOB SANDLIN
LAKE CYPRESS SPRINGS
MATCHLINE STA 30+00
MATCHLINE STA 45+00
PI STA 31+78.44
N 7083994.61
E 2998174.56
NEW ROCK RIPRAP
REF SHEET DT-1
N 7083737.01
E 2998272.22
PI STA 34+86.96
N 7083686.05
E 2998186.93
N 7083731.18
E 2998229.56
GPS CONTROL
ELEV. 340.92
EXISTING CONCRETE HEADWALL
N 7083649.78
E 2998292.36
EDGE OF CONCRETE HEADWALL SERVICE SPILLWAY OUTLET STRUCTURE
N 7083677.30
E 2998238.64
N 7083636.25
E 2998223.36
PI STA 35+54.52
N 7083518.85
E 2998189.95
STA 35+85.09, OFFSET 7.5' L OF ℄ END ROCK RIPRAP
N 7083587.93
E 2998195.86
PI STA 35+88.46
N 7083586.95
E 2998188.30
STA. 36+00, OFFSET 41.67' R OF ACCESS ROAD ℄ END TOE DRAIN
N 7083588.78
E 2998144.21
PI STA 37+78.93
N 7083406.37
E 2998121.70
PI STA 38+56.13
N 7083333.51
E 2998096.20
SLOPE @10%
LIMITS OF CONSTRUCTION
PI STA 40+24.92
N 7083169.67
E 2998055.59
REMOVE AND REINSTALL ~ 60 LF OF EXISTING PIPE RAIL FENCE AND GATE TO ACCOMMODATE EARTH FILL PLACEMENT
NEW GRAVEL ACCESS ROAD REF SHEET DT-1
PI STA 44+95.07
N 7082732.78
E 2997883.28
EXISTING COUNTY ROAD (ASPHALT)
NEW TOE DRAIN REF SHEET DT-1
NEW DISCHARGE BOX (TYP) REF SHEET DT-1
SLOPE BREAK
3H:1V
GPS CONTROL
N 7084142.52
E 2997999.74
ELEV. 397.81
EXISTING PIEZOMETER TO REMAIN
N 7083606.02
E 2998127.18
EXISTING PIEZOMETER TO REMAIN
N 7083595.70
E 2998022.28
GPS CONTROL
N 7083552.51
E 2998023.27
ELEV. 397.81
BM-1
BENCHMARK
N 7083643.83
E 2997905.78
ELEV. 398.0
BM LOCATED AT THE CORNER OF THE SPILLWAY STRUCTURE IN LAKE CYPRESS SPRINGS
EXISTING SIGN TO REMAIN
℄ FM 3007
FARM MARKET ROAD NO. 3007
REMOVE EXISTING 12"ø CMP AND INSTALL 40 LF OF NEW 18"ø CMP AT SAME FLOW LINE AS EXISTING CMP
APPROXIMATELOCATION NEW 6' CHAIN LINK FENCE AND DOUBLE SWING GATE
NOTE:
GUARD RAIL, POWER POLE AND OVERHEAD ELECTRIC ARE LOCATED ON THE EAST SIDE OF FM 3007.
LEGEND
POWER POLE
OVERHEAD ELECTRIC
GUARD RAIL
FILL SLOPE
EXISTING PIEZOMETER
NORTH
0 50' 100'
SCALE IN FEET

FIGURE 6

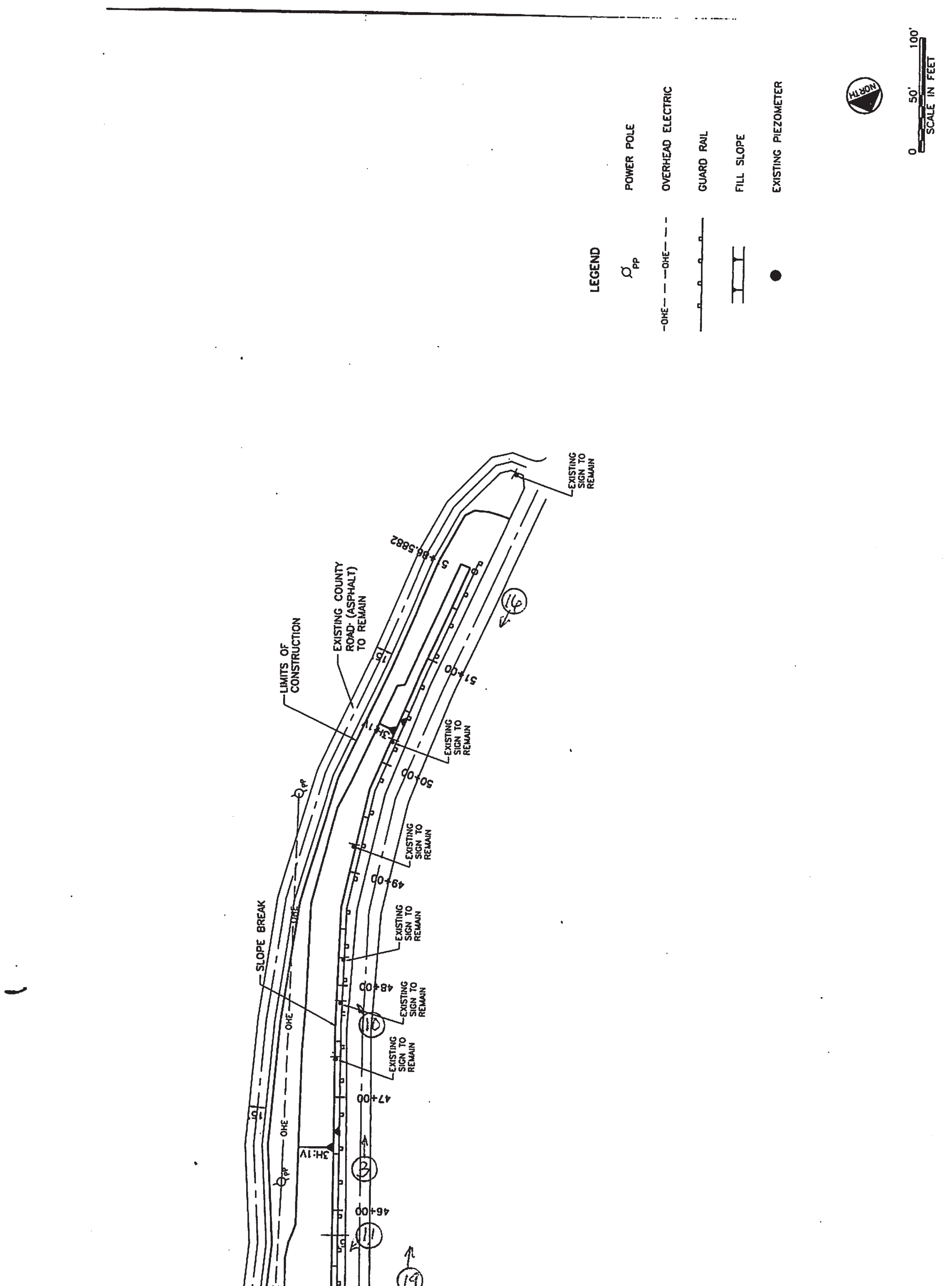

LEGEND
PP
POWER POLE
OHE
OVERHEAD ELECTRIC
GUARD RAIL
FILL SLOPE
EXISTING PIEZOMETER
NORTH
0
50'
100'
SCALE IN FEET
LIMITS OF CONSTRUCTION
EXISTING COUNTY ROAD (ASPHALT) TO REMAIN
SLOPE BREAK
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
EXISTING SIGN TO REMAIN
3H:1V
3H:1V
15
15
46+00
47+00
48+00
49+00
50+00
51+00
51+86.5882
19
11
3
10
16

FIGURE 7

Photo No. 1. An aerial view (dated July 27, 2017) of the dam's downstream slope as seen from the right end of the dam.

Photo No. 2. An aerial view (dated July 27, 2017) of the dam's downstream slope as seen from the left end of the dam.

Photo No. 3. The crest of the dam, FM 3007, was in good condition. This view is looking toward the right end of the dam.

Photo No. 4. The crest near the center of the dam looking toward the left end of the dam.

Photo No. 5. The crest and downstream slope at the left end of the dam.

Photo No. 6. The upstream guardrail. Note the grass cover on the crest. The area near the guardrail is well maintained. Also note the straightness of the guardrail.

Photo No. 7. Another view of the upstream guardrail. Note the lack of cover on the upstream slope above the riprap.

Photo No. 8. Another view of the guardrail, crest and upstream slope near the left end of the dam.

Photo No. 9. The guardrail on the downstream side of the crest. Note the leaning utility poles. The area around the guardrail was well maintained.

Photo No. 10. This is one of a number of ant mounds near the downstream guardrail.

Photo No. 11. An example of an animal burrow at the edge of the crest with the downstream slope.

Photo No. 12. This animal burrow was next to a utility pole. There were others near guardrail posts.

Photo No. 13. Piezometer P-1 was located at Station 10+00 between the road and the downstream guardrail.

Photo No. 14. Piezometer P-3 was located on the crest at Station 18+50.

Photo No. 15. Piezometer P-5 was located on the crest at Station 30+00.

Photo No. 16. The upstream slope at the right end of the dam. The area above the riprap had no cover and was eroded in a number of places.

Photo No. 17. The upstream slope to the left of the service spillway. Note the mix of old and new riprap.

Photo No. 18. The upstream slope at the left end of the dam. Again, the slope is exposed with little to no cover.

Photo No. 19. This is located to the right of the service spillway. This is the old riprap. Note the vegetation in the rock.

Photo No. 20. The riprap near the left end of the dam. This is primarily new riprap. Note the vegetation in the rock.

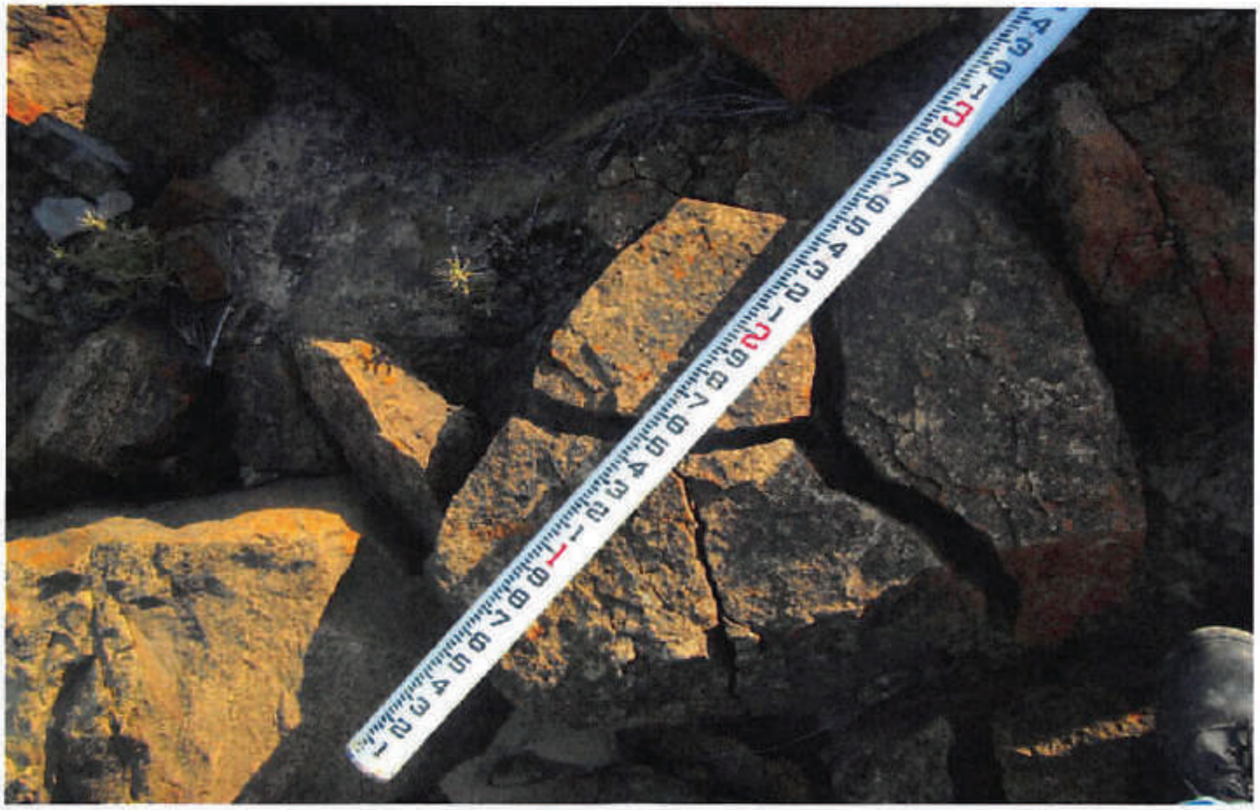


Photo No. 21. Some of the old riprap was deteriorating and cracking.

Photo No. 22. Note the indention at the water line (arrow).

Photo No. 23. A close-up of the indention shown in Photo No. 22.

Photo No. 24. This area of old riprap near the right end of the dam lacked large rock.

Photo No. 25. This erosion was located above the riprap to the right of the service spillway. It is about 5 feet across and 2 feet deep.

Photo No. 26. A larger area of erosion on the upstream slope to the right of the service spillway.

Photo No. 27. This erosion is affecting a guardrail post.

Photo No. 28. This erosion was located near the left end of the dam. The indicated area is 3 feet across and about 1.5 feet deep.

Photo No. 29. The downstream slope as seen from the right abutment. The arrow marks the approximate location of the service spillway outlet, which is submerged by Lake Bob Sandlin.

Photo No. 30. A view of the road along the downstream toe of the dam. Note the deposited soil that is from the eroded holes on the slope.

Photo No. 31. The downstream slope as seen looking toward the right end of the dam. The taller weeds are in areas with holes.

Photo No. 32. The left half of the downstream slope.

Photo No. 33. Rock riprap along the lower slope. Lake Bob Sandlin is located to the right of the photo.

Photo No. 34. The road on the downstream slope. Note the soil on the road coming from the holes on the slope. The arrow indicates Piezometer P-6.

Photo No. 35. An aerial photograph (dated July 27, 2017) of the right downstream slope. Note the numerous holes and collapsed tunnels on the slope.

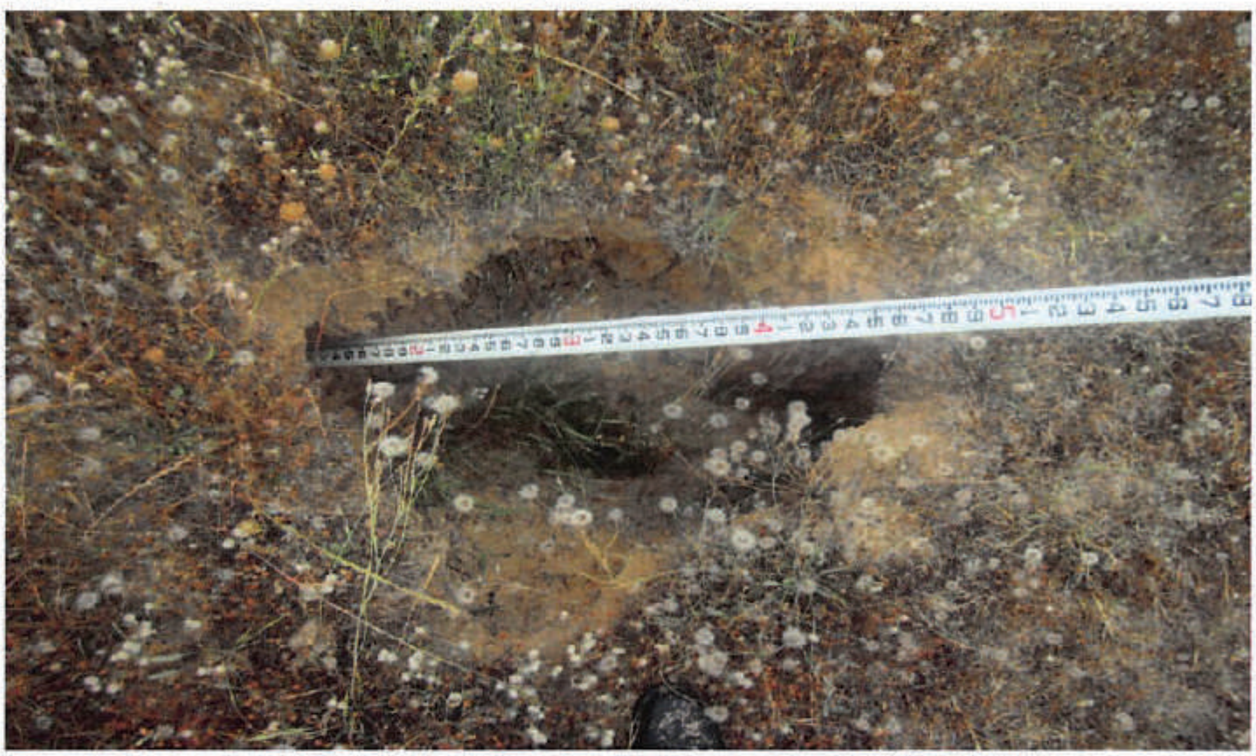


Photo No. 36. A hole formed as a result of dispersive soil. Note the tunnels at each end of the hole. This was located to the right of the service spillway on the downstream slope.

Photo No. 37. This is a series of holes where the tunnel between holes had collapsed. The arrow marks a wooden stake used to mark holes. This is around Station 35+00.

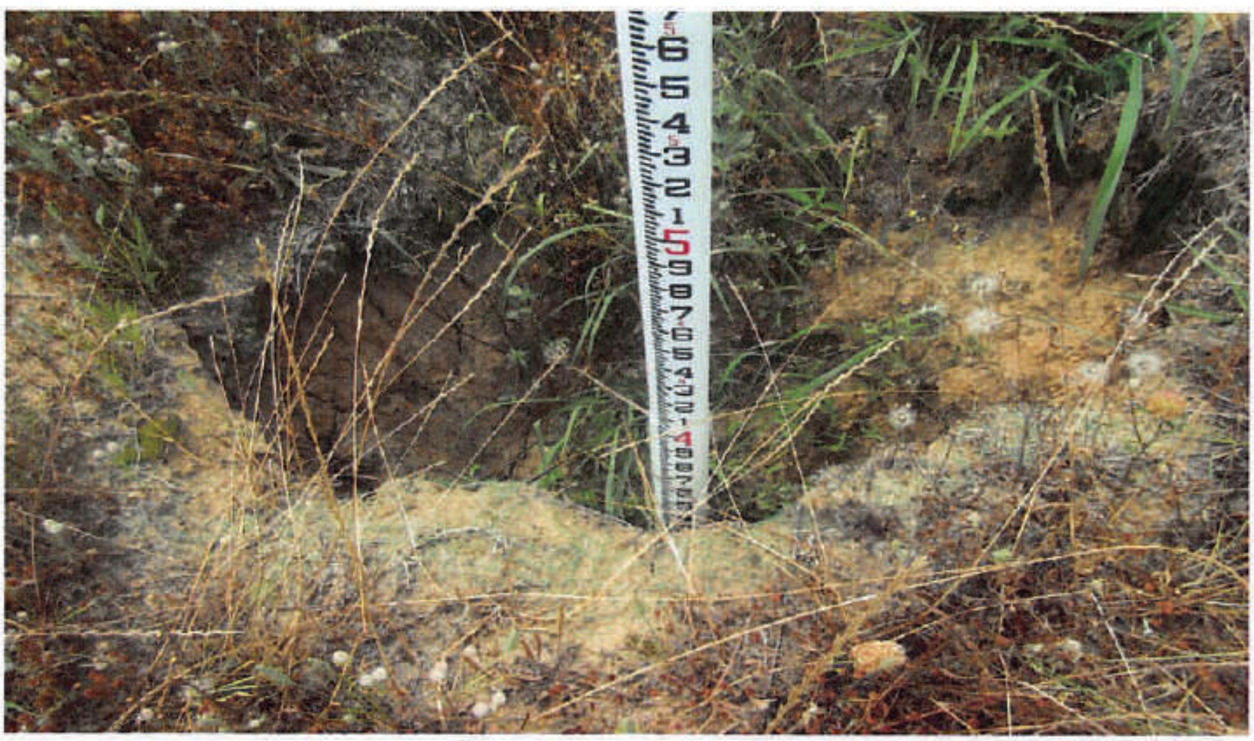


Photo No. 38. This hole measured 3.5 feet deep. Note the geotextile on the slope.

Photo No. 39. Another series of collapsed holes and tunnels. Note the several wooden stakes indicating additional holes.

Photo No. 40. The hole in the foreground connects with the hole beside the inspector down the slope. Note the amount of soil on the road. This is around Station 34+00.

Photo No. 41. This is the hole referenced in Photo No. 40.

Photo No. 42. The tunnel is measured to be 5 feet deep downstream. This is the same location as Photos 40 and 41, around Station 34+00.

Photo No. 43. This hole extends at least 5.5 feet down slope. Note the soil on the slope at the road and the soil on the road.

Photo No. 44. This is looking upslope from Photo No. 43. The tunnel had collapsed.

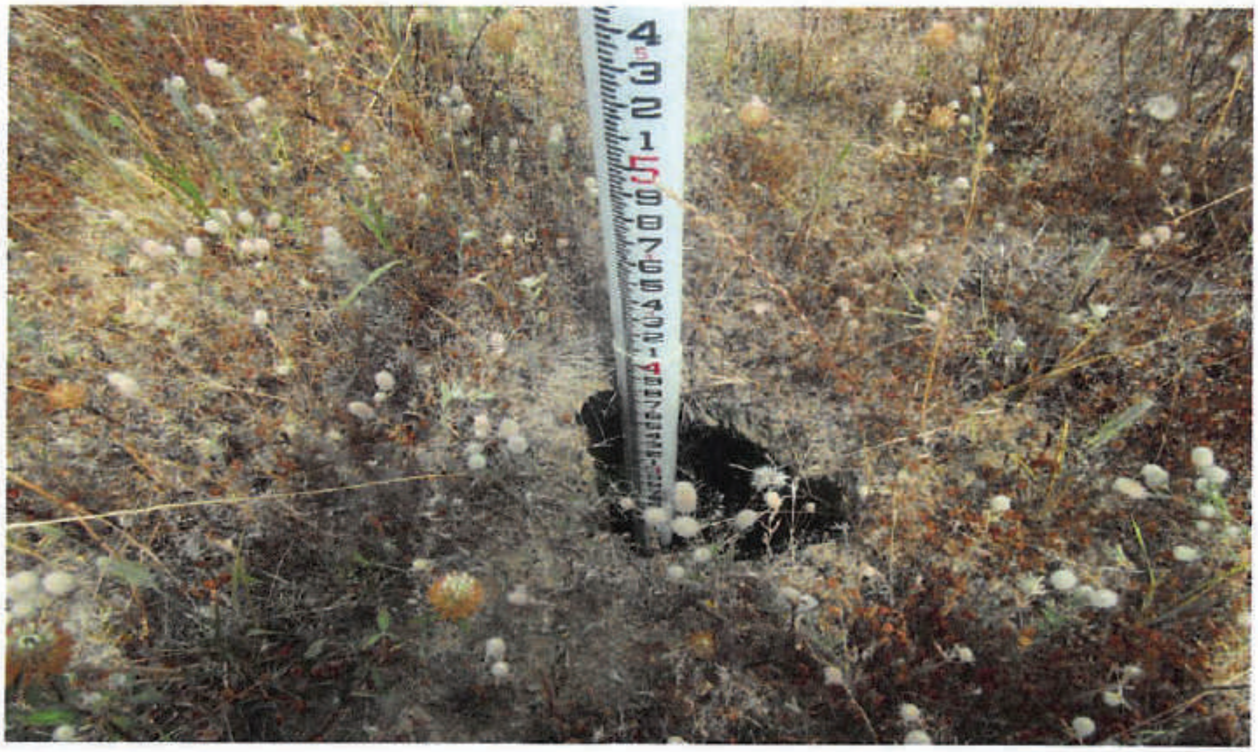


Photo No. 45. This appeared to be a newer hole near Station 30+00.

Photo No. 46. Another collapsed tunnel and holes near Station 30+00.

Photo No. 47. This appeared to be a recently collapsed hole.

Photo No. 48. This large hole was located near Station 16+00.

Photo No. 49. This hole is 6 feet deep near Station 16+00.

Photo No. 50. An aerial photograph (dated July 27, 2017) of the left downstream slope. Note the numerous holes on the slope.

Photo No. 51. Two different sets of holes to the left of Station 16+00.

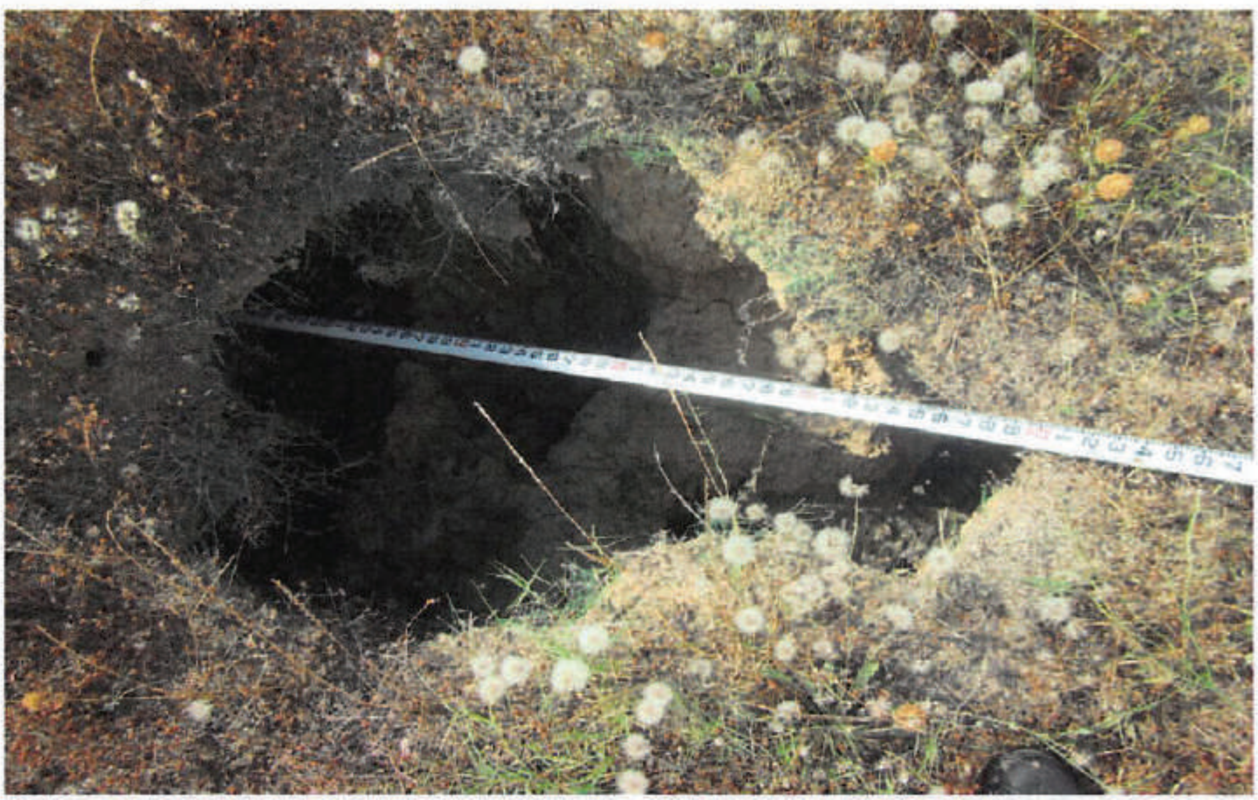


Photo No. 52. The survey rod is extended 8 feet into a tunnel.

Photo No. 53. Multiple holes between Stations 12+00 and 14+00. The hole is 4 feet deep.

Photo No. 54. Another series of holes and tunnels near Station 12+00.

Photo No. 55. Light was observed in this tunnel (arrow). Note that the integrity of the soil has been compromised.

Photo No. 56. The inspector is standing in the hole for Photo No. 55. The inspector is over 6 feet tall. Note the line of wooden stakes. This is around Station 11+00.

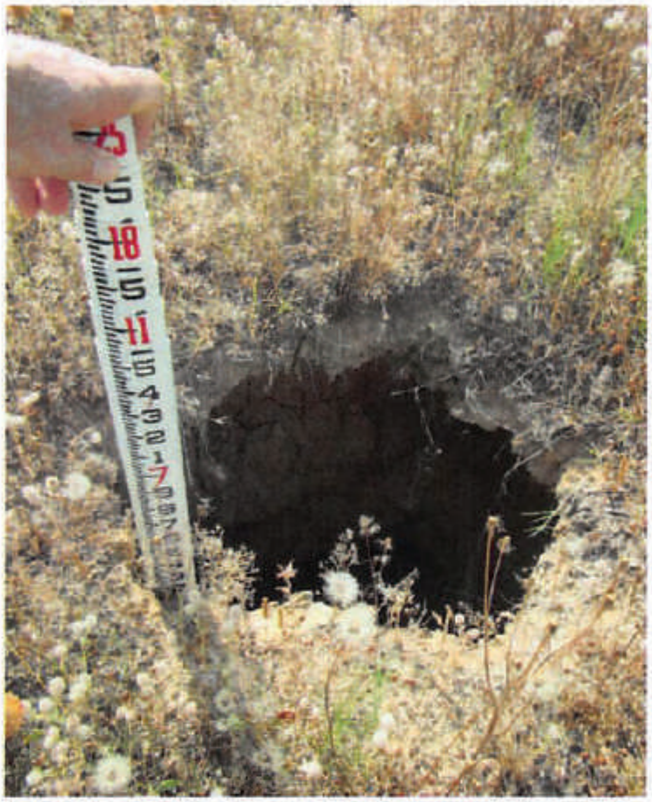


Photo No. 57. This hole is over 6 feet deep.

Photo No. 58. This collapsed hole is above Piezometer P-1. It is 3 feet deep.

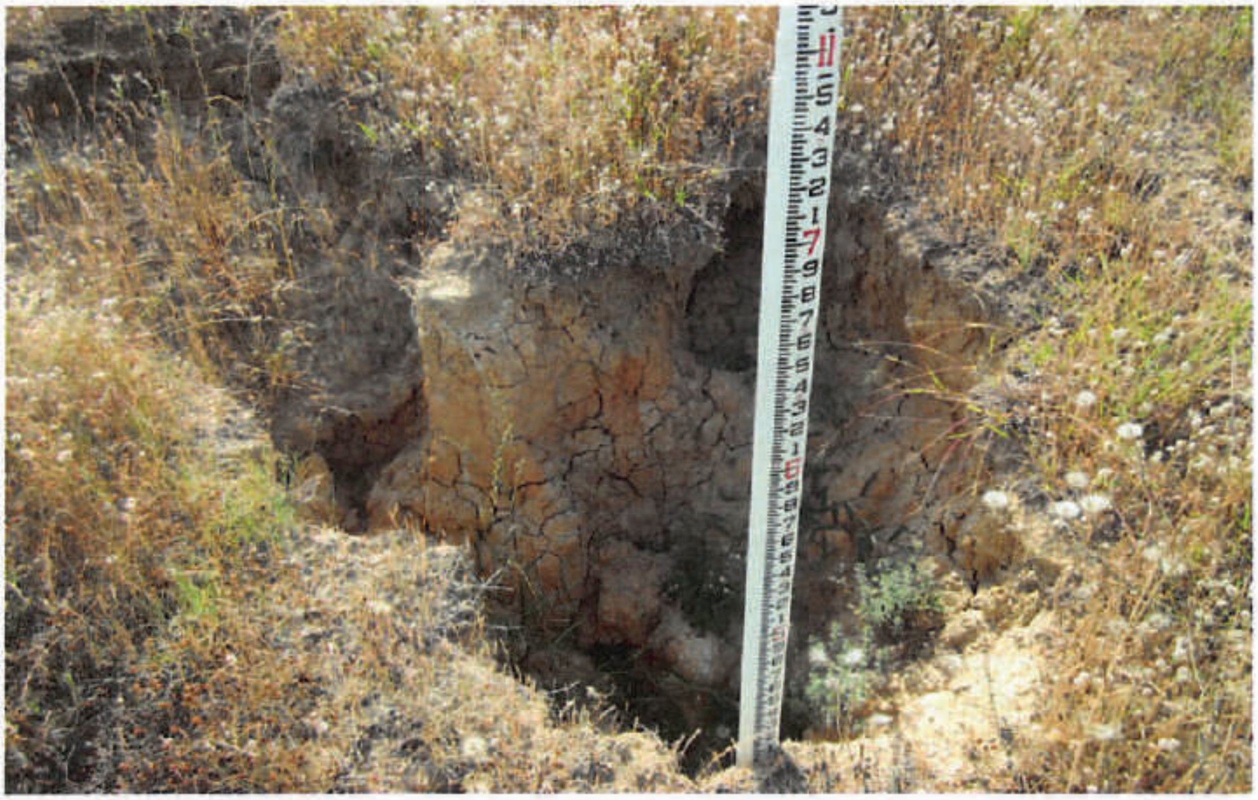


Photo No. 59. This hole was located left of Station 10+00. It is over 4 feet deep.

Photo No. 60. This crack was observed on the downstream slope towards the left end of the dam.

Photo No. 61. This erosion was located on the right groin.

Photo No. 62. Note the erosion on the road at the left groin of the dam.

Photo No. 63. The toe drain at Station 35+50.

Photo No. 64. The drain in Photo No. 63 was dry.

Photo No. 65. This toe drain was located at Station 34+00. Note the small amount of flow.

Photo No. 66. This is the flow when the flap was raised for the drain in Photo No 65. There was a build-up of water in the drain.

Photo No. 67. The drain at Station 20+00. This drain was dry.

Photo No. 68. This drain at Station 16+00 before it was opened. Note the wet condition and the vegetation. There was flow when the flap was raised, but not as much as at Station 18+00.

Photo No. 69. The drain at Station 14+00 was dry when the flap was raised.

Photo No. 70. The drain at Station 18+00 after a period of time after the first opening. Note the stain in the pipe from standing water.

Photo No. 71. This seepage area was located in the hillside right of the service spillway. This area has been noted in the past.

Photo No. 72. This seepage was located along the left downstream toe.

Photo No. 73. Piezometer P-6 was located at Station 30+00.

Photo No. 74. Piezometer P-4 is located at Station 18+50.

Photo No. 75. Piezometer P-1 is located at Station 10+00.

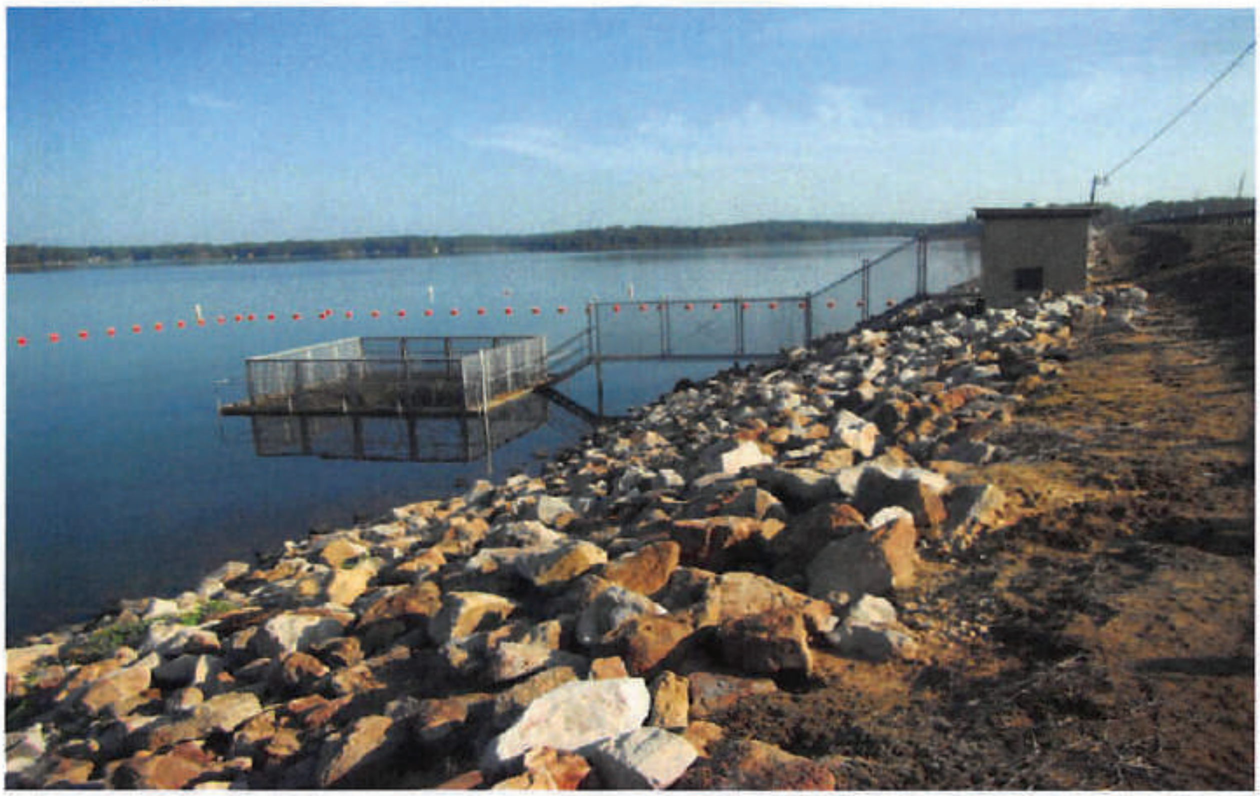


Photo No. 76. The service spillway morning glory.

Photo No. 77. Another view of the inlet. The arrow indicates the valve controls housing. The building holds lake level instrumentation.

Photo No. 78. A closer view of the service spillway inlet. Water was barely flowing over the crest.

Photo No. 79. A close-up of the valve controls housing.

Photo No. 80. Lake Bob Sandlin is located downstream. The outlet for the service spillway exits in the center of the photo.

Photo No. 81. The entrance to the emergency spillway. It is well maintained.

Photo No. 82. The emergency spillway discharge channel.

Appendix D

TCEQ MEETING PRESENTATION

Franklin County Dam Restoration

Meeting with Texas Commission on Environmental Quality

Dam Safety Report Comments and Responses

WATER
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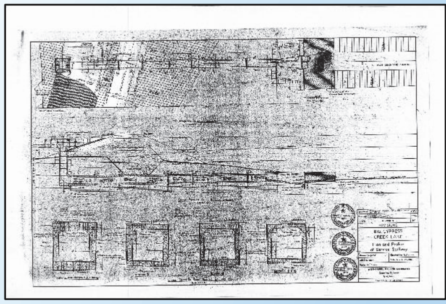
March 5, 2019

A Brief Timeline

Dam Construction



1966-1970

Dam Issues with Slope

2007

Dam Revitalization

2009-2010

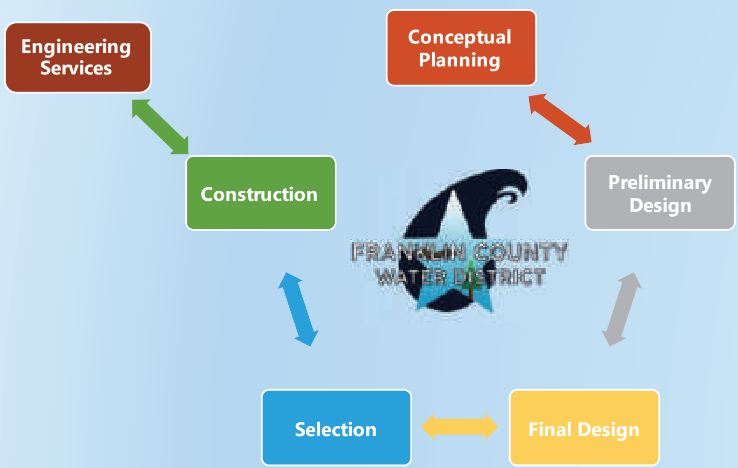
Dam Issues w/ Dispersive Soils

2012

Lawsuit

2013-2017

Today's Embarkment



Preliminary Timeline

		Franklin County Water District (FCWD) Dam Revitalization Schedule	2019 April	2019 Aug.	2019 Dec.	2020 April	2020 Aug.	2020 Dec.	2021 April	2021 Aug.	2021 Dec.
A		**Pre-Engineering Tasks**									
	1	Carollo Team Site Visit									
	2	Carollo Team Qualifications Presentation									
	3	Carollo Team Proposal Presentation									
	2.2	Statistical Analysis and Results									
B		**Preliminary Engineering Report (PER)**	4 Mo.								
	1	Choice of Alternatives									
	2	Comparision of Alternatives									
	2.1	Capital Costs									
	2.2	Continue Maintenance									
	2.3	Timeline for Revitalization									
	2.4	Impacts to Future Risk									
	2.5	Environmental Requirements									
	3	Project Recommendations									
C		**FCWD Evaluation and Alternative Selection**									
	1	Alternative Selection									
D		**Permitting**		9 Months							
E		**Design**		6 Months							
	1	Phased Design Submittal									
	1.1	30% Design Drawings									
	1.2	90% Design Drawings									
	2	Final Design									
F		**Construction**				10 Months					
	1	Project Bidding and Mobilization									
	2	Construction									
G		**Close-Out and As-Built Drawings**							2 Mo.		
H		**Continued Maintanance and Future Monitoring**							Perpetuity		

Our Project Team

Client

FRANKLIN COUNTY WATER DISTRICT

Prime Consultant

carollo

Engineers...Working Wonders With Water®

Sub Consultant

Schnabel ENGINEERING

Sub Consultant

Arroyo Environmental Consultants, LLC

TCEQ Dam Safety Meeting

- TEXAS COMMISSION ON ENVIRONMENTAL QUALITY Issued a letter August 8, 2018 to FCWD indicating 14 Requirements/Recommendations
- The project team has the following responses and a proposed action for a solution for each item

Requirement and / or Recommendation No. 1

It is recommended that the District take immediate steps to retain an engineer, possibly someone not involved in the litigation, to develop a permanent repair plan for the entire downstream slope. The plan needs to take into consideration: the length of time that the slope has been exposed with no repairs or surface treatment undertaken; the increasing size and depth of the holes and tunnels; the formation of new holes; the observation of cracks on the slope, which could lead to new holes; the presence of dispersive soils, as evidenced by tests taken by various engineers and the appearance of the slope; and the loss of soil integrity evident on the sides of the hole. LiDAR data has been developed by the District, which should be incorporated into the development of the plan. The plans and specifications and geotechnical report should then be submitted to this agency for review at various percentages of completion and eventually approval.

Requirement and / or Recommendation No. 1 Response

Carollo Engineers, Inc. has been engaged to develop plans to address issues associated with dispersive soils in the downstream slope.

Requirement and / or Recommendation No. 2

The toe drain outlets need to be monitored and the flap valves opened and cleaned on a quarterly schedule. A log of observations (including drain flow rates and lake levels) and photographs should be kept. The results should be evaluated by the District's engineer with the piezometer readings. The District may desire to consider a lighter flap valve, which may prevent water ponding in the pipe

Response:

Carollo has been engaged to evaluate the drain flows and piezometer readings, based on readings performed by the owner.

Requirement and / or Recommendation No. 3

It is recommended that the erosion on the upstream slope be repaired before the damage becomes worse. The erosion is affecting the guardrail posts in several places. A grass cover needs to be established once the repairs are completed.

Response:

Carollo has been engaged to develop plans to address erosion on the upstream slope and establish permanent grass cover.

Requirement and / or Recommendation No. 4

The erosion along the downstream berm and at the downstream groins also needs to be repaired.

Response:

Carollo has been engaged to develop plans to address erosion on the downstream berm and groins.

Requirement and / or Recommendation No. 5

The leaning utility poles on the crest of the dam should be monitored to determine if there is any additional movement of the dam. There does not appear to be any movement at this time. However, if movement does occur, the District's engineer should be contacted to determine the source of the movement and to recommend a method for correction.

Response:

The District will review the dam maintenance manual and incorporate a visual pole inspection into the observation requirements.

Requirement and / or Recommendation No. 6

The vegetation in the upstream slope riprap should be sprayed or removed on a regular schedule.

Response:

The District has already incorporated vegetative control measures for the upstream slope riprap. The District will rectify this issue and continue with the vegetative control schedule.

Requirement and / or Recommendation No. 7

The older riprap on the right end of the upstream slope was cracked and deteriorated. The rock needs to be evaluated by the District's engineer to determin if rock needs to be added or replaced. In addition, the pockets lacking riprap need to have new rock placed.

Response:

Carollo has been engaged to evaluate the condition of the rock on the upstream slope and develop plans to place additional riprap, as necessary.

Requirement and / or Recommendation No. 8

The indention along the upstream slope water line and the slope above this area should be monitored. If movement occurs, the District's engineer should be contacted to determine the source of the movement and to recommend a method of correction.

Response:

The District will review the dam maintenance manual and incorporate a visual indentation inspection along the upstream slope into the observation requirements.

Requirement and / or Recommendation No. 9

The animal burrows and ant mounds on the crest need to be addressed as part of the regular maintenance program.

Response:

The District has already incorporated pest control measures to control animal burrows and ant mounts. This task has grown in difficulty as erosion jug-holes in the dam continue to grow in size. The District will rectify this issue and continue with pest control measures, as necessary.

Requirement and / or Recommendation No. 10

The seepage areas at both ends of the downstream slope should be regularly monitored. Any changes in flow or evidence of soil movement should be documented and the District's engineer should be contacted.

Response:

These areas will be mentioned in the upcoming maintenance plan with courses of action provided by the District's Engineer during the design phase of the FCWD Dam Restoration Project.

Requirement and / or Recommendation No. 11

As required in the rules, an EAP table top exercise needs to be undertaken as soon as possible. The Dam Safety Program should be informed of the exercise.

Response:

An EAP table top exercise will be completed by the District as soon as possible, and the Dam Safety Program will be informed of the exercise.

Requirement and / or Recommendation No. 12

A hydraulic adequacy study needs to be performed due to the emergency spillway being higher than designed and the crest of the dam possibly being lower than designed. In 2018, Carollo Engineers, Inc. did not address the percent passage of the PMF.

Requirement and / or Recommendation No. 12

Response:

The modeling results provided by Carollo Engineers, Inc., in 2018 provided for a 2D hydraulic analysis to determine if the emergency spillway would perform differently in its existing condition than designed. Carollo was not hired to perform a PMF hydrologic analysis. As such, the 2D modeling results were not derived by a hydrologic boundary condition, but instead by applying a time vs. WSE boundary condition, with a maximum WSE of 393 msl (2-feet below the dam crest). The analysis proved to the District that the discrepancies in the emergency spillway elevation when compared to the design were inconsequential to the hydraulic performance of the emergency spillway, particularly in higher-flow events. The PMF analysis referenced by the TCEQ was completed during the dam breech modeling and does not contradict the results provided in Carollo's report.

Requirement and / or Recommendation No. 13

The piezometric data should be evaluated by the District's engineer as there appear to be some inconsistencies. It is recommended that the quarterly readings be continued until the District's engineer provides a basis for changing the reading frequency. The TCEQ Dam Safety Program has no documentation that the piezometers that were existing as the time of the 2010 rehabilitation project were abandoned and possibly replaced. The District's engineer should also determine in the piezometers were abandoned or replaced and if additional piezometers are required.

Requirement and / or Recommendation No. 13

Response:

The piezometric readings will be evaluated by the District engineer. In the upcoming FCWD Dam Restoration project, the piezometers will be inventoried and a portion of the report will document best management practices and future recommendations for monitoring. This report will also evaluate the existing data and evaluate the need for new/additional/or rehabilitated piezometers.

Requirement and / or Recommendation No. 14

It was recommended by the District's engineer in the past that the service spillway pipe be inspected every 5 years, preferably with the water drained from the pipe. It is recommended in the future to determine if the surging that occurs in the pipe is causing any damage to the concrete and the joints in the pipe. A report should be developed as a result of each inspection. Some of the inspections should be undertaken with the water drained from the pipe.

Requirement and / or Recommendation No. 14

Response:

The District's morning-glory spillway culvert cannot be isolated. The construction of a coffer dam in Lake Bob Sandlin for the purpose of a drained inspection is a costly endeavor and can be dangerous. Lake Bob Sandlin is a water supply reservoir managed by the Titus County Fresh Water Supply District No. 1 (TCFWSD) and is not able to be lowered for the purpose of the pipe's inspection. The District will investigate and recommend alternative inspection methods, including diving and wet-multisensor inspections, during the future FCWD Dam Restoration Project.

Thanks for your time

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OUR PASSION

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Appendix E

CAROLLO COMMENT RESPONSE 1 TCEQ

TCEQ COMMENTS AND RESPONSES

Project Name:	Franklin County Dam Restoration Project	**Date:**	March 11, 2019
Client:	Franklin County Water District	**Project Number:**	10070B.00
Prepared By:	Phil Bullock, P.E., & Paul Dossett, P.E., Carollo Engineers, Inc., & James R. Crowder, P.E. Schnabel Engineering, LLC		
Reviewed By:	David Harkins, P.E., Carollo Engineers, Inc., Joseph Monroe, P.E., Schnabel Engineering, LLC		
Subject:	**Comment Response to TCEQ Dam Safety Report comments dated 8/8/2018**		

1.0 INTENT

The intent of this document is to respond to the comments provided to Franklin County Water District with regard to the Franklin County Dam Inventory No. TX03288 Dam Safety Inspection and Report. The following requirements and/or recommendations are based on the inspection and the TCEQ's responsibilities under the Texas Water Code.

2.0 GENERAL COMMENTS

#	Comments	Response
	Requirements/Recommendations	
1	It is recommended that the District take immediate steps to retain an engineer, possibly someone not involved in the litigation, to develop a permanent repair plan for the entire downstream slope. The plan needs to take into consideration: the length of time that the slope has been exposed with no repairs or surface treatment undertaken; the increasing size and depth of the holes and tunnels; the formation of new holes; the observation of cracks on the slope, which could lead to new holes; the presence of dispersive soils, as evidenced by tests taken by various engineers and the appearance of the slope; and the loss of soil integrity evident on the sides of the hole. LiDAR data has been developed by the District, which should be incorporated into the development of the plan. The plans and specifications and geotechnical report should then be submitted to this agency for review at various percentages of completion and eventually approval.	Carollo Engineers, Inc. has been engaged to develop plans to address issues associated with dispersive soils for the entire downstream slope.

RESPONSE TO COMMENTS

#	Comments	Response
	Requirements/Recommendations	
2	The toe drain outlets need to be monitored and the flap valves opened and cleaned on a quarterly schedule. A log of observations (including drain flow rates and lake levels) and photographs should be kept. The results should be evaluated by the District's engineer with the piezometer readings. The District may desire to consider a lighter flap valve, which may prevent water ponding in the pipe	Carollo has being engaged to evaluate the drain flows and piezometer readings, based on monthly readings performed by the owner.
3	It is recommended that the erosion on the upstream slope be repaired before the damage becomes worse. The erosion is affecting the guardrail posts in several places. A grass cover needs to be established once the repairs are completed.	Carollo has been engaged to develop plans to address erosion on the upstream slope and establish permanent grass cover.
4	The erosion along the downstream berm and at the downstream groins also needs to be repaired.	Carollo has been engaged to develop plans to address erosion on the downstream berm and groins.
5	The leaning utility poles on the crest of the dam should be monitored to determine if there is any additional movement of the dam. There does not appear to be any movement at this time. However, if movement does occur, the District's engineer should be contacted to determine the source of the movement and to recommend a method for correction.	The District will review the dam maintenance manual and incorporate a visual pole inspection into the observation requirements.
6	The vegetation in the upstream slope riprap should be sprayed or removed on a regular schedule.	The District has already incorporated vegetative control measures for the upstream slope riprap. The District will rectify this issue and continue with the vegetative control schedule.
7	The older riprap on the right end of the upstream slope was cracked and deteriorated. The rock needs to be evaluated by the District's engineer to determine if rock needs to be added or replaced. In addition, the pockets lacking riprap need to have new rock placed.	Carollo has been engaged to evaluate the condition of the rock on the upstream slope and develop plans to place additional riprap, as necessary.
8	The indention along the upstream slope water line and the slope above this area should be monitored. If movement occurs, the District's engineer should be contacted to determine the source of the movement and to recommend a method of correction.	The District will review the dam maintenance manual and incorporate a visual indentation inspection along the upstream slope into the observation requirements.

RESPONSE TO COMMENTS

#	Comments	Response
	Requirements/Recommendations	
9	The animal burrows and ant mounds on the crest need to be addressed as part of the regular maintenance program.	The District has already incorporated pest control measures to control animal burrows and ant mounts. This task has grown in difficulty as erosion jug-holes in the dam continue to grow in size. The District will rectify this issue and continue with pest control measures, as necessary.
10	The seepage areas at both ends of the downstream slope should be regularly monitored. Any changes in flow or evidence of soil movement should be documented and the District's engineer should be contacted.	These areas will be mentioned in the upcoming maintenance plan with courses of action provided by the District's Engineer during the design phase of the FCWD Dam Restoration Project.
11	As required in the rules, an EAP table top exercise needs to be undertaken as soon as possible. The Dam Safety Program should be informed of the exercise.	An EAP table top exercise will be completed by the District as soon as possible, and the Dam Safety Program will be informed of the exercise.
12	A hydraulic adequacy study needs to be performed due to the emergency spillway being higher than designed and the crest of the dam possibly being lower than designed. In 2018, Carollo Engineers, Inc. did not address the percent passage of the PMF.	At this time, with indicated extension approval from TCEQ, FCWD intends to focus on the priority of rehabilitating the dam. For the time being, FCWD will continue to maintain the existing emergency spillway as recommended in the FNI Manual by Janis Murphy titled "Franklin County Dam Operation and Maintenance Manual" dated July 2011. This item will be addressed with TCEQ at a later date.
13	The piezometric data should be evaluated by the District's engineer as there appear to be some inconsistencies. It is recommended that the quarterly readings be continued until the District's engineer provides a basis for changing the reading frequency. The TCEQ Dam Safety Program has no documentation that the piezometers that were existing as the time of the 2010 rehabilitation project were abandoned and possibly replaced. The District's engineer should also determine in the piezometers were abandoned or replaced and if additional piezometers are required.	The piezometric readings will be evaluated by the District engineer to determine if there is a correlation between flow increases. In the upcoming FCWD Dam Restoration project, the piezometers will be inventoried and a portion of the report will document best management practices and future recommendations for monitoring. This report will also evaluate the existing data and evaluate the need for new/additional/or rehabilitated piezometers.
14	It was recommended by the District's engineer in the past that the service spillway pipe be inspected every 5 years, preferably with the water drained from the pipe. It is recommended in the future to determine if the surging that	The District's morning-glory spillway culvert cannot be isolated. The construction of a coffer dam in Lake Bob Sandlin for the purpose of a drained inspection is a costly endeavor and can be dangerous. Lake Bob Sandlin is a

#	Comments	Response
	Requirements/Recommendations	
	occurs in the pipe is causing any damage to the concrete and the joints in the pipe. A report should be developed as a result of each inspection. Some of the inspections should be undertaken with the water drained from the pipe.	water supply reservoir managed by the Titus County Fresh Water Supply District No. 1 (TCFWSD) and is not able to be lowered for the purpose of the pipe's inspection. The District will investigate and recommend alternative inspection methods, including diving and wet-multisensor inspections, during the future FCWD Dam Restoration Project.

Appendix F

CAROLLO COMMENT RESPONSE 2 TCEQ

TCEQ COMMENTS AND RESPONSES

Project Name:	Franklin County Dam Restoration Project	**Date:**	October 2, 2019
Client:	Franklin County Water District	**Project Number:**	10070B.00
Prepared By:	Phil Bullock, P.E., & Erika Cooper, P.E., Carollo Engineers, Inc.		
Reviewed By:	David Harkins, P.E., Carollo Engineers, Inc.		
Subject:	**PER Comment Response to TCEQ Dam Safety Report comments dated 8/8/2018**		

1.0 INTENT

The intent of this document is to provide a second planning-level response to the comments developed by the Texas Commission on Environmental Quality (TCEQ) to the Franklin County Water District (FCWD) regarding the Franklin County Dam Inventory No. TX03288 Dam Safety Inspection and Report.

The following comments have been prepared to accompany the Franklin County Dam Restoration Project - Preliminary Engineering Report (PER) prepared by Schnabel Engineering, LLC (Schnabel) as a subconsultant to Carollo Engineers, Inc., Inc. (Carollo) These comments are provided to represent the continued commitment of the District to developing a permanent repair plan for the Dam's downstream slope. The following requirements and/or recommendations are based on the inspection and the TCEQ's responsibilities under the Texas Water Code.

2.0 GENERAL COMMENTS

#	Comments	Response
	Requirements/Recommendations	
1	It is recommended that the District take immediate steps to retain an engineer, possibly someone not involved in the litigation, to develop a permanent repair plan for the entire downstream slope. The plan needs to take into consideration: the length of time that the slope has been exposed with no repairs or surface treatment undertaken; the increasing size and depth of the holes and tunnels; the formation of new holes; the observation of cracks on the slope, which could lead to new holes; the presence of dispersive soils, as evidenced by tests taken by various engineers and the appearance of the slope; and the loss of soil integrity evident on	Carollo has been engaged to develop plans to address issues associated with dispersive soils for the entire downstream slope, and has engaged Schnabel as a subconsultant for their dam inspection, design, and construction expertise. Schnabel has prepared a PER with two viable conceptual alternatives to address the downstream slope issues. Either alternative, after detailed design, would improve surficial deficiencies and improve maintenance of the currently affected areas. This PER represents the commitment of the District to develop a permanent repair plan for the entire downstream slope. With respect to

#	Comments	Response
	Requirements/Recommendations	
	the sides of the hole. LiDAR data has been developed by the District, which should be incorporated into the development of the plan. The plans and specifications and geotechnical report should then be submitted to this agency for review at various percentages of completion and eventually approval.	the LiDAR data, Schnabel recommends traditional topographic survey of the dam and appurtenant areas. This survey will be completed during the design of the selected dam remediation alternative.
2	The toe drain outlets need to be monitored and the flap valves opened and cleaned on a quarterly schedule. A log of observations (including drain flow rates and lake levels) and photographs should be kept. The results should be evaluated by the District's engineer with the piezometer readings. The District may desire to consider a lighter flap valve, which may prevent water ponding in the pipe	This PER addresses drain flows and piezometer readings, based on monthly readings performed by the owner. Refer to Section 2 of the PER.
3	It is recommended that the erosion on the upstream slope be repaired before the damage becomes worse. The erosion is affecting the guardrail posts in several places. A grass cover needs to be established once the repairs are completed.	Schnabel recommends placement of compacted earthfill with suitable topsoil and the establishment of vegetation with permanent turf. Placement of sod will be considered as an alternative to using seed to expedite establishment of vegetation. Portions of the existing guardrail may need to be removed and reinstalled to facilitate these efforts. Some grading may be necessary to provide a uniform grade more conducive for turf grass establishment and growth. Revegetated areas will be irrigated as necessary until vegetation is established and the potential for weather conditions to negatively affect the vegetation have diminished.
4	The erosion along the downstream berm and at the downstream groins also needs to be repaired.	Recommended improvements to the downstream slope of the dam described in Section 3 of the PER will address erosion along the downstream berm. To address the erosion along the downstream contact points, or groins, Schnabel recommends excavating the erosion gullies adjacent to the access road to

RESPONSE TO COMMENTS

#	Comments	Response
	Requirements/Recommendations	
		form a trapezoidal channel. This channel should be lined with an appropriate geotextile fabric, bedding stone, and riprap sized according the anticipated surface water flows and velocities based on channel geometry.
5	The leaning utility poles on the crest of the dam should be monitored to determine if there is any additional movement of the dam. There does not appear to be any movement at this time. However, if movement does occur, the District's engineer should be contacted to determine the source of the movement and to recommend a method for correction.	FCWD will review the dam maintenance manual and incorporate a visual pole inspection into the observation requirements.
6	The vegetation in the upstream slope riprap should be sprayed or removed on a regular schedule.	FCWD has already incorporated vegetative control measures for the upstream slope riprap. FCWD will rectify this issue and continue with the vegetative control schedule.
7	The older riprap on the right end of the upstream slope was cracked and deteriorated. The rock needs to be evaluated by the District's engineer to determine if rock needs to be added or replaced. In addition, the pockets lacking riprap need to have new rock placed.	Schnabel recommends refreshing rock riprap in this area in accordance with accepted engineering standards. This will be performed in conjunction with remedial activities associated with the downstream slope.
8	The indention along the upstream slope water line and the slope above this area should be monitored. If movement occurs, the District's engineer should be contacted to determine the source of the movement and to recommend a method of correction.	FCWD will review the dam maintenance manual and incorporate a visual indentation inspection along the upstream slope into the observation requirements.
9	The animal burrows and ant mounds on the crest need to be addressed as part of the regular maintenance program.	FCWD has already incorporated pest control measures to control animal burrows and ant mounts. This task has grown in difficulty as erosion jug-holes in the dam continue to grow in size. FCWD will rectify this issue and continue with pest control measures, as necessary.
10	The seepage areas at both ends of the downstream slope should be regularly monitored. Any changes in flow or evidence of soil movement should be documented and the District's engineer should be contacted.	These areas will be mentioned in the upcoming maintenance plan with courses of action provided by FCWD's Engineer during the design phase of the FCWD Dam Restoration Project.

#	Comments	Response
	Requirements/Recommendations	
11	As required in the rules, an EAP table top exercise needs to be undertaken as soon as possible. The Dam Safety Program should be informed of the exercise.	An EAP table top exercise will be completed by FCWD as soon as possible, and the Dam Safety Program will be informed of the exercise.
12	A hydraulic adequacy study needs to be performed due to the emergency spillway being higher than designed and the crest of the dam possibly being lower than designed. In 2018, Carollo Engineers, Inc. did not address the percent passage of the PMF.	At this time, with indicated extension approval from TCEQ, FCWD intends to focus on the priority of rehabilitating the dam. For the time being, FCWD will continue to maintain the existing emergency spillway as recommended in the FNI Manual by Janis Murphy titled “Franklin County Dam Operation and Maintenance Manual” dated July 2011. This item will be addressed with TCEQ at a later date.
13	The piezometric data should be evaluated by the District's engineer as there appear to be some inconsistencies. It is recommended that the quarterly readings be continued until the District's engineer provides a basis for changing the reading frequency. The TCEQ Dam Safety Program has no documentation that the piezometers that were existing as the time of the 2010 rehabilitation project were abandoned and possibly replaced. The District's engineer should also determine if the piezometers were abandoned or replaced and if additional piezometers are required.	FCWD has continued with quarterly piezometer readings. Schnabel completed a review of piezometric readings from 2012 through 2019. Schnabel recommends installation of additional piezometers to document the phreatic surface within the embankment as part of the remedial activities associated with the downstream slope. Additional review of piezometer data will be performed during design of the remedial activities and recommendations for best management practices and monitoring frequency will be provided.
14	It was recommended by the District's engineer in the past that the service spillway pipe be inspected every 5 years, preferably with the water drained from the pipe. It is recommended in the future to determine if the surging that occurs in the pipe is causing any damage to the concrete and the joints in the pipe. A report should be developed as a result of each inspection. Some of the inspections should be undertaken with the water drained from the pipe.	FCWD’s morning-glory spillway culvert cannot be isolated. The construction of a coffer dam in Lake Bob Sandlin for the purpose of a drained inspection is a costly endeavor and can be dangerous. Lake Bob Sandlin is a water supply reservoir managed by the Titus County Fresh Water Supply District No. 1 (TCFWSD) and is not able to be lowered for the purpose of the pipe’s inspection. FCWD will investigate and recommend alternative inspection methods, including diving and wet-multisensor inspections, during the future FCWD Dam Restoration Design Project.